

The Technological Legacy of the Cold War: Military Procurement and US Innovation

Marco Cerundolo

Bocconi University

17.07.2021

Introduction



Figure: World's first microchip, made by Jack Kilby from Texas Instruments in 1958.

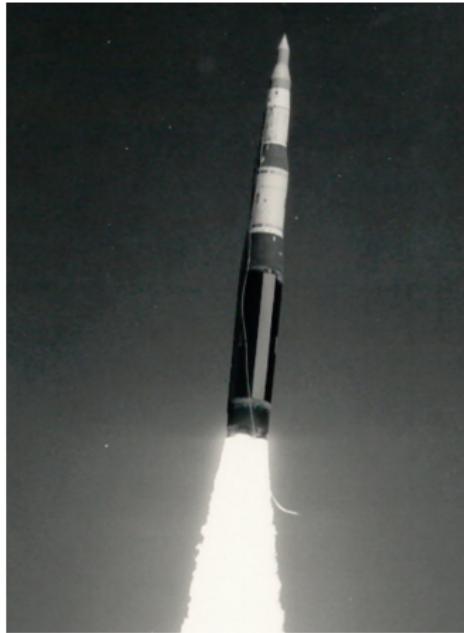


Figure: Minuteman II. Development started in 1962. Contained 2000 microchips.

Introduction

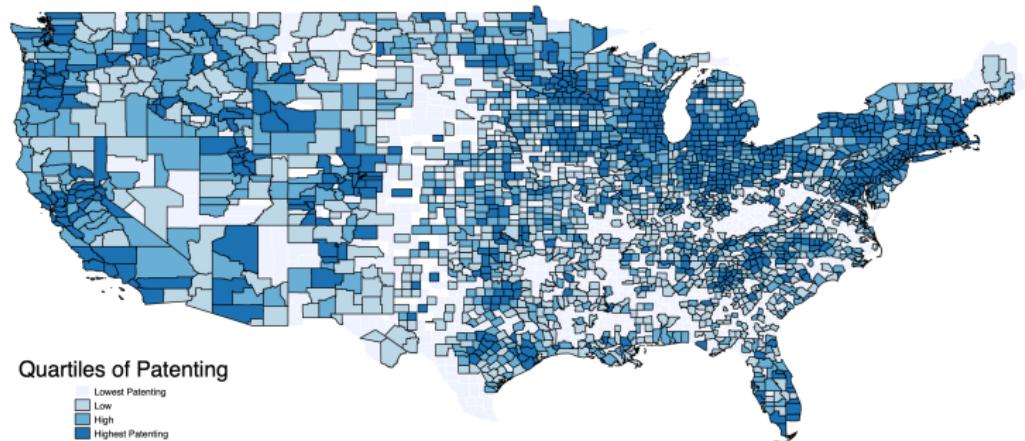


Figure: US counties by quartiles of patenting intensity.

- Can military procurement spending explain the concentration and location of innovative activity in the US?

Introduction

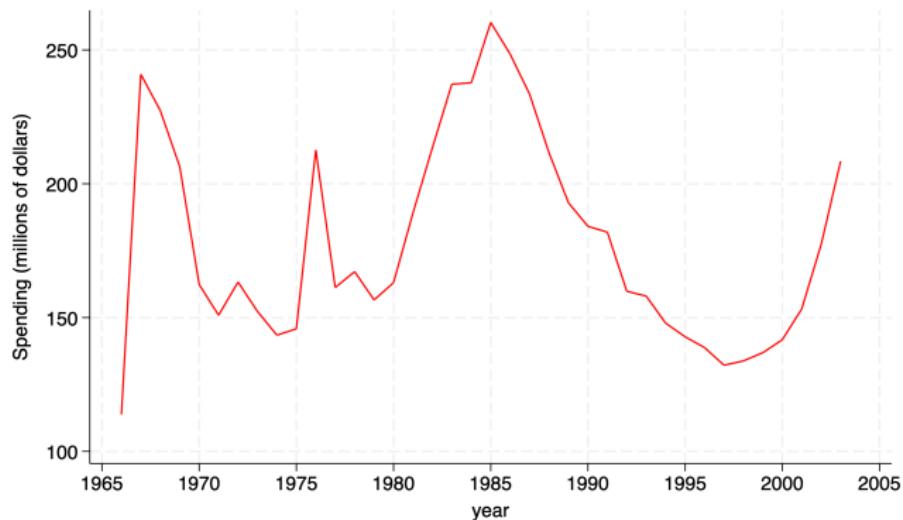


Figure: US Department of Defence yearly procurement spending.

- Focus on spending surge under Reagan
- Industrial Policy: Innovation vs Regional Development

This Thesis

- Event study as motivating evidence. Suggests
 - Long-run treatment effect
 - No differential patenting trends prior to Reagan
- Shift-share IV estimates county patenting elasticity to procurement of 0.11% (sig. 1%)
- Heterogeneity analysis: treatment effect larger in counties with more local competition
 - Consistent with presence of local knowledge spillovers

Related Literature

- Effect of Public R&D programmes
 - Firm effects: Howell (2017), Zivin et al. (2016)
 - Aggregate effects: Gross & Sampat (2023/25), Kantor & Walley (2023), Schweiger et al. (2022)
- Geography of Innovation
 - Concentration: Carlino & Kerr (2015)
 - Local Knowledge Spillovers: Jaffe et al. (1992), Thompson (2006)
- Effect of Defence Procurement on Firm Innovation: Draca (2013), Moretti et al. (2019)

Data

Data

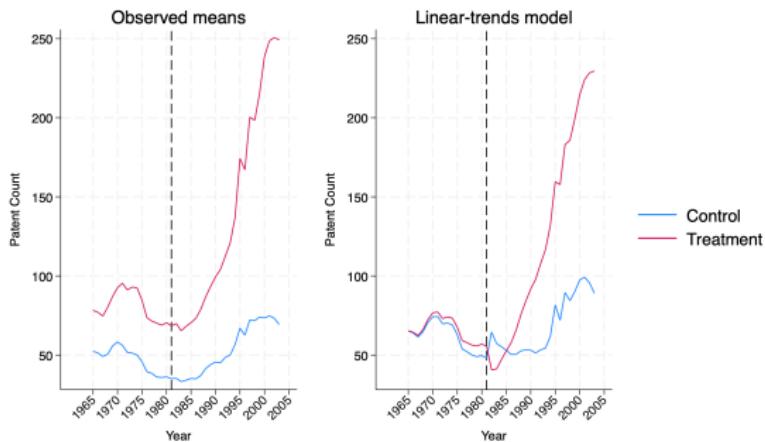
- Defence contracts: National Archives and Records Administration
 - 1966 to 2003
 - Each contract in one of 176 product types
- Patents: Comprehensive Universe of US Patents
 - Have citations allowing construction of citation weighted measure
- County characteristics (population, average wages, inventor share): Census and other sources

Sample

- Panel A: all counties
- Panel B: semi-intensive margin counties 
 - Patent and procure in at least 80% of sample years

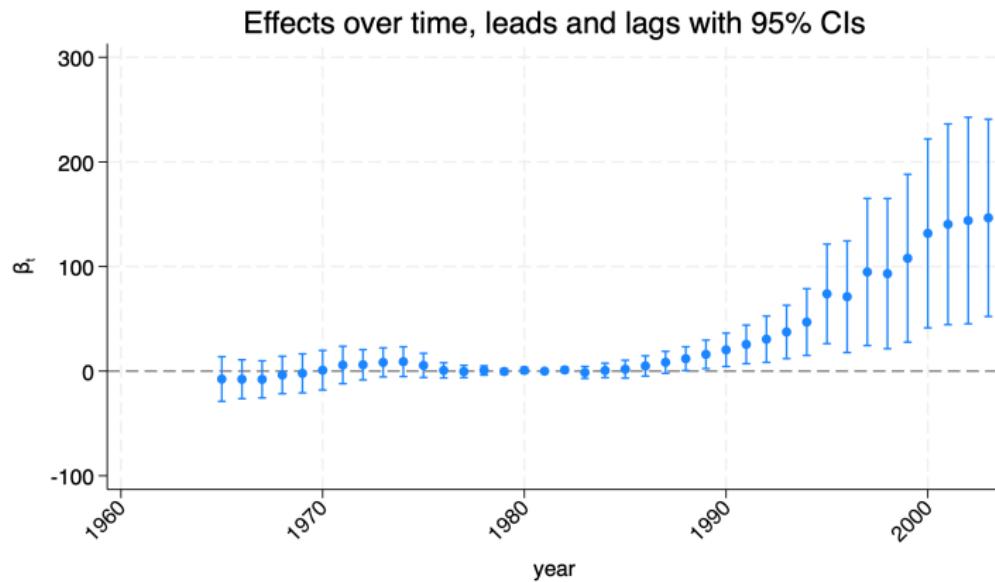
Event Study: Parallel Trends

- Treatment group = counties with largest rise in procurement spending under Reagan



- No evidence of non-parallel trends parallel trends test
- Effect of 54.4 significant at 1% level treatment effect
- Similar results using citation weighted patents cit. weighted

Event Study: Long-Run Effect



- Similar results using citation weighted patents ➔ cit. weighted

Main Empirical Strategy

$$\ln \text{Patents}_{i,t} = \alpha_i + \beta \ln \text{Spending}_{i,t} + \chi_{i,t} + f_t + \eta_{s(i),t} + \epsilon_{i,t}$$

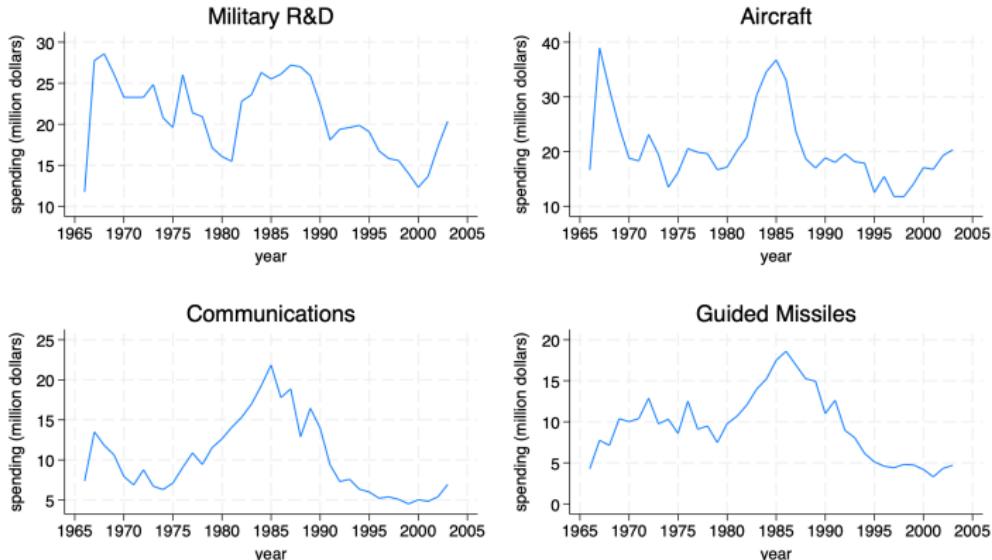
where

- $\text{Patents}_{i,t}$ = patents in county i in year t ;
- $\text{Spending}_{i,t}$ = value of procurement contracts in county i in year t ;

and

- α_i = county FE;
- $\chi_{i,t}$ = time-varying county controls ;
- f_t = time FE;
- $\eta_{s(i),t}$ = state-year FE.

Shift-Share Instrument



- 4 product types which receive most spending out of the 176;
- Exogeneity from Shocks: Variation in spending across product types driven by geopolitical strategy.

Shift-Share Instrument Definition

Specialisation of county i in product k in year t :

$$\Phi_{i,t,k} = \frac{d_{i,t,k}}{s_{i,t}}$$

where

- $d_{i,t,k}$ = procurement of product k in county i in year t
- $s_{i,t}$ = procurement in county i in year t

Shift-share IV:

$$z_{i,t} = \sum_{k=1}^{176} \Phi_{i,t-5,k} \ln(D_{t,k})$$

where

- $D_{t,k}$ = national procurement of product k in year t

Results I: Citation Weighted Patent Count

Table: OLS and IV Estimates for Effect of Spending on Citation Weighted Patents

VARIABLES	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
<i>Panel A: All Counties</i>						
In Spending	0.00427*** (0.00137)	0.04177*** (0.01390)	0.00347*** (0.00131)	0.03395** (0.01691)	0.00410*** (0.00128)	0.03857** (0.01738)
Observations	87,386	87,386	75,982	75,982	75,944	75,944
F-stat.	NA	200.98	NA	119.51	NA	111.81
<i>Panel B: Semi-Intensive Margin</i>						
In Spending	0.02877*** (0.00474)	0.12534*** (0.03361)	0.02384*** (0.00448)	0.13049*** (0.03849)	0.01967*** (0.00420)	0.11226*** (0.03695)
Observations	24,476	24,476	21,530	21,530	21,529	21,529
F-stat.	NA	58.99	NA	47.18	NA	45.19
County and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	Yes	Yes
State-Year FE	No	No	No	No	Yes	Yes

Results II: Patent Count

Table: OLS and IV Estimates for Effect of Spending on Number of Patents

VARIABLES	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
<i>Panel A: All Counties</i>						
In Spending	0.00560*** (0.00095)	0.01175* (0.00667)	0.00248*** (0.00094)	-0.00329 (0.00997)	0.00275*** (0.00092)	-0.00344 (0.01036)
Observations	114,865	99,705	75,982	75,982	75,944	75,944
F-stat.	NA	305.89	NA	119.69	NA	111.81
<i>Panel B: Semi-Intensive Margin</i>						
In Spending	0.03811*** (0.00504)	0.10283*** (0.02564)	0.02855*** (0.00504)	0.09440*** (0.03198)	0.02199*** (0.00481)	0.06773** (0.03196)
Observations	32,088	27,854	21,530	21,530	21,529	21,529
F-stat.	NA	71.27	NA	47.18	NA	45.56
County and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	Yes	Yes
State-Year FE	No	No	No	No	Yes	Yes

Robustness

Robust to:

- Fixed pre-sample shares ► robustness 1
- Dropping all R&D contracts ► robustness 2
- Dropping highest growth contracts ► robustness 3
- Dropping 3 most innovative counties ► robustness 4
- Dropping 3 counties with most contracts ► robustness 5

Mechanisms

- ① Recipient firm becomes more innovative
 - Relax capital constraints
 - Attract best inventors
 - Greater incentive to innovate
- ② Neighbouring firms become more innovative
 - Local Knowledge Spillovers
 - Immigration

Theory

Local Competition $\uparrow \Rightarrow$ Local knowledge spillovers \uparrow

- Patents more relevant
- Firm-to-firm employee movement
- Word of mouth

Heterogeneity Analysis

Measuring Local Competition

Industry k concentration:

$$HHI_{i,k} = \sum_f (MS_{i,k,f})^2$$

where

- $MS_{i,k,f}$ = market-share of firm f in county i in product market k .

Weighted average by industry importance:

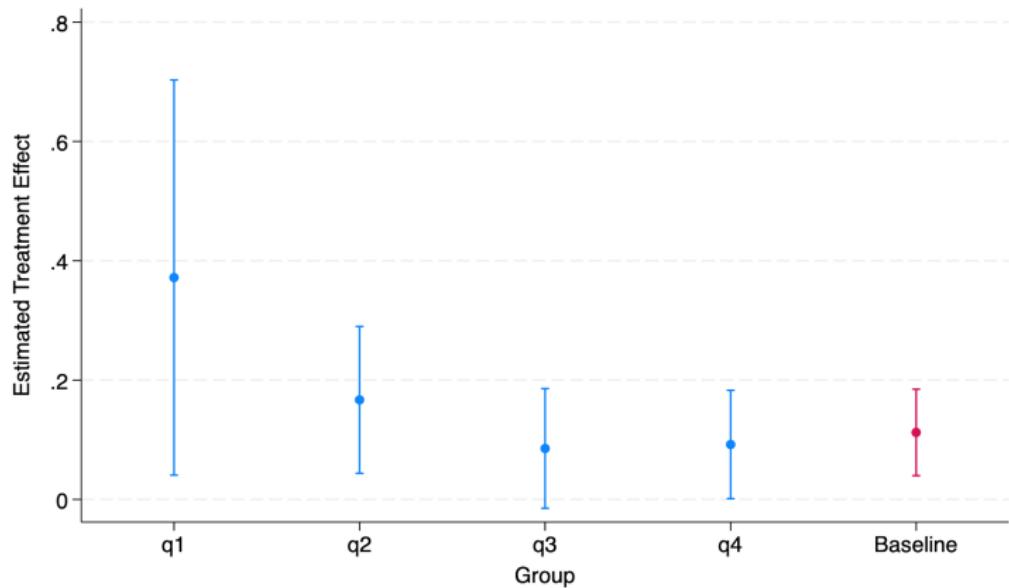
$$HHI_i = \sum_k s_{i,k} HHI_{i,k}$$

where

- $s_{i,k}$ = share of procurement in county i from product k .

Heterogeneity Analysis

$$\ln \text{Patents}_{i,t} = \alpha_i + \sum_{q=1}^4 \beta_q D_{i,q} \ln \text{Spending}_{i,t} + \chi_{i,t} + f_t + \eta_{s(i),t} + \epsilon_{i,t}$$



Summary & Implications

- Cold War defence spending led to formation of innovative clusters
 - Quantity and quality of patents
 - Long-run effects of Reagan's spending surge
- Treatment effect correlates with local competition
 - Suggests presence of local knowledge spillovers
 - Suggests that spending for innovation should be targeted at innovative clusters

Future Work

- ① Identify whether effect is driven by recipient or non-recipient firms
- ② Use patent citations to quantify local knowledge spillovers
- ③ Nature of knowledge spillovers (e.g. defence vs civilian)

Appendix

Panel B Map

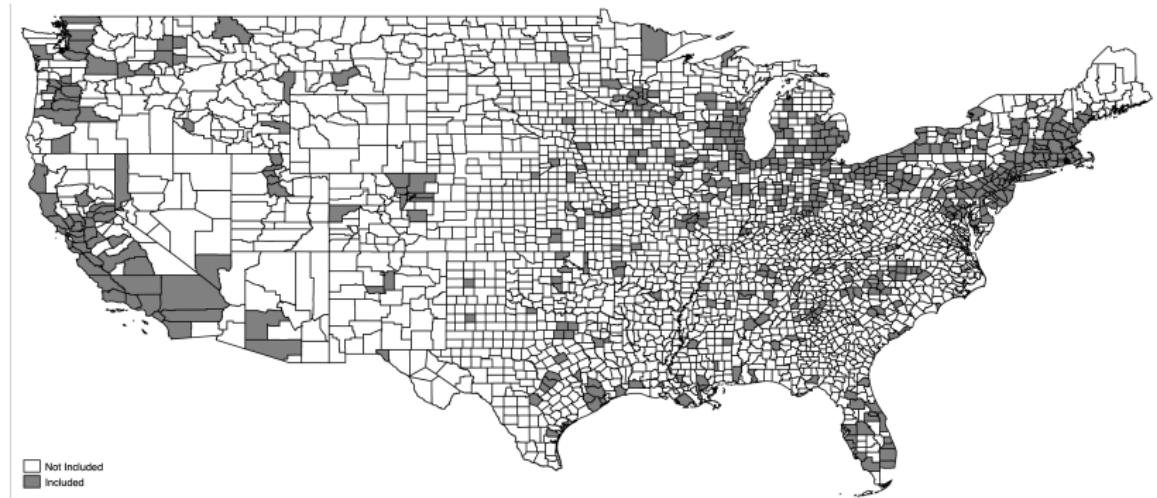


Figure: Map of counties included in Panel B. They are 562 out of the 3042 total counties.

Event Study

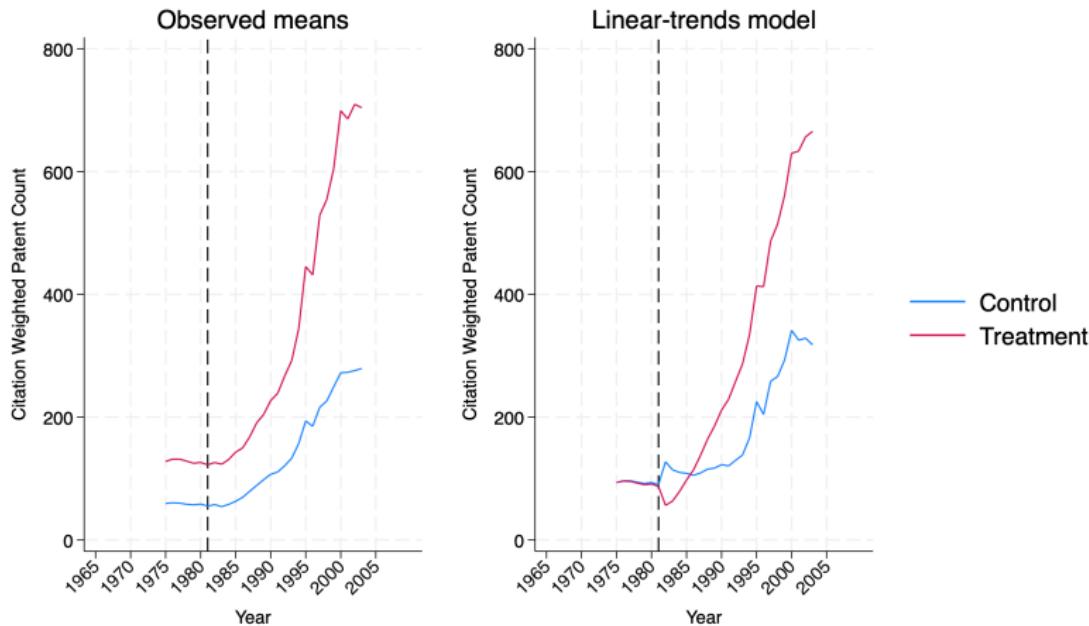
Table: Parallel Trends Test

	(1) Patents	(2) Citation Weighted Patents
F-Statistic(1, 496)	0.44	0.52
P-value(Prob > F)	0.5077	0.4725

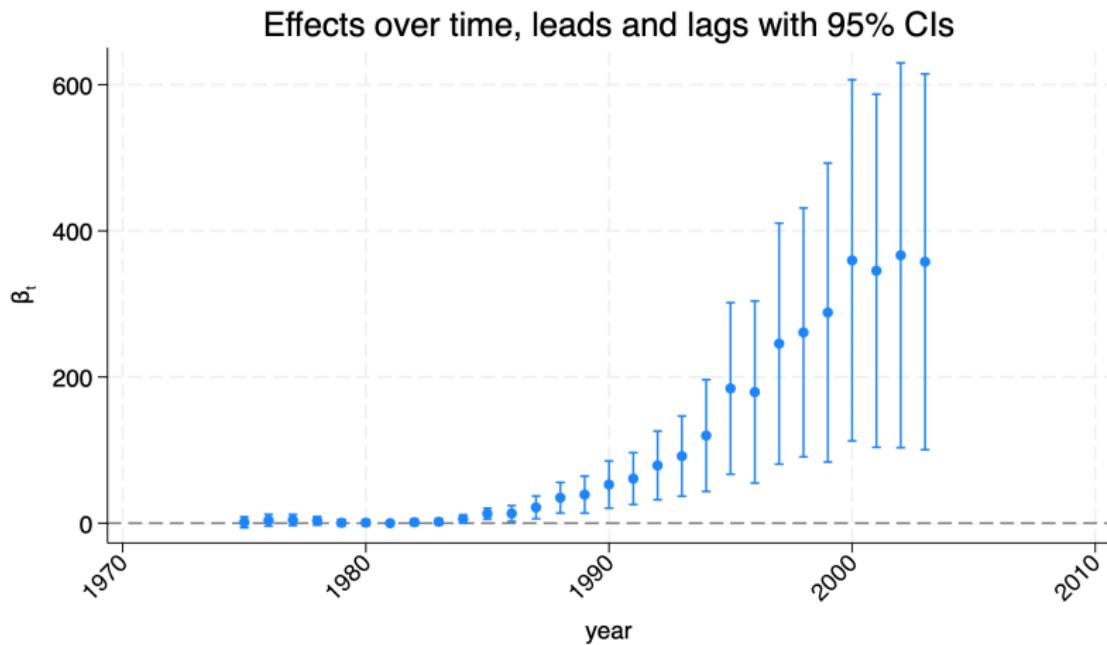
Table: Difference-in-Differences Estimates

VARIABLES	(1) Patents	(2) Citation Weighted Patents
Treated * Post-1981	54.42699 *** (20.42682)	139.9752*** (48.37009)
Observations	21,918	16,298
FE	Yes	Yes

Event Study: Citation Weighted



Event Study: Citation Weighted



Robustness: Alternative Shift-Share

Table: OLS and IV Estimates using Fixed Pre-Sample Shares

VARIABLES	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
<i>Panel A: All Counties</i>						
In Spending	0.00428*** (0.00133)	-0.16050*** (0.05185)	0.00339*** (0.00127)	-0.08884** (0.04097)	0.00402*** (0.00124)	-0.04677 (0.04890)
Observations	85,008	85,008	74,246	74,246	74,209	74,209
F-stat.	NA	24.08	NA	21.08	NA	15.73
<i>Panel B: Semi-Intensive Margin</i>						
In Spending	0.03811*** (0.00641)	0.26372*** (0.09733)	0.03198*** (0.00596)	0.24636*** (0.09095)	0.02475*** (0.00543)	0.20530* (0.11501)
Observations	15,736	15,736	13,856	13,856	13,805	13,805
F-stat.	NA	19.77	NA	19.03	NA	10.26
County and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	Yes	Yes
State-Year FE	No	No	No	No	Yes	Yes

Robustness: Leave-One-Out Product

Table: Leave-One-Out Analysis: Product Types

PRODUCTS DROPPED	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
<i>Panel A: All Counties</i>						
R & D Contracts	0.00398*** (0.00136)	0.04213*** (0.01423)	0.00341*** (0.00131)	0.03633** (0.01742)	0.00406*** (0.00128)	0.04057** (0.01791)
Aircraft & Communication	0.00456*** (0.00136)	0.03892*** (0.01416)	0.00370*** (0.00131)	0.03187* (0.01736)	0.00432*** (0.00128)	0.03621** (0.01783)
<i>Panel B: Semi-Intensive Margin</i>						
R & D Contracts	0.02616*** (0.00452)	0.11343*** (0.03243)	0.02159*** (0.00425)	0.12049*** (0.03735)	0.01813*** (0.00403)	0.10466*** (0.03623)
Aircraft & Communication	0.02880*** (0.00473)	0.12830*** (0.03486)	0.02297*** (0.00449)	0.13563*** (0.04067)	0.01869*** (0.00421)	0.11308*** (0.03879)
County and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	Yes	Yes
State-Year FE	No	No	No	No	Yes	Yes

Robustness: Leave-One-Out County

Table: Leave-One-Out Analysis: Counties

PRODUCTS DROPPED	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV
<i>Panel A: All Counties</i>						
Defence Counties	0.00422*** (0.00137)	0.04159*** (0.01390)	0.00347*** (0.00132)	0.03383** (0.01691)	0.00410*** (0.00128)	0.03852** (0.01738)
Innovative Counties	0.00429*** (0.00137)	0.04179*** (0.01390)	0.00347*** (0.00132)	0.03371** (0.01690)	0.00411*** (0.00128)	0.03841** (0.01737)
<i>Panel B: Semi-Intensive Margin</i>						
Defence Counties	0.02849*** (0.00475)	0.12442*** (0.03361)	0.02383*** (0.00448)	0.13004*** (0.03850)	0.01964*** (0.00420)	0.11158*** (0.03690)
Innovative Counties	0.02894*** (0.00476)	0.12505*** (0.03356)	0.02390*** (0.00449)	0.12957*** (0.03839)	0.01966*** (0.00422)	0.11088*** (0.03685)
County and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	Yes	Yes
State-Year FE	No	No	No	No	Yes	Yes