

# Spillover from the Haven: Cross-border Externalities of Patent Box Regimes within Multinational Firms

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# Motivation

- Patent box regimes became an important instrument to create a *favorable tax environment*
  - Partly exempt profit from *intangible assets* (mostly patents) from tax
  - Targeting *mobile* firms

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  - Fostering domestic R&D vs. attracting foreign R&D
  - Knowledge spillover vs. location distortion
  - Revenue increasing vs. profit shifting

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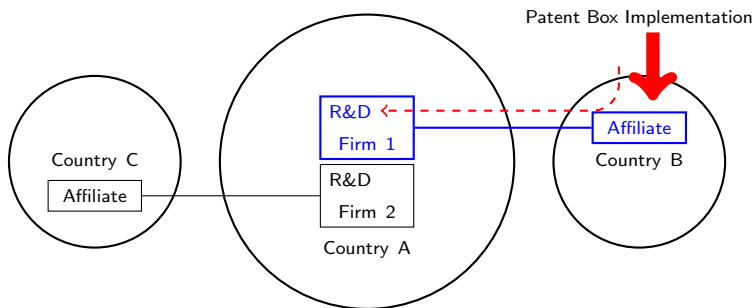
**Many questions relate to cross-border externalities of patent boxes**

# Research Question

Do patent box regimes create cross-border externalities on R&D activity?

If so, to what extent?

# In a Nutshell



- Foreign patent boxes reduce effective taxation of IP income at home (if IP shifting possible) and may thus foster domestic R&D activity Stylised model
- **Estimate cross-border effects of R&D related tax reforms**

# Contribution

## Results

- Measure R&D activity in MNE using micro-level data
- Determine the role of patent boxes in an international context
- Identify cross-border effect of tax reforms on R&D
  - *Positive* cross-border externalities of patent boxes *w/o nexus requirement*: R&D ↑ by ~2.3% per implied tax rate differential
  - *Negative* cross-border externalities on *average patent quality*

## Existing Literature

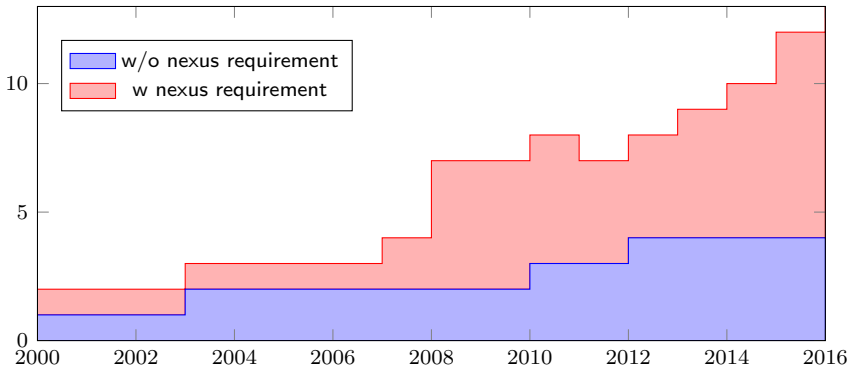
- **Taxes and R&D**: investment (Bloom et al, 2002; Wilson, 2009), location (Dischinger & Riedel, 2011; Karkinsky & Riedel, 2012; Griffith et al, 2014) and quality (Ernst et al, 2014)
- **Foreign tax reductions and domestic investment** (Desai et al., 2006; Dharmapala, 2008; Hong & Smart, 2010)

# Two main types of patent boxes

- Patent boxes **with** nexus requirement
  - (Part of) R&D has to be conducted in patent box country
  - Real relocation of R&D activity necessary
  - In use between 2000-2012: NL, ES, BE, IE (until 2010), LU
- Patent boxes **without** nexus requirement
  - No requirement to conduct R&D in patent box country
  - Offer profit shifting opportunities → **patent havens**
  - In use between 2000-2012: CY, FR, HU, MT



# Rise of patent box regimes



Recent implementations:

UK (2013), PT (2014), IT (2015), TR (2015), IE (2016)

# Relating patent output on patent box implementation

Poisson Fixed Effects estimator:

$$E(P_{ijt}) = \exp(\mathbf{x}'_{ijt}\beta)$$

$$\text{with } \mathbf{x}'_{ijt}\beta = \alpha \text{BOX}_{jt} + \beta \mathbf{X}_{it} + \gamma \mathbf{Z}_{jt} + \delta \mathbf{C}_{ct} + \phi_t + \phi_i + u_t$$

$P_{ijt}$  Number of granted patents of firm  $i$  of group  $j$  in year  $t$

$\text{BOX}$  binary, equals 1 if a patent box **w/o nexus requirement** is implemented in a country of a foreign affiliate of firm  $i$

$\phi_i, \phi_t$  firm-fixed effects, year-fixed effects

$\mathbf{X}_{it}$  firm-specific characteristics

log age, log total assets, working capital, log capital intensity

$\mathbf{Z}_{jt}$  group-specific characteristics

log total number of affiliates

$\mathbf{C}_{ct}$  location-specific characteristics

log GDP p.c., GDP growth, R&D expenditures (% GDP), Corporate income tax rate, user cost of R&D

*Usage of cluster robust standard errors (clustered at firm level)*

# Patent data

- PATSTAT (via Orbis)
  - patent applications on a global scope
  - information to judge patent quality
  - linked to firms via Bureau van Dijk ID
- Focus on patents generated within the firm: domestic patents  
(identified via inventors, as in Guellec & de la Potterie, 2001; Bradley et al, 2015)
- Compute composite quality indicator:  
(following Lanjouw & Schankerman, 2004; Hall et al, 2007)
  - forward citations
  - patent family size
  - number of classification codes

# Firm data

- Amadeus
  - Shareholder structure of firms
  - Linking multinational groups
  - Trace changes over time via M&A data from Zephyr
- Included firms Sample selection
  - active in patenting sector (manufacturing, knowledge-intensive services, business-related services)
  - no change in ownership structure with respect to affiliate in patent box countries (avoid endogeneity)

# Sample in use

- 22,559 European firms in 22 countries (w/o patent boxes)
- 2000-2012
- 12% (11%) of firms have an affiliate in a location where a patent box is implemented without (with) nexus
- On average, firms successfully apply for patents every 3 years

# Summary statistics

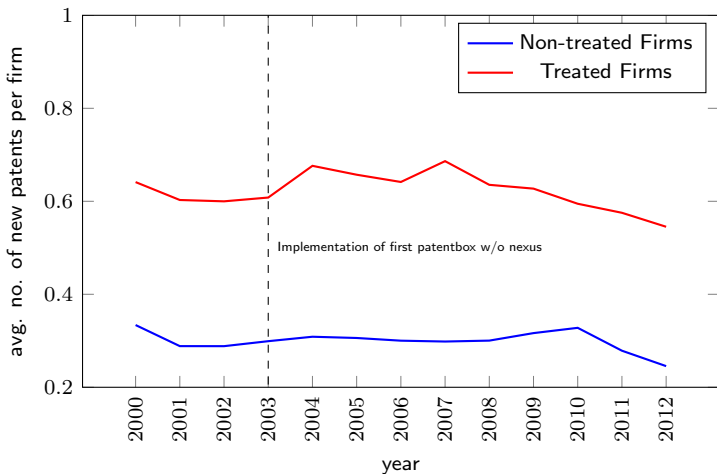
Panel A: Distribution across industries (share of firms in industry)

	Manufacturing	Transportation and Storage	Information & Commu- nication	Professional, Scientific & Technical Activities	Administrative & Support Service Activities
Treated	0.8069	0.0021	0.0282	0.1394	0.0233
Non-treated	0.7371	0.0042	0.0440	0.1828	0.0319

Panel B: Means of key variables

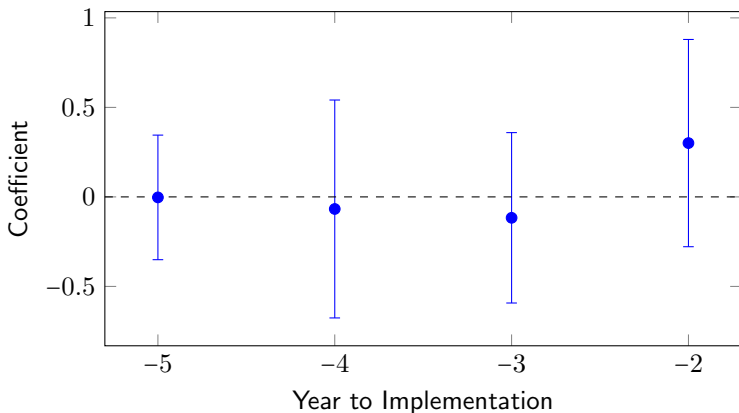
	User cost of R&D Capital	CIT	Log GDP per capita	Total Assets (th. USD)	Age	No. of affiliates
Treated	0.35	32.23	10.43	173,582.76	27.46	66.39
Non-treated	0.340	30.49	10.32	122,265.82	22.13	3.28

# Common pre-trend



# Common pre-trend

Figure: Test for Pre-trend





# Benchmark Results: Patent havens

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
$BOX_{Haven}$	0.670*** (0.202)		0.611**** (0.221)	
$BOX_{Haven} \times \Delta t$		0.023*** (0.008)		0.020*** (0.008)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	229,723	229,723	222,701	222,701
No. of firms	20,414	20,414	19,761	19,761
Pseudo LL	-115,431	-115,433	-67,719	-67,719

Results controls

# Benchmark Results: Nexus requirement

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
$BOX_{Nexus}$	0.002 (0.032)		-0.042 (0.034)	
$BOX_{Nexus} \times \Delta t$		-0.001 (-0.001)		-0.002 (0.002)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	229,723	229,723	222,701	222,701
No. of firms	20,414	20,414	19,716	19,716
Pseudo LL	-115,442	-115,441	-67,722	-67,721

Results controls

# Robustness

Results are robust when ...

- aggregating affiliates within the same country [Results](#)
- excluding all domestic firms [Results](#)
- controlling for group-size-specific time-trends [Results](#)
- using a linear fixed-effects model [Results](#)
- focussing on effective tax rate variation only [Results](#)
- using an event-study design [Results](#)
- using matching approaches (PSM and CEM) [Results](#)

# R&D Quality

- How does average patent quality respond to patent box implementation abroad?
  - **Patent haven:** Encourages more patent realisations, but with lower profitability: **dom. patent quality ↓**
  - **Patent box w nexus requirement:** Drives out research projects, but mostly those with high profitability: **dom. patent quality ↓**

# R&D Quality

- How does average patent quality respond to patent box implementation abroad?
  - **Patent haven:** Encourages more patent realisations, but with lower profitability: **dom. patent quality ↓**
  - **Patent box w nexus requirement:** Drives out research projects, but mostly those with high profitability: **dom. patent quality ↓**
- Compute average patent quality per firm and year and relate it to the average in its industry (SIC-2-digit)  $s$ , country  $c$ , year  $t$ :

$$q_{ijt} = \frac{P_{ijt}^{qual.}}{P_{ijt}} \Rightarrow \tilde{q}_{ijt} = \frac{q_{ijt}}{\tilde{q}_{sct}}$$

$$\log(\tilde{q}_{ijt}) = \alpha BOX_{jt} + \beta \mathbf{X}_{it} + \gamma \mathbf{Z}_{jt} + \delta \mathbf{C}_{ct} + \phi_t + \phi_i + u_{it}$$

# Results: Patent quality

	Average Patent Quality			
	(1)	(2)	(3)	(4)
$BOX_{Haven}$	-0.269** (0.108)			
$BOX_{Haven} \times \Delta t$		-0.009** (0.004)		
$BOX_{Nexus}$			-0.048*** (0.015)	
$BOX_{Nexus} \times \Delta t$				-0.002*** (0.001)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	50,766	47,225	39,613	36,136
No. of firms	21,513	19,857	15,772	14,117
Adj. $R^2$	0.014	0.017	0.014	0.018

Sample: Firms with granted patents before and after the patent box implementation in one of their foreign affiliates

Further controls

# R&D Input: Preliminary Results

- **How does R&D input respond to foreign tax incentives?**
- Preliminary results from **confidential data on R&D expenditures**
  - approx. 30,000 German firms
  - panel data for R&D activity (2000–2013)
  - collected by Stifterverband (R&D data for Eurostat)
  - detailed information on type, location, expenditure, expectations, personnel etc.

# Results: R&D expenditures

	(1)	(2)	(3)	(4)
	Internal R&D Expenditures			External R&D Expenditures
	Total	Experimental	Applied	
<i>BOX<sub>Haven</sub></i>	-0.0290 (0.140)	1.491** (0.593)	-0.603*** (0.129)	-0.893*** (0.175)
Firm- & year FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
N	30,134	29,712	29,764	15,625
No. of firms	7,682	7,578	7,593	3,528
Pseudo LL	-1,851,681	-1,833,620	-1,791,755	-782,394

Further controls



# Summary

## Results

- Patent havens generate *positive* cross-border externalities: Increase in number of granted patents by about 2.3% per implied tax rate differential after implementation
- Patent boxes *with nexus requirement* do not generate significant cross-border-externalities
- Patent boxes create negative cross-border externalities on *average patent quality*

## Insights

- Type of patent boxes matters for direction of cross-border spillovers
- Patent boxes without nexus provide tax haven benefits in the sense of Hong & Smart (2010)
- OECD modified nexus approach: more tax-driven R&D diversion?

# Simple Framework I

- Firm locates in country  $h$  and has an affiliate in country  $p$
- Faces a set of  $i = 1, \dots, n_j$  potential R&D projects with
  - profits  $\pi_i = (\underline{\pi}_j, \bar{\pi}_j)$  (revenue less deductible costs)
  - cumulative distribution function  $F$
- Location-specific return  $r_l$  of research project  $i$  depends on
  - tax rate  $t_l$  and
  - non-deductible fixed cost  $c_l$ :

$$r_{i,l} = (1 - t_l)\pi_i - c_l \quad l \in \{h, p\} \quad (1)$$

- How many R&D projects are realised in firm location  $h$ ?
  - Decision 1: *Whether or not* to realise a project: realise any  $i$  with  $r_{i,l} \geq 0$  (**cut-off profit**  $\tilde{\pi}$ )
  - Decision 2: *Where* to realise the project: choose  $l \in \{h, p\}$  such that  $r_{i,l} = \max(r_{i,h}, r_{i,p})$  (**cut-off profit**  $\tilde{\pi}'$ )

# Simple Framework II

- Initially:  $t_h = t_p$  and  $c_h < c_p$  (simplifies presentation)  $\implies r_{i,h} > r_{i,p}$ 
  - firm realises all projects in  $h$  with profit  $r_{i,h} > 0 \iff \pi_i > \tilde{\pi} \equiv \frac{c_h}{1-t_h}$
  - Number of patents realised in  $h$ :  $P_j = n_j(1 - F(\tilde{\pi}))$
- What happens if a patent box is implemented in  $p$ , i.e.  $t_h > t_p$ ?

## Without nexus requirement

- R&D activity remains in  $h$  but is taxed in  $p$  (patent transfer)
- realise only projects with  $\pi_i > \tilde{\pi}'' \equiv \frac{c_h}{1-t_p}$

$$P_j'' = n_j (1 - F(\tilde{\pi}'')) \\ \Rightarrow P_j''(\tilde{\pi}'') > P_j(\tilde{\pi})$$

## With nexus requirement

- Need to locate R&D in  $p$  (and bear  $c_p$ ) to benefit from lower tax rate
- Locate projects with  $\pi_i > \tilde{\pi}' \equiv \frac{c_p - c_h}{t_h - t_p}$  to  $p$

$$P_j' = \max(n_j (F(\tilde{\pi}') - F(\tilde{\pi})), 0) \\ \Rightarrow P_j'(\tilde{\pi}') \leq P_j(\tilde{\pi})$$

- Taken together:  $P_j''(\tilde{\pi}'') > P_j(\tilde{\pi}) \geq P_j'(\tilde{\pi}')$

# Graphical Presentation

- Initially:  $t_h = t_p$  and  $c_h < c_p \implies r_{i,h} > r_{i,p}$
- What happens if a patent box is implemented in  $p$ , i.e.  $t_h > t_p$ ?

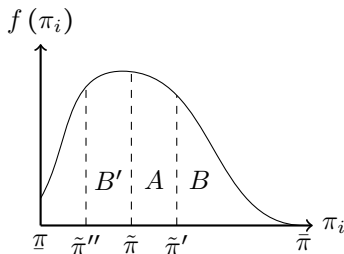


Figure: Profit distribution and realised R&D projects

- Patent box **without nexus** requirement **increases** R&D:  $P_j'' > P_j$
- Patent box **with nexus** requirement **decreases** R&D:  $P_j' \leq P_j$
- Patent box decreases avg. profit of realised patents

# Sample Selection

	Number of Firms in the Sample
Firms in patenting sectors that conduct R&D with data for 2000-2012	38,906
Excluding firms located in patent box countries	30,923
Excluding firms with a change in the firm structure with respect to patent box locations	26,393
Trimming at the 99% quantile of the patent count	26,314
Excluding firms with no patent application in the observation period	22,559

This table displays the sample selection. Patenting sectors are defined by 2-digit NACE Rev. 2 codes 10-32, 51-53, 58-63, 69-74 and 77-82. Firms that conduct R&D are defined as firms included in the PATSTAT database that have successfully filed a patent application at any point in time.

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# Results: Affiliates consolidated at country-level I

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
$BOX_{Haven}$	0.681*** (0.192)		0.634**** (0.212)	
$BOX_{Haven} \times \Delta t$		0.023*** (0.008)		0.021*** (0.008)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	208,348	208,348	202,001	202,001
No. of firms	18,509	18,509	17,914	17,914
Pseudo LL	-107,916	-107,918	-63,495	-63,496

# Results: Affiliates consolidated at country-level II

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
$BOX_{Nexus}$	0.013 (0.033)		-0.032 (0.034)	
$BOX_{Nexus} \times \Delta t$		0.000 (0.001)		0.001 (0.002)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	208,348	208,348	202,001	202,001
No. of firms	18,509	18,509	17,914	17,914
Pseudo LL	-107,927	-107,927	-63,499	-63,499

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# Results: Domestic firms excluded I

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
$BOX_{Haven}$	0.656*** (0.204)		0.662*** (0.221)	
$BOX_{Haven} \times \Delta t$		0.022*** (0.008)		0.022*** (0.008)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	53,178	53,178	52,342	52,342
No. of firms	4,878	4,878	4,799	4,799
Pseudo LL	-36,727	-36,728	-24,171	-24,172



# Results: Domestic firms excluded II

	No. of new Patents		No. of new Patents (adjusted)	
	(1)	(2)	(3)	(4)
$BOX_{Nexus}$	0.017 (0.038)		-0.007 (0.040)	
$BOX_{Nexus} \times \Delta t$		0.000 (0.002)		-0.001 (0.002)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	53,178	53,178	52,342	52,342
No. of firms	4,878	4,878	4,799	4,799
Pseudo LL	-36,736	-36,736	-24,176	-24,176

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# Results: Group-size-specific time-trends

	Only MNEs		Full Sample	
	Patent Count (1)	Quality- adj. (2)	Patent Count (3)	Quality- adj. (4)
<i>BOX<sub>Haven</sub></i>	0.656*** (0.204)	0.662*** (0.221)	0.657*** (0.201)	0.653*** (0.221)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	53,178	52,342	229,723	229,723
No. of firms	4,878	4,799	20,414	19,761
Pseudo LL	-36,727	-24,171	-115,380	-67,697

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# Results: Linear fixed-effects model I

	Log No. of new Patents		Log No. of new Patents (adjusted)	
	(1)	(2)	(3)	(4)
$BOX_{Haven}$	0.311*** (0.117)		0.122*** (0.035)	
$BOX_{Haven} \times \Delta t$		0.009* (0.005)		0.004*** (0.001)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	49,289	49,289	26,349	26,349
No. of firms	20,588	20,588	25,110	25,110
$R^2$	0.005	0.005	0.004	0.004

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# Results: Linear fixed-effects model II

	Log No. of new Patents		Log No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
$BOX_{Nexus}$	0.005 (0.019)		0.010 (0.007)	
$BOX_{Nexus} \times \Delta t$		-0.000 (0.001)		-0.001* (0.000)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	49,289	49,289	26,349	26,349
No. of firms	20,588	20,588	25,110	25,110
$R^2$	0.004	0.004	0.004	0.004

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# Effective tax burden for R&D

Poisson Fixed Effects estimator:

$$E(P_{ijt}) = \exp(\mathbf{x}'_{ijt}\beta)$$

$$\text{with } \mathbf{x}'_{ijt}\beta = \alpha\mathbf{t} + \beta\mathbf{X}_{it} + \gamma\mathbf{Z}_{jt} + \delta\mathbf{C}_{ct} + \phi_t + \phi_i + u_t$$

The corporate income tax rate  $\mathbf{t}$  is

- the statutory rate in the country of residence
- the minimum tax rate in the group, taking into account
  - patent havens
  - patent boxes with nexus

Differentiation between MNEs and domestic firms

# Results: Effective tax burden for R&D

	No. of new Patents			
	(1) Full Sample	(2) Domestic Firms	(3) Full Sample	(4) Full Sample
CIT	-0.004 (0.002)	-0.007** (0.003)		
Minimum Tax Rate (no nexus)			-0.004** (0.002)	
Minimum Tax Rate (nexus)				-0.003 (0.002)
Year & Firm FE	✓	✓	✓	✓
Country & firm controls	✓	✓	✓	✓
N	229,723	175,163	229,723	229,723
No. of firms	20,414	15,701	20,414	20,414
Pseudo LL	-115,442	-77,860	-115,439	-115,442

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# Robustness: Event-study design

$$P_{ijct} = \alpha_4 \sum_{n=4}^{t-2000} b_{j,t-n} + \sum_{n=-4}^3 \alpha_n b_{j,t-n} + \alpha_{-5} \sum_{n=5}^{2012-t} b_{j,t+n} \\ + \beta \mathbf{X}_{it} + \gamma \mathbf{Z}_{jt} + \delta \mathbf{C}_{ct} + \phi_t + \phi_i + u_{it}.$$

$P_{ijct}$  number of newly granted patents in year  $t$  of firm  $i$  member of multinational group  $j$

$b_{j,t}$  dummy indicating firm  $i$  has affiliate in patent haven country

$\phi_i, \phi_t$  firm-fixed effects, year-fixed effects

$\mathbf{X}_{it}$  firm-specific characteristics

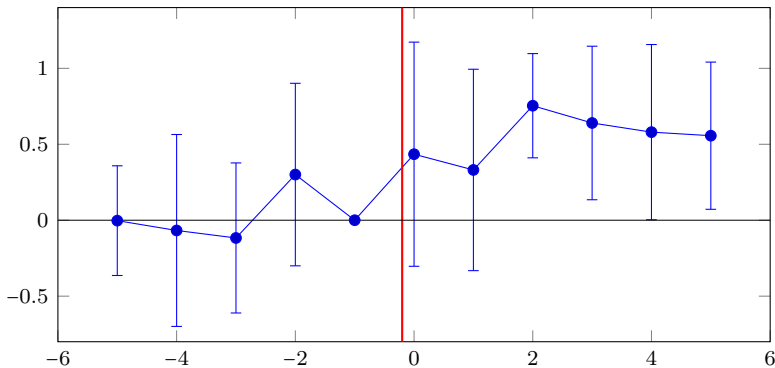
$\mathbf{Z}_{jt}$  group-specific characteristics

$\mathbf{C}_{ct}$  location-specific characteristics

## Event study settings

- 10 year time window: 4 years before implementation, 5 years after implementation and implementation year
- Adjustment of end points:  $\alpha_4 \sum_{n=4}^{t-2000} b_{j,t-n}$  and  $\alpha_{-5} \sum_{n=5}^{2012-t} b_{j,t+n}$

# Robustness: Event-study design



(a) Implementation of patent haven in foreign affiliate

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# Robustness: Matching approaches

		No. of new patents			
		(1)	(2)	(3)	(4)
	ATT	0.608*** (0.199)	0.637*** (0.058)	0.804** (0.402)	0.277*** (0.035)
	PSM	✓	✓		
	CEM			✓	✓
	Matched on initial firm characteristics	✓		✓	
	Matched on yearly firm characteristics		✓		✓

ATT denotes 'average treatment effect of the treated'. The calculation of the ATT includes firm-fixed effects if feasible (columns 1 and 3). Stars behind coefficients indicate the significance level, \* 10%, \*\* 5%, \*\*\* 1%.

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# Extension: Industry heterogeneity I

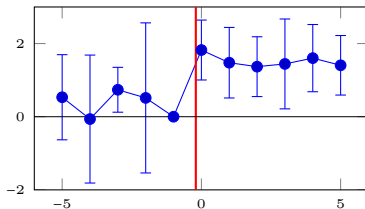
	No. of new Patents ICT		No. of new Patents Manufacturing	
	(1)	(2)	(3)	(4)
$BOX_{Haven}$	0.924** (0.408)		0.575** (0.247)	
$BOX_{Haven} \times \Delta t$		0.028* (0.016)		0.020** (0.010)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	22,243	22,243	162,224	162,224
No. of firms	2,012	2,012	13,937	13,937
Pseudo LL	-10,856	-10,857	-82,597	-82,598

# Extension: Industry heterogeneity II

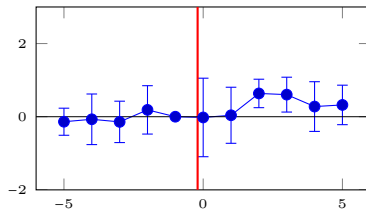
	No. of new Patents ICT		No. of new Patents Manufacturing	
	(1)	(2)	(3)	(4)
$BOX_{Nexus}$	-0.187 (0.115)		-0.026 (0.036)	
$BOX_{Nexus} \times \Delta t$		-0.008 (0.005)		-0.002 (0.002)
Year & Firm FE	✓	✓	✓	✓
Firm controls	✓	✓	✓	✓
Country controls	✓	✓	✓	✓
N	22,243	22,243	162,224	162,224
No. of firms	2,012	2,012	13,937	13,937
Pseudo LL	-10,855	-10,856	-82,602	-82,600

[Back: Robustness](#)
[Further controls](#)

# Extension: Industry heterogeneity - Event Study



(b) ICT



(c) Other Manufacturing (excl. ICT)

[Event Study framework](#)

[Back: Robustness](#)

# Controls Benchmark Results: Patent havens

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.333*** (0.065)	0.334*** (0.065)	0.444*** (0.072)	0.445*** (0.072)
Log GDP p.c.	-0.380* (0.223)	-0.380* (0.223)	0.890*** (0.234)	0.890*** (0.234)
CIT	-0.004* (0.002)	-0.004* (0.002)	-0.007*** (0.003)	-0.007*** (0.003)
GDP Growth	-0.000 (0.005)	-0.000 (0.005)	-0.015** (0.006)	-0.015** (0.006)
User Cost of R&D	-5.337*** (0.555)	-5.570*** (0.555)	-4.368*** (0.588)	-4.365*** (0.588)
Real interest rate	-1.395** (0.545)	-1.393** (0.545)	-1.730*** (0.563)	-1.728*** (0.563)
No. of affiliates	0.119*** (0.039)	0.119*** (0.039)	0.112*** (0.041)	0.112*** (0.041)
Log Age	0.089*** (0.021)	0.089*** (0.021)	0.088*** (0.023)	0.088*** (0.023)
Log Total Assets	0.035*** (0.005)	0.035*** (0.005)	0.023*** (0.006)	0.023*** (0.006)
Working Capital	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.017*** (0.005)	0.017*** (0.005)	0.016*** (0.005)	0.016*** (0.005)

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# Controls Benchmark Results: Nexus requirement

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.340*** (0.065)	0.340*** (0.065)	0.452*** (0.072)	0.452*** (0.072)
Log GDP p.c.	-0.387* (0.224)	-0.388* (0.223)	0.885*** (0.235)	0.883*** (0.235)
CIT	-0.004* (0.002)	-0.004* (0.002)	-0.006** (0.003)	-0.007** (0.002)
GDP Growth	-0.000 (0.005)	-0.000 (0.005)	-0.014** (0.006)	-0.014** (0.006)
User Cost of R&D	-5.563*** (0.557)	-5.543*** (0.556)	-4.284*** (0.589)	-4.292*** (0.589)
Real interest rate	-1.383** (0.545)	-1.379** (0.544)	-1.704** (0.562)	-1.704** (0.563)
No. of affiliates	0.120*** (0.039)	0.120*** (0.039)	0.112*** (0.041)	0.112*** (0.041)
Log Age	0.088*** (0.021)	0.088*** (0.021)	0.086*** (0.023)	0.086*** (0.023)
Log Total Assets	0.035*** (0.005)	0.035*** (0.005)	0.024*** (0.006)	0.024*** (0.006)
Working Capital	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.017*** (0.005)	0.017*** (0.005)	0.016*** (0.005)	0.016*** (0.005)

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# Controls Results: Affiliates consolidated at country level I

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.340*** (0.065)	0.342*** (0.065)	0.457*** (0.074)	0.458*** (0.074)
Log GDP p.c.	-0.488* (0.254)	-0.488* (0.254)	0.732*** (0.260)	0.732*** (0.260)
CIT	-0.004 (0.002)	-0.004 (0.002)	-0.007** (0.003)	-0.007** (0.003)
GDP Growth	0.002 (0.006)	0.002 (0.006)	-0.011* (0.006)	-0.011* (0.006)
User Cost of R&D	-5.639*** (0.566)	-5.639*** (0.566)	-4.591*** (0.601)	-4.588*** (0.601)
Real interest rate	-1.189** (0.535)	-1.187** (0.535)	-1.556*** (0.555)	-1.554** (0.555)
No. of affiliates	0.168*** (0.040)	0.168*** (0.040)	0.158*** (0.043)	0.158*** (0.043)
Log Age	0.115*** (0.022)	0.115*** (0.022)	0.130*** (0.024)	0.130*** (0.024)
Log Total Assets	0.028*** (0.003)	0.028*** (0.003)	0.025*** (0.003)	0.025*** (0.003)
Working Capital	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.020*** (0.005)	0.020*** (0.005)	0.017*** (0.005)	0.017*** (0.005)

# Controls Results: Affiliates consolidated at country level II

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.346*** (0.065)	0.347*** (0.065)	0.464*** (0.074)	0.463*** (0.074)
Log GDP p.c.	-0.497* (0.255)	-0.495* (0.254)	0.729*** (0.260)	0.727*** (0.260)
CIT	-0.004 (0.002)	-0.004 (0.002)	-0.006** (0.003)	-0.007** (0.003)
GDP Growth	0.002 (0.006)	0.002 (0.006)	-0.011* (0.006)	-0.011* (0.006)
User Cost of R&D	-5.644*** (0.567)	-5.631*** (0.566)	-4.520*** (0.600)	-4.535*** (0.601)
Real interest rate	-1.179** (0.535)	-1.177** (0.535)	-1.534*** (0.555)	-1.535** (0.555)
No. of affiliates	0.169*** (0.040)	0.169*** (0.040)	0.159*** (0.043)	0.159*** (0.043)
Log Age	0.116*** (0.022)	0.115*** (0.022)	0.127*** (0.025)	0.127*** (0.025)
Log Total Assets	0.028*** (0.003)	0.028*** (0.003)	0.025*** (0.003)	0.025*** (0.003)
Working Capital	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.020*** (0.005)	0.020*** (0.005)	0.017*** (0.005)	0.017*** (0.005)

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# Controls Results: Domestic firms excluded I

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.303*** (0.099)	0.306*** (0.098)	0.345*** (0.108)	0.348*** (0.108)
Log GDP p.c.	-0.628 (0.474)	-0.626 (0.473)	0.450 (0.505)	0.450 (0.505)
CIT	0.001 (0.004)	0.001 (0.004)	-0.004 (0.004)	-0.004 (0.004)
GDP Growth	0.002 (0.009)	0.003 (0.009)	-0.005 (0.010)	-0.005 (0.010)
User Cost of R&D	-1.105 (1.234)	-1.091 (1.234)	-1.599 (1.318)	-1.586 (1.317)
Real interest rate	0.210 (0.888)	0.215 (0.888)	-0.492 (0.935)	-0.488 (0.935)
No. of affiliates	0.080 (0.098)	0.080 (0.098)	0.071 (0.104)	0.071 (0.104)
Log Age	0.110*** (0.038)	0.110*** (0.038)	0.106*** (0.041)	0.106*** (0.041)
Log Total Assets	0.045*** (0.012)	0.045*** (0.012)	0.032*** (0.012)	0.032*** (0.012)
Working Capital	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Log Capital Intensity	0.029*** (0.010)	0.029*** (0.010)	0.029*** (0.010)	0.029*** (0.010)

# Controls Results: Domestic firms excluded II

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.315*** (0.099)	0.316*** (0.099)	0.357*** (0.108)	0.356*** (0.108)
Log GDP p.c.	-0.654 (0.476)	-0.653 (0.473)	0.426 (0.508)	0.422 (0.508)
CIT	0.001 (0.004)	0.001 (0.004)	-0.004 (0.004)	-0.004 (0.004)
GDP Growth	0.003 (0.009)	0.003 (0.009)	-0.005 (0.010)	-0.004 (0.010)
User Cost of R&D	-1.092 (1.250)	-1.080 (1.250)	-1.573 (1.323)	-1.589 (1.324)
Real interest rate	0.226 (0.888)	0.229 (0.888)	-0.475 (0.934)	-0.476 (0.935)
No. of affiliates	0.086 (0.098)	0.084 (0.098)	0.074 (0.104)	0.073 (0.104)
Log Age	0.109*** (0.038)	0.108*** (0.038)	0.105*** (0.041)	0.105*** (0.041)
Log Total Assets	0.045*** (0.012)	0.045*** (0.012)	0.032*** (0.012)	0.032*** (0.012)
Working Capital	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Log Capital Intensity	0.029*** (0.010)	0.029*** (0.010)	0.029*** (0.010)	0.029*** (0.010)

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# Controls Results: Group-size-specific time-trends

	Only MNEs		Full Sample	
	Patent Count	Quality-adj.	Patent Count	Quality-adj.
R&D Exp.	0.303*** (0.099)	0.345*** (0.108)	0.327*** (0.065)	0.450*** (0.073)
Log GDP p.c.	-0.628 (0.474)	-0.450 (0.505)	-0.398* (0.223)	0.885*** (0.234)
CIT	0.001 (0.004)	-0.004 (0.004)	-0.004* (0.002)	-0.006** (0.003)
GDP Growth	0.002 (0.009)	-0.005 (0.010)	-0.001 (0.005)	-0.013** (0.006)
User Cost of R&D	-1.105 (1.243)	-1.599 (1.318)	-5.437*** (0.560)	-4.065*** (0.592)
Real interest rate	0.210 (0.888)	-0.429 (0.935)	-1.259** (0.547)	-1.555*** (0.566)
Log No. of affiliates	0.080 (0.098)	0.071 (0.104)	0.089** (0.041)	0.090** (0.044)
Log Age	0.110*** (0.038)	0.106*** (0.041)	0.089*** (0.021)	0.084*** (0.023)
Log Total Assets	0.045*** (0.012)	0.032*** (0.012)	0.035*** (0.005)	0.026*** (0.006)
Working Capital	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.029*** (0.010)	0.029*** (0.011)	0.017*** (0.005)	0.017*** (0.005)

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# Controls Results: Linear fixed-effects model I

	Log no. of new Patents		Log no. of new Patents (adjusted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.022 (0.039)	0.024 (0.039)	0.048*** (0.009)	0.049*** (0.009)
Log GDP p.c.	-0.430*** (0.122)	-0.430*** (0.122)	-0.094*** (0.026)	-0.094*** (0.026)
CIT	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.000)	-0.001 (0.000)
GDP Growth	0.002 (0.003)	0.002 (0.003)	0.000 (0.001)	0.000 (0.001)
User Cost of R&D	-0.376 (0.307)	-0.376 (0.307)	-0.760*** (0.063)	-0.760*** (0.059)
Real interest rate	-0.340 (0.346)	-0.339 (0.346)	-0.190*** (0.067)	-0.189*** (0.067)
No. of affiliates	0.036 (0.022)	0.036 (0.022)	0.016*** (0.006)	0.016*** (0.006)
Log Age	0.016 (0.013)	0.016 (0.013)	0.014*** (0.003)	0.014*** (0.003)
Log Total Assets	0.009*** (0.003)	0.009*** (0.003)	0.003*** (0.001)	0.003*** (0.001)
Working Capital	-0.000** (0.000)	-0.000** (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.001 (0.003)	0.001 (0.003)	0.002*** (0.001)	0.002*** (0.001)

# Controls Results: Linear fixed-effects model II

	Log no. of new Patents		Log no. of new Patents (adjusted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.025 (0.039)	0.026 (0.039)	0.049*** (0.009)	0.049*** (0.009)
Log GDP p.c.	-0.433*** (0.122)	-0.433*** (0.122)	-0.095*** (0.026)	-0.095*** (0.026)
CIT	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.000)	-0.001 (0.000)
GDP Growth	0.002 (0.003)	0.002 (0.003)	0.000 (0.001)	0.000 (0.001)
User Cost of R&D	-0.376 (0.308)	-0.367 (0.308)	-0.751*** (0.063)	-0.750*** (0.063)
Real interest rate	-0.336 (0.346)	-0.335 (0.346)	-0.188*** (0.067)	-0.188*** (0.067)
No. of affiliates	0.036 (0.022)	0.036 (0.022)	0.016*** (0.006)	0.016*** (0.006)
Log Age	0.016 (0.013)	0.016 (0.013)	0.014*** (0.003)	0.014*** (0.003)
Log Total Assets	0.009*** (0.003)	0.009*** (0.003)	0.004*** (0.001)	0.004*** (0.001)
Working Capital	-0.000** (0.000)	-0.000** (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.001 (0.003)	0.001 (0.003)	0.002*** (0.001)	0.002*** (0.001)

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# Controls Results: Effective tax burden for R&D

	(1) Full Sample	(2) Domestic Firms	(3) Full Sample	(4) Full Sample
R&D exp.	0.340*** (0.065)	0.319*** (0.086)	0.347*** (0.063)	0.352*** (0.063)
Log GDP p.c.	-0.387* (0.224)	-0.237 (0.254)	-0.390* (0.223)	-0.391* (0.223)
GDP Growth	-0.000 (0.005)	-0.002 (0.007)	0.000 (0.005)	0.001 (0.005)
User Cost of R&D	-5.560*** (0.555)	-6.814*** (0.627)	-5.492*** (0.553)	-5.563*** (0.554)
Real interest rate	-1.382** (0.545)	-1.882*** (0.690)	-1.338** (0.531)	-1.276** (0.530)
Log no. of affiliates	0.120*** (0.039)	0.110** (0.046)	0.115*** (0.039)	0.117*** (0.039)
Log Age	0.088*** (0.021)	0.077*** (0.025)	0.087*** (0.021)	0.088*** (0.021)
Log Total Assets	0.035*** (0.005)	0.032*** (0.006)	0.036*** (0.005)	0.035*** (0.005)
Working Capital	0.000 (0.000)	0.000* (0.000)	0.000 (0.000)	0.000 (0.000)
Log Capital Intensity	0.017*** (0.005)	0.013** (0.005)	0.017*** (0.005)	0.017*** (0.005)

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# Controls Results: Patent quality

	No. of new Patents		No. of new Patents (quality-weighted)	
	(1)	(2)	(3)	(4)
R&D Exp.	0.111*** (0.034)	0.110*** (0.034)	0.129*** (0.037)	0.127*** (0.037)
Log GDP p.c.	-0.205** (0.101)	-0.205** (0.101)	-0.190* (0.114)	-0.190* (0.114)
CIT	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.000 (0.002)
GDP Growth	0.001 (0.003)	0.001 (0.003)	-0.000 (0.003)	-0.000 (0.003)
User Cost of R&D	-0.913*** (0.316)	-0.914*** (0.316)	0.480 (0.401)	0.467 (0.401)
Real interest rate	-0.621* (0.320)	-0.620* (0.320)	-0.464 (0.352)	-0.467 (0.352)
No. of affiliates	-0.034 (0.022)	-0.034 (0.022)	-0.041 (0.025)	-0.041 (0.025)
Log Age	-0.006 (0.013)	-0.006 (0.013)	-0.011 (0.015)	-0.010 (0.015)
Log Total Assets	-0.022*** (0.004)	-0.022*** (0.004)	-0.023*** (0.004)	-0.024*** (0.004)
Working Capital	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Log Capital Intensity	0.001 (0.003)	0.001 (0.003)	0.001 (0.004)	0.001 (0.0004)

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# Controls Results: R&D expenditures

	(1)	(2)	(3)	(4)
	Internal R&D Expenditures			External R&D Expenditures
	Total	Experimental	Applied	
No. of affiliates	0.129* (0.070)	0.239** (0.0946)	0.049 (0.0942)	0.359 (0.297)
Log Age	-0.054 (0.060)	-0.022 (0.0766)	-0.077 (0.114)	-0.044 (0.175)
Log Total Assets	0.040*** (0.011)	0.239*** (0.095)	0.058*** (0.014)	0.058 (0.036)
Working Capital	-0.000** (0.000)	-0.000 (0.000)	-0.000*** (0.000)	0.008*** (0.002)
Log Capital Intensity	0.001 (0.007)	0.009 (0.011)	-0.008 (0.012)	0.010 (0.019)

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# Controls Results: Industry heterogeneity I






	ICT		Manufacturing	
	(1)	(2)	(3)	(4)
R&D Exp.	0.408* (0.220)	0.415* (0.220)	0.365*** (0.077)	0.367*** (0.077)
Log GDP p.c.	-0.986 (0.960)	-0.997 (0.961)	-0.590** (0.245)	-0.590** (0.245)
CIT	-0.000 (0.008)	0.000 (0.008)	-0.003 (0.003)	-0.003 (0.003)
GDP Growth	0.004 (0.019)	0.005 (0.019)	0.002 (0.007)	0.002 (0.007)
User Cost of R&D	-3.912* (2.014)	-3.890* (2.014)	-1.221* (0.666)	-1.221* (0.666)
Real interest rate	-3.912* (2.014)	-3.890* (2.014)	-1.221* (0.666)	-1.220 (0.666)
No. of affiliates	0.239* (0.141)	0.240* (0.141)	0.104** (0.046)	0.104** (0.046)
Log Age	-0.025 (0.067)	-0.026 (0.067)	0.108*** (0.026)	0.108*** (0.026)
Log Total Assets	0.045*** (0.017)	0.045*** (0.017)	0.035*** (0.007)	0.035*** (0.007)
Working Capital	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Log Capital Intensity	0.028** (0.013)	0.028** (0.013)	0.013** (0.007)	0.013** (0.007)

# Controls Results: Industry heterogeneity II

	ICT		Manufacturing	
	(1)	(2)	(3)	(4)
R&D Exp.	0.448** (0.221)	0.437** (0.220)	0.373*** (0.077)	0.372*** (0.077)
Log GDP p.c.	-1.039 (0.954)	-1.040 (0.956)	-0.593** (0.246)	-0.596** (0.245)
CIT	0.001 (0.008)	0.000 (0.008)	-0.003 (0.003)	-0.003 (0.003)
GDP Growth	0.007 (0.019)	0.007 (0.019)	0.002 (0.007)	0.002 (0.007)
User Cost of R&D	-3.824* (2.009)	-3.829* (2.011)	-1.201* (0.666)	-1.198* (0.666)
Real interest rate	-3.824* (2.014)	-3.829* (2.011)	-1.201* (0.666)	-1.198* (0.666)
No. of affiliates	0.244* (0.141)	0.244* (0.141)	0.105** (0.046)	0.105** (0.046)
Log Age	-0.036 (0.066)	-0.035 (0.066)	0.107*** (0.026)	0.107*** (0.026)
Log Total Assets	0.050*** (0.017)	0.050*** (0.017)	0.036*** (0.007)	0.036*** (0.007)
Working Capital	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Log Capital Intensity	0.028** (0.013)	0.028** (0.013)	0.013** (0.007)	0.013** (0.007)

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