RIETI-NISTEP Policy Symposium

Open Innovation as a Key Driver of Japan's Industrial Competitiveness

Handout

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Evaluating the Performance of Public Research Subsidy Programmes

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Background

- Policy should be based on evidence
- But often it seems like the evidence is based on policy

The Problem

- A policy or a programme is like a new drug. We would like to know if it is effective, and how its effectiveness compares to alternatives.
- With a drug, it is not enough that the patient gets better. With a policy, it is not enough that the policy goal is met.
- Want to measure the treatment effect, i.e. how the state of the policy objectives compares to what it would have been without the policy.

Analytical Issues

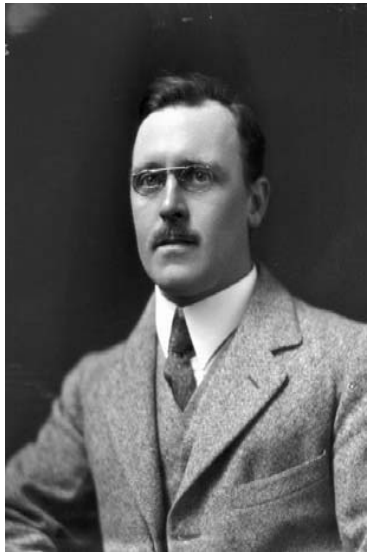
- Characterizing the unobserved "but for" world
  - Selection bias in programme participation
- Outputs and outcomes that are hard to measure
- Long and/or uncertain lags between action and outcomes
- Incremental versus average impact
- General equilibrium effects

Selection Bias

- Frequently, government program provides assistance to some individuals or firms but not to others
- Makes those not provided assistance a natural control group, but…
- Programme targets are chosen on the basis of need (unemployed; under-achieving students), or expectation of success (scholarships; research grants)
- Creates selection bias in difference-in-difference analysis

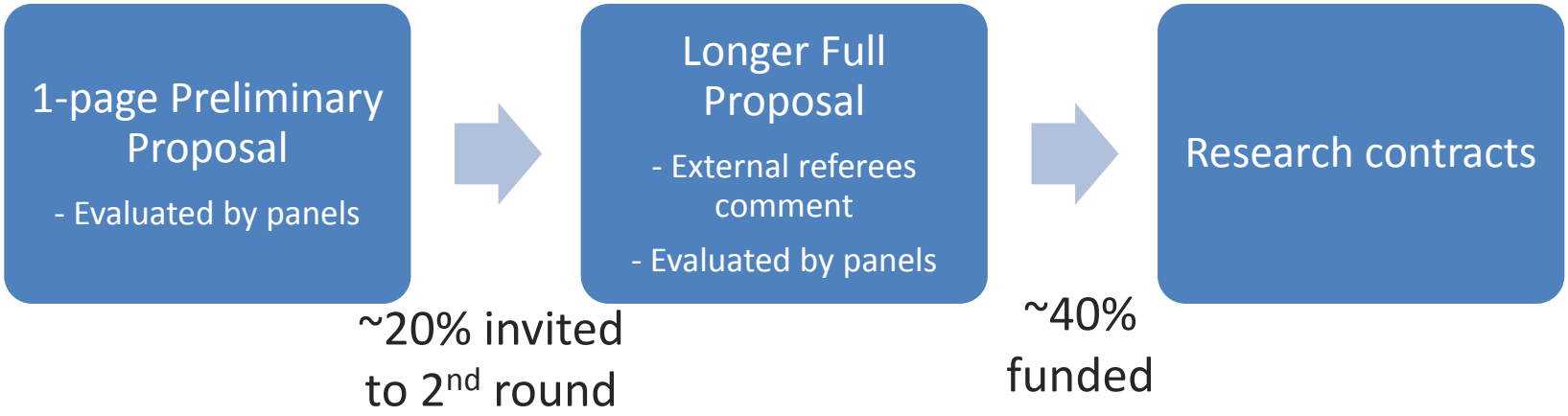
Case Study I: Basic Science and the New Zealand Marsden Fund

- Named for Sir Ernest Marsden (1889-1970)
- Highly competitive, topic unrestricted research grants
- About USD 50 million/year, about 2/3 the size of NSF as a share of GDP
- ~1000 proposals per year, of which ~80 are funded across ten broad disciplinary “panels”



The NZ Marsden Fund

- Proposal teams are made up of PIs, AIs, and other staff
- Two routes evaluated separately: Standard and Fast-Start Proposals (investigators within 7 years of a PhD)
- Two-step proposal process:



- We analyze 1254 **second round** proposals from 2003-2008

Empirical Approach

- Measure research output using publications and citations of researchers from Scopus—*not* tied to specific proposals
- The "treatment effect" is the performance of funded research teams, conditional on their previous performance, relative to those research teams that were not funded
- Control for selection bias using the evaluation scores given to the proposals by the review process
- Citations are dated from publication year, and normalized by field and year: "2005 citations" means citations received 2005-2012 by researcher's papers published in 2005, divided by the mean for researcher's "discipline" for 2005
- Evaluation scores include referee scores (percentage), panel scores (percentage), and scaled panel rank (0 to (n-1)/n)

Marsden Results

OLS Log-Log Baseline Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Pubs	Pubs	ΔPubs	Cites	Cites	ΔCites
Log(Past Performance + 1)	0.766***	0.787***		0.733***	0.734***	
Funded	**0.0638****	**0.145*****	**0.126****	**0.124*****	**0.264*****	**0.255*****
Fast-Start		0.154***	0.329***		0.159**	0.412***
FS*Funded		0.0327	0.0572		-0.0242	-0.00149
Subsequent contract		0.160***	0.0912***		0.338***	0.222***
Scaled rank		-0.214***	-0.217**		-0.293**	-0.360***
Constant	0.554***	0.444***	0.0926	0.755***	0.583***	-0.806***

Marsden Fund Summary

- Results all suggest a modest but robust boost in publications and citations from receiving Marsden grants.
  - These are increases in *total* research output – we make no attempt to attribute papers to the fund
  - Research outcomes are not completely captured by bibliometrics
- No robust evidence of effective selection by second round panels
  - Proposal evaluation is an inherently difficult task, particularly after first-round culling; broad interdisciplinary nature of panels probably a factor
  - Possible that selection is focussed on outcomes not reflected in metrics
  - These results suggest that selection may be inefficient if its goal is to identify future research productivity.

Case Study II: NZ R&D grants to firms

- Examine the impact of R&D subsidy on “innovation” in NZ, as measured by innovation survey carried out in NZ based on the Oslo manual
- The Longitudinal Business Data (LBD) of Statistics NZ has rich data from administrative and survey records on a large number of NZ firms

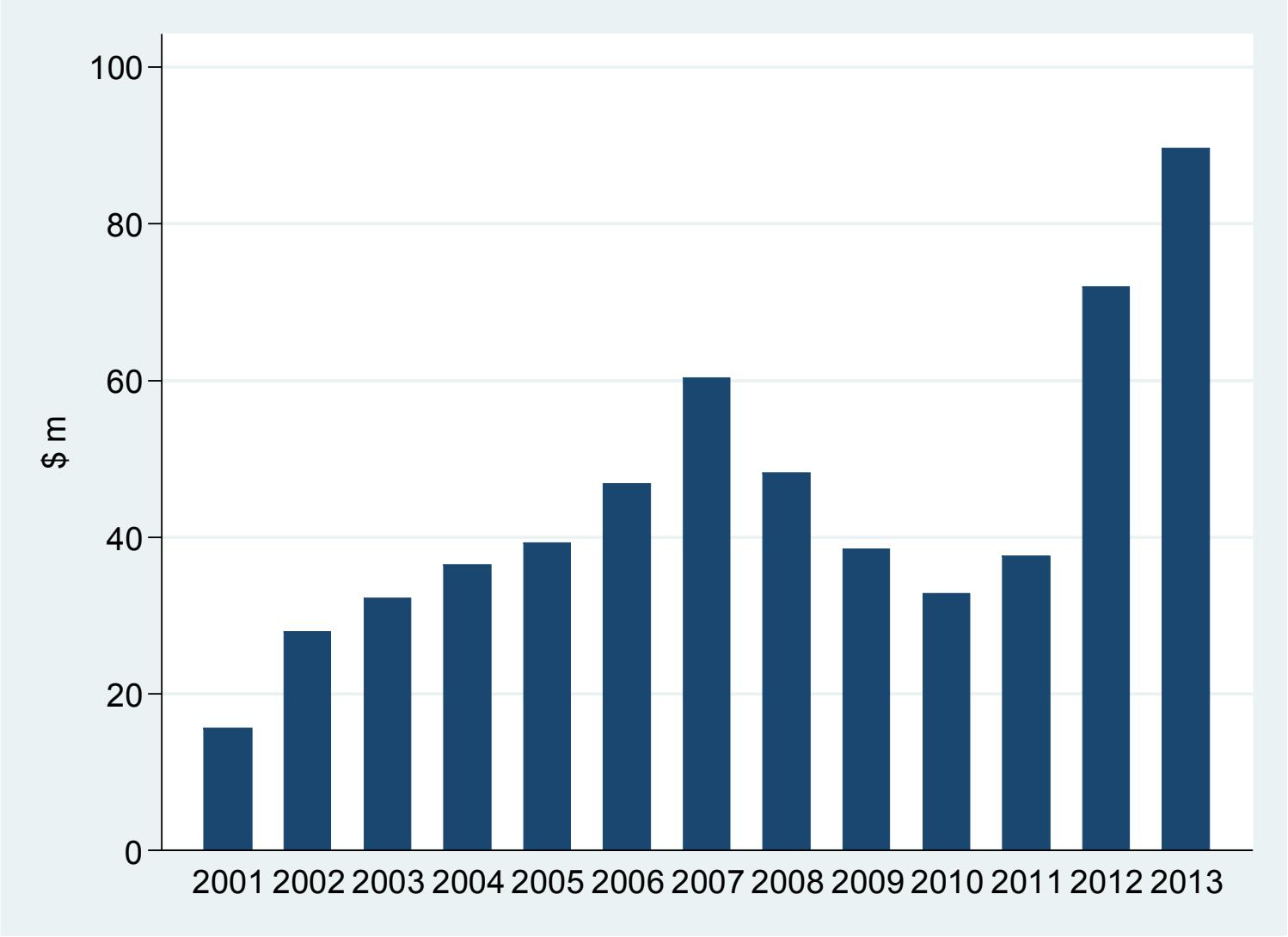
Our approach

- Control sample of matching firms:
  - We identify a set of firms that are matched to the funded firms as closely as possible based on observable characteristics (size, performance, history)
  - We compare the innovativeness of funded firms to that of the control sample of firms
- How to measure innovation
  - Statistics NZ Business Operations Survey ("BOS") every two years asks a series of questions about firms' innovation—we use all of these measures
  - Also have data from IPONZ on patent and trademark applications from NZ firms—alternative measures of innovation

Statistics New Zealand disclaimer

- The results in this paper are not official statistics, they have been created for research purposes from the Integrated Data Infrastructure (IDI) managed by Statistics New Zealand. The opinions, findings, recommendations and conclusions expressed in this paper are those of the authors not Statistics NZ, the NZ Productivity Commission, or Motu Economy & Public Policy Research.
- Access to the anonymised data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business or organisation and the results in this paper have been confidentialised to protect these groups from identification. Careful consideration has been given to the privacy, security and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the privacy impact assessment for the IDI available from www.stats.govt.nz.
- The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes. Any person who has had access to the unit-record data has certified that they have been shown, have read, and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.
- Statistics NZ confidentiality protocols were applied to the data sourced from the Ministry of Business, Innovation and Employment; New Zealand Trade and Enterprise; and Te Puni Kōkiri. Any discussion of data limitations is not related to the data's ability to support these government agencies' core operational requirements.

Govt R&D funding for businesses



Measures of innovation

- Intellectual Property (IP) data: patents, trademarks
  - Accurate on its own terms
  - But not all innovations patented and not all patents lead to innovation
  - Quite rare among NZ firms
- BOS Survey questions: variety of categories (good or service verus process); various levels of newness (new to firm, new to NZ, new to world)
  - Self-reported, definition varies by reporter
  - Capture aspects of innovation not captured by IP data
  - Some innovation reported by many firms, but not clear how meaningful
- Overall, over 100K firms, of which about 11K are covered by BOS, 2005-2013

BOS Descriptive statistics

	Grant Recipients*	Control
Any innovation	67%	44%
Process innovation	42%	23%
Product innovation	58%	25%
New Good/Service to the world	25%	3.5%
Sales due to new Good/Service	7.4%	2.9%
Number of observations	1,194	22,785

** Firms that received an R&D grant in prev. 3 years*

Estimation method: Propensity score matching (PSM)

- PSM estimates the treatment effect by comparing a 'treated' firm with an control firm that is as similar to the treated firm as possible
  - Estimate a propensity score
  - Match a treated with an control
  - Calculate the difference in outcome between treated and control
- Robustness confirmed using several technical variations on these methods.

Impact of R&D grant receipt on innovation outcomes

		Kernel bw=0.01
Process innovation	Mean of control	0.347
	Treatment effect	0.053**
Product innovation	Mean of control	0.445
	Treatment effect	0.100***
New GS to the world	Mean of control	0.124
	Treatment effect	0.094***
Sales due to new GS (%)	Mean of control	5.012
	Treatment effect	1.964***
N. control		20,121
N. treated		1,017

Effects on patents and trademarks

		Kernel bw=0.01
New patent	Mean of control	0.014
	Treatment effect	0.011***
New trademark	Mean of control	0.091
	Treatment effect	-0.001
N. control		292,455
N. treated		4,137

Robustness checks

- Ultimately hard to know if PSM has succeeded in controlling for selection bias.
- Could be “good firms” get funded and “good firms” have more innovation, in ways that are not captured by observable firm characteristics on which we match.
- Test: do firms getting grants show “effect” on unrelated “good” outcome?
  - No effect of grant on reported “employee satisfaction”
- Test: does a non-R&D-related programme show apparent increase in innovation?
  - Recipients of Enterprise Training Programme (ETP) grants do show some weak innovation effects, particularly for “easiest” forms of innovation
  - Could be evidence of some residual selection bias
  - Could be evidence that ETP indirectly/weakly helps firms become more innovative

Other Robustness checks

- Results are very similar with the following variations:
  - Match on pre-treatment characteristics rather than post-treatment
  - “Window” for R&D/Innovation effect of 2 or 5 years rather than 3
  - Lag time between grant and innovation effect increased (2-4 years or 3-5 years previous, rather than 1-3)

Firm R&D Grants Summary

- R&D grant receipt doubles the probability of reported introduction of goods or services new to the world, but much weaker effect on process innovation
- R&D project grants show stronger effects than R&D capability-building grants
- Little evidence of differential impacts by firm size
- R&D grant receipt doubles probability of filing a patent, but no significant effect on trademark activity
- Part of observed effects probably due to selection, but a large part still seems to indicate a causal relationship
- Ultimate interpretation requires more study of relationship of BOS-reported innovation to economic outcomes
- Important: we are looking for “direct” effect—if spillovers create benefits for other firms that are comparable to the direct benefit to the funded firm, we wouldn’t find effect.

Case Study III: Targeted or Mission Research

- Biggest challenge is how to measure the research outputs and outcomes.
  - Identify categories of desired potential impacts
  - Outputs, intermediate impacts and impacts
  - Proxies and indicators
  - No “bottom line”
  - Include qualitative assessments

PROTOTYPE DIMENSIONS OF PUBLIC RESEARCH IMPACT

Economic
- New or improved products or services
- Reduced operating cost or reduced commercial risk
- Increased wages or improved job opportunities

Environmental
- Reduced pollution or other anthropogenic environmental impact

Public policy
- Improvement of public policy or of the delivery of public services

Capability
- Enhancement of the scientific and technological capabilities of the work force

Social
- Improved morbidity and mortality, or reduction in the cost of maintaining health
- Increased communal knowledge and interest in science
- Reduction in real or perceived communal risk
- Enhancement of international reputation, or contribution to sustainable development
- Enhancement of other social, cultural or community values

Examples of Metrics

Impact dimension	Direct Measure	Proxy or indicator	Intermediate outcome
1. New or improved products or services	additional revenue	enumeration of new products and processes	private sector development investment
4. Reduced pollution or other anthropogenic environmental impact	reduction in emissions or other environmental impact (tons; percent of total emissions)		
5. Improvement of public policy or of the delivery of public services	issuance or implementation of policy or practice incorporating research results		workshops or other delivery of policy, programmatic or operational advice to governmental body
7. Improved morbidity and mortality, or reduction in the cost of maintaining health.	increase in quality-adjusted life years		adoption of new technology or practice in health care
8. Increased knowledge and interest in science			time spent in interactions with public
			development and use of educational materials
9. Reduction in real or perceived communal risk		expert assessment of communal risk reduction	
		survey results regarding public risk perceptions	
11. Enhancement of social, cultural or community values		expert assessment of values impacts	

Final Thoughts

- All analyses are incomplete and subject to criticism, but don't let that stop you.
- In terms of metrics, let a thousand flowers bloom.
- Evaluation is greatly facilitated by building it in up front in programme operation—e.g. retention of information on rejected proposals
- More generally, government's job is to collect, retain and make available basic data on interactions with public system. Then—
- Internet-based world creates all kind of opportunities for clever researchers to collect new proxies and indicators for activities of these agents.