Rotunde, 10:15-11:00

Understanding impact

Dietmar Harhoff (Chair)

Wiljan van den Akker

Isabel Roessler

Toby Smith

Understanding impact

Dietmar Harhoff (Chair)

Director, Max Planck Institute for Innovation and Competition, Germany

Science Quality and the Value of Inventions

Dietmar Harhoff

Max Planck Institute for Innovation and Competition

Impact of Science – AESIS Conference

Allianz Forum, Berlin - June 6/7 2019

MAX-PLANCK-GESELLSCHAFT

Research Questions

- Inspired by: Tom Allen, Harvey Brooks, Ashton Carter, Lewis Branscomb, Rebecca Henderson, Mike Scherer …
- Relating technology and science (and their knowledge bases) to each other offers interesting opportunities for learning about knowledge production and utilization
- Some research questions

  - **Is high-quality science more likely to be selected for technology development?**
  - **Does high-quality science (measured in science space) *lead to* high-value technology (measured in technology/commercial space)?**
  - **Does the combination of science from different fields (interdisciplinarity) make for „better“ technology?**

A New Look at the Path from Science to Technology

The “Research Lens“ – Example: WO2011075861A1

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Published:

— *with international search report (Art. 21(3))*

— *with sequence listing part of description (Rule 5.2(a))*

Excerpt from the Search Report

[X]US2005069539 (COHEN BRUCE D [US], et al) [X] 1,2,12-15 * claims paragraphs [0008], [0044], [0125] - [0148] *;
[XP]WO2009155725 (ESBATECH AN ALCON BIOMEDICAL R [CH], et al) [XP] 12-14 * pages 2-5, 16-20 *;
[XP]WO2009155726 (ESBATECH AN ALCON BIOMEDICAL R [CH], et al) [XP] 12-15 * pages 14 - 16, 50 claims *

[I] - XIONG S ET AL, "ENGINEERING VACCINES WITH HETEROLOGOUS B AND T CELL EPITOPES USING IMMUNOGLOBULIN GENES", NATURE BIOTECHNOLOGY, NATURE PUBLISHING GROUP, NEW YORK, NY, US, (19970901), vol. 15, no. 9, doi:DOI:10.1038/NBT0997-882, ISSN 1087-0156, pages 882 - 886, XP000918882 [I] 1-16 * the whole document *
DOI: http://dx.doi.org/10.1038/nbt0997-882

[A] - HONEGGER A ET AL, "Yet Another Numbering Scheme for Immunoglobulin Variable Domains: An Automatic Modeling and Analysis Tool", JOURNAL OF MOLECULAR BIOLOGY, LONDON, GB, (20010608), vol. 309, no. 3, doi:DOI:10.1006/JMBI.2001.4662, ISSN 0022-2836, pages 657 - 670, XP004626893 [A] 1-16 * the whole document * * figure 4 *
DOI: http://dx.doi.org/10.1006/jmbi.2001.4662

[AD] - NAGATA S ET AL, "Removal of B cell epitopes as a practical approach for reducing the immunogenicity of foreign protein-based therapeutics", ADVANCED DRUG DELIVERY REVIEWS, ELSEVIER BV, AMSTERDAM, NL, vol. 61, no. 11, doi:DOI:10.1016/J.ADDR.2009.07.014, ISSN 0169-409X, (20090930), pages 977 - 985, (20090811), XP026666157 [AD] 1-16 * the whole document *
DOI: http://dx.doi.org/10.1016/j.addr.2009.07.014

A New Look at the Path from Science to Technology

Data Exercise in the Background

- Supported by Max Planck Digital Library – deep knowledge in bibliometrics, machine learning, Web of Science and Scopus data
- PATSTAT version 2017-04: 33.2 million NPL records
- 6.0 million records for EP/WO documents, 3.1 million from applicants, 2.9 million from examiners
- Many technical issues in matching and disambiguation, scaling

arXiv.org > econ > arXiv:1903.05020

Search or Article

(Help | Advanced search)

Economics > General Economics

Science Quality and the Value of Inventions

Felix Poege, Dietmar Harhoff, Fabian Gaessler, Stefano Baruffaldi

(Submitted on 12 Mar 2019)

Despite decades of research, the relationship between the quality of science and the value of inventions has remained unclear. We present the result of a large-scale matching exercise between the universes of 4.8 million patent families and 43 million publication records. We find a strong positive relationship between quality of scientific contributions referenced in patents and the value of the respective inventions. We rank patents by the quality of the science they are linked to. Strikingly, patents in the top decile are twice as valuable as patents in the bottom decile, which in turn are about as valuable as patents with no direct science link. We show this core result for various measures of science quality and patent value. The effect of science quality on patent value remains relevant even when science is linked indirectly, i.e., through other patents. Our findings imply that what is considered "excellent" within the science sector also leads to outstanding outcomes in the technological or commercial realm.

Comments: 42 pages

Subjects: **General Economics (econ.GN)**; Digital Libraries (cs.DL)

Cite as: **arXiv:1903.05020 [econ.GN]**

(or **arXiv:1903.05020v1 [econ.GN]** for this version)

A New Look at the Path from Science to Technology

Some Descriptive Statistics

Table S1: Structure of the dataset

Scientific publications (1980-2012)	Total	Excluding social/humanities	Excluding self-references
Scientific publications	42 962 463	35 874 824	
Scientific publications in SNPL references	2 248 563	2 203 035	2 079 713
Scientific publications in SNPL references (within five years)	1 627 872	1 597 426	1 465 312
Patent families (1985-2012)	**Total**	**EPO**	**USPTO**
Patent family - SNPL reference combinations	6 962 239	1 009 481	6 177 977
Unique SNPL references	2 229 658	575 637	2 017 694
Patent families	4 767 844	1 960 772	4 442 742
Patent families with SNPL references	952 932	490 848	921 929

Notes: Observation counts in the dataset. Discrepancies originate from the different views on the data. The first part of the table also considers SNPL citations from the 1980-1984 range, whereas the second part does not.

A New Look at the Path from Science to Technology

Some

Descriptive

Statistics

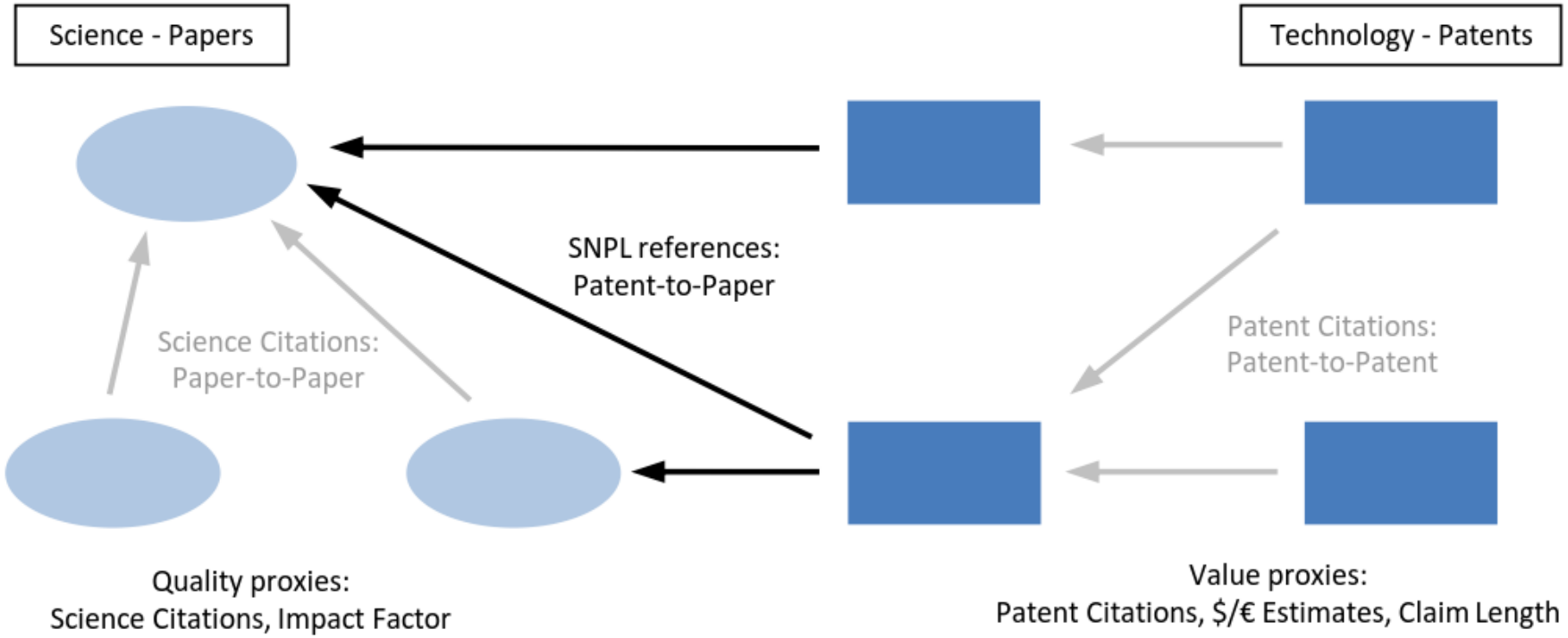
Table S2: Match quality

Office	Precision	Recall
EPO	0,99	0,96
USPTO	0,99	0,92
WIPO	0,99	0,97

Notes: Based on a manual validation exercise of 1000 NPL references per office, as reported in (*15*). Precision is the share of NPL reference matches that was correct. Recall is, when considering all NPL references that could have been matched, the share that were matched correctly.

A New Look at the Path from Science to Technology

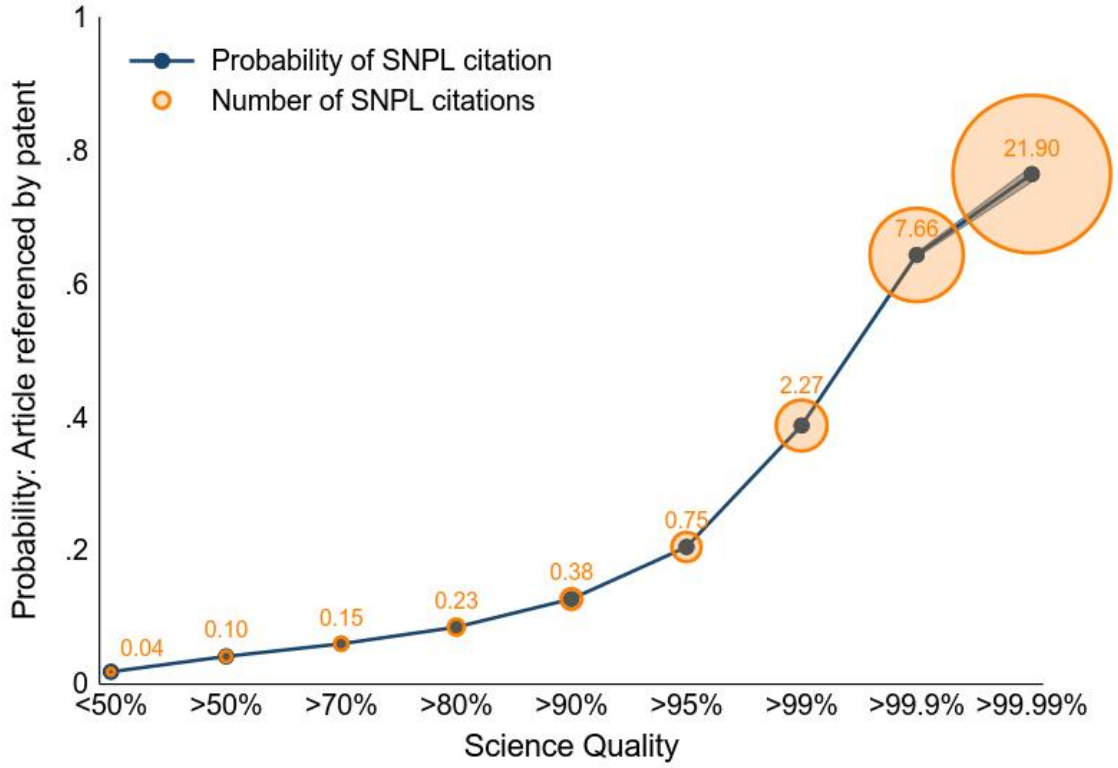
Setting for the empirical analysis



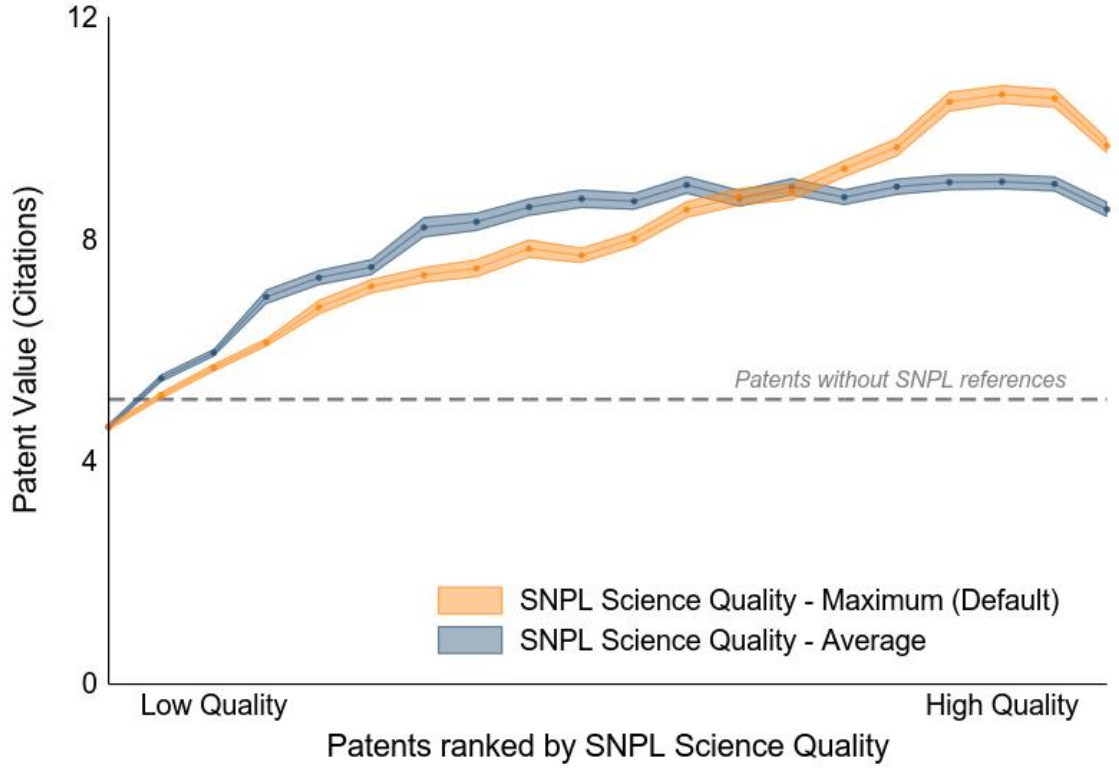
(a) Setting: The domains of science (left), technology (right) and patent-paper references

A New Look at the Path from Science to Technology

Some results



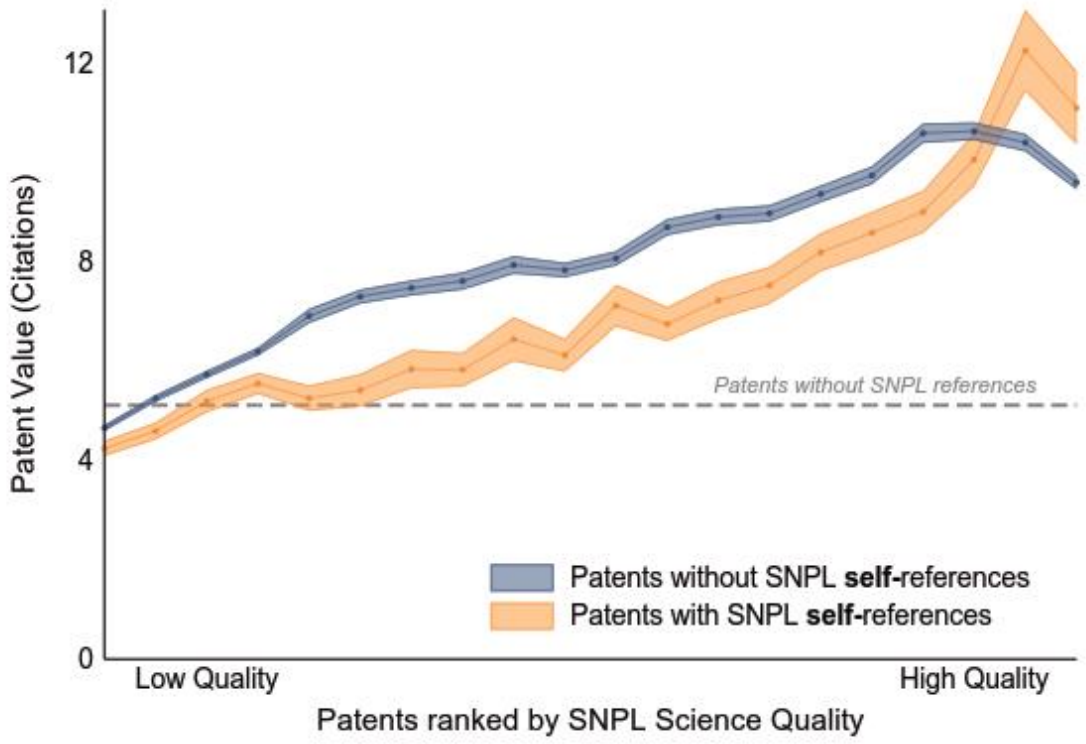
(b) SNPL references by science quality



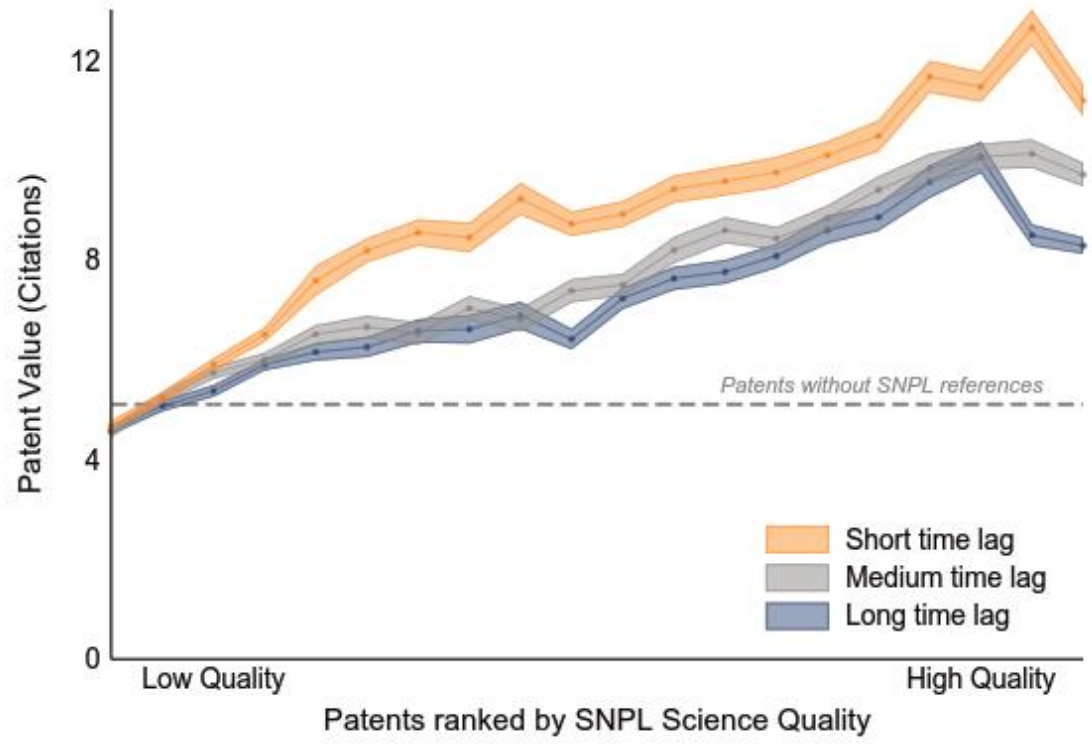
(c) Patent value by SNPL science quality

A New Look at the Path from Science to Technology

Some results



(a) SNPL self-references

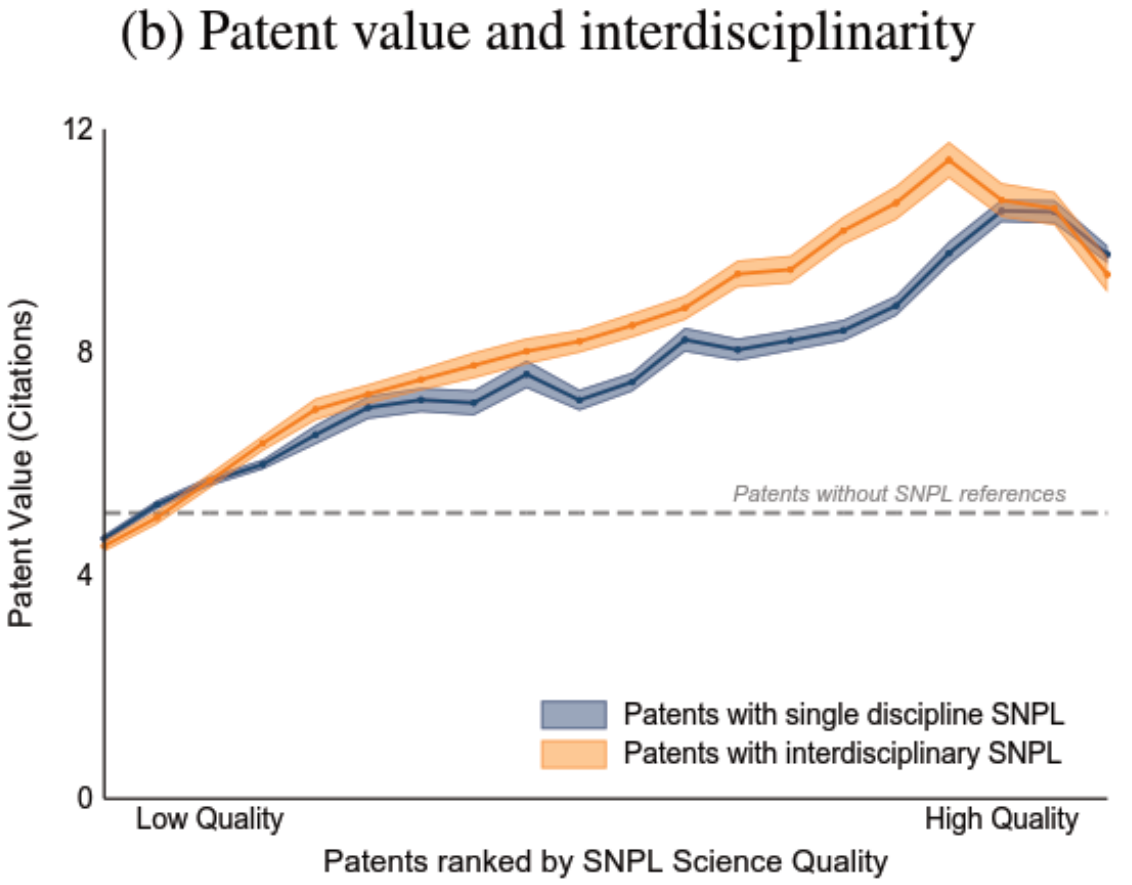


(c) Patent value by SNPL science quality and time

A New Look at the Path from Science to Technology

Interdisciplinarity

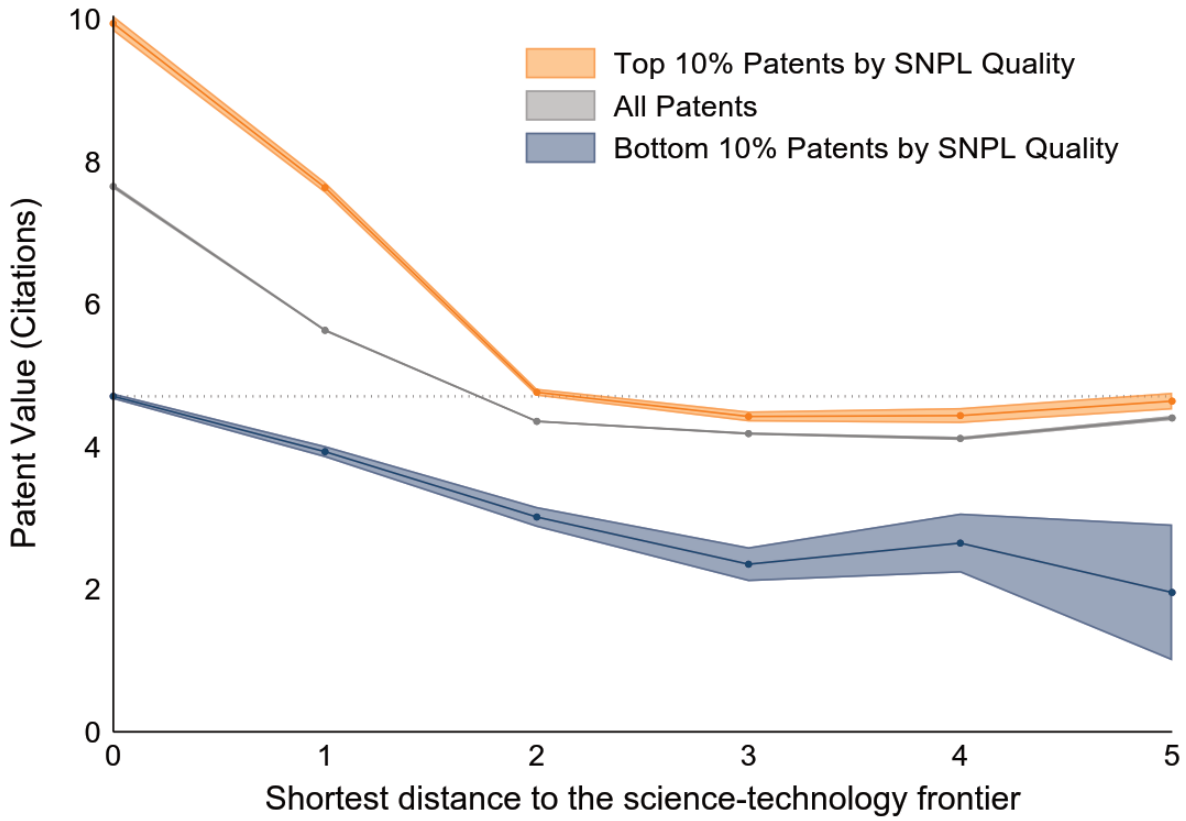
- patents with single discipline SNPLs appear to have lower value than patents with multiple discipline SNPLs
- to be explored further with other measures of inter-/multidisciplinarity



A New Look at the Path from Science to Technology

Some results

- Distance D = length of shortest path to a patent with SNPL reference (Ahmadpoor & Jones 2017)
- indirect citations (via another patent) are relevant
- science quality matters largely for distances D=1 and D=2



(b) Patent value by distance to the scientific frontier and SNPL science quality

Notes: SNPL science quality is the maximum 3 year citation count across scientific publications appearing as SNPL references in a patent. Patent value is measured as the 5 year count of patent forward citations by US patents. Patent value and science quality are residualized using technology field × first filing year FEs. Shaded areas show 95% confidence intervals around the respective means.
a) SNPL self-references of the highest-quality SNPL reference are considered. N = 4,767,844 patents (952,932 with SNPL references).
b) The distance to the science frontier (x-axis) is measured as the shortest path to a patent with SNPL references in the patent references network. For patents not at the science frontier, SNPL science quality is the maximum SNPL science quality in patents at the frontier to which they are linked. N = 3,816,176
c) Time-distance is measured as the lag between the first filing year of the patent and the publication year of the scientific publication in SNPL references with the the highest science quality. N = 4,767,844 patents (952,932 with SNPL references).

Research Questions

- Citation measures as used in science are positively related to patent value.
- Trivial? Not in any way …
- Technologists are not guided by citation statistics, but by profit expectations.
- Citations and these expectations conincide to some degree – that is a statistical accident.
- What to do with it?

Understanding impact

Wiljan van den Akker

Director of the Centre for the Humanities, Utrecht University &
Author Impact report LERU, Netherlands

MOST STRATEGIC PROGRAMS

1. TEACHING

2. RESEARCH

3. SOCIETAL IMPACT

- **TEACHING IS OUR BIGGEST IMPACT**

- **TEACHING IS OUR BIGGEST IMPACT**

- **RESEARCH**
  - driven by curiosity
  - risk and (repeated) failure
  - unpredictability / serendipity
  - timespan – short / long
  - conceptually identical for all disciplines
  - range from fundamental to applied

IMPACT IS *NOT* A THIRD PART OF ACADEMIA

IMPACT IS *NOT* A THIRD PART OF ACADEMIA

WRONG WAY OF THINKING

LINEAR (TRL)

OUTPUT: 'LANDING' IN/ON SOCIETY

IMPACT IS A VITAL PART OF TEACHING + RESEARCH

RIGHT WAY OF THINKING

DYNAMIC (SRL INSTEAD OF TRL)

SOCIETAL STAKEHOLDERS FROM THE START

Societal Demands/Challenges:

Grand Societal Challenges

Health, demographic change […]

Food security […]

Secure, clean and efficient energy

Smart, green and integrated transport

Climate action, environment […]

Europe in a changing world […]

Secure societies

Sustainable Development Goals

- No poverty
- Affordable and clean energy
- Zero hunger
- Good health and well being
- Quality education & lifelong learning for all
- Gender equalitY
- Clean water and sanitation
- Decent work and economic growth
- Industry, innovation, infrastructure
- Peace, justice and strong institutions
- […]

- **EVERY ACADEMIC HAS TO TELL A STORY**

WILJAN VAN DEN AKKER & JACK SPAAPEN:

http://www.leru.org/files/publications/LERU_Position_Paper_Societal_Impact.pdf

Understanding impact

Isabel Roessler

Senior Project Manager, Centre for Higher Education (CHE), Germany

CHE
Centre for
Higher Education

About the right language

Dr Isabel Roessler | CHE | 07 June 2019

Impact of Science Conference | Berlin

CHE
Centre for
Higher Education

Creating an **impact** is **not** a question of **loudness**.

HEI can focus on impact in general…

„We will therefore be located in the knowledge triangle and will design our teaching excellently, position our research according to expectations and contribute to innovation in the sense of social innovation.“
UAS rector

We take teaching or research, education and transfer as a triad, which we want to see together as a unity. We must do everything with a very high quality in order to achieve a certain level of excellence as a university. That is our objective at the moment.
UAS rector

We want knowledge not only to be generated.
More importantly: knowledge is applied. Knowledge is brought from the university into the environment, is applied to business, is applied in the municipality, is applied to social institution, is applied in politics, is applied in society. This transfer from A to B is done by us. This is how we build our reputation, make ourselves useful outside.
#UAS rector

…or can have impact in various smaller kinds

What: Teddy hospital

Impact: take away the fear.

Source: SVZ.de, zB Uni Kiel, Uni Münster

…or can have impact in various smaller kinds

Source: HS Bremen, Projekt „ThinkMusic!“

What: Culture for disadvantaged children

Impact: Access to culture, experience, overcoming cultural barriers

…or can have impact in various smaller kinds

Quelle: HS Magdeburg-Stendal

What: Integration of Refugees

Impact: Enabling of a successful integration, increase of acceptance

…or can have impact in various smaller kinds

Source: MZ, zB HTWK Leipzig

What: Development of district concepts

Impact: Social and regional development

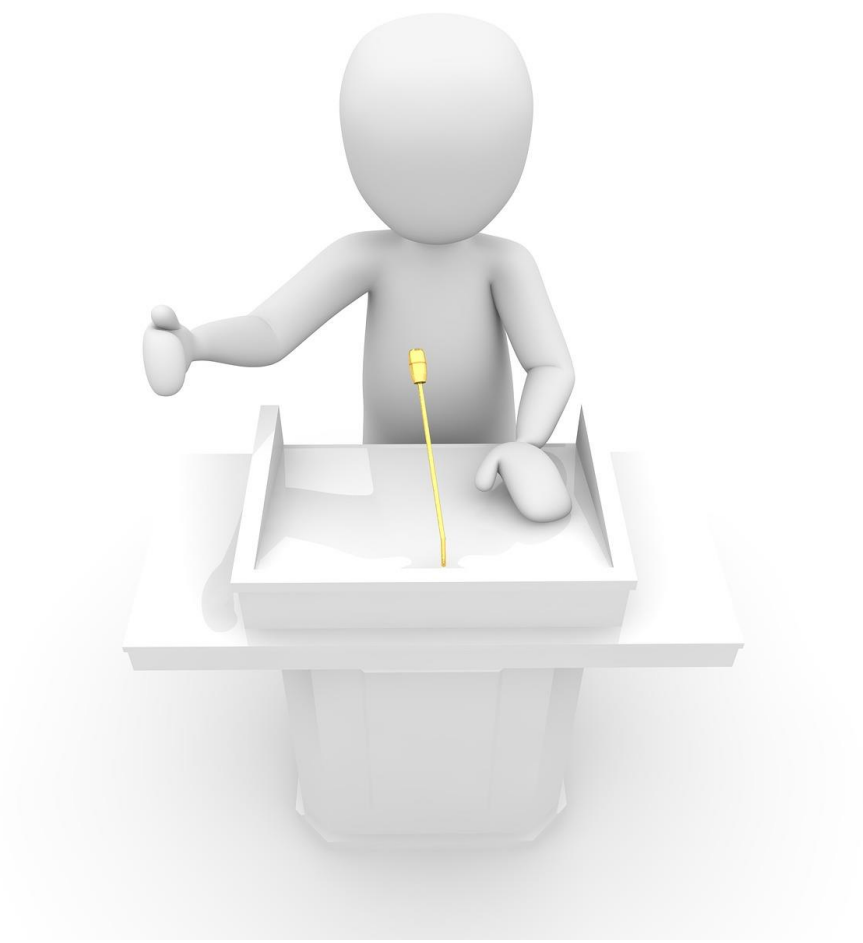
Our lessons learned: Science has an impact. Whether you like it or not.

CHE
Centre for
Higher Education

- **Become clear** what you want to achieve
- **Think** about impact from the beginning on
- **Use indicators** to measure your work
- Make sure, that you are able to **address the target groups**

„If you want to have an **impact** on other people, you first have to **talk** to them **in their language**."

Kurt Tucholsky



CHE
Centrum für Hochschulentwicklung

Today, a university education is open to almost everyone. Universities and politics must make a successful study possible.

We offer impulses and solutions.

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Understanding impact

Toby Smith
Vice President of Policy at the
American Association of Universities, USA

WHAT IS IMPACT… AND WHY DO WE CARE?

Tobin L. Smith, Association of American Universities

Impact of Science 2019

Allianz Forum, Berlin, Germany

7 June 2019

Association of American Universities

WHY DO SCIENTISTS CARE ABOUT IMPACT?

Association of American Universities

WHY DOES THE PUBLIC CARE ABOUT IMPACT?

Association of American Universities

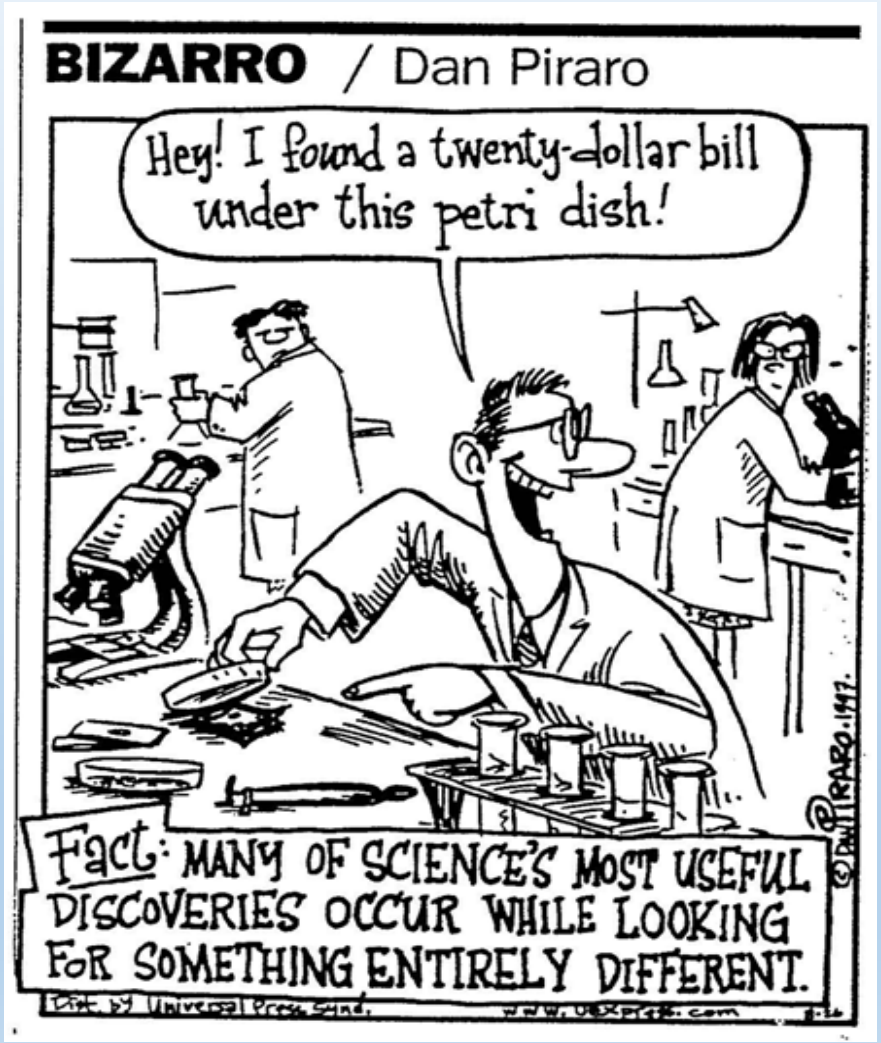
Governments View of Impact

By Cartoonist Sidney Harris in the American Scientist

Association of American Universities

Challenge in Demonstrating Impact

- Cannot easily predict scientific outcomes
- Societal value & impact are often not immediately known
- Full social & economic impacts are impossible to assess in the short-term
- Scientists & the public view & measure impact differently



Association of American Universities

IMPACT IS IN THE EYE OF THE BEHOLDER

Association of American Universities

Historical Discussions Around Measuring Impact

- *NSF Traces Study*
- *Bibliometrics*
- *Economic Impact*
- *Multipliers & ROI*

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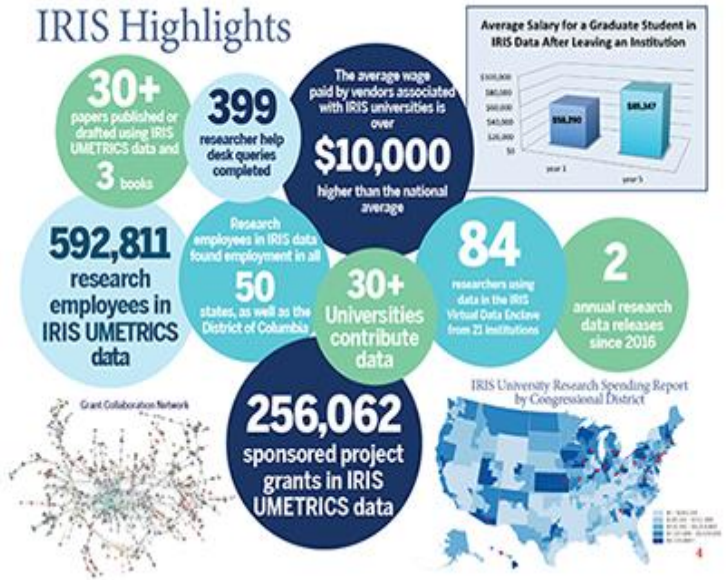
IRIS INSTITUTE FOR RESEARCH ON INNOVATION & SCIENCE



THE GOLDEN GOOSE AWARD

DATA VS. CASE STUDIES AND IMPACT STORIES

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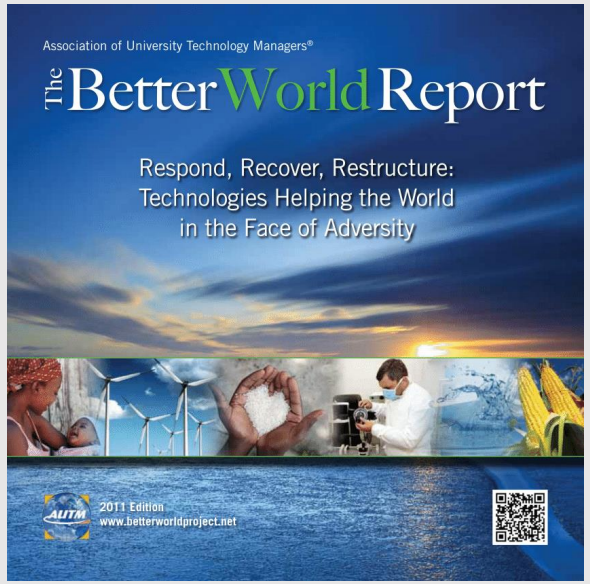

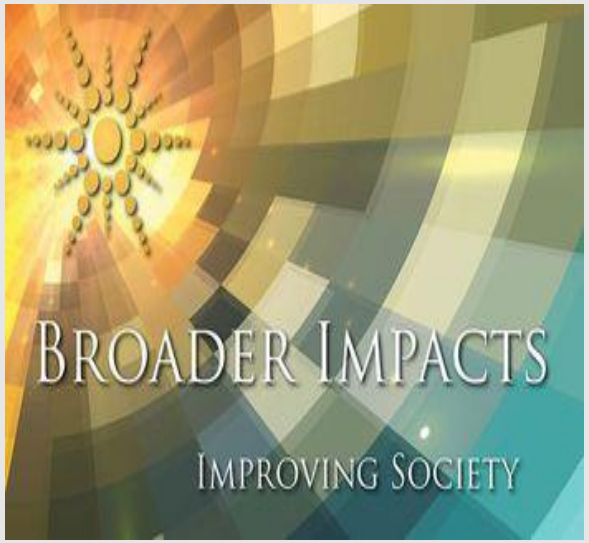

LOOKING BACKWARDS VS. FORWARDS

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Direct vs. Indirect Impacts

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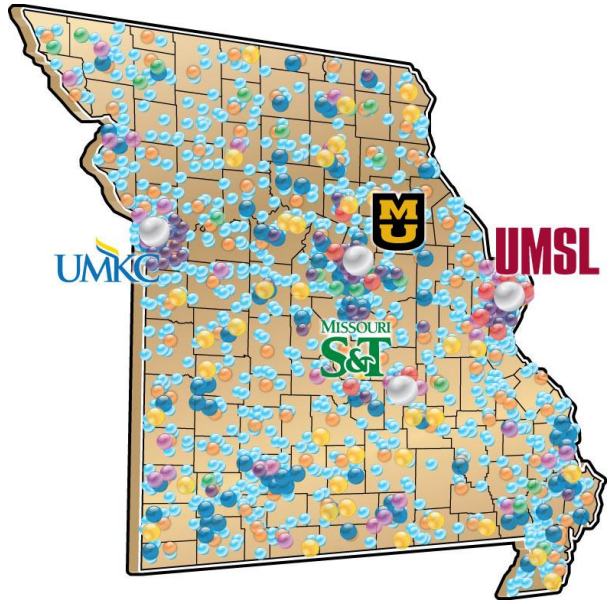
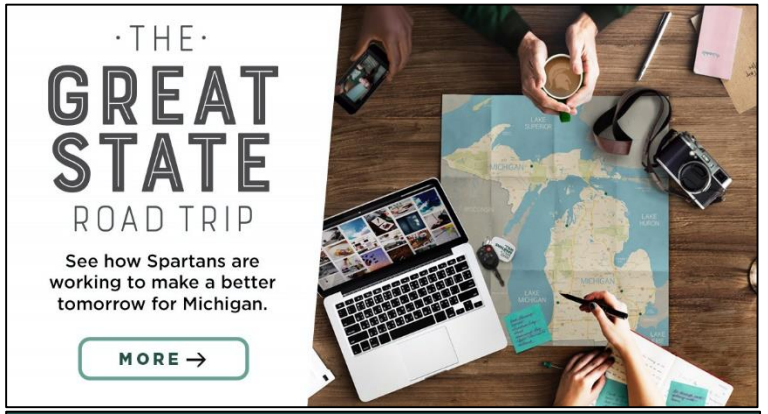
All Politics is Local…

…All Impact is Local Too



UNIVERSITY OF MISSOURI
IMPACT



MICHIGAN STATE UNIVERSITY

IOWA STATE UNIVERSITY
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Questions

- Is there a right or wrong way to assess impact?
- Can you know at the outset which science will have the greatest impact?
- How do we train scientists to be better at understanding, explaining, and engaging with others about the impact of their science?

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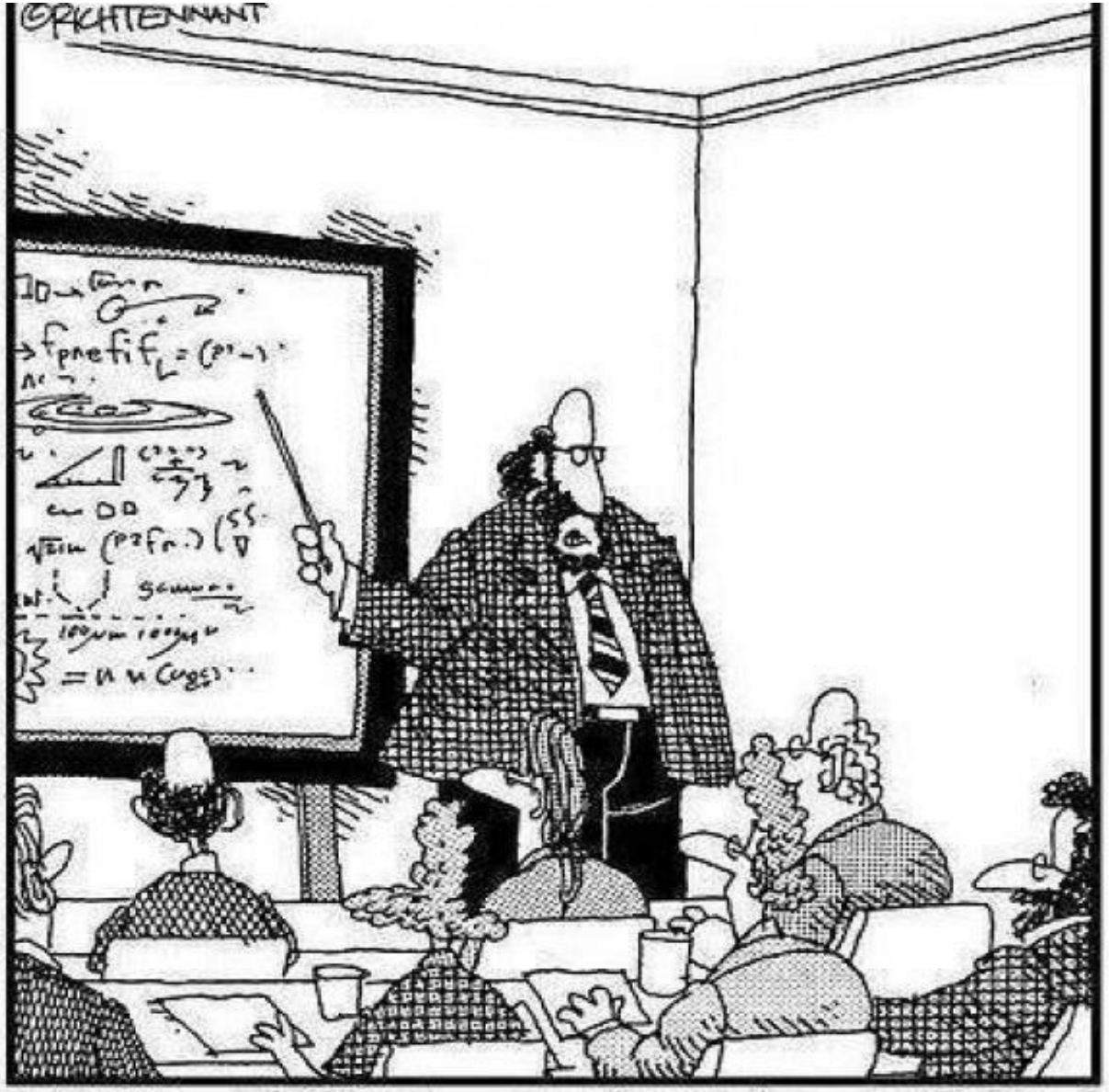
WHY *DO* WE CARE ABOUT IMPACT?



Association of American Universities

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