“Research evaluation: comparing methodologies and indicators”

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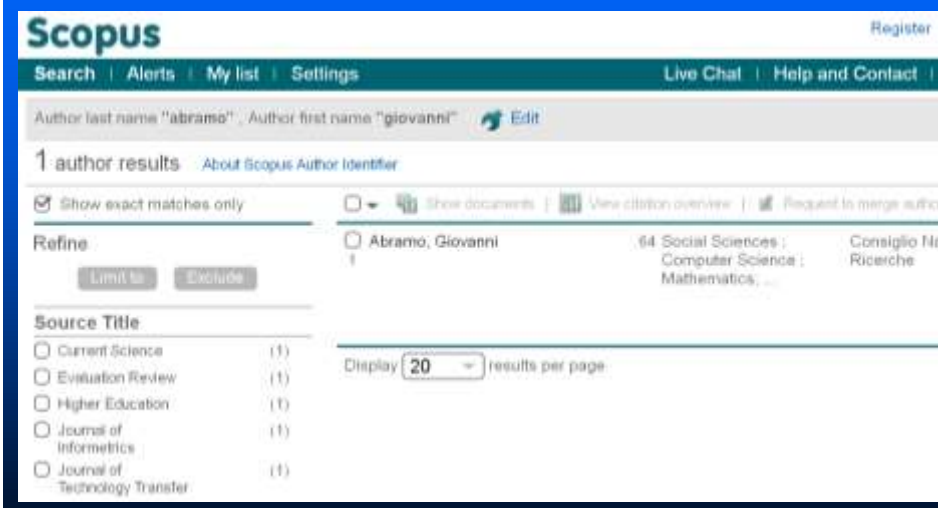
I introduce myself



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I introduce myself

1	A heuristic approach to author name disambiguation in bibliometrics databases for large-scale research assessments View at Publisher	D'Angelo, C.A., Giuffrida, C., Abramo, G.	2011	Journal of the American Society for Information Science and Technology	45
2	Allocative efficiency in public research funding: Can bibliometrics help? View at Publisher	Abramo, G., D'Angelo, C.A., Caprasecca, A.	2009	Research Policy	40
3	The measurement of Italian universities' research productivity by a non parametric-bibliometric methodology View at Publisher	Abramo, G., D'Angelo, C.A., Puglini, F.	2008	Scientometrics	40
4	Research collaboration and productivity: Is there correlation? View at Publisher	Abramo, G., D'Angelo, C.A., Di Costa, F.	2009	Higher Education	38
5	Assessment of sectoral aggregation distortion in research productivity measurements View at Publisher	Abramo, G., D'Angelo, C.A., Di Costa, F.	2008	Research Evaluation	33
6	University-industry collaboration in Italy: A bibliometric examination View at Publisher	Abramo, G., D'Angelo, C.A., Di Costa, F., Solazzi, M.	2009	Technovation	31

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Articulation

- ✓ Introduction
- ✓ The most popular indicators, methodologies and rankings
- ✓ The DSS-ORP

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Research assessment problems

- ✓ Proliferation of performance indicators
- ✓ Doubtful assessment methods
- ✓ Abundance of not science-based rankings
- ✓ Media fanfare for (wrong!) world institutions rankings
- ✓ Do-it-myself practices
- ✓ Poor strategic and policy perspectives

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Research evaluation goals

- ✓ Stimulating higher research productivity
- ✓ Allocating resources according to performance
- ✓ Informing research policy (strategy)
- ✓ Reducing information asymmetry between supply and demand
- ✓ Demonstrating that investment in research is effective and delivers public benefits

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The Shanghai Ranking

ARWU
by Shanghai Jiao Tong University

http://www.shanghairanking.com/ARWU2013.html

Pisa, Sapienza: 101-150

Milan, Padua: 151-200

Academic Ranking of World Universities 2013

World Rank	Institution	Country /Region	National Rank	Total Score
1	Harvard University		1	100
2	Stanford University		2	72.6
3	University of California, Berkeley		3	71.3
4	Massachusetts Institute of Technology (MIT)		4	71.1
5	University of Cambridge		1	69.6
6	California Institute of Technology		5	62.9
7	Princeton University		6	61.9
8	Columbia University		7	59.8
9	University of Chicago		8	57.1
10	University of Oxford		2	55.9
11	Yale University		9	55.4
12	University of California, Los Angeles		10	52.9
13	Cornell University		11	50
14	University of California, San Diego		12	49.9
15	University of Pennsylvania		13	49.8

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ARWU
(Shanghai Jiao Tong University)

Metodology: total score

Criteria	Indicator	Weight
Quality of Education	Alumni of an institution winning Nobel Prizes and Fields Medals	10%
Quality of Faculty	Staff of an institution winning Nobel Prizes and Fields Medals	20%
	Highly cited researchers in 21 broad subject categories	20%
Research Output	Papers published in Nature and Science	20%
	Papers indexed in SCI-E and SSCI (Web of Science)	20%
Per Capita Performance	Per capita academic performance of an institution	10%

90% of the score is size dependent!

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Research-based (?!) Leiden rankings

http://www.leidenranking.com/ranking.aspx

Mean citation score (MCS). The average number of citations of the publications of a university.

Mean normalized citation score (MNCS). The average number of citations of the publications of a university, normalized for field differences, publication year, and document type. An MNCS value of two for instance means that the publications of a university have been cited twice above world average.

Proportion top 10% publications ($PP_{top\ 10\%}$). The proportion of the publications of a university that, compared with other similar publications, belong to the top 10% most frequently cited. Publications are considered similar if they were published in the same field and the same year and if they have the same document type.

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Research-based (?!) 2013 CWTS ranking

Rank	University	Country	P	MNCS
1	Politecnico Milano		2637	0.96
2	Univ Milan		3909	0.94
3	Univ Trieste		1766	0.93
4	Univ Torino		4041	0.93
5	Univ Parma		1887	0.93
6	Univ Milan Bicocca		1629	0.91
7	Univ Bologna		3953	0.91
8	Univ Padova		3714	0.91
9	Univ Ferrara		1402	0.90
10	Univ Florence		4127	0.90
11	Politecnico Torino		2241	0.88
12	Univ Perugia		1879	0.88
13	Univ Pavia		2175	0.87
14	Univ Modena & Reggio Emilia		1763	0.84
15	Univ Pisa		3852	0.84
16	Sapienza Univ Roma		4767	0.82
17	Univ Roma Tor Vergata		2702	0.81
18	Univ Napoli Federico II		4276	0.78
19	Univ Cattolica Sacro Cuore		2264	0.78
20	Univ Genoa		2021	0.78
21	Univ Bari Aldo Moro		2257	0.77
22	Univ Siena		1879	0.77
23	Univ Palermo		2462	0.75
24	Univ Catania		2111	0.73

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Validity of the most popular indicators

- ✓ The CWTS new crown indicator (MNCS): The average number of citations of the publications of a university …

Univ. A = (10) => MNCS = 10

Univ. B = (10, 10, 10, …,9) => MNCS < 10

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Validity of the most popular indicators

- ✓ The h-index: the maximum number *h* of works by a scientist that have at least *h* citations each

John Doe I = (4,4,4,4)

John Doe II = (400,400,400,400, 3,3, …,3)

John Doe I	John Doe II
h = 4	h = 4

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Official national research assessment exercises

- ✓ UK: RAE series (peer-review) up to 2010; REF, 2014 (informed peer-review)
- ✓ Italy: VTR, 2006 (peer-review); VQR, 2011 (hybrid)
- ✓ Australia: ERA, 2010 (bibliometrics)
- ✓ …

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The Italian university system

- ✓ 96 universities
- ✓ 67 public (94.9% of total research staff)
- ✓ 6 schools for advanced studies (0.5%)
- ✓ 1.8% foreign staff
- ✓ 16.8% unproductive staff (hard sciences)
- ✓ 7.8% uncited
- ✓ Govt funding = 56% of total income

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The Italian VQR 2004-2010

- ➢ Public universities;
- ➢ legally-recognized privati universities;
- ➢ research institutions under the responsibility of the MIUR;
- ➢ 3 (6) products per professor (researcher);
- ✓ 50% of score based on the quality of the research products submitted and 50% derived from a composite of six other indicators;

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VQR: quality of products

- A = Excellent (score 1), if the product places in the top 20% on "a scale of values shared by the international community";
- B = Good (score 0.8), if the product places in the 60%-80% range;
- C = Acceptable (score 0.5), if the product is in the 50%-60% range;
- D = Limited (score 0), if the product is in the bottom 50%.
- -0.5 for each missing product

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The Italian VQR 2004-2010

Classification matrix for products in Chemistry

$I_R \rightarrow$ / $I_C \downarrow$	1	2	3	4
1	A	A	A	IR
2	B	B	B	IR
3	IR	C	C	C
4	IR	D	D	D

IR = "evaluated by Informed Peer Review"

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VQR: main limits

- ✓ *Robustness:* How sensitive are rankings to the share of the output evaluated?
- ✓ *Reliability:* Do universities submit their best outputs?
- ✓ *Accuracy:* How accurate is the quality evaluation of products and institutions?
- ✓ *Functionality:* How useful are national rankings for universities, students, companies, …?
- ✓ *Costs and time of execution:* Spending review

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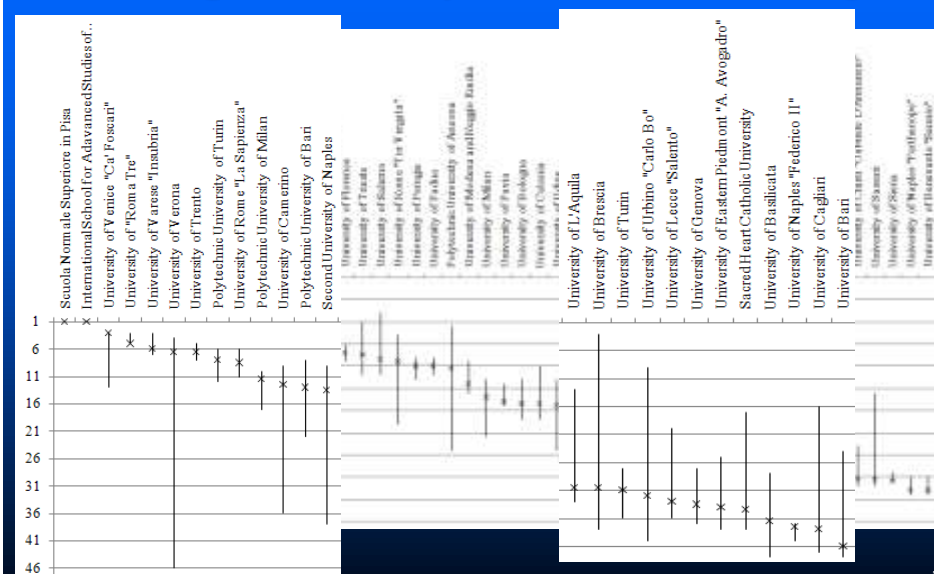
Rankings sensitivity to the share of output



Median and range of variation (max – min) of rankings in Physics, when varying output share 8 times

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Reliability: how effective is selection of outputs by universities?

Universities' do-it-oneself selection worsened the maximum score achievable in the hard sciences by 23% to 32%, compared to the score from an efficient selection.

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Accuracy: VQR main problems

- The use of the journal impact factor;
- the failure to consider products' quality values as a continuous range;
- the full counting of the submitted publications regardless of the number of co-authors and their position in the byline;
- aggregation of SDSs (medicine);
- academic rank not accounted for;
- scores referred to world benchmark.

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- ✓ *Costs and time of execution:* Spending review

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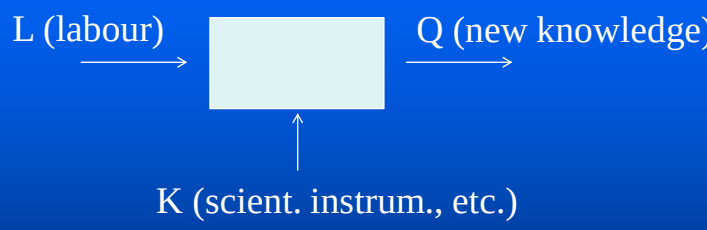
Back to the fundamentals of microeconomics



Theory:

$$Q = F(K, L)$$

$$AP_{L,\bar{K}} = \frac{Q}{L}$$

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The ORP-based evaluation system

- ✓ Assigns publications to each author:
  - ➢ Affiliation unification
  - ➢ Authors' name disambiguation
- ✓ Classifies authors by field
- ✓ Classifies publications by subject category

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ORP database

- ✓ Source: Web of Science (WoS)
- ✓ Observation period: from 2001
- ✓ All Italian universities (96), research institutions (76), research hospitals (196)
- ✓ 350,000 publications, 120,000 proceedings
- ✓ 320,000 (66,000 university) authors
- ✓ Publications classification: 245 (182) WoS subject categories; 12 (8) disciplines
- ✓ Researchers classification: 370 (205) university disciplinary sectors (SDS); 14 (9) university disciplinary areas (UDA)

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The Fractional Scientific Strength (FSS)

individual level

$$FSS_R = \frac{1}{w_R} \cdot \frac{1}{t} \sum_{i=1}^{N} \frac{c_i}{\bar{c}} f_i$$

Where:

w_R = average yearly salary of the researcher

t = number of years of work of the researcher in the period of observation

N = number of publications of the researcher in the period of observation

c_i = citations received by publication i

$\bar{c}$ = average of the distribution of citations received for all cited publications of the same year and subject category of publication i

f_i = fractional contribution of the researcher to publication i

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Additional bibliometric indicators

- *Publication Output* (PO), number of publications;
- *Fractional Output* (FO), number of publications, each divided by the number of co-authors*;
- *Scientific Strength* (SS), number of field-normalized citations;
- Average Impact (AI), average field-normalized citations per publication. IJ is similar but based on impact factor.

** In the life science, the position of co-authors in the byline reflects the relative contribution to the project and is weighted accordingly.*

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The importance of researchers' classification

Name	John Doe I	John Doe II
Discipline	Clinical medicine	Clinical medicine
Indicator	*Absolute value*	*Absolute value*
PO	6.6	3.6
FO	1.442	1.220
SS	8.891	2.141
FSS	**1.228**	**0.692**
AI	2.021	0.95
h-index	12	5
g-index	19	7

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The importance of researchers' classification

Name	John Doe I		John Doe II	
SDS	MED/15 (Blood diseases)		MED/22 (Vascular surgery)	
Indicator	*A.v.*	**Rank%**	*A.v.*	**Rank%**
PO	6.6	**67.4**	3.6	**90.5**
FO	1.442	**68.4**	1.220	**95.2**
SS	8.891	**74.2**	2.141	**85.7**
FSS	1.228	**78.4**	0.692	**91.3**
AI	2.021	**78.9**	0.595	**58.7**
h-index	12	**76.4**	5	**79.6**
g-index	19	**77.0**	7	**80.4**

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The importance of researchers' classification

SDS	Staff	Active	Average output	Average output (active only)
AGR/01 - Rural economy and Estimate	353	28.5%	0.11	0.39
AGR/02 - Agronomy and Herbaceous Cultivation	188	74.8%	0.55	0.74
AGR/03 - General Arboriculture and Tree Cultivation	159	76.7%	0.87	1.14
AGR/04 - Horticulture and Floriculture	61	70.0%	0.83	1.18
AGR/05 - Forestry and Silviculture	65	58.7%	0.65	1.11
AGR/06 - Wood Technology and Woodland Management	15	27.8%	0.07	**0.24**
AGR/07 - Agrarian Genetics	94	86.4%	0.92	1.06
AGR/08 - Agrarian Hydraulics and Hydraulic Forest Management	73	74.4%	0.48	0.64
AGR/09 - Agricultural Mechanics	100	57.8%	0.32	0.56
AGR/10 - Rural Construction and Environmental Land Management	71	50.0%	0.25	0.49
AGR/11 - General and Applied Entomology	133	69.6%	0.59	0.85
AGR/12 - Plant Pathology	167	84.9%	0.90	1.06
AGR/13 - Agricultural Chemistry	136	87.9%	1.08	1.23
AGR/14 - Pedology	30	77.1%	0.64	0.82
AGR/15 - Food Sciences	188	86.4%	1.04	1.20
AGR/16 - Agricultural Microbiology	135	92.9%	1.34	**1.44**
AGR/17 - General Techniques for Zoology and Genetic Improvement	75	93.0%	1.33	1.43
AGR/18 - Animal Nutrition and Feeding	88	87.3%	1.07	1.23
AGR/19 - Special Techniques for Zoology	166	91.7%	1.04	1.14
AGR/20 - Animal Husbandry	51	94.3%	0.95	1.00

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The performance of single researchers

The national percentile ranking of researchers of the Biopathology Dept of university "X" (2006-2010).

Name	Ac. rank	SDS	PO	FO	SS	FSS
John Doe 1	Ass.	MED/03	37	25	22	**23**
John Doe 2	Full	MED/08	75	59	61	**58**
John Doe 3	Full	MED/15	42	23	23	**27**
John Doe 4	Full	MED/30	52	37	39	**41**
John Doe 5	Res.	MED/36	23	13	6	**11**
John Doe 6	Ass.	BIO/14	50	36	38	**38**
John Doe 7	Ass.	MED/08	83	72	70	**64**
John Doe 8	Full	FIS/07	74	56	62	**55**
John Doe 9	Res.	MED/15	54	35	40	**44**
John Doe 10	Ass.	BIO/14	25	23	18	**20**
John Doe 11	Res.	MED/15	28	25	27	**22**
John Doe 12	Res.	MED/30	38	22	20	**21**
John Doe 13	Res.	FIS/07	27	25	15	**17**
John Doe 14	Res.	MED/36	83	70	70	**67**
John Doe 15	Res.	MED/36	31	13	13	**13**
John Doe 16	Full	BIO/13	86	72	69	**75**
John Doe 17	Full	MED/30	95	83	75	**77**

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The Fractional Scientific Strength (FSS)

research unit

Labor productivity of research units (e.g. SDS, UDA, Department) based on FSS_R

$$FSS_D = \frac{1}{RS}\sum_{j=1}^{RS}\frac{FSS_{R_j}}{\overline{FSS_R}}$$

Where:

RS = research staff of the unit, in the observed period

FSS_{Rj} = productivity of researcher *j* in the research unit

$\overline{FSS_R}$ = average productivity of all national productive researchers in the same SDS of researcher *j*

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The performance in each field (SDS)

The fields within the UDA "Mathematics" of university "*X*"

	FO			FSS		
SDS	A.v.	Rank	Rank%	A.v.	Rank	Rank%
MAT/01 - Mathematical logic	1.007	11	79	1.910	12	76
MAT/02 - Algebra	0.525	34	25	1.784	15	67
MAT/03 - Geometry	0.863	18	63	1.734	16	66
MAT/04 - Complementary mathematics	0.646	28	33	0.946	33	21
MAT/05 - Mathematical analysis	0.592	31	19	2.015	10	74
MAT/06 - Probability and statistics	0.519	33	4	1.161	28	16
MAT/07 - Mathematical physics	0.764	22	36	2.026	10	72
MAT/08 - Numerical analysis	-	-	-	-	-	-
MAT/09 - Operational research	0.286	31	26	0.974	38	15
INF/01 - Computer science	0.945	12	77	1.953	10	82

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The performance of university *X* in each discipline (UDA)

	PO		SS		FO		FSS	
	A.v.	Rank%	A.v.	Rank%	A.v.	Rank%	A.v.	Rank%
UDA 1	0.559	33	0.863	48	0.487	25	1.100	48
UDA 2	1.011	83	0.870	77	1.146	92	1.513	92
UDA 3	0.575	62	0.884	75	0.896	67	1.456	83
UDA 4	0.378	17	0.647	32	0.878	48	1.451	48
UDA 5	0.213	4	0.228	4	0.549	4	0.653	4
UDA 6	0.339	8	0.359	17	0.132	8	0.196	17
UDA 7	1.781	100	1.117	92	0.608	92	0.178	78
UDA 8	1.002	75	0.968	83	1.151	100	1.646	100
UDA 9	0.753	67	0.838	50	1.073	83	1.277	67

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Our university ranking indicators

- *Productivity (FSS)*
- *Rate of unproductive staff*
- *Rate of top scientists*
- *Rate of higly-cited articles per professor*

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Distortion of rankings by the Leiden's new crown indicator (MNCS)

UDA	Percentage of top 25% scientists by FSS not included in the same set by MNCS
Mathematics and computer science	31
Physics	57
Chemistry	42
Earth sciences	40
Biology	44
Medicine	46
Agricultural and veterinary science	42
Civil engineering	26
Industrial and information engineering	35
Total	42

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Distortion of universities rankings by h and g indexes

UDA	Percentage of top 25% universities by FSS not included in the same set by h	g
Mathematics and computer science	45	47
Physics	48	51
Chemistry	49	46
Earth sciences	42	35
Biology	42	36
Medicine	40	35
Agricultural and veterinary science	41	33
Civil engineering	28	26
Industrial and information engineering	40	35
Total	*42*	*38*

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Comparison of VQR and FSS quartile university ranking lists

UDA	No. of universities	% shifting quartile	Correlat.	From top to non top
Mathematics and computer science	50	46.0%	0.60	46.2%
Physics	43	60.5%	0.25	38.5%
Chemistry	42	59.5%	0.69	45.5%
Earth sciences	30	60.0%	0.52	37.5%
Biology	50	52.0%	0.60	69.2%
Medicine	43	48.8%	0.73	45.5%
Agricultural and veterinary sciences	28	46.4%	0.77	42.9%
Industrial and information engineering	46	47.8%	0.56	50.0%

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Conclusions

- ✓ Count only what counts and be aware of what you cannot count
- ✓ The most popular research performance indicators are invalid
- ✓ Field classification of scientists is absolutely required to compare performance at the individual level
- ✓ Research performance at the individual level is absolutely required to measure performance at organizational level
- ✓ Avoid the “do it myself” temptation

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