The Case for Growth: Innovation and Diffusion Policies

Mannheim Public Finance Conference
May 5th, 2022

John Van Reenen

LSE and MIT

The Argument

- OECD countries face unprecedented **growth challenge** due to Pandemic & Ukraine crisis.
- But even going into these crises, there was global problem of **low productivity growth** since (at least) Financial Crisis
- Policy framework should be unashamedly around equitable and environmentally **sustainable growth**
- **Innovation and Diffusion** of better *technologies* and *management practices* are key
- We know much about *what* to do, join up in a new **Marshall Growth Plan**
  - Short-run: Balance between **protection** and **reallocation**
  - Long Run: Frame around Climate **Mission**

OUTLINE OF TALK

Background: The Challenge

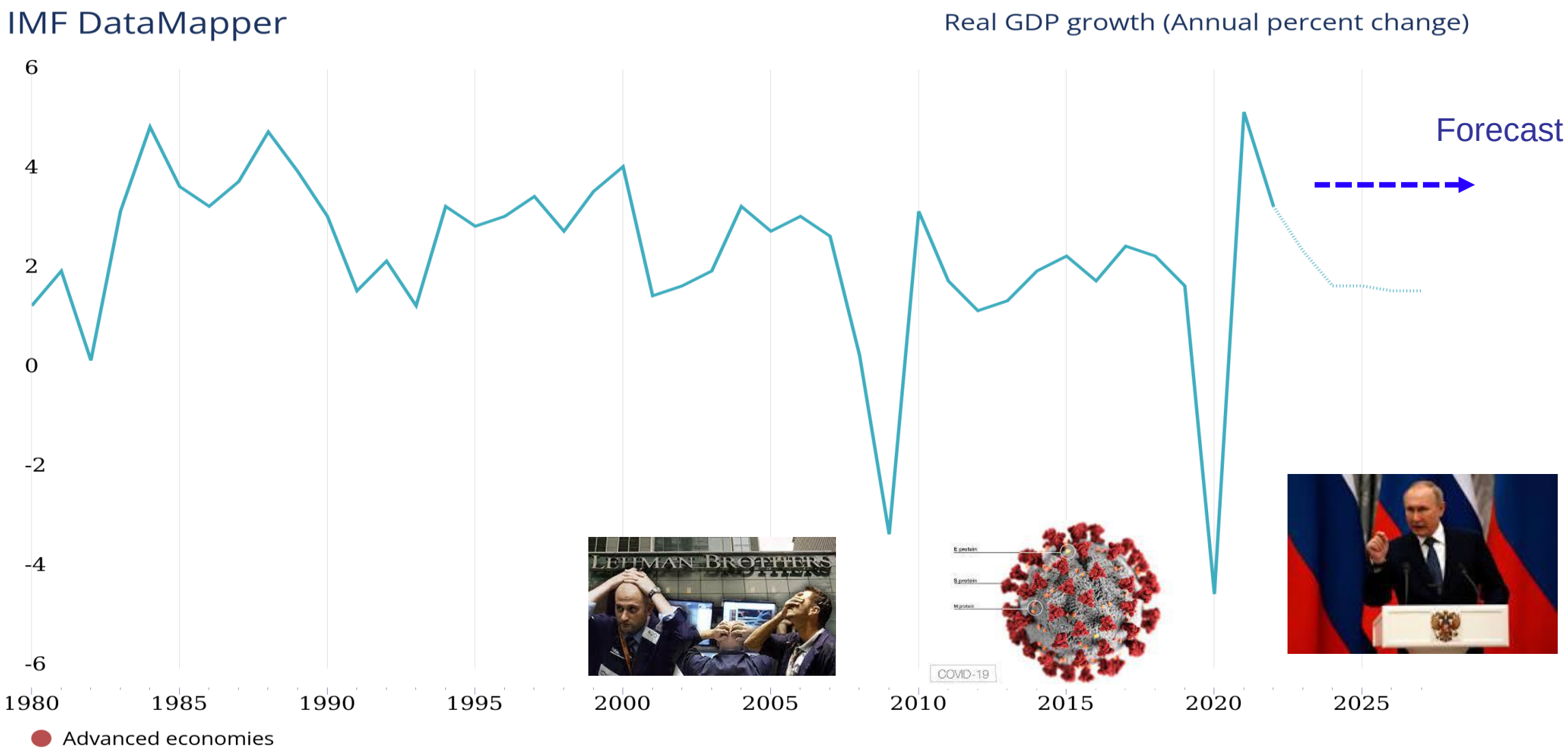
Innovation Policy

Diffusion Policy: Management

Misallocation

Growth Plan 2.0

The Big Hit I: GDP growth in Advanced Economies, 1980-2022

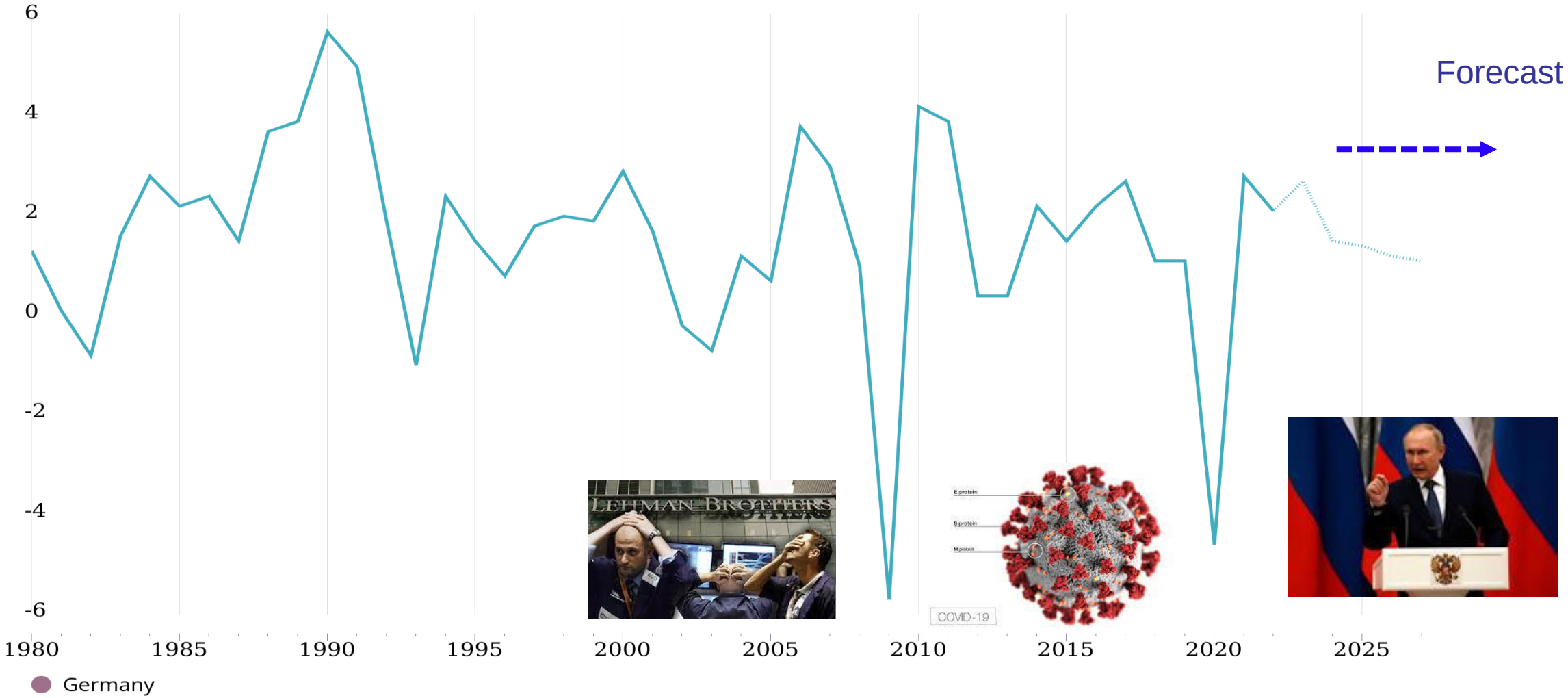


©IMF, 2022, Source: World Economic Outlook (April 2022)

The Big Hit II: GDP growth in Germany, 1980-2022

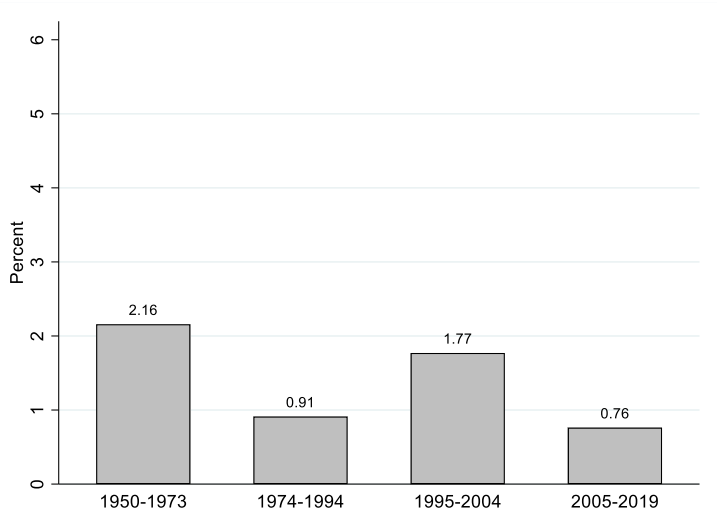
IMF DataMapper

Real GDP growth (Annual percent change)

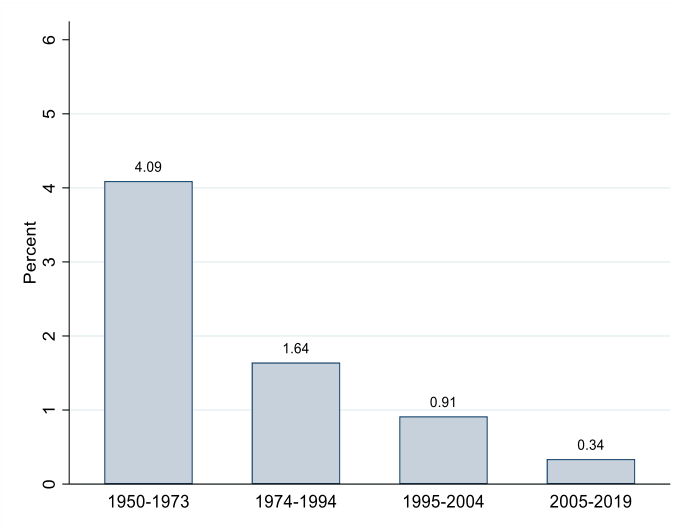


Productivity problems started long before COVID: Total Factor Productivity (TFP) growth 1950-2019: US, Euro-area and UK

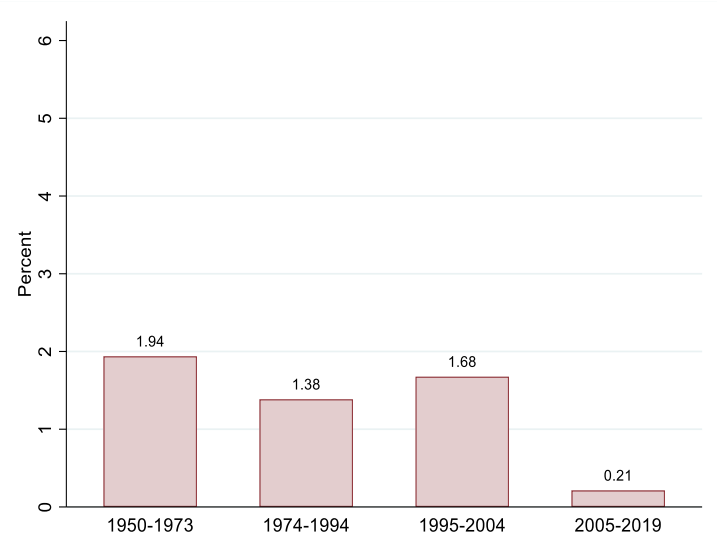
A. United States



B. Euro Area



C. United Kingdom



Source: Teichgraber & Van Reenen (2022) Updated data from Bergeaud, Cette, and Lecat (2016). Data publicly available at: http://www.longtermproductivity.com/

Notes: Average annual TFP growth in the US (panel A), Euro-area (panel B), and UK (panel C). Insufficient data for whole EU, so we use Euro-area, represented by Germany, France, Italy, Spain, Netherlands, and Finland.

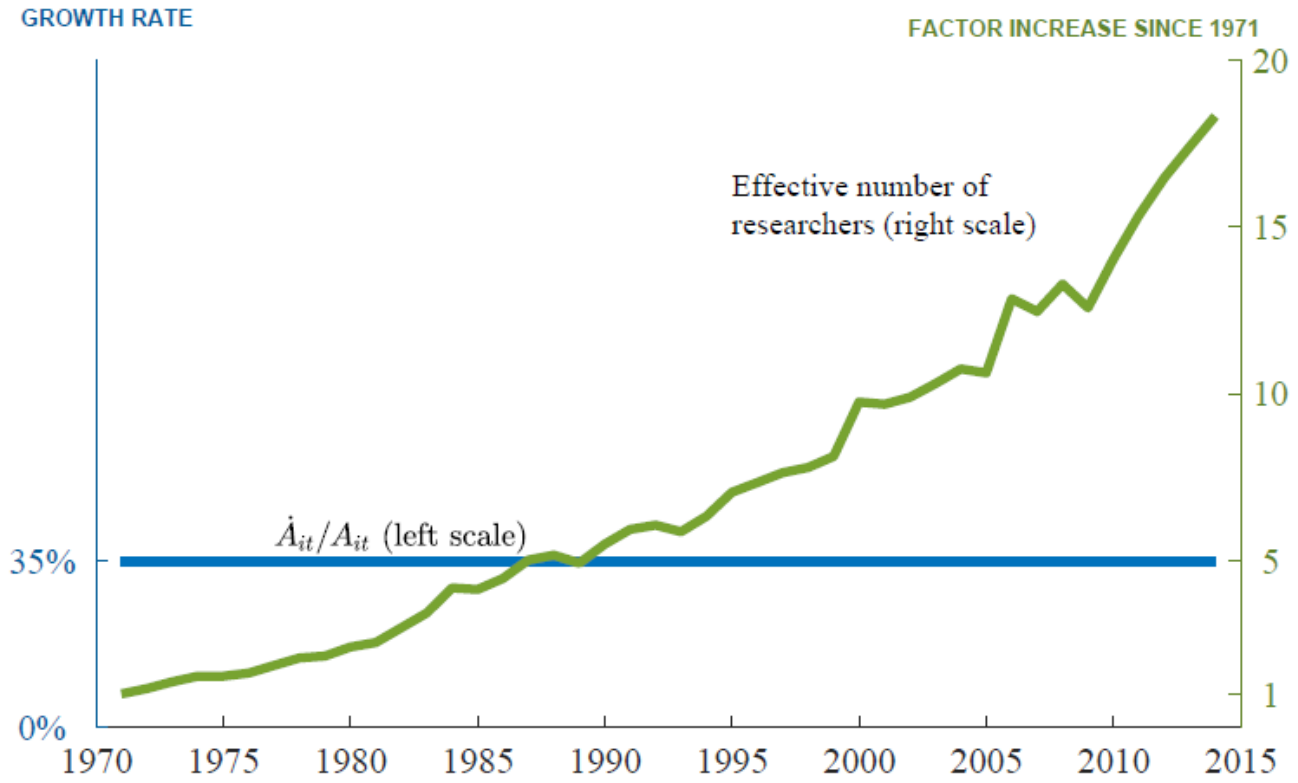
Drivers of Aggregate Productivity

- Pushing out the **technological frontier**
  - Important for advanced countries like Germany, but not the only thing…

- **Catching Up** to frontier
  - **Diffusion** of technology
  - Reducing **Misallocation**

Ideas Getting Harder to Find? R&D productivity decline means we need <u>more</u> investment to maintain good growth rate (not less)

Figure 4: Data on Moore's Law



Note: The effective number of researchers is measured by deflating the nominal semiconductor R&D expenditures of key firms by the average wage of high-skilled workers. The R&D data includes research by Intel, Fairchild, National Semiconductor, Texas Instruments, Motorola, and more than two dozen other semiconductor firms and equipment manufacturers; see Table 1 for more details.

Source: Bloom, Jones, Van Reenen and Webb (2020, AER)

OUTLINE OF TALK

Background: The Challenge

Innovation Policy

Diffusion Policy: Management

Misallocation

Growth Plan 2.0

Why should the government subsidize innovation?

- **Multiple market failures:**
  - Knowledge spillovers most important
  - Frictions in other markets (e.g. finance and SMEs)

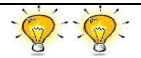
- **Empirical evidence suggests strong role for knowledge spillovers:**
  - Bloom, Shankerman & Van Reenen (2013); Lucking, Bloom and Van Reenen (2020); Jones & Summers (2022)
  - Social return to R&D is ~3-4 times as large as the private return. Implies large under-investment

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**

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

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	↑

"Demand"

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

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"

"Supply"

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

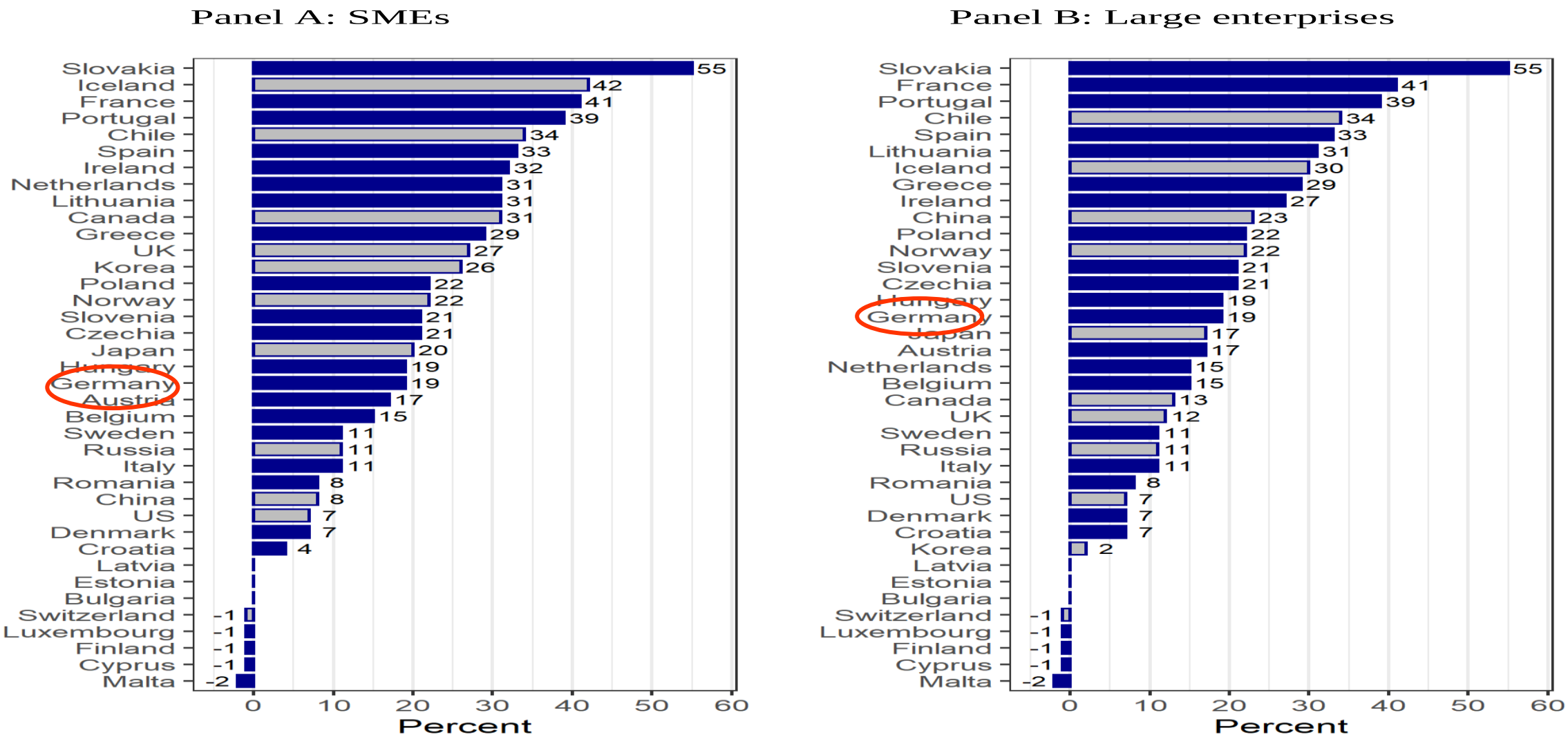
Successful Innovation Policies

- **R&D tax credits**
- Direct government grants
- Human capital supply
  - Expanding STEM workforce
  - Universities
  - Immigration
  - “Lost Einsteins”
- Competition and trade policy

Successful Innovation Policies: 1. R&D tax credits

- **Background facts**
  - OECD (2021): 34/42 countries have tax credits (up from 20 in 2000)

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.

Successful Innovation Policies I: R&D tax credits

- **Fiscal incentives increase R&D (Stantcheva, 2021)**
  - Cross country (e.g. Bloom et al, 2002)
  - Cross state (e.g. Wilson, 2009)
  - Cross firm (e.g. Hall, 1992; Rao, 2016)
  - Elasticity of R&D wrt user cost >1

- **Fiscal incentives increase Innovation**
  - Important because of re-labelling concern (Chen et al, 2021)
  - See also Akcigit et al (2021) and Stantcheva (2021)
  - Dechezlepretre et al (2022) using Regression Discontinuity Design. Change in SME R&D thresholds

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

Antoine Dechezleprêtre (OECD)

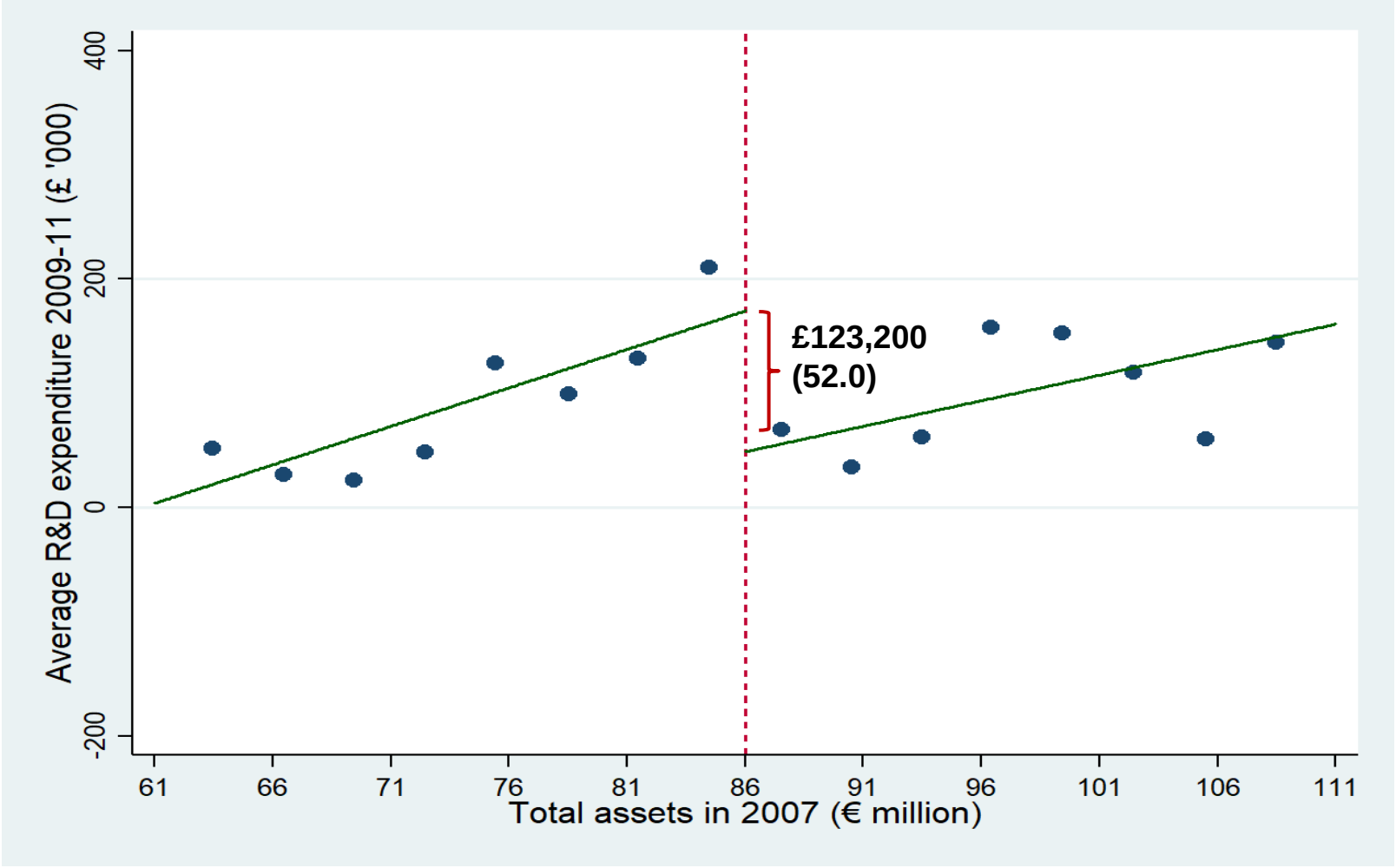
Elias Einiö (VATT)

Ralf Martin (Imperial College)

Kieu-Trang Nguyen (Northwestern)

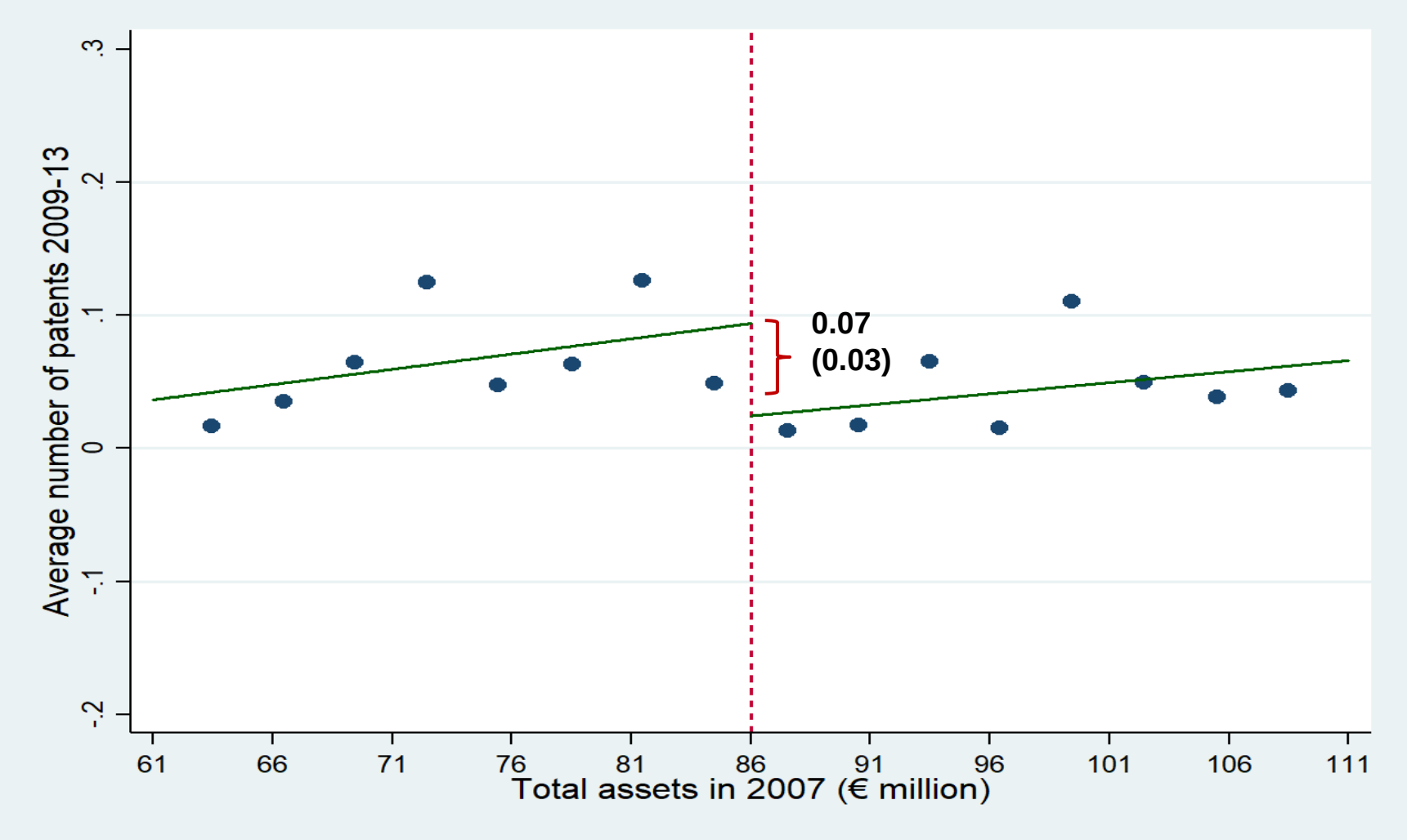
John Van Reenen (LSE, MIT)

Discontinuity effects on R&D



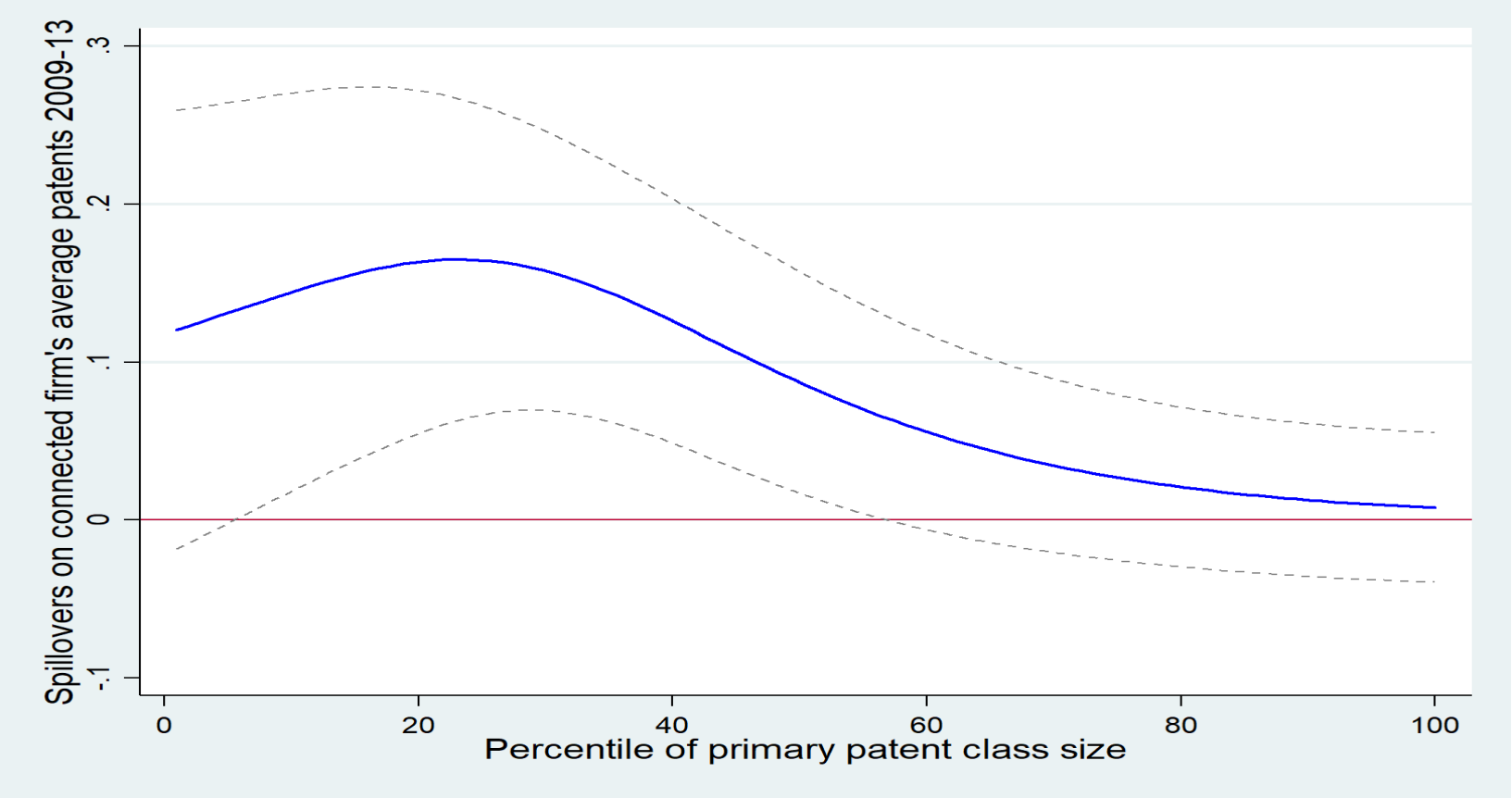
Source: Dechezlepretre et al (2022); **Notes:** 5,888 obs. Assets from FAME based on SME threshold (€86m). R&D from CT600. Sample of firms with €25m above & below the threshold. 368 obs per €3m bin.

Discontinuity effects on patenting



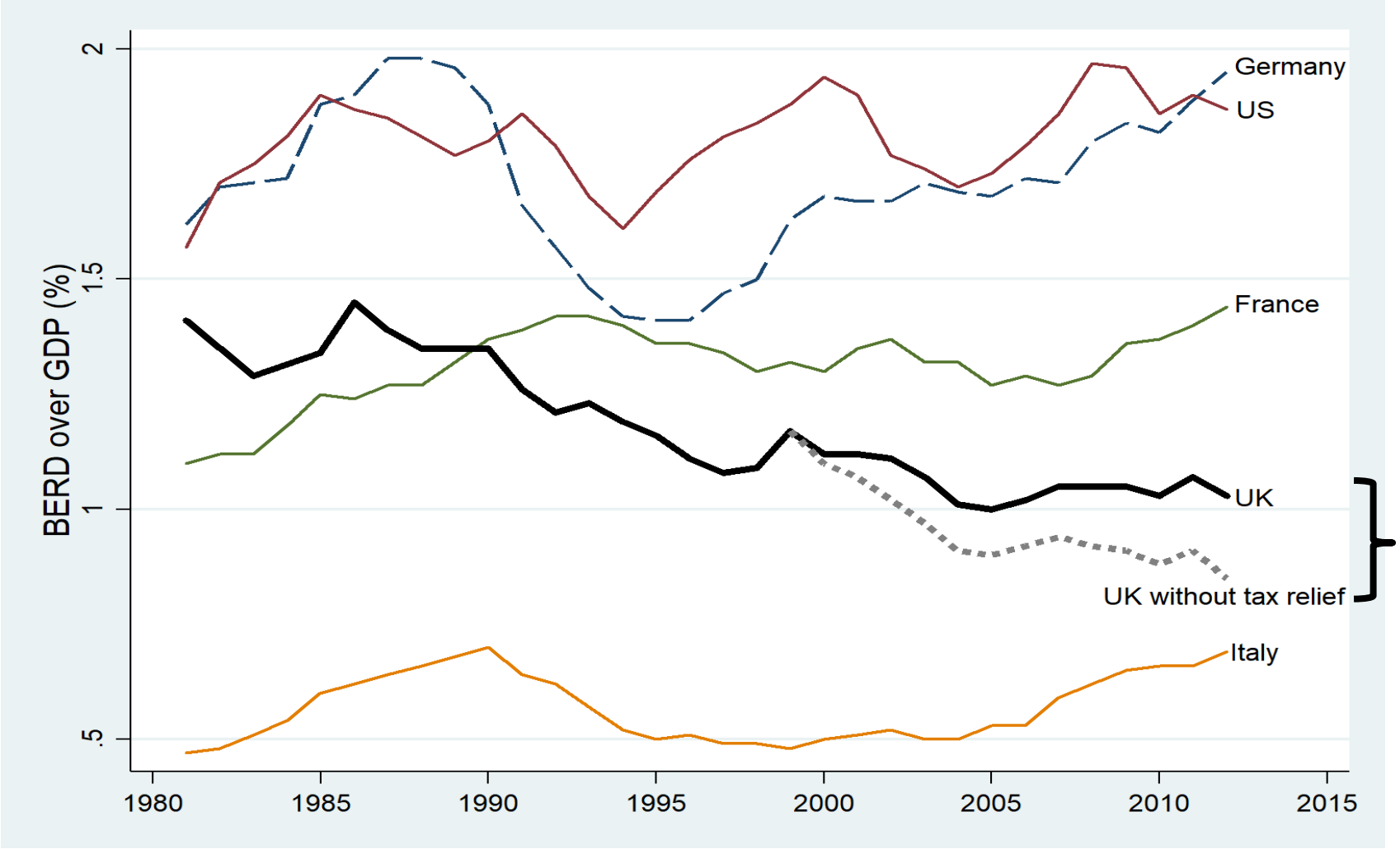
Source: Dechezlepretre et al (2022); **Notes:** 5,888 observations. Assets from FAME based on SME assets threshold (€86m) definition. R&D is from CT600. Sample of firms with €25m above & below the threshold. Outcome is average number of patents filed between 2009 and 2013.

R&D 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.

UK Business R&D/GDP ratio would have continued decline without 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.

Successful Innovation Policies II: R&D Grants

- **Direct government grants (in theory, can be targeted better than tax incentives).** Examples: Health (Azoulay et al ‘19); Green Energy (Howell, ’17)
  - Well designed public R&D programs **crowd-in** private innovation on average
  - Moretti, Steinwender & Van Reenen (2022) use **defense shocks** across ~30 year period:
    - Industry-country panel data
    - French firm level panel data
    - Find 10% more public R&D stimulates ~5% more private sector R&D in long-run

Successful Innovation Policies II: R&D Grants

- Type of R&D procurement matters

OPENing up Military Innovation: Causal effects of Reforms to U.S. Defense Research

Sabrina Howell (NYU), Jason Rathje (US Air Force), John Van Reenen (LSE and MIT) and Jun Wong (Chicago)

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

poid Programme on Innovation and Diffusion

Successful Innovation Policies II: R&D Grants

- OPEN reforms to US Air Force (USAF) military innovation procurement
- Conventional SBIR program centralized top-down approach: tightly specified calls in SBIR program. Example:
  - *“Affordable, Durable, Electrically Conductive Coating or Material Solution for Silver Paint Replacement on Advanced Aircraft"*
- OPEN Reform allowed firms more freedom to propose the innovations **they** thought USAF needed “unknown unknowns”
- Admin data on all applicants, grant scores and outcomes 1983-2021 to implement a sharp RDD

Findings from Howell et al (2022)

- New types of firms starting applying & winning: younger, smaller, based in VC hubs of Silicon Valley, Boston, etc.

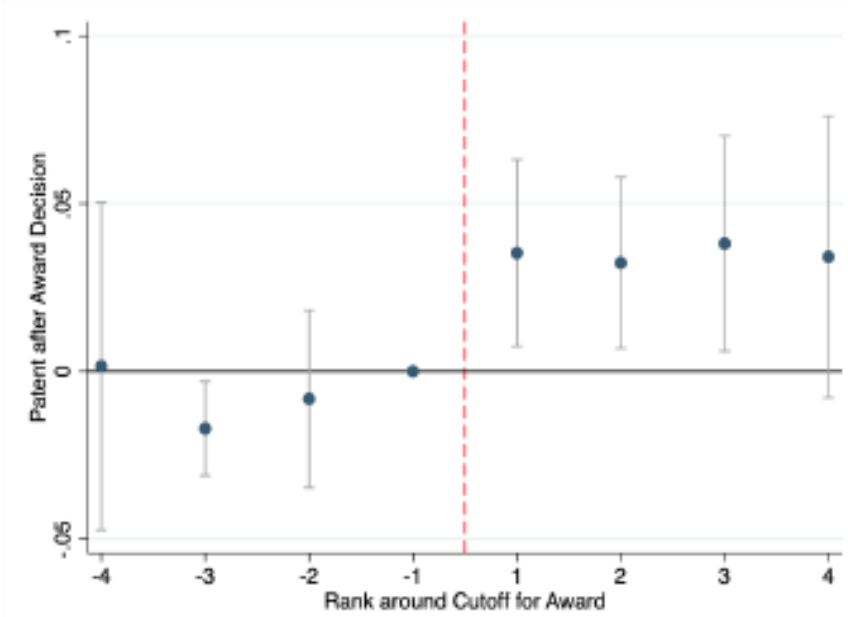
- Positive effects of OPEN program on:
  - VC funding
  - Defense Department Technology adoption
  - Innovation (quality-weighted patents)

- Conventional program had no causal effect on these & (unlike Open) only increased chances of winning another SBIR contract (implies lock-in by “SBIR mills”)

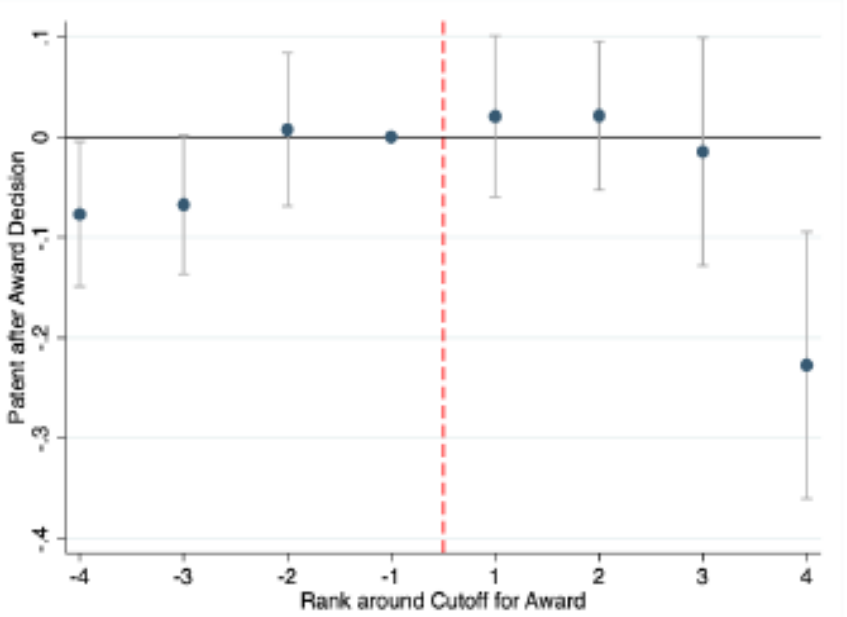
Big jump in innovation near threshold of winning

Figure 7: Probability of Patents by Rank Around Cutoff

(a) Open



(b) Conventional (2017-19)



Note: These figures show the probability that an applicant firm had any ultimately granted patent applications within 24 months after the award decision. In both panels, the x-axis shows the applicant's rank around the cutoff for an award. A rank of 1 indicates that the applicant had the lowest score among winners, while a rank of -1 indicates that the applicant had the highest score among losers. We plot the points and 95% confidence intervals from a regression of the outcome on a full complement of dummy variables representing each rank, as well as fixed effects for the topic. The omitted group is rank=-1.We include first applications from 2017-19.

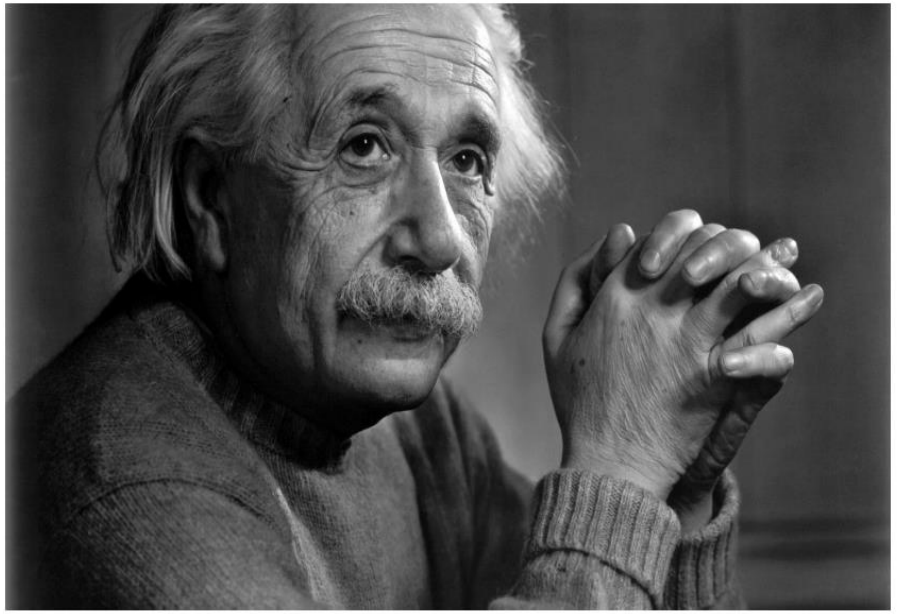
Successful Innovation Policies III

- R&D tax credits
- Direct government grants
- **Human capital supply**
  - Problem with tax and grants is that they subsidize *demand*. If supply side inelastic, the effect is to just drive up price of R&D (scientist wages) rather than volume of R&D
  - Increasing human capital more effective: directly increases innovation and reduces cost of R&D (reduces inequality)
- Competition and trade policy

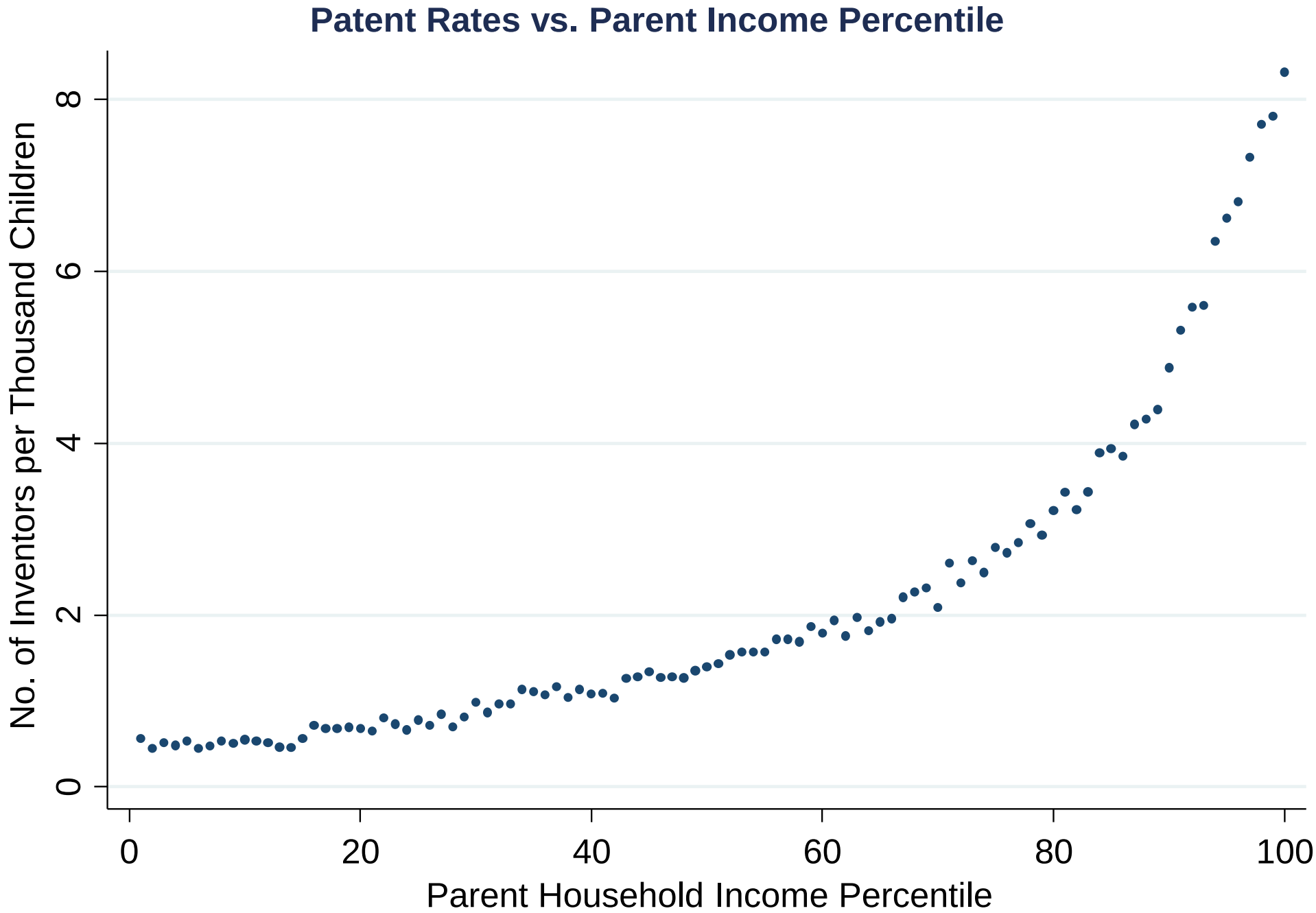
Successful Innovation Policies III

- R&D tax credits
- Direct government grants
- **Human capital supply**
  - Expanding STEM workforce
  - Universities
  - **Immigration:** Positive effects of immigrants on innovation. Can also be quickly increased, but politics hard.
  - “Lost Einsteins & Marie Curies”
- Competition and trade policy

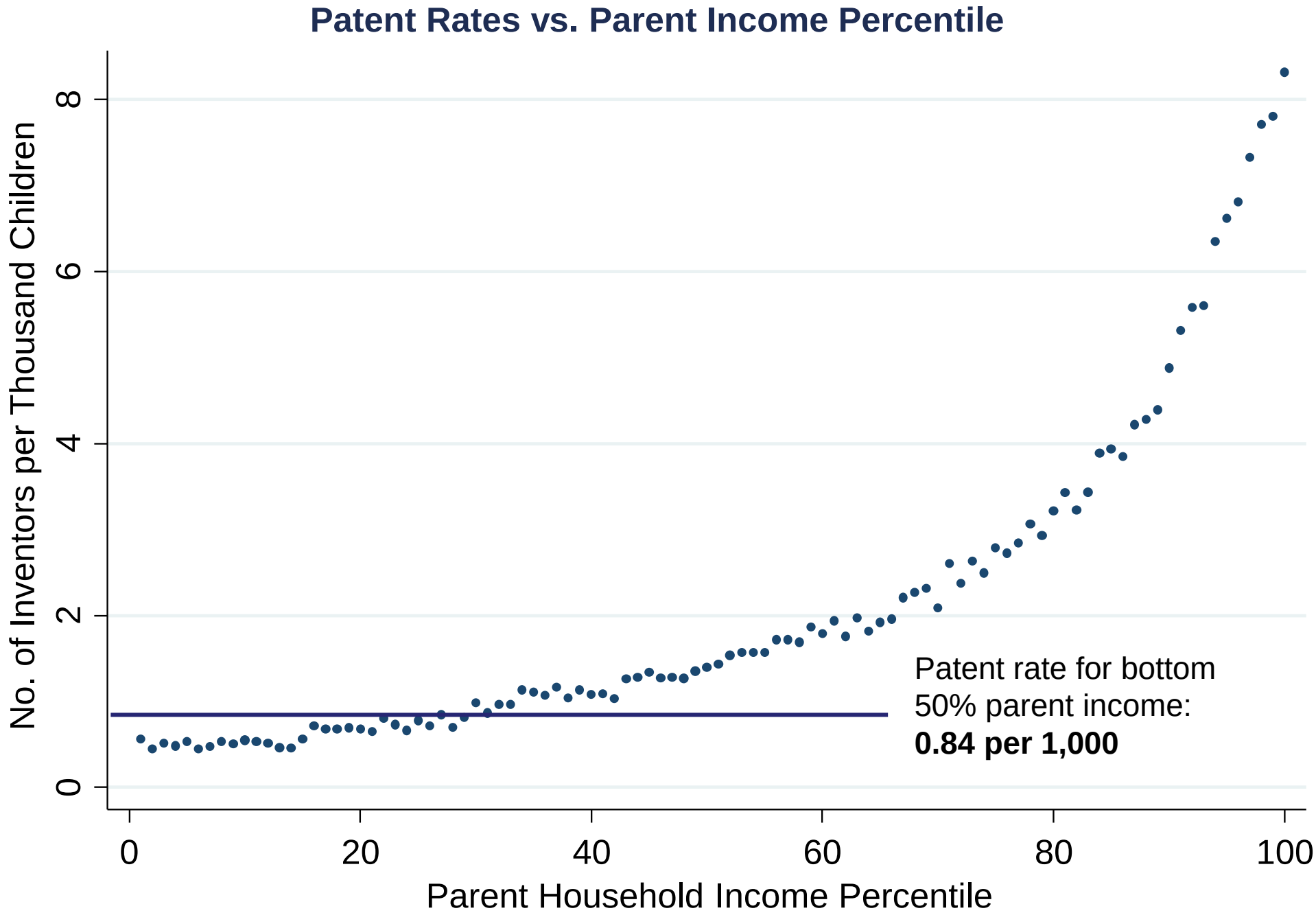
Successful Innovation Policies III



- R&D tax credits
- Direct government grants
- **Human capital supply**
  - Expanding STEM workforce
  - Universities
  - Immigration
  - **“Lost Einsteins & Marie Curies”:** Few women, minorities & kids from low income families in inventor pool = big loss of talent (Bell, Chetty, Jaravel, Petkova & Van Reenen, 2019, QJE)
- Competition and trade policy

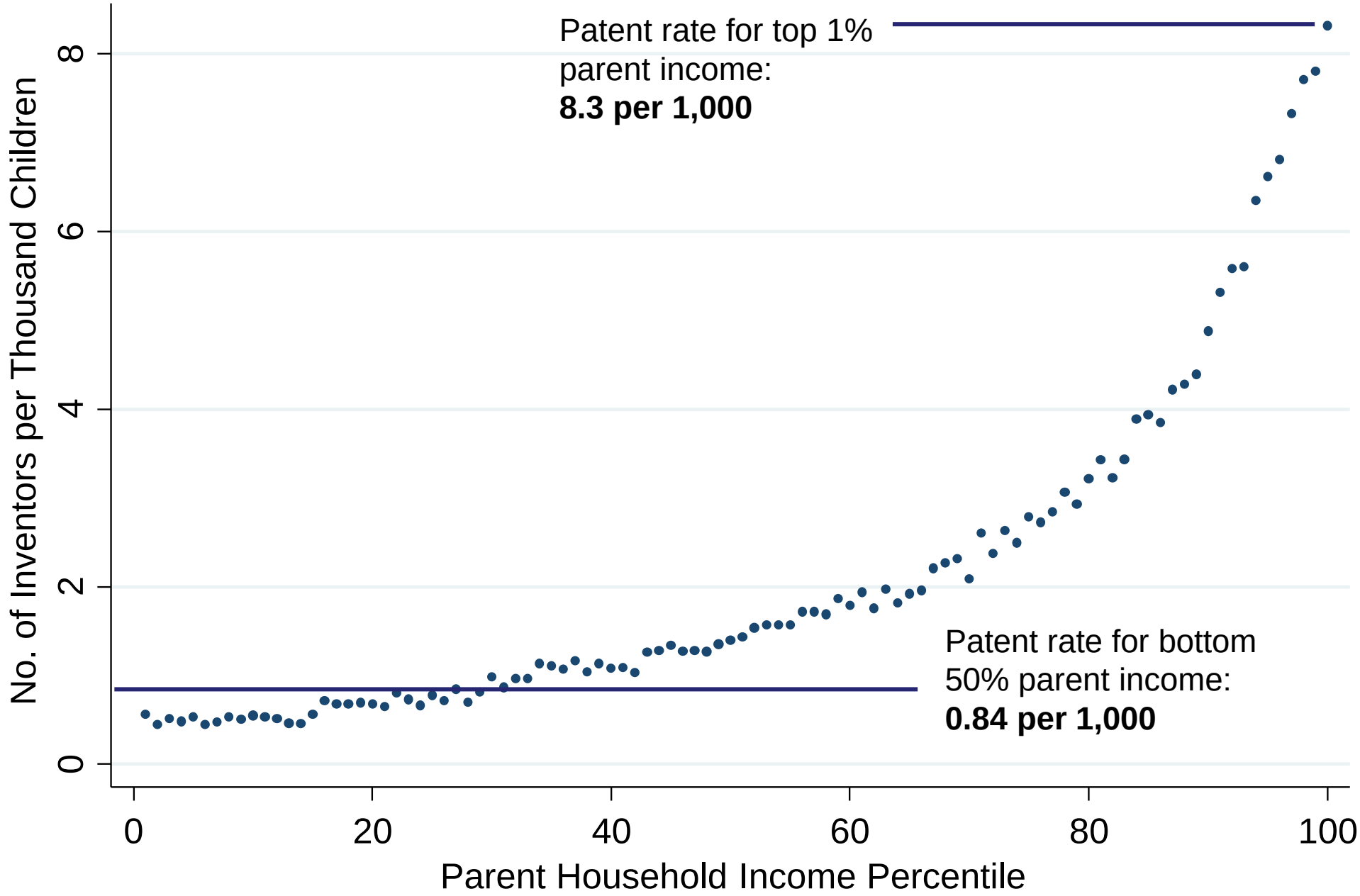


Note: Sample of children is 1980-84 birth cohorts. **Source:** Bell et al (2019)



Note: Sample of children is 1980-84 birth cohorts. **Source:** Bell et al (2019)

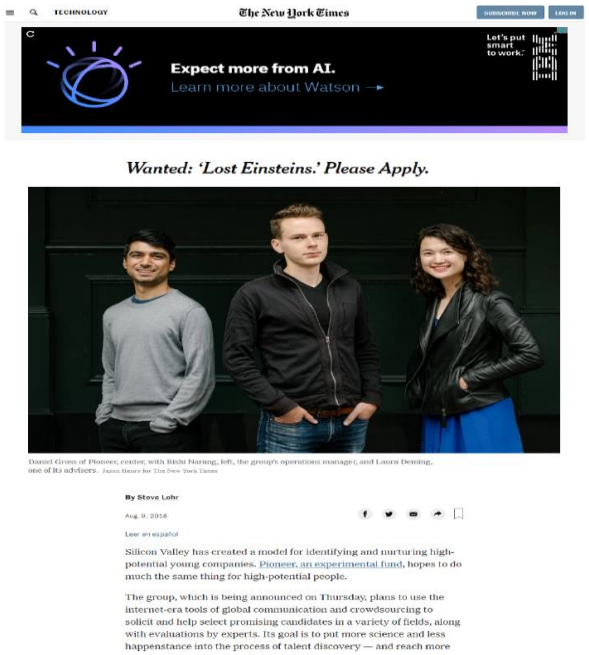
Patent Rates vs. Parent Income Percentile

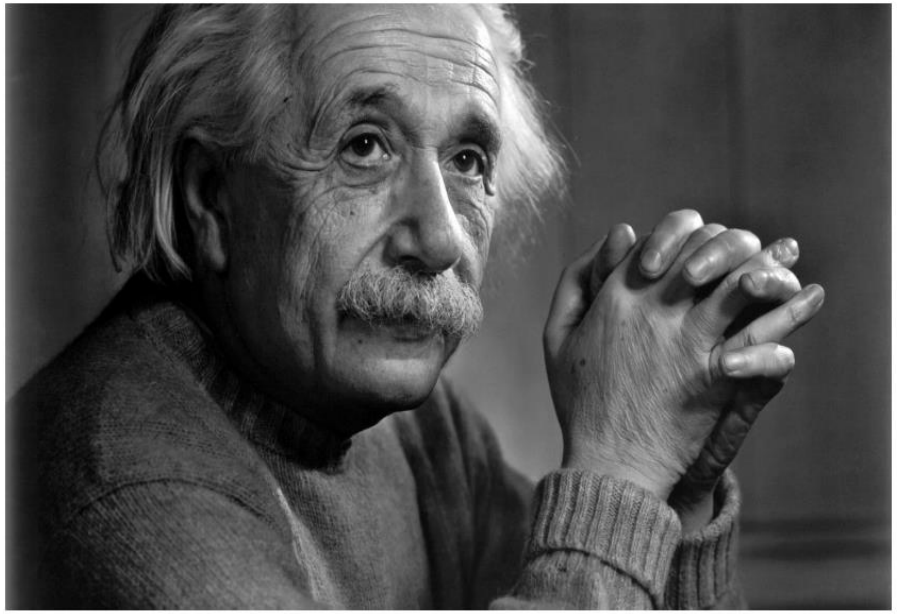


Note: Sample of children is 1980-84 birth cohorts. **Source:** Bell et al (2019)

Finding the “Lost Einsteins and Marie Curies”

- Kids born into richest 1% ten times more likely to grow up to be an inventor than those born in bottom 50% (not explained by early ability)
- Unlocking this hidden talent could quadruple innovation rate
- An example of policies that help growth <u>and</u> equity: e.g. education policies (Card & Giuliano ‘16; Cohodes ’20)





OUTLINE OF TALK

Background: The Challenge

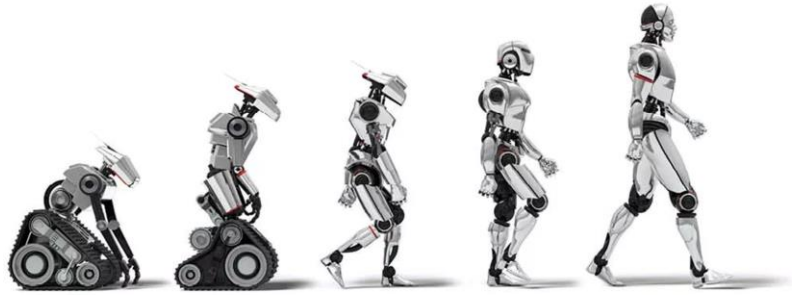
Innovation Policy

Diffusion Policy: Management

Misallocation

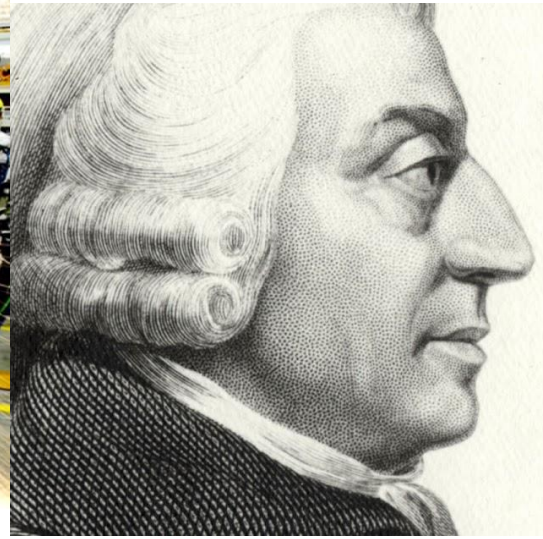
Growth Plan 2.0

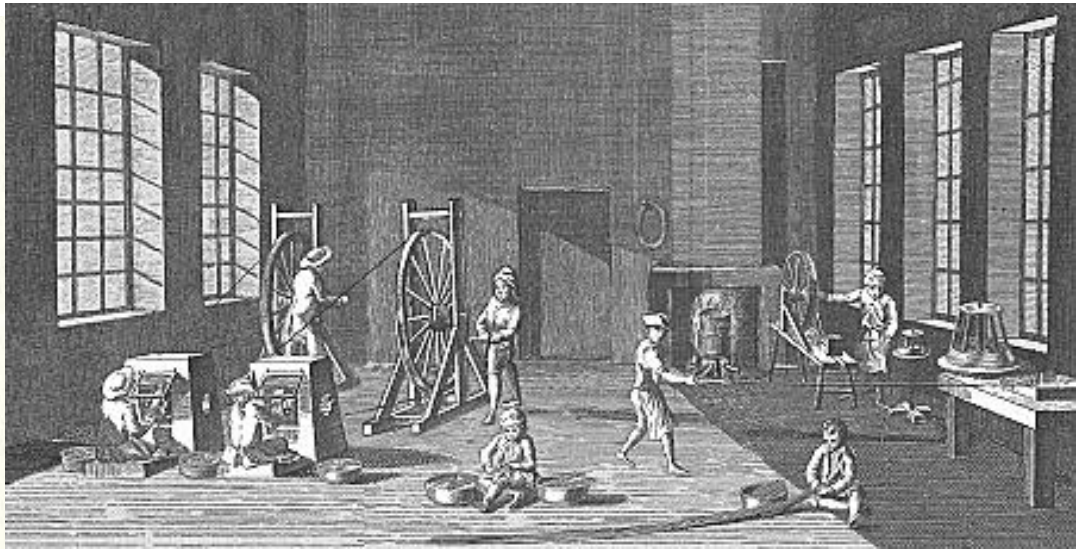
Two fundamental aspects of diffusion



- **Technology**
- **Management practices** (focus here today)

Toyota Plant





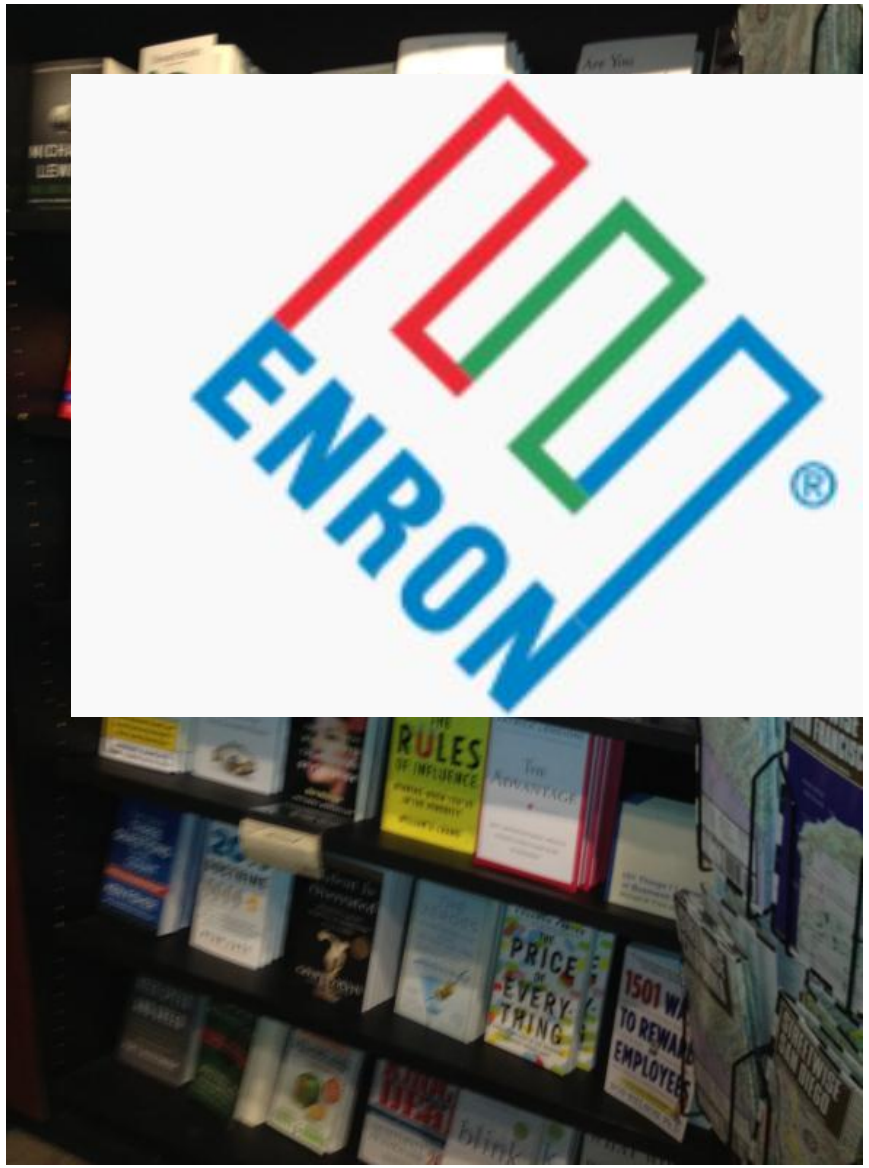
Adam Smith and the Pin Factory

There is still debate on whether management practices really matter

"*No potential driving factor of productivity has seen a higher ratio of speculation to empirical study*".

Chad Syverson (*Journal of Economic Literature*)

There is still debate on whether management practices really matter



There is still debate on whether management practices really matter

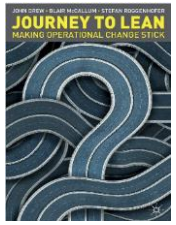
Enron ex-CEO, Jeff Skilling

There is still debate on whether management practices really matter

WORLD MANAGEMENT SURVEY (WMS); BLOOM & VAN REENEN (2007)

1) Developing management questions

- Scorecard for 18 monitoring (e.g. lean), targets & people (e.g. pay, promotions, retention and hiring). ≈45 minute phone interview of manufacturing plant managers



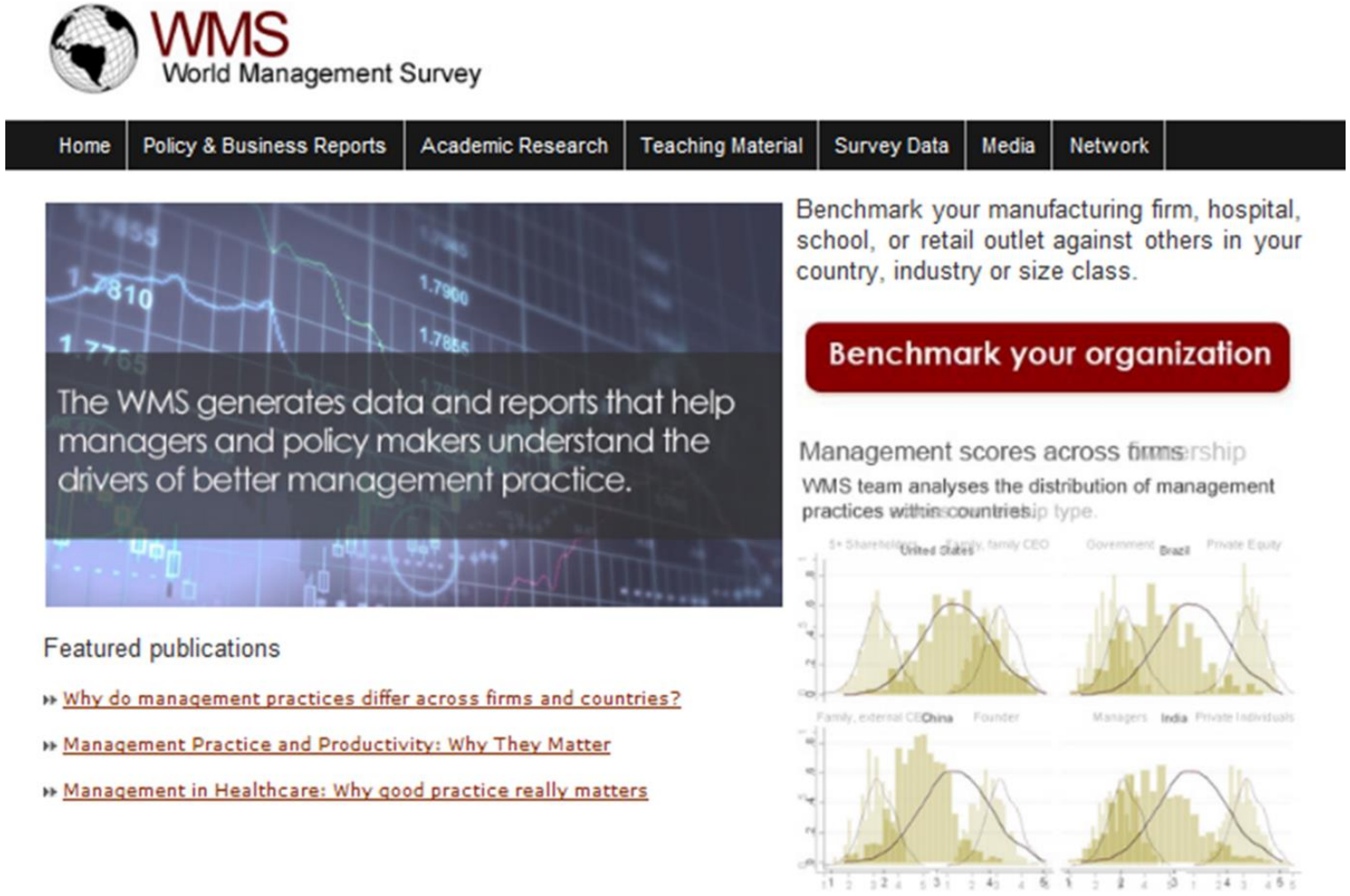
2) Obtaining unbiased comparable responses (“Double-blind”)

- Interviewers do not know the company’s performance
- Managers are not informed (in advance) they are scored

3) Getting firms to participate in the interview

- Official Endorsement: Bundesbank, Bank of England, RBI, etc.
- Run by 200 MBA types (loud, assertive & business experience)

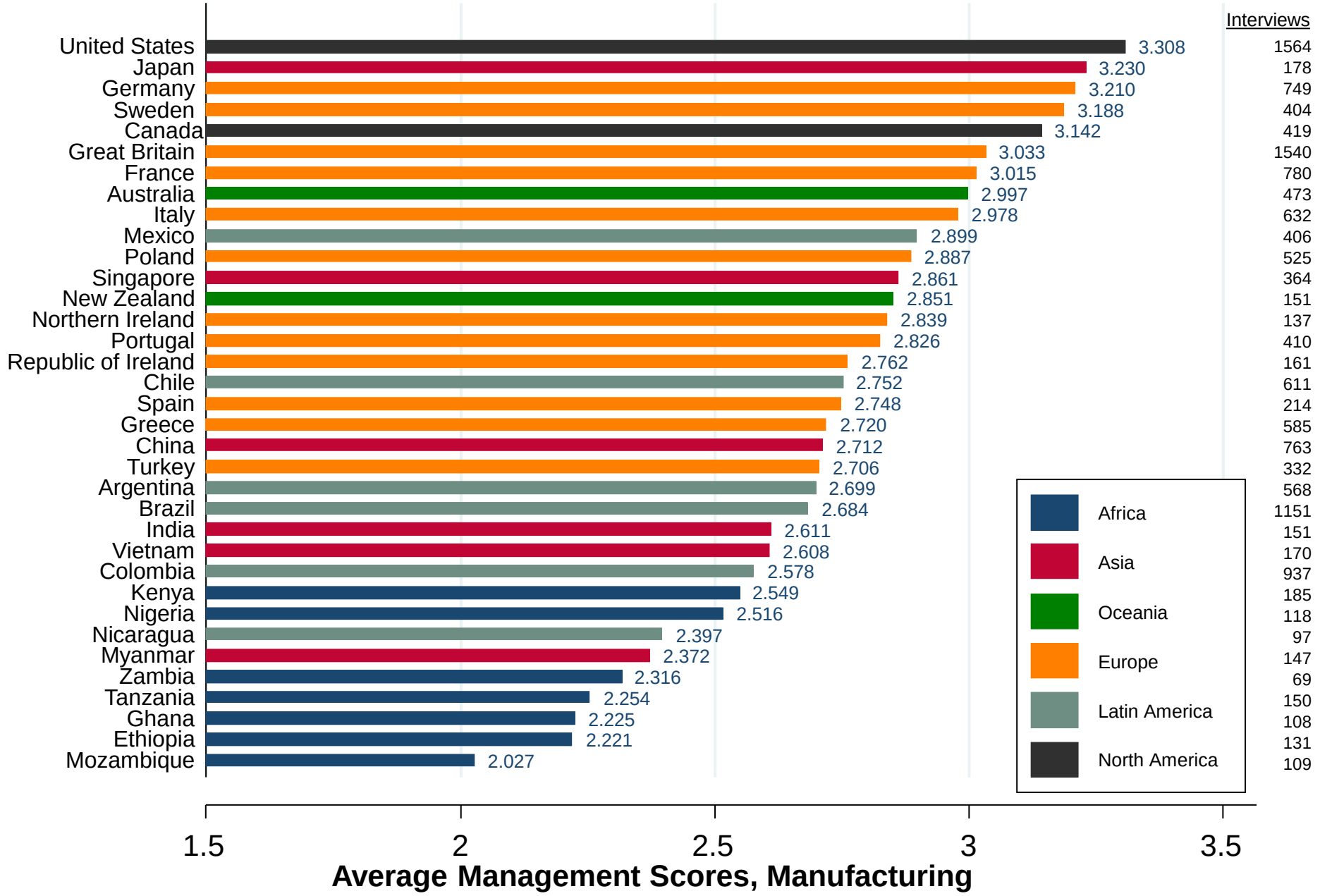
World Management Survey (~20,000 interviews, 4 major waves: 2004, 2006, 2009/10, 2013/14; [2022]; 34 countries)



Medium sized manufacturing firms(50-5,000 workers, median≈250)

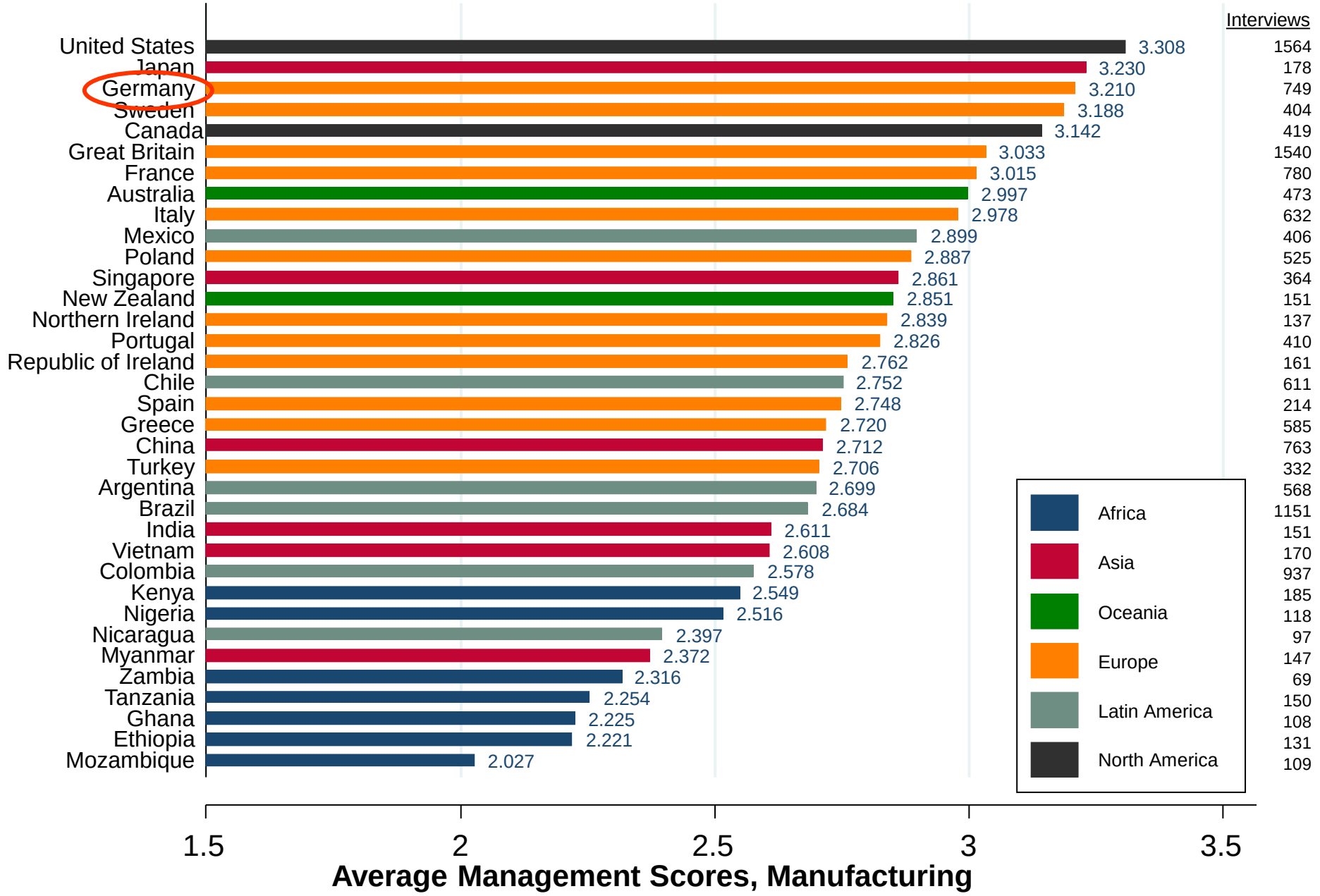
Now extended to Hospitals, Retail & Schools [& more]

Average Management Scores by Country



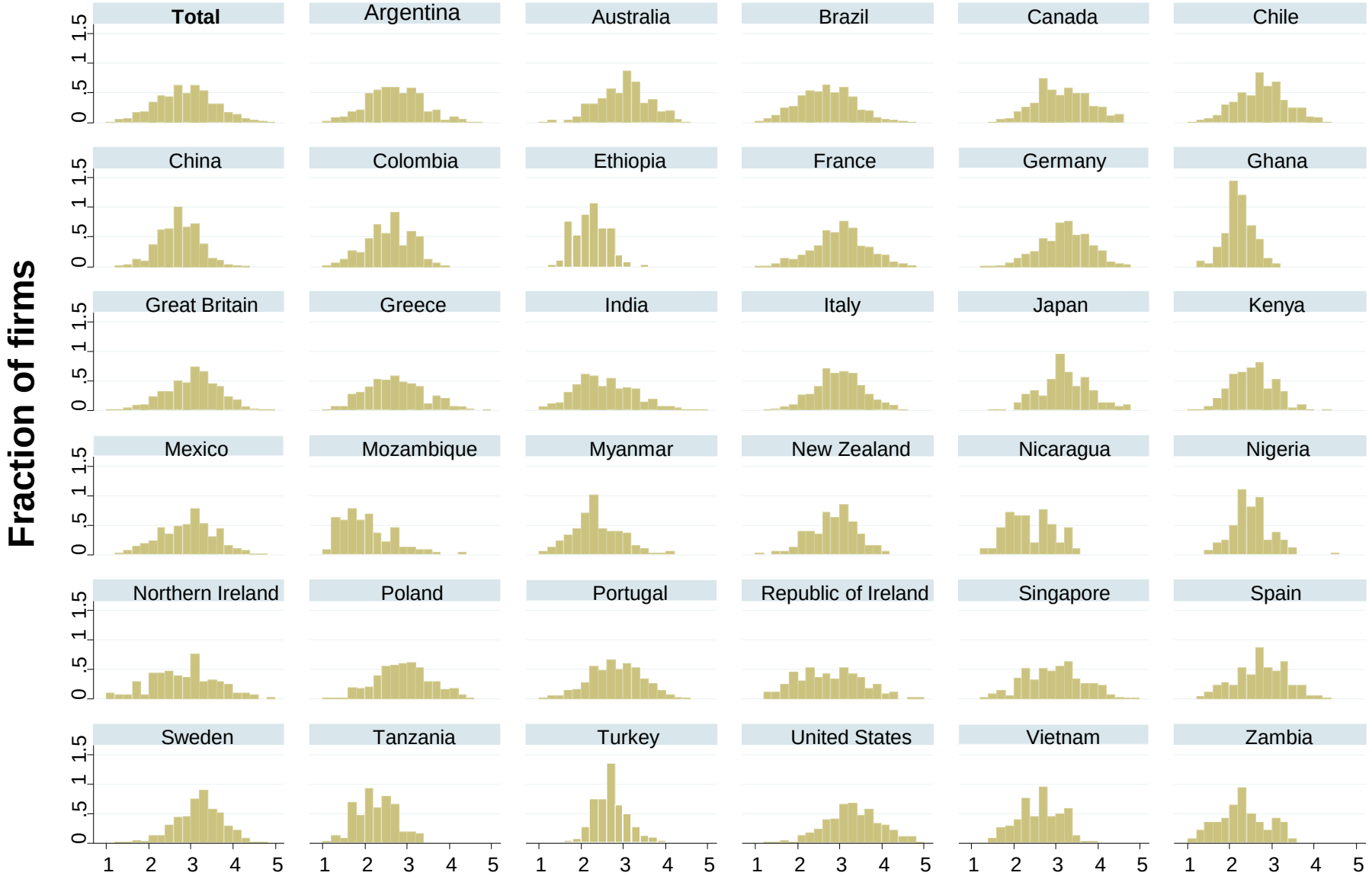
Source: Bloom, Sadun & Van Reenen (2020). **Note:** Unweighted average management scores; # interviews in right column (total = 15,489); all waves pooled (2004-2014)

Average Management Scores by Country



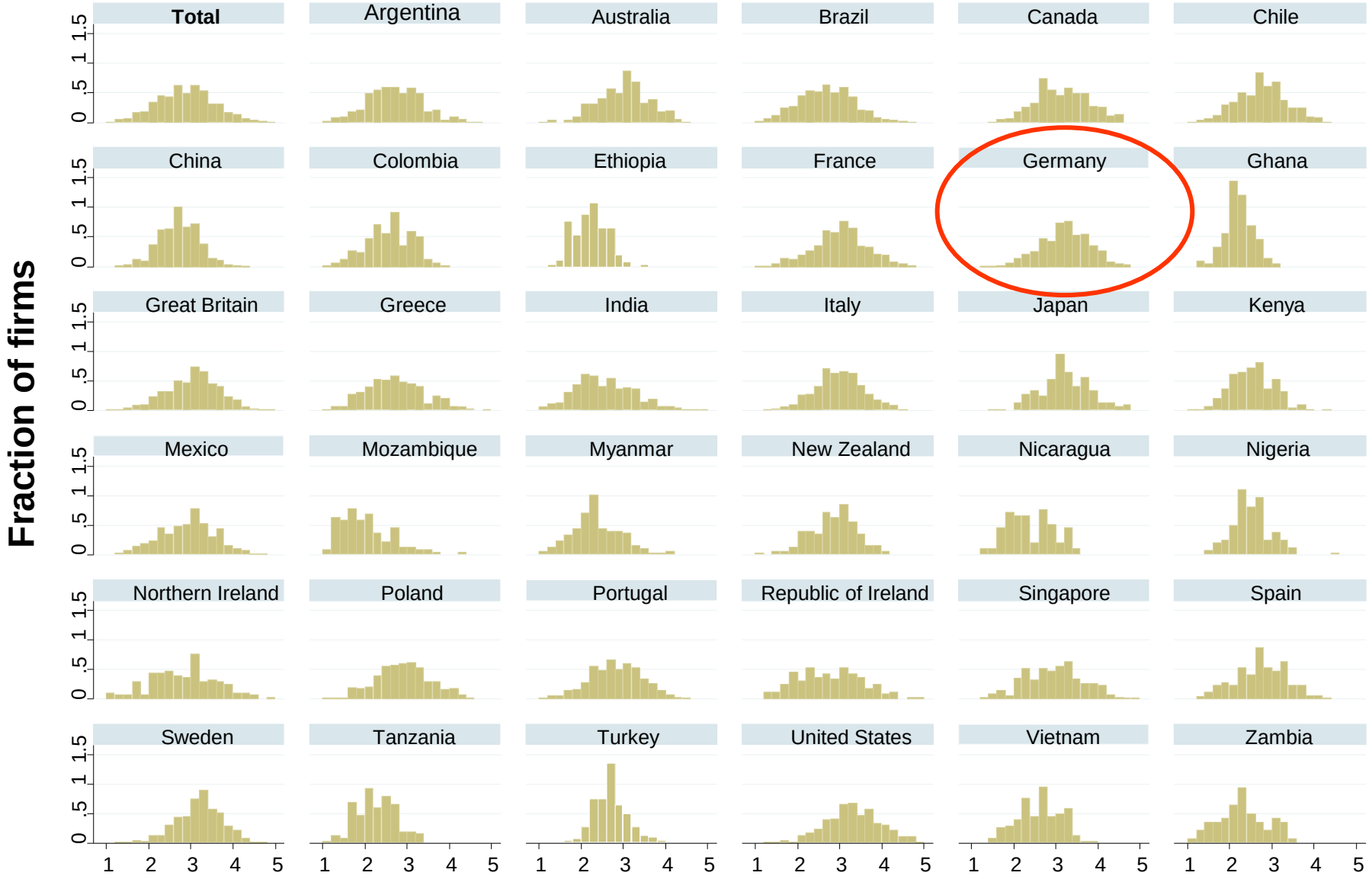
Source: Bloom, Sadun & Van Reenen (2020). **Note:** Unweighted average management scores; # interviews in right column (total = 15,489); all waves pooled (2004-2014)

Management also varies heavily within countries



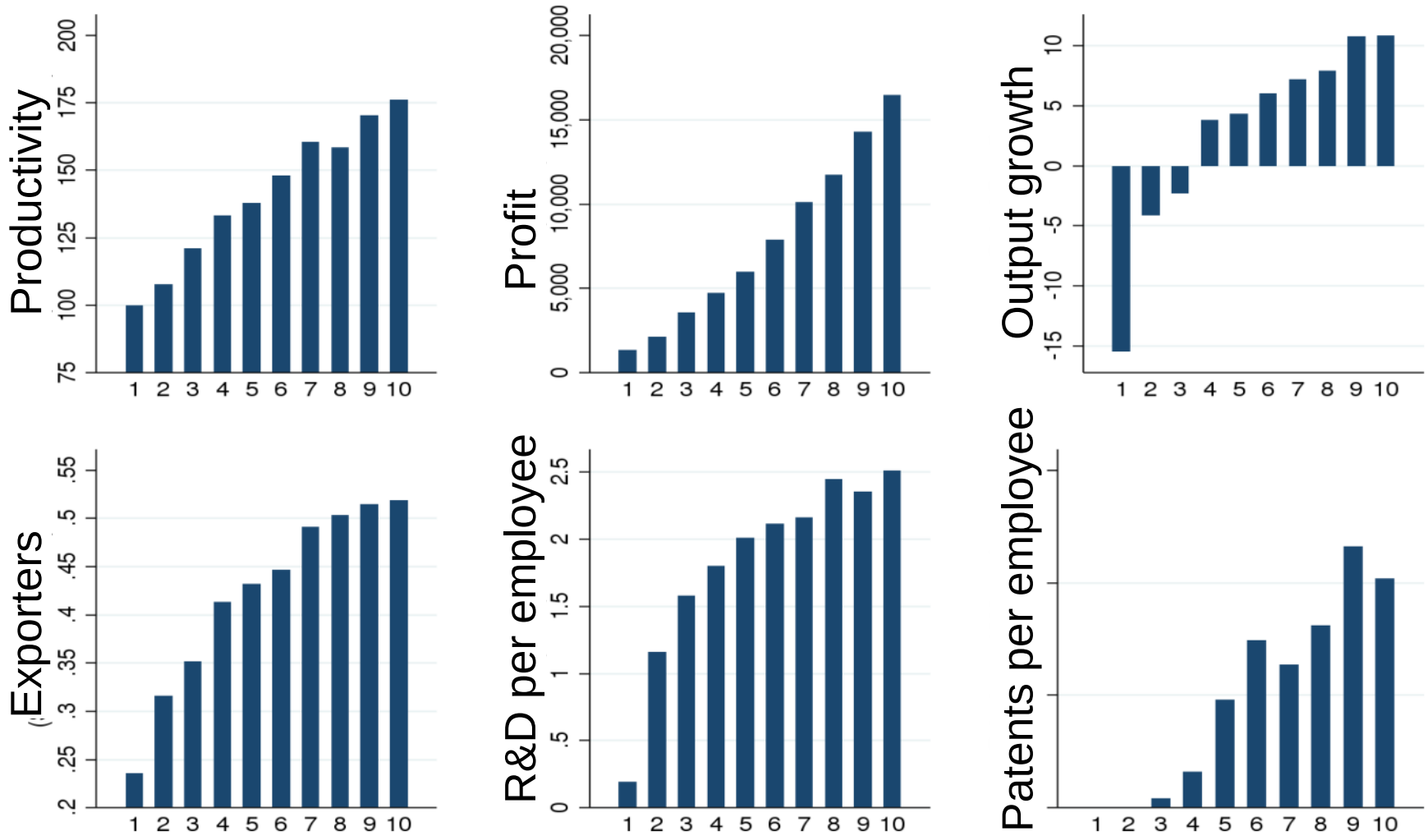
Source: Scur, Sadun, Van Reenen, Lemos and Bloom (2021)

Management also varies heavily within countries



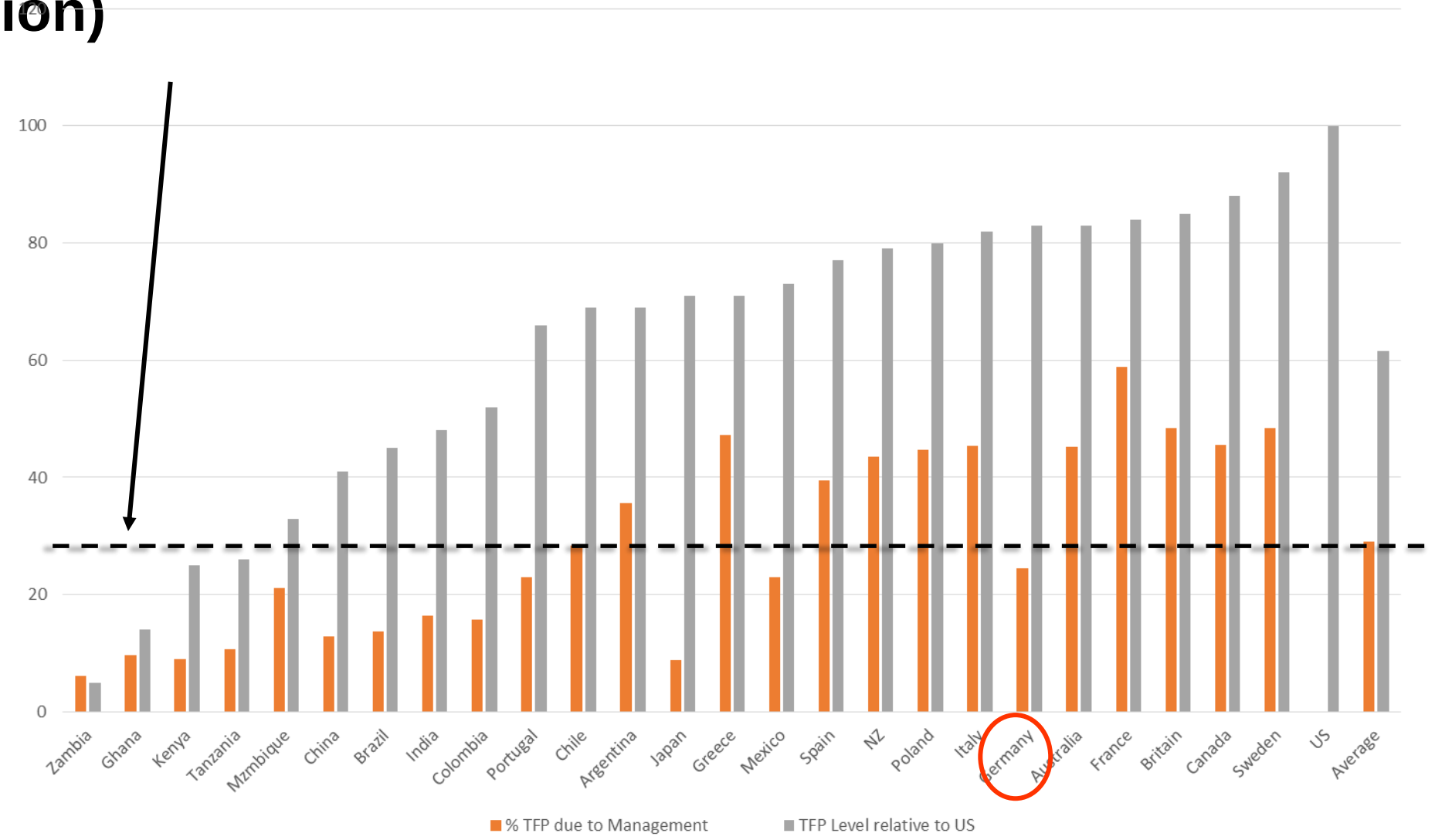
Source: Scur, Sadun, Van Reenen, Lemos and Bloom (2021)

Management scores positively correlated with many other measures of firm performance



Source: Bloom, Brynjolfsson, Foster, Jarmin, Patnaik, Saporta-Eksten & Van Reenen (2019, AER). MOPS

Globally Management accounts for a third of TFP Gap with US (~30% reallocation)



Source: Bloom, Sadun & Van Reenen "Management as a Technology"

Notes: TFP gaps from Penn World Tables; fraction accounted for by management uses the weighted average management scores and an assumed 10% impact of management on TFP

Toolkit of Management policies

L = Low; Not politically easy
M = medium
H = Highly possible

Policy type	Strength of evidence	Policy Net benefit (out of 5)	Difficulty of implementation	Time frame
Structural				
Competition	H		M	medium
Trade and FDI	H		L	medium
Education	M		M	long
Deregulation	M		L	medium
Governance	M		M/L	long
Direct				
Training - consulting	H		H	short
Training - formal classroom	M		H	medium
Information/benchmarking	L/M		H	medium

Source: Scur, Sadun, Van Reenen, Lemos & Bloom (2021)

OUTLINE OF TALK

Background: The Challenge

Innovation Policy

Diffusion Policy: Management

Misallocation

Growth Plan 2.0

Misallocation

- Enormous variation of productivity (& management) across firms
- About half of productivity growth is reallocation from less efficient to more efficient firms
- Productivity dispersion between firms has grown *larger* over time
  - e.g. Andrews, Criscuolo & Gal, 2015; Van Reenen, 2018; de Loecker, Obermeier & Van Reenen, 2022

OUTLINE OF TALK

Background: The Challenge

Innovation Policy

Diffusion Policy: Management

Misallocation

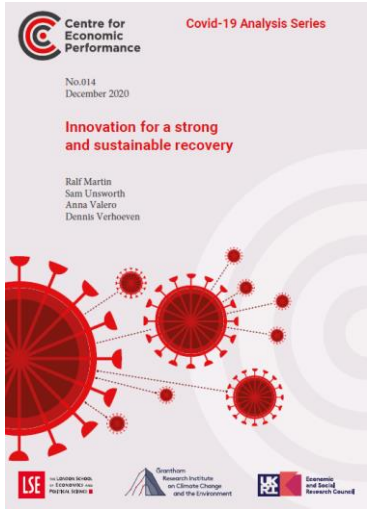
Growth Plan 2.0

Growth Plan 2.0

- **Short Run** Post-COVID policies balance reallocation & protection

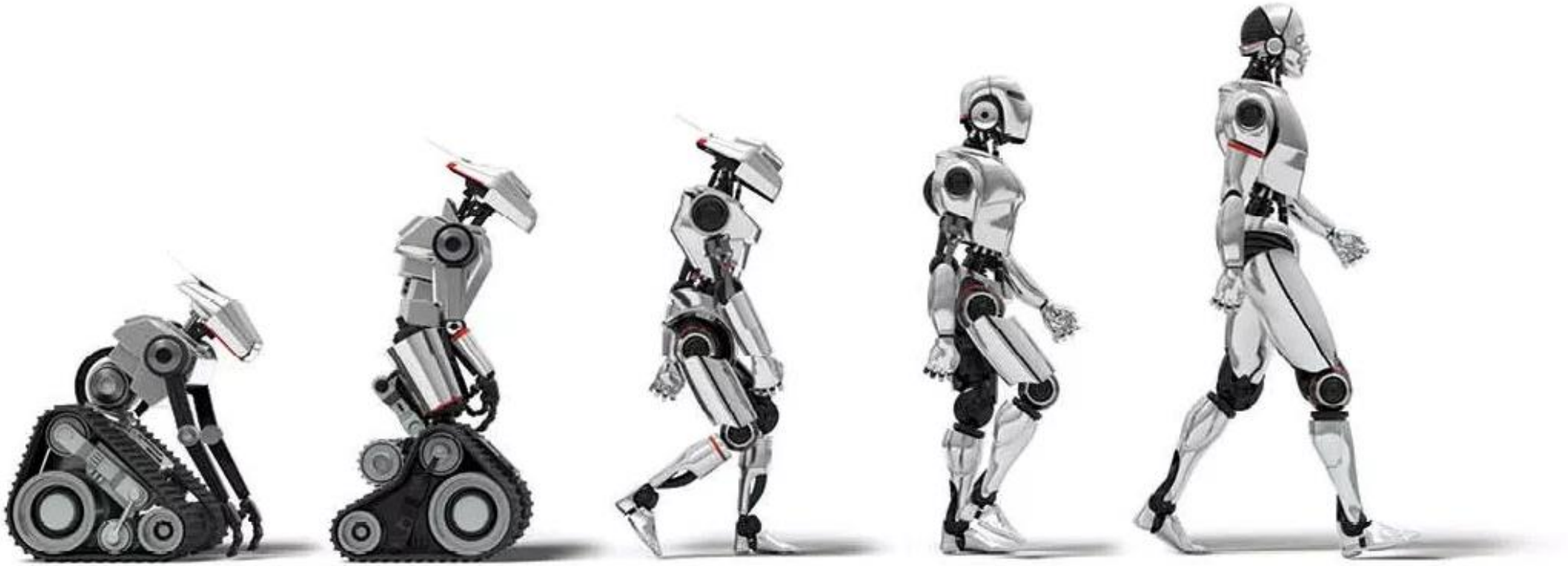
- **Long run** policies
  - *Structural* (**competition**, trade, skills, infrastructure, tax & subsidies)
  - *Direct* (e.g. management information and training)

- Use evidence:
  - Toolkits for innovation & management policy



- Bind together in a **mission**: Climate Change

THANKS!



Some Further Reading (and viewing)

"Innovation Policies to Boost Productivity" (2020) Hamilton Policy Proposal 2020-13 https://www.hamiltonproject.org/assets/files/JVR_PP_LO_6.15_FINAL.pdf webinar

"A Toolkit of Policies to promote Innovation" (Nick Bloom, Heidi Williams and John Van Reenen), *Journal of Economic Perspectives* *(2019)* 33(3) 163–184 http://cep.lse.ac.uk/pubs/download/dp1634.pdf

"Why Do We Undervalue Competent Management" (Raffaella Sadun, Nick Bloom and John Van Reenen) *Harvard Business Review* (2017), September-October

"Measuring and Explaining Management practices across firms and nations" (Nick Bloom and John Van Reenen) *Quarterly Journal of Economics* (2007) 122(4), 1351–1408.

"Who Becomes an Inventor in America? The Importance of Exposure to Innovation" (Alex Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova and John Van Reenen), http://cep.lse.ac.uk/pubs/download/dp1519.pdf Data *Quarterly Journal of Economics* (2019)134(2) 647–713, New York Times Vox Atlantic Fortune Conversation VoxUS Economist VC Centrepiece INET

"OPENing up Military Innovation: An Evaluation of Reforms to the U.S. Air Force SBIR Program" (Sabrina T. Howell, Jason Rathje, John Van Reenen and Jun Wong), Vox 2021 https://poid.lse.ac.uk/textonly/publications/downloads/poidwp004.pdf

"The Intellectual Spoils of War: Defense R&D, Productivity and Spillovers" (Enrico Moretti, Claudia Steinwender and John Van Reenen) http://cep.lse.ac.uk/pubs/download/dp1662.pdf Vox

Further reading

- "The World Management Survey at 18" (Scur, Sadun, Van Reenen, Lemos & Bloom, 2021), *Oxford Review of Economic Policy* https://poid.lse.ac.uk/textonly/publications/downloads/poidwp002.pdf

- World Management Survey http://worldmanagementsurvey.org/

- "Increasing Difference Between Firms" *Changing Market Structures and Implications for Monetary Policy*, Jackson Hole Symposium (Van Reenen, 2018) 19-65 http://cep.lse.ac.uk/pubs/download/dp1576.pdf NYT NPR

- LSE Growth Commission Final Report (Aghion et al, 2013)

http://www.lse.ac.uk/researchAndExpertise/units/growthCommission/documents/pdf/GCReportSummary.pdf

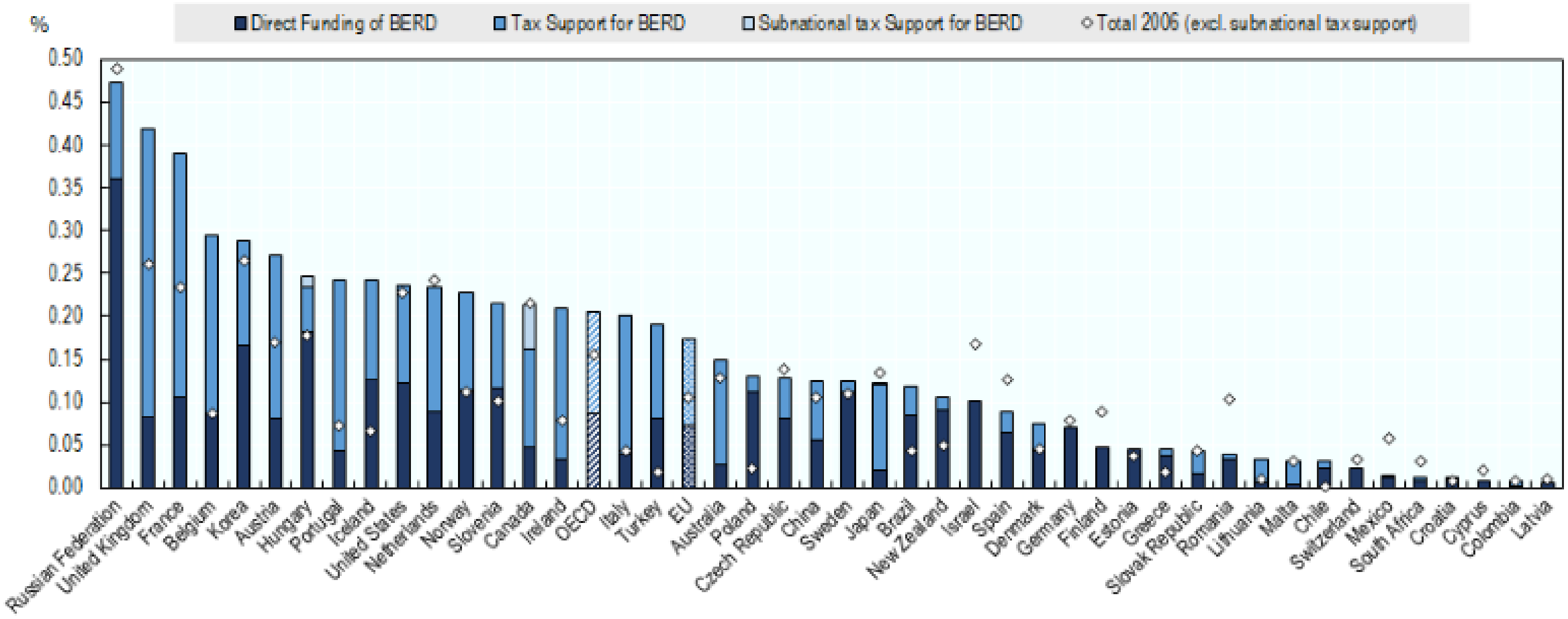
- "Management as a Technology" (Bloom, Sadun and Van Reenen, 2017): http://cep.lse.ac.uk/pubs/download/dp1433.pdf

- "Do Fiscal Incentives increase innovation? An RD Design for R&D" (Antoine Dechezlepretre, Elias Einio, Ralf Martin, Kieu-Trang Nguyen and John Van Reenen), CEP Discussion Paper 1413 Vox, http://cep.lse.ac.uk/pubs/download/dp1413.pdf

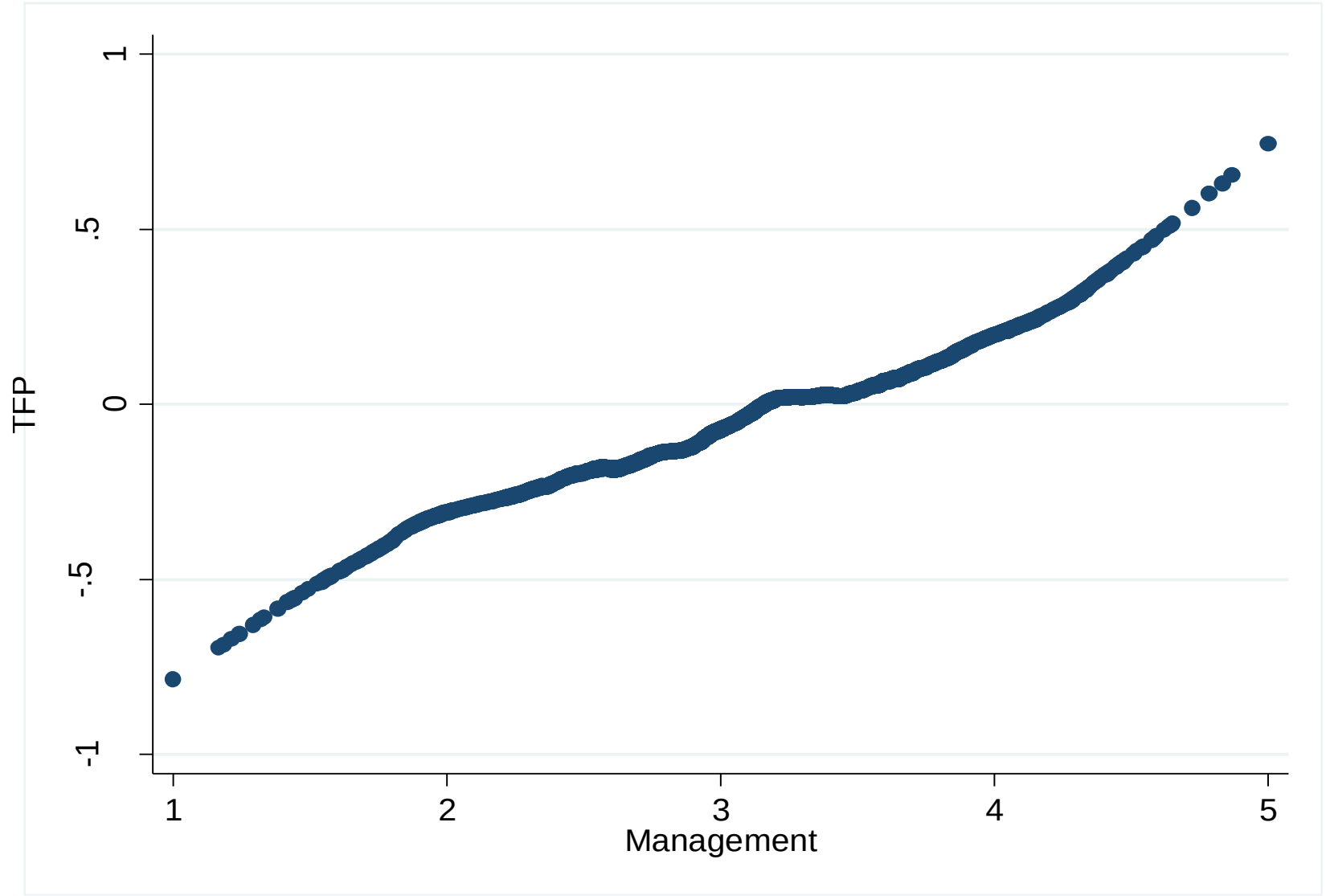
Table 8: Spillovers

Sample	All (OLS)	All (OLS)	Large tech class (OLS)	Small Tech class (OLS)	Small Tech class (IV)
Dependent variable (patents) mean over 2006-08	*0.396*	*0.396*	*0.397*	*0.291*	*0.291*
Baseline firm's below-asset-threshold indicator (in 2007)	0.019	0.067***	0.018	0.196**	
	(0.012)	(0.019)	(0.011)	(0.093)	
Baseline firm's below-threshold indicator*tech. class size *('000)*		-0.029**			
		(0.007)			
Baseline firm's R&D 2009-11 average (millions)					0.222***
					(0.111)
Observations	203,832	203,832	201,739	2,093	2,093

Note: Sample of tech-connected pairs of a baseline firm & connected firm. Baseline firms (547) include patenting firms with total assets in 2007 between €61m and €111m. Connected firms (17,632) = universe of firms patenting before 2008. Running variable: baseline firm's 2007 assets in with a threshold of €86m. Controls for polynomials of running variable and connected firm's 2007 assets. SEs in brackets clustered by baseline and connected firms' shared tech class. Tech class size is # firms in tech area. Small is under 200 firms in class.


%
Direct Funding of BERD
Tax Support for BERD
Subnational tax Support for BERD
Total 2006 (excl. subnational tax support)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Russian Federation
United Kingdom
France
Belgium
Korea
Austria
Hungary
Portugal
Iceland
United States
Netherlands
Norway
Slovenia
Canada
Ireland
OECD
Italy
Turkey
EU
Australia
Poland
Czech Republic
China
Sweden
Japan
Brazil
New Zealand
Israel
Spain
Denmark
Germany
Finland
Estonia
Greece
Slovak Republic
Romania
Lithuania
Malta
Chile
Switzerland
Mexico
South Africa
Croatia
Cyprus
Colombia
Latvia

Productivity strongly positively correlated with Management Scores



Notes: Management is an average of all 18 questions (set to sd=1). TFP residuals of sales on capital, labor, skills controls plus a full set of SIC-3 industry, country and year dummies controls. N=10,900. **Source:** Bloom, Sadun and Van Reenen (2017)