INNOVATION AND TAXATION

DIETMAR HARHOFF

MAX PLANCK INSTITUTE FOR INNOVATION AND COMPETITION

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Agenda

- R&D and Innovation
- A Brief History of R&D and Innovation (and Public Policy)
- Some Comparisons – What do Countries do?
- Innovation and Taxation
  - R&D Tax Relief
  - Patent Boxes
- Summary and Conclusions

R&D and Innovation

Definition of Research and Experimental Development (R&D) and R&D Expenditures

- Frascati Manual (1st edition in 1963; now in its 7th edition: 2015)
- Definition of R&D in the Frascati Manual: Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.
- The term R&D covers three activities: basic research, applied research and experimental development.
- Many exclusions (see section 2.8)
- … and many controversies around them.
- The Frascati Manual has been an important guide for agencies, ministries and tax authorities.

http://www.oecd.org/sti/inno/frascati-manual.htm

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R&D and Innovation

Definition of Innovation and Innovation Expenditures (R&D)

- Oslo Manual (now in its 3rd edition: 2005)
- Increasing awareness in 1980s/90s – R&D is central to innovation, but not the whole picture
- Definition of innovation according to Oslo Manual: An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.
- Innovation activities are all scientific, technological, organizational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations.
- Revision of Oslo Manual in process right now.

http://www.oecd.org/sti/inno/oslomanualguidelinesforcollectingandinterpretinginnovationdata3rdedition.htm

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A Brief History of R&D and Innovation (and Public Policy)

Before 19th century: All elements of modern policies emerge and are tried out unsystematically (patents, tournaments, cluster policies, ...)

19th century: Emergence of R&D labs

Early 20th century: Industry model of innovation being perfected

1950s-1980s:

- science policy (Vanevar Bush)
- technology policy (e.g. nuclear technology, space)
- subsidies for large-scale projects
- market failure approach
- measurement of R&D (Frascati Manual)

A Brief History of R&D and Innovation (and Public Policy)

1970s: evolution of tax instruments (USA)

1980s: expansion of terminology – from R&D to innovation (Oslo Manual)

1990s: cluster policies

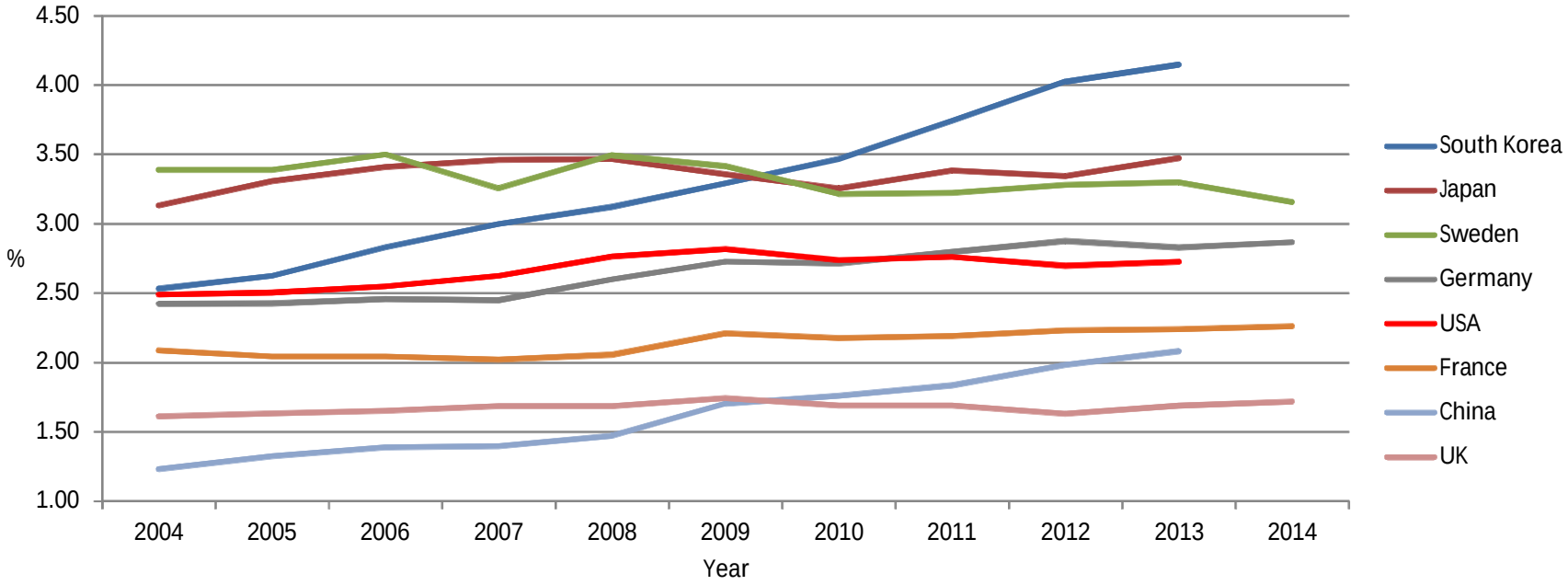
2000s: direction of technical change, “grand challenges” as an organizing principle

Recent:

- participatory frameworks (citizen involvement, citizen science)
- social innovation
- “broadcast search” and “open innovation”

Some Comparisons – What do Countries do?

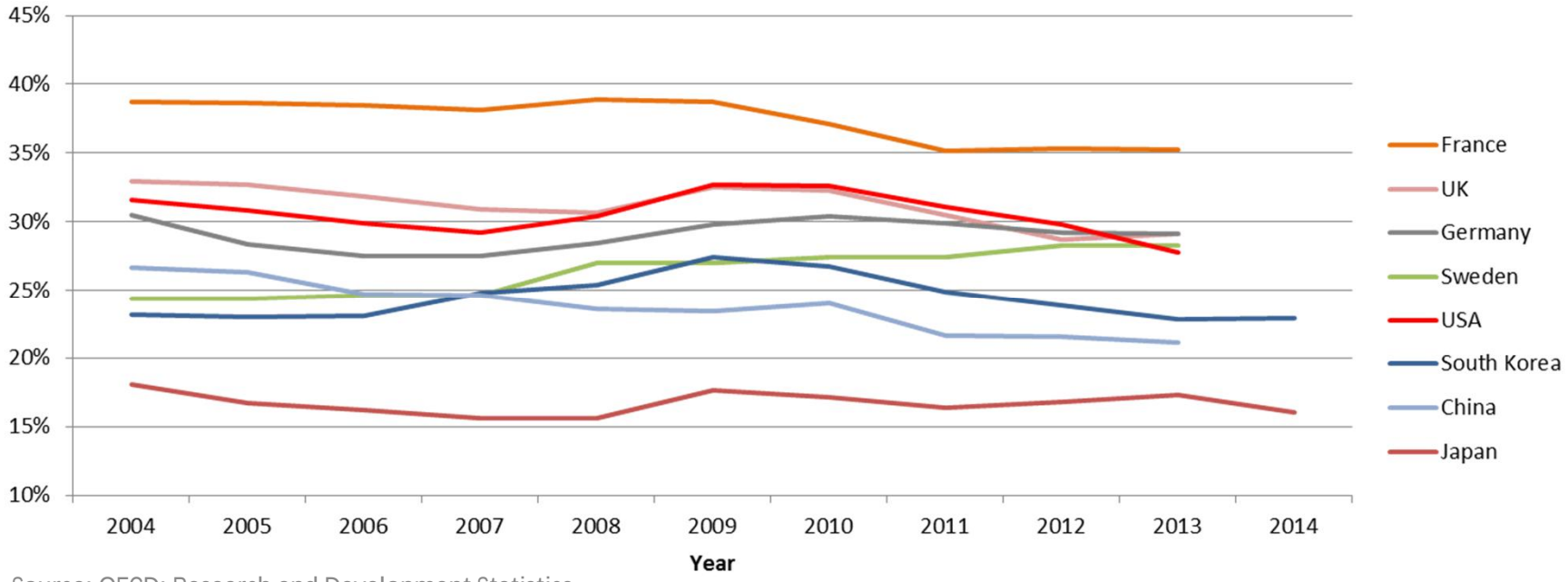
R&D Intensity (Percentage of an Economy's GDP spent on R&D) in Selected Countries



Source: OECD, EUROSTAT. Calculations and estimates by NIW in Schasse et al. (2016).

Some Comparisons – What do Countries do?

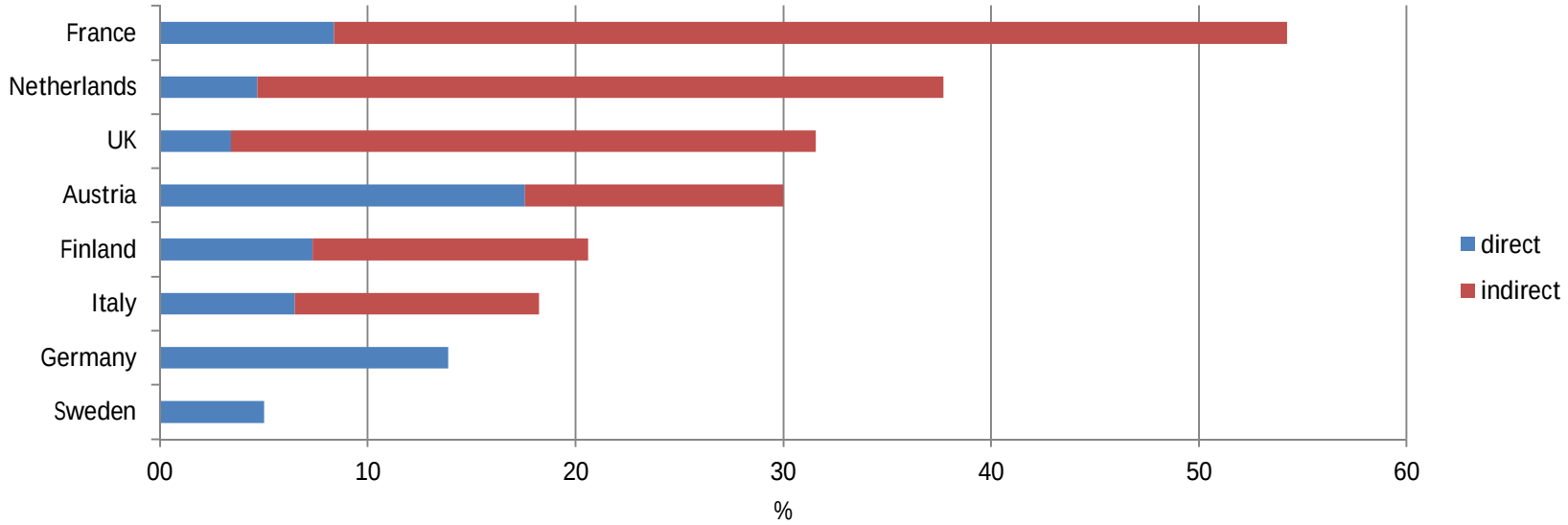
Share of Public Funding in Total R&D Funding



Source: OECD: Research and Development Statistics

Some Comparisons – What do Countries do?

Direct and Indirect Public Financing of R&D in SMEs as a Percentage of Total R&D Expenditure by SMEs

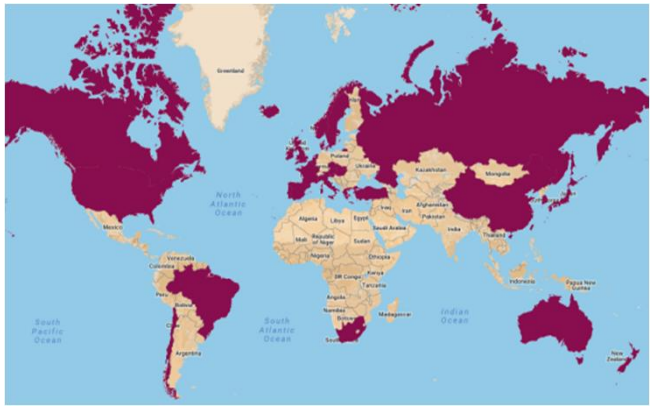


Source: OECD: Research and Development Statistics, Main Science and Technology Indicators. Calculations by ZEW in Rammer et al. (2016).

Innovation and Taxation – R&D Tax Relief

R&D Tax Relief (Indirect R&D Support)

- Initiated in several countries in the 1970s and 1980s
  - first in Australia, Canada, USA
  - spreading quickly to other countries: now, e.g., in 28 of 35 OECD countries
- Various forms, including R&D tax credits, R&D tax allowances, SSC exemptions, payroll withholding tax credits
- Political objectives in most countries:
  - supporting SMEs facing financing constraints
  - impacting R&D location decisions, attracting R&D-intensive firms
- Usually competing with subsidy schemes requiring applications for grants – presumed advantage: non-directional, low cost of utilization for firms
- Many assessments – one of the largest literatures on government instruments – two "exemplary" studies: Dechezlepretre et al. (2016) and Simcoe (2015)



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Innovation and Taxation – R&D Tax Relief

Dechezlepretre et al. (2016)

- Study exploits changes in R&D tax credit design in a regression discontinuity study
- Statistically and economically significant effects on R&D and patenting
- R&D tax price elasticities at about -2.6 (high in comparison to other studies)
- Authors' interpretation: treated group is from a sub-population of smaller firms and subject to financial constraints
- Overall impact: over the 2006-11 period aggregate business R&D would be around 10% lower in the absence of the tax relief scheme
- Evidence for positive spillovers from treated firms on the innovations of technologically related firms

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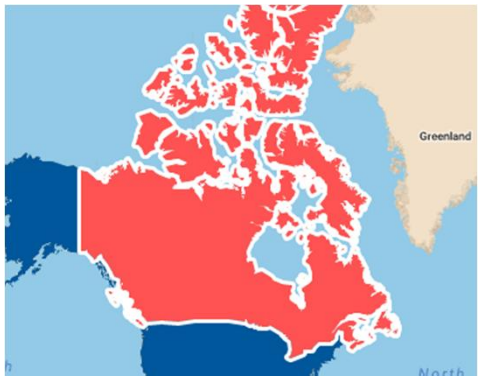
Innovation and Taxation – R&D Tax Relief

Agrawal, Rosell and Simcoe (2015)

- Exploiting a change in eligibility rules for the Canadian Scientific Research and Experimental Development (SRED) tax credit
- Following a 2004 program change, privately owned firms eligible for a 35 percent tax credit (up from a 20 percent rate) on a greater amount of qualifying R&D expenditures increased their R&D spending by an average of 15 percent.
- Estimated after-tax cost elasticity of R&D about -1.5
- Response to changes in the after-tax cost of R&D is larger for contract R&D expenditures than for the R&D wage bill and is larger for firms that (a) perform contract R&D services or (b) recently made R&D-related capital investments.
- Seen as evidence that small firms face fixed adjustment costs that lower their responsiveness to a change in the after-tax cost of R&D.



Innovation and Taxation – Patent Boxes

Patent Boxes

- Tax policy that provides a lower tax rate on income related to intellectual property (various definitions)
- Initiated in several European countries, starting in early 1970s and again after 2005
- Discussion in the USA: draft for “innovation box“ by Reprs. Charles Boustany (R-LA) and Richard Neal (D-MA)
- Skepticism from OECD (Pascal Saint-Amans): “a policy that may not be smart“ – focal theme in BEPS discussions
- Skepticism from CEA (Jason Furman): R&D tax credit preferred over a patent box
- What do patent boxes do?

Belgium	Malta
Cyprus	Netherlands
France	Portugal
Hungary	Spain
Ireland	Switzerland
Liechtenstein	UK
Luxembourg	

Innovation and Taxation – Patent Boxes

Patent Boxes – Recent studies

- What has been done to study them?
- Most studies on applications, one prior study on transfers, none on priority filings

Authors	Year	Version	Level of observation	Dependent variable
Alstadsaeter et al.	2015	Working paper	Patent	Number of EP patent filings by applicant country
Boehm et al.	2015	Working paper	Patent	EP applicant/inventor country divergence
Bösenberg & Egger	2015	Working paper	Country	Number of EP applications and pre-grant transfers by applicant country
Dudar et al.	2015	Working paper	Country	Size of royalty streams
Griffith et al.	2014	JPubE	Patent	EP applications by applicant country
Karkinsky & Riedel	2012	JIntE	MNC	EP applications by applicant country
Koethenbuerger et al.	2016	Working paper	MNC	Stated profit before tax by subsidiary

Patent Transfers – Transfer Example

Internationaal Octrooibureau B.V. - P.O. Box 220 - 5600 AE Eindhoven - The Netherlands

European Patent Office
Erhardtstrasse 27
80331 MÜNCHEN
Germany

onderw. re. conc. betr.	doorkiesnummer accès intern dir.	in-dialling Durchwahl	datum, date
PHA 23486 EP EE.	+31 40 27 43505		2003-01-10

REQUEST FOR REGISTRATION OF A TRANSFER (Rule 20(1), EPC)

Re: European Patent Application No. 99202415.8
Applicant: Koninklijke Philips Electronics N.V.
Assignment to BROADBAND ROYALTY CORPORATION

I, the undersigned, hereby request the registration of the transfer of the above-identified European Patent Application to BROADBAND ROYALTY CORPORATION on the basis of the enclosed instrument of assignment.

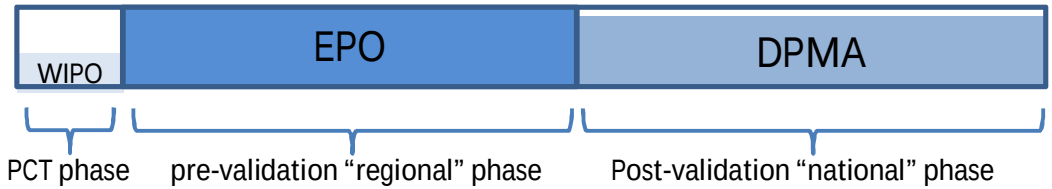
The Professional Representative

J.L. van der Veer

Patent Transfers – Scope of Data

Dataset Covers Transfers of European Bundle Patents (EP) 1981-2014

- Patents with „change in ownership information“ in (WIPO), DPMA and EPO data
- Identification of 800 000+ patents with change in ownership information concerning person, name, and/or address.
- Sector allocation: corporations, natural persons, universities, non-profit, etc.
- Distinction between market, M&A and intra-group patent transfers
- About 130 000 EP patents subject to cross-country transfer



Notes: DPMA: German Patent an Trademark Office. EPO: European Patent Office. WIPO: International Bureau of the World Intellectual Property Organization. Only a subset of EP patents experiences a prior PCT phase and not all EP patents are validated in Germany

Innovation and Taxation – Patent Boxes

Effects of Patent Boxes

- The implementation of patent box regimes will allow firms to optimize tax debt by shifting patents into low-tariff harbors.
- Some results from joint work (Fabian Gaessler, Bronwyn H. Hall, Dietmar Harhoff)
- Systematic analysis of tax-induced
  - international patent transfers
  - patterns of inventor, priority, and applicant country
- Probability models at patent and country level
  - Tax differences affect flows of international patent transfers.
  - Valuable patents are more likely to be transferred to low tax countries.
  - Mixed results concerning priority and applicant country patterns.

Innovation and Taxation – Patent Boxes

Patent Transfer Flows – Europe (2000-2014)

Code	Country	Year patent box introduced	Patents transferred out	Patents transferred in	Difference in patents transfers
AT	Austria		1313	1041	-272
BE	Belgium	2007	1073	1540	467
CH	Switzerland	2011	6049	9354	3305
CY	Cyprus	2012	158	219	61
DE	Germany		12266	9449	-2817
DK	Denmark		1078	861	-217
ES	Spain	2008	398	322	-76
FI	Finland		1611	1838	227
FR	France	1971	4730	4282	-447
GB	UK	2013	8949	4084	-4865
HU	Hungary	2003	127	241	115
IE	Ireland	1973	473	1906	1433
IS	Iceland		28	90	62
IT	Italy		1784	1316	-469
LI	Liechtenstein	2011	306	271	-35
LU	Luxembourg	2008	724	2607	1883
MT	Malta	2010	36	77	42
NL	Netherlands	2007	6068	8023	1955
NO	Norway		452	503	51
PT	Portugal	2014	105	165	60
SE	Sweden		2672	3514	841

- generally positive balance for countries with patent boxes
- exceptions: France, UK

Innovation and Taxation – Patent Boxes

Patent Transfer in and out Flows – Rest of the World and Tax Havens (2000-2014)

Code	Country	Tax haven	Patents transferred out	Patents transferred in	Difference in patents transfers
AU	Australia		1088	503	-586
BB	Barbados	yes	569	1710	1141
BM	Bermuda	yes	205	809	604
BS	Bahamas	yes	44	129	85
CA	Canada		3214	1846	-1368
CW	Curacao	yes	478	527	49
GG	Guernsey	yes	211	269	58
GI	Gibraltar	yes	28	86	58
HK	Hong Kong	yes	145	611	467
IL	Israel		872	643	-228
IM	Isle of Man	yes	105	141	36
JE	Jersey	yes	67	132	66
JP	Japan		4205	2579	-1627
KR	South Korea		528	809	281
KY	Cayman Islands	yes	500	1507	1007
MC	Monaco	yes	70	38	-33
MX	Mexico		62	176	115
NZ	New Zealand		161	78	-83
SG	Singapore	yes	236	1354	1118
US	US		23520	20293	-3227

- generally negative balance for large countries (US, JP, CA, AU)
- generally positive balance for tax havens

Innovation and Taxation – Patent Boxes

Incidence of International Transfer of Patent

Dependent variable: International transfer of patent				
Variable	All	To low tax countries	To low tax countries and intra-group	To low tax countries, from high tax countries, and intra-group
Patent family size (DOCDB)	0.027	0.051*	0.076**	0.072**
	0.025	0.027	0.031	0.031
Number of claims	0.035**	0.006	0.003	0.001
	0.016	0.024	0.028	0.028
Number of forward citations (5yrs)	-0.005	-0.006	-0.000	0.000
	0.007	0.009	0.011	0.011
Multinational research activity	0.027	0.111***	0.305***	0.303***
	0.037	0.047	0.060	0.062
Year effects	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes
Technology effects (34 areas)	Yes	Yes	Yes	Yes
Observations	808,077	808,077	808,077	808,077
Pseudo R2	0.083	0.097	0.114	0.112

Probit regression. Only first international transfer by patent during first 10 years after filing included. Low tax = patent box and tax haven countries; high tax: all other countries.
Sample includes all granted EP patents with filing date between 1990 and 2010.
Standard errors are clustered by patent holder. * p<0.1, ** p<0.05, *** p<0.01.

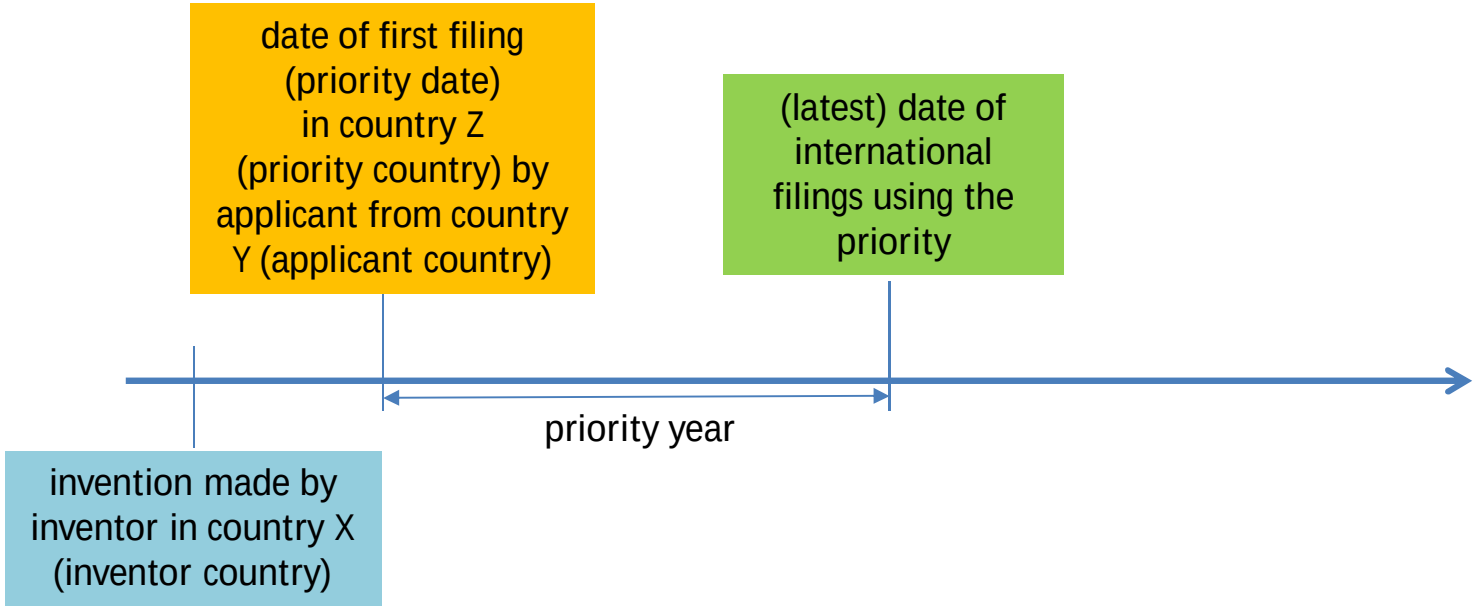
Innovation and Taxation – Patent Boxes

"Seller to Buyer" Patent Transfer Flows

Dependent variable: Number of patents transferred from seller country to buyer country during the year				
Variable	All	Intra-group	All	Intra-group
Buyer corp tax rate	-0.068	-0.604		
	0.489	0.654		
D (buyer patent box)	0.079*	0.021		
	0.046	0.061		
Difference: seller-buyer corp tax			0.803**	1.345***
			0.335	0.443
Difference: buyer-seller patent tax wedge			0.314*	0.442*
			0.176	0.235
Seller corp tax rate	1.452***	1.994***		
	0.483	0.653		
D (Seller patent box)	-0.072	-0.169***		
	0.048	0.065		
Observations	19,980	19,980	19,980	19,980
Country pairs	1,332	1,332	1,332	1,332
Chi-squared	2890.8	2083.8	2878.5	2068.5
Degrees of freedom	93	93	91	91
Negative binomial panel regression.				
All regressions include complete sets of dummies for the 37 buyer and seller countries, and years 2000-2014.				
Standard errors are clustered on buyer-seller country pairs. * p<0.1, ** p<0.05, *** p<0.01.				

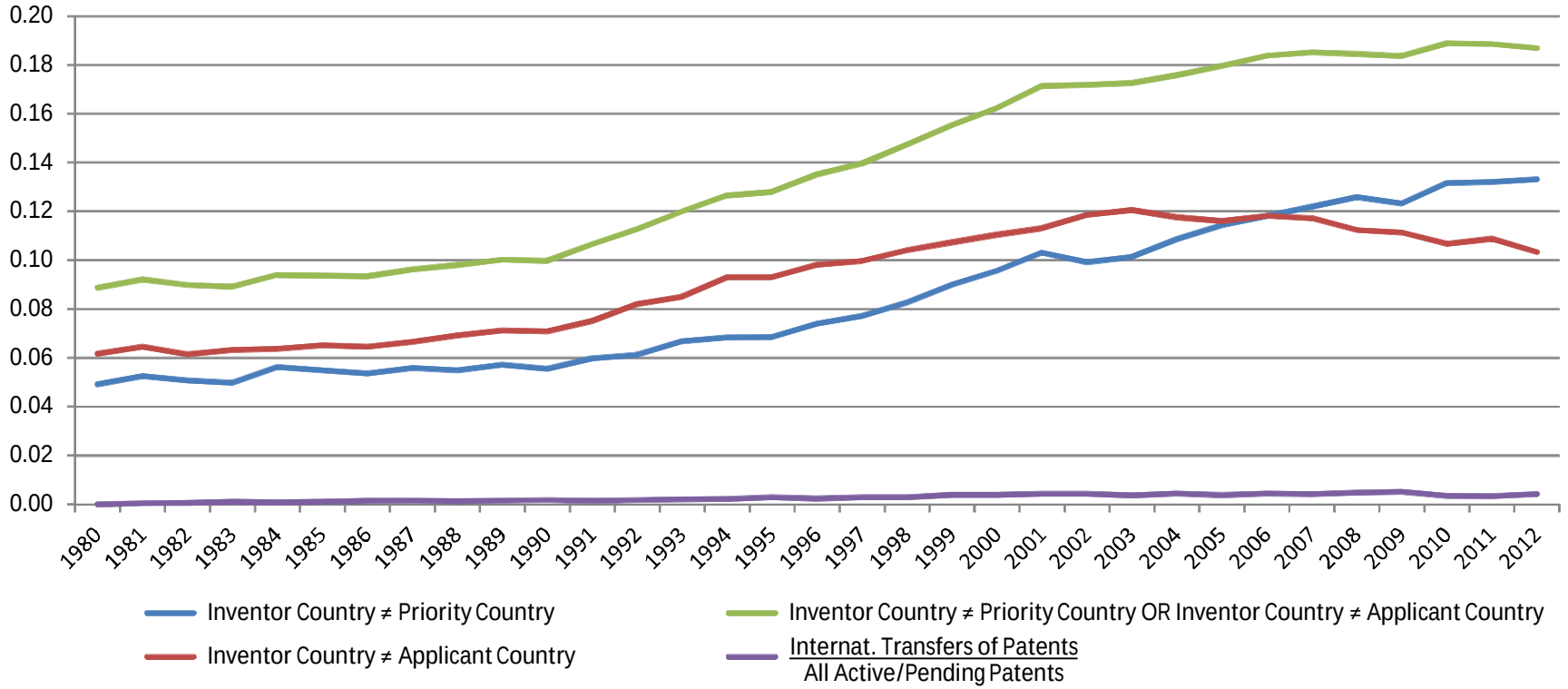
Innovation and Taxation – Patent Boxes

A Different Variable: Inventor/Applicant Country – Priority Country Pairs



Innovation and Taxation – Patent Boxes

Time Trend: Transfers and Filing Pattern



Innovation and Taxation – Patent Boxes

Inventor Country to Priority / Applicant Country Patent Flows

Dependent variable: Number of patents with inventor country different from priority filing / applicant country ("destination")				
Variable	Priority country	Applicant country	Priority country	Applicant country
Destination corp tax rate	-1.822***	-1.118***		
	0.354	0.390		
D (destination patent box)	0.132*	0.018		
	0.068	0.079		
Difference: inventor-destination corp tax			-1.282***	0.530**
			0.224	0.235
Difference: destination-inventor patent tax wedge			0.558***	0.128
			0.157	0.168
Inventor corp tax rate	-0.788**	0.066		
	0.335	0.340		
D (Inventor patent box)	-0.085**	-0.001		
	0.034	0.038		
Observations	19,440	19,440	19,440	19,440
Country pairs	1,296	1,296	1,296	1,296
Chi-squared	4199.8	4584.3	4174.8	4603.6
Degrees of freedom	97	97	95	95
Negative binomial panel regression.				
All regressions include annual GDP, and complete sets of dummies for the 37 inventor and destination countries, and years 2000-2013.				
Standard errors are clustered on buyer-seller country pairs. * p<0.1, ** p<0.05, *** p<0.01.				

Summary and Conclusions

- R&D tax relief is the dominant innovation policy instrument in many countries.
  - Large literature, but only few studies with causal evidence – more urgently needed.
  - Generally viewed positively, some dissenting voices
  - Not contested: relatively strong effects for SMEs
  - Where are the smart designs?
  - Political economy issues
- Patent boxes have real-world effects
  - Tax differences affect flows of international patent transfers.
  - Valuable patents are more likely to be transferred to low tax countries.
  - Mixed results concerning priority and applicant country patterns
- Effects of BEPS and introduction of Nexus principle topics for more research.

The Ultimate Innovation Incentive?

Illustration by Zhou Tao/Shanghai Daily

Tan Weiyun in ShanghaiDaily.com on February 6, 2015,

- UNDER the Penal Law of China, inmates who make patentable inventions while in prison can get their sentences reduced.
- Prisoners can get their sentences commuted if they have genuine repentance or make "significant contributions."
- And "great inventions and technological innovations" are regarded as "significant contributions."
- A former deputy director of a road transport bureau in Sichuan Province was credited with inventing a wall-mounted cigarette holder while serving his sentence.

http://www.shanghaidaily.com/feature/news-feature/Corrupt-officials-exit-jail-early-by-inventing/shdaily.shtml#jtss-fb

BACKUP: Innovation and Taxation – Patent Boxes

Patent Transfer in and out Flows – Europe (2000-2014)

Code	Country	Year patent box introduced	Year abolished	Includes existing patents	Includes acquired patents	Patents transferred out	Patents transferred in	Difference in patents transfers
AT	Austria					1313	1041	-272
BE	Belgium	2007			yes%	1073	1540	467
CH	Switzerland	2011		yes	yes	6049	9354	3305
CY	Cyprus	2012		yes	yes	158	219	61
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NL	Netherlands	2007		no	no	6068	8023	1955
NO	Norway					452	503	51
PT	Portugal	2014		no	no	105	165	60
SE	Sweden					2672	3514	841

if held for at least 2 years, % if further developed,