How to evaluate, measure and compare the global research output

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Empowering Knowledge

Agenda

- **Research Performance Evaluation has changed**

- **Research Today's Landscape:**

    - Big Data

    - Semantic Technology

    - Basket of Metrics

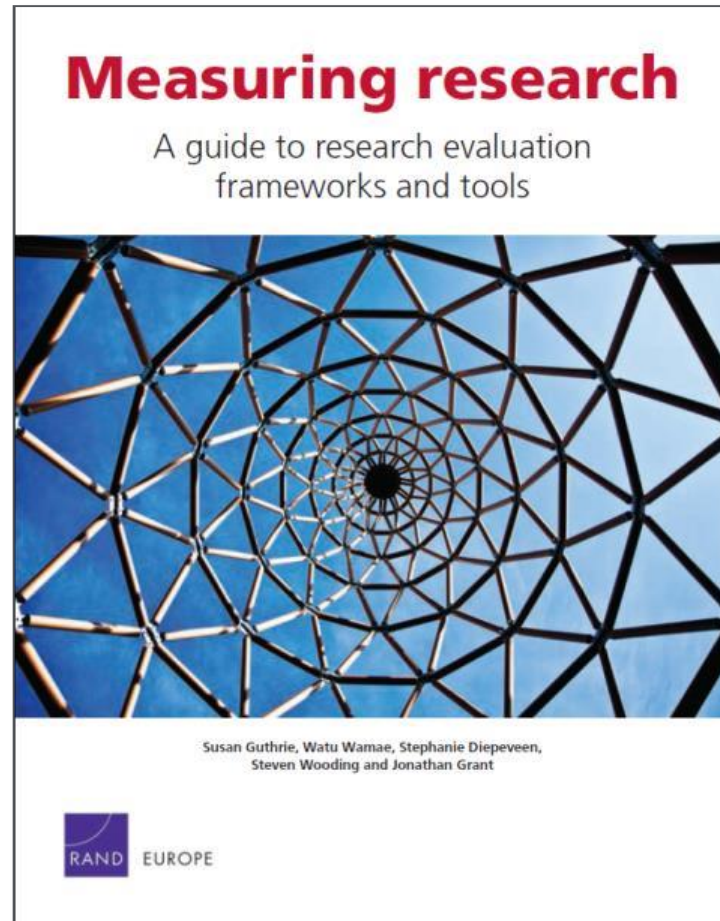- **Closer look on Brazil**

- **Powerful Analytics**

- Summary

In the age of optimism…

*"The returns [of Science] are so large that
it is hardly necessary to justify or evaluate the investment"*

National Science Foundation, USA, "Basic Research: A National Resource", 1957

Now

Measuring research
A guide to research evaluation frameworks and tools

Susan Guthrie, Watu Wamae, Stephanie Diepeveen,
Steven Wooding and Jonathan Grant

RAND EUROPE

**http://www.rand.org/pubs/monographs/MG1217.html**

*"There is need to show that policymaking is **evidence-based** and, in the current economic climate, to **demonstrate accountability** for investment of public funds in research."*

Review of 14 Research performance Assessment systems (including the ERA 2012 and UK REF)
Commissioned by the Association of American Medical Colleges

Research Performance Evaluation: a Necessity
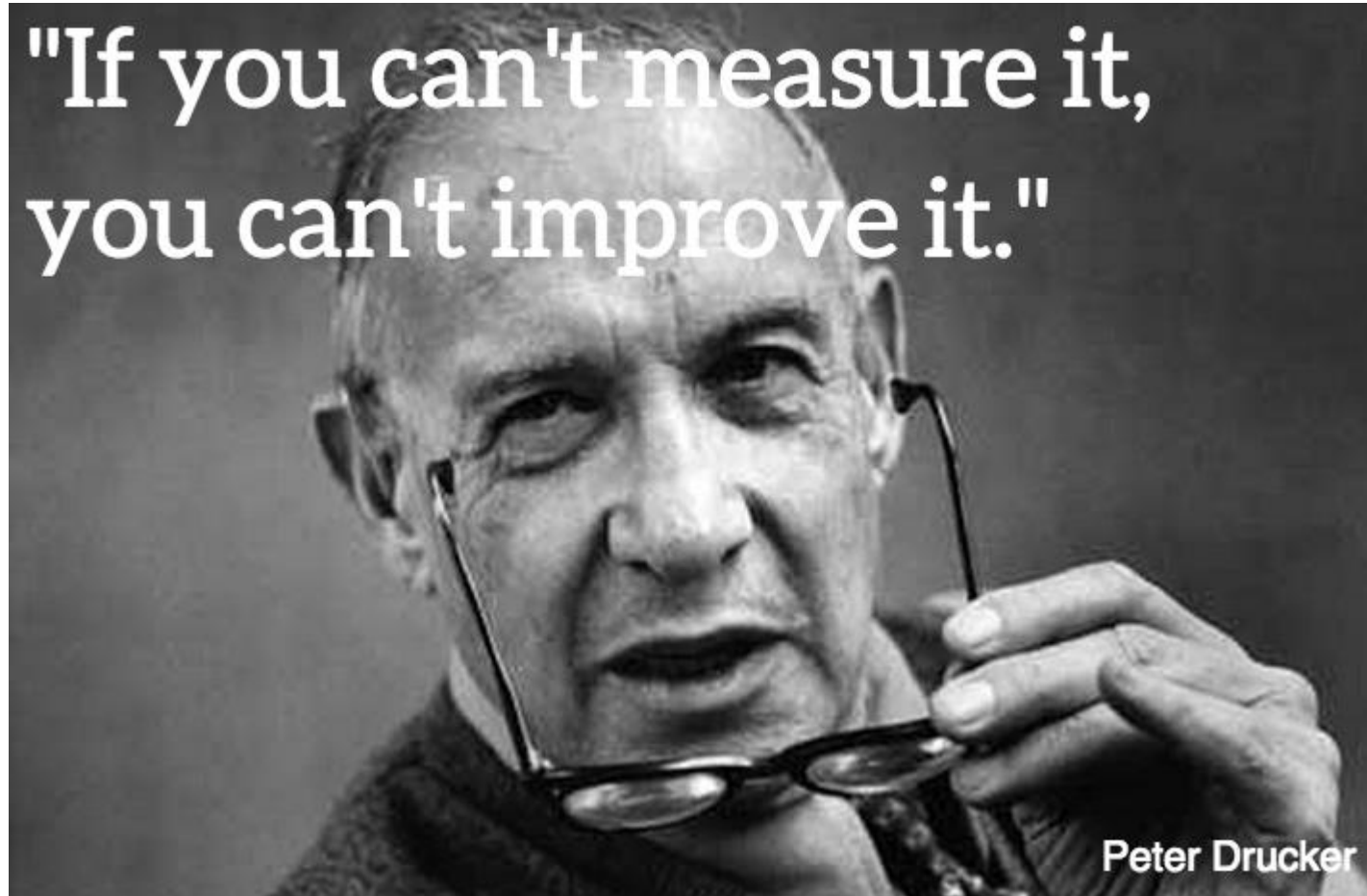
A Unique Vantage Point on the Global World of Research

Elsevier – From publisher to solution provider

- Founded 130+ years ago
- Serving 30 million+ scientists, students, health and information professionals in 180+ countries
- 2,500 E-journals, 2,000 E-books published each year, dozens of research-oriented databases
- RELX (Reed Elsevier), the largest digital company in Europe

Each year

- 1.3 million manuscripts submitted to 2,500+ Elsevier journals
- 350,000+ articles published
- 900 million digital article downloads delivered
- 22,000+ journals from 5000+ publishers, >2 million articles per year tracked by Scopus (>69M articles in total)
- Terabytes of data in the Elsevier Research Intelligence suite
- Interactions with every university and government

Assisting policy and decision makers around the globe

Global University Rankings
- Times Higher World University Rankings
- QS rankings
- US News rankings (Arab Region)
- China University Rankings

National research assessment & benchmarking reports
- UK REF, UK BIS reports
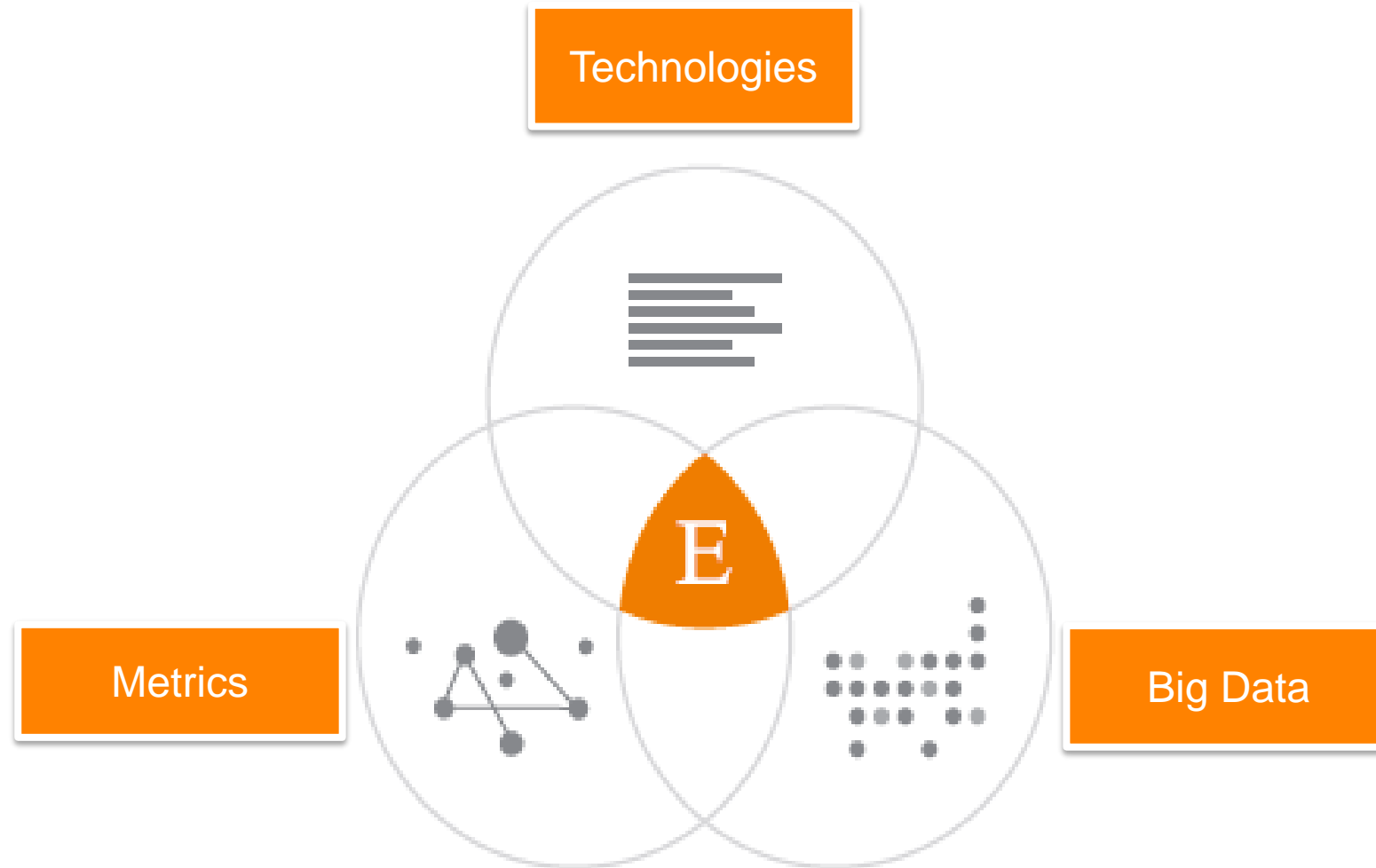- NSF (NCSES)
- FCT (Portugal)
- VQR (Italy)

Initiatives and reports (selection)
- UK Royal Society
- Science Europe
- European Commission, FENS, HBP, Kavli Foundation, RIKEN BSI
- World Bank
- EuroStemCell, Kyoto University
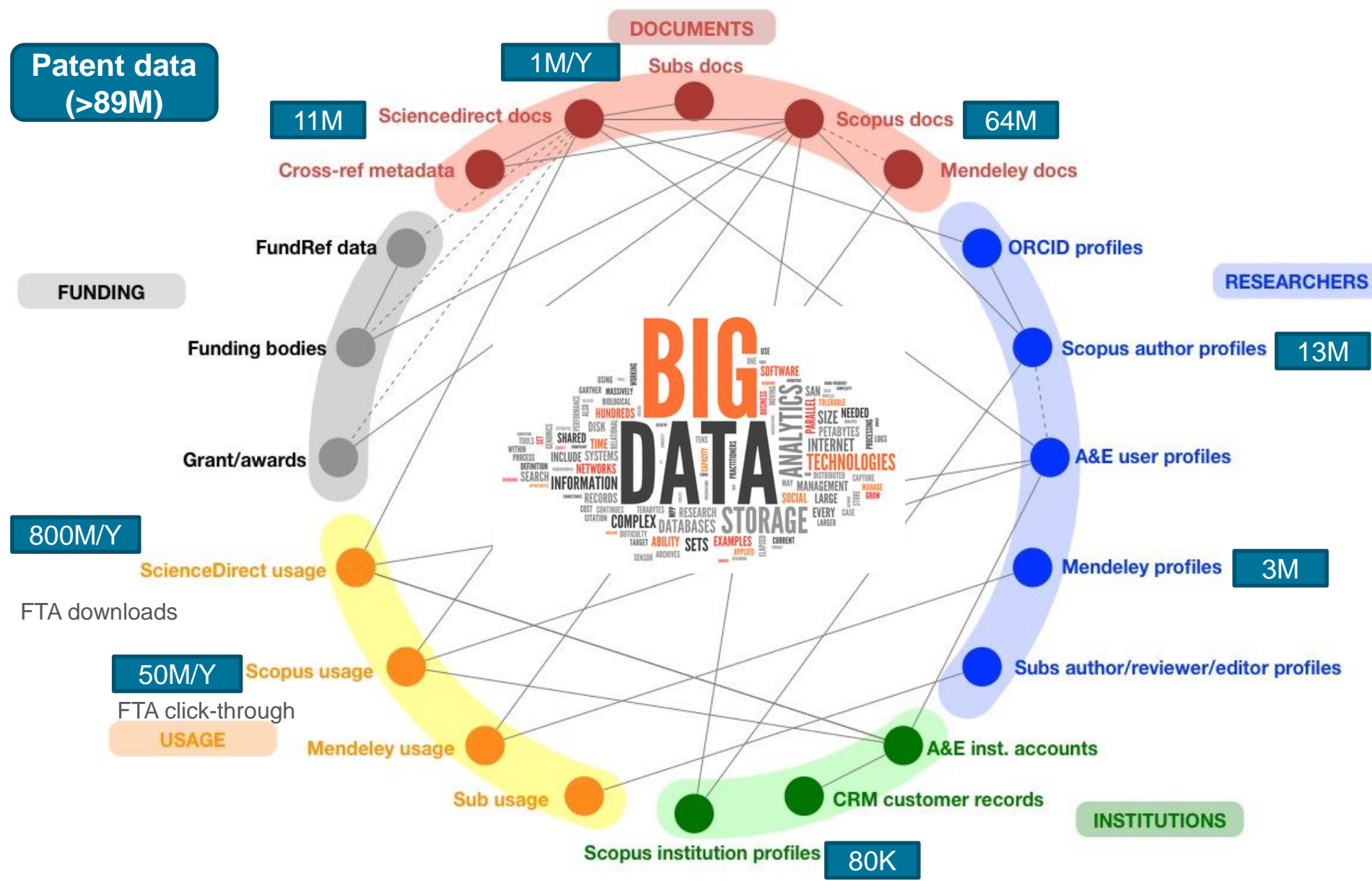- Snowball Metrics
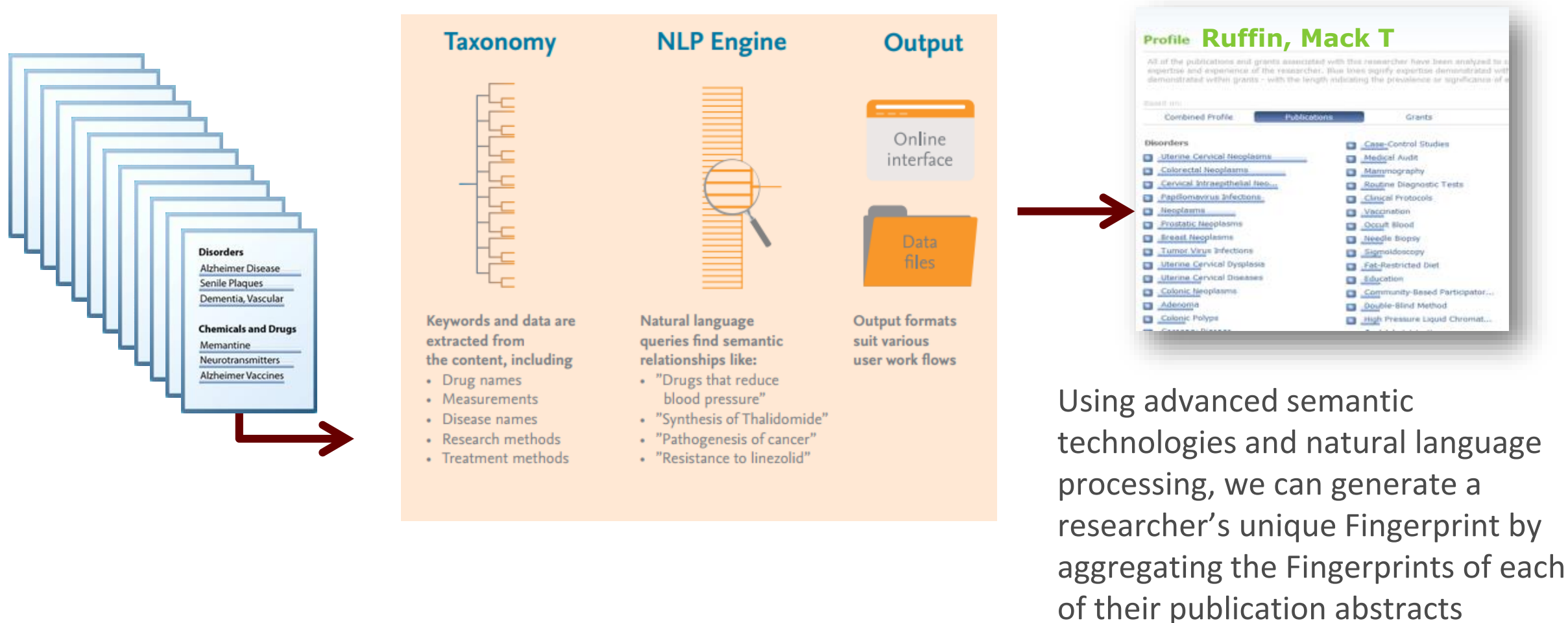
Research Today's Landscape

Empowering Knowledge

Elsevier 3 pillars to support the Research Community

The Big Data we bring to the table

Patent data (>89M)

DOCUMENTS

1M/Y — Subs docs

11M — Sciencedirect docs

64M — Scopus docs

Cross-ref metadata

Mendeley docs

FundRef data

FUNDING

Funding bodies

Grant/awards

RESEARCHERS

ORCID profiles

Scopus author profiles — 13M

A&E user profiles

Mendeley profiles — 3M

Subs author/reviewer/editor profiles

800M/Y — ScienceDirect usage

FTA downloads

50M/Y — Scopus usage

FTA click-through

USAGE

Mendeley usage

Sub usage

A&E inst. accounts

CRM customer records

INSTITUTIONS

Scopus institution profiles — 80K

Semantic and NLP Technology--Elsevier Fingerprint Engine

Using advanced semantic technologies and natural language processing, we can generate a researcher's unique Fingerprint by aggregating the Fingerprints of each of their publication abstracts
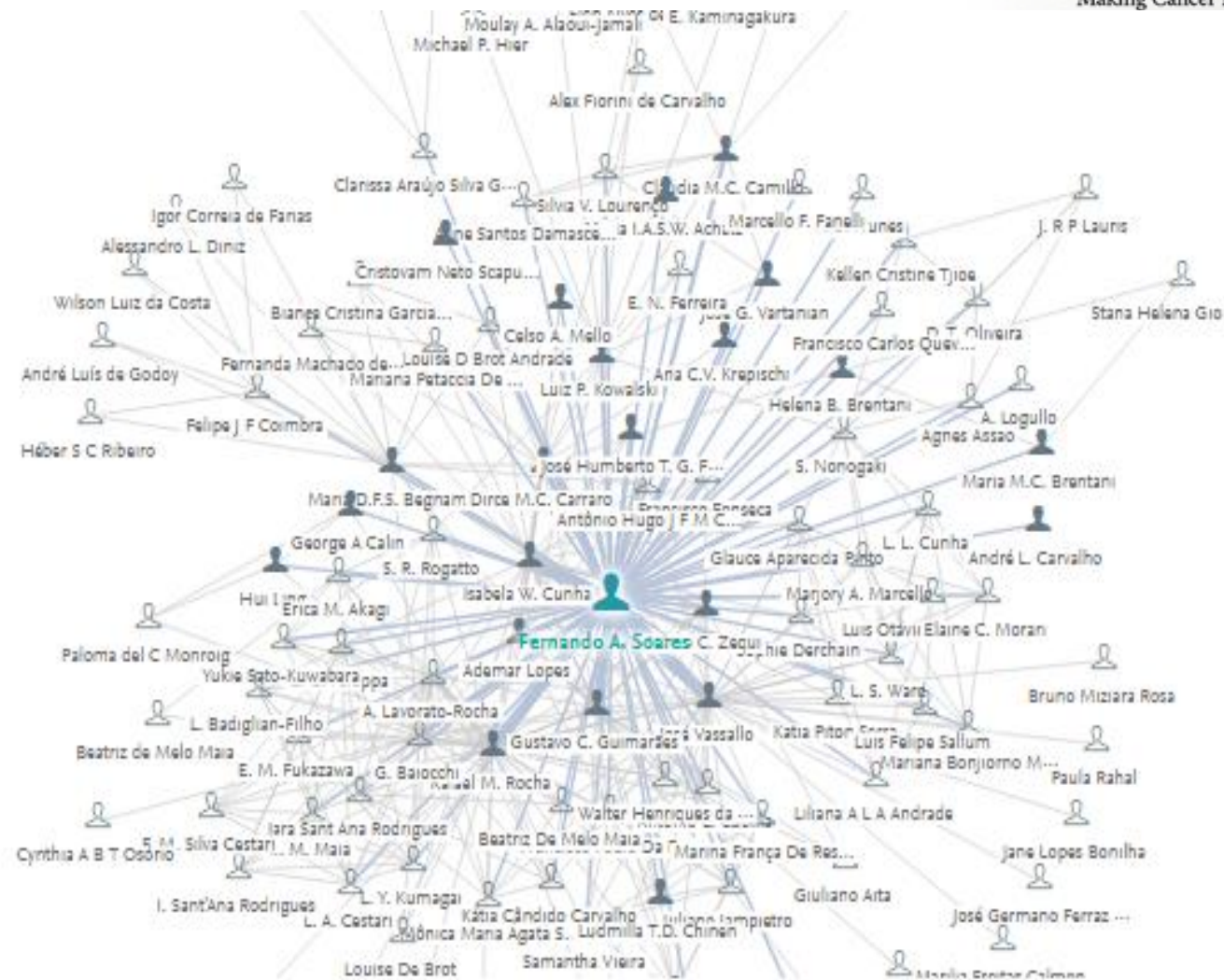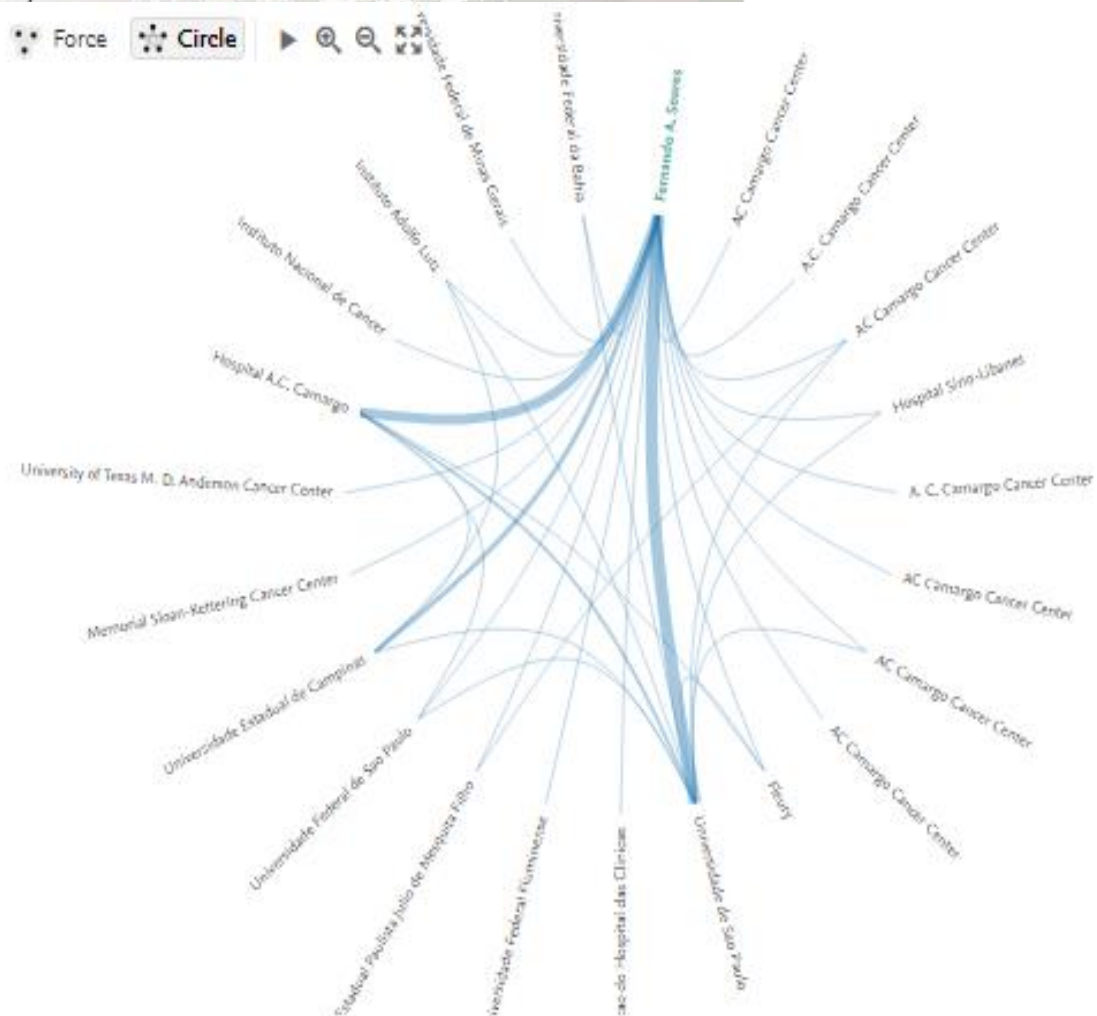
Two Golden Rules for using research metrics

Basket of Metrics Approach:

When used correctly, research metrics together with qualitative input give a balanced, multi-dimensional view for decision-making

Always use more than one research metric as the quantitative input

Always use both qualitative and quantitative input into your decisions

Example: importance of using multiple metrics from the basket - compensate for weaknesses

Field-Weighted Citation Impact
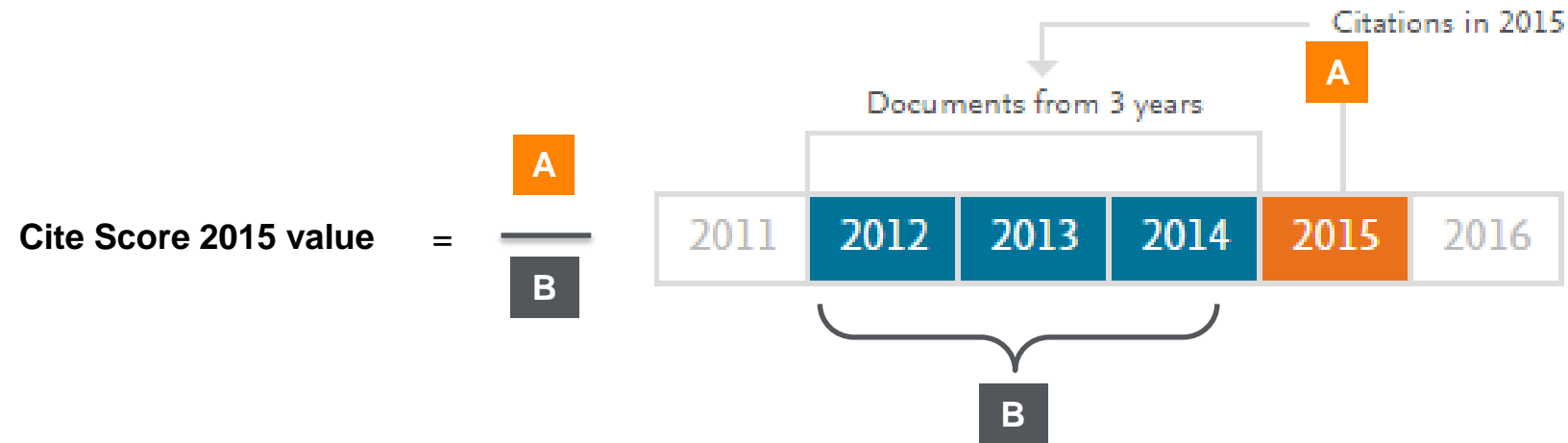**= 2.53**

with

Citations per Publication
= 27.8

✓ Compensates for differences in field, type and age
✓ Meaningful benchmark is "built in" – 1 is average for a subject area

✓ Large number
✓ Simple, easy to validate
✓ Communicates magnitude of activity

✗ People may not like small numbers
✗ Complicated; difficult to validate
✗ No idea of magnitude: how many citations does it represent?

✗ Affected by differences in field, type and age
✗ Meaningless without additional benchmarking

CiteScore Launched : a simple metric for all Scopus journals – Free.

Citations in 2015

A

Documents from 3 years

Cite Score 2015 value $=\dfrac{A}{B}$

| 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |

B

CiteScore	Impact Factor
A = citations to 3 years of documents	A = citations to 2 or 5 years of documents
B = all documents indexed in Scopus, same as A	B = only citable items (articles and reviews), different from A

Note: at launch, all titles in the May 2016 title list, and with some documents indexed in 2016, will have CiteScore metrics

Beyond citations: Downloads and Views
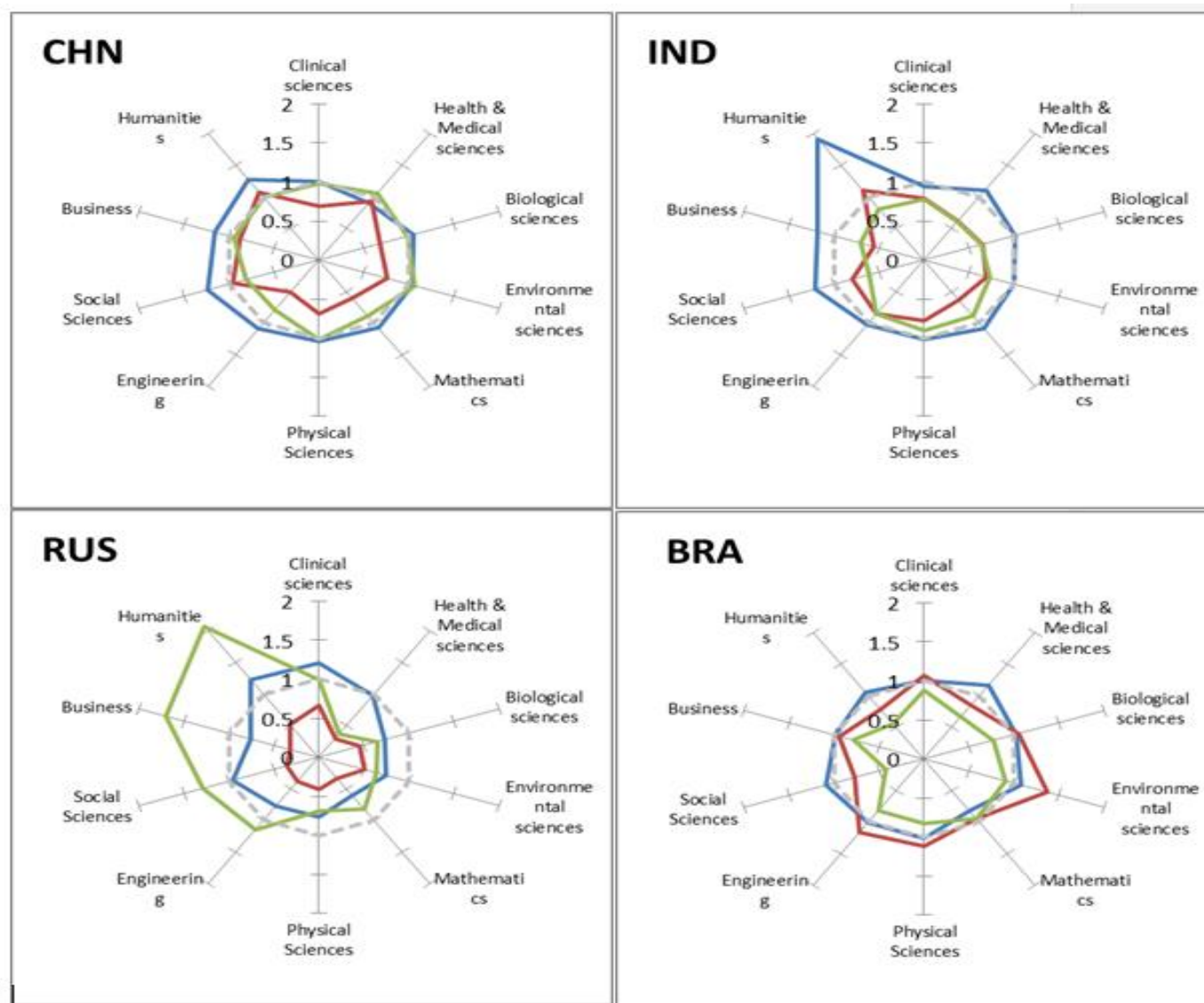
Field-weighted citation impact (FWCI), Field-weighted download impact (FWDI), Field-weighted readership impact (FWRI) across ten research fields in 2014.

For all research fields, a field-weighted citation, download or readership impact of 1.0 equals the world average in that particular research field

source: "International Comparative Performance of the UK Research Base " by BEIS and Elsevier, in press

Beyond citations: Social Impact with PlumX Metrics
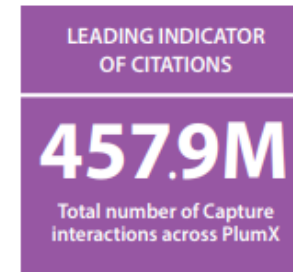
Researchers have moved online

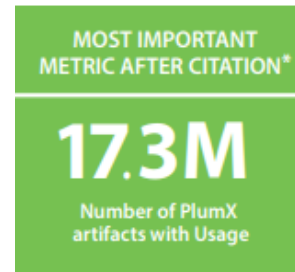| USAGE	CAPTURES	MENTIONS	SOCIAL MEDIA	CITATIONS
MOST IMPORTANT METRIC AFTER CITATION*	LEADING INDICATOR OF CITATIONS	WHERE THE STORIES OF RESEARCH ARE FOUND	INDICATES HOW RESEARCH IS PROMOTED	TRADITIONAL MEASURE OF IMPACT
17.3M	**457.9M**	**17.6M**	**4.7%**	**6.9X**
Number of PlumX artifacts with Usage	Total number of Capture interactions across PlumX	Total number of Wikipedia Mentions across PlumX	Percentage of PlumX artifacts with Social Media	Number of times articles are Cited more than books in PlumX

Social metrics provide a window into what is happening to the research and how the world is interacting with it

PlumX considers research output anything that the customer's consider research output

Topics of Prominence - A Planning Solution

Prominence is Elsevier's latest new indicator

It shows the current momentum of a topic by looking at citations, views and CiteScore values.

## Topics with high prominence tend to attract more funding on average

We have evidence that researchers in prominent topics receive more funding (per researcher) than their peers in other topics.

Help improve grant applications

We can truly help researchers to increase their grant success rate by focusing on high prominence topics.

Topics resonate with researchers

Researchers recognize them intuitively and agree with the level of granularity.

Focus on Brazil

Empowering Knowledge
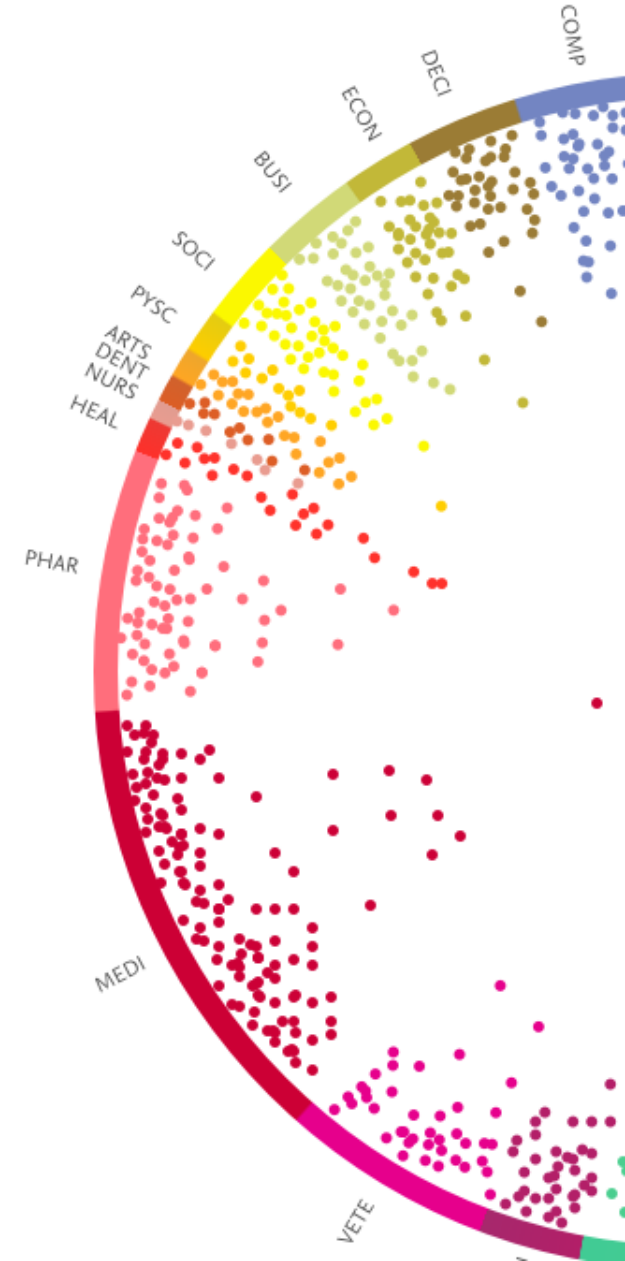
R&D Forecast

2017 GLOBAL R&D FUNDING FORECAST

Forecast Gross Expenditures on R&D

		2015 Actual			2016 Estimated			2017 Forecast		
		GDP PPP Bil, US$	R&D as % GDP	GERD PPP Bil, US$	GDP PPP Bil, US$	R&D as % GDP	GERD PPP Bil, US$	GDP PPP Bil, US$	R&D as % GDP	GERD PPP Bil, US$
1	United States	17,950.0	2.77%	496.84	18,237.0	2.81%	512.46	18,638.0	2.83%	527.46
2	China	19,390.0	1.92%	372.81	20,669.7	1.94%	400.99	21,951.3	1.96%	429.54
3	Japan	4,830.0	3.41%	164.59	4,854.2	3.55%	172.32	4,883.3	3.50%	173.36
4	Germany	3,841.0	2.92%	112.16	3,906.3	2.88%	112.50	3,961.0	2.84%	112.49
5	South Korea	1,849.0	4.04%	74.70	1,898.9	4.26%	80.89	1,955.9	4.29%	83.91
6	India	7,965.0	0.85%	67.70	8,570.3	0.85%	72.85	9,221.7	0.84%	77.46
7	France	2,647.0	2.26%	59.82	2,681.4	2.24%	60.06	2,716.3	2.24%	60.84
8	Russia	3,718.0	1.50%	55.77	3,688.3	1.50%	55.32	3,728.8	1.50%	55.93
9	United Kingdom	2,679.0	1.78%	47.69	2,727.2	1.75%	47.73	2,757.2	1.75%	48.25
10	Brazil	3,192.0	1.21%	38.62	3,086.7	1.20%	37.04	3,102.1	1.20%	37.22
11	Australia	1,489.0	2.39%	35.59	1,532.2	2.30%	35.24	1,573.5	2.30%	36.19
12	Canada	1,632.0	1.79%	29.21	1,651.6	1.80%	29.73	1,683.0	1.80%	30.29
13	Italy	2,171.0	1.27%	27.57	2,188.4	1.27%	27.79	2,208.1	1.27%	28.04
14	Taiwan	1,099.0	2.35%	25.83	1,110.0	2.40%	26.64	1,128.9	2.45%	27.66
15	Spain	1,615.0	1.30%	21.00	1,665.1	1.27%	21.15	1,701.7	1.27%	21.61
16	Netherlands	832.6	2.16%	17.98	846.8	2.10%	17.78	860.3	2.10%	18.07
17	Sweden	474.4	3.40%	16.13	491.5	3.28%	16.12	504.3	3.30%	16.64
18	Turkey	1,589.0	0.86%	13.67	1,641.4	0.92%	15.10	1,690.7	0.92%	15.55
19	Switzerland	482.3	2.90%	13.99	487.1	2.96%	14.42	493.5	2.98%	14.71
20	Singapore	471.9	2.60%	12.27	479.9	2.60%	12.48	490.5	2.60%	12.75

OECD

- The world as a whole spent over $1.98T in R&D in 2016

- In 2016 South Korea 4.0% of its GDP, on R&D. It now spends more than any EU country except Germany, with a much smaller population

- India's investments in R&D were the sixth-highest globally. Three years ago they were the tenth-highest spender.

- Brazil R&D spending in 2016 was up 1.2% and remains constant due to economy

2015 Global R&D Expenditures
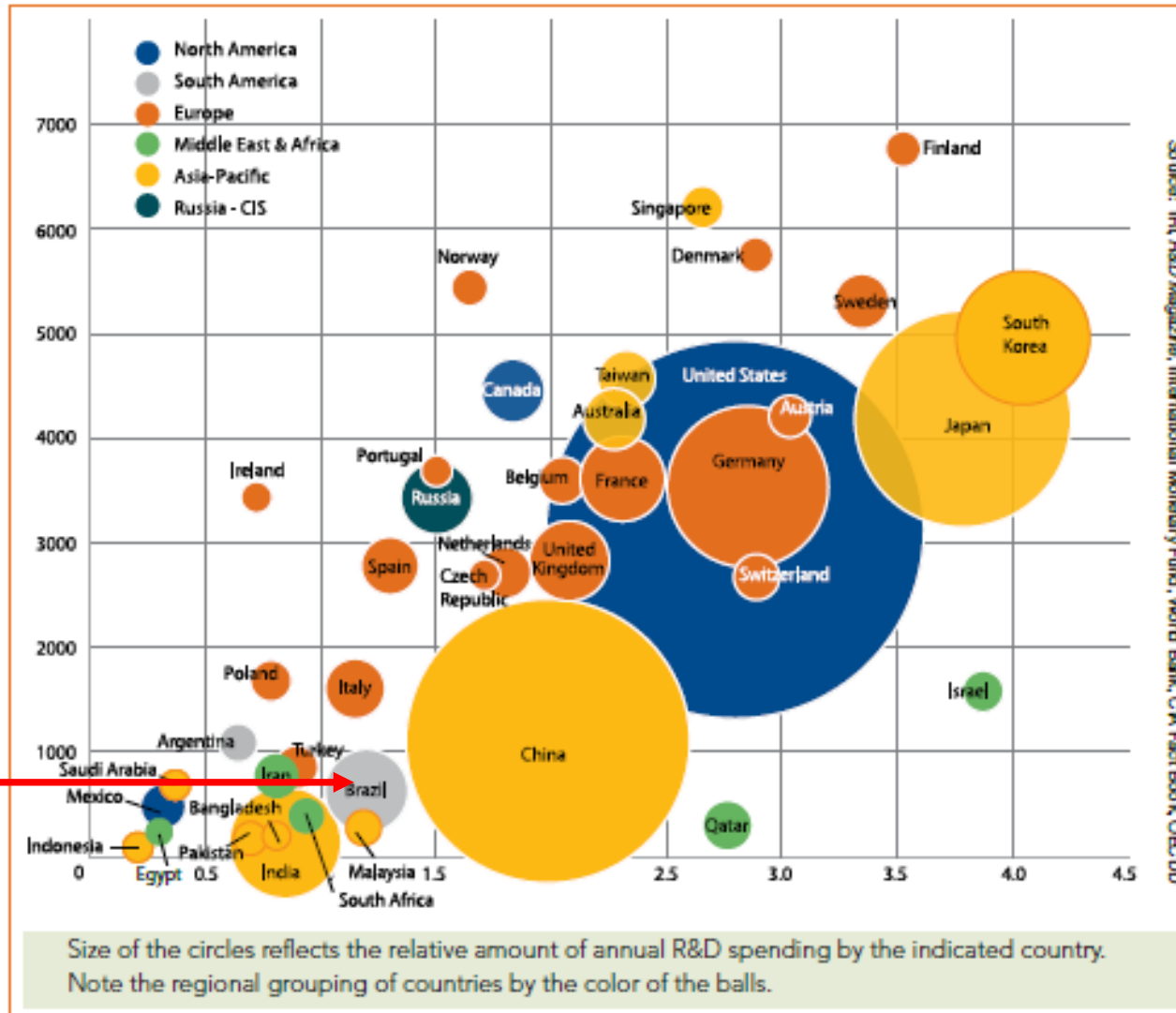
Source: IRL R&D Magazine, International Monetary Fund, World Bank, CIA Fact Book, OECD D

Size of the circles reflects the relative amount of annual R&D spending by the indicated country.
Note the regional grouping of countries by the color of the balls.

- The world as a whole spent over $1.98T in R&D in 2016

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- India's investments in R&D were the sixth-highest globally. Three years ago they were the tenth-highest spender.

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http://www.rdmag.com/articles/2016/03/2016-global-r-d-funding-forecast-predicts-continued-moderate-growth

On National level: Brazil Performance (2012 - 2017)

Scholarly Output
391,365 ▲

Authors
502,594 ▲

Field-Weighted Citation Impact
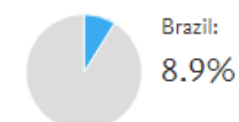0.86

Citation Count
1,642,344

Citations per Publication
4.2
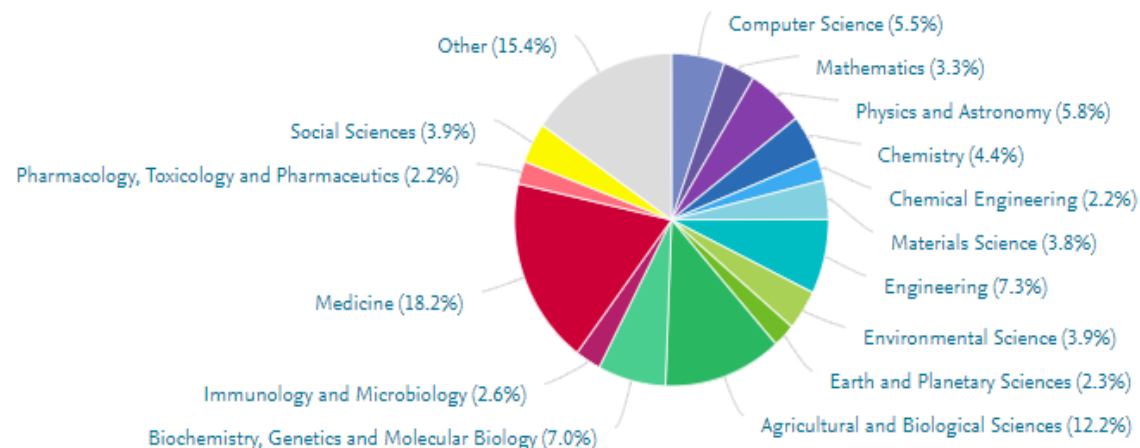
Outputs in Top Citation Percentiles
+ Add to Reporting
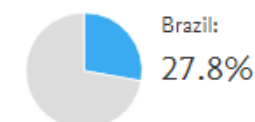Publications in top 10% most cited worldwide
Brazil: 8.9%
> Analyze in more detail

Publications in Top Journal Percentiles
+ Add to Reporting
Publications in top 10% journals by CiteScore Percentile
Brazil: 18.3%
> Analyze in more detail

International Collaboration
+ Add to Reporting
Publications co-authored with Institutions in other countries
Brazil: 27.8%
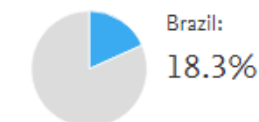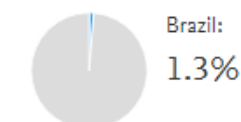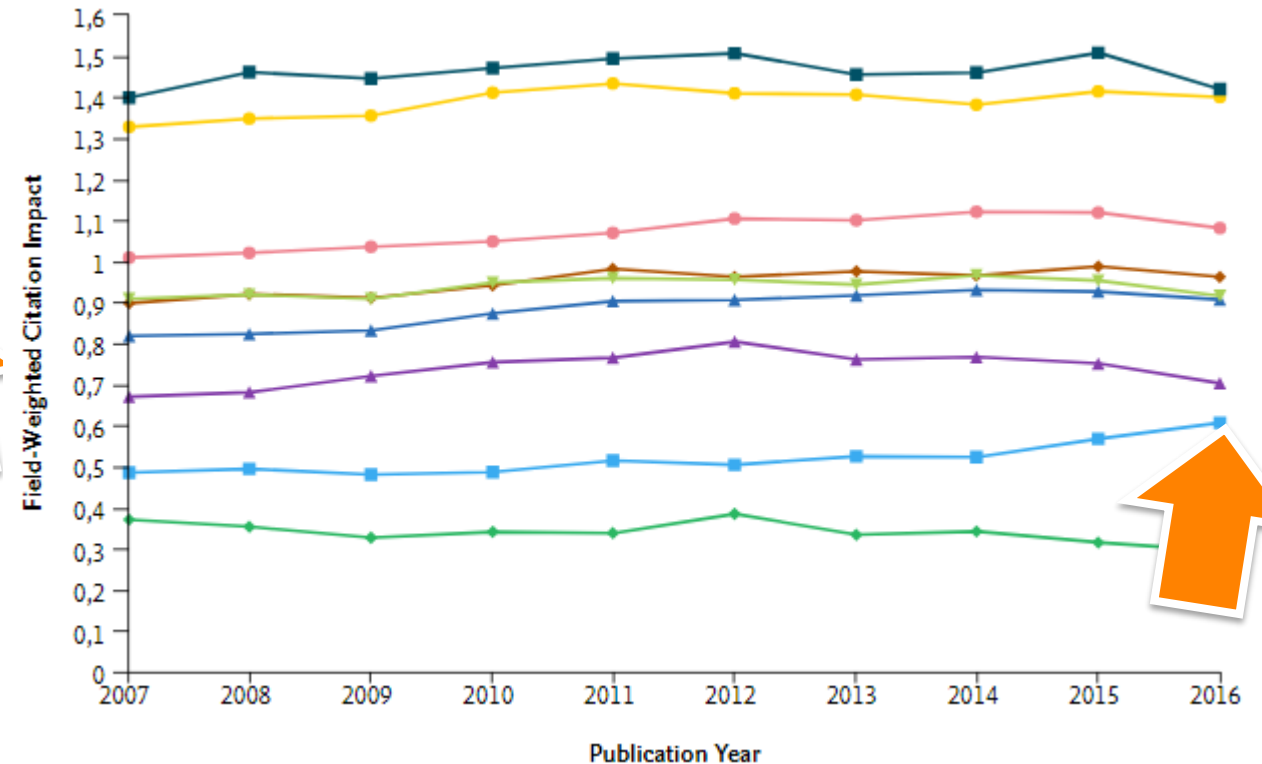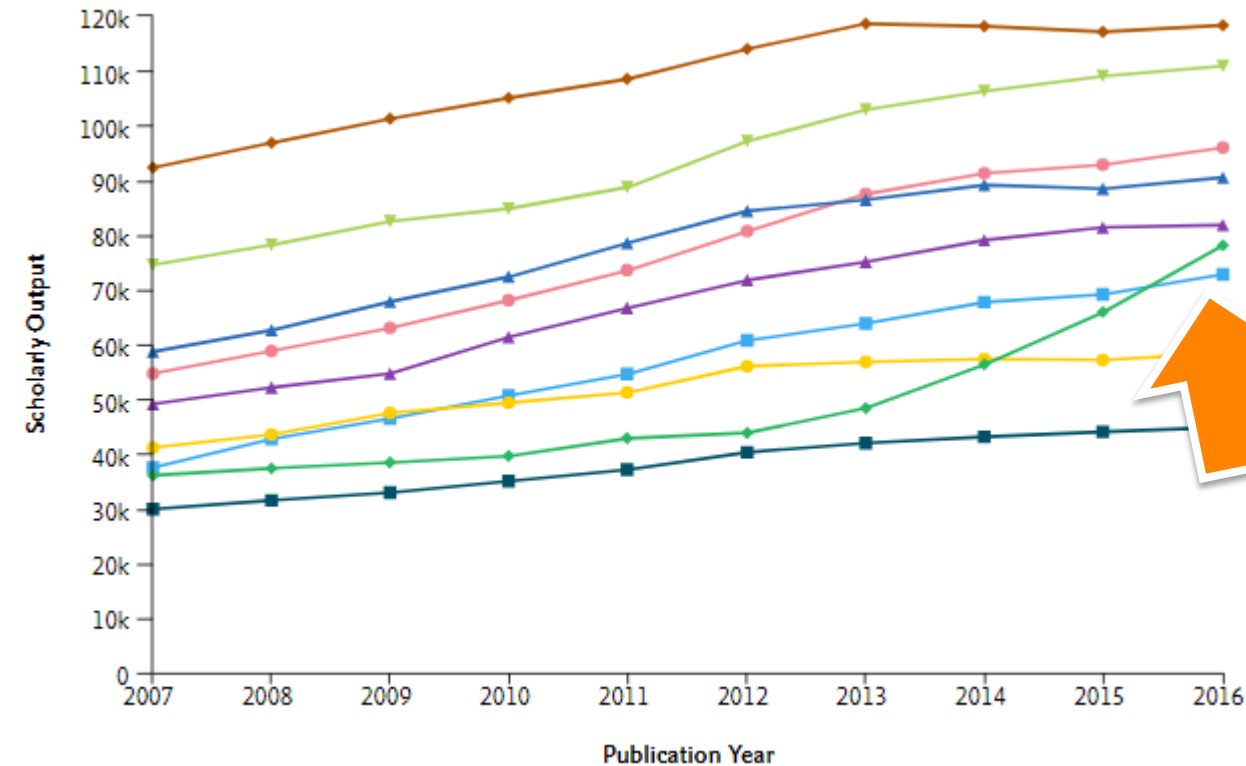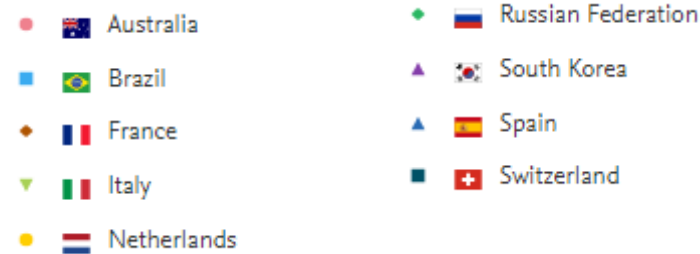
Academic-Corporate Collaboration
+ Add to Reporting
Publications with both academic and corporate affiliations
Brazil: 1.3%

Computer Science (5.5%)
Mathematics (3.3%)
Physics and Astronomy (5.8%)
Chemistry (4.4%)
Chemical Engineering (2.2%)
Materials Science (3.8%)
Engineering (7.3%)
Environmental Science (3.9%)
Earth and Planetary Sciences (2.3%)
Agricultural and Biological Sciences (12.2%)
Biochemistry, Genetics and Molecular Biology (7.0%)
Immunology and Microbiology (2.6%)
Medicine (18.2%)
Pharmacology, Toxicology and Pharmaceutics (2.2%)
Social Sciences (3.9%)
Other (15.4%)

Benchmarking Brazilian Productivity and Impact vs. Closest Peers

Top Collaborating Countries for Brazil
by Total Number of Publications (2012-2017>)

International Collaborations: Brazil and the World

Country	Co-authored publications ↓	Co-authors in Brazil	Co-authors in the other country	Field-Weigh... ⌄
🇺🇸 United States	40,016 ▲	58,244 ▲	82,994 ▲	2.19
🇬🇧 United Kingdom	15,474 ▲	22,328 ▲	23,538 ▲	3.14
🇫🇷 France	13,794 ▲	18,927 ▲	20,195 ▲	2.81
🇪🇸 Spain	13,121 ▲	17,632 ▲	17,146 ▲	2.70
🇩🇪 Germany	12,880 ▲	16,881 ▲	21,087 ▲	2.93
🇮🇹 Italy	10,503 ▲	13,134 ▲	20,103 ▲	3.17
🇵🇹 Portugal	9,667 ▲	14,862 ▲	12,227 ▲	1.98
🇨🇦 Canada	9,299 ▲	15,185 ▲	12,641 ▲	3.21
🇦🇺 Australia	6,896 ▲	10,539 ▲	7,971 ▲	4.04
🇳🇱 Netherlands	5,999 ▲	8,302 ▲	7,415 ▲	4.02
🇦🇷 Argentina	5,866 ▲	10,276 ▲	7,046 ▲	2.54
🇨🇳 China	5,391 ▲	5,669 ▲	7,597 ▲	4.24
🇨🇭 Switzerland	5,257 ▲	6,801 ▲	14,154 ▼	4.25

Co–authored   United Kingdom

15,474 ▲   23,538 ▲
publications   co–authors with Brazil

3.14   1.56
Field–Weighted Citation Impact   Field–Weighted Citation Impact

–   676,947 ▲
–   1,108,273 ▲
524,878   18,057,712
3.20   1.31
263,921   8,616,765
707

Co–authored   China

5,391 ▲   7,597 ▲
publications   co–authors with Brazil

4.24   0.87
Field–Weighted Citation Impact   Field–Weighted Citation Impact

–   3,341,577 ▲
–   2,708,561 ▲
313,618   29,743,519
5.85   0.78
133,823   12,459,283
718

Brazil

58,244 ▲
co–authors with the United States

0.86
Field–Weighted Citation Impact

Authors	502,594 ▲
Scholarly Output	391,365 ▲
Views count (from Scopus)	5,421,999
Field–Weighted Views Impact	1.06
Citation Count	1,642,344
Number of Institutions	189

Co–authored   France

13,794 ▲   20,195 ▲
publications   co–authors with Brazil

2.81   1.35
Field–Weighted Citation Impact   Field–Weighted Citation Impact

–   451,429 ▲
–   675,720 ▲
463,933   9,962,752
3.18   1.14
215,861   4,949,827
391

Co–authored   United States

40,016 ▲   82,994 ▲
publications   co–authors with Brazil

2.19   1.45
Field–Weighted Citation Impact   Field–Weighted Citation Impact

–   2,892,238 ▲
–   3,723,821 ▼
911,914   50,726,284
2.02   1.08
464,829   28,594,550
1,240

Brazil—Topics of Prominence—Top 5%

Researchers in Brazil have contributed to 45,745 topics between 2012 to 2016

	At this Country			Worldwide
Topic	Scholarly Output ↓	Publication Share	Field-Weighted Citation Impact	Prominence percentile
soil; Oxisols; limiting water ... T.3375	447	93.91% ▲	0.56	90.088
Brazil; Primary Health Care; private health ... T.6274		89.54% ▼	0.52	86.517
Laser Therapy, Low-Level; Lasers; level laser ... T.381		34.79% ▼	1.18	98.464
Viruses; Infection; ZIKV T.3007				
grasses; pastures; elong T.2126				
Siluriformes; Characifor T.1603				
Anura; Brazil; advertisen T.2234				
Psychodidae; Brazil; Lu T.1011				

This shows how prominence provides a different and innovative perspective, that of the visibility and emergence of a topic.
This is the most 'popular' topic in Brazil with the highest number of publications. However, although its relativelly high prominence (90%), the impact (FWCI) achieved by its publication, the majority being Brazilian, is very low.

27

Brazil—Topics of Prominence—Top 5%

Researchers in Brazil have contributed to 45,745 topics between 2012 to 2016 | Worldwide

Topic	Scholarly Output	Publication Share	Field-Weighted Citation Impact	Prominence percentile ↓
Perovskite; Solar cells; methylammonium lead ... T.20	10	0.26% ▲	3.78	100.000
Molybdenum compounds; Monolayers; dichalcogenides TMDs ... T.63	33	0.87	3.61	99.999
Genome; RNA, Guide; effector nucleases ... T.456	5	0.1	0.69	99.998
Electrolytic capacitors; Capacitance; asymmetric supercapacit... T.6				99.997
Solar cells; Heterojunctions; organic photovoltaics ... T.0				99.996
Viruses; Infection; ZIKV infections ... T.3007				99.993
Electrolytic reduction; Electrocatalysts; non-precious metal ... T.350	9	0.33% ▲	2.03	99.992
Immunotherapy; Melanoma; immune-related adverse ... T.403	20	0.88% ▲	30.47	99.991

Although being one of the most prominent topic, with very high impact, Brazil has a very tiny share, with only 10 publications . Maybe this is the topic to invest more.

Brazil—Top topic revealed Semantically

soil; Oxisols; limiting water T.3375 ⓘ

Overall research performance
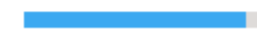
Scholarly Output ❄
667

Field-Weighted Citation Impact ❄
0.59

International Collaboration ❄
55

Views Count
7,746

Citation Count ❄
2,131

Topic Prominence percentile ⓘ
90.088

chemical substances
soil penetration resistance
Eucalyptus
physical properties
compaction
tillage
chiseling soil compaction
soil heterogeneity
soil quality
sugarcane
Brazil
soybeans
density
yields
zero tillage sampling
no-tillage
crops
cerrado
corn
Zea mays
soil management
Oxisols soil
Oxisol
variability
penetration
Ultisols
livestock
coffee
water forests
models
soil properties
cover crops porosity resistance to penetration
bulk density
geostatistics
management systems
traffic soil physical properties
clay
administrative management
pastures
spatial distribution
soil chemical properties soil property
physical property

A A A relevance of keyphrase | declining ▣▣ growing (2012-2016)

Institutions Top 5 by Scholarly Output
- Universidade Estadual Paulista Julio de Mesquita Filho — 125
- Universidade de Sao Paulo — 79
- Universidade Federal de Santa Maria — 75
- Embrapa - Empresa Brasileira de Pesquisa Agropecuaria — 71
- Universidade Federal de Lavras — 57
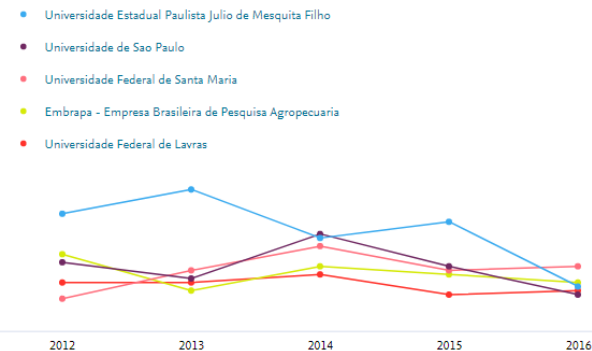
Countries Top 5 by Scholarly Output
- Brazil — 631
- United States — 19
- Iran — 8
- Argentina — 7
- Spain — 6
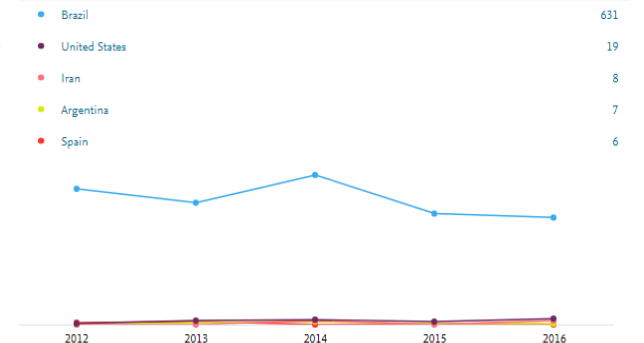
Authors Top 5 by Scholarly Output
- Reichert, José Miguel — 27
- Tormena, Cássio Antônio — 27
- Reinert, Dalvan José — 23
- Montanari, Rafael — 22
- Campos, Milton César Costa — 21
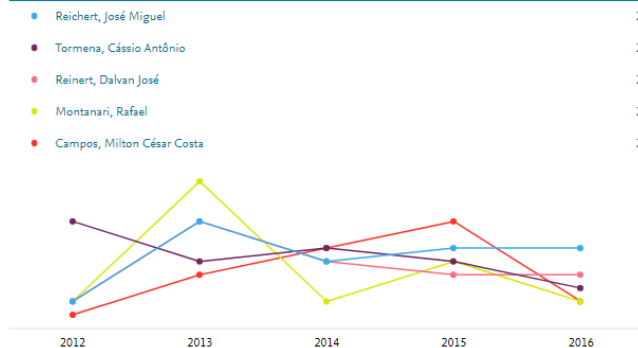
Scopus Sources Top 5 by Scholarly Output
- Revista Brasileira de Ciencia do Solo — 156
- Revista Brasileira de Engenharia Agricola e Ambiental — 76
- Engenharia Agricola — 33
- Pesquisa Agropecuaria Brasileira — 29
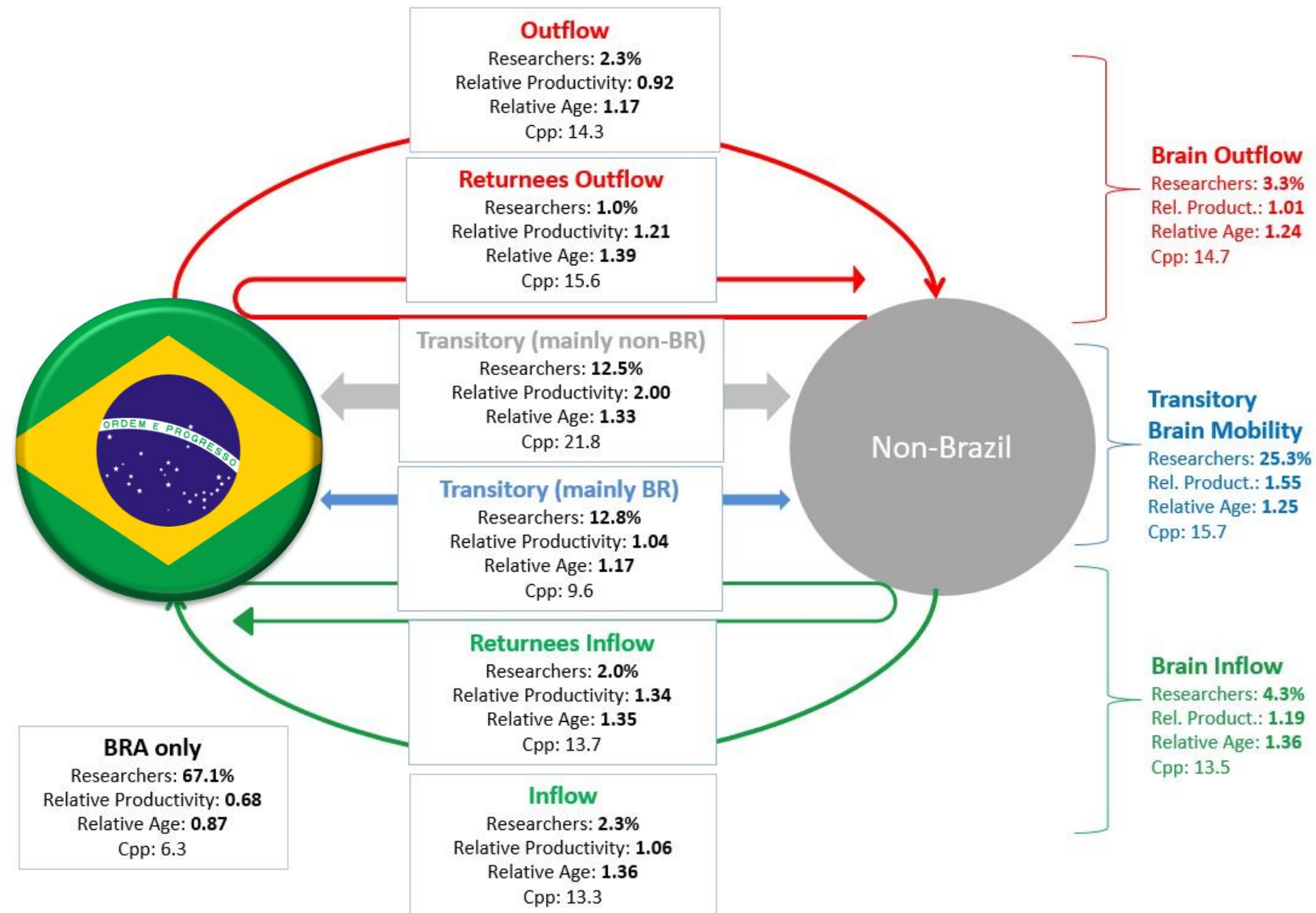- Revista Ciencia Agronomica — 24

2013
Revista Brasileira de Ciencia do Solo: 33
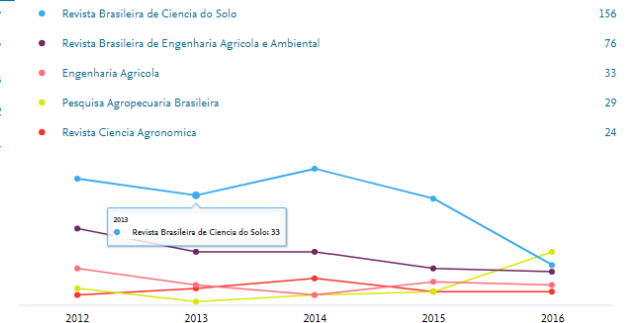
Powerful Analytics

International Collaborations: Brazil's Brain Circulation Map

Are you making the right use of your mobility an Network ?

Outflow
Researchers: **2.3%**
Relative Productivity: **0.92**
Relative Age: **1.17**
Cpp: 14.3

Returnees Outflow
Researchers: **1.0%**
Relative Productivity: **1.21**
Relative Age: **1.39**
Cpp: 15.6

Transitory (mainly non-BR)
Researchers: **12.5%**
Relative Productivity: **2.00**
Relative Age: **1.33**
Cpp: 21.8

Transitory (mainly BR)
Researchers: **12.8%**
Relative Productivity: **1.04**
Relative Age: **1.17**
Cpp: 9.6

Returnees Inflow
Researchers: **2.0%**
Relative Productivity: **1.34**
Relative Age: **1.35**
Cpp: 13.7

Inflow
Researchers: **2.3%**
Relative Productivity: **1.06**
Relative Age: **1.36**
Cpp: 13.3

BRA only
Researchers: **67.1%**
Relative Productivity: **0.68**
Relative Age: **0.87**
Cpp: 6.3

Non-Brazil

Brain Outflow
Researchers: **3.3%**
Rel. Product.: **1.01**
Relative Age: **1.24**
Cpp: 14.7

Transitory Brain Mobility
Researchers: **25.3%**
Rel. Product.: **1.55**
Relative Age: **1.25**
Cpp: 15.7

Brain Inflow
Researchers: **4.3%**
Rel. Product.: **1.19**
Relative Age: **1.36**
Cpp: 13.5

Gender in the Global Research Landscape: The Brazilian Evolution
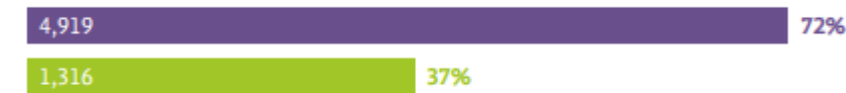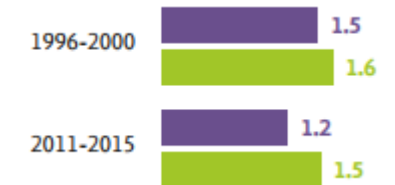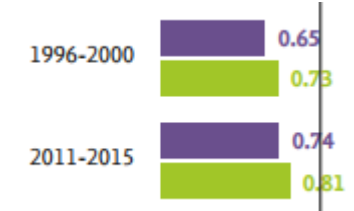
Mapping research and Innovation: Understanding Amsterdam's Competitive Advantage

A report by the Urban Innovation Network and Elsevier

Elsevier Analytical Services and the Urban Innovation Network partn on this report to examine how cities can align development strategie and priorities with research strengths. Using Amsterdam as a case study, the report analyzes the city's competitiveness across multiple dimensions of research performance from 2004-2013. The report benchmarks Amsterdam against ten other European cities of comparable size and standing, namely: Barcelona, Berlin, Brussels, Copenhagen, Dublin, Hamburg, Madrid, Manchester, Stockholm and Vienna.
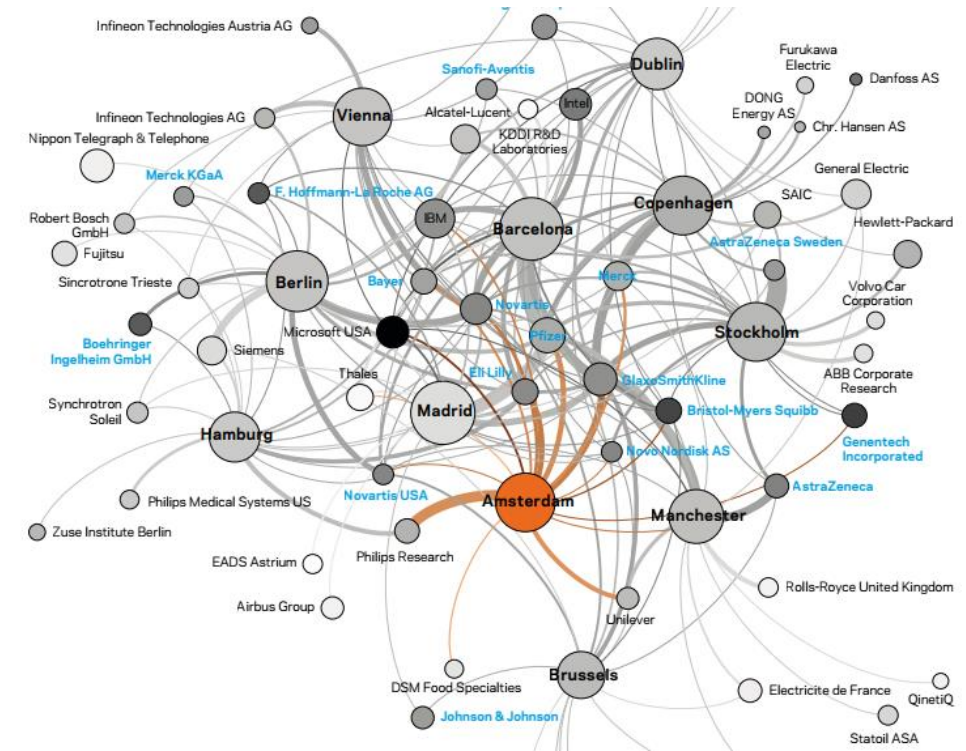

Question: How are Amsterdam and peer cities connected to major life sciences and other firms?

# The Illinois science and technology roadmap report

The Illinois Science & Technology Coalition (ISTC) collaborated with Elsevier, Ocean Tomo and Dr. C. Scott Dempwolf from the University of Maryland, to write the Illinois Science and Technology Roadmap. The report uses a unique data and analysis approach to identify technology areas where Illinois' innovation strengths can improve business competitiveness across the state's diverse industry base.

The report provides unprecedented understanding of Illinois' research strengths, the commercial potential of the state's intellectual property, and the opportunities to build mutually beneficial partnerships between academic and industry talent to drive technology innovation and commercialization.
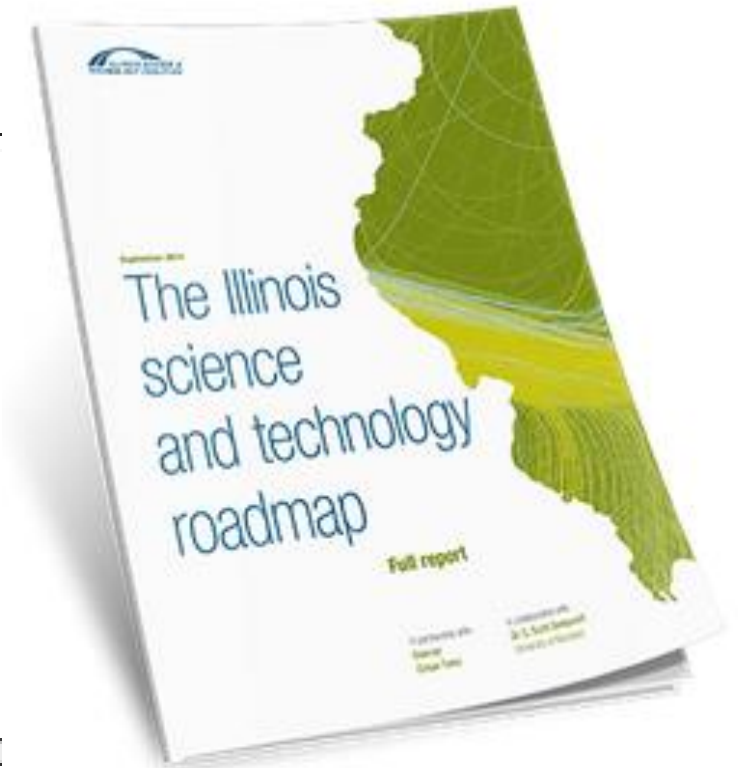
Summary

- Research performance evaluation is becoming **increasingly important and complex** by incorporating **multiple perspectives**
  - Quantitative vs. qualitative measurements
  - Scientific, social, economic dimensions

- Evaluation is very important to **all research stakeholders** (national, institutional, teams and individuals)

- New technologies and tools are allowing **a more qualitative approach to evaluation** and a better understanding about how research fits into the nations ambitions and needs

- By identifying opportunities for **collaborations, especially with companies more recently**, the research community is achieving new levels of effectiveness and **contribution to economic growth and society**
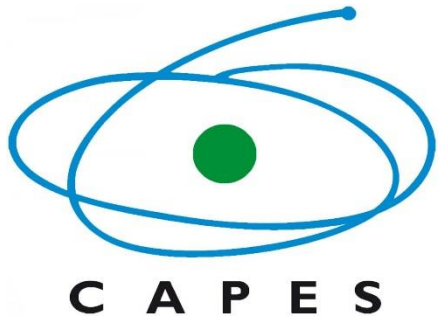
Research Intelligence

Obrigado!

www.elsevier.com/research-intelligence