# Science and Productivity – Evidence form a randomized natural experiment

Thomas Alslev Christensen, Novo Nordisk Foundation
Johan Kuhn, Copenhagen Business School
Cédric Schneider, Copenhagen Business School
Anders Sørensen, Copenhagen Business School

# Introduction

- Academic research plays an important role in industry performance:
- Higher productivity (Adams 1990)
- More patents (Cassiman et al. 2008; Jaffe 1989)
- new products and processes (Cohen et al. 2002; Toole 2007)
- New industries (Zucker et al. 1998)

# Introduction

- Universities: widespread dissemination of basic scientific and pre-commercial research
- Spillovers are likely to be disproportionately large and important (Dasgupta & David 1994; Jaffe 1989; Merton 1973).
- Corporations: applied R&D
- Interactions between universities and corporations are important

# Introduction

ISLs are more likely to take place in new technological fields :

- More uncertainty
- Low initial demand
- High search cost

(Nelson 1959; Hall, Link & Scott, 2003; Veugelers & Cassiman 2005)

- Government support of ISLs for correction of this market failure

# Introduction

For SMEs, additional market failure:

- Univ. have little incentives in working with small firms: low absorptive capacity, lower returns
- Government support of ISLs for correction of this “double” market failure

# Innovation Voucher Program

- Program to support ISLs
- Max. DKK 100.000 (~EUR 15.000 USD 20.000)
- Targeted at SMEs
- Use voucher to collaborate with univerities or Research and Technology Organizations (RTOs)
- scientific consulting or access to equipment
- Aim: encourage future ISLs

# Innovation Voucher Program

Eligibility criteria:

- At least one year of existence
- Less than 250 employees
- No previous interaction with universities or RTOs

# Innovation Voucher Program (2009)

- 305 applicants
- 178 qualified
- Random assignment to treatment through a lottery (October 26th 2009)
- Lottery winners: 130
- Lottery losers: 48
- program effects that are similar  to those arising from a randomized trial

# Data

- Lottery winners and losers from the Danish Agency for Science, Technology and Innovation
- Merge with financial data (EXPERIAN)
- And Danish firm registry
- Covers the period: 2007-2012

# Characteristics of applicants

**TABLE 2: Industry distribution**

| | Treatments | | Controls | |
|---|---|---|---|---|
| Agriculture | 7 | 6% | 1 | 2% |
| Cultural activities | 2 | 2% | 0 | 0% |
| Manufacturing | 48 | 42% | 25 | 57% |
| Construction | 7 | 6% | 3 | 7% |
| Trade | 14 | 12% | 12 | 27% |
| IT&Communication | 11 | 10% | 2 | 5% |
| Business services | 24 | 21% | 1 | 2% |
| Financial services | 1 | 1% | 0 | 0% |

# Randomization integrity

**Table 1: Pre-treatment characteristics (2007-2009)**

| | Treated | non-treated | diff. P-value |
|---|---|---|---|
| Full-time equivalent employement | 36.74386 | 34.04425 | 0.5612 |
| sales (in DKK 1000) | 52401.67 | 57593.02 | 0.5089 |
| wage rate (in 1000 DKK) | 382.8828 | 402.5979 | 0.2329 |
| Earnings before interest and taxes | 1492.007 | 2260.556 | 0.5393 |
| Book value of assets | 36404.02 | 33969.83 | 0.6857 |

# Empirical strategy

- Estimate Intent-to-treat effects of winning the lottery:

$$Y_{it} = \beta_1 treat \times Post + d_t + \delta_i + \eta_j \times t + \varepsilon_{it}$$

**Table 2: descriptive statistics**

| | N | Mean | s.d. |
|---|---|---|---|
| labor Productivity (in DKK 1000) | 771 | 1639 | 1321 |
| Wage rate (in DKK 1000) | 633 | 418.2 | 152.8 |
| OROA | 812 | -0.055 | 0.793 |

# Results: Productivity and wages

**Table 3: Productivity and wages**

| | (1) log labor productivity | | | (2) log wage rate | | | (3) log labor productivity | | | (4) log wage rate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coeff. | | s.e. | coeff. | | s.e. | coeff. | | s.e. | coeff. | | s.e. |
| Treat x Post | 0.153 | ** | 0.067 | 0.116 | ** | 0.051 | | | | | | |
| Treat x 2010 | | | | | | | 0.173 | ** | 0.076 | 0.096 | * | 0.052 |
| Treat x 2011 | | | | | | | 0.106 | | 0.084 | 0.109 | * | 0.062 |
| Treat x 2012 | | | | | | | 0.181 | ** | 0.091 | 0.145 | ** | 0.064 |
| Firm fixed-effects | Yes | | | yes | | | yes | | | yes | | |
| year fixed-effects | Yes | | | yes | | | yes | | | yes | | |
| Industry trends | Yes | | | yes | | | yes | | | yes | | |
| Number of observations | 771 | | | 633 | | | 771 | | | 633 | | |
| Number of firms | 147 | | | 129 | | | 147 | | | 129 | | |

# Robustness checks

**Table 4: Robustness checks**

| | (1) log labor productivity (placebo) | | (2) log wage rate (placebo) | | (3) log labor productivity (balanced) | | (2) log wage rate (balanced) | |
|---|---|---|---|---|---|---|---|---|
| | coeff. | s.e. | coeff. | s.e. | coeff. | s.e. | coeff. | s.e. |
| Treat x Placebo | 0.051 | 0.064 | 0.081 | 0.053 | | | | |
| Treat x Post | | | | | 0.174 ** | 0.069 | 0.096 * | 0.05 |
| Firm fixed-effects | Yes | | yes | | yes | | yes | |
| year fixed-effects | Yes | | yes | | yes | | yes | |
| Industry trends | Yes | | yes | | yes | | yes | |
| Number of observations | 771 | | 633 | | 690 | | 554 | |
| Number of firms | 147 | | 129 | | 121 | | 103 | |

# Results: Financial performance

**Table 5: Operating Return on Assets**

| | (1) OROA | | (2) OROA | | |
|---|---|---|---|---|---|
| | coeff. | s.e. | coeff. | | s.e. |
| Treat x Post | 0.142 | 0.118 | | | |
| Treat x 2010 | | | -0.030 | | 0.080 |
| Treat x 2011 | | | 0.208 | | 0.172 |
| Treat x 2012 | | | 0.263 | * | 0.143 |
| Firm fixed-effects | Yes | | yes | | |
| year fixed-effects | Yes | | yes | | |
| Industry trends | Yes | | yes | | |
| Number of observations | 812 | | 812 | | |
| Number of firms | 157 | | 157 | | |

# Conclusion

- Lottery winners are 20% more labor productive than lottery losers
- wage rates are 17% higher
- operating profitability goes up, but only significant three  years after the program