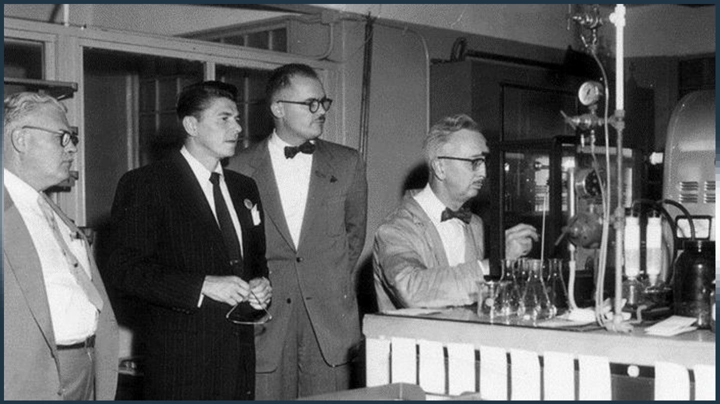

R&D Tax Credits

NBER Innovation Boot Camp
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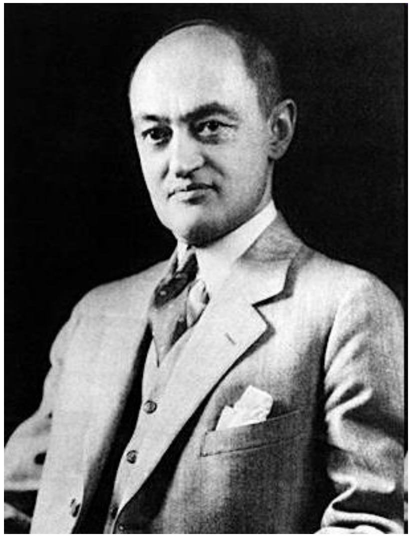
THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

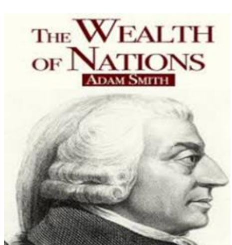
“On the one hand, taxation is an essential attribute of commercial society . . . on the other hand, it is almost inevitably . . . an injury to the productive process.”

Joseph Schumpeter, *Capitalism, Socialism, and Democracy* (1942)



Although probably his most famous quote was:

- "*Early in life I had three ambitions. I wanted to be the greatest **economist** in the world, the best **horseman** in all of Austria, and the greatest **lover** in all of in Vienna.*"



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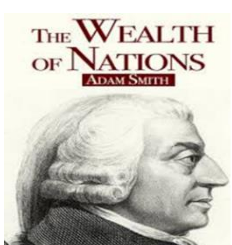
- "*Early in life I had three ambitions. I wanted to be the greatest* ***economist*** *in the world, the best* ***horseman*** *in all of Austria, and the greatest* ***lover*** *in all of in Vienna.*"

- "Those who knew *Schumpeter as an Economist, Lover or a Horseman presumed his skills were in the other two fields*"



Introduction

- The impact of taxation on innovation is a broad question

- **Narrow:** Specific taxes around innovation (**R&D tax credit**, patent and innovation boxes, etc.). Start here.
- **Wider**: what is impact of general personal and corporate tax systems on innovation? Akcigit, Grigsby, Nicholas & Stantcheva (2022)
- **Very wide**: Many policies can be seen as implicit taxes or subsidies on innovation incentives. Example:-
  - Some regulations like an implicit tax: see Garicano et al, 2016 and Aghion et al, 2022 on size-dependent regulations. If larger firms face bigger tax burdens this is like an implicit tax on growth and innovation

Innovation Policy: The "Lightbulb" Table

(1)	(2)	(3)	(4)	(5)	(6)
Policy	**Quality of evidence**	**Conclusiveness of evidence**	**Benefit - Cost**	**Time frame:**	**Effect on inequality**
Direct R&D Grants	Medium	Medium	💡💡	Medium-Run	↑
R&D tax credits	High	High	💡💡💡	Short-Run	↑
Patent Box	Medium	Medium	Negative	n/a	↑
Skilled Immigration	High	High	💡💡💡	Short to Medium-Run	↓
Universities: incentives	Medium	Low	💡	Medium-Run	↑
Universities: STEM Supply	Medium	Medium	💡💡	Long-Run	↓
Exposure Policies	Medium	Low	💡💡	Long-run	↓
Trade and competition	High	Medium	💡💡	Medium-Run	↑

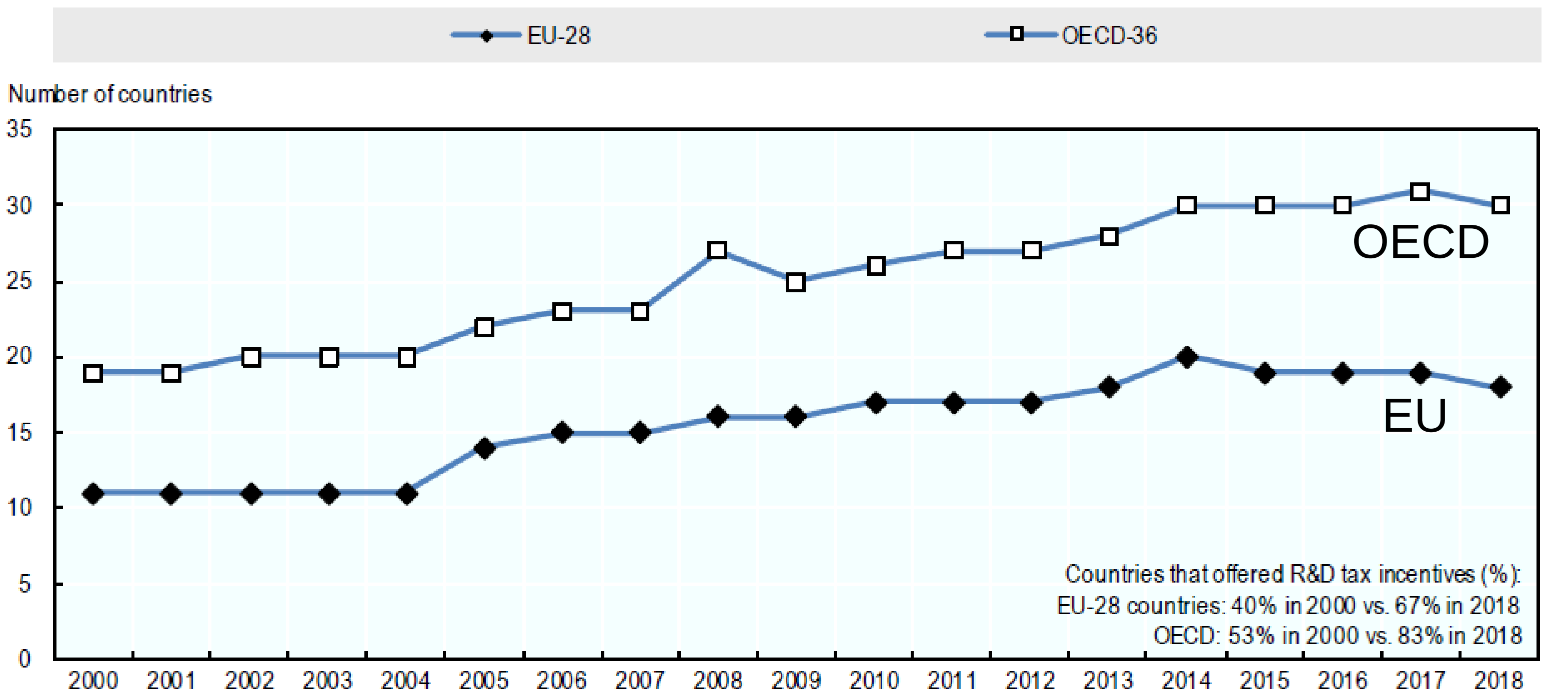
Source: Bloom, Van Reenen and Williams (2019, JEP)

R&D Tax credits

- A way of supporting R&D through the tax code
- Basic idea is to change the tax system to make R&D more attractive than other forms of spending
- Increasingly popular all over the world
  - There has been a general a shift from direct support via R&D grant policies to indirect support via tax system

- **Background facts**
  - Reagan introduced first R&E tax credit in 1981
  - OECD (2021): 34/42 countries have tax credits (up from 20 in 2000)
  - Has been a general switch away from direct support via grants to indirect support through tax system

Increase in use of R&D tax incentives in OECD 83% of countries in 2018 compared to 40% in 2000

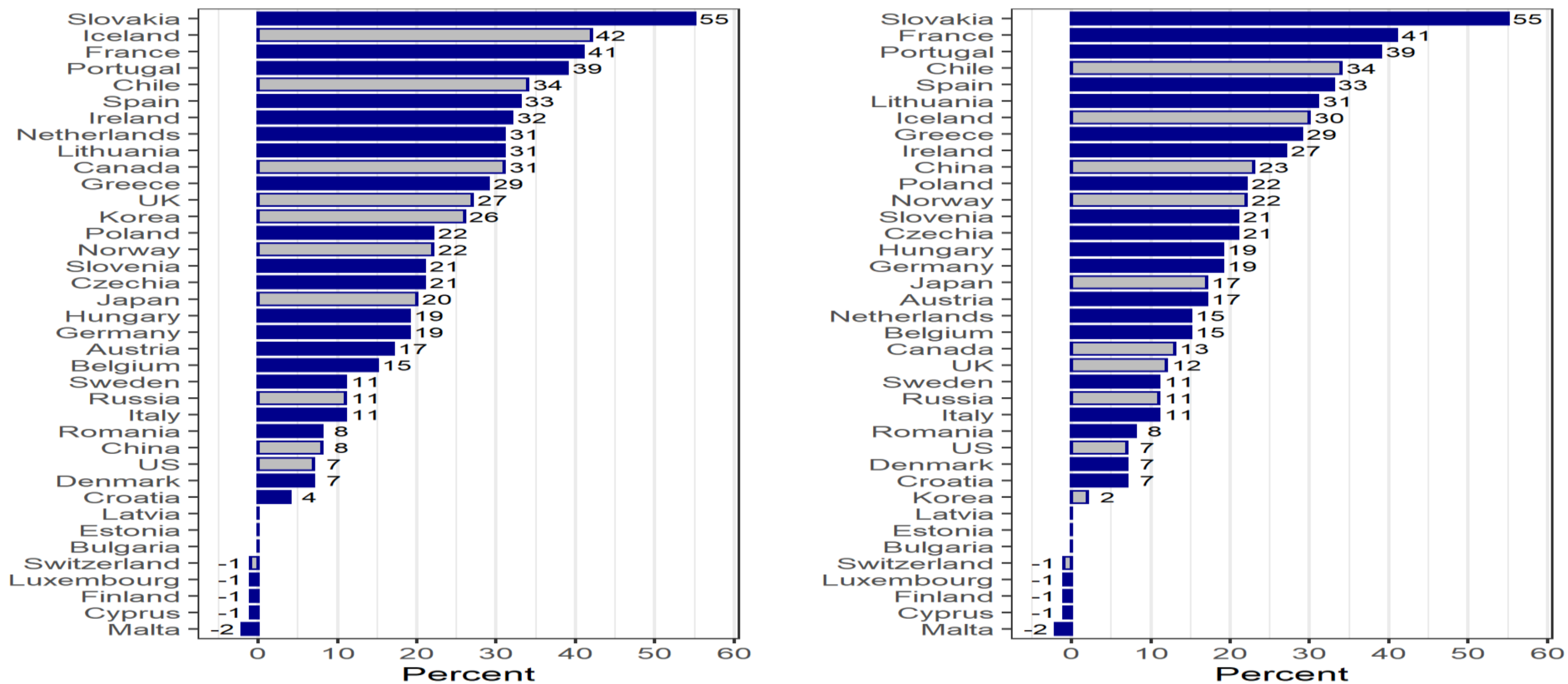


Note: EU-28 excludes Malta as no sufficiently detailed information is available on R&D tax relief provisions.
Source: OECD R&D Tax Incentives Database, http://oe.cd/rdtax, March 2019.

- In 2016 OECD countries granted $45bn R&D tax relief 46% of all gov support in form of tax relief (up from 36% in 2006)

Generally, R&D tax credits are more generous to SMEs

Figure 1: Implied tax subsidy rates on R&D expenditure in different countries in 2020



Source: OECD R&D Tax Incentives Database. https://stats.oecd.org/Index.aspx?DataSetCode=RDSUB
Notes: Shown are implied tax subsidy rates for Small and medium size enterprises (SMEs, (Panel A) and Large enterprises (Panel B) in different countries in 2020. The bars of EU countries are blue, those of non-EU countries gray. This is the "profitable scenario". For a detailed methodology behind calculations see https://stats.oecd.org/Index.aspx?DataSetCode=RDSUB#. Countries with no notable bar (i.e. Latvia, Estonia, and Bulgaria) have an implied tax subsidy rate of 0%. Countries are ordered by level of tax subsidy rate (descending order). A corresponding graph showing the values for both firm types in 2007 as a comparison can be found in the Appendix.

R&D Tax credits: Advantages

- Performed by private sector: probably more efficient than government labs
- No need for government to explicitly *choose* projects so economizes on bureaucracy and information
- Mitigates risk of political capture by single firm/industry

R&D Tax credits: Disadvantages

- **Blunt:** not well targeted at high externality R&D "near market" rather than basic R&D (e.g. universities)
- Firms may **re-label** activities get re-classified to obtain tax break (Chen et al, 2021, in China)
- Limited use for new/small firms because low/zero tax liabilities carry
  - Can overcome with refundable credits and carry-forward provisions help (but discounting limits usefulness)
- Perverse incentives due to **design features**
  - Example of moving "base" in US 1980s R&E credit
- As with other R&D demand side policies:
  - R&D narrowly defined: some innovation costs not classified as R&D (e.g. service firms)
  - Deadweight cost if not targeting marginal investments

Questions about R&D tax credits

- **Do Fiscal incentives increase *R&D?***
  - Elasticity of R&D with respect to user cost >1
  - See (Hall, 2022) and Blandinieres et al (2020) meta-study

- **Do Fiscal incentives increase *Innovation*?**
  - Important because of re-labelling concern (e.g. Chen et al, 2021)
  - Dechezlepretre et al (2022) using Regression Discontinuity Design. Change in SME R&D thresholds (discuss later)

Simplified tax-adjusted user cost of R&D capital (Hall & Jorgensen, 1984)

Discounted value of tax credits and depreciation allowances

interest rate

Inflation rate

$$\rho_{it} = \left(\frac{1 - D_{it}}{1 - \tau_{it}} \right) \left(i_t + \delta - \frac{\Delta p_t}{p_{t-1}} \right)$$

Statutory corporate tax rate

R&D capital depreciation rate

- R&D is a form of intangible capital, so if R&D treated like other capital $D_{it} = 0$ and higher corporate tax discourages R&D
- If R&D just treated as an expense $D_{it} = \tau_{it}$ & tax system neutral (so favored relative to other forms of capital)

What are the effects of R&D tax credits?

1. Federal tax credit generates substantial heterogeneity in firm level R&D user cost

2. Cross country variation in R&D tax credits

3. State-specific tax credits

4. Use non-linear design of tax credits to generate Regression Discontinuity Design (RDD), example of Dechezlepretre et al (2022)

What are the effects of R&D tax credits?

1. **Federal tax credit generates substantial heterogeneity in firm level R&D user cost**
   - Firm's history (e.g. via "base" for incremental credit) matters, as does it's corporate tax eligibility, etc.

Constant fiddling around with the design of the R&D tax credit (1981-2013: see Hall, 2022)

Table 1: Legislative History of the Federal Research and Experimentation Tax Credit, 1981-2013

	Credit Rate*	Corporate Tax Rate	Definition of Base	Qualified Research Expenditures	Sec. 174 deduction**	Foreign Allocation Rules	Carryback/Carryforward
July 1981 to Dec 1981	25%	48%	Maximum of previous 3-year average or 50% or current year	Excluded: research performed outside US; humanities and soc. science research; research funded by others	None	100% deduction against domestic income	3 years/15 years
Jan 1982 to Dec 1985	Same	46%	Same	Same	Same	Same	Same
Jan 1986 to Dec 1986	20%	34%	Same	Definition narrowed to technological research. Excluded leasing	Same	Same	Same
Jan 1987 to Dec 1987	Same	Same	Same	Same	Same	50% deduction against domestic income; 50% allocation	Same
Jan 1988 to Apr 1988	Same	Same	Same	Same	Same	64% deduction against domestic income; 36% allocation	Same
May 1988 to Dec 1988	Same	Same	Same	Same	Same	30% deduction against domestic income; 70% allocation	Same
Jan 1989 to Dec 1989	Same	Same	Same	Same	-50% credit	64% deduction against domestic income; 36% allocation	Same
Jan 1990 to Dec 1991	Same	Same	1984-1988 R&D to sales ratio times current sales (max of 16%); 3% of current sales for startups	Same	-100% credit	Same	Same
Jan 1992 to Dec 1993	Same	Same	Startup rules modified	Same	Same	Same	Same
Jan 1994 to June 1995	Same	35%	Same	Same	Same	50% deduction against domestic income; 50% allocation	Same
July 1995 to June 1996	0%	Same	None	-	-	Same	Same
July 1996 to June 1999	20%	Same	1984-1988 R&D to sales ratio times current sales (max of 16%); 3% of current sales for startups	Same as before lapse	-100% credit	50% deduction against domestic income; 50% allocation	Same
July 1999 to June 2004	Same	Same	Also includes research undertaken in Puerto Rico and U.S. possessions.	Same	Same	Same	Same
July 2004 to Dec 2005	Same	Same	Same	Same	Same	Same	Same
Jan 2006 to Dec 2007	Same	Same	Same	Transition rules altered slightly and alternative credits modified as outlined on next sheet.	Same	Same	Same
Jan 2008 to Dec 2013	Same	Same	Same	Same	Same	Same	Same

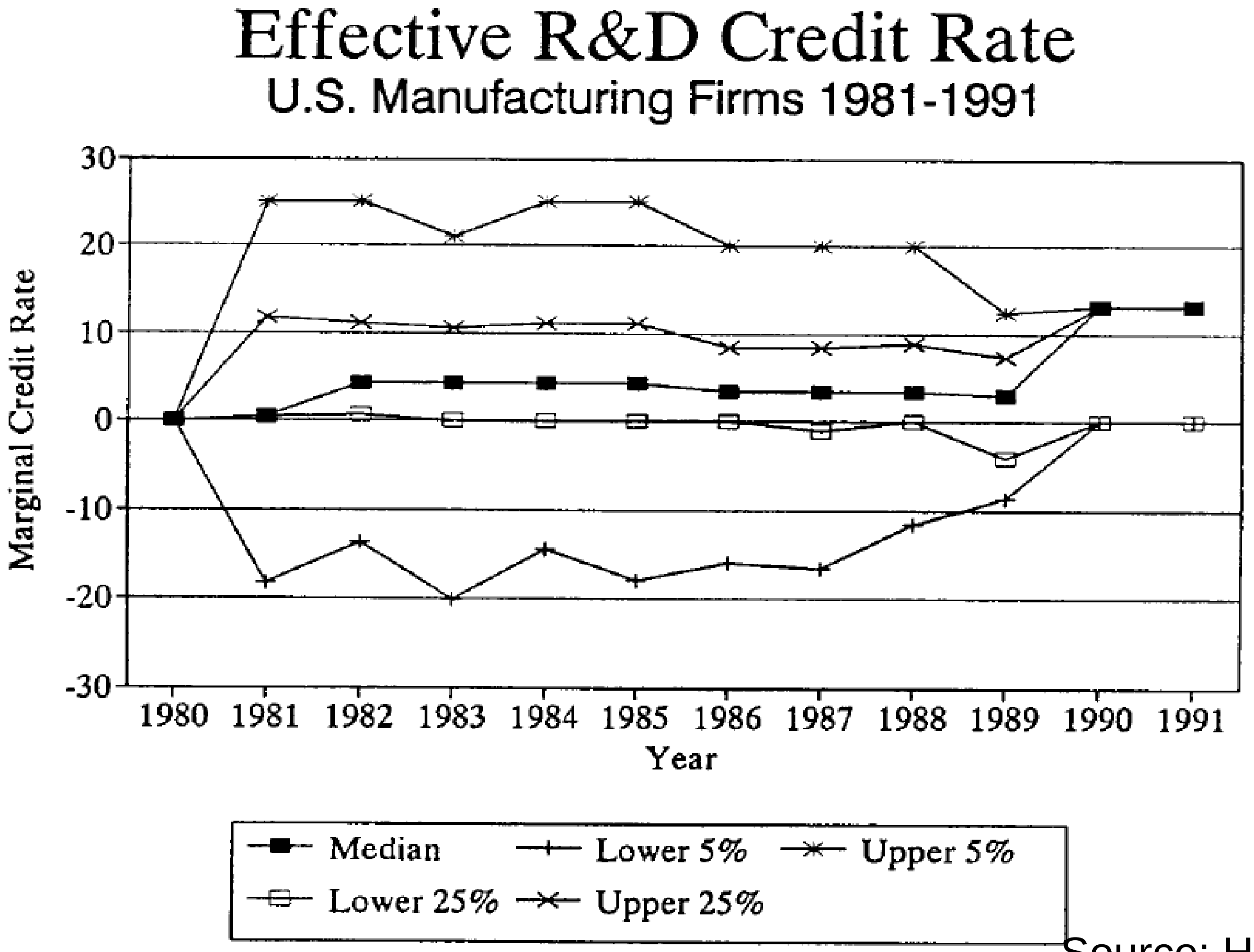
* In all years the firm can apply the credit rate to 50% of current QREs if the base amount is less than 50% of current QREs.

** Section 174 of the IRC provides an immediate deduction for most research and experimentation expenditures. Taxpayers can also elect to amortize these expenditures over 60 months, but in practice most firms immediately expense R&D. However, the IRC does not define what qualifies as R&D expenditures. Treasury regulations have generally interpreted them to mean "R&D costs in the experimental or laboratory sense."

Note: Based on Hall (1994), the Senate Budget Committee's 2006 Tax Expenditures compendium and Thomas legislative summaries.

Source: Rao (2016)

Cross firm Heterogeneity of the effective R&D tax credit rate (Federal Only)



Source: Hall (1993)

An Empirical Model of R&D

R&D knowledge stock, *G*, perpetual inventory method**:**

$$G_t = R_t + (1-\delta)G_{t-1}$$

Production function: *Y = AF(L,K,G); K* = non-R&D capital, *L* = non-R&D labor. If CES, First Order Condition:

$$\ln G = a + \sigma \ln \rho + \mu \ln Y$$

σ = elasticity of substitution; μ = returns to scale (μ = 1 if Constant Returns To Scale). **In steady state:**

$$R = \delta G$$

$$\ln R = \ln G + \ln \delta$$

Empirical Models of R&D, R

Implies typical firm level empirical model (firm *i* at time *t*)

$$\ln R_{it} = \beta \ln \rho_{it} + \alpha' x_{it} + \mathrm{u}_{it}$$

$$\beta = \sigma; \alpha' x_{it} = a + ln\delta + \mu lnY_{it}$$

- Add fixed effects and time dummies
- **Static:** adjustment costs mean that investment model is more complex. Path of *R* depends on expectations of fundamentals & shocks.
- **Dynamics** of adjustment: add lags of dependent variable & distributed lag of R&D user cost
- Standard issues of dynamic panel data models

Basic empirical firm model

$$\ln R_{it} = \alpha \ln R_{it-1} + \beta_1 \ln \rho_{it} + \gamma' x_{it} + \eta_i + \tau_t + e_{it}$$

- Short run elasticity: $\frac{\partial lnR}{\partial ln\rho} = \beta_1$
- Long run elasticity: $\frac{\partial lnR}{\partial ln\rho} = \frac{\beta_1}{1-\alpha}$

Results using firm-level approach

- Surveys by Hall & Van Reenen (2000), Hall (2022)
- Hall (1992)
  - Uses Compustat firms and dynamic panel data approaches (e.g. Arellano & Bond, 1992)
- Rao (2016)
  - Use IRS data with actual tax credit receipt
  - Construct synthetic instruments (Gruber and Saez, 2002): simulate federal changes holding firm characteristics at lagged values
- Find long-run elasticity of around unity or greater

Endogeneity issue with basic empirical model

$$\ln R_{it} = \alpha \ln R_{it-1} + \beta_1 \ln \rho_{it} + \gamma ' x_{it} + \eta_i + \tau_t + e_{it}$$

- User cost will in general be correlated with error term.
  - e.g. a positive shock raising incentive to R&D will affect the base, incremental credit & incentives
  - Even lagged characteristics (used for IVs) will be endogenous if serial correlation
- Many elements that are exogenous (e.g. interest rates, tax rate) do not usually vary across firms and so are collinear with time dummies

General Equilibrium (GE) Issues

- GE effects. If demand curve inelastic then price effects rather than quantity effects
  - Goolsbee (1998): Federal R&D subsidies just drive up scientist wages. Hard to identify (US time series)

- Policy Solutions?
  - In long-run more people switch into R&D;
  - Even in short-run, international mobility of R&D workers in short-run

- **Alternative empirical approach:** Exploit cross country panel data which controls for country GE effects

What are the effects of R&D tax credits?

1. Federal tax credit generates substantial heterogeneity in firm level R&D user cost

2. **Cross country variation in R&D tax credits**

3. State-specific tax credits

4. Use non-linear design of tax credits to generate Regression Discontinuity Design (RDD)

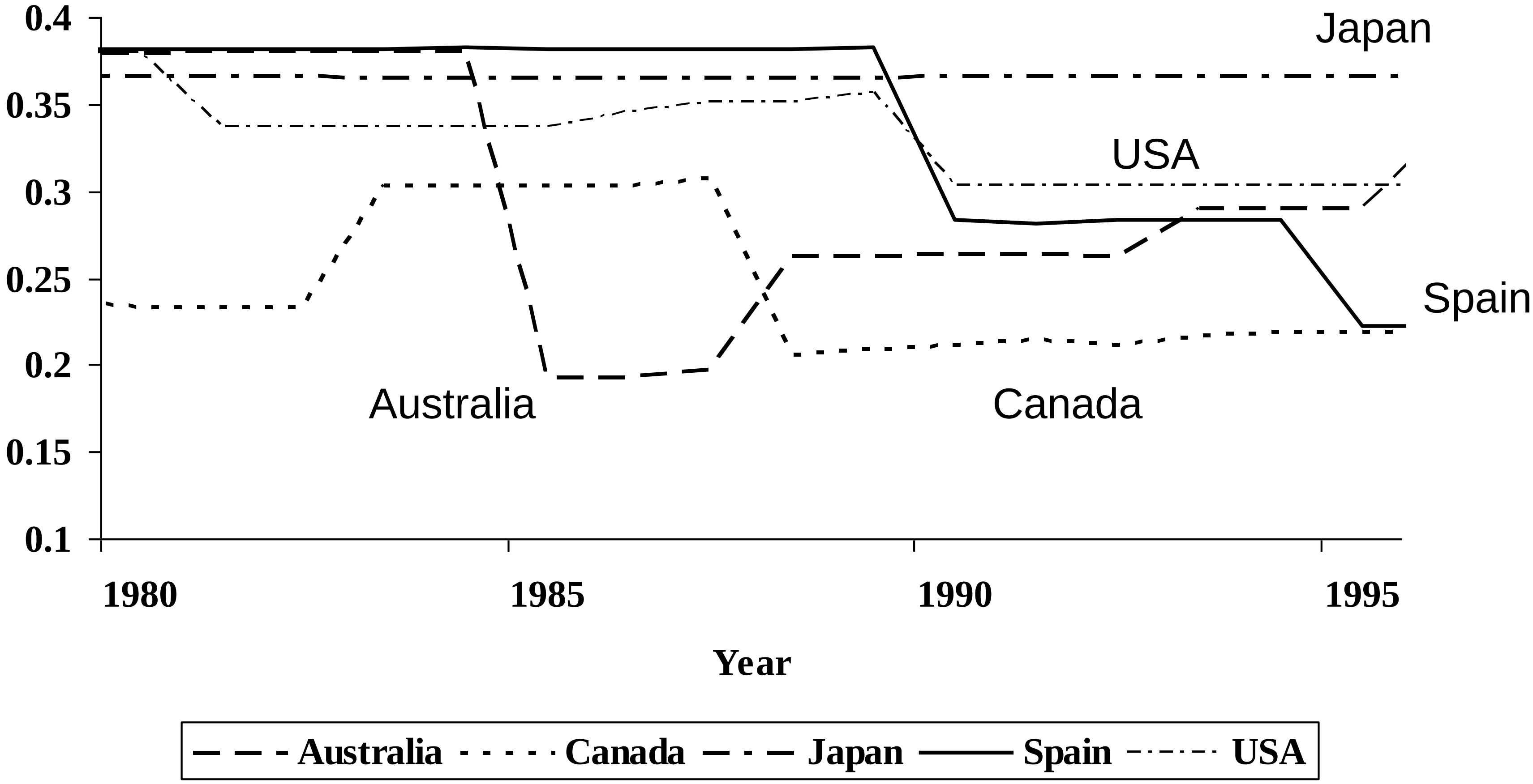
International variation in tax-adjusted user cost of R&D

- Many different R&D tax regimes generates much variation in use cost over countries & over time

- UK introduces tax credit in 2001, Australia 1985 150% super deduction, France changes (almost) every year

- Bloom, Griffith & Van Reenen (BGVR, 2002) look at 9 OECD countries 1979-1997 & use tax rules in all nations to construct user cost (see over)

Cross country Heterogeneity of the effective R&D tax credit rate



Source: Bloom, Griffith & Van Reenen (2002)

International variation

$$\ln R_{it} = \alpha \ln R_{it-1} + \beta_1 \ln \rho_{it} + \gamma \ln GDP_{it} + \eta_i + \tau_t + e_{it}$$

- Estimate same basic equation, but *i* is now country not firm
- Focus on tax price & use this to IV total R&D user cost
- BGVR find long-run elasticity of ~1 & short-run ~0.15. Interpret this as indicating substantial adjustment costs for R&D
- OECD (2013, Appelt et al, 2019) find similar

What are the effects of R&D tax credits?

1. Federal tax credit generates substantial heterogeneity in firm level R&D user cost

2. Cross country variation in R&D tax credits

3. State-specific tax credits generate additional variation

4. Use non-linear design of tax credits to generate Regression Discontinuity Design (RDD).

Problems with Cross-country approach

- Many other factors varying in a year that are country-specific and could be correlated with user cost

- Wilson (2009) uses US state-specific variation
  - Many states have a more generous R&D tax credit that Federal government (like Minimum Wage)
  - Use this to construct state-specific user cost and estimate using a state-level panel

Wilson (2009) findings

- Wilson finds similar long-run elasticity to BGVR
  - Argues that this is mainly due to cross-state relocation, i.e. aggregate US R&D stays the same, but "tax competition" effects the location of activity
- **Problem**: Uses geographical proximity to define competitors. But unlikely to be appropriate (e.g. California vs. Massachusetts rather than California vs. Nevada)
- Issue of endogeneity of state policy (Chang, 2018, instruments with Federal changes)

What are the effects of R&D tax credits?

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2. Cross country variation in R&D tax credits

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4. Use non-linear design of tax credits to generate Regression Discontinuity Design (RDD). Dechezlepretre et al (2022)

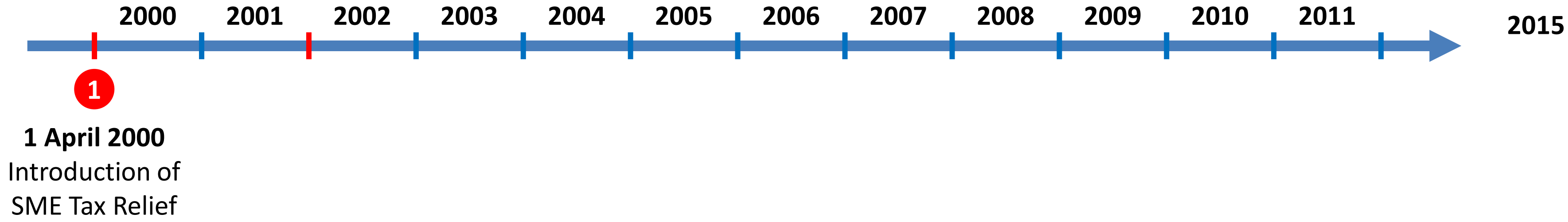
Do tax incentives for research increase firm innovation? An RD Design for R&D

Antoine Dechezleprêtre (OECD)
Elias Einiö (VATT)
Ralf Martin (Imperial College)
Kieu-Trang Nguyen (Northwestern)
John Van Reenen (LSE, MIT)

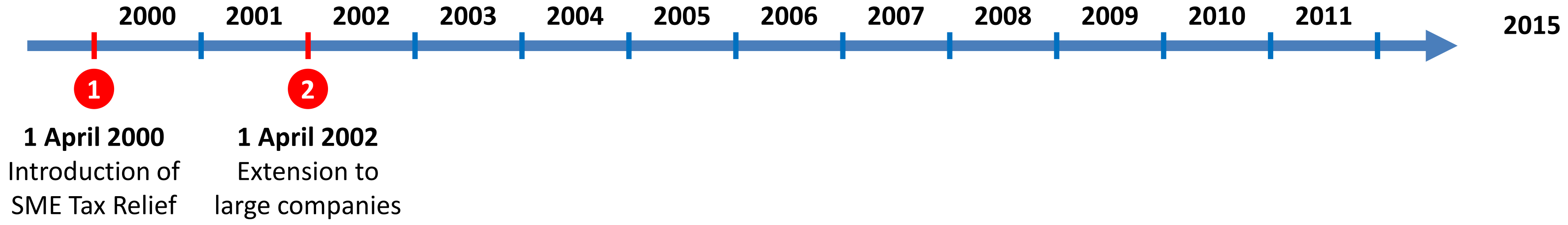
What does paper do?

- Use administrative tax data & firm accounts in UK to evaluate impact of R&D Tax Relief Scheme on:
  - Firm R&D
  - Firm patenting (& jobs, productivity, etc.). Important as innovation is what policy is trying to generate (not just more R&D inputs)
  - Effects on the subsidized firm itself **and** technology **spillovers** to other firms
- Exploit **discontinuity** in generosity of R&D tax relief at new (lower) asset eligibility thresholds for Small & Medium Enterprises (SME) in 2008.
  - SME eligibility determined by pre-2008 assets so can implement a **Regression Discontinuity Design** (RDD)
- **An RDD for R&D!**

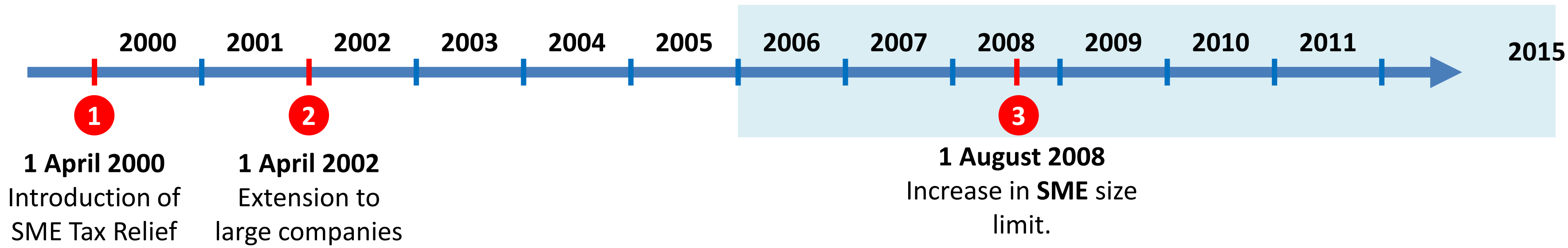
UK R&D Tax Relief Scheme – major changes



UK R&D Tax Relief Scheme – major changes



UK R&D Tax Relief Scheme – major changes



- In 2008, UK doubled size limits for SME eligibility, only for the R&D Tax Relief scheme (**no other policies at new thresholds**)
- Part of criteria to be small depended on assets/capital
  - **2007**: **Assets** ≤ €43m
  - **2008**: **Assets** ≤ €86m
- Must meet SME criteria for at 2 consecutive years to qualify, so Discontinuity uses 2007 data.

Data

- **IRS/HMRC Datalab CT600** panel of firm tax returns (including R&D expenditure) for all firms
- **BVD FAME/ORBIS**: Financial accounts of all incorporated UK firms - assets, industry, location, 3.1m firms between 2006-11
- **PATSTAT**: All patents applications to every patent office (EPO, USPTO, etc.) Use patent "family", but also consider quality weights (e.g. citations, grants, countries)

Regression Discontinuity Design

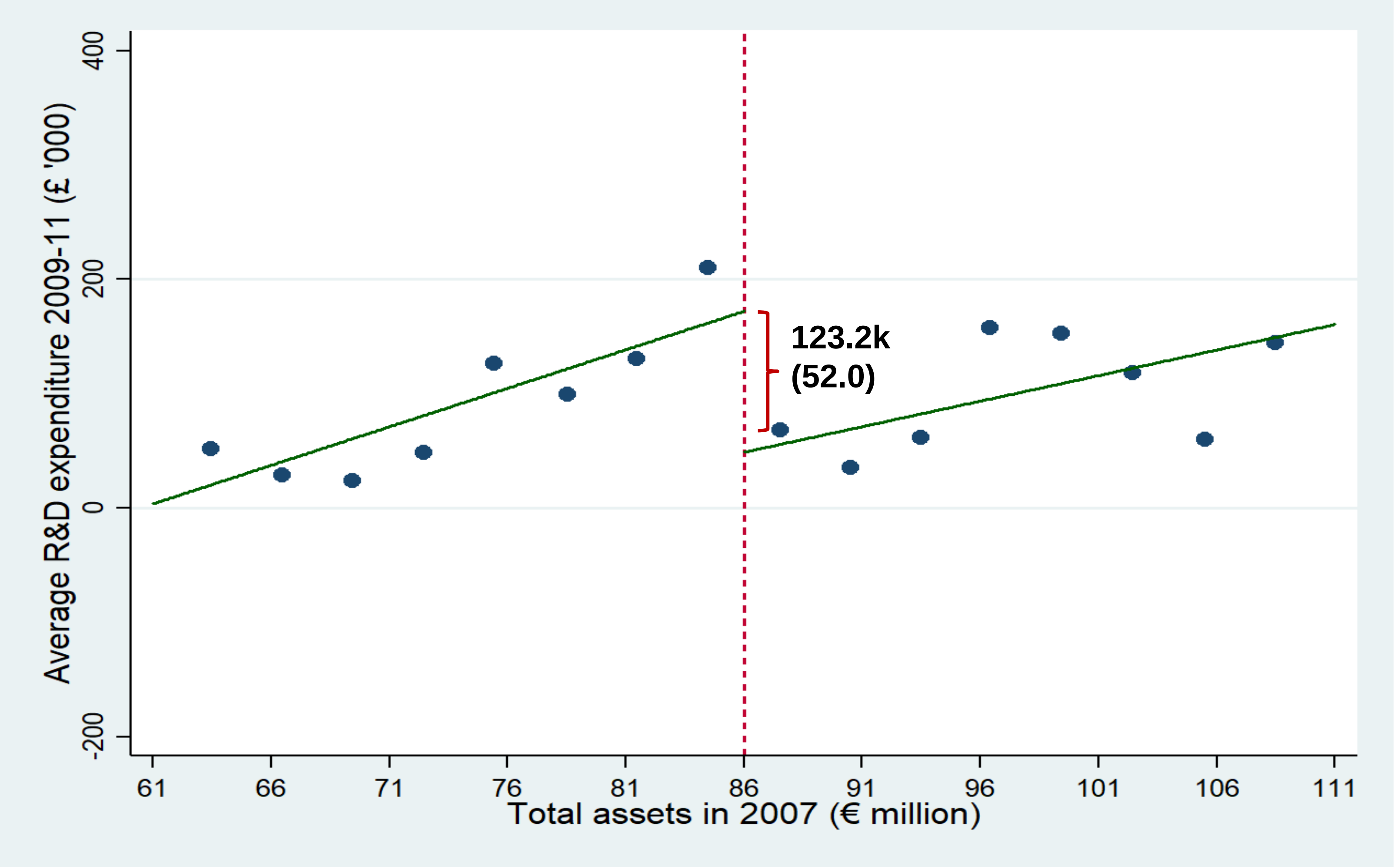
<u>Outcomes for firm *i* in year *t*</u>

$$Y_{i,t} = \alpha_{1,t} + \beta_t^R E_{i,2007} + f_{1,t}\left(z_{i,2007}\right) + \varepsilon_{1i,t}$$

- $Y_{i,t}$ outcomes are R&D spend, Patents, Productivity, etc. through 2015

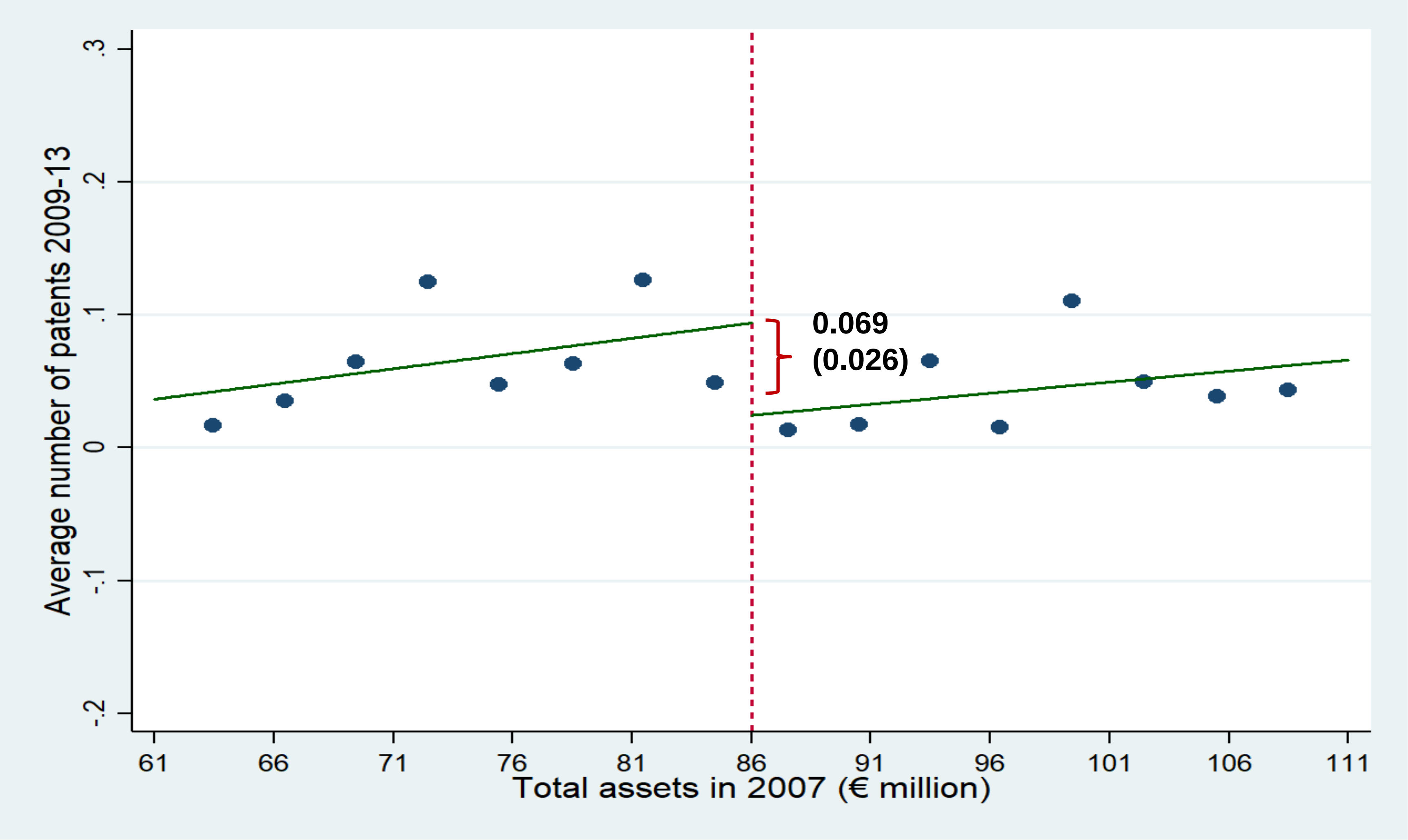
- $E_{i,2007} = I\left(z_{i,07} \leq \bar{z}\right)$: dummy = 1 if firm i's total assets (z) in 2007 is below €86m & zero otherwise
  - Total assets in 2007 as the running variable

Discontinuity in R&D



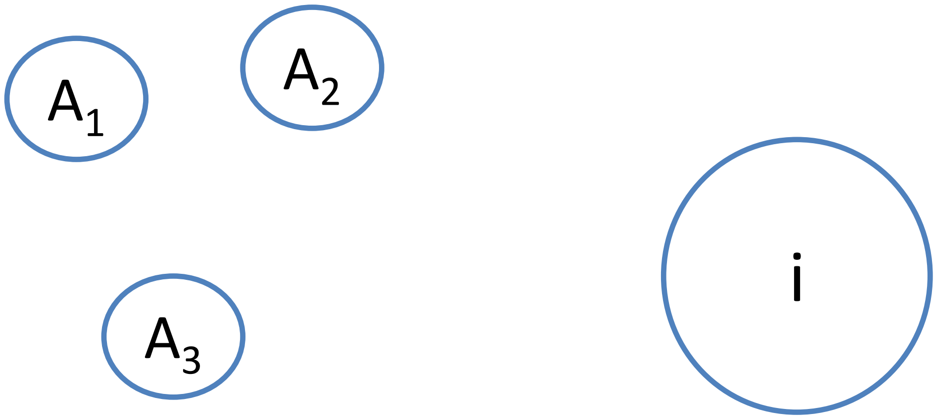
Notes: 5,888 obs. Assets from FAME based on SME threshold (€86m). R&D from CT600. Sample of firms with €25m above & below the threshold. 368 obs per €3m bin.

Discontinuity on patenting



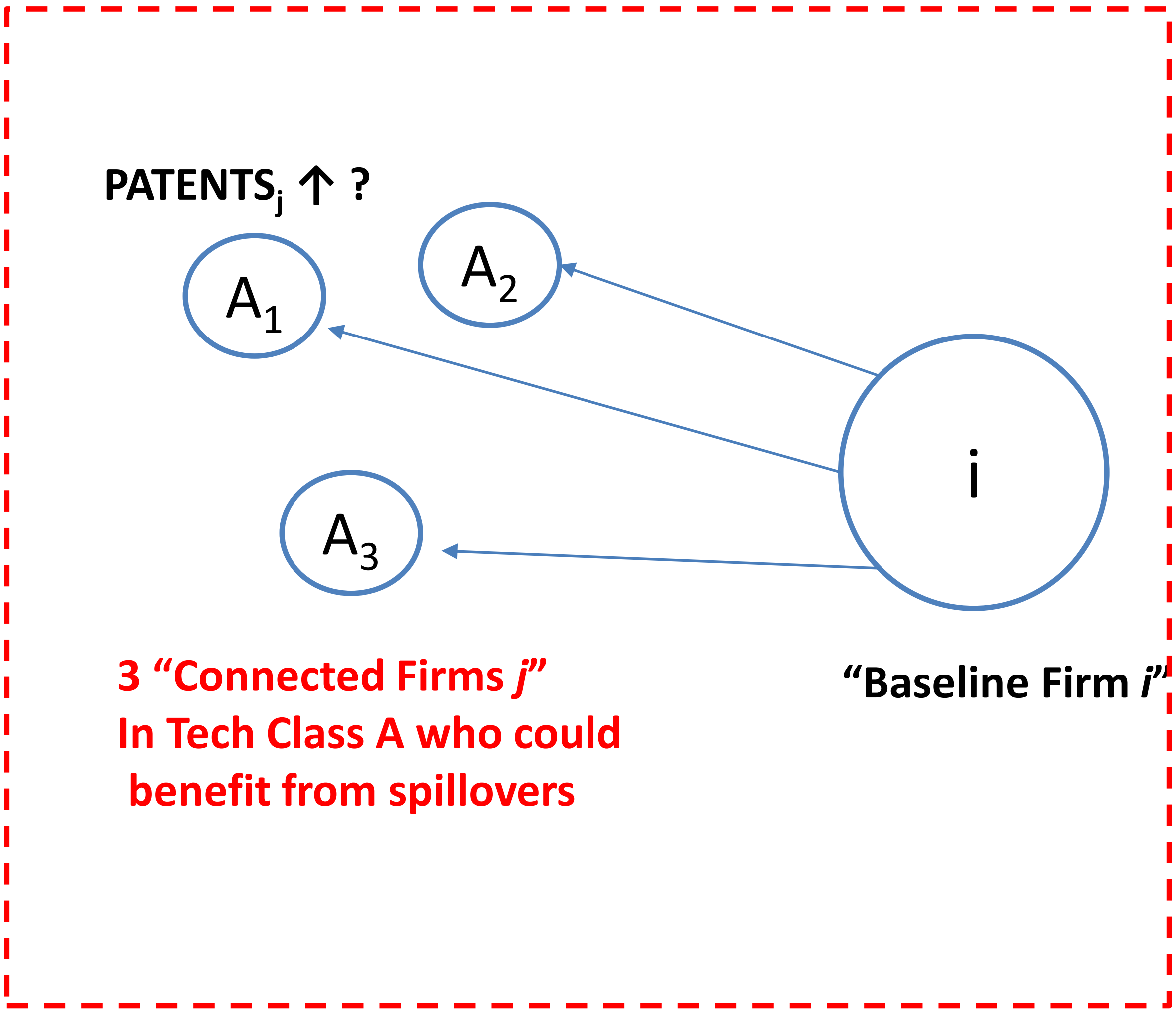
Notes: 5,888 observations. Assets from FAME based on SME assets threshold (€86m) definition. R&D is from CT600. Sample of firms with €25m above & below the threshold. Outcome is average number of patents filed between 2009 and 2013.

So far: R&D tax credit boosts R&D & patents in firm *i*



"Baseline Firm *i*"
(affected by R&D credit
$R\&D_i$ ↑; $PATENTS_i$ ↑)

Spillovers: R&D tax credit boosts R&D in firm *i*, which may also increase innovation in other firms



Technology Class A

Spillovers: Peer effect RD Design

- Consider dyad of 2 firms {*i,j*} If firm *i* is below new assets threshold, did innovation rise in "connected" firm *j*?
- Connection = Same 3 digit technology class (& above median Jaffe, 1986, distance metric). Use firm population for this.

$$PAT_{j,09-13} = \alpha_5 + \boxed{\theta E_{i,2007} + f_5(z_{i,2007})} + \mu E_{j,2007} + g_5(z_{j,2007}) + \varepsilon_{5ij}.$$

Spillover: Shifted exogenously by firm *i* being near threshold

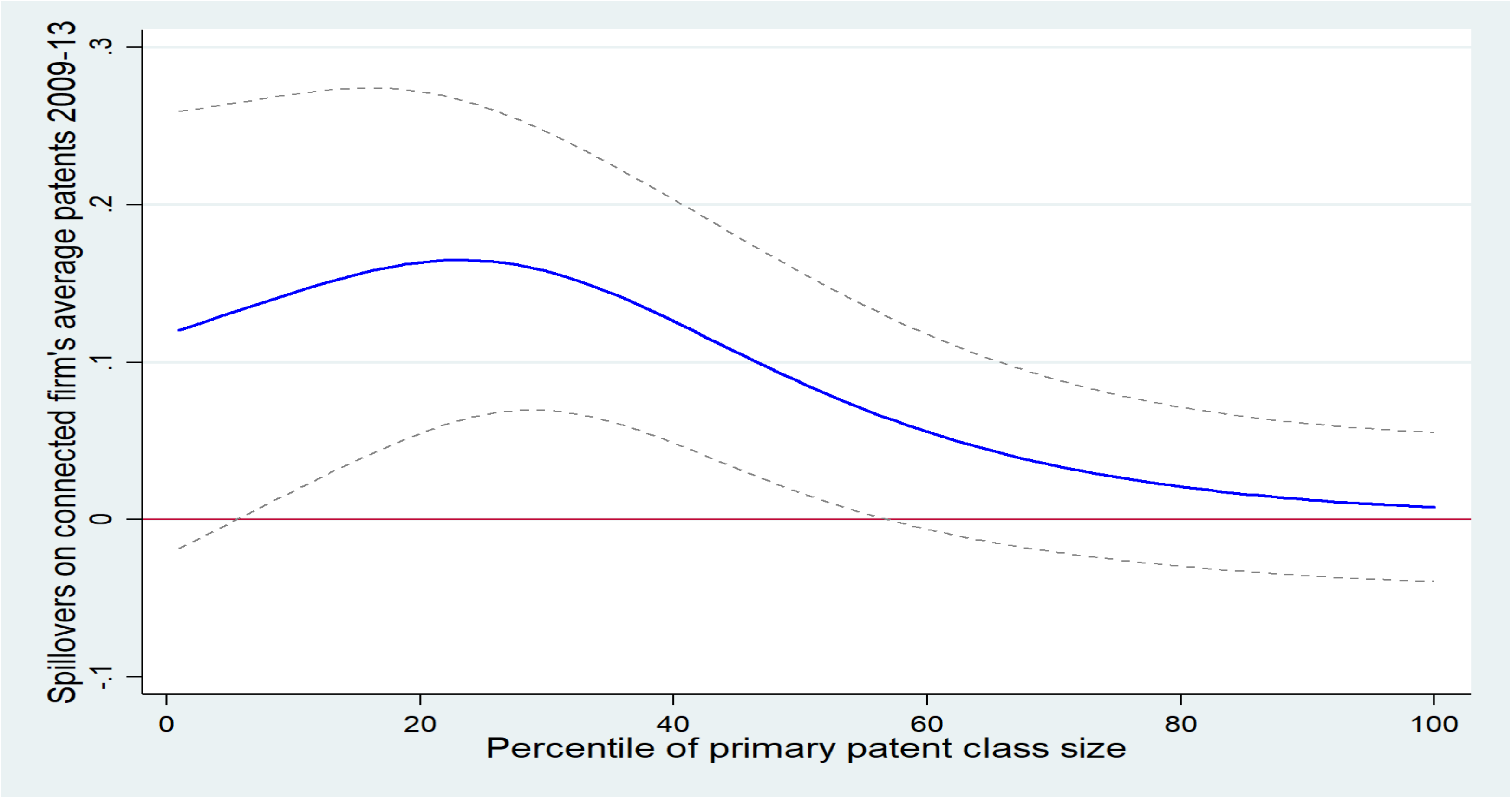
Own: If firm *j* is also near the threshold – very few

Issues with Spillover analysis

- If large numbers of peer firms, magnitude of coefficient likely to be smaller & hard to identify.
  - For example, firm *i*'s R&D less likely to be shifting the technology frontier if there are many firms in same class

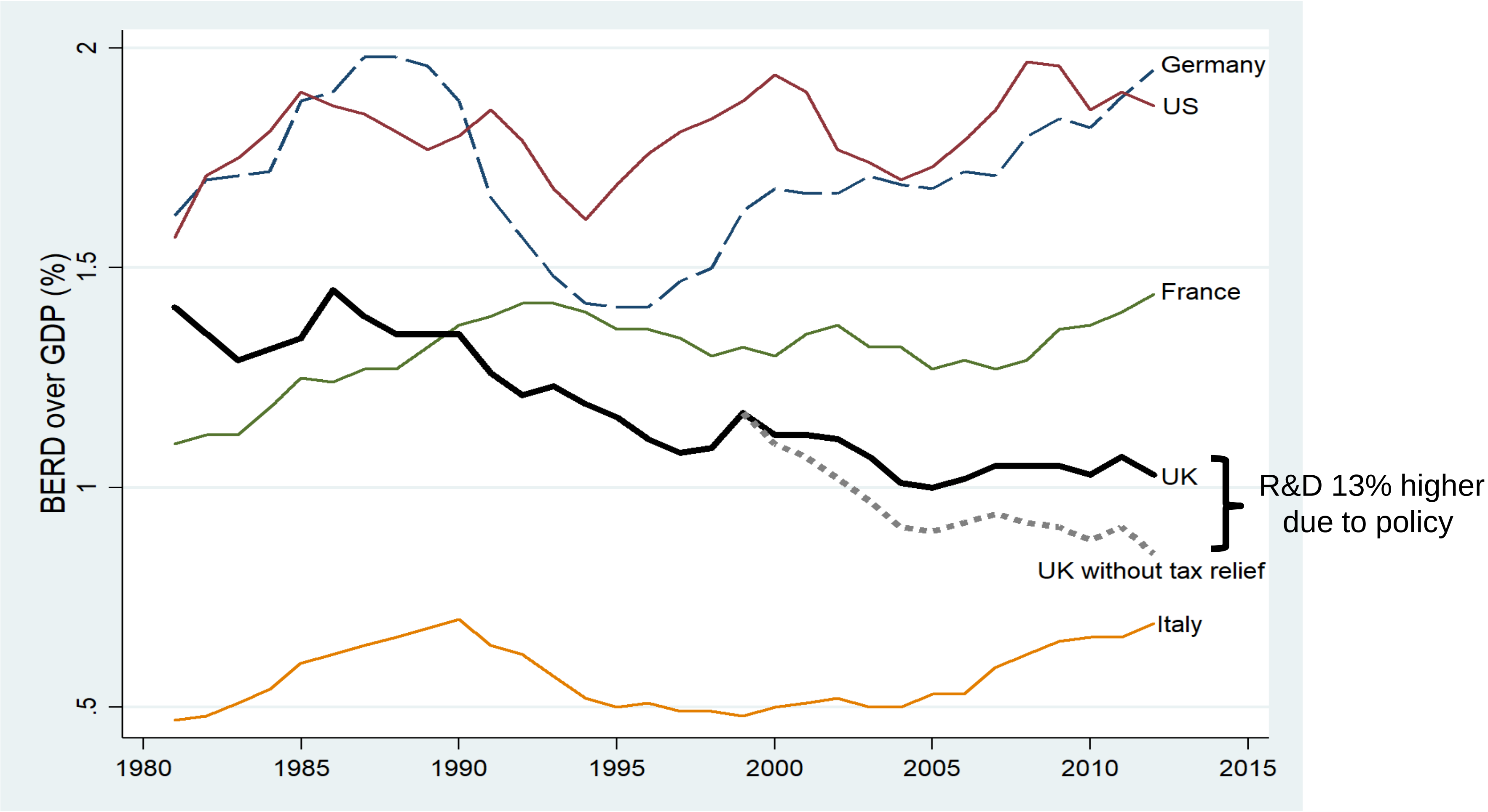
- So, allow spillover treatment effect θ to vary with number of neighbors (size of technology class)

Tax policy induces spillovers: patenting by technologically close firms (stronger in smaller technology classes)



Source: Dechezlepretre et al (2022); **Notes:** Semi-parametric estimates of spillover coefficient on technologically-connected firm's patents as a function of # peers in technology class (percentiles on X-axis). Uses Gaussian kernel function of the X-axis variable and a bandwidth of 20%. For example, there are 200 firms in 40th percentile technology class.

Simulation R&D/GDP would be 13% lower in absence of R&D tax policy



Source: Dechezleprêtre, Einiö, Martin, Nguyen and Van Reenen (2022). **Note:** The data is from OECD MSTI. The dotted line ("UK without tax relief") is the counterfactual R&D intensity in the UK that we estimate in the absence of the R&D Tax Relief Scheme.

Summary of Dechezleprêtre et al (2022) findings

- For firms around the threshold, policy approximately:
  - Doubled R&D 2009-11
  - Increase (quality adjusted) patents by 60% (by 2015)
- These larger effects than elsewhere in literature
  - likely because the treated firms are smaller than most of existing literature & more likely to be financially constrained (Arrow, 1962)
- RD Design shows positive **technology spillovers** (peer effects in small technology classes for close neighbors)
- **Issues**
  - LATE, so how to generalize?

Innovation Policy: The "Lightbulb" Table

(1) Policy	(2) Quality of evidence	(3) Conclusiveness of evidence	(4) Benefit - Cost	(5) Time frame:	(6) Effect on inequality
Direct R&D Grants	Medium	Medium	💡💡	Medium-Run	↑
R&D tax credits	High	High	💡💡💡	Short-Run	↑
Patent Box	Medium	Medium	Negative	n/a	↑
Skilled Immigration	High	High	💡💡💡	Short to Medium-Run	↓
Universities: incentives	Medium	Low	💡	Medium-Run	↑
Universities: STEM Supply	Medium	Medium	💡💡	Long-Run	↓
Exposure Policies	Medium	Low	💡💡	Long-run	↓
Trade and competition	High	Medium	💡💡	Medium-Run	↑

"Demand" (Direct R&D Grants, R&D tax credits, Patent Box)

"Supply" (Skilled Immigration, Universities: incentives, Universities: STEM Supply, Exposure Policies, Trade and competition)

Source: Bloom, Van Reenen and Williams (2019, JEP)

Patent Boxes

- Rather than subsidize R&D these grant tax relief on income from patents (& other IP)
- Patent boxes do not cover nonpatentable R&D and not in direct control of firm
- Intangible income can be shifted within multnationals
  - Shift innovation costs to high tax country (e.g. US) and take royalties in low tax country (e.g. Ireland)
  - Patent boxes lower tax burden on intangibles - an attempt to keep/attract tax revenue (e.g. Cyprus, Liechtenstein & Malta latest to introduce)
- Sometimes justified as a way of incentivizing R&D, but unlikely as location of R&D and patent income can be very different

Patent Boxes

- Hall (2022)
  - 22 countries have some kind of Patent Box
  - Almost all in Western Europe (plus Israel, India, Japan and Turkey)
  - Literature suggests location and transfer respond to lower taxes on patent income, but effect is modest
- Gaessler, Hall and Harhoff (2021) through 2016 (17 countries with patent box for at least 2 years)
  - Higher corp tax reduces amount of patents located in a country (like Akcigit et al, 2022 in US)
  - But no effect on patented invention or R&D
- Essentially a form of (harmful) tax competition rather than innovation policy

Summary on innovation-specific tax policies

- R&D tax credits
  - Surveys in Hall & Van Reenen (2000); OECD (2012); Hall (2022); Bloom, Van Reenen & Williams (2019)
  - Long-run (absolute) elasticity of greater than unity
  - Much smaller short-run elasticity
  - Probably best studied of all innovation policies and suggests that it is a successful policy
- Patent Box, by contrast, shows no effect on innovation, but some tax-shifting

Thanks!

Back Up

Policies towards diffusion

1. Adoption of specific technologies (e.g. Broadband)

2. Information provision (e.g. Small Business services)

3. Technology transfer (e.g. FDI support or export credits)

4. University-business linkages (Technology Licensing Offices, 1980 Bayh-Dole Act)

TABLE 4—ROBUSTNESS OF ESTIMATES TO UNRESTRICTED CURVATURE

Technology	Invention year ($\underline{v}_\tau$)	Percentage H_0 not rejected*	Correlation between Estimated adoption lags
Steam- and motorships	1788	65	.99
Railways - Passengers	1825	67	.89
Railways - Freight	1825	62	.97
Cars	1885	75	.82
Trucks	1885	81	.81
Aviation - Passengers	1903	66	.93
Aviation - Freight	1903	77	.83
Telegraph	1835	59	.95
Telephone	1876	80	.94
Cellphones	1973	67	.70
PCs	1973	59	.41
Internet users	1983	100	.59
MRIs	1977	92	.56
Blast Oxygen Steel	1950	72	.73
Electricity	1882	41	.91
Total		69	.80**

Note: All results are for plausible and precise estimates under restricted specification.
* At 5 percent significance level. ** Correlation is weighted average of correlations across technologies.

Source: Comin & Hobijn (2010, AER)

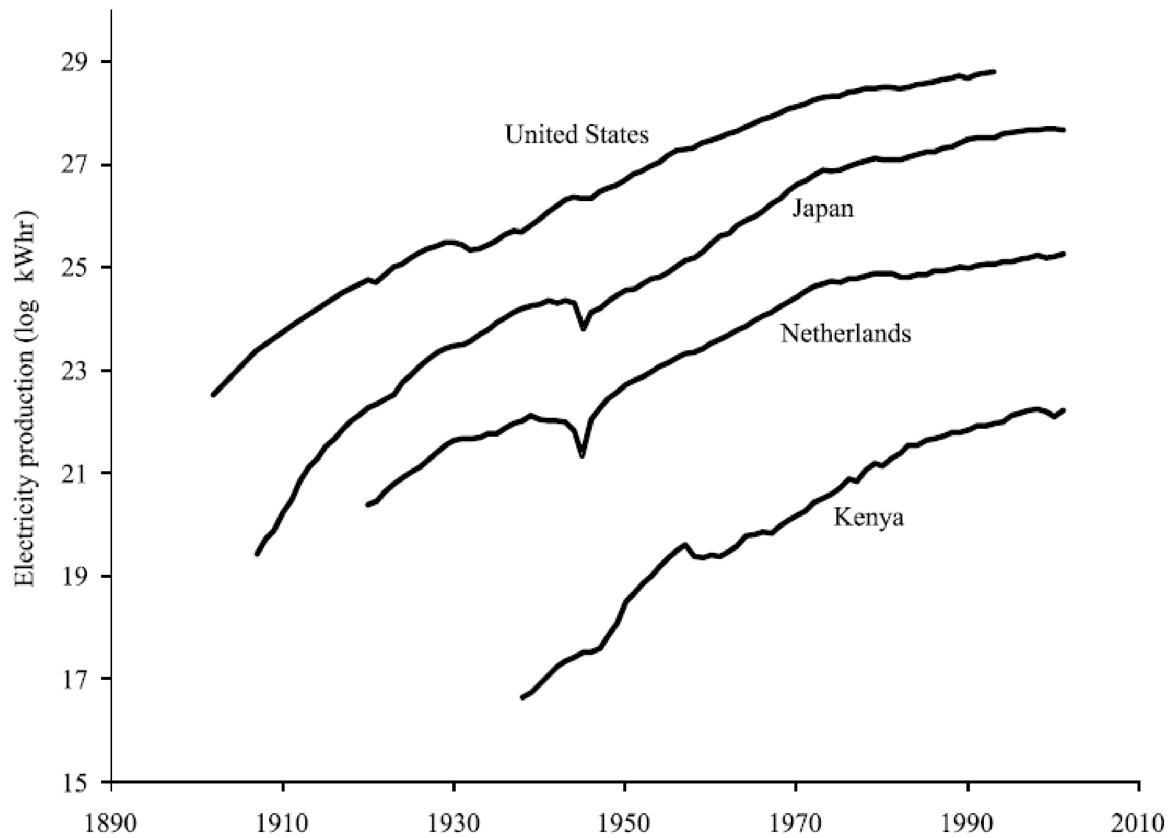


FIGURE 1. ELECTRICITY PRODUCTION IN FOUR COUNTRIES.

Source: Comin & Hobijn (2010, AER)

R&D Tax credits design issues

- Whole of tax system interacts
- "Qualified R&D" (scientific vs. marketing)
- Usually territorial – only if R&D performed in geographical area (e.g. within US)
- Sometimes restricted to certain classes of firms (e.g. SMEs, industries) or activities (labor, collaborative)
- Often capped at a maximum (e.g. France)
- Often targeted incremental R&D dollar
  - Seeks to reduce cost & give political cover
  - But creates many perverse incentives
- Creates complexity, but useful for identification because lots of cross firm heterogeneity!

What are the effects of R&D tax credits? Early studies

- Estimate the user cost over time and how it varies across firms (Eisner et al, 1982)
- Case studies and “industrial surveys” (e.g. Mansfield and Switzer, 1985. on Canada) An IQ test for firms?
- Estimate from R&D user cost without R&D tax credit data – variation from asset prices and depreciation (Bernstein and Nadiri, 1989)
  - Unclear where exogenous variation comes from to separate from general user cost of capital
  - And in absence of tax design unclear how to separate from time dummies
- All these methods up to mid 1990s suggested little effect of R&D tax incentives

What is the “base” of R&D Tax credits?

- **Volume** – simplest, but expensive for any given credit because of deadweight
- **Incremental** over a “base”
  - Previous year’s R&D spend (e.g. France)
  - “Rolling base” (US 1981, average of last 3 years R&D)
  - Builds in “ratchet”. Firms discouraged from increasing R&D this year as base will be higher next year
    - Reduces the headline generosity of the credit
    - Firms planning rapid growth deterred in order to take advantage of credit (Eisner et al, 1982,1984)
  - Fixed base: US after 1989 using historical average of R&D/sales ratio. But new firms? As time goes on, increasingly inappropriate

Simplified tax-adjusted user cost of R&D capital

$$\rho_{it}^{E} = Tax\ Price = \left(\frac{1 - D_{it}}{1 - \tau_{it}}\right)$$

- $D_{it} = \tau_{it} *$(NPV of allowance claims)*(%deductables) + credit

Effects of tax price on R&D: cross country panel

Table 1
Main results[a]

Dependent variable		(1) r_t OLS	(2) r_t IV	(3) r_t IV	(4) $r_t - y_t$ IV	(5) $r_t - y_t$ IV
Lagged ln (R&D)	r_{t-1}	–	–	0.868	–	–
				0.043		
Lagged ln (R&D/Y_t)	$r_{t-1} - y_{t-1}$	–	–	–	0.859	0.850
					0.047	*0.045*
ln (user cost)	ρ_t	−0.354	−0.499	−0.144	−0.124	−0.143
		0.101	*0.115*	*0.054*	*0.060*	*0.059*
ln (output)	y_t	1.184	1.364	0.143	–	–
		0.224	*0.319*	*0.163*		
Long run elasticity — user cost				−1.088	−0.878	−0.957
(*P*-value)				*0.024*	*0.056*	*0.027*
Wald test (*P*-value)		–	0.000	0.813	0.368	–
Durbin–Watson statistic		0.374	0.428	1.842	1.768	1.753
Country dums		Yes	Yes	Yes	Yes	Yes
Year dums		Yes	Yes	Yes	Yes	Yes
Observations		165	156	155	155	164

Source: Bloom, Griffith & Van Reenen (2002)

Main BGVR Specification

$$\ln R_{it} = \alpha \ln R_{it-1} + \beta_1 \ln \rho_{it} + \gamma \ln GDP_{it} + \eta_i + \tau_t + e_{it}$$

$$\rho_{it} = \left(\frac{1 - D_{it}}{1 - \tau_{it}} \right) \left(i_{it} + \delta - \frac{\Delta p_{it}}{p_{it-1}} \right)$$

i = country, t= year

R&D spillovers

- R&D augmented production function:

$$q_{it} = a_0 + \alpha_L l_{it} + \alpha_K k_{it} + \alpha_G g_{it} + \mu SPILLTECH$$

- SPILLTECH = technology spillovers (weighted sum of R&D stocks of other firms)

- At macro level regression of TFP growth on R&D reflects both private return & spillovers ($\alpha + \mu$). We expect to be larger than micro level (& in principle a comparison reveals private vs social returns to R&D)

- How to measure spillovers?

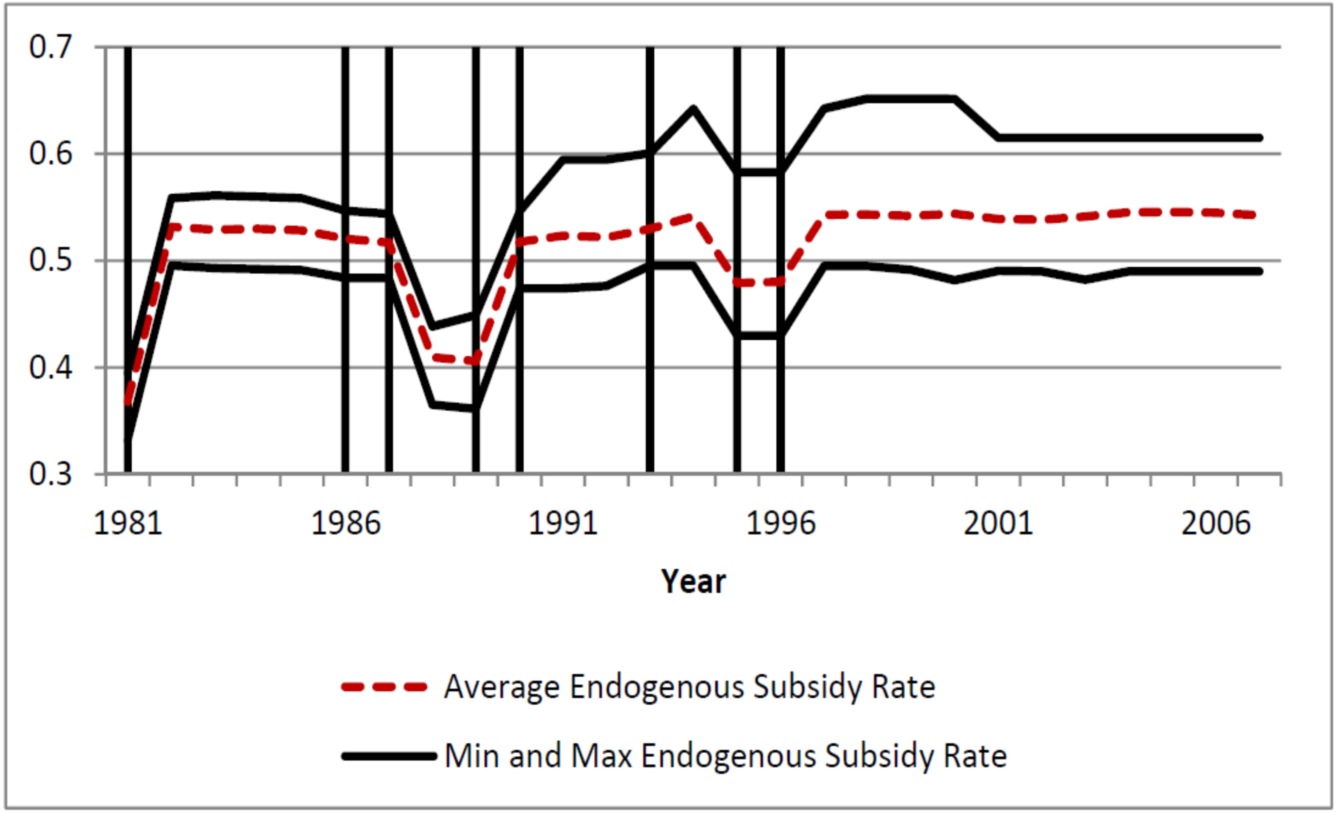
Problem of R&D policy endogeneity

- All papers using policy experiments face issue that policy introduction may be in response to shocks affecting R&D
- Similar issue to assessing impact of fiscal policy as stimulus programmes are introduced when government expects a downturn (Romer & Romer; Ramey, etc.)
- Little work on this
  - BGVR/BSVR: tax credits can't be Granger predicted by shocks
  - Chang (2013) uses "exogenous" element of state tax credit caused by Federal changes to R&D code.
    - E.g. 1989 change to fixed base was followed (with lag) by other states & this was heterogeneous across states
    - Finds <u>larger</u> effects of R&D tax credits because states cut in "bad times"

Endogeneity of firms R&D user cost

- In panel, lagged values of dependent or independent variable may be "weakly exogenous", i.e. do not immediately respond to shocks
  - Hence can be used to construct instruments
- Synthetic instruments idea (e.g. Gruber & Saez, 2002)
  - Use changes of tax rules interacted with lagged values
  - Applied to firm-level R&D tax credits case by Rao (2013). Rao uses IRS tax data on qualified R&D 1981-1991 constructs IV from lagged R&D values & changes in tax rules
    - Elasticity between -1 and -2

Cross State Heterogeneity of the R&D tax credit

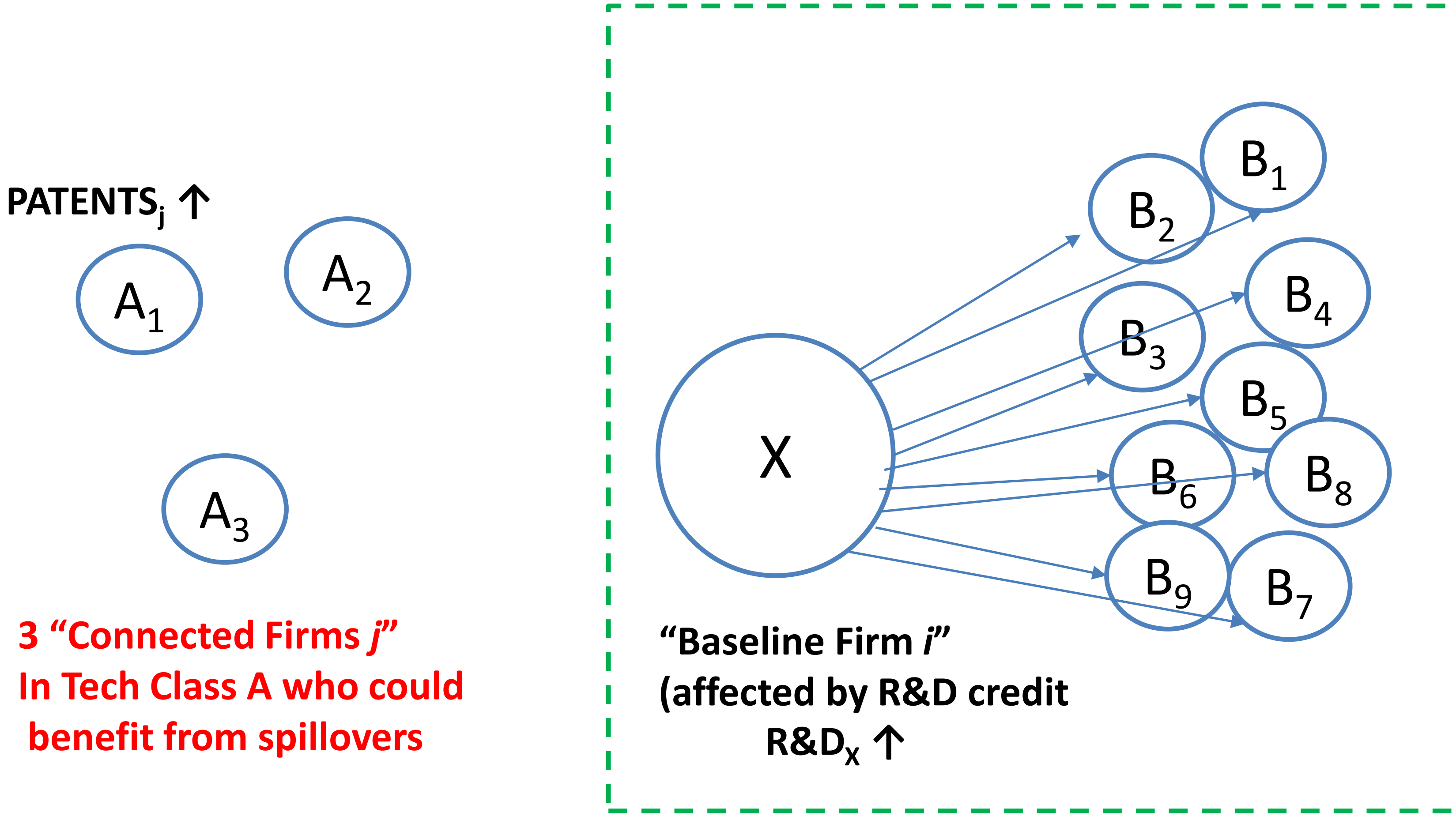


Source: Chang (2013)

R&D Tax Relief Scheme

- Current R&D always deducted as expense (rather than capitalized as intangible asset)
- Under post-2000 scheme taxable profits can be further reduced by a proportion of a firm's R&D
- Includes SME & Large Company component
  - Eligible firms get enhanced deduction
  - Enhancement of extra 75% of R&D for SMEs vs. 30% for large companies
  - SMEs also get **payable tax credits** (effectively direct government cash via reduced payroll tax) when insufficient corporate income tax liability

Spillovers: Firm X also in tech class B, but large number of peers in this space



9 Connected Firms *j* in Tech Class B. <u>Less</u> likely to identify an effect