KU LEUVEN
RESEARCH & DEVELOPMENT

Digitisation shaping libraries, libraries shaping digitisation

Reflections on drivers and performance of library innovation

Koenraad Debackere, IGeLU Conference, September 11-14th, 2023

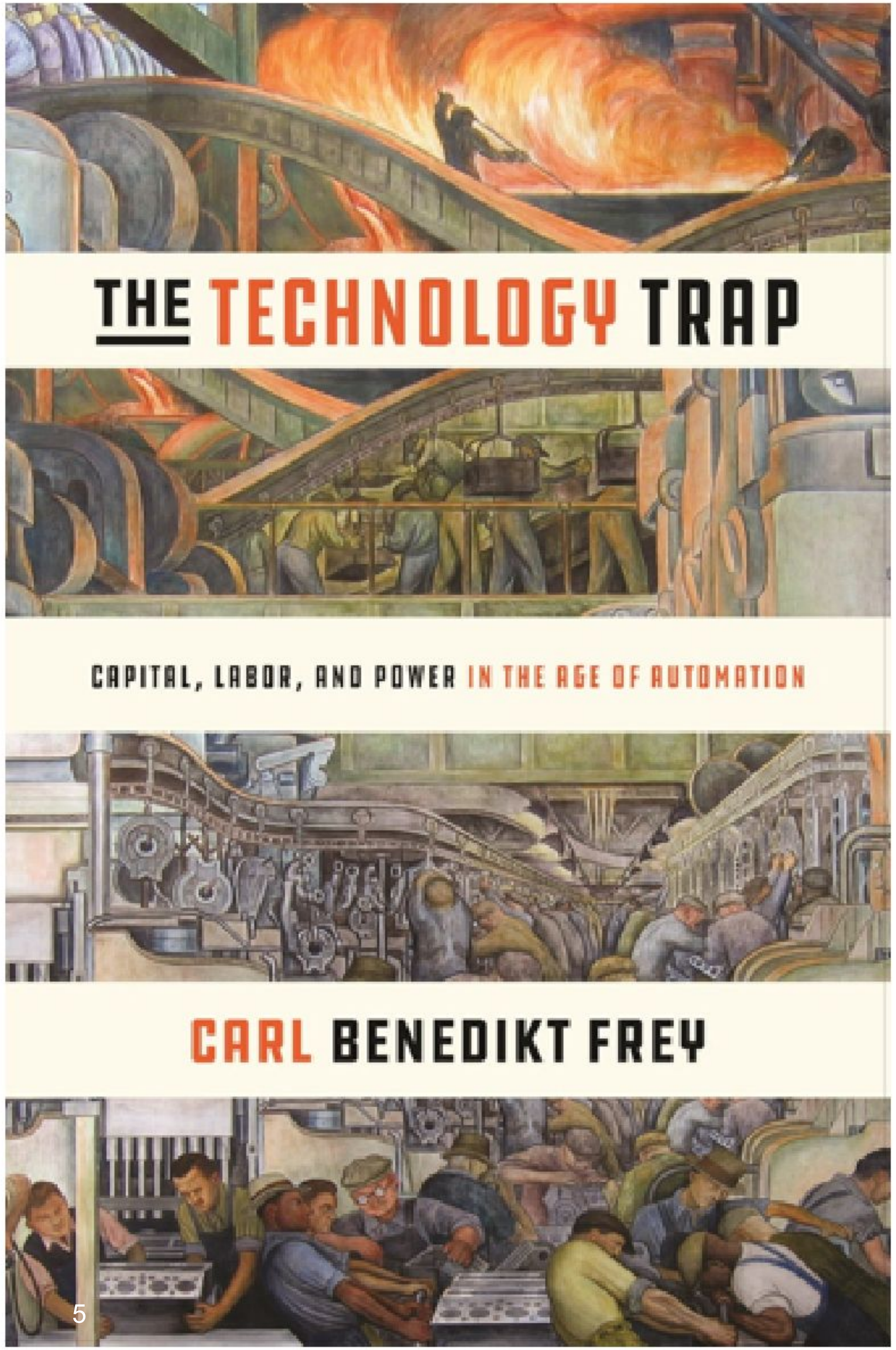
Evolutions,
Digital Societies

| Our world in 2023

1. Complex and connected
2. Multipolar and volatile
3. Transparent and fragile

| Our world in 2023

1. Digital is ubiquitous
2. Transition challenges are huge
3. Regional and global networks & tensions co-exist

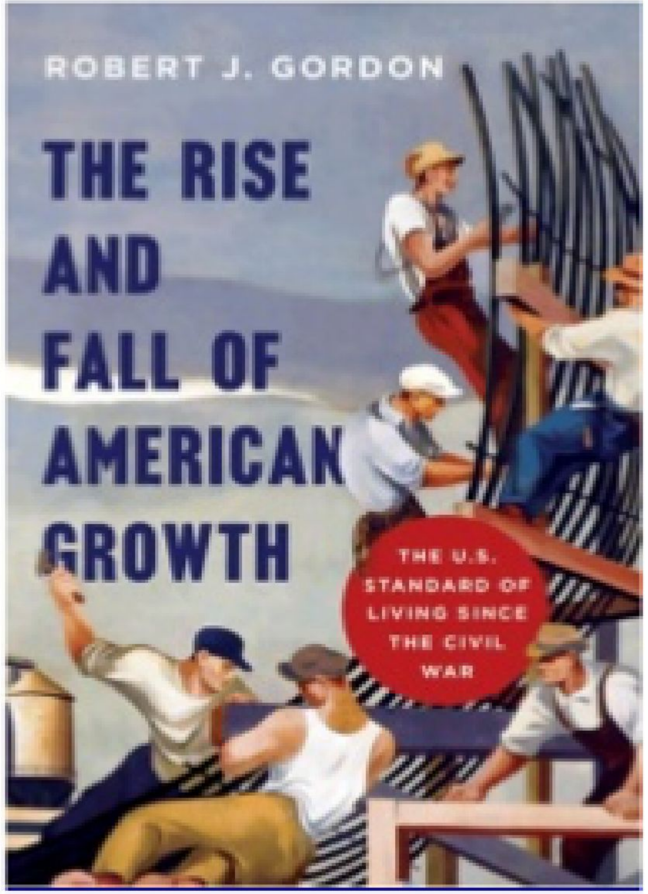


| Our world in 2023

1. The augmented power of creative destruction
2. Anxiety and optimism on technology
3. Though we shape its economic and societal impact

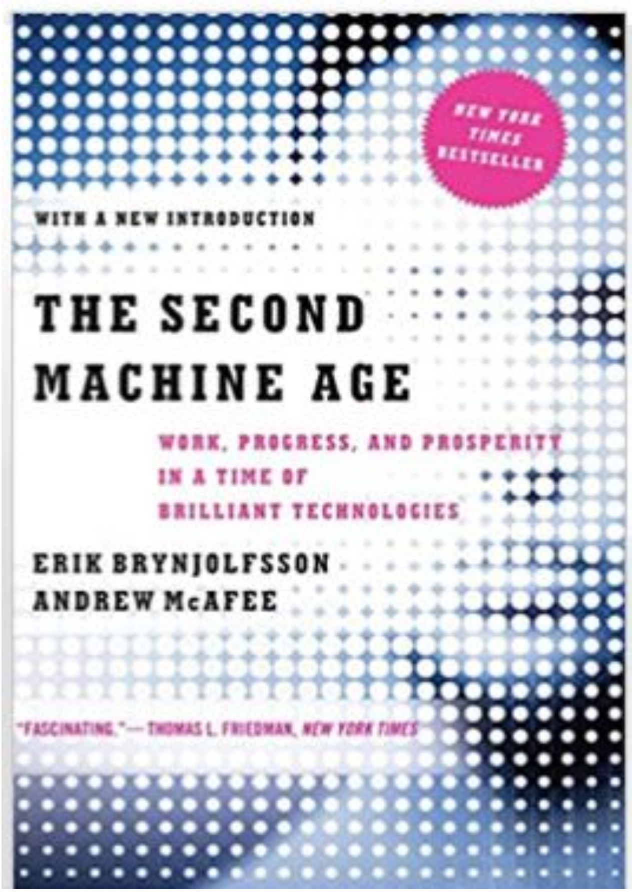
The Digitisation Journey

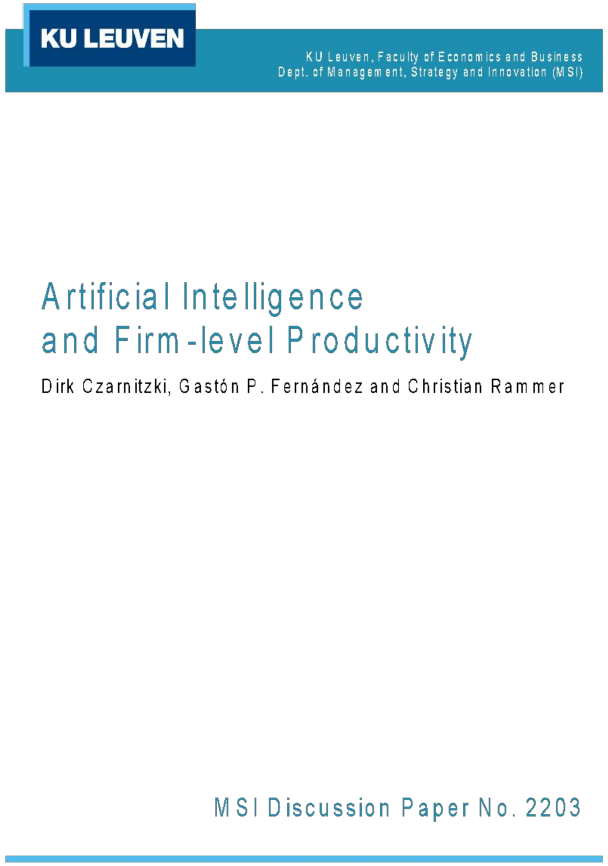
Digitisation and productivity



Gordon is not alone in highlighting the so-called productivity paradox: We see technology everywhere, but not in productivity measures. Some argue that the measurement is wrong, that standard measures of productivity fail to consider the value and benefit of the goods and services of the new economy. How do we value access to Wikipedia on a mobile phone; the power of social media in keeping us connected and informed; and the role of big data analytics in improving production and distribution efficiency? But economists like Gordon respond that such issues are not new at all. Disruptive technologies have come in waves through the centuries, always presenting difficulty in measuring their impact. The data can't have a new (or systematically larger) bias.

Digitisation and productivity





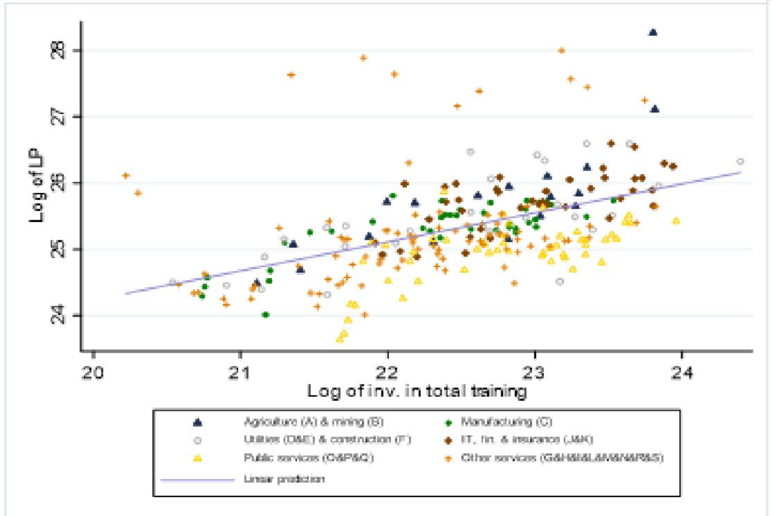
Digitisation and innovation

Invention of a Method of Invention		General-Purpose Technology: NO	General-Purpose Technology: YES
	NO	Industrial Robots (e.g. Fanuc R2000)	‘Sense & React” Robots (e.g. Autonomous vehicles)
	YES	Statically-coded Algorithmic Tools (e.g. fMRI)	**Deep Learning**

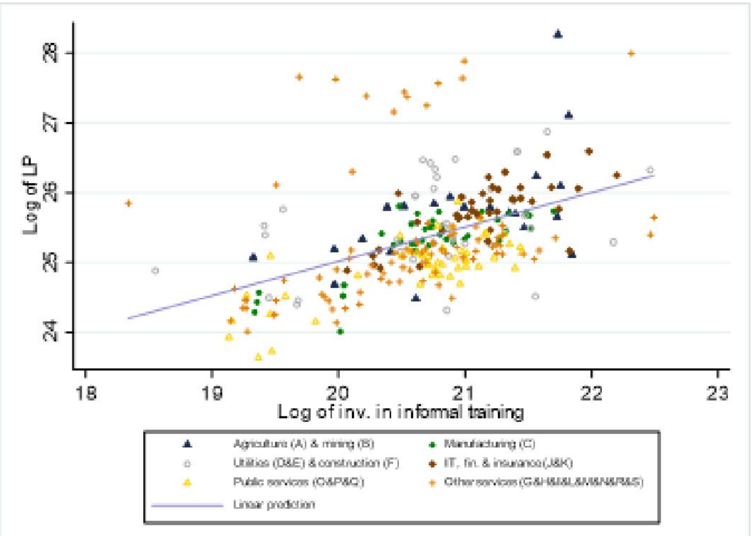
Source: Cockburn, Henderson & Stern, NBER, 2018

Digitisation and talent

Scatter plot: investment in total training and labour productivity



Scatter plot: investment in informal training and labour productivity



The analysis finds that innovative output, the proportion of OC-related workers, investment in training (especially in informal training) and physical capital intensity are positively and significantly related to productivity. In most estimates ICT skills, cognitive skills and the presence of highly skilled workers in an industry also emerge as having a significant and positive relationship with productivity. ICT skills further appear to indirectly shape productivity, through a positive relationship with innovation.

Cammeraat, Samek and Squicciarini,

OECD, March 2021

Innovation Theory and the Library

Library innovation: where it started, lead users

Major finding: *many* users innovate

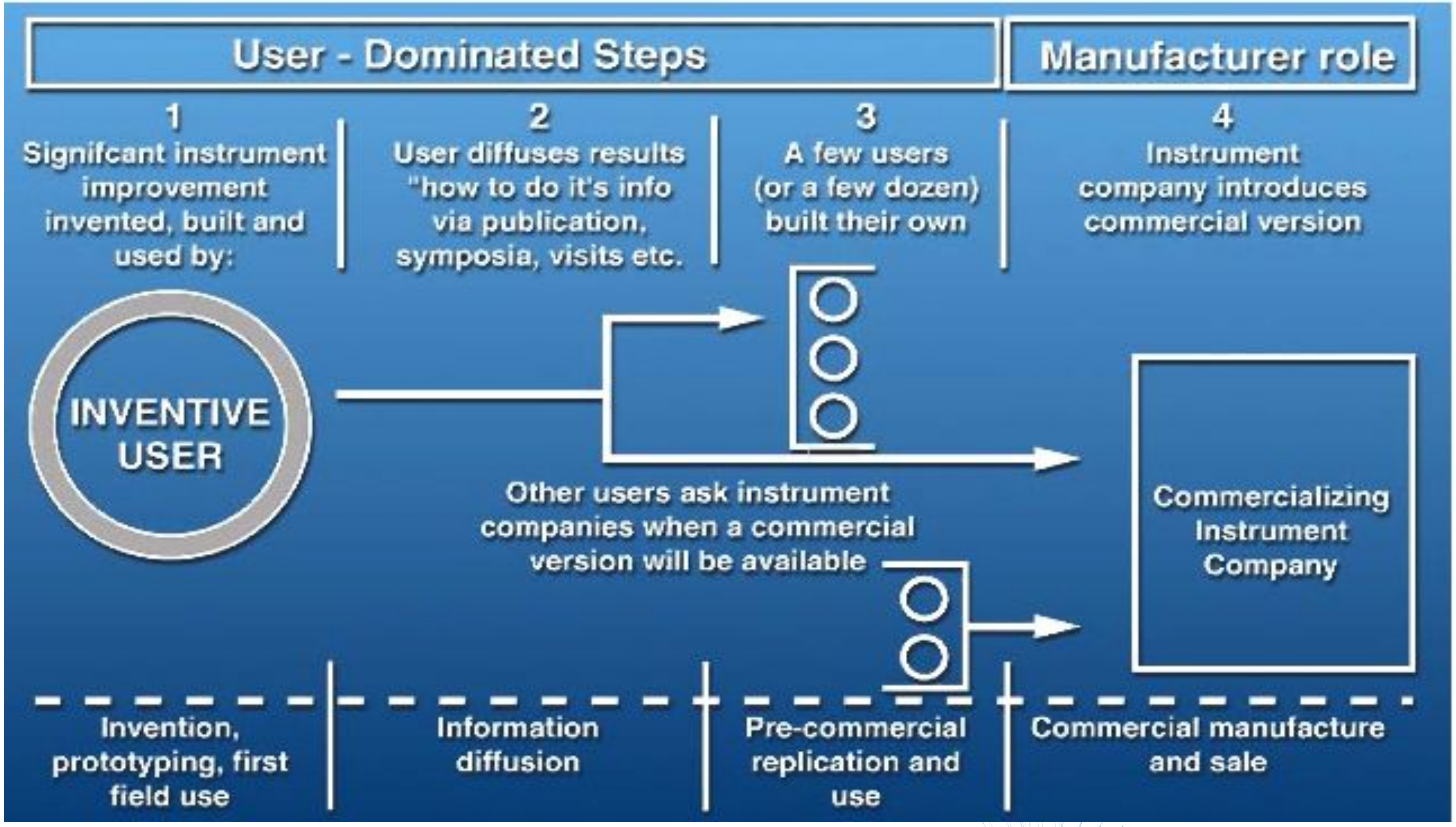
Industrial products	n	% Innovating
Printed Circuit CAD	136	24.3%
Pipe Hanger Hardware	74	36%
Library IT Systems	102	26%
Software security features	131	19.1%
Surgical Equipment	262	22%
Consumer products	**n**	**% Innovating**
Outdoor Products	153	9.8%
"Extreme" sports equipment	197	37.8%
Mountain biking equipment	291	19.2%

Lead Users are users that:

1. Have needs that ***foreshadow general demand*** in the marketplace;
2. Expect to ***obtain high benefit*** from a solution to their needs. (Such users are more likely to innovate – "Necessity is the mother of invention!")

Source: Eric von Hippel, The Sources of Innovation, Oxford University Press, 1988

The lead user driven innovation process



The unique role of lead users

Lead Users foreshadow a general demand trend

Lead Users expect high benefit from innovation

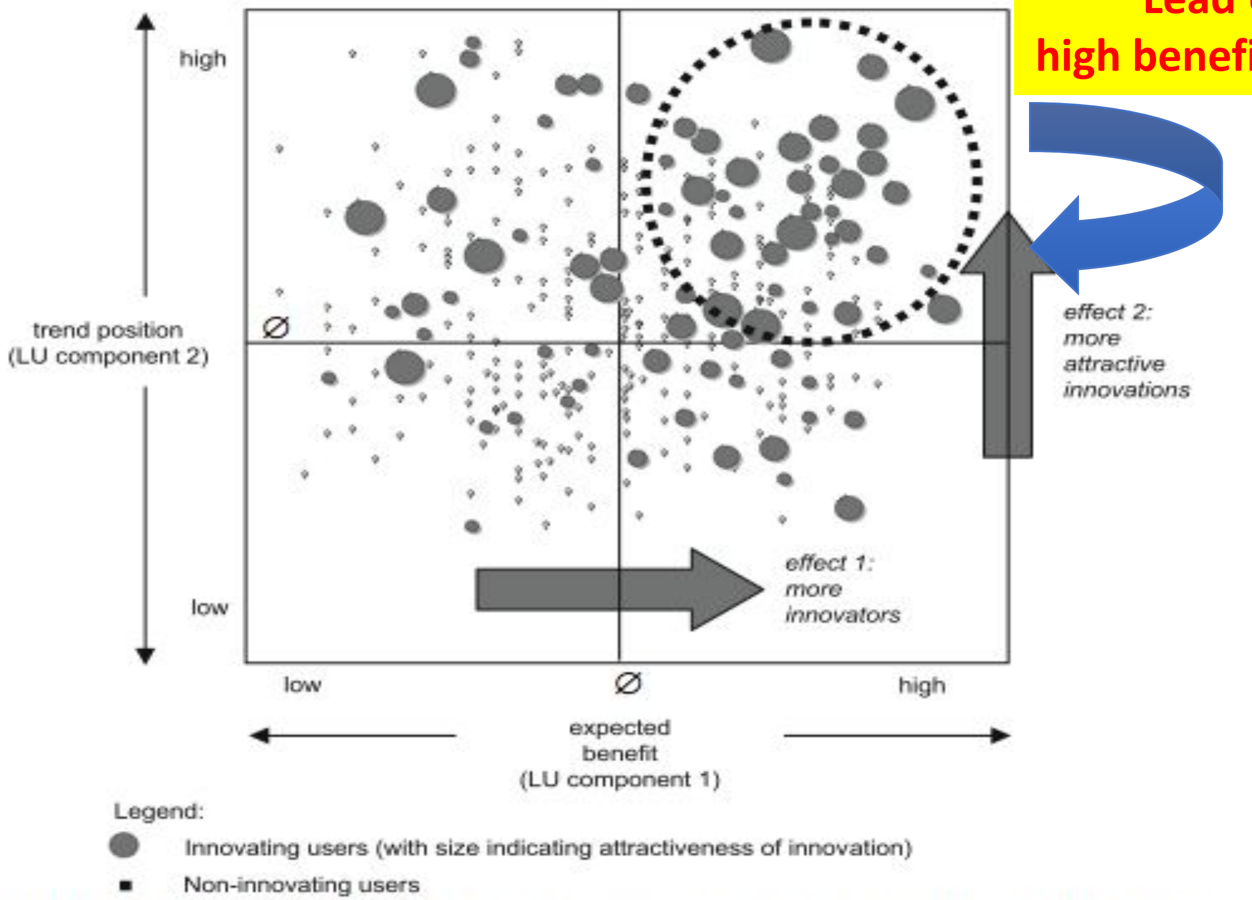


Figure 1. Effects of Lead-User Components (Users with a higher expectation of innovation-related benefit are more likely to innovate—as users move increasingly ahead of the trend, there is an increase in both innovation attractiveness and innovation likelihood; in accordance with lead-user theory, when both lead-user components are high, the largest fraction of users innovate, and average innovation attractiveness is high—see area highlighted in segmented circle)

Lead user impact

Table 1 LU vs. Non-LU Funded Ideas (Census)

	LU ideas ($n = 5$)[2]	Non-LU ideas ($n = 42$)[3]	Sig.
Factors related to value of idea			
Novelty compared with competition[1]	9.6	6.8	0.01
Originality/newness of customer needs addressed[1]	8.3	5.3	0.09
% market share in Year 5	68%	33%	0.01
Estimated sales in Year 5 (deflated for forecast error)	$146m	$18m	0.00
Potential for entire product family[1]	10.0	7.5	0.03
Operating profit	22%	24.0%	0.70
Probability of success	80%	66%	0.24
Strategic importance[1]	9.6	7.3	0.08
Intellectual property protection[1]	7.1	6.7	0.80
Factors related to organizational fit of idea			
Fit with existing distribution channels[1]	8.8	8.0	0.61
Fit with existing manufacturing capabilities[1]	7.8	6.7	0.92
Fit with existing Strategic Plan[1]	9.8	8.4	0.24

[1]These items were measured using a 10-point rating scale, where 10 = high, 1 = low.

[2]Funded LU ideas: all are for major product lines.

[3]Funded non-LU ideas: one is for a major product line, 41 are incremental ideas.

Table 3 What Is a Major (New) Product Line (MNPL) Worth?

	LU MNPL five-year sales forecasts*	Non-LU MNPL five-year sales forecasts and actual*
	1997–2000 ($n = 5$)	1950–2000 ($n = 16$)
Mean	$146m	$62m
Median	$124m	$38m
Range	$67.5m–$232.5m	$11.7m–$276m

Note. Five-year sales forecasts for all major product lines commercialized in 1994 or later (five LU and two non-LU major product lines) have been deflated by 25% in line with 3M historical forecast error experience (see text). Five-year sales figures for major product lines commercialized *before* 1994 are actual historical sales data. This data has been converted to 1999 dollars using the Consumer Price Index from the Economic Report of the President (Council of Economic Advisors 2000).

The Library at the Heart of a Digital Revolution

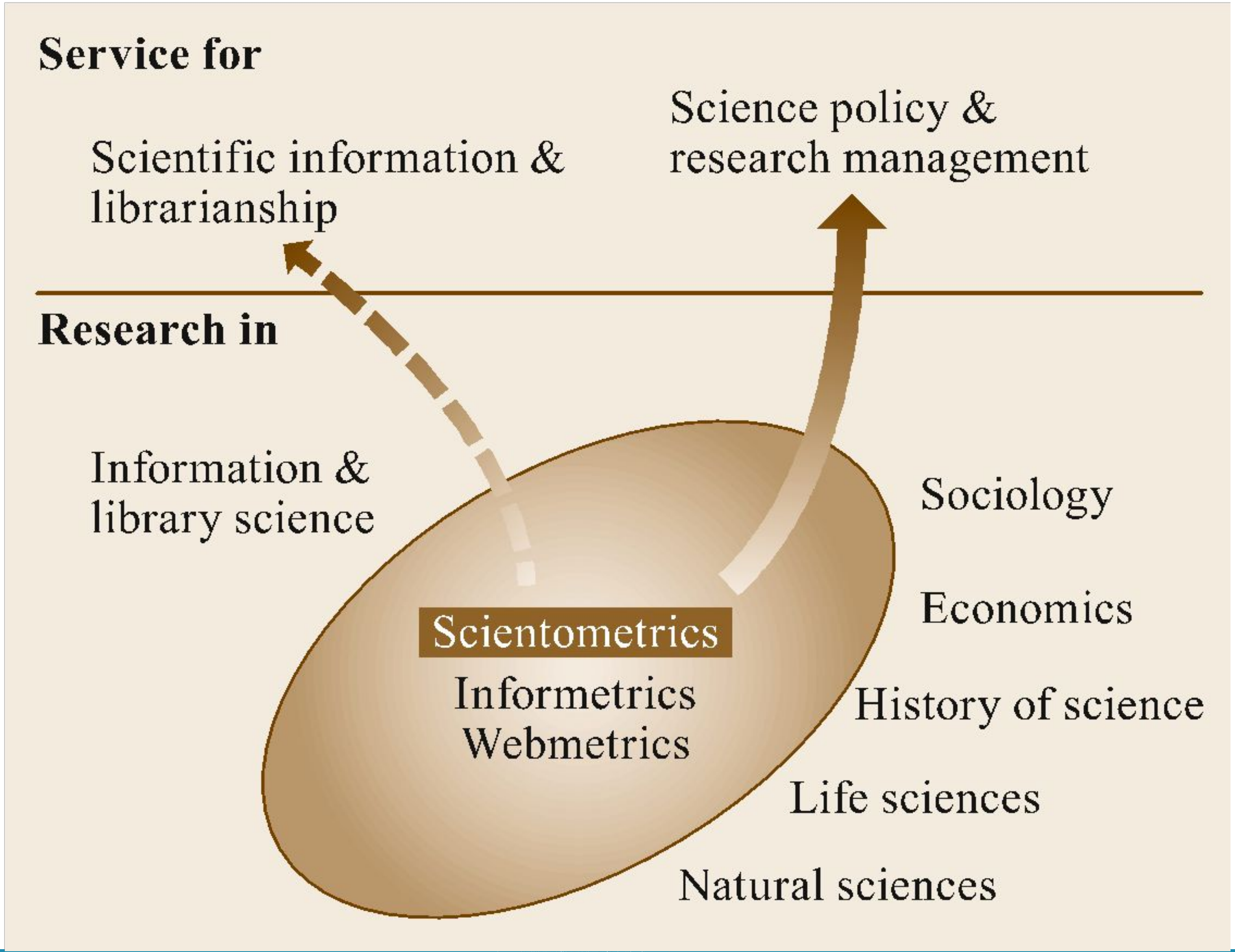
Science, pushing the library’s endless frontier

“The mistake that people sometimes make, and often teach, is that science is a bank of knowledge. After all, the word “science” comes from the Latin scire – to know. But science isn’t just about knowing, it’s about not knowing and having a way to find out.” (Adam Rutherford & Hannah Fry, 2021)

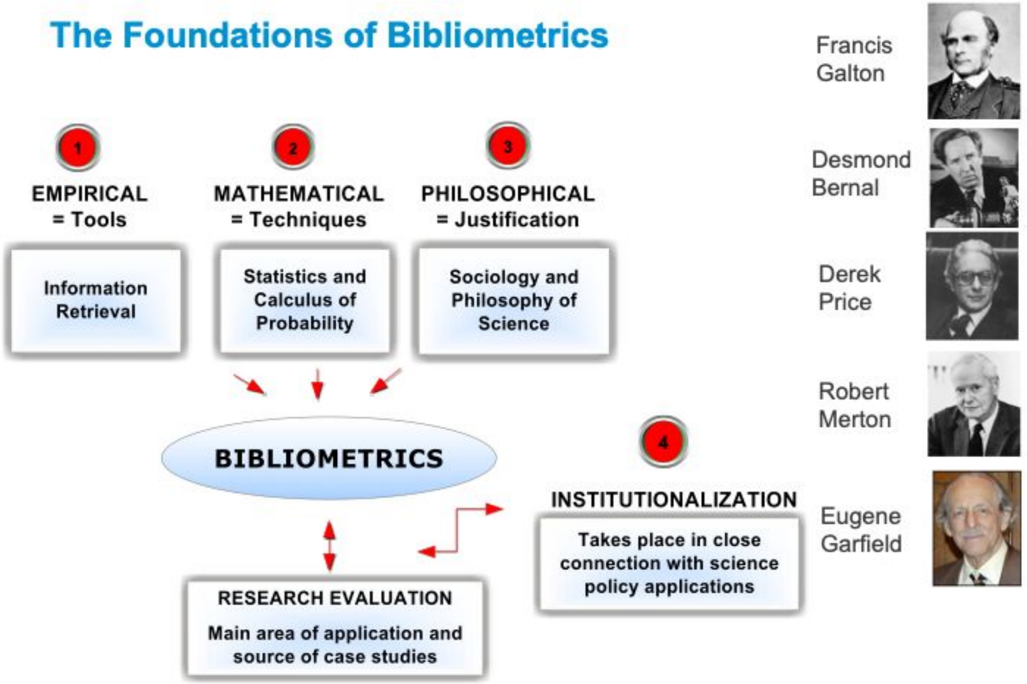
“The iron rule of explanation: (1) strive to settle all arguments by empirical testing, and (2) to conduct an empirical test to decide between a pair of hypotheses, perform an experiment or measurement, one of whose possible outcomes can be explained by one hypothesis (and accompanying cohort) but not the other.” (Michael Strevens’s Knowledge Machine, 2020, building on Thomas Kuhn and Karl Popper).

“The knowledge machine is a social institution governed by the iron law.” Robert Merton and the sociology of science, 1973.

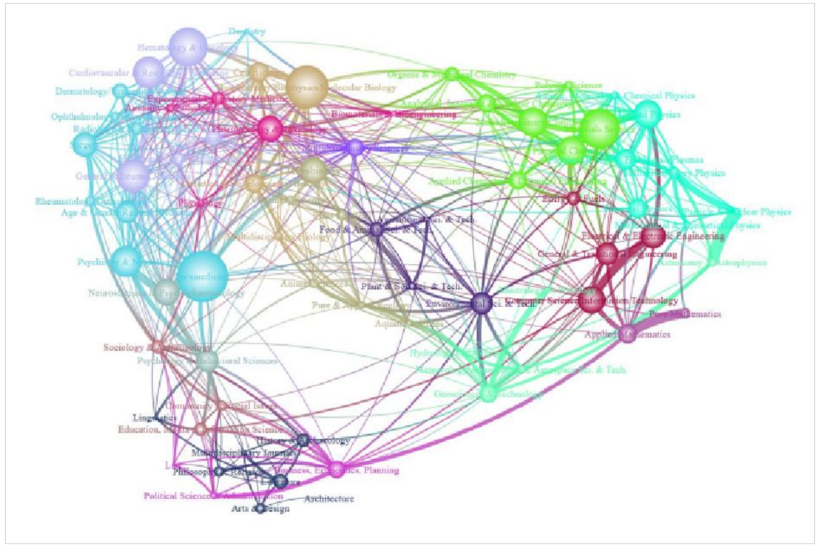
Libraries: wealth of data, wealth of opportunity



Library sciences by digitisation



The cross-citation based structure of the Leuven-Budapest scheme at the discipline level (1999–2018)



Source: ECOOM project *IDR & Impact*; data sourced from on Clarivate Analytics WoS Core Collection

Library sciences understanding science

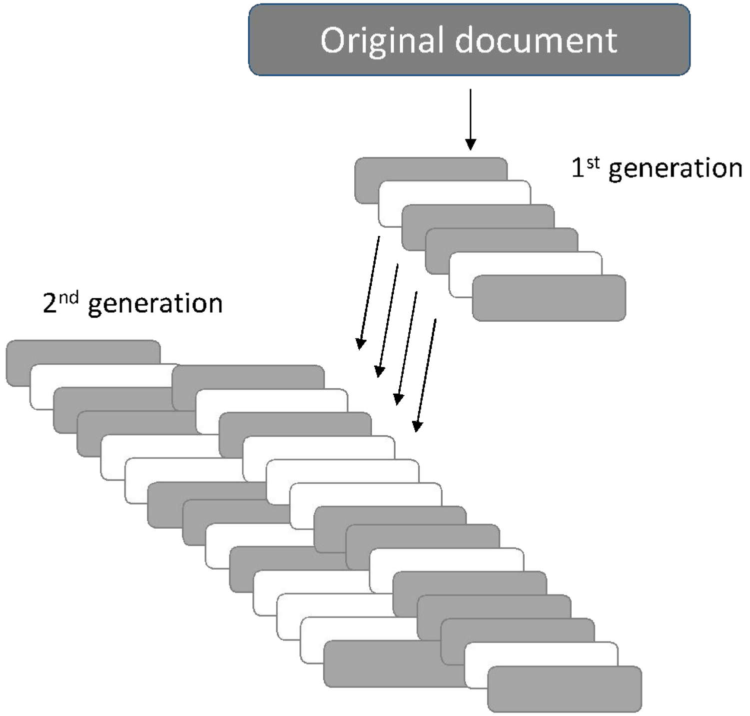
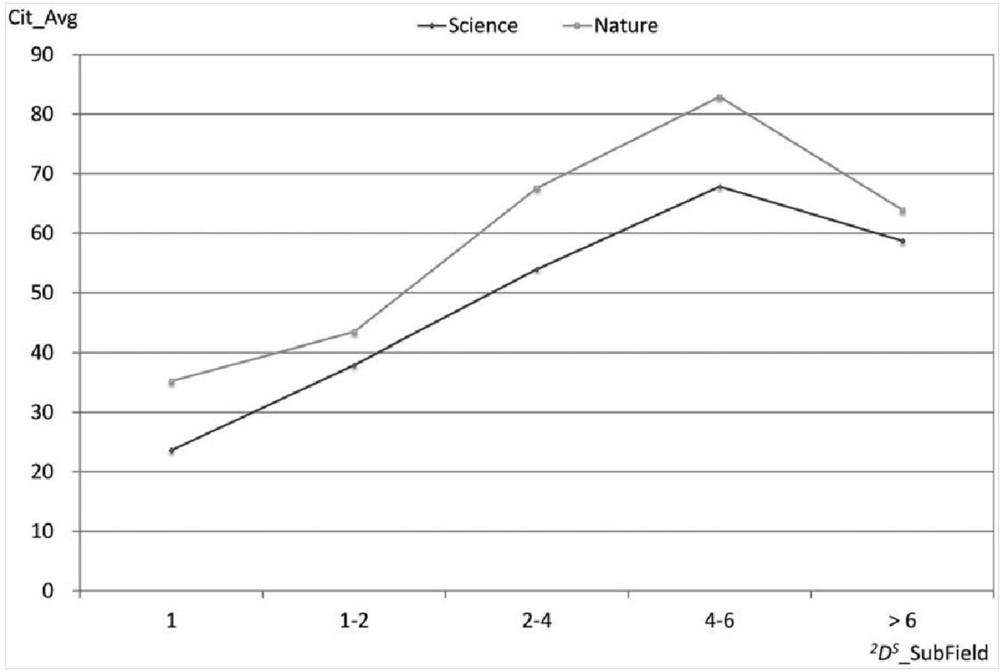


Table 2. The distribution of discipline similarity between 1st and 2nd generation references by major fields, with a colour gradient from red (strong similarity) over white to blue (weak)

Field	[.95,1]	[.9, .95)	[.85, .9)	[.8, .85)	[.75, .8)	[.7, .75)	[.65, .7)	[.6, .65)	.55, 1.6)	[.5, .55)	[.0, .5)
A	0.456	0.268	0.120	0.062	0.034	0.020	0.012	0.008	0.006	0.004	0.009
B	0.484	0.282	0.119	0.054	0.026	0.014	0.008	0.004	0.003	0.002	0.003
C	0.510	0.249	0.109	0.054	0.029	0.017	0.010	0.007	0.004	0.003	0.007
E	0.578	0.199	0.090	0.047	0.027	0.019	0.011	0.008	0.006	0.004	0.011
G	0.729	0.139	0.055	0.028	0.015	0.010	0.007	0.005	0.004	0.003	0.007
H	0.640	0.164	0.076	0.041	0.023	0.020	0.010	0.007	0.006	0.004	0.010
I	0.467	0.280	0.124	0.058	0.029	0.016	0.009	0.006	0.004	0.002	0.005
K	0.368	0.160	0.108	0.077	0.050	0.061	0.032	0.026	0.029	0.023	0.065
L	0.692	0.144	0.064	0.033	0.019	0.015	0.009	0.006	0.005	0.004	0.010
M	0.501	0.241	0.113	0.058	0.032	0.019	0.012	0.008	0.005	0.004	0.008
N	0.675	0.195	0.067	0.029	0.014	0.008	0.005	0.003	0.002	0.001	0.003
P	0.535	0.228	0.101	0.052	0.029	0.018	0.011	0.008	0.005	0.004	0.009
R	0.339	0.295	0.162	0.086	0.047	0.027	0.016	0.010	0.006	0.004	0.008
Y	0.444	0.230	0.117	0.067	0.040	0.030	0.019	0.014	0.011	0.008	0.022
Z	0.484	0.262	0.113	0.056	0.031	0.019	0.011	0.007	0.005	0.004	0.008

Data sourced from Clarivate Analytics Web of Science Core Collection

Library sciences understanding science



As shown in Tables 4–5, the diversity of NPs is significantly lower than that of the top 10% and the median 10% groups, but higher than that of the bottom 10%, suggesting that the knowledge concentration of Nobel Prize winning work is higher than in non-NP work. Moreover, we divided the whole period into three parts based on the Nobel Prize publication year to provide insight into the difference over time in the diversity of NPs and matching groups. The results in Figs. 3–6 indicate that although the diversity of references increased over time, the difference between NPs and conventional research remains, except for NPs in 1980–2016 vs the bottom 10% group in corresponding fields based on *True R-S*. This observation can be considered as an indication that our results are sufficiently stable.

Is low interdisciplinarity of references an unexpected characteristic of Nobel Prize winning research?

Xian Li[1] · Ronald Rousseau[2,3] · Liming Liang[4] · Fangjie Xi[1] · Yushuang Lü[1] · Yifan Yuan[1] · Xiaojun Hu[1]

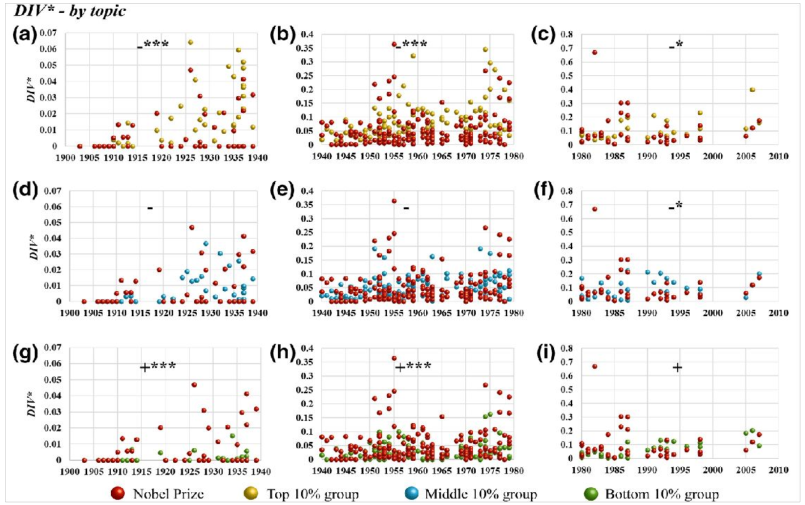
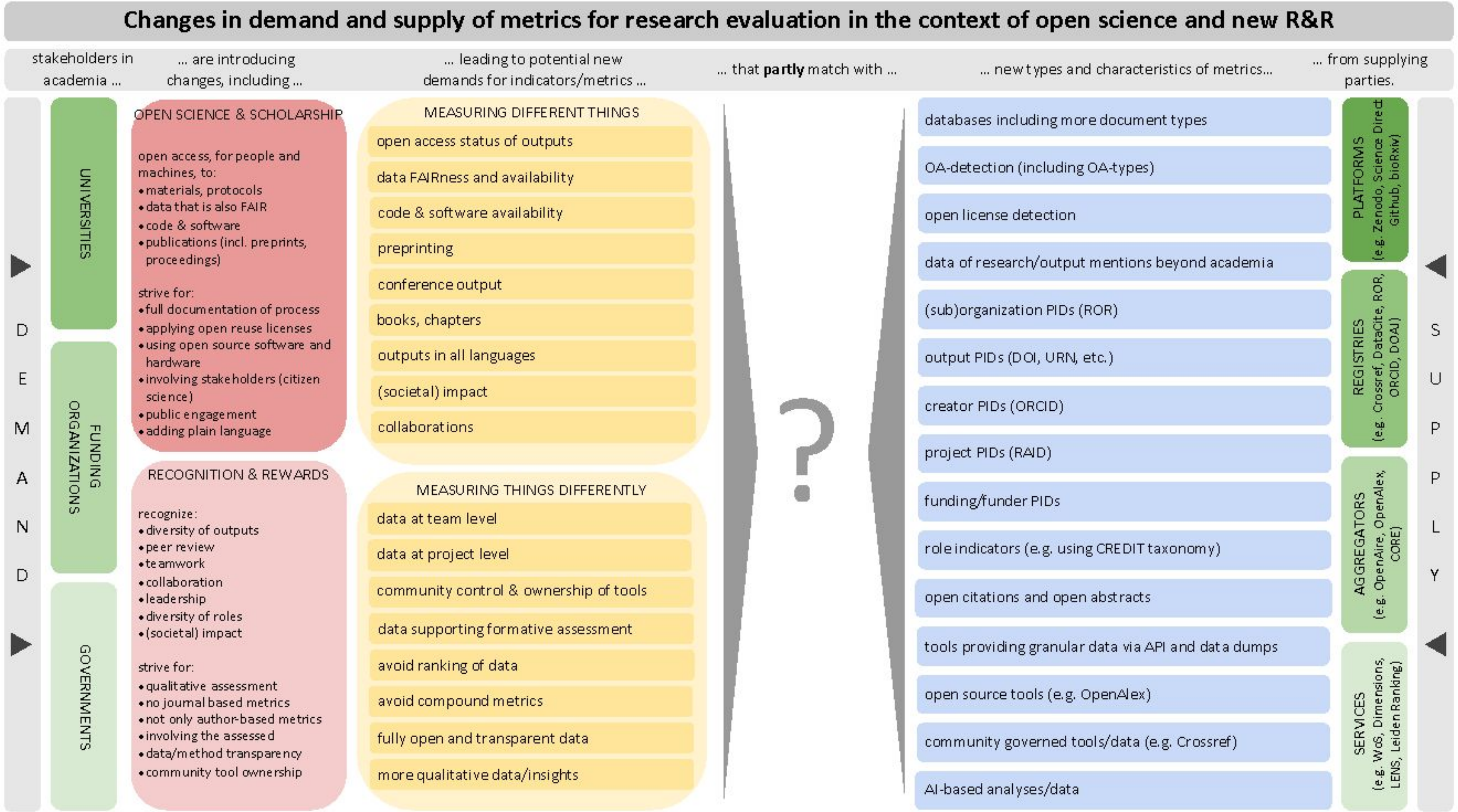


Fig. 5 The DIV* of NPs and matching groups per year with common topics

The Library – Digitisation Symbiosis

Open science at the heart of digitisation



The broader context (EOSC …)

1. Human Resources
All researchers are trained "open science" scientists and proper investments have been made in human resources and training

2. Rewards and Incentives
Open Science is recognized in the research reward and funding system

3. Legal Aspects
As open as possible, as closed as necessary is implemented and not only a principle.

4. Infrastructure
Researchers can rely on open and sustainable infrastructure to support Open Science

5. Reuse of Data
Reuse of data is a common practice and has led to scientific and societal innovations

6. Quality of Research
More reproducible and replicable research thanks to Open Science

7. Open Access for Publications
Academia has (re)taken control on the publishing and dissemination of research outputs

8. Societal Role
Open Science has closed the gap between research and society

9. Digital Technology
Digital technologies and Open Science have transformed scientific practices profoundly

10. Change of Mindset
A shared belief in the transformative potential of Open Science has been embraced

The library in the science ecosystem

THANK YOU

What If?

What if an AI won the Nobel prize for medicine?

Controversy ensues when the greatest prize in medical research is awarded to a non-human. An imagined scenario from 2036