# Tax policy for innovation

Bronwyn H. Hall
University of California at Berkeley,
NBER, IFS London, MPI Munich, and
Innovation Lab, College de France

# Introduction – some questions

- How does taxation affect innovation?
- Why are there special tax incentives for innovative activity?
- How should R&D tax credits be designed?
- Are reduced taxes on patent income a good way to spur innovation?
- Do countries provide enough resources to support private R&D?
- Should there be coordination across countries?

# Taxation and innovation

- Two broad topics:
  1. Via personal and corporate taxes imposed for other purposes, see Akcigit et al. (2018)
     - Measure incentive effects using cross-state data, negative and stronger for corporate inventors
     - Show that international inventor migration depends strongly on effective tax rates, especially for corporate inventors and those where local research weak
  2. Tax subsidies targetted toward innovation – topic of this talk

# Rationale(s) for innovation support

- Innovative activity generates unpriced spillovers to other firms and to the overall economy
  - Some of these may be local to a region or economy
- Resources for innovation may be undersupplied because of
  - (relative) ease of imitation
  - risk and uncertainty that cannot be diversified away or insured against
  - high cost of financing (especially for SMEs)
  - related to the production of public goods (health, environment, defense, etc.)

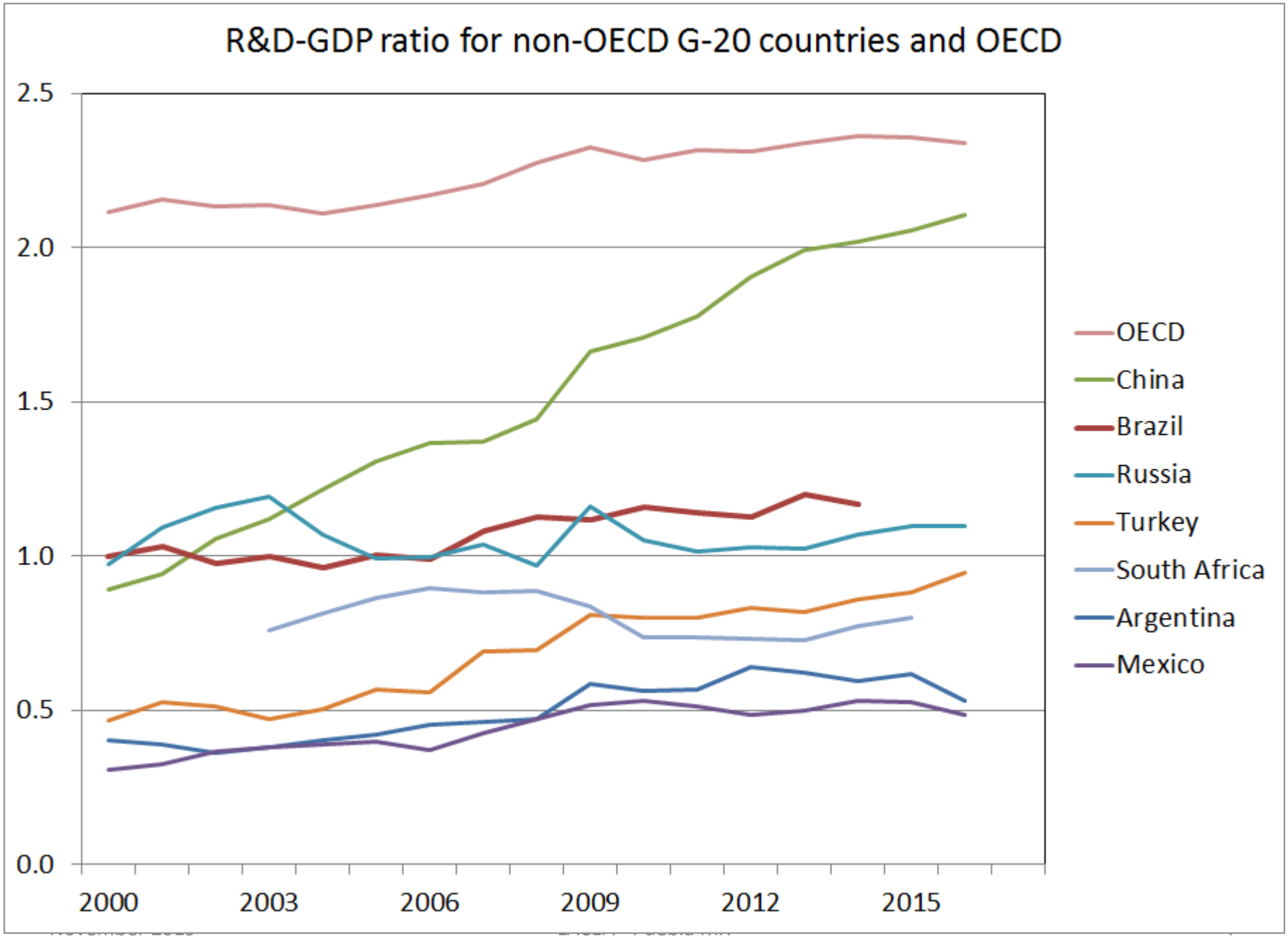
# What comprises innovative activity?

- R&D
  - Research – basic and applied
  - Development (sometimes modified by “experimental”)
- Purchase of external IP (patents, knowhow, etc.)
- Purchase, installation, and use of new (technologically advanced) equipment
- Training of employees in new processes, or in supporting new products
- Marketing new goods and services
- Costs of organizational innovation

The extent of potential spillovers varies across the type of spending, as does appropriability via IP protection or other means

# Do countries provide enough support for R&D?

- Much evidence that social returns are much higher than private (Kao et al 1999, Keller 1998, Coe and Helpman 1995). Some nuances:
  - Domestic spillovers larger than those from other countries (Branstetter 2001, Peri 2004)
  - Spillovers from foreign R&D more important for smaller open economies than for US, Japan, and Germany (Park 1995, van Pottelsberghe 1997)
  - Absorptive capacity of recipient country important for making use of R&D spillovers (Guellec and van Pottelsberghe 2001)
  - Typical social rates of return are quite large, but imprecise
- Jones and Williams (1998) – using endogenous growth model, argue that socially optimal R&D investment 2-4 times actual in US


R&D-GDP ratio for non-OECD G-20 countries and OECD
2.5
2.0
1.5
1.0
0.5
0.0
2000
2003
2006
2009
2012
2015
OECD
China
Brazil
Russia
Turkey
South Africa
Argentina
Mexico

# Possible remedies for low R&D spending

- Property rights (IPRs)
  - at the cost of restricted output; cumulative invention
  - under TRIPS, less variation across countries possible
- Subsidies
  - often targetted to particular type of firm or project
  - high administrative costs
- Direct government spending
  - Especially for R&D towards public goods
- Tax credits of various kinds
  - firm chooses projects
  - some audit costs

# Corporate tax and innovation

- What special features of the tax system support innovation?
  - R&D tax credit – widely used
    - Sometimes targetted toward basic research - university cooperation, use of PROs, etc.
  - Various IP "boxes"
    - Reduced corporate tax rates on income from IP (patents, design rights, copyright, trademarks, etc.)
  - Investment tax credits; accelerated depreciation
    - reducing the cost of acquiring new equipment and IT
  - Relative treatment of debt vs equity finance.
    - If debt favored, cost of intangible non-securable finance relatively more expensive

# (Innovation) tax policy design

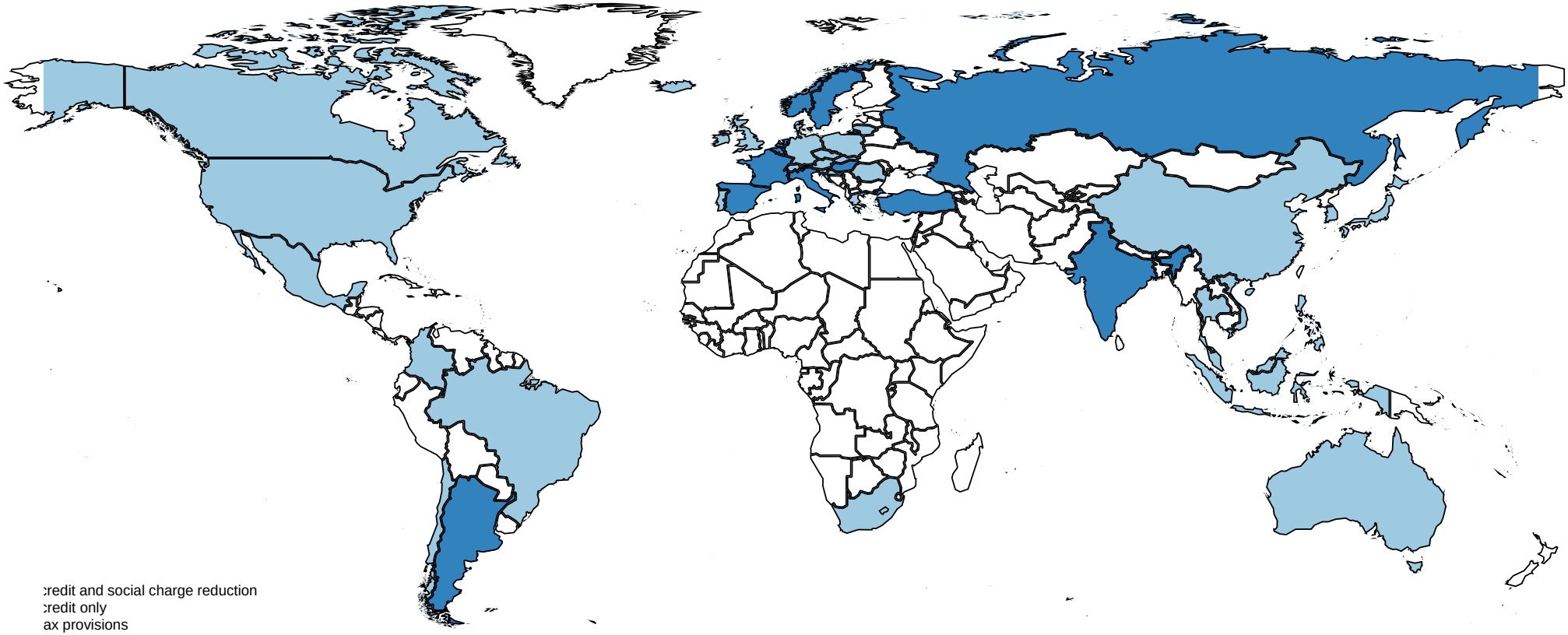
- Some issues in design
  - Is the policy instrument visible to the firm's decision-makers?
  - Does the time horizon of benefits match that of investment?
    - Does it reduce cost or increase profits in the near term, when firms may have losses?
    - Is the system stable enough to allow forward planning?
  - Does it target activities with spillovers?
  - Is it comparatively easy to audit?

# R&D tax incentives & IP boxes

- R&D tax incentives
  - Reduces cost of R&D input
  - Does not cover other innovation inputs
- IP boxes
  - Reduced tax rate on income from intellectual property (patents, copyrights, designs, etc.)
  - Broader coverage, but rewards more appropriable innovation

# Which countries have R&D tax relief?

Special tax provisions for R&D 2018



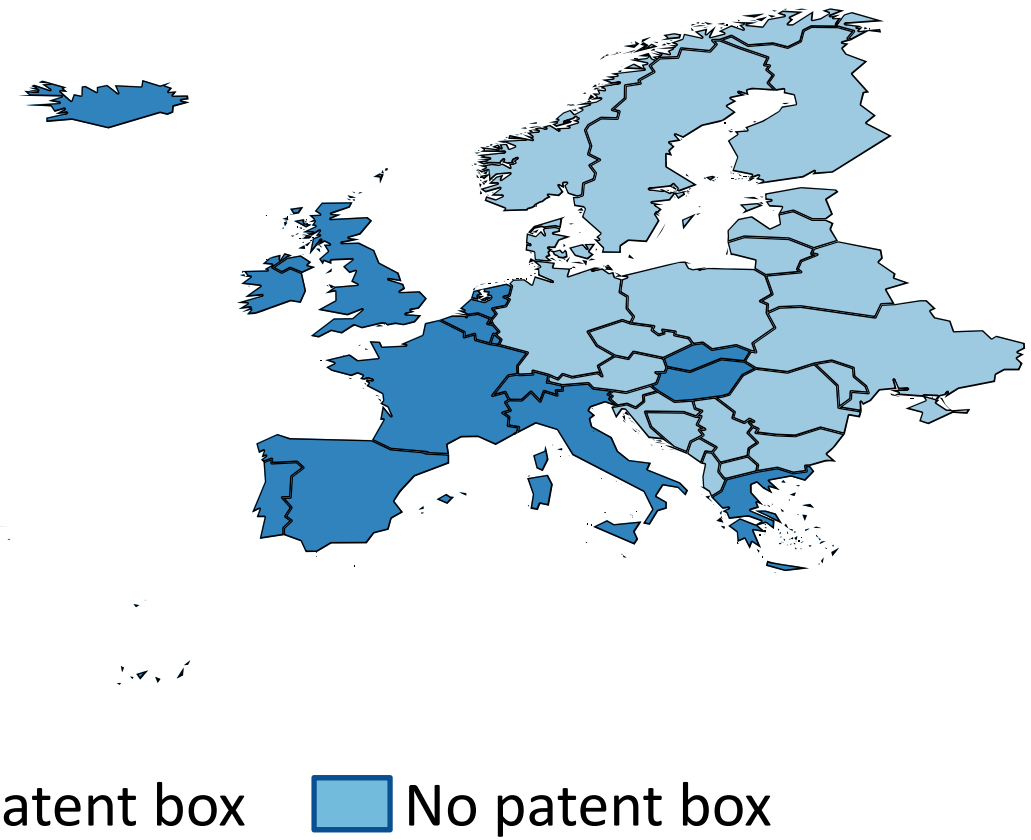

Tax relief & social charge reduction

Tax relief only

# Which countries have IP boxes?

Mostly European (+ Japan):

| | |
|---|---|
| Belgium | Luxembourg |
| Cyprus | Malta |
| France | Netherlands |
| Greece | Portugal |
| Hungary | Slovakia |
| Iceland | Spain |
| Ireland | Switzerland |
| Italy | Turkey |
| Liechtenstein | UK |

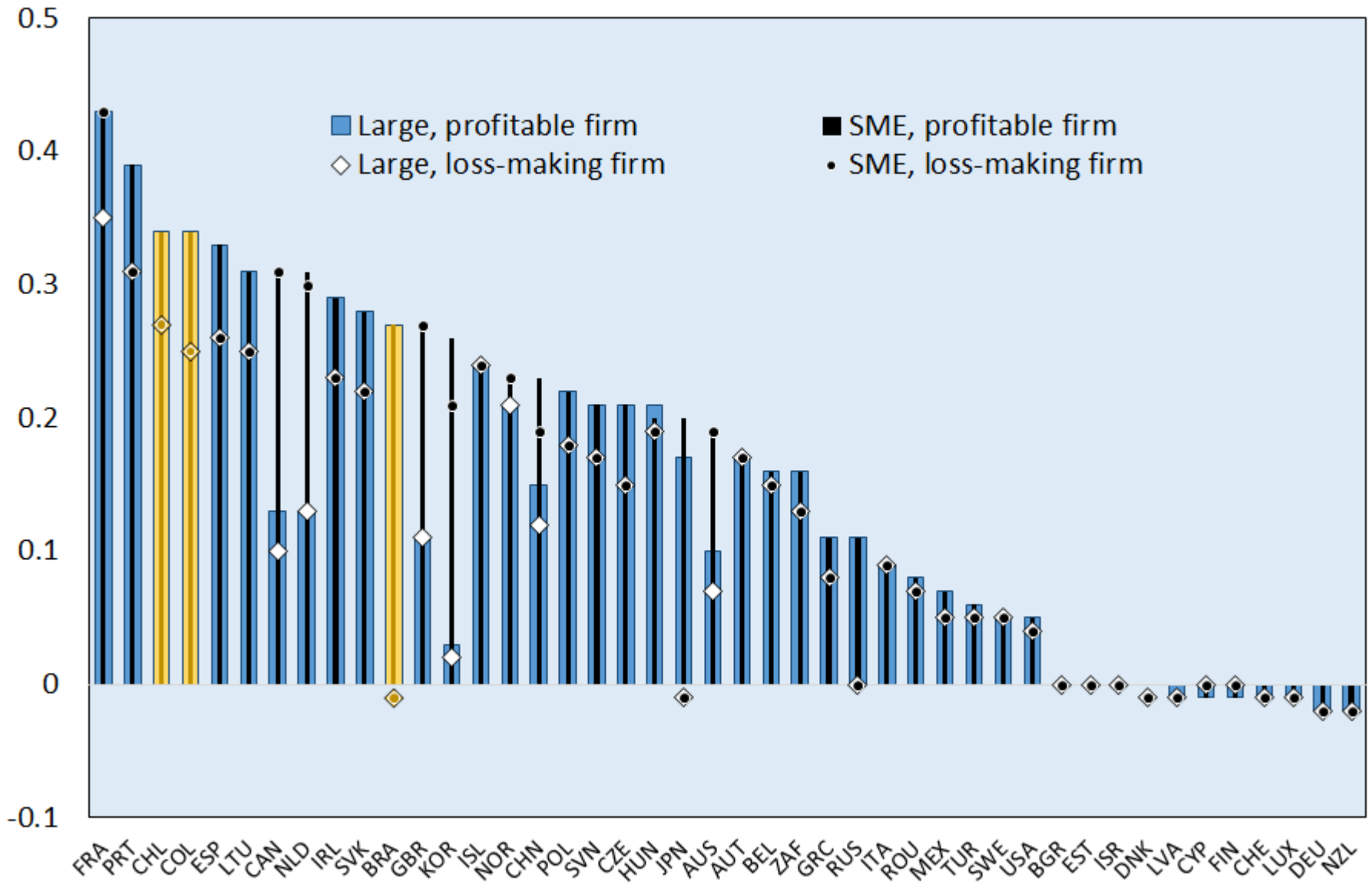


# More info on R&D tax credits

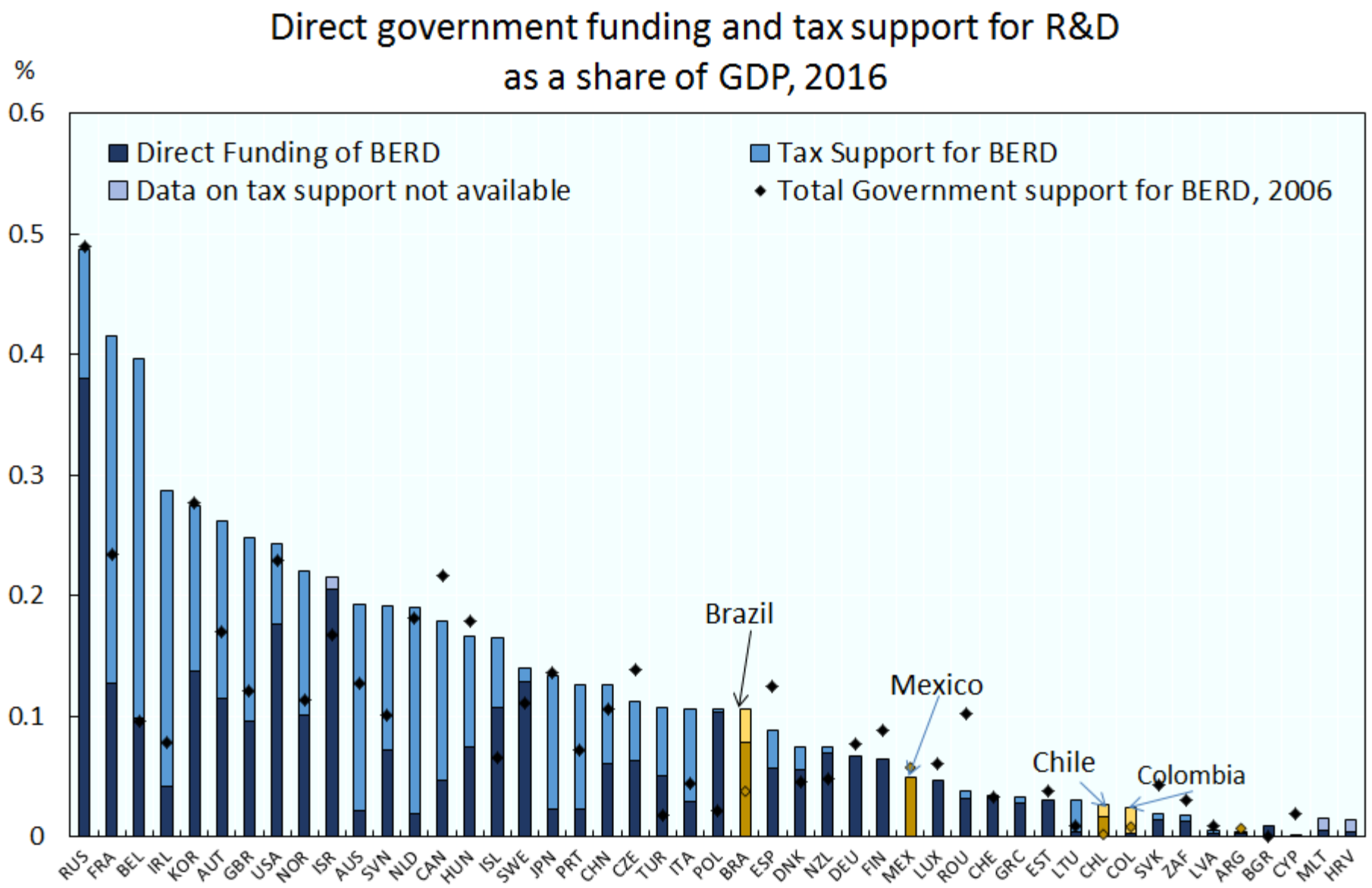
- 2000: 16 OECD countries.
- 2017: 30 out of 36 OECD countries
  - Also Brazil, China, and the Russian Federation
- B-index = level of pre-tax profit a "representative" company needs to generate to break even on a marginal expenditure of one unit on R&D

## Per cent subsidy implied by B-index for OECD and LA countries

| | OECD average | | Brazil | Mexico | Chile | Colombia |
|---|---|---|---|---|---|---|
| | 2000 | 2017 | 2018 | 2018 | 2018 | 2018 |
| Profitable SME | 6 | 16 | 27 | 7 | 34 | 34 |
| Loss-making SME | 4 | 13 | -1.0 | 5 | 27 | 25 |
| Profitable Large firm | 4 | 13 | 27 | 7 | 34 | 34 |
| Loss-making Large firm | 3 | 11 | -1.0 | 5 | 27 | 25 |
| *Source: Warda and Lester 2018, OECD 2019* | | | | | | |




Source: OECD R&D Tax Incentive Database, http://oe.cd/rdtax, March 2019.




Source: OECD R&D Tax Incentive Database, http://oe.cd/rdtax, March 2019.

# R&D tax incentive design

- Incremental schemes can be cheaper but more difficut to design and administer
  - Avoid basing on recent firm R&D spending
- If targeted, should be towards larger spillovers or credit constraints:
  - Collaboration with universities or non-profit research institutions
  - Small or new firms (Recent OECD study finds larger response)
- Loss carry-forwards, especially for new firms
- Alternative form – reduced social charges on S&E employment for R&D
  - Avoids carry-forward problem, an immediate subsidy
  - Somewhat easier to audit

# Incremental tax credits

- Currently used by
  - Czech Republic, (Ireland), Italy, Portugal, Spain
  - Mexico, Korea, Japan, USA
- Rate is generally higher than level tax credit
- Good idea in principle, but problem determining increment when firms are heterogeneous
  - Best predictor of current R&D is firm's own past behavior, but that means the firm can manipulate its response

# Special tax credits for SMEs

- Currently used by
  - Level: Australia, Canada, Norway
  - Incremental: Japan, Korea
  - Payroll-based: Poland, UK
  - Startups or young firms: Belgium, France, Netherlands, Portugal, Spain
- Difference between large and SME subsidy rate varies from 20% in UK to 1% in France

*Source: Warda and Lester 2018*

# R&D tax credit evaluation

- Does it increase business R&D as intended?
  - Well studied – generally yes
- Do private rates of return fall? - as they should, theoretically
  - Not studied as much, and sometimes misintepreted
- Do spillovers to other firms increase?
  - Not much studied at all

# Evidence on R&D tax credits

- Hall and Van Reenen (2000) – cross-country survey finds credits are effective
  - Estimated price elasticity about one or even higher
  - Increased R&D spending by the amount of lost tax revenue (on the margin)
- Recent research generally confirms above results
  - OECD (2019) confirms the conclusions above
  - Chang (2018) – IV estimates using US state data give high elasticites of 2.8-3.8
  - Mairesse-Mulkay (2012) for France – 2008 reform, elasticity of 0.4, higher in their newer work
  - Dechezlepretre et al. (2016) for UK – RD study obtains elasticity of 2.6 (SMEs, financially constrained)
  - Acconcia & Cantabene (2017) – Italian R&D tax credit 2009 - higher response if firm has cash available; elasticity 0.8

# R&D tax incentives & patent boxes

- Is the widespread adoption of patent boxes a good development to spur innovation?

  my answer: NO!

- Why are R&D tax credits preferred?
  - Directly related to cost and location of activity (firm decisions)
  - No incentives to transfer patents to low tax jurisdictions
  - No tax subsidy for patent trolling
  - No incentive to keep zombie patents alive to reduce taxes
  - Patent boxes target the most appropriable part of innovation
  - Much higher audit cost for patent box income; depending on box design,
    - Relative size of non-R&E budget can affect credit
    - Incentive to choose projects with high non-R&E expenses

# Gaessler, Hall, & Harhoff 2018

- Our questions:
  - Do patent boxes induce transfers of patent ownership to lower tax countries?
    - How is this affected by features of the patent box and other tax regulations?
  - Do patent boxes increase patentable invention in a country?

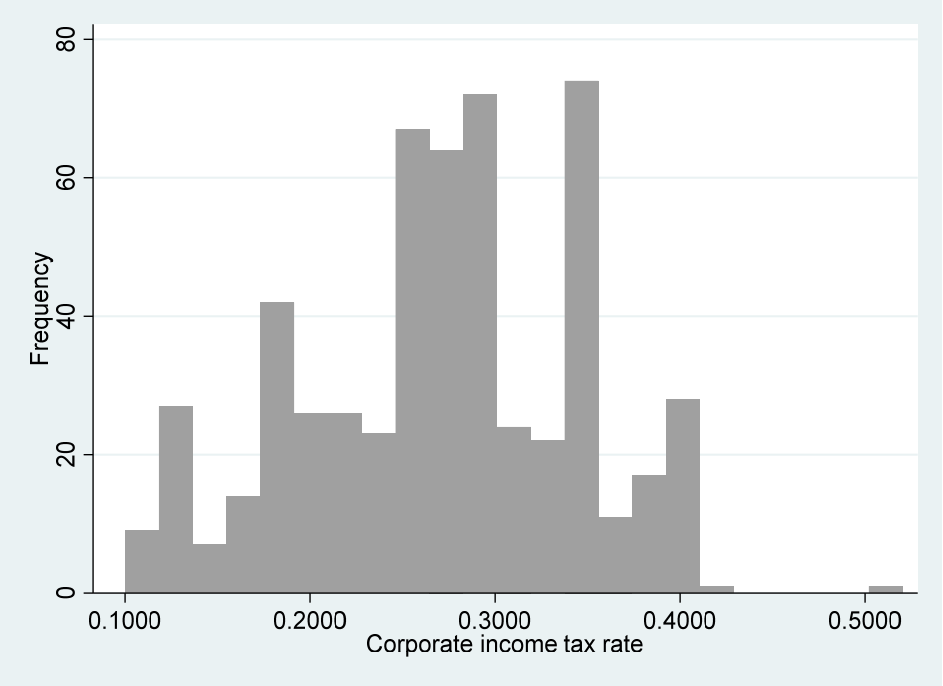
# Details on patent box incentives

- Variations in IP covered (sometimes even informal IP)
- Variations in treatment of income and expense
  - Gross income in some countries, rather than net
  - Recapture of past R&D expense deductions in some cases
- Use affected by CFC rules (home country taxes income received in low tax country at domestic rate)
  - However, the ECJ has limited the application of CFC rules within the EEA area.
- In practice, variation in patent box features
  - Use of patent box as a "natural experiment" somewhat imprecise
  - Accounting for the features leaves little variation for identification
- Note: can transfer patent income to low tax jurisdiction even without a patent box (subject to CFC rules)

# Summary of evidence on patent boxes

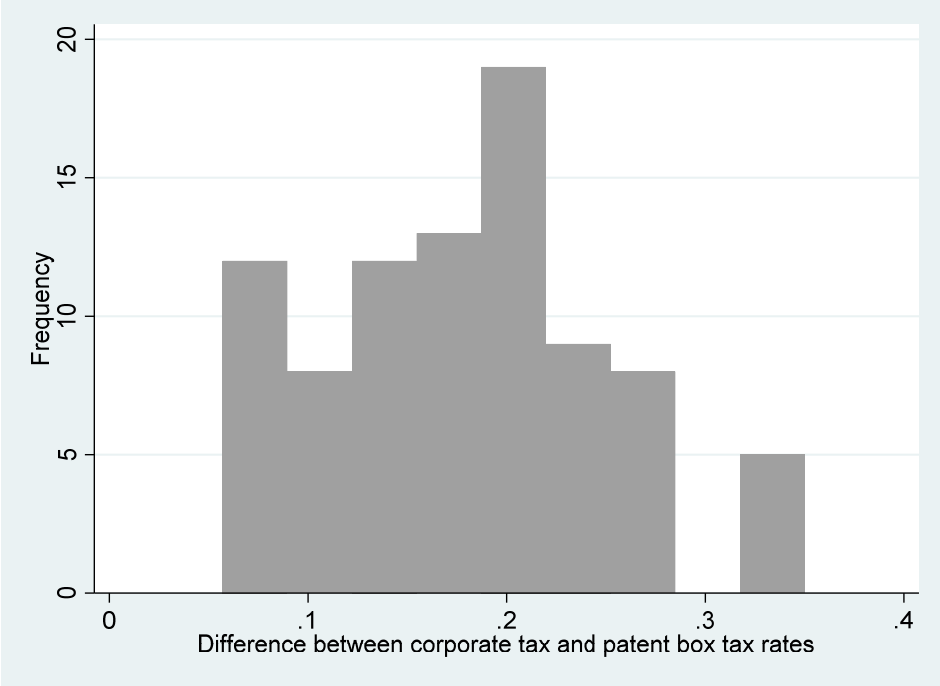
- Do firms transfer patents to patent box countries?
  - Evidence that patent location responds to corporate tax rates even before the boxes
  - Some additional transfer from patent boxes
  - Griffith et al. 2014 - empirical model of patent location and taxes to simulate introduction of a patent box.
    - Attracts patent income, lose large amounts of revenue
- Do patent boxes increase domestic invention?
  - Mixed evidence, mostly no
- Also, some evidence of international spillovers and profit shifting to lower tax areas

# Tax variables




Statutory corporate tax rate

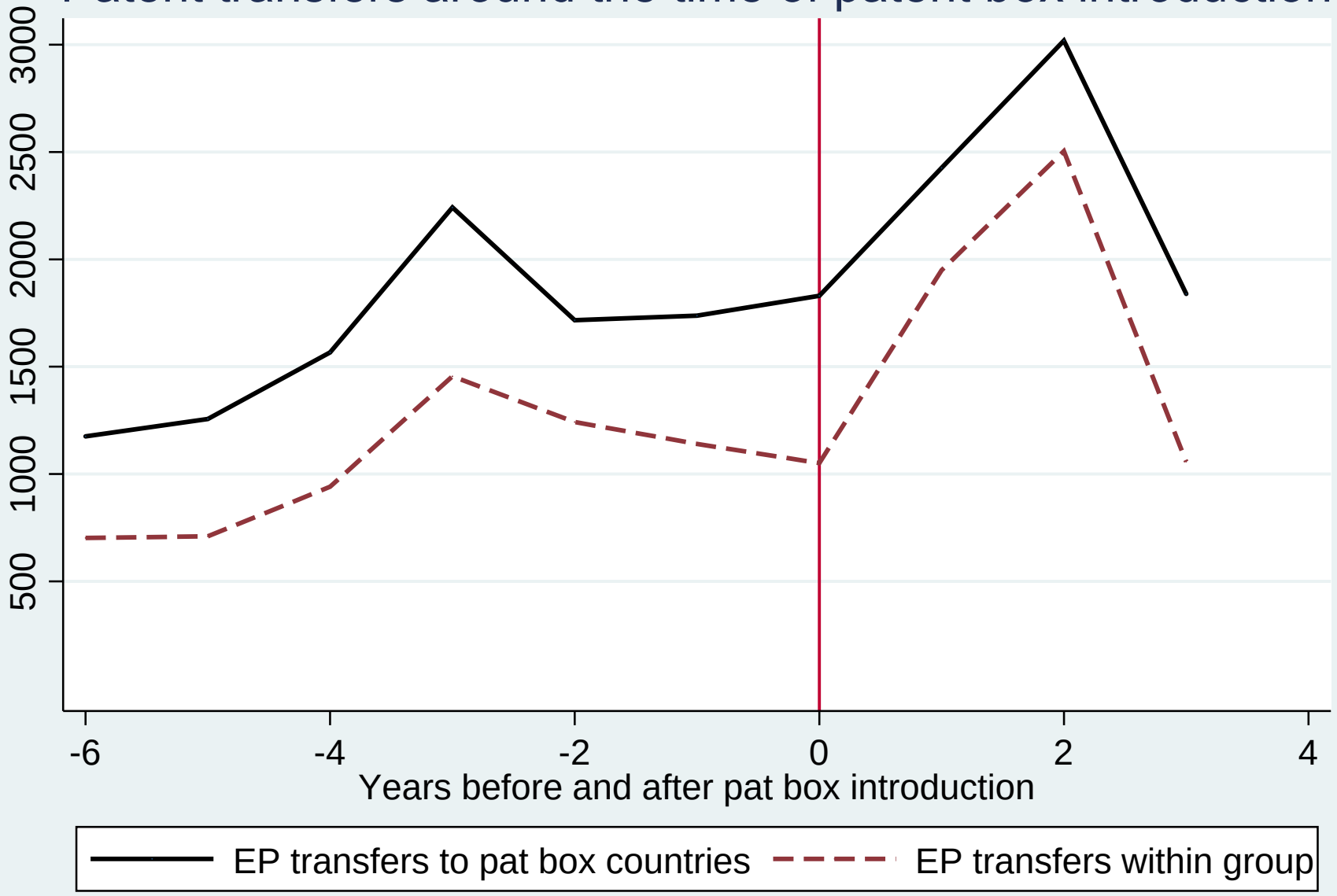
For 36 OECD countries plus Estonia, Slovenia




Corporate tax rate less patent box rate

For countries with patent box

# Patent transfers around the time of patent box introduction



# Aggregate transfer results

- Seller corporate tax rate remains a strong influence on patent transfer, regardless of the presence of a patent box
- Patent boxes do not seem to encourage transfer to a country unless existing and/or acquired patents are included without a development condition
  - A 10 per cent increase in patent tax advantage associated with 14 per cent increase in transfers in this case
  - Intra-group transfers respond to patent box wedge if there is also a CFC restriction

# Patent boxes and invention

- Does the presence of a patent box increase patentable invention in a country?
  - Difficult to see because all countries have an upward trend in patents
  - log (EP filings in a country-year) on
    - the patent box, corporate tax rates, log population, log GDP per capita, log R&D per GDP, country and year dummies.
  - We find a *negative* impact of the patent box on patented invention.
  - Similar but insignificant results for business R&D.

# Patent boxes and invention

| Dependent variable: | Log (EP filings) | | Log (BERD) | |
|---|---|---|---|---|
| D (patent box) | -0.13* (0.06) | | -0.08 (0.04) | |
| Patent box tax wedge | | -0.49* (0.24) | | -0.41 (0.22) |
| Corporate tax rate | -1.45 (1.12) | -1.43 (1.14) | -0.06 (0.46) | -0.05 (0.46) |
| Log population | -0.97 (1.19) | -1.00 (1.21) | -0.08 (0.52) | -0.07 (0.52) |
| Log GDP per capita | 1.55*** (0.34) | 1.51*** (0.35) | 1.60*** (0.21) | 1.60*** (0.21) |
| Log R&D per GDP | 0.70*** (0.19) | 0.72*** (0.19) | ---- | ---- |
| Standard error | 0.25 | 0.25 | 0.11 | 0.11 |

Unit of observation is country-year: 555 observations on 37 countries, 2000-2014

All regressions include a complete set of country and year dummies
Standard errors are robust and clustered on country.

Development/existing/acquired patent restrictions are insignificant.

# Summary

- Do patent boxes induce transfers of patent ownership to lower tax countries?
  - Transfers respond to seller country corporate tax
  - Also respond to patent boxes, but only if existing/acquired patents without development condition included
  - CFC rules do impact transfer by MNEs
- Do patent boxes increase patentable invention in a country?
  - Controlling for country characteristics, patented invention falls
  - Controlling for country characteristics, R&D does not change significantly
- Are more valuable patents transferred internationally?
  - Yes, as expected.

# International coordination

- Should these policies be better coordinated between countries?
  - To exploit cross-border spillovers? Maybe
  - To avoid wasteful tax competition? YES
- Evidence
  - Bloom & Griffith (2001) find domestic R&D responds to foreign cost of R&D with an elasticity of ~unity (roughly equal and opposite to domestic cost response) – 8 large OECD economies, 1981-1999
  - Corrado et al. (2016) find similar results for 10 EU countries, 1995-2007
  - Wilson (2009) finds similar, but even larger, results for US states
  - Note that equal and opposite elasticities does not imply zero-sum

# Some questions, answered

- How does taxation affect innovation? Mostly negatively overall
- Why are there special tax incentives for innovative activity? Externalities, financing constraints
- How should R&D tax credits be designed? Carefully
- Are patent boxes a good way to spur innovation? No
- Do countries provide enough resources to support private R&D? Probably not
- Should there be coordination across countries? Possibly

# BACKUP SLIDES

# Incremental tax credits

$\theta$ = tax credit rate  R = R&D

$\pi$ = current profit  $\Pi$ = PDV of profits

$\beta$ = discount rate

Year $t$: increase $R_t$ by $\Delta R_t$

Tax credit benefit is $\Delta\pi_t = \theta\, \Delta R_t$

For the next 3 years, this increase is in the base R&D, so there is a cost each year given by $(\theta/3)\, \Delta R_t$

Total (cost) impact of increase in R&D at year $t$:

# Implication of rolling base

$$\frac{\partial \Delta \Pi_t}{\partial \Delta R_t} = \theta \left[ 1 - \frac{(\beta + \beta^2 + \beta^3)}{3} \right]$$

| Nominal credit rate = 30% | |
|---|---|
| Discount rate | Actual credit rate |
| 1.0 | 0.0 |
| 0.95 | 0.03 = 0.1 * 0.3 |
| 0.9 | 0.057 = 0.19 * 0.3 |

# Recent studies on patent boxes

- Most studies on applications, two studies on transfers, none on priority filings and only one on subsequent invention

| Authors | Years | Level of observation | Dependent variable | Result |
|---|---|---|---|---|
| Alstadsaeter et al. (2015) | 2000-2011 | Firm-tech-country | Number of EP patent filings by applicant country-tech field | Broader pat box makes affiliate locations more attractive but small negative impact on invention |
| Bradley et al. (2015) | 1990-2012 | Country | Inventor pats; owner pats; mismatch | Domestic inventing increases if rate falls; no impact on mismatch |
| Bösenberg & Egger (2015) | 1996-2012 | Country-technology | Number of EP applications and ***pre-grant*** transfers by applicant country-tech field | Filings respond to tax rates; more valuable patents transferred. |
| Schwab & Todtenhaupt (2016) | 2000-2012 | MNC affiliate | Worldwide patent grants | Pat box in other countries generates positive spillovers on R&D |
| Koethenbuerger et al. (2016) | 2007-2013 | MNC affiliate | Stated profit before tax by subsidiary | Evidence that pat box used for profit shifting |
| Ciaramella (2017) | 1997-2015 | Firm | ***Granted*** EP application transfers | Recipient patent box increases prob of transfer |

# 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

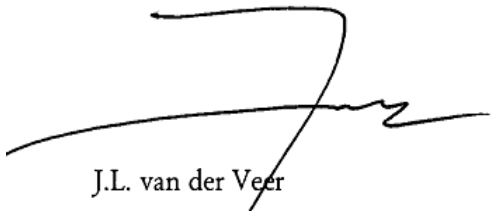
| onderw. re.<br>conc. betr. | doorkiesnummer<br>accès intern dir. | in-dialling<br>Durchwahl | datum, date |
|---|---|---|---|
| PHA 23486 EP<br>EE. | +31 40 27 43505 | | 2003-01-10 |

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

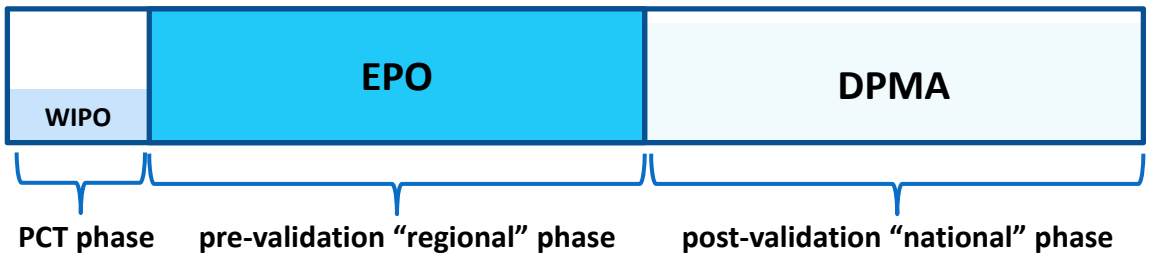
# Basic patent box features

| *Country* | *Years with IP box* | *R&E tax credit@* | *Includes existing patents* | *Includes acquired patents* | *Corp tax rate (statutory)* | *IP box rate (statutory)* |
|---|---|---|---|---|---|---|
| Belgium | 2007- | x | yes% | yes% | 34 | 6.8 |
| Cyprus | 2012- | | yes | yes | 10 | 2.5 |
| France | 1971- | x | yes | yes# | 34 | 16 |
| Hungary | 2003- | x | yes | yes | 20 | 10 |
| Ireland | 1973-2010 | x | yes | no | 12.5 | 0 |
| Liechtenstein | 2011- | | yes | yes | 12.5 | 2.5 |
| Luxembourg | 2008- | | no | yes | 29 | 5.84 |
| Malta | 2010- | | yes | yes | 35 | 0 |
| Netherlands | 2007- | x | yes% | yes% | 25.5 | 5 |
| Portugal | 2014- | x | no | no | 31.5 | 15 |
| Spain | 2008- | x | yes | no | 30 | 12 |
| Switzerland | 2011- | | yes | yes | 21 | 8.8 |
| UK | 2013- | x | yes | yes% | 22 | 10 |

# if held for at least 2 years. % if further developed.
@Some kind of R&D tax credit (beyond expensing) available during the period.

# MPI for Innovation and Competition Patent Transfers Data 2016

- Dataset Covers Transfers of European Patents (EP) 1981-2014
  - 1.2 million registered patent ownership transfers
  - Patents with „change in ownership information“ in WIPO, DPMA and EPO data
  - Sector allocation: firms, individuals, universities, non-profit, etc.
  - Distinction between market, M&A and intra-group patent transfers
  - About 12% of these transfer are cross-country
  - For further info, see Gaessler and Harhoff (2016)




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

# 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
- exception: UK

# Patent Transfer in and out Flows – Rest of 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

# Model for aggregate patent transfers

- # patents transferred from "seller" country S to "buyer" country B

$$E(\#transfersS \rightarrow B \mid S, B, t, tax) =$$

$$\alpha_S + \beta_B + \lambda_t + f(tax_{St}, tax_{Bt})$$

where *t* = calendar time.

- Tax variables:
  - Statutory corporate tax rates in *B* and *S*
  - Dummies for patent box or difference between corp tax rate and patent box rate in each country
  - Alternatively: difference in corp tax rates and difference in patent box wedge between countries *B* and *S*.
- Unit of observation: country pairs at time *t*
- 37 countries: EU24, NO, IS, CH, US, JP, KR, CA, AU, NZ, CL, MX, TR, IL
- Method of estimation is Poisson with robust standard errors

# Aggregate results – patent transfers

| Dependent variable: # patents transferred from seller to buyer country during the year | | | | |
|---|---|---|---|---|
| | ---------- All transfers ---------- | | | Within group |
| Buyer corp tax rate | 0.81 ()1.28 | | | |
| Buyer patent tax wedge | -0.04 (0.76) | | | |
| Seller-buyer corp tax | | 0.35 (0.90) | -0.31 (0.95) | 0.29 (1.24) |
| Buyer-seller pat tax wedge | | 1.35** (0.63) | 0.33 (0.55) | 0.40 (0.74) |
| D (dev condition)*wedge | | -1.95* (1.03) | | |
| D (CFC rules for buyer) | | | -0.37** (0.17) | -0.02 (0.27) |
| D (CFC)*corp tax diff | | | 3.31*** (1.13) | 1.20 (1.77) |
| D (CFC)*wedge diff | | | 1.27 (1.04) | 2.22* (1.26) |
| Seller corp tax rate | 1.11 (1.03) | | | |
| Seller patent tax wedge | -1.52** (0.63) | | | |
| 19,980 observations on 1,332 country pairs; robust s.e. clustered on pairs. | | | | |
| All regressions include dummies for buyer and seller countries, and years 2000-2014 | | | | |

# Patent level analysis

- Sample: ~700,000 EP granted patents filed 2000-2012, granted by 2014
- Look at first transfer only
- Either Probit or hazard rate model of probability of an international transfer as a function of
  - Patent characteristics – family size, claims, forward citations, number of inventors
  - Applicant characteristics – patent portfolio size, D (research active in more than one country), D (corporation, not research active MNC)
  - Dummies for applicant country, application year
- 3,428,110 observations at risk, with 104,664 transfers, 343,154 patents.

# Patent level analysis

| Dependent variable: Dummy for first international transfer of patent | |
|---|---|
| | All |
| Patent family size (docdb) | 0.063*** (0.001) |
| Claims | 0.021*** (0.001) |
| Forward citations | 0.010*** (0.001) |
| Inventors | 0.040*** (0.002) |
| Applicant patent portfolio size | -0.040*** (0.001) |
| Dummy for research active MNE | 0.271*** (0.003) |
| Dummy for corporation, not MNE | -0.022*** (0.003) |

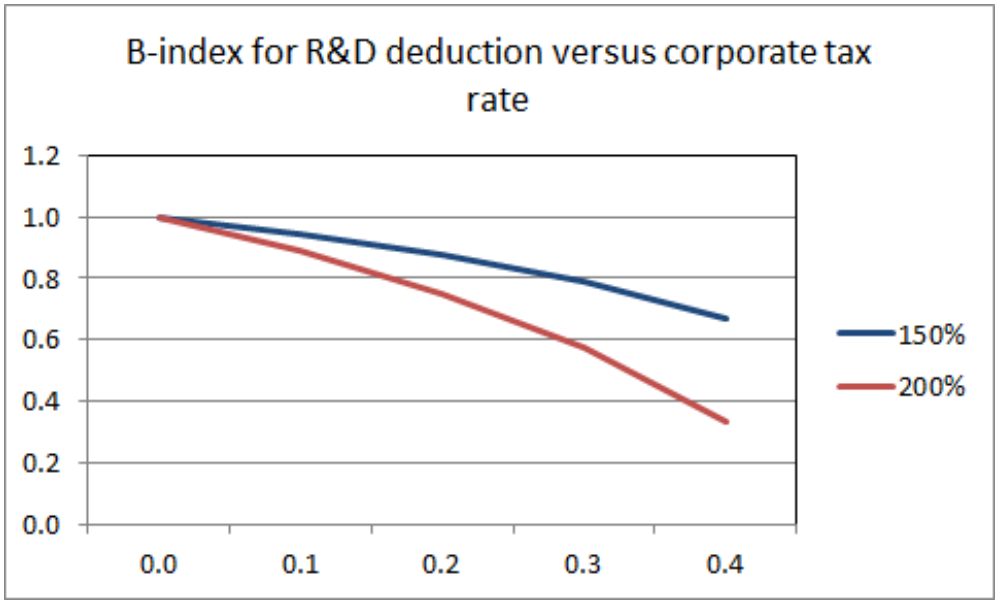
A complete set of applicant country and application year dummies included in all regressions. Left-out category is individuals and non-profits.

Estimates - average marginal impact on probability; all non-dummy variables in logs.
3,428,110 observations on 343,154 patents; 104,664 transfers

Standard errors are clustered by patent.

# For discussion

- Recent EU proposal for a common corporate tax base in Europe - super deduction of 150 percent, to replace patent boxes and existing R&D tax credit schemes
  - Good idea but effectivness depends on corporate tax rate




  - One caveat: costs of adjustment of supply of S&Es; wage impacts

# For discussion

- How much extra growth could countries achieve if they were to expand support for private R&D?
  - Very difficult to answer, especially given the other factors that influence growth
  - Typical numbers for “back of envelope” computation:
    - Elasticity of R&D wrt cost about 1.0
    - Elasticity of output wrt R&D about 0.1
    - => 20% fall in cost => 2% greater output
  - Partial equilibrium, not general