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### **Guest Speaker Presentation Thursday Afternoon June 2015**

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# Institute for Research on Innovation and Science (IRIS)

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# **Key ideas**

- Demonstrate value for money invested in research
- Document the value of education
- Insure permanent, independent, statistical evidence

# **Overview**

- Background
- What has been achieved
- Immediate Next Steps
- The future

# **Overview**

- Background
- What has been achieved
- Immediate Next Steps
- The future

# **Background**

In 2012, our society invested \$209 in academic research for every man, woman, and child in the US

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

# The Challenge

- ➤ Universities spend a lot on research, but we know too little about what those investments produce
- ➤ We have trouble
  - explaining and justifying what we do
  - modifying and improving our processes
  - documenting the full public value of our work
- > Existing data and models are insufficient

### One answer

# Treat R&D funding like a straightforward investment, prioritize the really important stuff.

#### **Prioritizing Grants**

Even with a smaller budget, we can increase our investments in transformative science and basic research by simply setting priorities and better managing the resources available.

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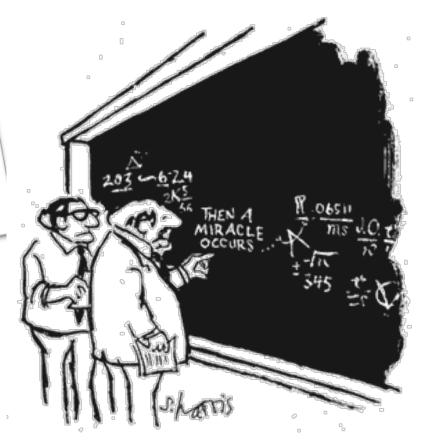
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While the scientific mind seeks to understand all aspects of the world around us, some research topics are simply more likely to contribute to truly meaningful discoveries or knowledge.





EXPLICIT HERE IN STEP TWO. "

# A conceptual framework



PRELIMINARY RESULTS Please do not cite or use without permission

# **Our Response**

- Establish a university-led institute to provide independent scientific evidence on the social and economic impact of research.
- ➤ Return timely, research-informed products to universities.

# **Overview**

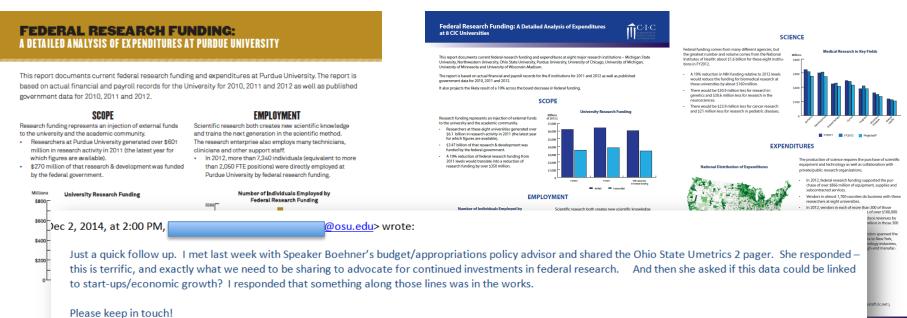
- Background
- What has been achieved
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# What has been achieved UMETRICS + CENSUS

### **UMETRICS**

- is a CIC initiative to create independent statistical evidence about the value of university research
- provides valuable information for outreach to Federal,
   State, and Local constituents
- integrates university administrative data with restricted
   U.S. Census Bureau data product

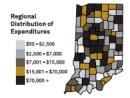
# What has been produced



The production of science requires the purchase of scientific equipment and technology as well as collaboration with

private/public research organizations.

• Purdue University research generated over \$14 million in



expenditures in Indiana counties alone

- In 2012, federal research funding to Purdue University supported the purchase of almost \$96 million of supplies and subcontracted services from the nation as a whole.
- Vendors in over 700 US counties do business with researchers at Purdue University.
- In 2012, vendors in each of more than 145 of those counties derived combined revenues of over \$60,000



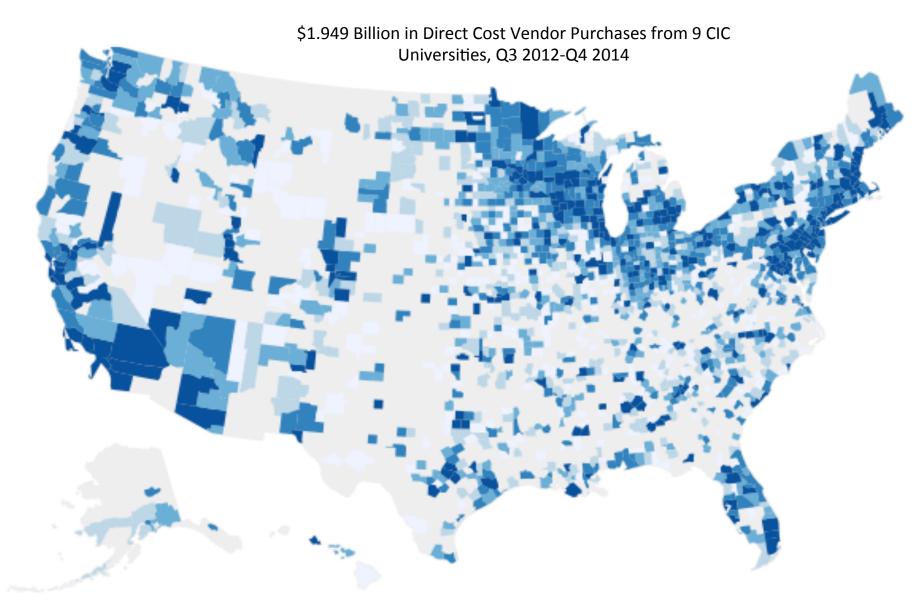
- Michigan: state legislature/regents
- OSU: Boehner's office
- Purdue: state and federal delegations

Federal Research Funding Analysis

November 2013

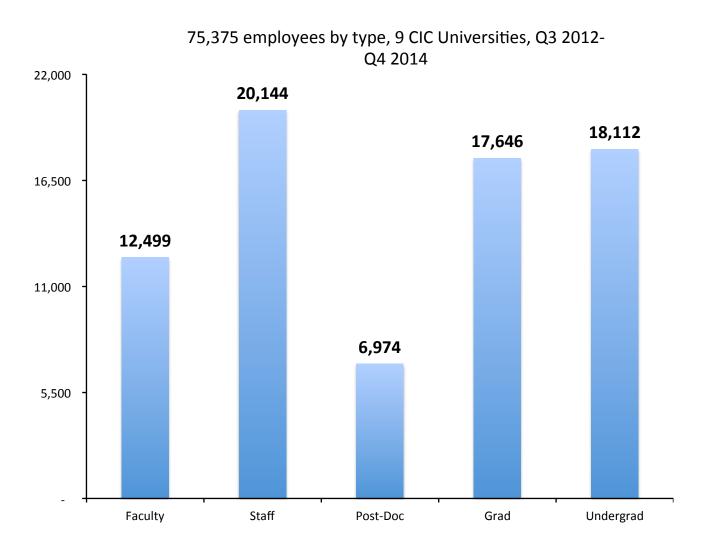
### **UMETRICS** currently provides

Independent statistical evidence about national, regional & local economic impact



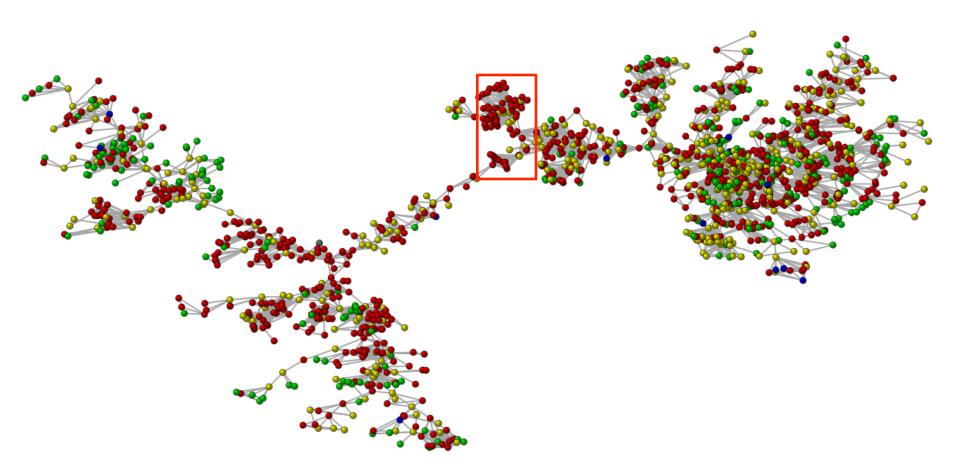
### **UMETRICS** currently provides

### Independent statistical evidence about academic workforce composition



### **UMETRICS** Currently provides

### Independent statistical evidence about academic research collaborations



Networks provide insights into conditions of training and their relationship to career outcomes

Links to academic outputs (publications, patents, grant information) inform innovation

# Research outputs from this approach

#### **POLICY** FORUM

SCIENCE INNOVATION

#### Assessing the Impact of Science Funding

nce supporters were rightly excited Sby the passage of the American Re-investment and Recovery Act (ARRA, i.e., the stimulus package). Headlines in nce (1) and Nature (2) rejoiced at the new value placed on science as a basis for economic growth and associated job creation. Indeed, federal investment was at least northy based on a belief that the result would be more competitive firms and more, and better,

jobs-and soon! (3). That belief was holstered by advocacy groups: For example, a report by the Information Technology and Innovation Foun-dation (ITIF) estimated that an additional \$20 billion investment in research in the stimulus package uld create ~402,000 American pbs for I year.

Within 2 years, the public will want to be informed about the impact of the stimulus on the economic recovery. Were the estimates accurate? How can they be validated? And, in the longer term, what were the on scientific knowledge, economic growth, and job creation? But we should also want to be informed about

questions that a obeyond For example, what de standing did we gain also anisms whereby knowled nomic and social oute the global nature of bot and scientific activity, he ence investments of oth-affect the United States measures and indicate be used to inform futur response to future eo Answers to these quest well as conveyed in a m tandable. Some insight

write enlies (SciSTP) (4)

researchers at the University of California a Sen Diego have been condited for the viluse Much of the public discussion about the growth of San Diego, creating more tha "science stimulus" consistent with the sprea-40,000 jobs in life sciences and over 12,800 in ent precision of the ITIF estimates, suggested electronics (9). The emergence of Google ha been traced to National Science Foundation that the outcomes of scientific investments support of one of its founders, Sergey Brin who was an NSF Graduate Research Fellow It istrue that science policy in the United States and abroad is largely predicated on such beliefs. The United Kingdom's Innovation and a \$4.5 million Digital Library Initiativ

grant from NSFto Stanford that helped suppor

early Google prototypes. However, much of the research in science policy is carrious about the impact of science investments—con sistent with Congressional Budge Office expectations that increases spending for basic research and edges expected impacts and might affect our put only after a number of years Cross-national evidence also suggest that investment in science, while ofter successful, is not a guarantee of short term economic growth and job ere ation. The U.S. experience of the pas decade, in which more than three quarters of post-1995 increase in pro

ductivity growth could be traced to sei

#### **OPINION**

#### Let's make science metrics more scientific

honst science says Julia Lane.

Quantifying the outcomes of investment

#### Science Funding and Short-Term Economic Activity

Bruce A. Weinberg, 123 Jason Owen-Smith, Rebecon F. Rosen, Lou Schwarz, 4 Barbara McFaddon Allon, Roy E. Weiss, Julia Lane M.A.

policy-makers in documenting shortterm effects of science funding. A multiyear scientific journey that it ads to longing, is more tangible if there is visible mores. term activity, such as the presence of astronauto. Vet audematic data en such activities have not heretofore existed. The only source of information for describing the production of most science is surveys that have been called "a rough estimate, frequently based before (3, 4). on unexamined assumptions that originated years carlier" (T).

But although science is complicated, it is not magic. It is productive work. Scientific endeavors employ people. They use capi-tal inputs Related economic activity occurs immediately. Data characterizing these activities can be directly captured through the financial and payroll records of research organizations and have been used in other arenas. such as labor policy. Our data provide the first detailed information about initial inputs to the publicly funded scientific enterprise and lay

the foundation to trace subsequent results (2). These new data were initially generated in response to the mandate put in place by the 2009 American Recovery and Reinvestment Act, also known as the stimulus package, which required that recipients of stimulus funds document the resulting jobs created and retained. In response, almost 100 U.S. universities and five federal agencies, with the support of the Federal Demonstration Part- NH Im that tership, established the STAR METRICS data program. The goal of the program was to document not just short-term, but also longerterm, results of scientific activity and to use

Carlo Sand Chemonic, S. M. (2011). Block, Germany, M. (2011). Block, Germany, M. (2011). Block, Germany, M. (2011). Block, Germany, M. (2014). G. (2014). Park, Force. "Bureau of Economie Thiorique et Appliquée (BETA University of Stratbourg, CNSS, 6700 Stateburg, Fonce." University of Melbourne, Victoda 2010, Australia.

\*Corresponding author | Intergrations

sutomated approaches to do so (2). The first saggregate, the 15 institutions that make up the transhe of rich data are drawn directly from CIC receive 8 to 10% of all federal research university personnel and financial administradive records that track actual expenditures large, Midwestern public universities, Hence of all active federal projects. These data provide project-level information about the occu-pations of the part-time and full-time work-type of science that is conducted with those force poid on each finded erent and about funds is markedly different from that conthe purchases made from vendors who supply ducted at many other major research univer scientific researchers. Neither of these types of information have reliably been available

There sults reported in this paper reported (CIC) universities participating in the emerg-ing UMETRICS initiative—Michigan, Wisconsin. Minnesota (Twin Cities). Ohio State. Northwestern, Purdue, Michigan State, Chicago, and Indiana [see supplementary material (SM) for full details ondata and analyses]. These universities received about \$7 billion

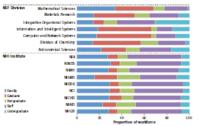
dollars. The majority of these institutions are they are not representative of all recipients of sities, and they provide a windowinto a large portion of federal research activity in the era of tightening federal budgets. Moreover, the 2012 data we analyzed reflect expenditures an analysis of 2012 expenditure data from from federal funds obligated over multiple nine Committee on Institutional Cooperation prior years. These data thus offer a different, and possibly smoother, picture than is appar ent in the often volatile annual federal-fundinacycle

POLICYFORUM

Expenditures from grant funds support many

d Fferent types of workers and vendors across

Our initial analysis of all expenditures supported by federal funding to these nine CIC institutions-monies from some 30 agencies-shows that the production of science in research and development (R&D) funding is complex but eminently traceable. We dofrom all sources in 2012; 56% of that came ument reliance on a wide variety of inputs, from federal government sources (5). In the including a heterogeneous mix of skills



Differences in workforce composition in projects funded by NSF divisions and NIH institutes. NA of Alleroy and Infectious Diseases: NHLBI, National Heart, Junio, and Blood Institute, (See SM.)

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#### **POLICY**FORUM

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#### Measuring the Results f Science Investments

ia Lane<sup>1</sup> and Stefan o Bertuzzi<sup>2</sup>

orically, federally funded basic and applied scientific research has promoted scientific knowledge, wation, economic growth, and social Il-being. However, there is increasing presto document the results of these research nents in a scientific manner (1, 2) and ntify how much of the work is linked to

effects of scientific research can be did help to improve research quality, the proin a variety of policy areas, ranging from
cribed? If so, what would be the inputs, cess of producing the data was burdensome crime to health care to labor markets (10). us, and structure of the

systematic ways of describing the results of Education Funding Councils in England has a sessed research with its Research Assess- and brought together experts in economics, ment Exercises (now a Research Assessment Framework) intended to a seess the quality, impact, and vita ity of funded research. Their

The challenge is not limited to the United cise. However, there are useful precedents States; other countries have been developing in other fields of policy in the United States. The Institute for Education Sciences has had science investments. Since 1986, the Higher a major impact on the quality of education dence about the effects of education investments (9). The Center for Evidence-Based lessons are salutary: Although the exercises Policy has identified high-quality evaluations

Sidence agencies and research institutions are

building the infrastructure to evaluate results

of federal funding of scientific research.

tem? What sei entific dis- "The intent is to leverage revolutionary digital technology to capture the broad lines should inform the ulation of such a model? scientific, social, economic, and workforce impacts of science investments."

tinga system in which the eets of scientific research be described on an ongoing basis— and complex (7). In 2009, the European Developing such a system and the asso-

Research Policy

journal homepage; www.elsevier.com/loss

New linked data on research investments: Scientific workforce, productivity, and public value

Julia I. Lane<sup>a,\*</sup>, Jason Owen-Smith<sup>b</sup>, Rebecca F. Rosen<sup>c</sup>, Bruce A. Weinberg<sup>d</sup> \* Search in Institution for Power of, USA, USA, USA University of Stranbourg CNES, France and University of Mollourus, Australia \* Monthly of Search (Search COS) \* Monthly in Search (Search COS) \* Monthly in Search (Search COS)

ARTICLE INFO Accepted 21 December 2014 Available online xxx

ise on institutional Cooperation. The resulting data set renects an emerging conceptual framework for analyzing the process, products, and impact of research, it grows from and engages the work of a diverse permunity. This paper situates the UMETRICS effort in the context of research evaluation and onesine data infrastructure efforts in order to highlight its novel and valuable features. Refocusing ction in this field around individuals, networks, and teams offers dramatic possibilities for data linkage, the evaluation of research investments, and the development of rigorous c empirical models. Two preliminary analyses of the scientific workforce and network approaches to char-acterizing scientific teams ground a discussion of future directions and a call for increased community

The ITG undertook a literature review to determine the state of the science to date. A questionnare was circulated to Federal agen-cles to ascertain what methods are currently in use for programmatic investment decision making: as well as to ask what tools and resources ar e needed by Federal agencies that are currently unavailable. The ITG Found that...the data infrastructure is inadequate for decisionmaking? National Science and Technology Council, 2008) emphasis added

\* Convergending author. Tel. + 1 2017181527. E- med authors: June Status; (J. Lauré). E- med authors: June Status; (J. Lauré). Montacion and Human Recoverne Neural Toldellini: NSE NCSES neural 1427005: NN POLIACIONES. POLIACIONATE: the US Corean Burwar, and the Doing Marion Exalitation and Albert. P. Clam Doundations. Data were generating provided by the Committee on Albert. F. Stant Institutions, Data were generously provided by the Committee on both informal Cooperation and in number institutions. We thank Wor Cheng, Camera Cornad, Bans Fank, Christina Josep, Felin Edo, Dippey Stochikhin, Yalin Margery, De Stands and Michael Felin Fer neural roops, Cang Care, Marietti Rarrinos, Divide Mayo, Mari Sweet and Stephanie Willia for help with data losses, and Earls Michael Gerin Alex, Jay Wolfe and All Conference on the Conference on the Conference on the research agental drawn on work with many considers, but pasticularly work with Paul Surchau, Januare Mairone, and Michael Person.

Internationally, public support for science and thus the details or science policy have come to depend on evaluating the results of research. In addition to measures of productivity, establishing the economic impact and public value of investments in RBO is of par-ticular concern. The Research Assessment Exercise in the United Kingdom places tremendous emphasis on scholarly production, as does the Excellence in Research Australia program (Jensen and Webster, 2014: Owens, 2013). The United States has focused both on measuring scientific and economic impact. The policy focus in

biomedical researchers. The timeframe and resources of the study did not allow for comprehensive data collection or the implementation of

a comprehensive model of the biomedical workforce. It is evident from the data-eathering and analyses undertaken by the working group that the data-gathering and alwayses unsurvives by one was singly op-there are major gaps in the data currently being collected on foreign-trained postdoctoral researchers and those who work in industry.

(NIH Biomedical Research Workforce Working Group, 2012)

Please cite this article in press as: Lane, J.L., et al., New linked data on research investments: Scientific workforce, productivity, and

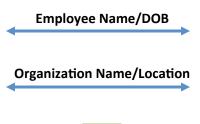
# **Census Links**

- Census data contains information on (essentially) the population of organizations that employ people and the population of people who are employed in the US
- ➤ Preliminary findings rigorously screened to protect privacy
- ➤ More Census work remains to be done to validate
- ➤ No burden on universities work all done at Census

### Linking UMETRICS to CENSUS data to generate new indicators

#### **UMETRICS DATA**

University data on Federal awards:
Employee, vendor, subaward transactions



#### **CENSUS DATA**

Secure data on people and businesses:

Employment records, business dynamics & characteristics



**JOB PLACEMENTS** 

Where research employees get their next jobs

**START-UP ACTIVITY** 

What types of businesses research employees found

VENDOR CHARACTERISTICS

What types of businesses supply research

Analyze by: Occupational category | Funding agency | Research area | Years since leaving university

### **2010 Cohort 2-digit NAICS**

	<u> </u>		
NAICS	NAICS Description	LBD	All Universities
11	Forestry, Fishing, Hunting, and Agriculture Support	1.12%	0.77%
21	Mining	0.59%	0.36%
22	Utilities	0.72%	0.32%
23	Construction	4.64%	2.63%
31-33	Manufacturing	9.75%	12.24%
42	Wholesale Trade		

### Where do research employees get their next jobs?

**2010 Cohort 3-digit NAICS** 

LBD

0.00%

0.33%

1.18%

0.85%

0.78%

0.01%

0.28%

1.01%

1.38%

1.73%

(Manufacturing)

31-33	Manufacturing		
42	Wholesale Trade		
44-45	Retail Trade		
48-49	Transportation and Warehousing		
51	Information		
52	Finance and Insurance		
53	Real Estate and Rental and Leasing		
54	Professional, Scientific, and Technical Services		
55	Management of Companies and Enterprises		
56	Administrative and Support and Waste Management and Remediation Services		
62	Health Care and Social Assistance		
71	Arts, Entertainment, and Recreation		
72	Accommodation and Food Services		
81	Other Services (except Public Administration)		

		_
NAICS	NAICS Description	
330	Primary Metal Manufacturing	Г
331	Primary Metal Manufacturing	ı
332	Fabricated Metal Product Manufacturing	ı
333	Machinery Manufacturing	L
334	Computer and Electronic Product Manufacturing	
335	Electrical Equipment, Appliance, and Component Manufacturing	
336	Transportation Equipment Manufacturing	r
337	Furniture and Related Product Manufacturing	l
339	Miscellaneous Manufacturing	l
541	Professional, Scientific, and Technical Services	
621	Ambulatory Health Care Services	l
622	Hospitals	l
623	Nursing and Residential Care Facilities	
624	Social Assistance	

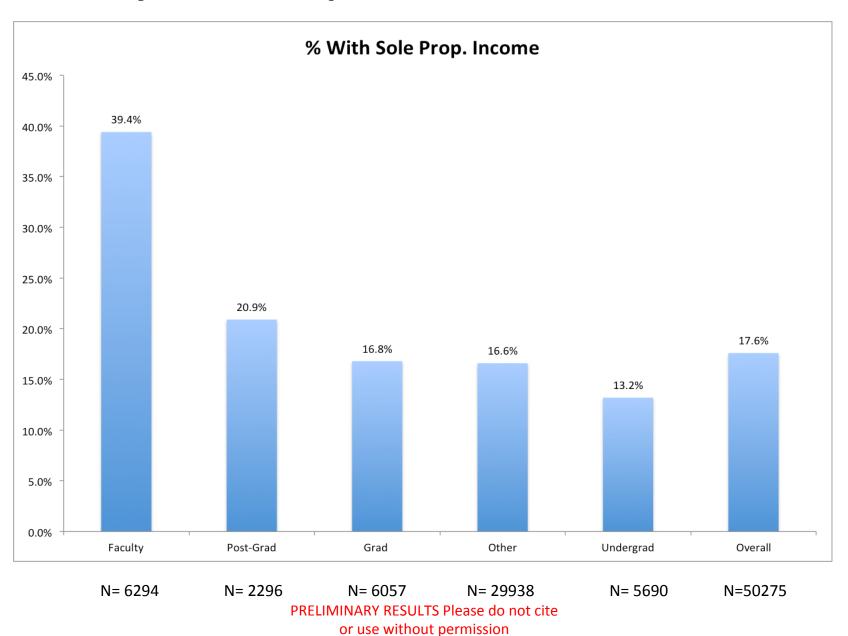
Universities 2010 Cohort 4-digit NAICS (Computer & Electronics **Manufacturing**)

			All
NAICS	NAICS Description	LBD	Universities
3341	Computer and Peripheral Equipment Manufacturing	0.06%	0.26%
3342	Communications Equipment Manufacturing	0.10%	0.17%
3343	Audio and Video Equipment Manufacturing	0.01%	0.02%
3344	Semiconductor and Other Electronic Component Manufacturing	0.25%	0.54%
3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	0.34%	0.74%
3346	Manufacturing and Reproducing Magnetic and Optical Media	0.01%	0.00%
5411	Legal Services	1.02%	1.23%
5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	1.15%	1.29%
5413	Architectural, Engineering, and Related Services	1.13%	1.92%
5414	Specialized Design Services	0.09%	0.04%
5415	Computer Systems Design and Related Services	1.30%	1.99%
5416	Management, Scientific, and Technical Consulting Services	0.86%	1.67%
5417	Scientific Research and Development Services	0.63%	0.00%

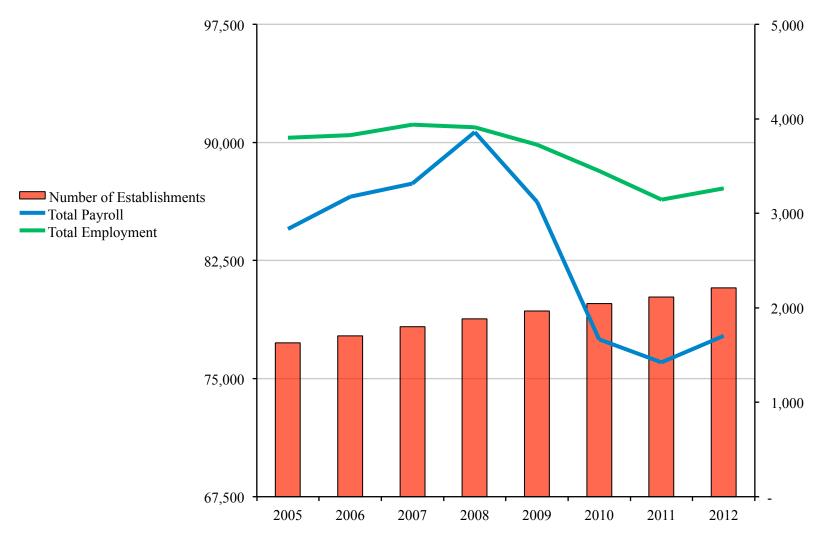
Over three years (2010 – 2012) just over 59% get jobs in industry, just under 33% get jobs in academia.

> PRELIMINARY RESULTS Please do not cite or use without permission

### How many are entrepreneurs?



### **Business Dynamics for the Companies They Found**



**1700-2200** new firms employing **3000-4000** people **per year** (2005-2012)

# Vendor Activity by Industry

- At a single university we find a focus on
  - Semiconductors and electronics
  - Engineering services
  - Research services

NAICS	NAICS Description	Univ X	US	
331	Primary Metal Manufacturing	0.20%	0.36%	
332	Fabricated Metal Product Manufacturing	9.68%	1.68%	
333	Machinery Manufacturing	4.67%	0.92%	
334	Computer and Electronic Product Manufacturing	17.63%	0.62%	
335	Electrical Equipment, Appliance, and Component Manufacturing	2.01%	0.25%	
336	Transportation Equipment Manufacturing	0.47%	0.64%	
337	Furniture and Related Product Manufacturing		0.39%	
339	Miscellaneous Manufacturing	1.63%	0.58%	
541	Professional, Scientific, and Technical Services	17.32%	8.27%	
	All 3-Digit Industries	100.00%	100.00%	

	NAICS	NAICS Description	Univ X	US
/	3341	Computer and Peripheral Equipment Manufacturing	1.11%	0.08%
	3342	Communications Equipment Manufacturing	0.99%	0.08%
	3343	Audio and Video Equipment Manufacturing	(D)	0.02%
	3344	Semiconductor and Other Electronic Component Manufacturing	8.25%	0.21%
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	7.07%	0.22%
	3346	Manufacturing and Reproducing Magnetic and Optical Media	(D)	0.02%
7	5411	Legal Services	0.36%	1.44%
	5412	Accounting, Tax Preparation, Bookkeeping, and Payroll Services	0.28%	0.50%
	5413	Architectural, Engineering, and Related Services	7.55%	1.25%
	5414	Specialized Design Services	0.07%	0.22%
	5415	Computer Systems Design and Related Services	2.93%	2.23%
	5416	Management, Scientific, and Technical Consulting Services	1.23%	1.10%
	5417	Scientific Research and Development Services	4.60%	0.29%
		All 4-Digit Industries	100.00%	100.00%

# Top Vendor Industries – Detail

- How do these industries compare to the average?
- Mostly older, with more receipts and payroll, and higher average wages

NAICS	Share of Young Firms	Age	Employment	Payroll	Receipts	Average Wage	Employment Growth
Chemical Manufacturing	-20.56%	26.83%	120.66%	254.06%	416.06%	45.32%	126.67%
Fabricated Metal Product Manufacturing	-52.06%	49.30%	48.96%	82.10%	81.33%	15.25%	108.08%
Machinery Manufacturing	-51.24%	55.73%	80.40%	156.90%	160.11%	34.46%	161.60%
Computer and Electronic Product Manufacturing	-27.57%	27.02%	102.16%	227.21%	202.75%	51.79%	28.19%
Miscellaneous Manufacturing	-28.11%	23.76%	3.71%	23.17%	24.39%	-0.90%	10.38%
Merchant Wholesalers, Durable Goods	-25.05%	17.04%	-23.66%	11.12%	196.09%	35.27%	-26.38%
Merchant Wholesalers, Nondurable Goods	-12.29%	10.42%	-10.13%	16.95%	493.91%	23.75%	-25.37%
Professional, Scientific, and Technical Services	9.58%	-14.28%	-48.76%	-16.26%	-37.42%	45.81%	-29.26%

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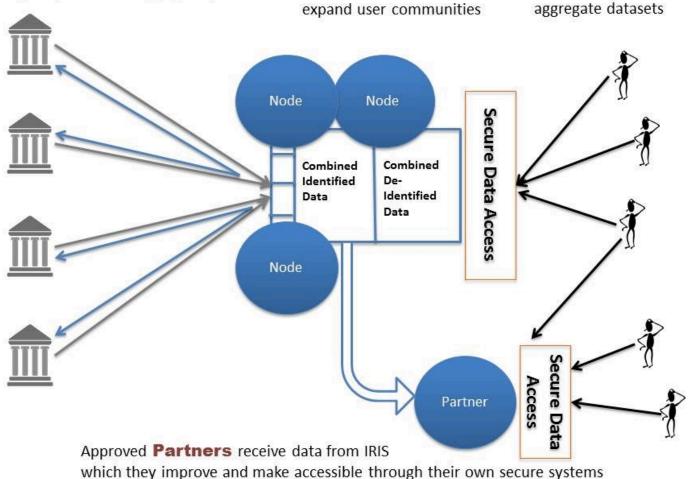
The Institute for Research on Innovation & Science (IRIS) is a new, IRB-approved platform to make UMETRICS a trusted and permanent national data resource for the academic community. It is member-driven, created by and for universities. IRIS's core data facility is located at the University of Michigan's Institute for Social Research.

### Institute for Research on Innovation & Science (IRIS)

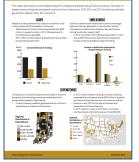
**Member** universities contribute data, support infrastructure and receive campus-specific and aggregate products

Approved **Nodes**materially improve data,
develop products, and
expand user communities

Approved **Users** securely access de-identified, aggregate datasets



Creating new research and reports





### **UMETRICS** @ IRIS

### **UMETRICS** participants:

























### **Goal: National Coverage in 3-5 Years**

- >150 institutions
- All 50 states
- >90% R&D Spending

### **Seed Funding for IRIS infrastructure:**





# **Overview**

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# **Future Possibilities**

### New work with existing data

- 1. National workforce (particularly post-doc) composition
- 2. Network of subcontract relationships across campuses allows e.g. analysis of initial and sustaining effects of multi-institution investments (e.g. STCs, EERCs, CTSAs, infrastructure commitments)
- 3. National distribution of vendor spending by county/congressional district

Additional research through Census Research Data Center Network

# **Future Possibilities**

### Future Possibilities with linkages include

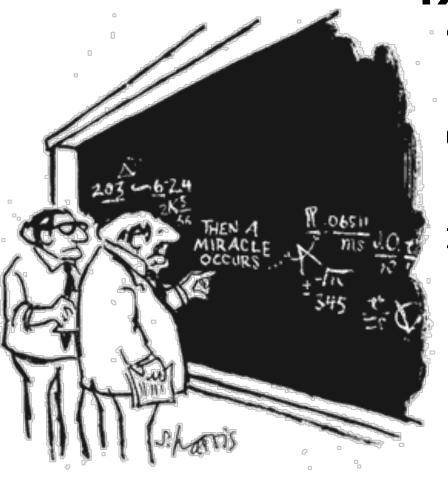
- 1. Economic outcomes (e.g. placement rates, earnings/career trajectories, startups/firm productivity & growth) by agency, topic, mechanism.
- 2. Scientific outcomes (e.g. dissertation/publication/patenting outcomes) through partnership with libraries (ARL and SHARE)
- 3. Undergraduate engagement in research, educational, and career outcomes

Additional research through Census Research Data Center Network

• Demonstr

Document

Insure per evidence



I TAINK YOU SHOULD BE MODE EXPLICIT HERE IN STEP TWO. II **Ley ideas** 

ed in research

istical

- IRIS is open to "early adopting" member institutions through
   September 1, 2015
- Early adopters will help finalize governance structure
- IRIS will reopen to new members when national governance is in place
- Contact Jason Owen-Smith
   (jdos@umich.edu) with questions
   about becoming an "early adopter"

# Questions & Reactions?

Julia.lane@nyu.edu jdos@umich.edu

**Thank You**