Do Returns to R&D Vary by Size of Firm? Evidence from Canada

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Estimating equation (in logs) – fixed effects

$$Y_{it} = a_0 + \alpha C_{it} + \beta L_{it} + \gamma K_{it} + \varphi S_{it} + q_t + \eta_i + \omega_t + u_{it}$$

Y is value added

C is tangible capital

L is number of employees

u is the error term

K is knowledge (R&D) capital

S is the spillover pool

q is industry-level value added

- TFP decomposed into all-firm mean (a_0), a firm-specific component (η_i) and a time varying component (ω_t)
- Equation includes dummies for year and for K=0
- Estimation period: 2000-12; unbalanced panel of R&D performers

Data cleaning

- Measurement errors: removed observations for which tangible capital is negative or zero.
- Estimation constraint: removed all observations for which VA is negative or zero.
  - Eliminates firms with no sales and highly unprofitable firms
- Removed "micro-firms"
- Trimmed Y/K outliers
  - Rate of return = (estimated output elasticity)*Y/K

Calculation of the initial stock of R&D

- Standard approach in the literature:

$$K_{i2000} \approx \frac{\bar{I}_i}{g_i^* + \partial}$$

$\bar{I}_i$, g_i^* are equilibrium level & growth rate of R&D

∂ is the economic depreciation rate

- Our approach to estimating g_i^* (James-Stein Estimator)

$g_i^* = \bar{g} + c_i(g_i - \bar{g})$

g_i is average annual growth in R&D spending by firm *i*

$\bar{g}$ is the "shrinkage point"

c_i is the "shrinkage factor"

Defining the spillover pool (Jaffe 1986)

- Technological position characterized by $F_i = [F_{i1} F_{i2} \ldots F_{iK}]$ where F_{ik} is the fraction of firm i's total research expenditure devoted to area k.

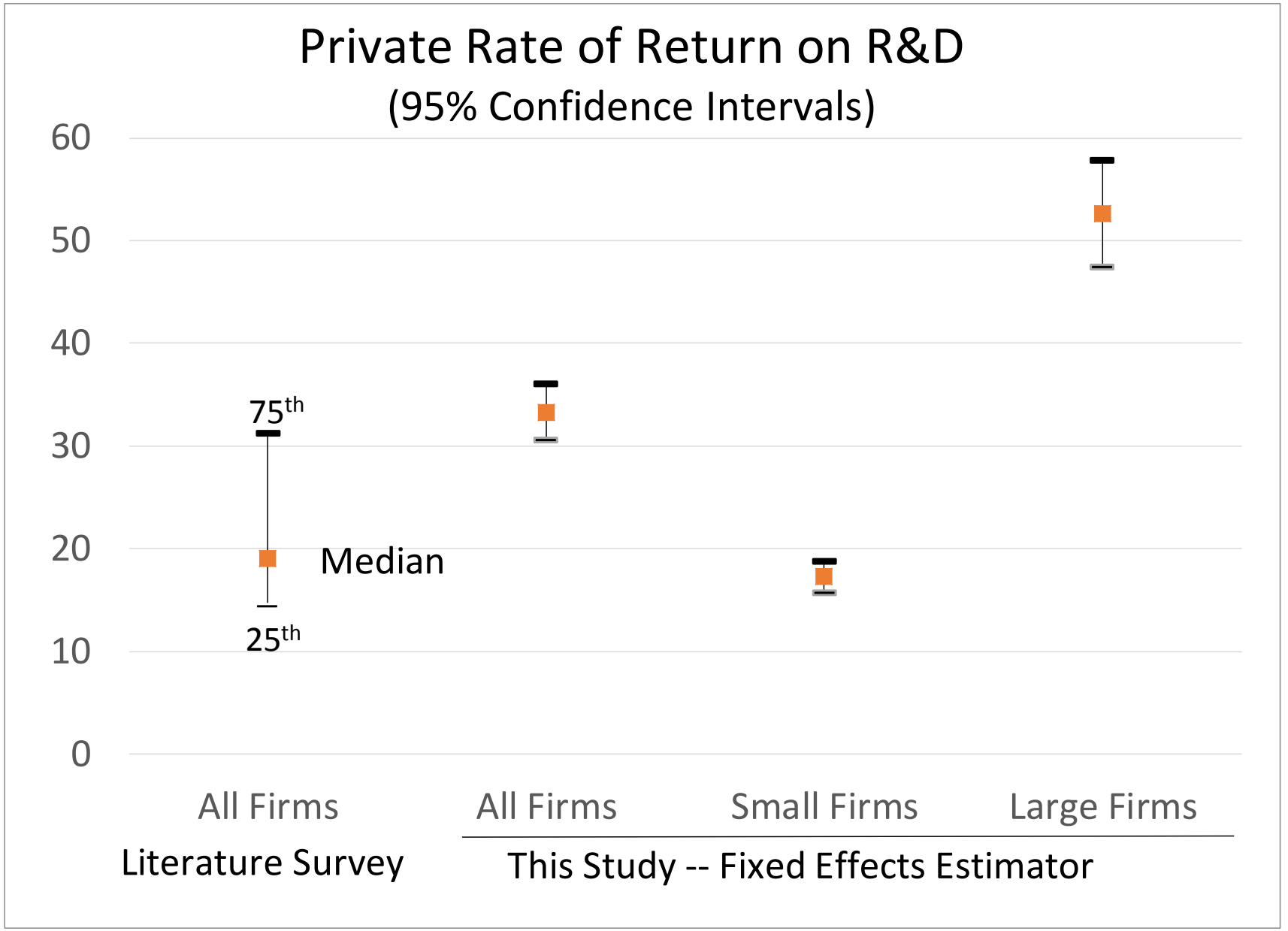
- The proximity of firm i and firm j measured as the uncentred correlation of firms' technological positions:

$$P_{ij} = F_i F_j' / [(F_i F_i')(F_j F_j')]^{1/2}$$

where F' is the transpose of F.

- The stock of external knowledge available to firm *i* is:

$$S_{it} = \sum_{j \neq i}^{J} P_{ij} K_{jt}$$

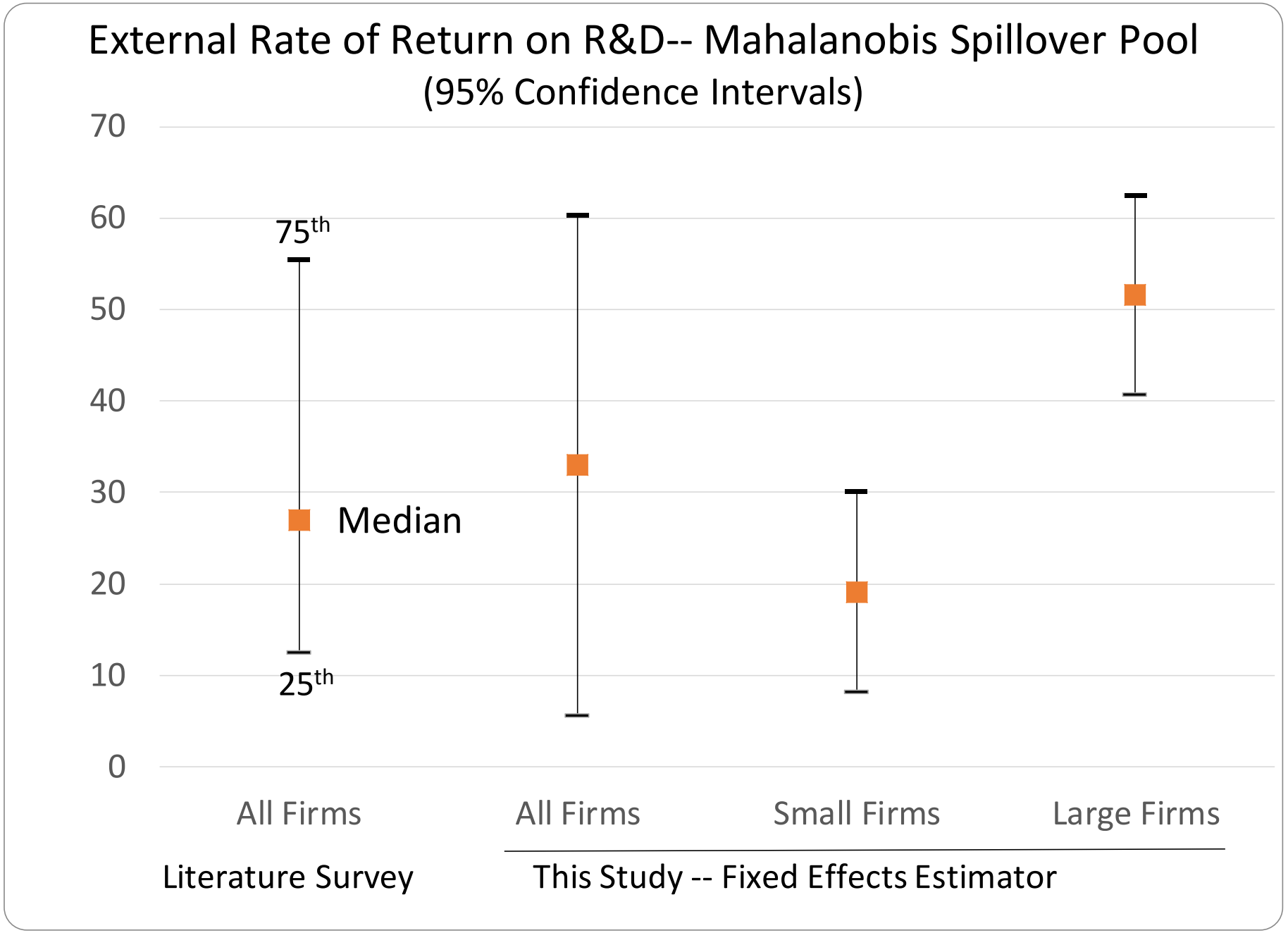

Private Rate of Return on R&D
(95% Confidence Intervals)
60
50
40
30
20
10
0
75th
Median
25th
All Firms
All Firms
Small Firms
Large Firms
Literature Survey
This Study -- Fixed Effects Estimator

Subsidies lower the hurdle rate for investment in R&D

Federal and Provincial SR&ED Investment Tax Credit Rates (2010-12 in percentage)			
	Federal	Provincial[1]	Combined[2]
Small firms	35.0	13.3	43.6
Large firms	20.0	6.3	25.0
Small less large	15.0	7.0	18.6

1. Expenditure-weighted sum of provincial statutory rates.

2. The base for the federal credit is reduced by the amount of provincial assistance provided.


External Rate of Return on R&D-- Mahalanobis Spillover Pool
(95% Confidence Intervals)
70
60
50
40
30
20
10
0
75th
Median
25th
All Firms
All Firms
Small Firms
Large Firms
Literature Survey
This Study -- Fixed Effects Estimator

Future research

Database will be made available to other researchers

- Do spillovers vary by:
  - Type of research?
  - Size of research budget?
  - Country of control?
  - Source of funding?
  - Share of scientists and engineers?
  - Collaborative research?
- Do spillovers decline with distance?
- Does creative destruction substantially offset knowledge spillovers?