Evaluating the Effect of Research and Innovation Policy on Small Business Start-ups: An Inflow-Sampling Approach*

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1. RESEARCH QUESTION

Do federal research, innovation, and technology policies and programs positively impact small business start-ups?

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

- largest federal R&D program for small businesses; > $ 1 billion/year
- started as an NSF project in 1980; expanded to other agencies through the 1982 Small Business Innovation Development Act
- objective: stimulate technological innovation among small firms
  - ✓ financing to develop unproven but promising technologies (Toole & Czarnitzki, 2007) $150,000 – $750,000
  - ✓ financing to small high-tech entrepreneurs at the start-up stage of technology development (Cooper, 2003)
  - ✓ public venture capital program for new high-tech firms (Etzkowitz et al., 2000)

PLAN FOR THE REST OF THE PRESENTATION

2. Motivation
3. Potential Contribution to the Literature
4. Data
5. Identification Strategy
6. Model
7. Results
8. Conclusion/Policy Implications/ Extensions

2. MOTIVATION

Importance of Small and Start-up Enterprises in the Economy

Job Creation (Birch, 1979; Armington, et al. 1999; Litan, 2009; SBA, 2009)

- over ½ of private sector employment
- net generator of jobs especially during economic recessions
- without start-ups, negative job growth

Division of Labor in Innovation (Acs & Audretsch, 1990; Breitzman & Hicks, 2008; Jewkes et al., 1958; Wetzel, 1982)

- produce 13 times more patent/employee than large firms
- 5 times and 20 times more patent per R&D dollar than large firms and universities/federal labs respectively
- twice as likely as large firms to produce most-cited patents
- more innovative in selected industries electronics, computing equipment, synthetic rubber, etc. than large firms
- introduce novel products and processes in less crowded technological fields

2. MOTIVATION

Market Failure in Early-stage Technology Development?

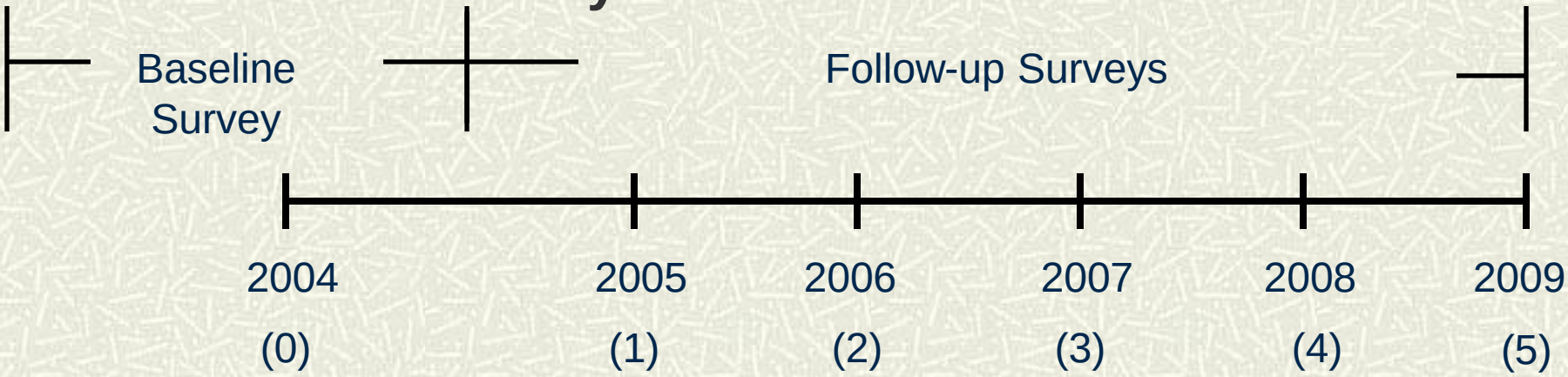
- Do small high-tech business start-ups underinvest in R&D?
- Are technology policy interventions matched with actual market failures? (Tassey, 2007)

3. POTENTIAL CONTRIBUTION TO THE LITERATURE

Prior Research	Focus/Approach/Extensions of this Research
R&D Subsidy Studies Aerts & Schmidt (2008); Gonzalez & Pazo (2007); Hall & Maffioli (2008); Hussinger (2008) (*) focused mostly on EU countries due to data availability -- CIS I-IV	(+) small business start-ups in the U.S. using the Kauffman Firm Survey (KFS) (+) effect of R&D subsidy at the early stage of technology development
SBIR Studies 1 Audretsch, Wiegand & Wiegand (2002); Audretsch, Link & Scott (2002); Link & Scott (2000) (*) used only recipient firms	(+) build new dataset including both recipient and non-recipient firms (+) use inflow sample
SBIR Studies 2 Lerner (1999); Wallsten (2000) (*) recipient and non-recipient samples manually combined	(+) recipient and non-recipient firms from one random sample; more comparable samples (+) use advances in statistical matching techniques

4. DATA

Kauffman Firm Survey



- *inflow* sample of 4,928 businesses **founded** in 2004
- 2004 baseline survey; follow-up surveys (2005-09); KFS 6th to be released in spring 2012
- (+) inflow sample eliminates confounding effects of macroeconomic variables

5. IDENTIFICATION STRATEGY

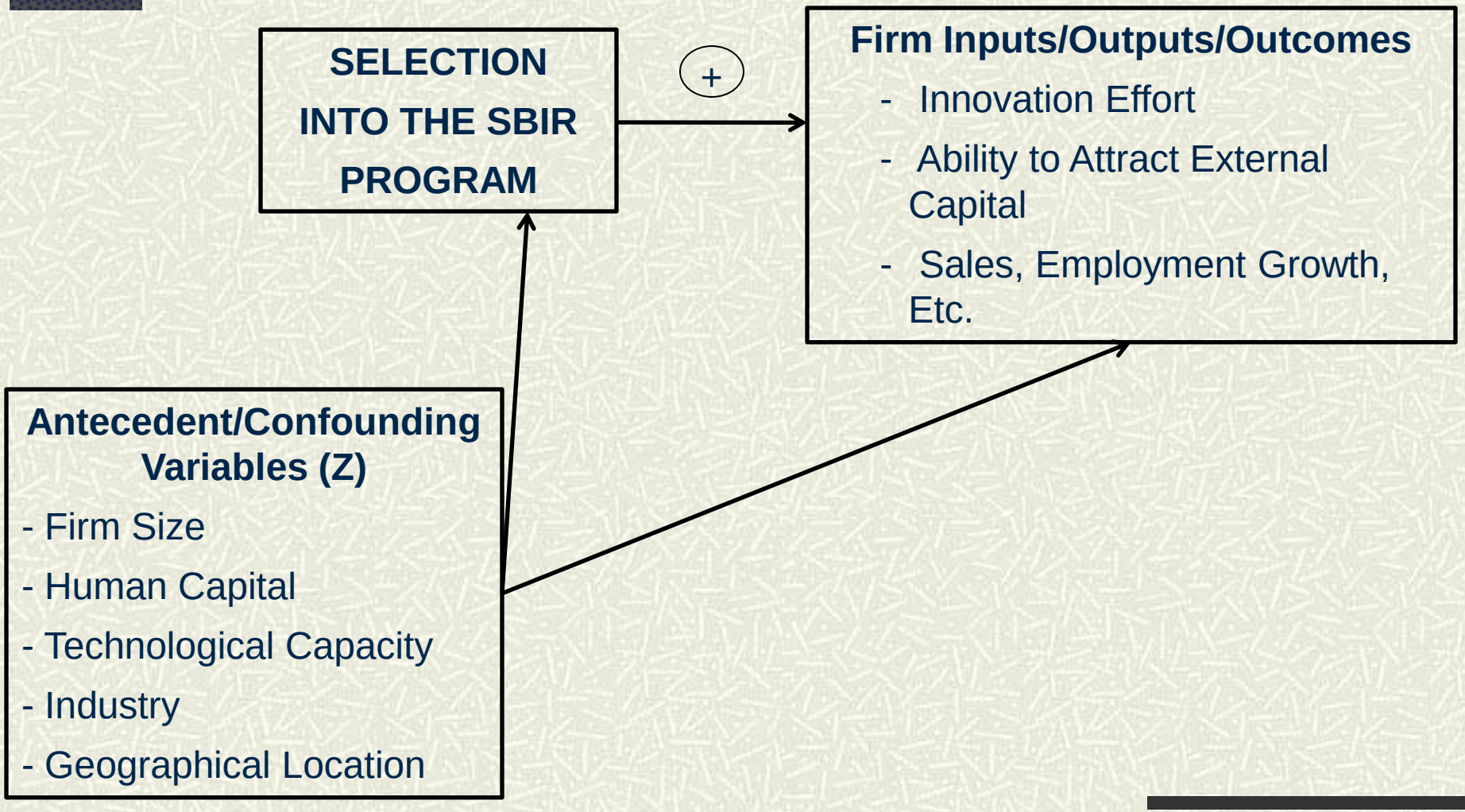
1. Propensity Score Matching (Rosenbaum & Rubin, 1983)
   - match statistically on the conditional probability of program selection $P(T=1 \mid X)$
   - sample of well-matched untreated units as empirical proxy for the control group
   - $ATT = E_{P(Xi \mid T=1)} [E(Y_i \mid T_i=1, X_i) - E(Y_i \mid T_i=0, X_i)]$
     - difference of mean outcomes between treated and observationally similar untreated groups
     - more meaningful comparison; compare only "comparable" units
   - (+) estimates ATT; more useful in policy evaluation
   - (+) semiparametric; avoids OLS assumptions
   - (+) reduces sensitivity to unobserved bias

5. IDENTIFICATION STRATEGY

2. Regression within common support (Gelman & Hill, 2007; Ho, Imai, King, & Stuart, 2007)

- apply regression analysis only on homogenous subsample
- subsample of (1) recipient small firms and (2) observationally similar non-recipient small firms
- (+) OLS estimates less susceptible to functional form assumptions when groups are balanced

6. MODEL


SELECTION INTO THE SBIR PROGRAM
+
Firm Inputs/Outputs/Outcomes
- Innovation Effort
- Ability to Attract External Capital
- Sales, Employment Growth, Etc.
Antecedent/Confounding Variables (Z)
- Firm Size
- Human Capital
- Technological Capacity
- Industry
- Geographical Location

7. RESULTS I : Before Matching

Test of Difference in Covariate Distribution of Start-ups Before Matching

Baseline Characteristics (2004)	Potential Controls (non-recipients)	Treated (SBIR recipients)	p-value
Firm Size			
Number of Employees	1.94	1.68	0.8401
Human Capital			
Post-Graduate Education	0.20	0.80	**0.0000**
Industry Experience	0.55	0.72	0.0955
Technological Capacity			
Prior R&D Performance	0.21	0.68	**0.0000**
Number of Patents	0.15	3.24	**0.0000**
Positive Sales	0.91	0.65	**0.0000**

Baseline Characteristics (2004)	Potential Controls (non-recipients)	Treated (SBIR recipients)	p-value
Industry			
Pharmaceutical	0.01	0.08	**0.0000**
Chemicals	0.02	0.08	**0.0139**
Machinery	0.04	0.08	0.3499
Electronics	0.04	0.24	**0.0000**
Electrical Equipment	0.01	0.04	0.2035
R&D Services	0.20	0.28	0.3458
Geographical Location			
Location in Top 25 R&D Intensive States (e.g. CA, MA)	0.84	0.80	0.5943

Note: p-values less than 0.05 indicate significant differences in the concerned covariate.

7. RESULTS II: After Matching

Test of Difference in Covariate Distribution of Start-ups After Matching

Baseline Characteristics (2004)	Matched Controls (non-recipients)	Treated (SBIR recipients)	p-value
Firm Size			
Number of Employees	0.79	1.10	0.4188
Human Capital			
Post-Graduate Education	0.85	0.85	0.9457
Industry Experience	0.74	0.74	0.9610
Technological Capacity			
Prior R&D Performance	0.50	0.63	0.3113
Number of Patents	1.67	2.26	0.8337
Positive Sales	0.70	0.68	0.9153

Note: p-values less than 0.05 indicate significant differences in the concerned covariate.

Baseline Characteristics (2004)	Matched Controls (non-recipients)	Treated (SBIR recipients)	p-value
Industry			
Pharmaceutical	0.09	0.05	0.5928
Chemicals	0.06	0.11	0.5031
Machinery	0.03	0.05	0.6421
Electronics	0.23	0.21	0.8773
Electrical Equipment	0.05	0.05	0.8964
R&D Services	0.32	0.26	0.6465
Geographical Location			
Location in Top 25 R&D Intensive States (e.g. CA, MA)	0.83	0.74	0.3431

7. RESULTS III: Estimates

Estimates of the Average Treatment Effect on the Treated

Models	Outcome Variable	Number of SBIR-financed Small Business Start-ups (Treated)	Number of Matched Untreated Business Start-ups (Control)	Sample Size	Treatment Effect Estimate		
					Naïve Estimator	**PSM Estimator**	**Regression within Common Support**
Model I	R&D Performance in 2008	19	67	86	0.73*** (8.57)	0.49***[1] (5.39)	0.48*** (4.67)
Model II	R&D Expenditure in 2008	19	66	85	672,092*** (10.31)	539,956*[2] (2.02)	497,144* (1.92)

[1] ATT = 0.89 – 0.40 = 0.49 [2] ATT= 691,223 – 151,667 = 539, 956

Note: one-tailed test; significant at ***0.1%, **1%, *5%, +10%; numbers in parentheses are t-statistics

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Model III	Innovation Propensity in 2009	19	65	84	0.47*** (5.51)	0.33**[3] (2.55)	0.33** (2.45)
Model IV	Employment Size in 2009	19	57	76	5.36* (1.94)	6.83**[4] (3.29)	6.34** (2.96)

[3] ATT = 0.63 – 0.30 = 0.33 [4] ATT= 9.05 – 2.22 = 6.83

Note: one-tailed test; significant at ***0.1%, **1%, *5%, +10%; numbers in parentheses are t-statistics

7. CONCLUSION AND IMPLICATIONS

- Presence of additionality effect of SBIR grant
  - SBIR not funding infra-marginal R&D projects of small business start-ups
    - SBIR recipients: $691 K
    - Matched non-recipients: $152 K
    - Treatment Effect: $539K (t-stat: 2.02)
  - recipient start-ups would not have implemented commercially-promising but 'risky' R&D projects without the SBIR subsidy
  - some evidence suggesting R&D underinvestment
  - positive impact on employment size and innovation propensities

7. CONCLUSION AND IMPLICATIONS *Cont*

- Limitations – small final sample size (n=76-86 small business start-ups); "selection on observables"

- Future Research
  - Investigate (1) certification effect: ability to attract external capital from banks, venture capitalists, angel investors, and other capital providers; (2) privately-financed R&D (i.e. total R&D less public subsidy)
  - KFS 6th Follow-up Survey – does the effect persist or disappear after 1 or 2 years of receiving subsidy?
  - Case studies as follow-up