Institute for Research on Innovation & Science (IRIS)

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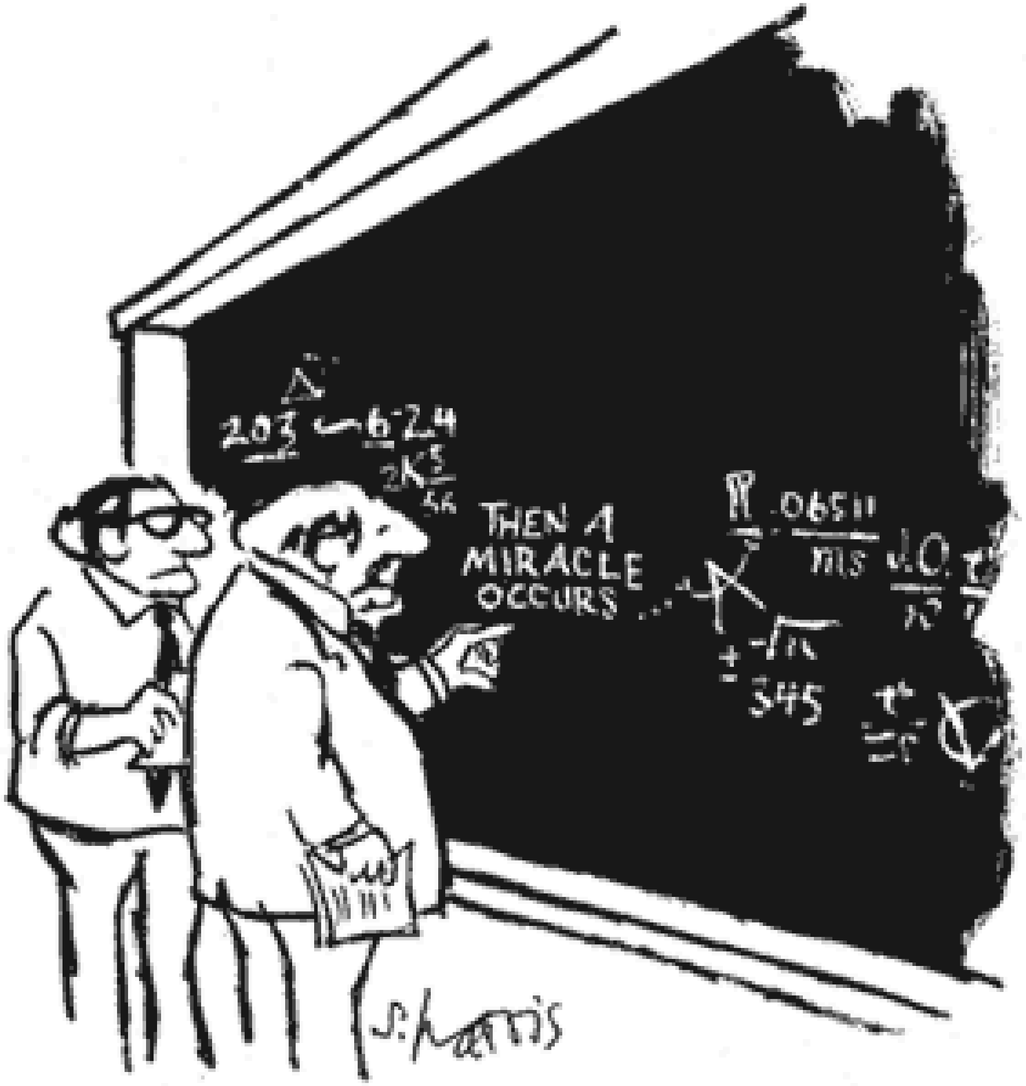
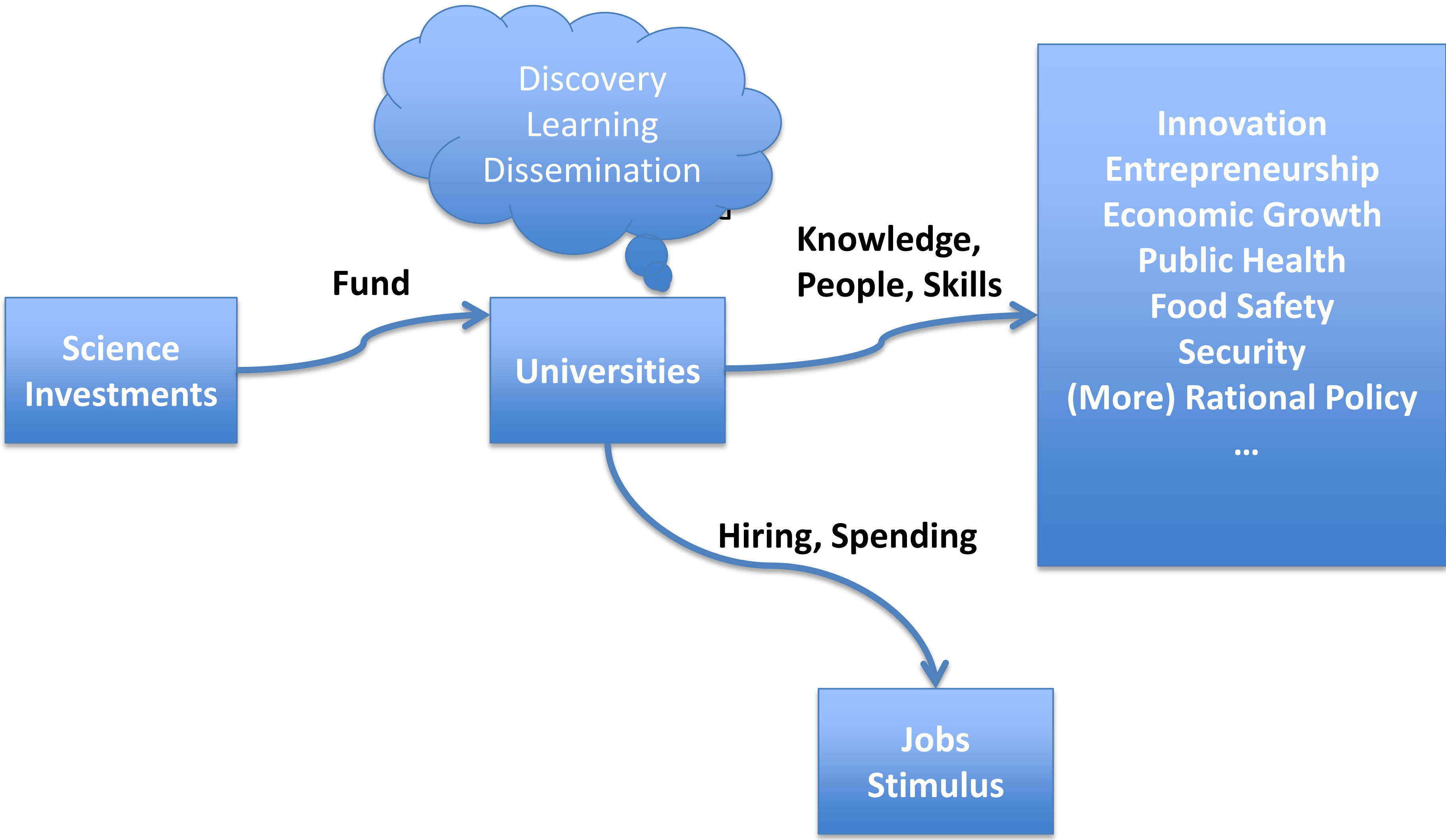
In 2014, our society invested $214 on academic research for every man, woman, and child in the country

- We make those investments to develop human knowledge and to improve quality of life and well being.
- How do we understand, explain and improve those effects?



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

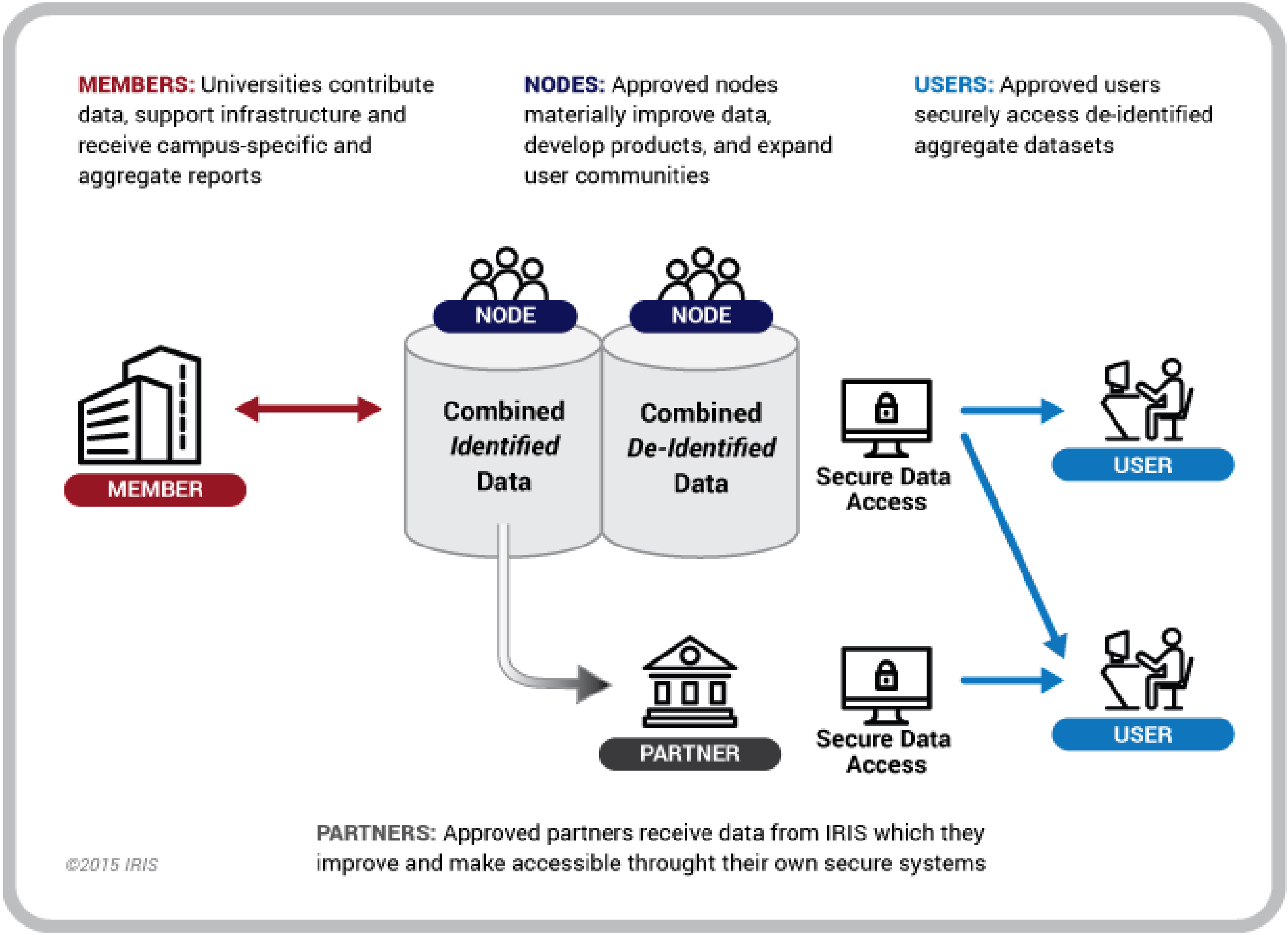
Framework


Discovery
Learning
Dissemination
Science
Investments
Fund
Universities
Knowledge,
People, Skills
Innovation
Entrepreneurship
Economic Growth
Public Health
Food Safety
Security
(More) Rational Policy
...
Hiring, Spending
Jobs
Stimulus

Background

- Recession & Stimulus
- Federal **STAR METRICS** (Level 1) Program
- **CIC/UMETRICS** Pilot Project
- **Institute for Research on Innovation and Science (IRIS)**
  - Founded 01/01/2015
  - Core facility at University of Michigan
  - Seed funding for infrastructure from Sloan & Kauffman
  - Significant research funding from NSF, NIH, USDA, SBA
  - 56 member institutions committed now
  - 3 year goal = 150 (~93% of federal R&D spending, ~85% of doctorate grants)

PI Team: Julia Lane (NYU), Jason Owen-Smith (Michigan), Bruce Weinberg (Ohio State), Ron Jarmin (U.S. Census)


MEMBERS: Universities contribute data, support infrastructure and receive campus-specific and aggregate reports
NODES: Approved nodes materially improve data, develop products, and expand user communities
USERS: Approved users securely access de-identified aggregate datasets
NODE
NODE
MEMBER
Combined *Identified* Data
Combined *De-Identified* Data
Secure Data Access
USER
PARTNER
Secure Data Access
USER
PARTNERS: Approved partners receive data from IRIS which they improve and make accessible throught their own secure systems
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“Wrapping it up in a person: Tracing flows from funded research into the economy using linked administrative records.” *Science*. 350:1367-1371

Zolas, N. N. Goldschlag, R. Jarmin, P. Stephan, J Owen-Smith, R. Rosen, B. Mcfadden-Allen, B. Weinberg, & J. Lane.

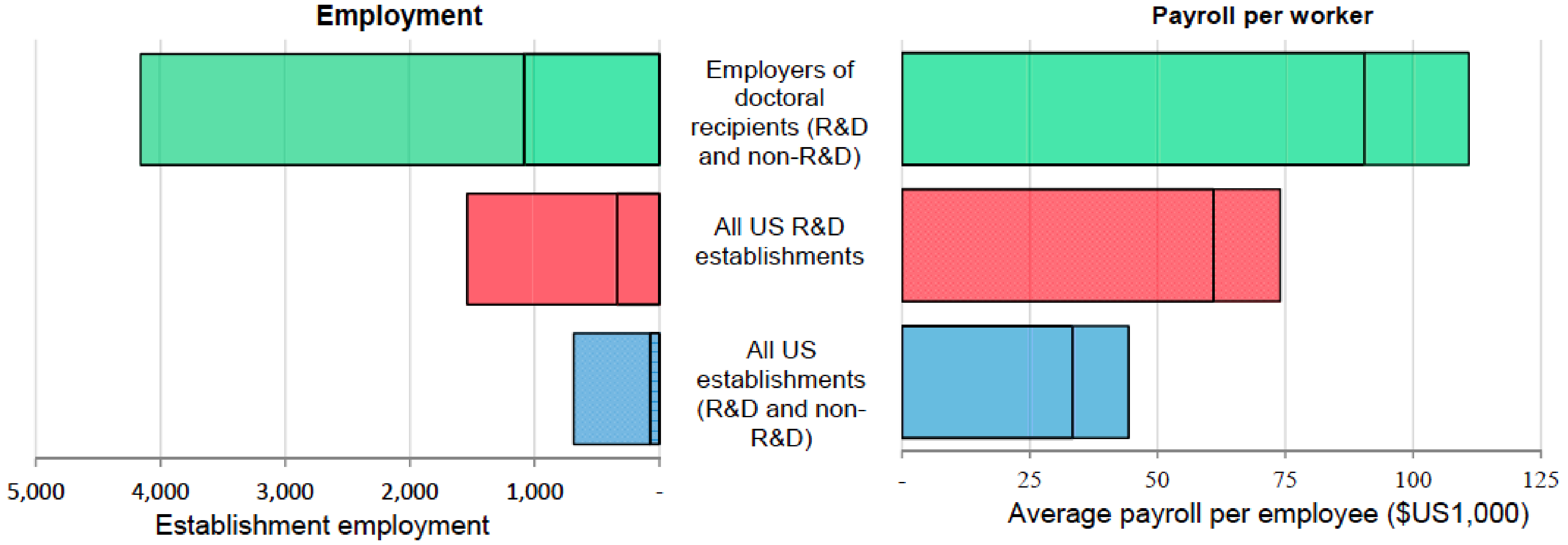
Media Coverage: Washington Post, Times Higher Education, Vox, PBS News Hour, Nature, numerous others

Placements by Sector & Location

Table 1. Postgraduation employment of UMETRICS doctoral recipients who were paid by research grants and left the university between 2009 and 2011. The national workforce distribution is calculated from all employment in all establishments covered by the Census's LBD between 2010 and 2012.

	Doctoral recipients placed in sector (%)				
	Industry		Academia	Government	All
Locale and small	R&D firms	Non-R&D firms			
Placed within sector	17.0	21.7	57.1	4.1	100.0
National sample (*M*)	10.8	75.0	10.7	3.5	100.0
Of those in sector, percent placed:					
Within 50 miles	10.1	23.5	8.9	18.2	12.7
Within state	16.6	36.0	18.0	25.8	22.0

Figure 1. UMETRICS Doctoral Recipients are placed at establishments that are larger and have higher payrolls per worker



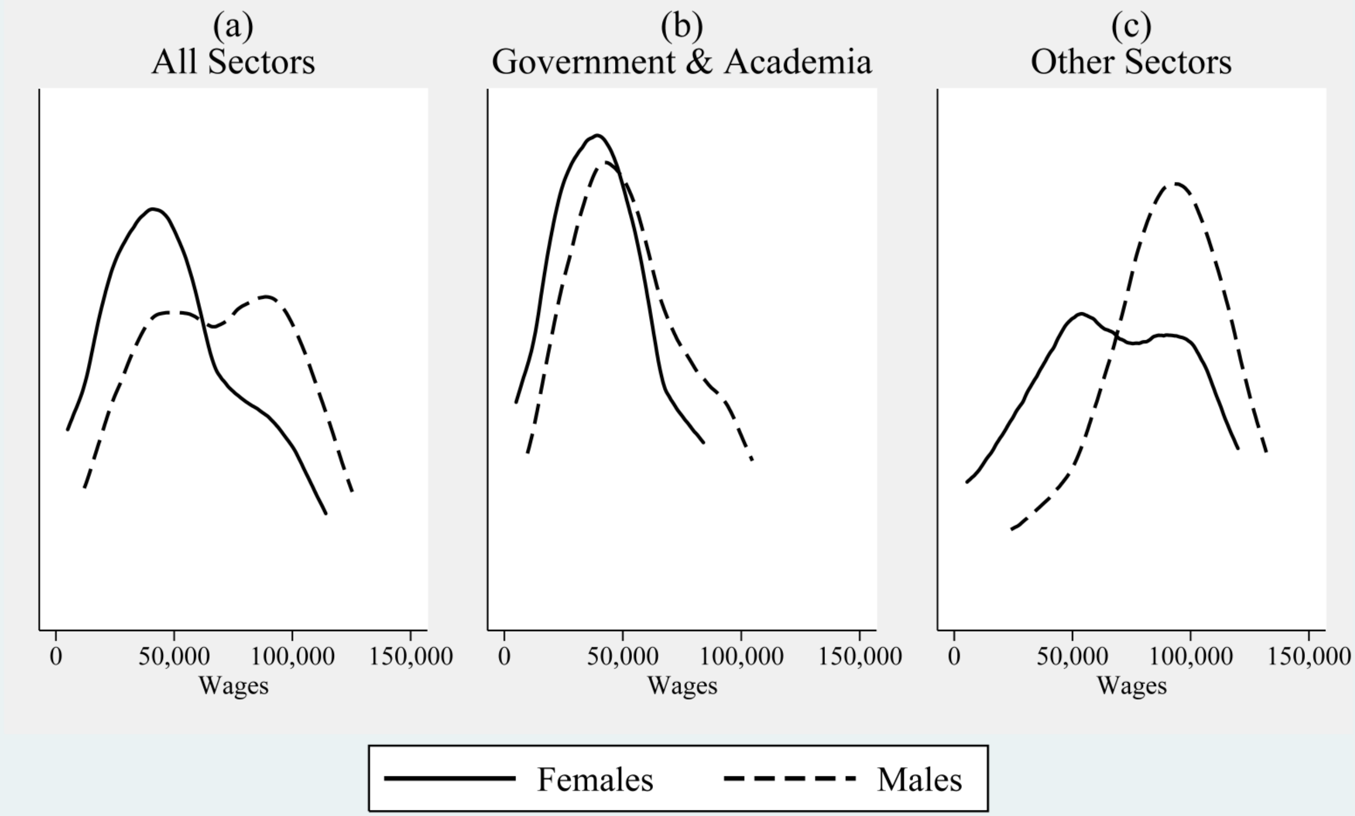
Most over represented industries

Industry Description (4 digit NAICS codes)	All U.S. Employers	Doctoral Recipients	Difference
Electrical and Electronic Goods Merchant Wholesalers	0.44%	6.67%	6.22%
Computer Systems Design and Related Services	1.32%	6.19%	4.87%
Architectural, Engineering, and Related Services	1.16%	5.95%	4.79%
Semiconductor and Other Electronic Component Manufacturing	0.26%	4.05%	3.79%
Pharmaceutical and Medicine Manufacturing	0.21%	3.33%	3.12%
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	0.36%	3.33%	2.98%
Management of Companies and Enterprises	2.71%	5.00%	2.29%
Basic Chemical Manufacturing	0.14%	2.38%	2.24%
Aerospace Product and Parts Manufacturing	0.32%	2.38%	2.06%
Other Information Services	0.16%	2.02%	1.86%

"STEM training and early career outcomes for male and female graduate students: Evidence from UMETRICS data linked to the 2010 Census." *American Economic Review.* 106(5): 333-338.

Buffington, C., B.J. Cerf, C. Jones & B.A. Weinberg.

Earnings Distributions



Source: UMETRICS linked to 2010 Census, ProQuest, LEHD, W2, LBD, BR, and iLBD.
Note: Sample includes STEM students in the 2007−2010 graduating cohort. Wages are in 2012 dollars and are from one year following graduation or leaving the university payroll, whichever was later. The tails of the k−density plots and the bandwidth size are not displayed to satisfy confidentiality requirements.

High Level Findings

- Women make 31 cents less per dollar at first job than men
- The effect disappears when controlling for the presence of dependent children in the house

Significant implications for how universities might support graduate students an post-docs.

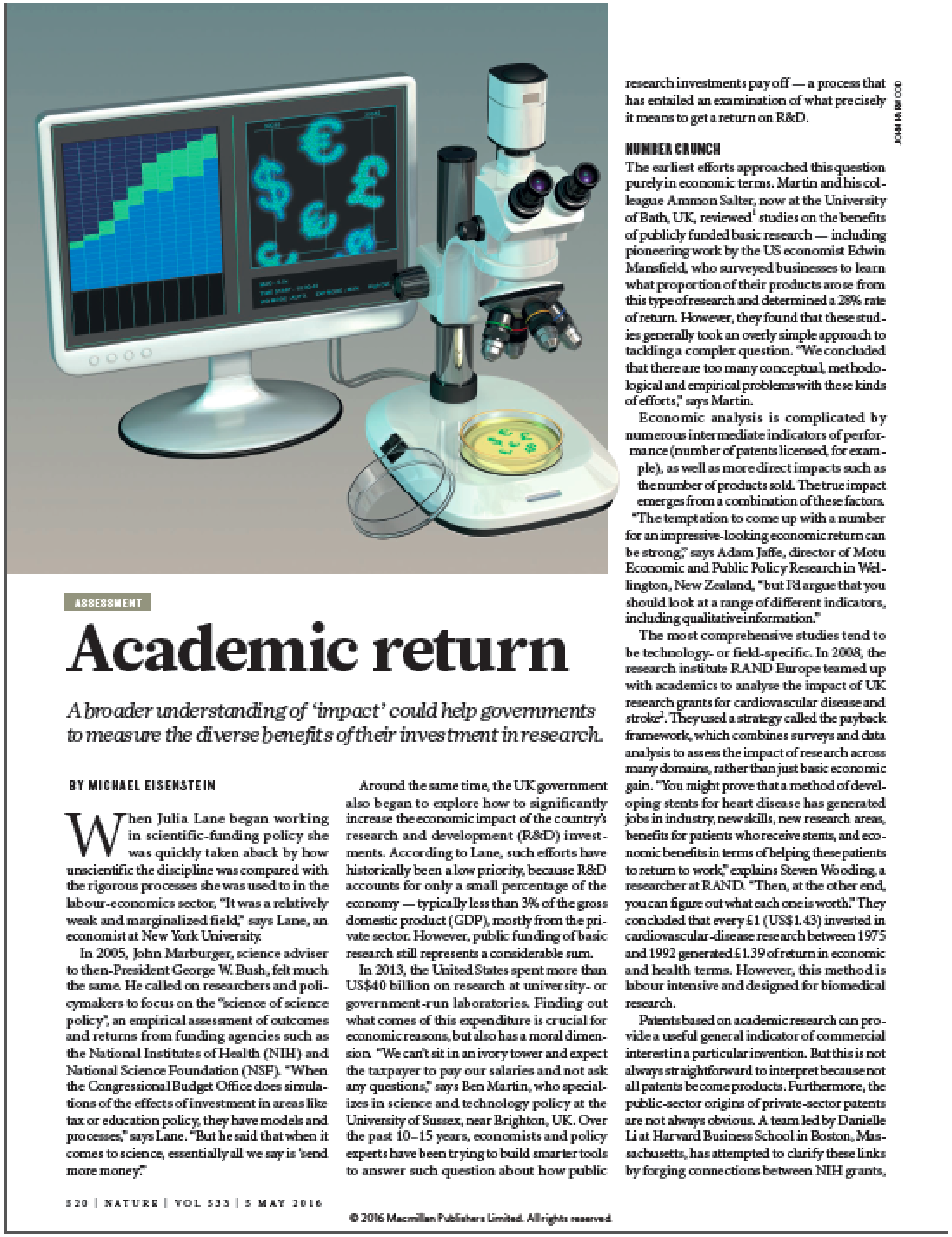
“The Link Between R&D and Entrepreneurship”

Working paper.

N. Goldschlag, R. Jarmin, J. Lane, N. Zolas

NSF grant 1535399 (EHR Core Research DGE) “STEM Training, employment in industry, and entrepreneurship”

- Preliminary findings from work in progress
- Introduce new measures of human capital – research training, extended with machine learning
- Investigate human capital composition of startups
- Findings: doubling research trained workforce
  - 8.7% increase in survival
  - 24.6% increase in high growth
- Next steps
  - Additional robustness, linking to productivity, explore mechanisms



ASSESSMENT

Academic return

A broader understanding of 'impact' could help governments to measure the diverse benefits of their investment in research.

BY MICHAEL EISENSTEIN

When Julia Lane began working in scientific-funding policy she was quickly taken aback by how unscientific the discipline was compared with the rigorous processes she was used to in the labour-economics sector, "It was a relatively weak and marginalized field," says Lane, an economist at New York University.

In 2005, John Marburger, science adviser to then-President George W. Bush, felt much the same. He called on researchers and policymakers to focus on the "science of science policy", an empirical assessment of outcomes and returns from funding agencies such as the National Institutes of Health (NIH) and National Science Foundation (NSF). "When the Congressional Budget Office does simulations of the effects of investment in areas like tax or education policy, they have models and processes," says Lane. "But he said that when it comes to science, essentially all we say is 'send more money'."

Around the same time, the UK government also began to explore how to significantly increase the economic impact of the country's research and development (R&D) investments. According to Lane, such efforts have historically been a low priority, because R&D accounts for only a small percentage of the economy — typically less than 3% of the gross domestic product (GDP), mostly from the private sector. However, public funding of basic research still represents a considerable sum.

In 2013, the United States spent more than US$40 billion on research at university- or government-run laboratories. Finding out what comes of this expenditure is crucial for economic reasons, but also has a moral dimension. "We can't sit in an ivory tower and expect the taxpayer to pay our salaries and not ask any questions," says Ben Martin, who specializes in science and technology policy at the University of Sussex, near Brighton, UK. Over the past 10–15 years, economists and policy experts have been trying to build smarter tools to answer such question about how public research investments pay off — a process that has entailed an examination of what precisely it means to get a return on R&D.

NUMBER CRUNCH

The earliest efforts approached this question purely in economic terms. Martin and his colleague Ammon Salter, now at the University of Bath, UK, reviewed[1] studies on the benefits of publicly funded basic research — including pioneering work by the US economist Edwin Mansfield, who surveyed businesses to learn what proportion of their products arose from this type of research and determined a 28% rate of return. However, they found that these studies generally took an overly simple approach to tackling a complex question. "We concluded that there are too many conceptual, methodological and empirical problems with these kinds of efforts," says Martin.

Economic analysis is complicated by numerous intermediate indicators of performance (number of patents licensed, for example), as well as more direct impacts such as the number of products sold. The true impact emerges from a combination of these factors. "The temptation to come up with a number for an impressive-looking economic return can be strong," says Adam Jaffe, director of Motu Economic and Public Policy Research in Wellington, New Zealand, "but I'd argue that you should look at a range of different indicators, including qualitative information."

The most comprehensive studies tend to be technology- or field-specific. In 2008, the research institute RAND Europe teamed up with academics to analyse the impact of UK research grants for cardiovascular disease and stroke[2]. They used a strategy called the payback framework, which combines surveys and data analysis to assess the impact of research across many domains, rather than just basic economic gain. "You might prove that a method of developing stents for heart disease has generated jobs in industry, new skills, new research areas, benefits for patients who receive stents, and economic benefits in terms of helping these patients to return to work," explains Steven Wooding, a researcher at RAND. "Then, at the other end, you can figure out what each one is worth." They concluded that every £1 (US$1.43) invested in cardiovascular-disease research between 1975 and 1992 generated £1.39 of return in economic and health terms. However, this method is labour intensive and designed for biomedical research.

Patents based on academic research can provide a useful general indicator of commercial interest in a particular invention. But this is not always straightforward to interpret because not all patents become products. Furthermore, the public-sector origins of private-sector patents are not always obvious. A team led by Danielle Li at Harvard Business School in Boston, Massachusetts, has attempted to clarify these links by forging connections between NIH grants,

"IRIS data allow observational experiments that can directly . . . [track] how scientific training affects career trajectories and returns to industry."

IRIS Data Release

- 19 universities
  - $11B in 2014 federal R&D (16% of total)
- Transaction level data
  - 162,694 federal and non-federal sponsored projects
  - 333,565 individuals
    - 28,641 Post-Docs
    - 76,295 Grad Students
    - 87,195 Undergrads
  - $18.1B in vendor spending to 441,796 establishments
  - $6B in subcontracts to other performers
- Links to abstracts etc for federal awards (NIH, NSF, USDA)
- Individual level links to patent and dissertation information
- Title 13 crosswalks to LEHD, LBD, ACS, Decennial Census (available only through the FSRDC system)

As IRIS expands

- More campuses mean more fine grained reporting & better research
- First research data release February 15, 2017
- Longer time frame, trustworthy trend data
- Detailed information on research outcomes
- Pilot work underway with undergraduate data
- Pilot study in collaboration with MICHR (Michigan CTSA)
- An administrative data facility to examine scientific training, career and workforce outcomes

Future Directions

- Undergraduate data pilot
  - University of Michigan, University of California System, University of Texas System
  - ~1.5 million enrolled students across 27 campuses
  - Linking to Census Data
  - Availability of highly detailed course and educational data
  - Marrying Learning Analytics with IRIS

Probing Impact of Research Experiences on Retention and Persistence at University of Michigan

Student Record Data

- Transcript
    - Research for credit
- Major
- Admission portfolio
- Demographic information

F2002-2014:
93,350 students

Data assembled: 12,006 students enrolled in research course

Federally Funded Research Records

- Payroll
- Grant account
- Job title
- Proportion of earnings

2002-2014: 49,487 personnel

Data assembled: 9,130 students paid on grant

Data consolidated:

- 18,720 students had "research experience"
- 2,416 students had both "research experiences"

Putting classes and employment together

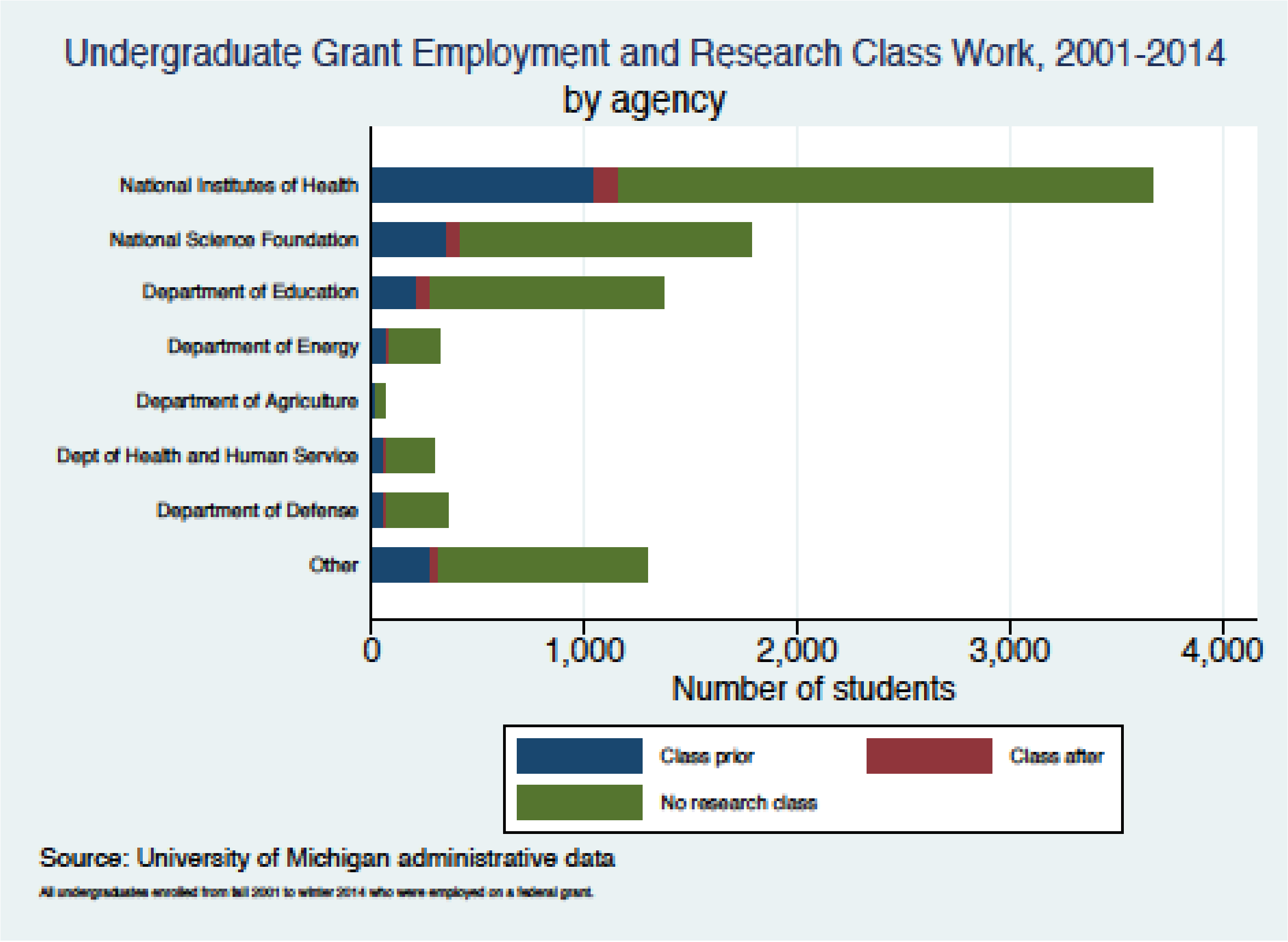
93,350 enrolled students

12,006 (12.9%) took a research class

9,130 (9.8%) paid on a grant

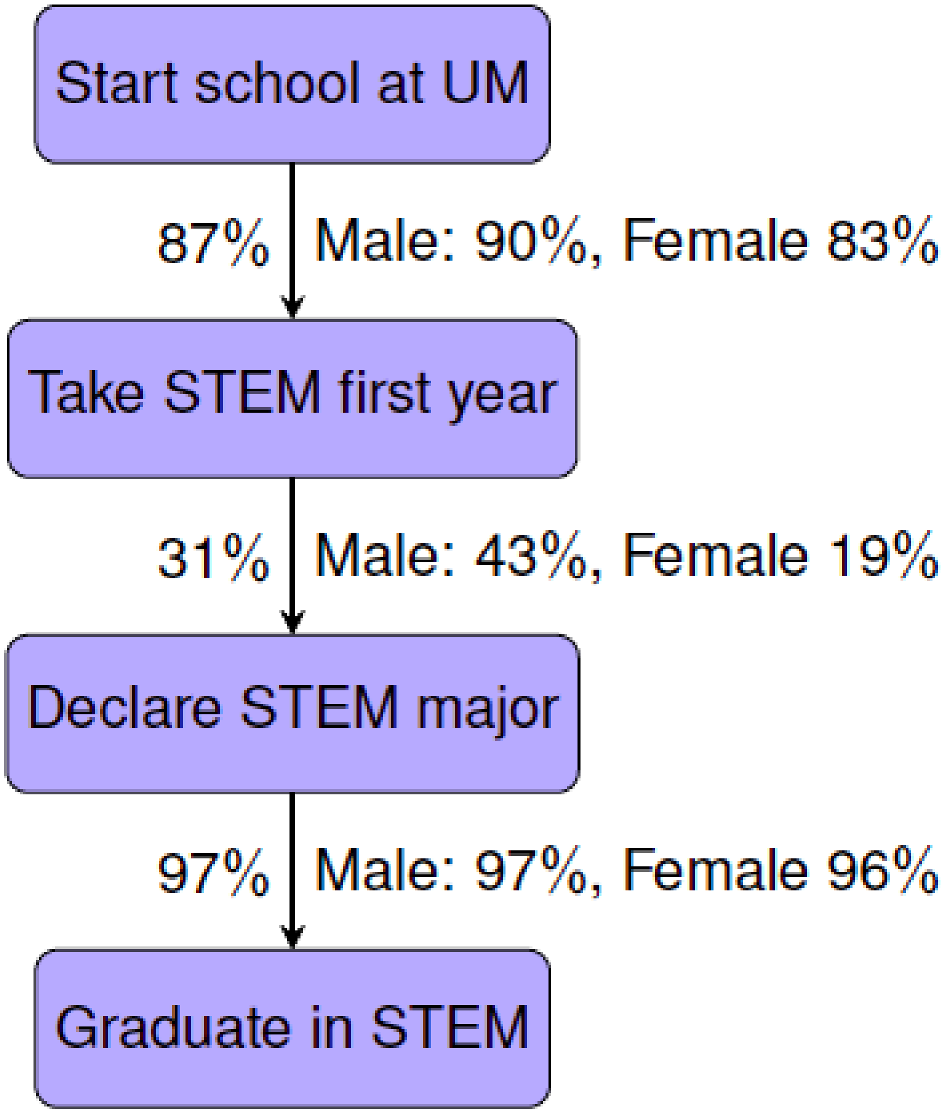
2416 (2.6%) did both

87.2% (2105) of students who did both took the class FIRST



Undergraduates (Fall 2001- Winter 2014)	
Registered for classes	112502
Coded as Freshmen	76816
Taking classes	76795
Classes before Winter 2010	51473

Variable	Mean
Female	0.51
Black	0.05
Hispanic	0.05
Asian	0.13
Other race race	0.03
International student	0.04
Low income	0.18
In state	0.63
ACT composite score	28.4
GPA	3.26


Start school at UM
87%
Male: 90%, Female 83%
Take STEM first year
31%
Male: 43%, Female 19%
Declare STEM major
97%
Male: 97%, Female 96%
Graduate in STEM