THE UNIVERSITY OF MELBOURNE

Effects of university-industry collaboration subsidies on firm performance

Paul H. Jensen (with Alfons Palangkaraya, Russell Thomson and Elizabeth Webster)

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Introduction

- Numerous government programs designed to stimulate university-industry collaboration around the world
  - e.g. ARC Linkage: competitive grants with subsidy for projects with industry co-contributions ~(USD $230m) p.a.
- Rationale for the subsidy: market failure in converting good ideas (science) into successful products (business)
- But we still don't know how well these programs work
  - Evidence that collaborating with universities is associated with increased research outputs and improved firm performance but is it causal?
  - Previous studies are subject to selection bias due to unobservability of all grant application data (i.e. successful and unsuccessful grant applications)
  - Our access to confidential data (ARC data and firm-level longitudinal data) enabled us to create more detailed control groups, controlling for time-varying factors

Our Research Question

- Most existing research on public subsidies on uni-industry collaboration focuses on scientific impacts
  - But impact on firm performance is at least as important
- How does participation in the ARC Linkage program shape firm performance?
  - We observe many different dimensions of firm performance (turnover, patents, employment etc)
  - Does the effect vary by cohort, firm size or over time?
- What does this tell us about subsidizing support for uni-industry collaboration?
  - Very hard to generalize our results, but there do appear to be some benefits from engaging with universities, even if the grant is unsuccessful!
- Should such schemes support projects that would have been funded (privately) anyway or only those marginal projects that wouldn't otherwise have been funded?
  - In theory, only the latter should be funded but this is practically impossible

Our Approach

- Issue: evaluate program participation effects on **firm performance** rather than **scientific output**
- In doing so, we examine why firms may choose to participate in this scheme
- To do so, we use confidential data on the population of ARC Linkage applications 2002-14 (~5,000 applications) linked to balance sheet data from tax records
  - we observe successful/unsuccessful (i.e. **funded/not funded**) ARC Linkage applications
  - Tax record data on the **population of Australian firms (millions of observations)**
  - Huge undertaking to 'link' these datasets, **all done remotely**
  - The project started 8+ years ago, most of which has involved data cleaning/linking
- We construct the following control groups:
  - i) observationally similar firms from the population selected via propensity score matching
  - ii) applicant firms which were not successful

Descriptive Statistics

		Matching year					
		2004		2007		2011	
		Sample size	Sales (log)	Sample size	Sales (log)	Sample size	Sales (log)
Unsuccessful & Non-applicant							
Before matching	Unsuccessful	72	14.35	68	13.79	105	14.70
	Non-applicant	399,923	12.74	349,224	12.87	379,983	12.81
	t-stat mean differences		-8.36		-4.61		-11.72
After matching	Unsuccessful	61	14.71	48	14.42	87	15.17
	Non-applicant	61	14.64	48	14.19	87	15.08
	t-stat mean differences		-0.16		-0.60		-0.34
Successful & Unsuccessful							
Before matching	Successful	87	14.76	63	14.52	52	14.68
	Unsuccessful†	796	14.42	792	14.56	834	14.52
	t-stat mean differences		-1.33		-0.18		-0.51
After matching	Successful	66	15.13	47	15.20	42	14.91
	Unsuccessful	66	14.86	47	15.11	42	14.53
	t-stat mean differences		-0.68		-0.23		-0.92

Our Contribution

- By exploiting detailed data covering both **successful and unsuccessful** applications, we provide robust evidence of the **causal impact** of university-industry collaboration grants
- Previous studies have compared participants to *observationally similar* non-participants, but this doesn't account for self-selection into the program
  - Comparing program participants with non-participants conflates the impact of funding with willingness to collaborate
  - Previous estimates using this approach are likely biased
- Our control groups mean we can control for **time-varying unobservables** (e.g. project quality and willingness to collaborate) which other studies cannot do

Institutional Setting

- ARC Linkage scheme: value of grants to universities (~USD$230m)
  - Open to **all tech areas/industries**, large and small firms, all universities
  - Scheme is competitive, but the success rate is higher (~30%) than the ARC Discovery Grant scheme (~10%)
  - Anonymous **peer reviewers** assess application on: investigator capability (25%), project quality (25%), feasibility and commitment (20%), and benefit (30%)
  - Each application receives a score and is then ranked for funding
  - Firms must contribute **at least 25%** of the total budget
  - Most grants only **involve one firm** (and one or many university partners), so no complex research consortia
  - However, firms can have many applications (one-to-many) and applications can have many firms (many-to-one). We use a firm's **first application**

Data

- Economic data: Australian Bureau of Statistics' (ABS) Business Longitudinal Analytic Database Environment (BLADE), containing annual economic information on the **full population of firms** since 2001-02
- ABS performed data merging/processing based on Australian Business Number (ABN). Outputs are scrutinised by ABS before being released
- Firm performance is measured as: log sales, log employment, log value added, patent applications and trade-mark applications to IP Australia
- ARC Linkage data has firm names **but not ABNs**: using machine matching, we identified 75% of the 7,500 firms' ABNs
  - Most firms in the dataset only have one ABN
  - Most firms in the dataset only have one ARC Linkage application
  - Identification of any effect is complicated by any many-many relationships
- Firms that applied for a grant are typically much larger than non-applicants in terms of size, patenting activity, etc

Method

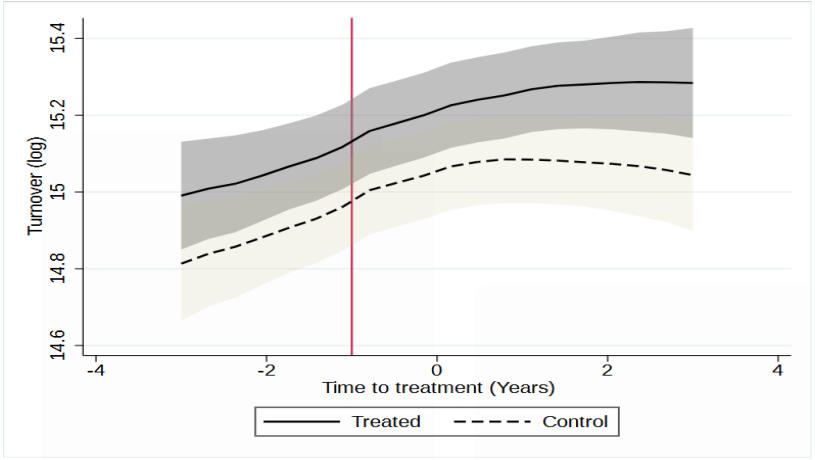
- Given potential **selection on unobservables** and the possibility that treatment start year varies because of annual nature of the grant process, we specify a **flexible event study** DID estimating model
- This approach allows for assessment of whether the treated and control groups satisfy the **parallel trend assumption** underlying the DID estimator
- A general form of the estimating model is specified in equation (1) below:

$$Y_{it} = \alpha_i + \lambda_t + \mu_{-\underline{T}} D_{it}^{-\underline{T}} + \cdots + \mu_{-2} D_{it}^{-2} + \mu_0 D_{it}^{0} + \mu_1 D_{it}^{1} \cdots + \mu_{\overline{T}} D_{it}^{\overline{T}} + \varepsilon_{it} \qquad (1)$$

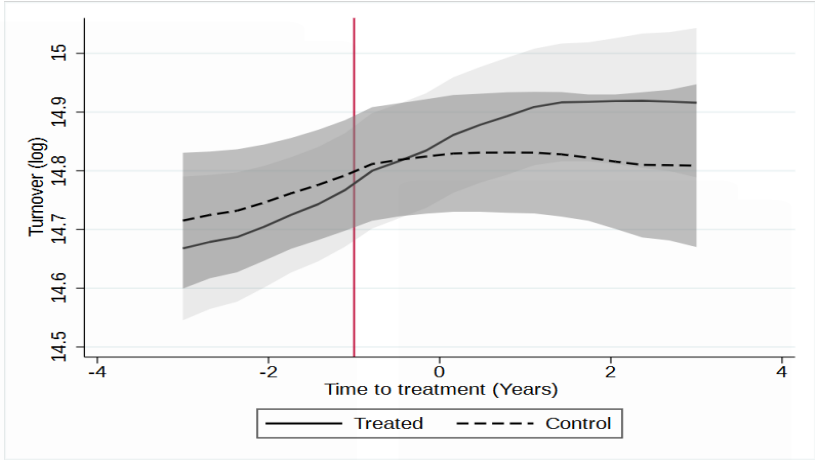
where i and t index firms and years and Y_{it} denotes firm performance (measured in multiple ways)

- The set of dummy variables denoted D_{it}^{k} are the relative time-to-treatment indicators. $D_{it}^{k} = 1$ for each treated firm i in k-years from the grant or the application year (corresponding to the start of each treatment type we consider) and zero otherwise.

Parallel Trends



(a) Successful vs Unsuccessful



(b) Unsuccessful vs Non-applicant

- Average turnover of matched successful v. unsuccessful firms and matched unsuccessful v. non-applicant firms across the time-to-treatment years.
- The line plots suggest for a pre-treatment years parallel trend between the firms in the matched treated and control groups and potential positive effects of the treatment especially starting from one year after the start of the treatment

Method (2)

- Each coefficient of the time-to-treatment indicators (μ_k) measures the **average change in the relative performance** of the treated firms between period k and the reference period relative.
- We expect that $\mu_k = 0$ in all $k < 0$. In contrast, if the university-industry grant has a positive effect on the performance of the partner firms, we expect $\mu_k > 0$ for $k \geq 0$.
- In estimating equation (1), we implement a recently proposed three-step interaction-weighted (IW) estimator.
- As argued in Baker et al. (2021) and Sun and Abraham (2021), the parameter estimates of μ_k might be biased if the **treatment timing is staggered**, as in our case, and the **treatment effect is heterogeneous**.
- Uncorrected, such bias could lead to incorrect inference with regards to the true effect
- **Treatment start year** is defined as the year the ARC Linkage project began or would have begun (if funded). i.e. if the treatment is 'application', the treatment start year is the year of the first application; if the treatment is 'grant', the treatment start year is the year of the first grant.

Results (by firm size, successful vs unsuccessful firms)

Time-to-treat (year)	All firms	Large firms	SMEs
	(1)	(2)	(3)
t-3	-0.086	-0.035	-0.106
	(0.056)	(0.074)	(0.067)
t-2	-0.022	0.033	-0.036
	(0.035)	(0.042)	(0.041)
t-1	0	0	0
	(.)	(.)	(.)
t (start of grant)	0.016	0.048	0.006
	(0.039)	(0.056)	(0.047)
t+1	0.040	0.176***	0.007
	(0.054)	(0.064)	(0.065)
t+2	-0.016	0.208**	-0.070
	(0.064)	(0.104)	(0.074)
t+3	0.004	0.205	-0.043
	(0.077)	(0.142)	(0.090)
Sample size	5021	861	4160
R-squared	0.897	0.946	0.844
N-treated	432	80	352
N-control	335	52	283

Results (by firm size, unsuccessful vs non-applicant)

Time-to-treat (year)	All firms	Large firms	SMEs
	(1)	(2)	(3)
t-3	-0.135**	-0.145	-0.140**
	(0.054)	(0.147)	(0.061)
t-2	-0.031	-0.077	-0.029
	(0.033)	(0.102)	(0.037)
t-1	0	0	0
	(.)	(.)	(.)
t (start of grant)	0.047	-0.006	0.055*
	(0.030)	(0.077)	(0.032)
t+1	0.093*	-0.077	0.108**
	(0.049)	(0.129)	(0.053)
t+2	0.102*	-0.103	0.127**
	(0.059)	(0.140)	(0.065)
t+3	0.064	-0.129	0.097
	(0.062)	(0.154)	(0.068)
Sample size	6011	867	5144
R-squared	0.916	0.876	0.894
N-treated	472	70	402
N-control	472	63	409

Headline Results

- Winning a grant has positive effect on firm performance
  - Grantees have 18-21% higher turnover compared with firms whose proposed university-industry research collaboration was unsuccessful
  - However, the result is limited to **large firms** using **turnover** as the **dependent variable** (no evidence of impact on **other performance indicators** e.g. employment)
  - Positive effect is **strong** in t+1 and t+2, but **dissipates quickly** thereafter
- Performance of 'unsuccessful' applicants is systematically different from the general population (non-applicant), **even after matching** on observable characteristics
  - 12.7 per cent increased turnover for **SMEs** who are partners in an unsuccessful bid
  - The **act of collaboration** between industry and universities has benefits for SMEs
  - This suggests that previous studies that only observe grants **are likely biased**

Conclusions and Caveats

- **Collaboration** with a university – forming a relationship, scoping the idea – has an impact on the firm's performance
- Why would that be true?
  - Funding is critical for raising production levels and perhaps unsuccessful ARC Linkage applicants find **funding elsewhere** to undertake the project, particularly large firms
  - However, we **do not observe the source** or level of any alternative funding
- **University quality** doesn't change the results – which might be due to the fact that this scheme is used widely by smaller less research-intensive universities
- **Necessary but not sufficient** evidence to support subsidizing university-industry collaboration
  - Study doesn't inform us about spillovers, etc