



Evaluating large-scale S&T initiatives: A case study on the complexity of capturing and disseminating meaningful outcome and impacts data

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Session Outline

A case study on performance measurement and evaluation, presenting three perspectives:

- **Institutional:** *Genome Canada;*
- **Practical/Methodological:** *Science-Matrix;*
- **Academic/Policy:** *VALGEN*

Introduction

Policy makers need to know their program investments provide them with the results they need. There is an impetus for S&T organizations to demonstrate:

- Success along the innovation continuum;
- Translational **benefits** (i.e. commercialization, tech transfer, & value-added impacts to society beyond science).

Genome Canada

Driven by a mission to:

- connect ideas and people across public and private sectors to find new uses for genomics.
- investing in large-scale science and technology (S&T) to fuel innovation
- and translate discoveries into applications to maximize impacts across all sectors.

How do we know if we are successful in achieving our mission?

A Systems Approach

Evaluation function based on systems approach that understands the role and relationship of components with the system as a whole, its:

- Holistic: a change in part of a system affects the whole system
- Non summative: The whole is more than the sum of the parts.
- Multifinality: A common starting-point and/or the use of different roads may lead to different results.
- Circular: a causal connection is not linear

A Systems Approach

In practice that means:

- Using frameworks to identify the complexity of component and their relationships;
- Paying careful attention to how boundaries are drawn (does not mean including everything);
- Use of a balanced approach to collecting performance data, before, during and after program design;
- Considers processes as well as outcomes and impacts;
- Uses evaluation for both learning and accountability;
- Quantitative and qualitative needed to properly support decision-making

Theory of Change

Inputs

Activities

Outputs

**Immediate
Outcomes**

**Intermediate
Outcomes**

**Ultimate or
Outcomes or
Impact**

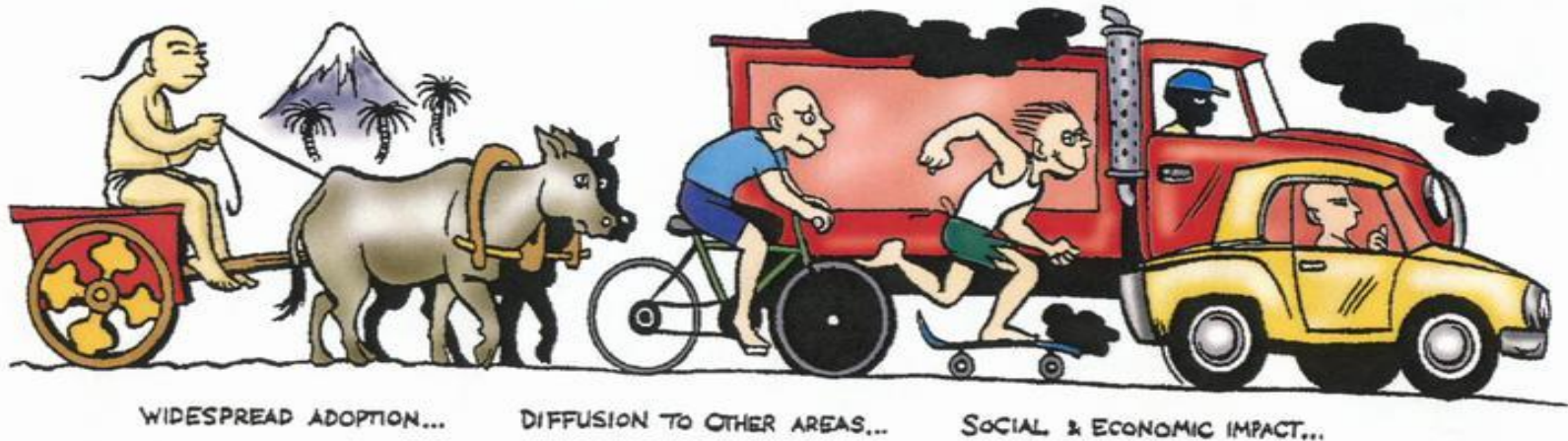


Institutional Challenges

The challenges we face when thinking about and establishing an evaluation function are.....

Measuring Along An Innovation Continuum

Stages of Innovation



Multiple Stakeholders, Multiple Sectors, Multiple Needs

Accountability

**Genome
Centres**

**Industry
Canada**

**Board of
Directors**

Communication

**Research
community**

Partners

**Strategic
Development**

Media

**Policy
Makers**

End users

Engagement

Multiple Foci

Complexity of measurement

Detailing
Scientific
Outputs

Capturing
Tangible
Scientific
and Social,
Economic &
Environmental
Outcomes

Capturing
Intangible
Translation
& Diffusion
Pathways

Evaluating
long term
Social,
Economic &
Environmental
Impact

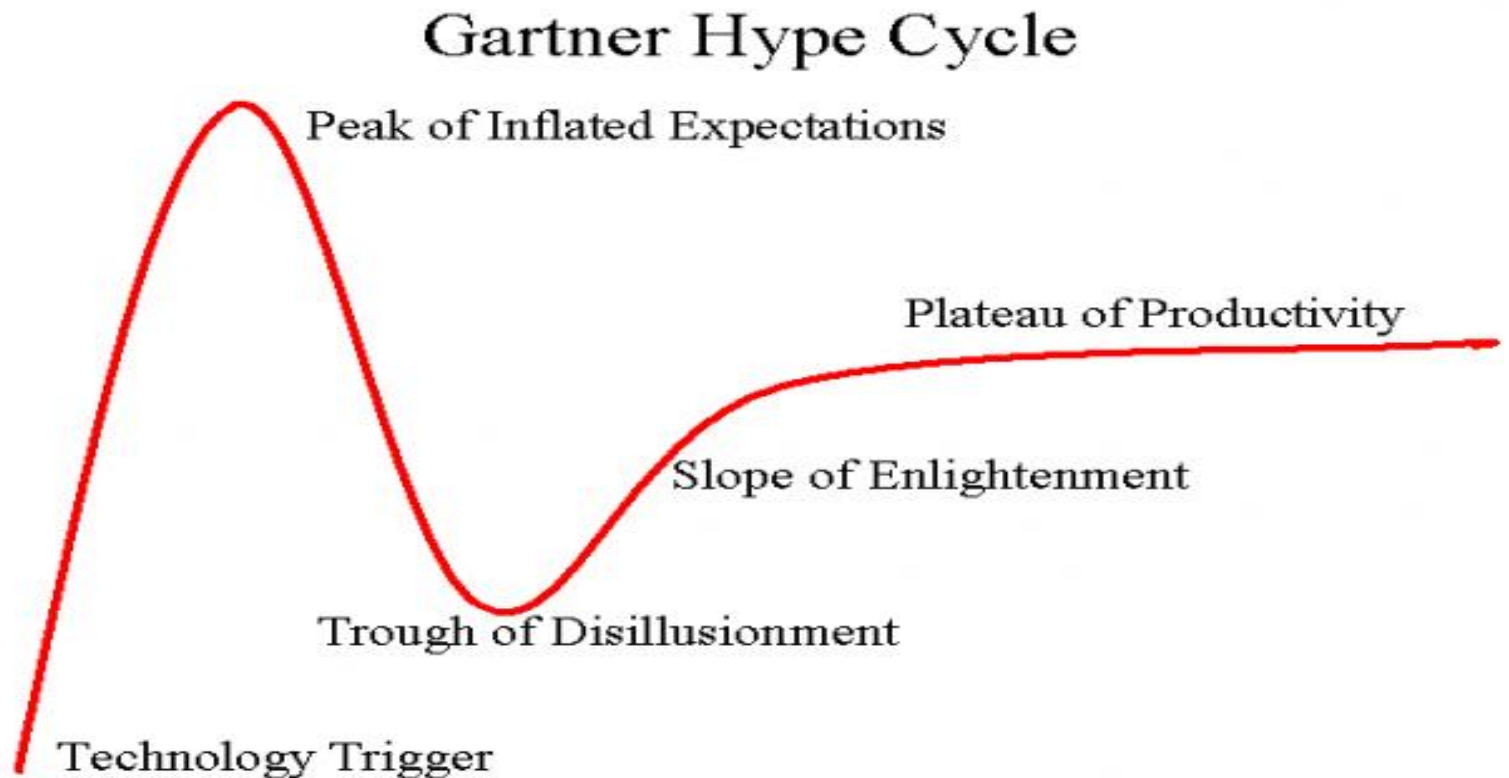
Time

Attribution and Contribution

- Attribution is relatively clear with measuring outputs, more tricky with both intermediary and long term outcomes and impacts;
- Observed change in outcomes may be the result of many other factors other than GC funding- other programs- economic factors-social trends etc etc;
- Need to shift thinking.....less about precision of attribution and more about increasing understanding and knowledge of our contribution



Then: Measuring The Truth Behind the Hype



Practical / Methodological Perspective: Evaluation

- Addressing contextual and methodological challenges in evaluating big science
- Responding to multiple needs
- Concept mapping – logic models
- Triangulation of evidence, mixed methods
- Cutting-edge methods



Methodological Challenges

- Substantive evaluation of the scientific/innovation process relatively new to researchers
- Accountability has been mainly administrative rather than substantial
- Introducing metrics/data collection and evaluation causes changes in practise – consequences not always known
- Evaluation budgets often limit risk-taking



Responding to Multiple Needs

- Accountability → Industry Canada, Board of Directors
 - Looking back, longitudinal analysis
- Strategy development and implementation → Board, GC staff
 - Looking forward
- Communication, engagement → external stakeholders
 - Telling the story/sense-making



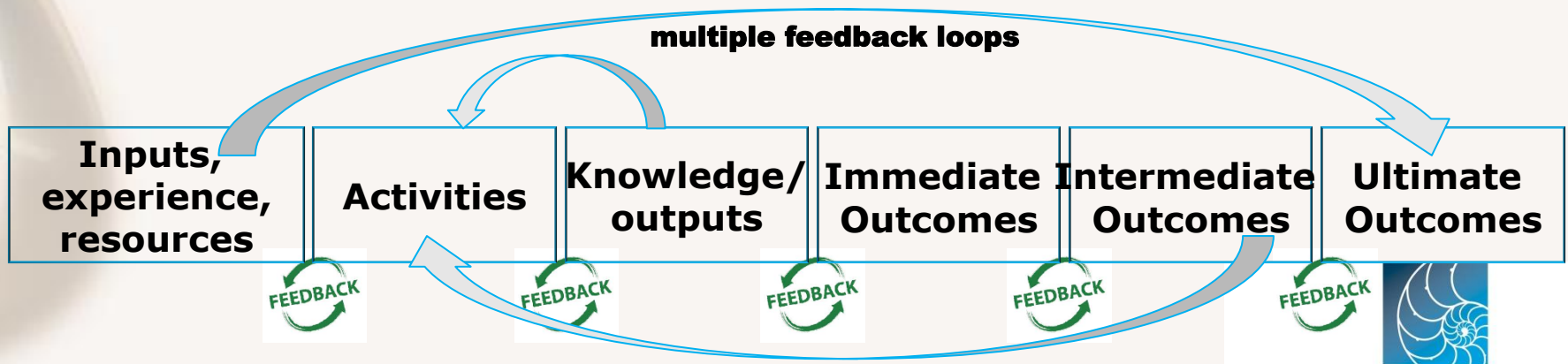
Responding to Multiple Needs

- Participatory approach: Evaluation Steering Committee
- Mandate “to provide direction and oversight” for third-party evaluation
- Membership:
 - 2 Board members
 - 2 external members from community
 - 1 representative from Industry Canada

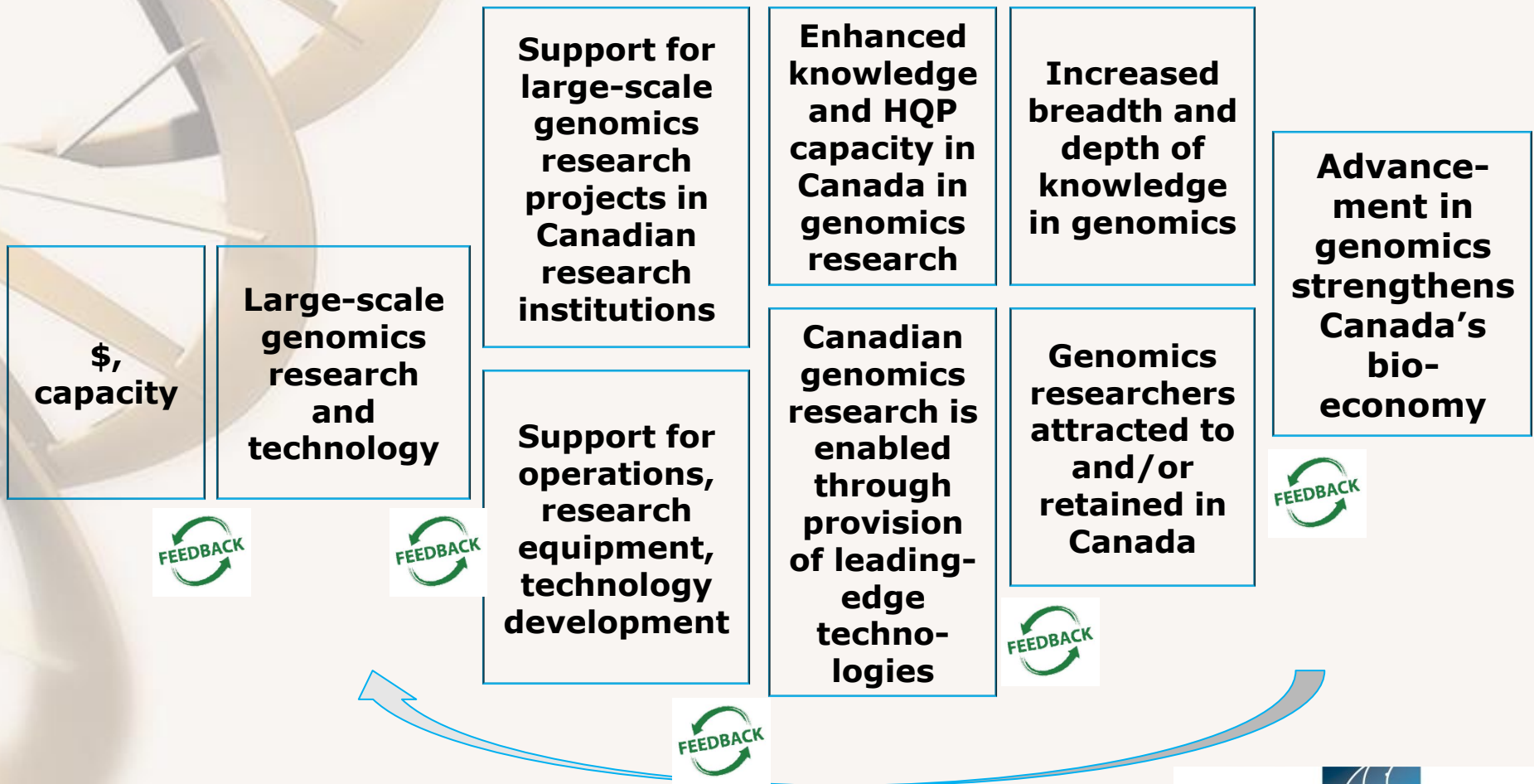


Concept Mapping

- Consultation-based identification of evaluation issues/questions
- Logic model or theory of change: shared understanding of building blocks required to bring about a given long-term goal or outcome



Logic Model – Excerpt



Triangulation – Mixed Methods

- Single line of evidence does not incorporate the complexity of the programs or show sufficient causal inference
- Integrated results from multiple enquiries – triangulation
- Find commonalities vs. anecdotal
- Mixing multiple “safe” methods and using them in “risky” ways



Mixed Methods – What Worked

- Surveys (5 groups)
 - Rich, comparable data
 - High response rates, even in hard to reach groups (alumni, external)
 - Cost-effective
- Bibliometrics
 - Capture scientific outputs, impacts and collaboration
- Interviews, qualitative document review
 - Generous community
 - Comprehensive documents



Mixed Methods – What Didn't Work

- Co-funder survey
 - Contact data not readily available
 - Mitigate with additional interviews
- In-depth quantitative data analysis (other than co-funding)
 - Incomplete database to compute project-level metrics
- Longitudinal analysis
 - Inadequate benchmarks



Mixed Methods – What Might Work

- Case studies
 - Focus on emerging resource sectors to identify success factors and barriers (strategy development)
 - Tension with need to capture translation and impact of practical applications (accountability)
 - Resource intensive
- International comparative review
 - Emergent approach: responsive to growing contextual understanding and availability of participants



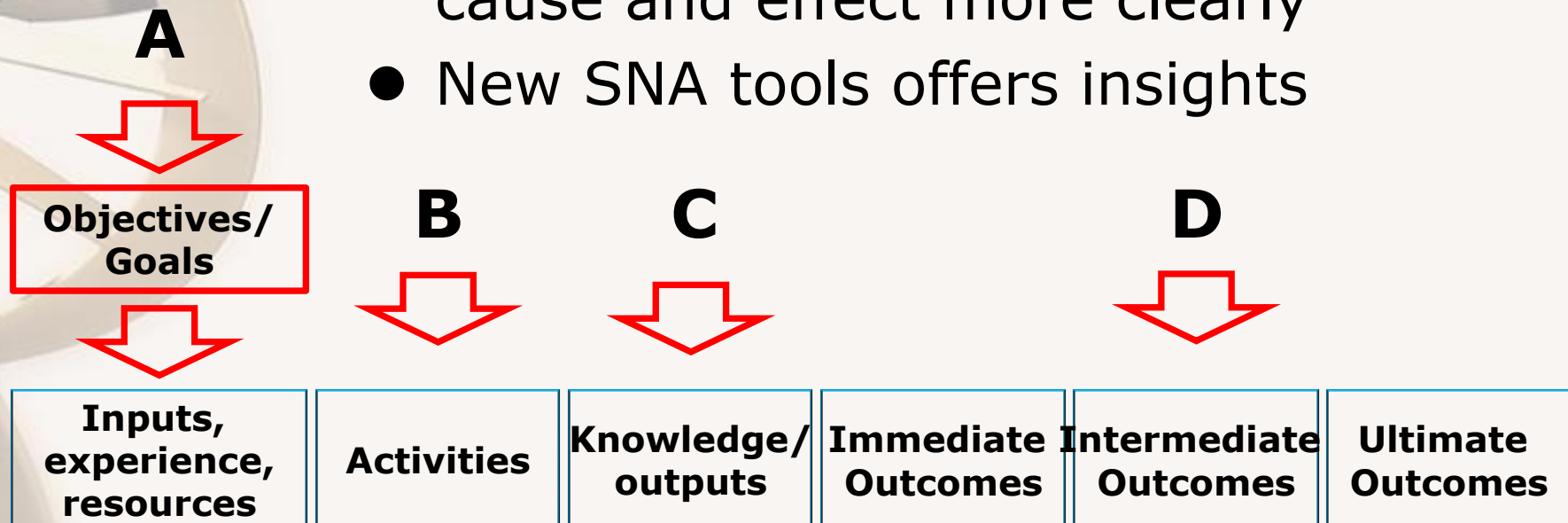
Cutting-Edge Methods

- In-depth input-output analysis (econometrics)
 - Requires system maturity
- Data mining on outreach and outcomes
 - Combined traditional bibliometrics (papers, patents) with webmetrics & social media analysis
 - Capture significant impacts and outcomes outside academia
 - Proposed by S-M, not retained due to budget



4 new evaluations of networked science

- Need to get inside black box and link cause and effect more clearly
- New SNA tools offers insights

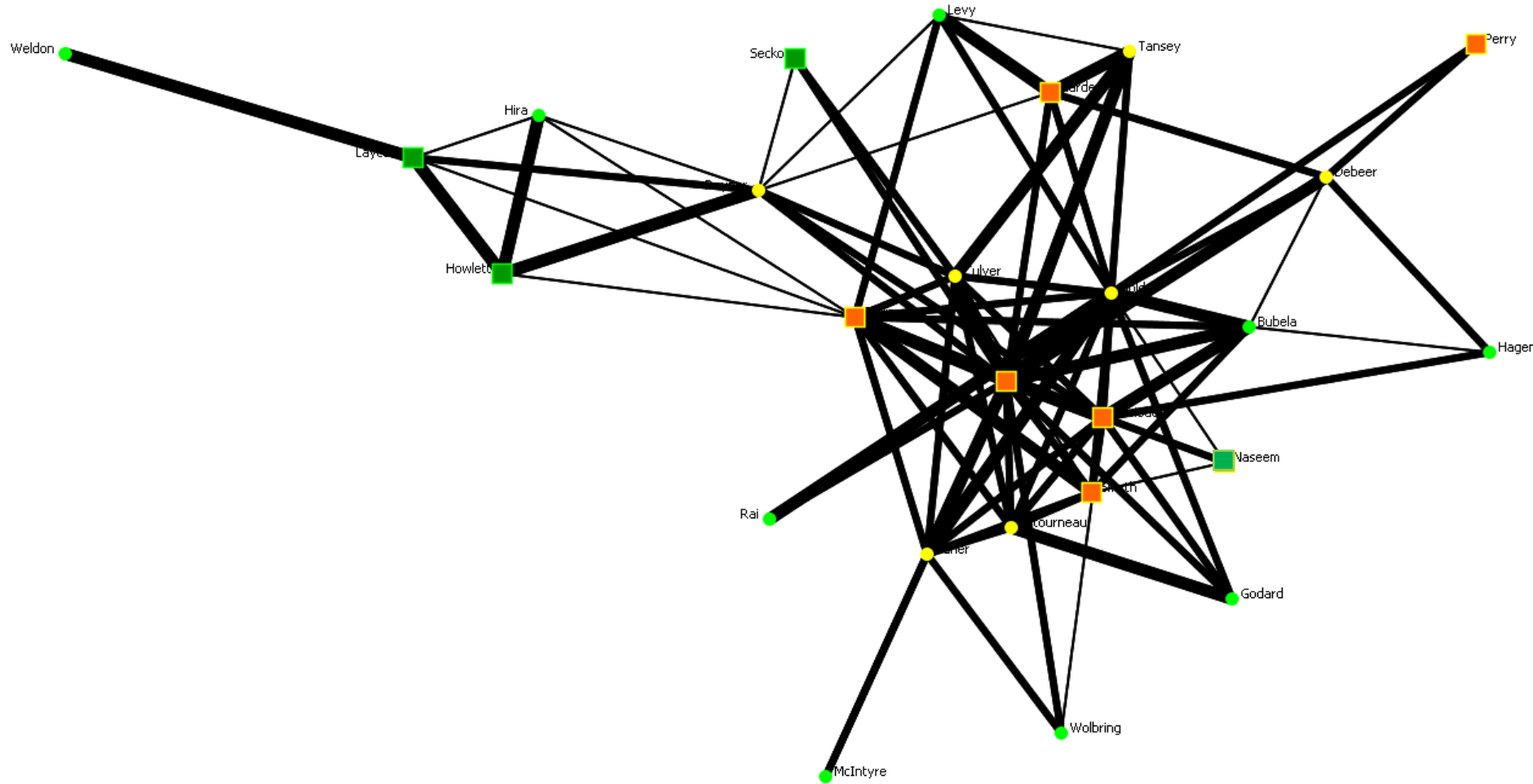


Case A: Inputs—matching goals to allocations of inputs for GC 2000-2012

	All Projects (Open and Directed)		Open Competition Projects
#	156		95
\$	\$996M	✓	\$485M
PI HI	++ ***	✓	++ **
UNI	Insig	→	Insig
GELS (61)	++ **	→	Insig
INT CO-\$	+ *	←	Insig
ONT (52)	Insig	✓	+ *
HEALTH (82)	++ ***	←	++ ***
Adj R ²	0.35		0.22

Source: Zhang (forthcoming).

What is going on? An emergent ABC GE3LS sub-net

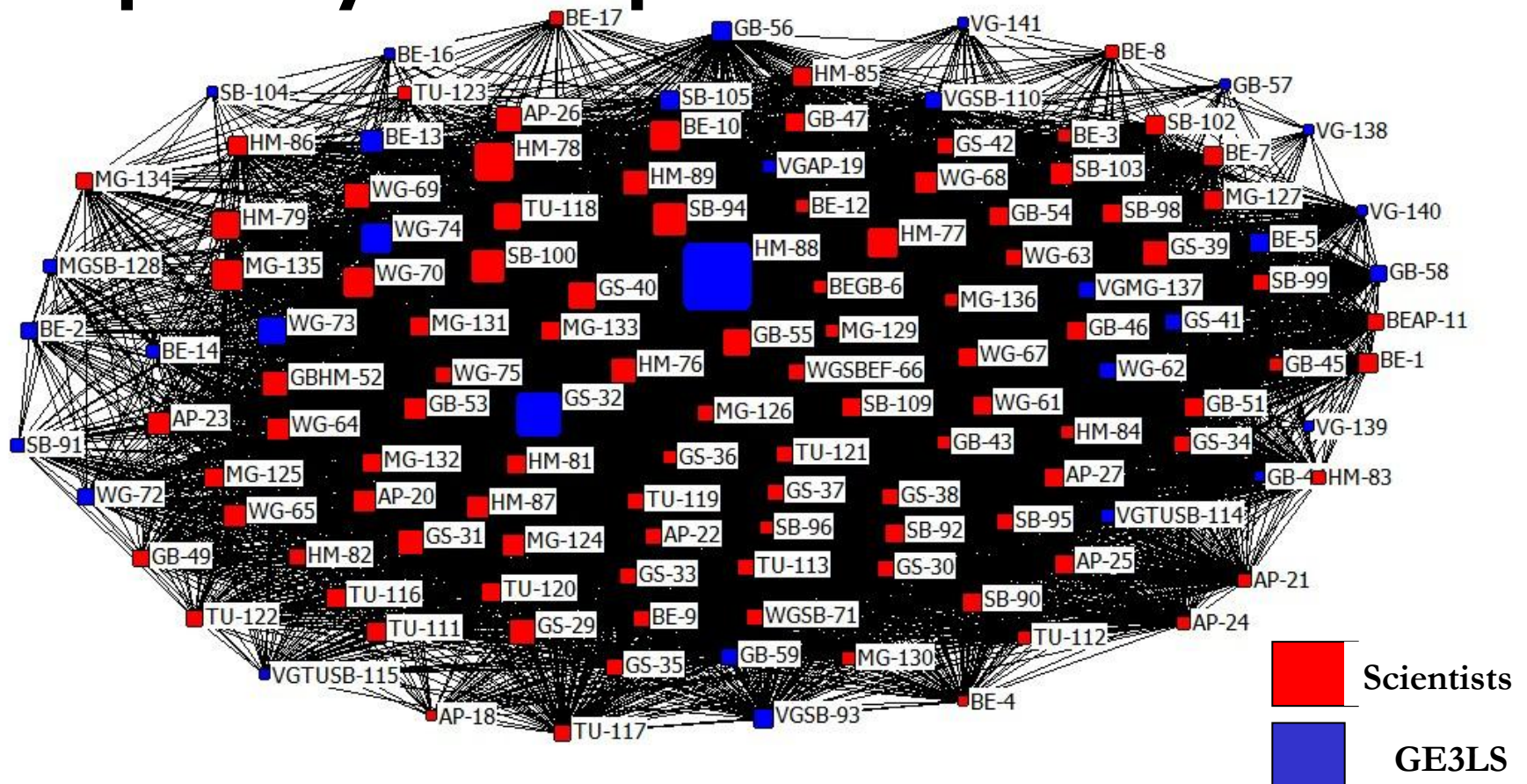


- Valgen Actor
- Valgen Actor & iGE3LS Lead
- iGE3LS
- iGE3LS Lead

Case C: Outputs—creating & accessing social capital in the networked ABC space

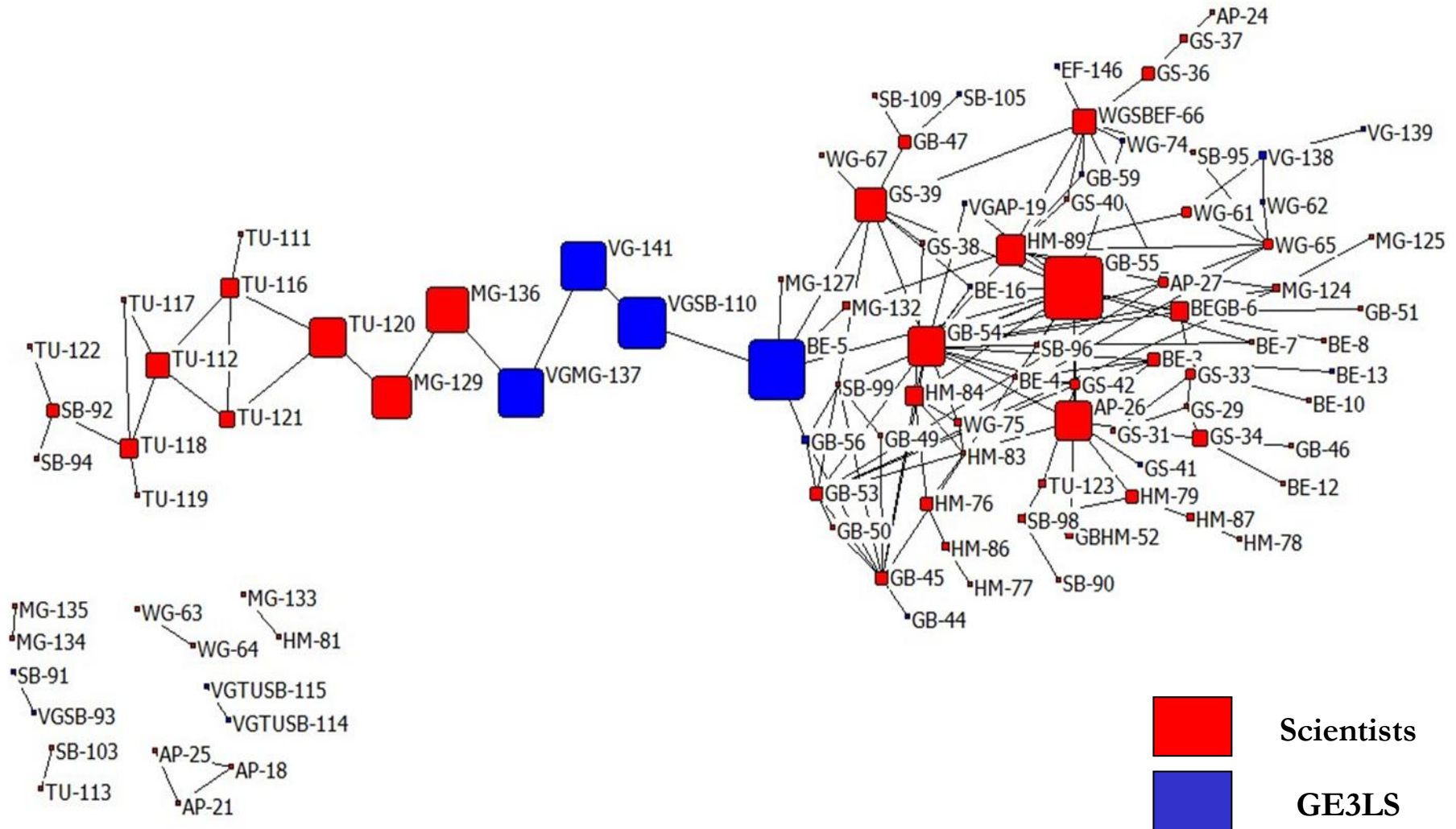
Source: Sharma (forthcoming).

Disciplinary overlaps



Co-production via co-publication (BC)

Source: Sharma (forthcoming).



Generated social capital supports individual success in the ABC space

Correlation between funding allocations and social capital

	TDC	BC	EC
Area of Expertise	-0.163*	-0.234***	-0.186*
Co-Location	0.056	-0.010	-0.053
Co-publication	0.147*	0.029	0.079
Research grants	0.049	0.178*	0.073

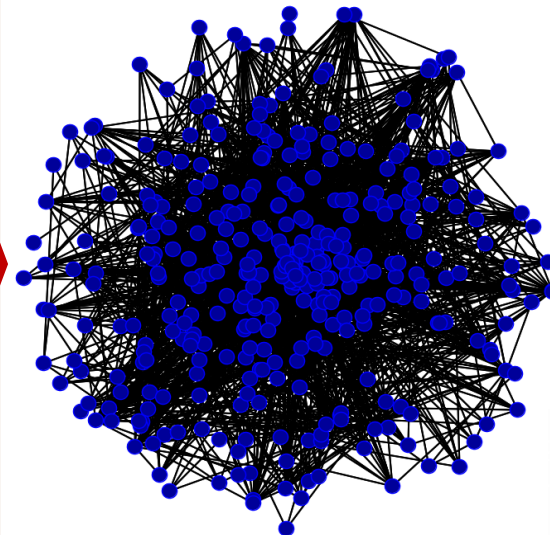
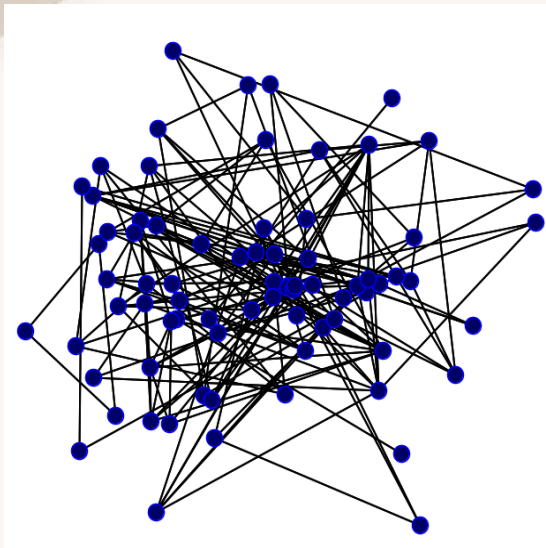
Source: Sharma (forthcoming).

Case D: Outcomes—leveraging networked science and economic outcomes



2006

2011



Source: Ryan
& Phillips
(2013).

n = 161 co-pubs

n = 1627 co-pubs

VALGEN

Climbing the reputational ladder

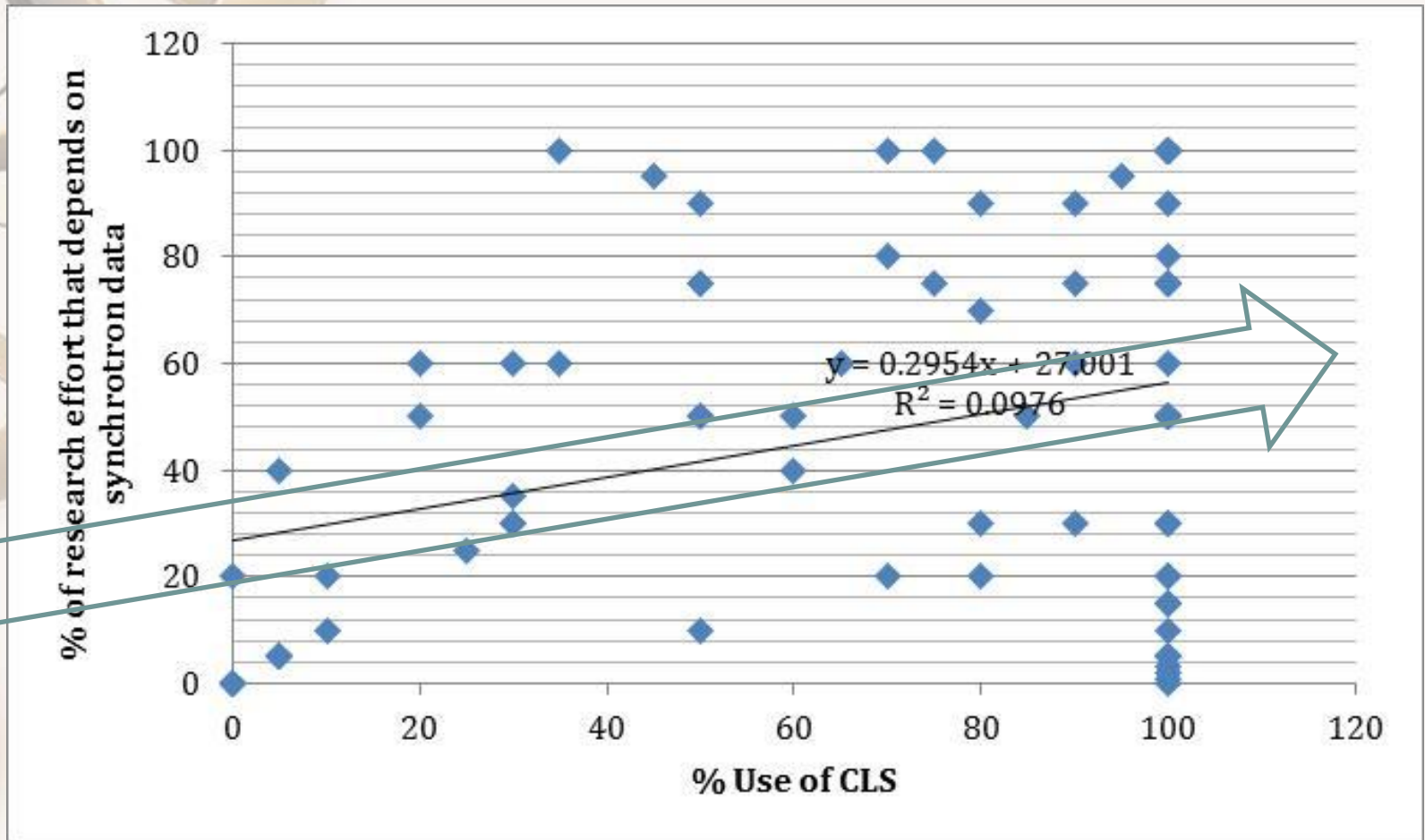
USask median institution (ranked 201-300)

Shanghai Index of researchers home institution

	Total	% of Total	}	60%
1-25	129	9%		
26-50	267	18%		
51-75	78	5%		
76-100	197	14%		
102-150	132	9%		
151-200	76	5%		
201-300	514	35%		
301-400	18	1%		
401-500	49	3%		
Totals	1460	100%		

Source: Ryan & Phillips (2013).

Specialists are attracted to CLS



Source: Ryan & Phillips (2013).

Research impact of pubs (ARC rank)

44% to 73%

Year	N	A*	A	B	C	Total
Expected dist'n		5%	15%	30%	50%	100%
2006	19	37%	32%	21%	11%	100%
2007	50	18%	26%	40%	16%	100%
2008	50	28%	20%	38%	14%	100%
2009	73	38%	32%	21%	10%	100%
2010	114	36%	32%	25%	6%	100%
2011	41	34%	39%	24%	2%	100%

Source: Ryan & Phillips (2013).

Assessing the outputs and outcomes

- Government policy and CLS strategy target to fully use facility to create world-class science, HQP and entrepreneurial outputs (patents, startups)
- Correlated social position to outputs...

Key Scholar Type	Use of Facility	Knowledge Advantage	People Advantage	Entrepreneurial Advantage
Indicators	Time	Pubs	HQP	IP/startups
In-the-know	↓	↑	↓	↓
Broker/bridger	↑	↑	↓	↓

The present and near future

- Need to build benchmarks—within-sample counterfactuals are second best
- Static, artifact-based analysis limited:
 - Agent Based Modelling can accommodate non parametric factors (e.g. power logs; learning) and identify emergent properties (e.g. Pyka and EU FP)
 - Behavioural experimentation can be used to assess relative impact of cognitive biases and institutional limits

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