Programme on
Innovation and Diffusion

The Case for Growth: Threats and Opportunities

OECD Global Forum on Productivity
July 8th, 2022

John Van Reenen

LSE and MIT

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Summary

- OECD countries face severe **growth threats** arising from Pandemic & Ukraine crises.
- Even before these crises, there was global problem of **low productivity growth** since (at least) the 2008-9 Financial Crisis
- Opportunity for policy framework to focus on equitable and environmentally **sustainable growth**
- **Innovation and Diffusion** of better *technologies* and *management practices* are key to this

- We know much about *what* to do. Main challenge is political *will*
  - Need to join up in new **Marshall Growth Plan**
  - Frame around missions on **climate, defense & health**

OUTLINE OF TALK

Threats and Opportunities

Productivity

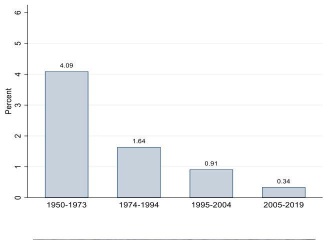
Climate Change

Defense

Health

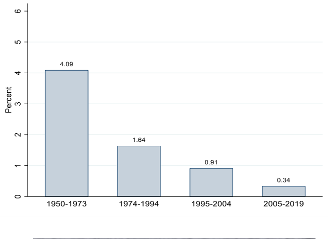
The Political Challenge

Threats and Opportunities (with examples!)



Threats	Examples
Long-run productivity Slowdown	Post Global Financial Crisis

Threats and Opportunities (with examples!)



Threats	Examples	Opportunities	Examples
Long-run productivity Slowdown	Post Global Financial Crisis	New Marshall Plan for Growth	Policy Toolkits

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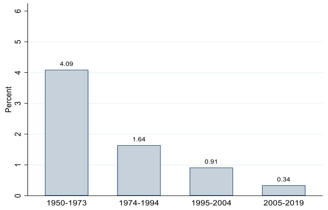	Long-run productivity Slowdown	Post Global Financial Crisis	New Marshall Plan for Growth	Policy Toolkits
	Environment	Climate Change		

Threats and Opportunities (with examples!)

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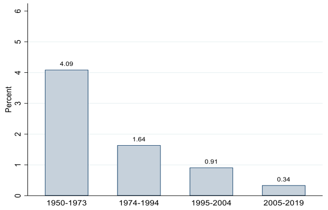
Environment	Climate Change	Directed Clean Technical Change	Solar



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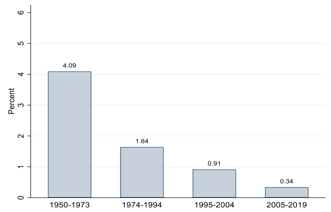	Long-run productivity Slowdown	Post Global Financial Crisis	New Marshall Plan for Growth	Policy Toolkits
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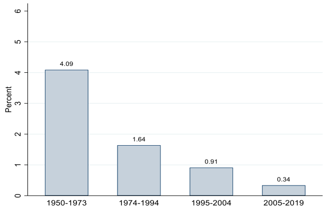

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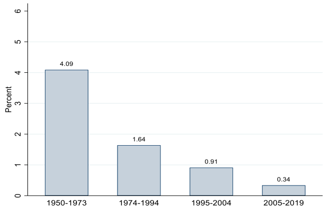

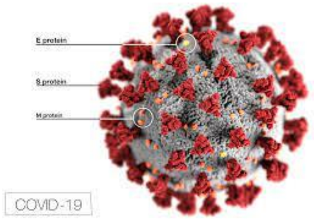

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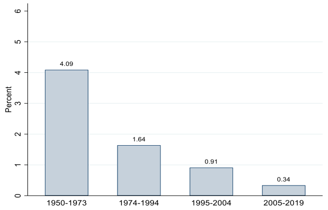

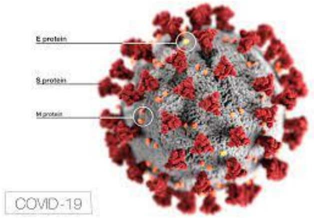

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Health	COVID-19	Public-Private partnerships	Vaccines, EHR

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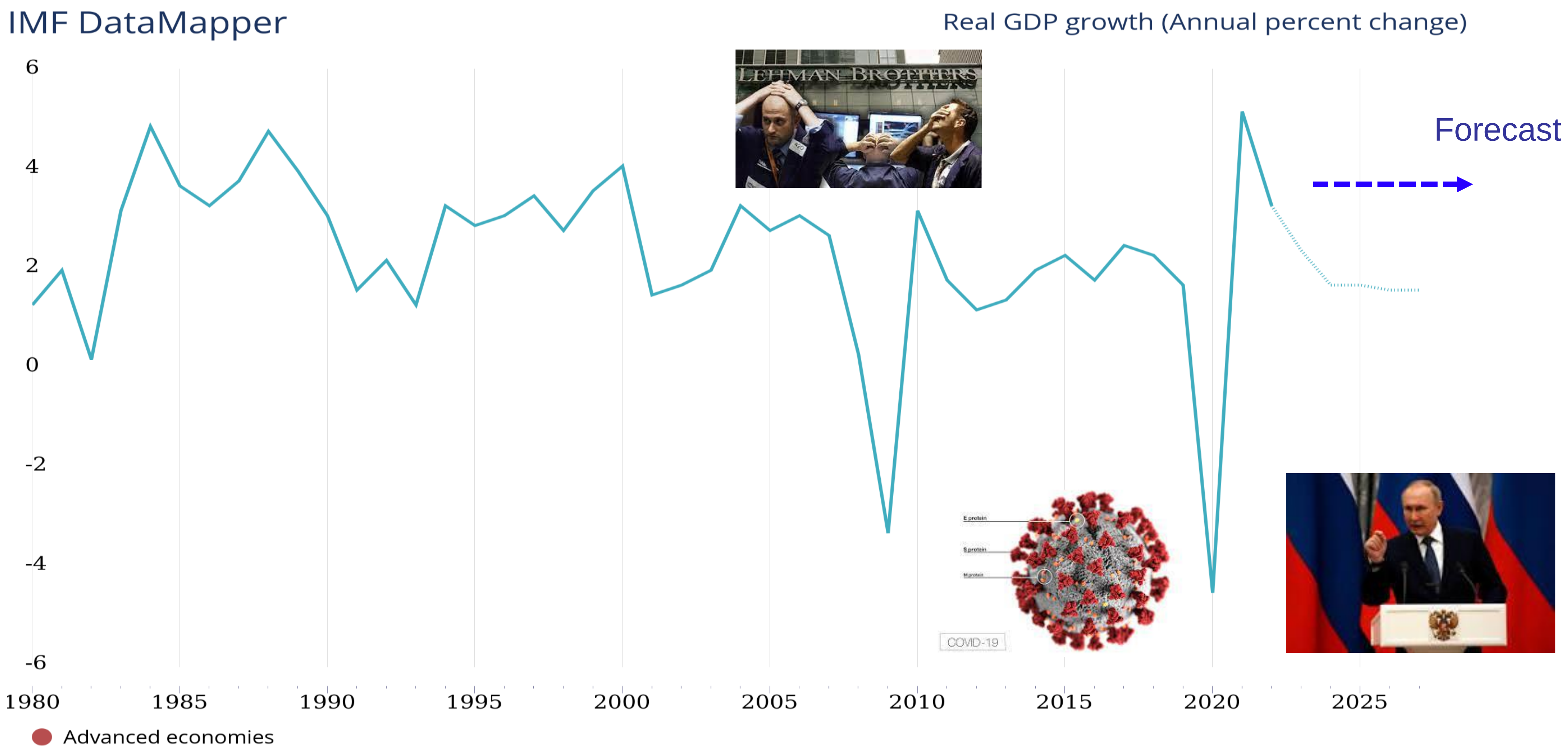
The Political Challenge

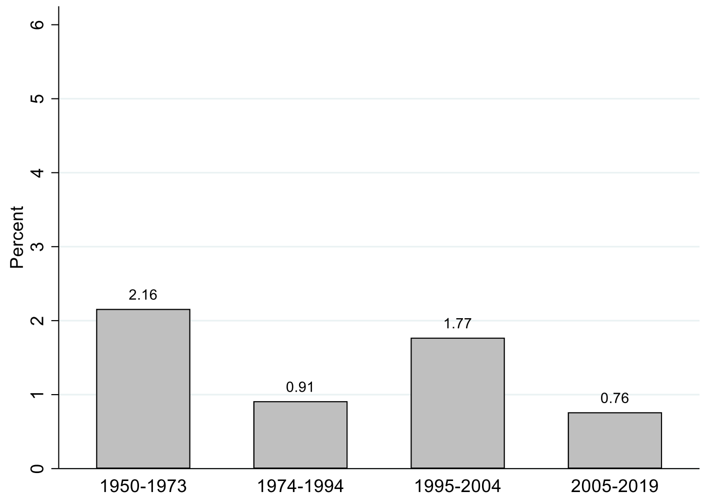
The Big Hit: GDP growth in Advanced Economies, 1980-2022



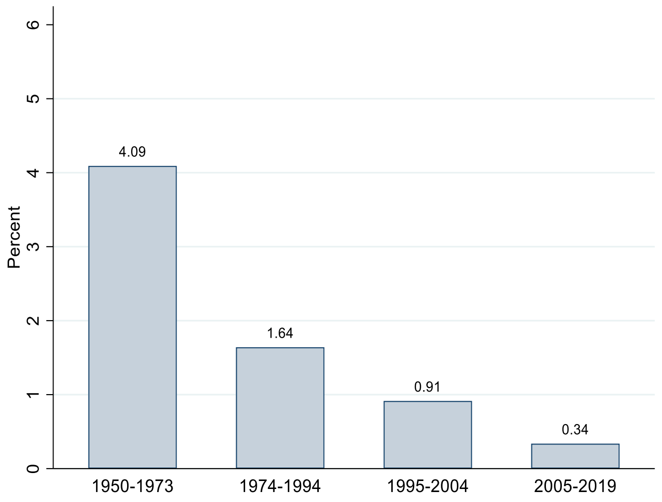
©IMF, 2022, Source: World Economic Outlook (April 2022)

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

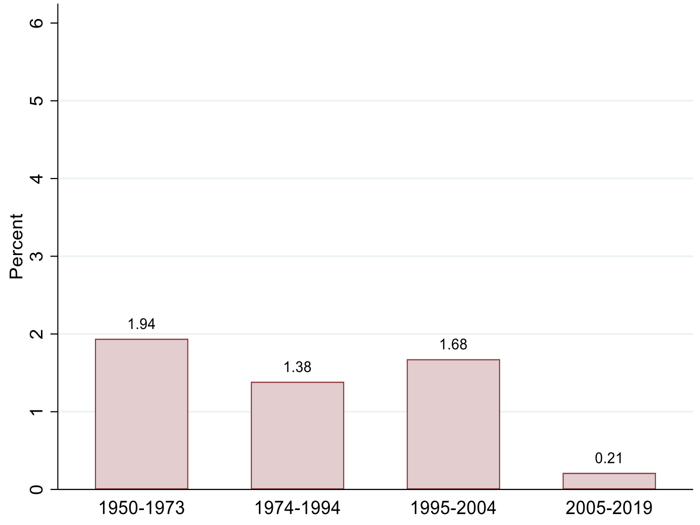
A. United States



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 Euro-area so Germany, France, Italy, Spain, Netherlands, and Finland are used.

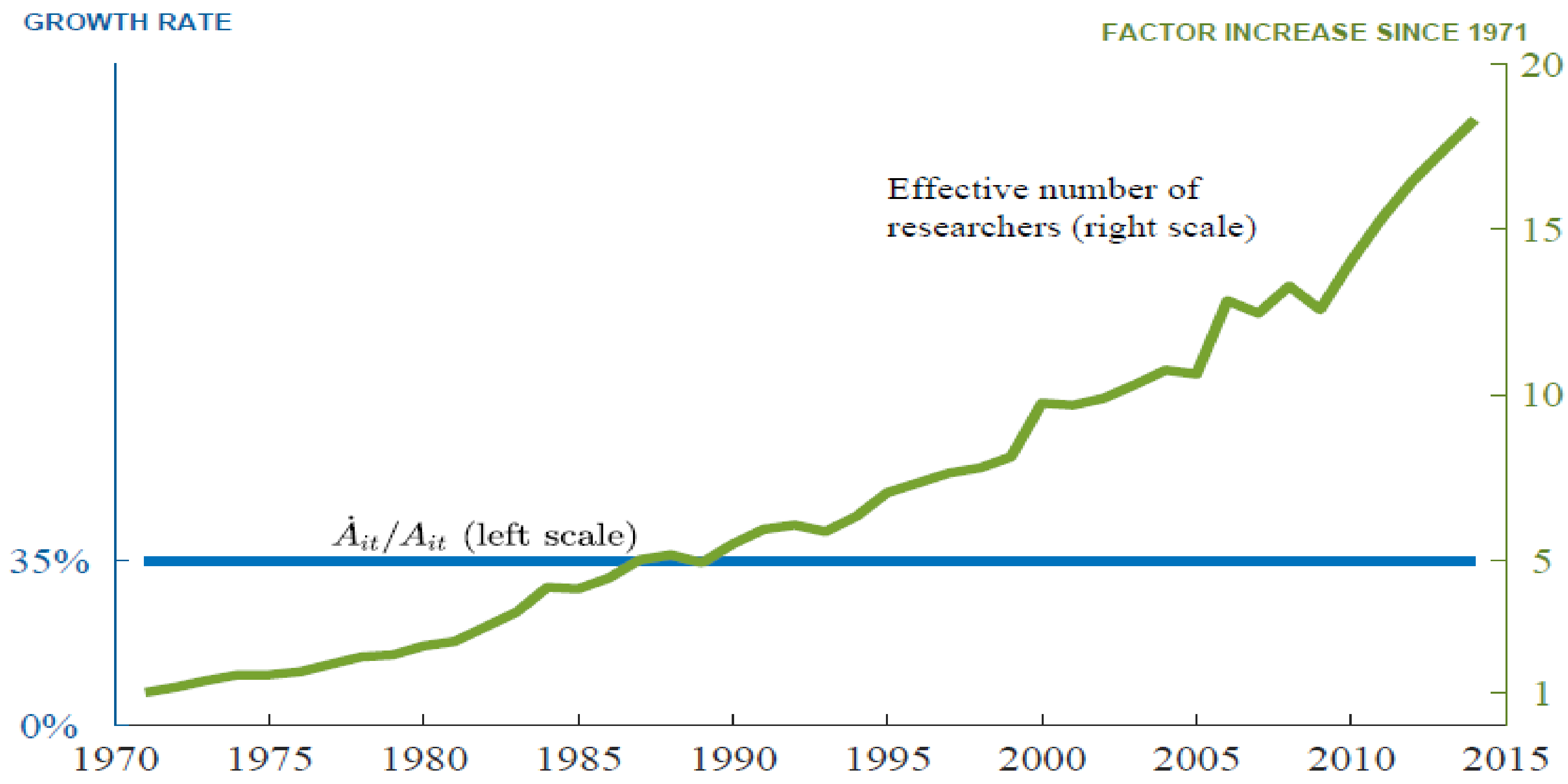
Drivers of Aggregate Productivity

- Pushing out the **technological frontier**
  - Important for OECD countries, 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)

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Threats and Opportunities

Productivity:

1. **Innovation Policies**
2. Diffusion Policies

Why should the government subsidize innovation?

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

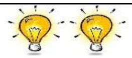
- **Empirical evidence suggests strong role for knowledge spillovers:**
  - Bloom, Shankerman & Van Reenen (2013); Lucking, Bloom and Van Reenen (2020); Jones & Summers (2022)
  - Social return to R&D is ~3-4 times as large as the private return. Implies large under-investment

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)	(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	↑

“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

Example of Innovation Policy: R&D tax credits

- **Do Fiscal incentives increase R&D (Hall, 2022)?**
  - Cross country (e.g. Bloom, Griffith & Van Reenen, 2002)
  - Cross state (e.g. Wilson, 2009)
  - Cross firm (e.g. Hall, 1992; Rao, 2016)
  - Elasticity of R&D with respect to user cost >1 (see Blandinieres et al, 2020 meta-study)

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

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

Antoine Dechezleprêtre (OECD)

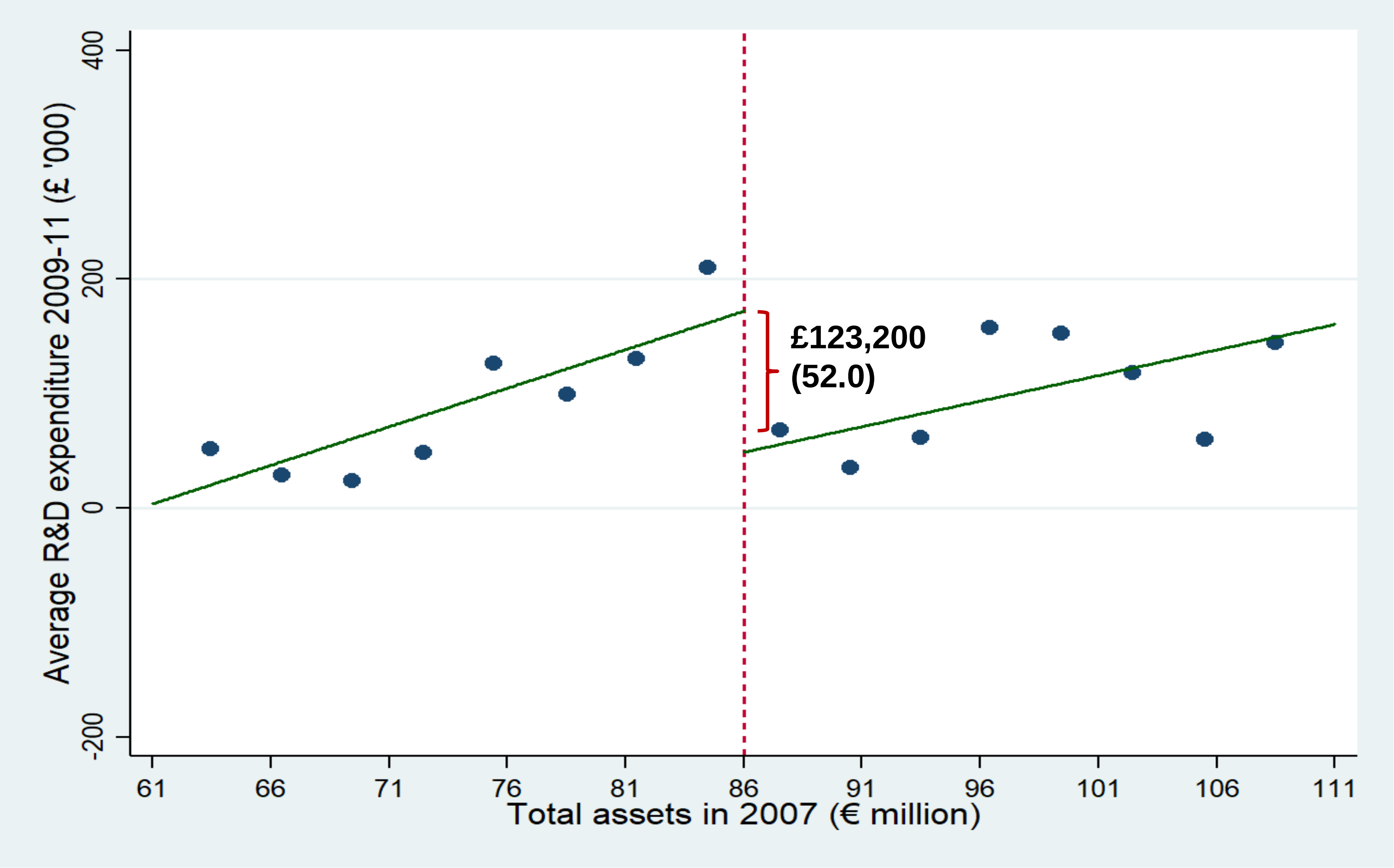
Elias Einiö (VATT)

Ralf Martin (Imperial College)

Kieu-Trang Nguyen (Northwestern)

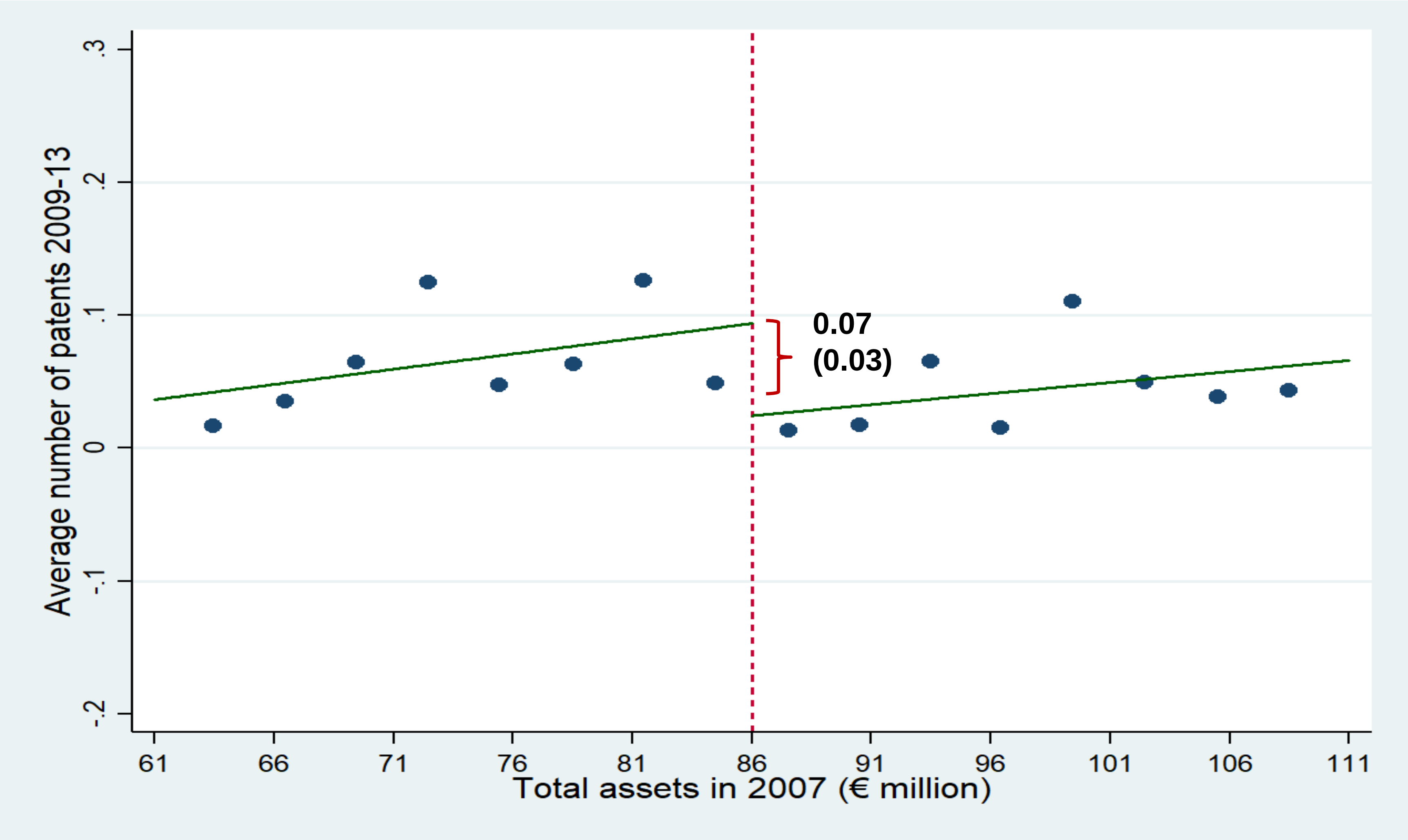
John Van Reenen (LSE, MIT)

Discontinuity effects on R&D



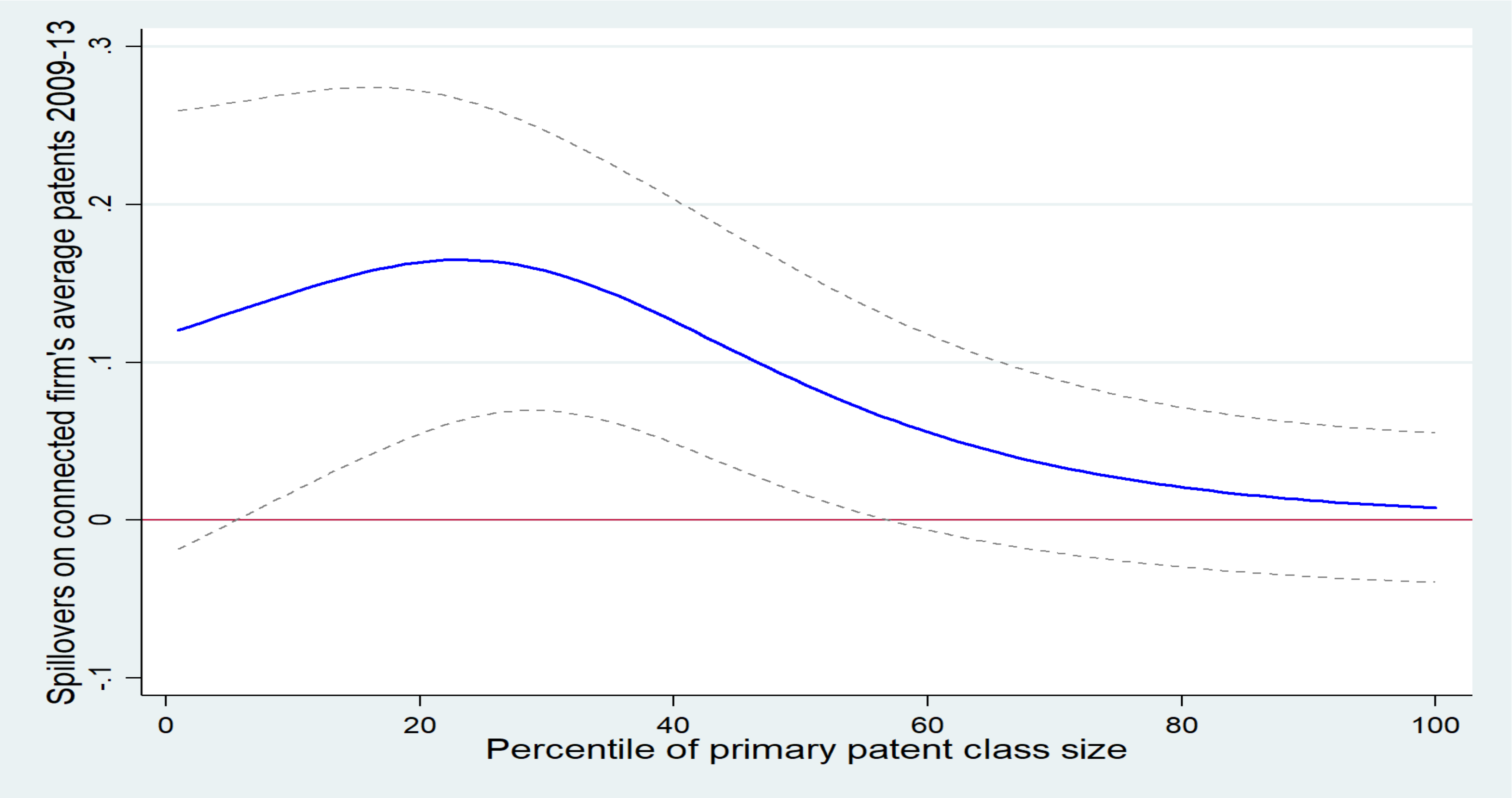
Source: Dechezlepretre et al (2022); **Notes:** 5,888 obs. Assets from FAME based on SME threshold (€86m). R&D from CT600. Sample of firms with €25m above & below the threshold. 368 obs per €3m bin.

Discontinuity effects on patenting



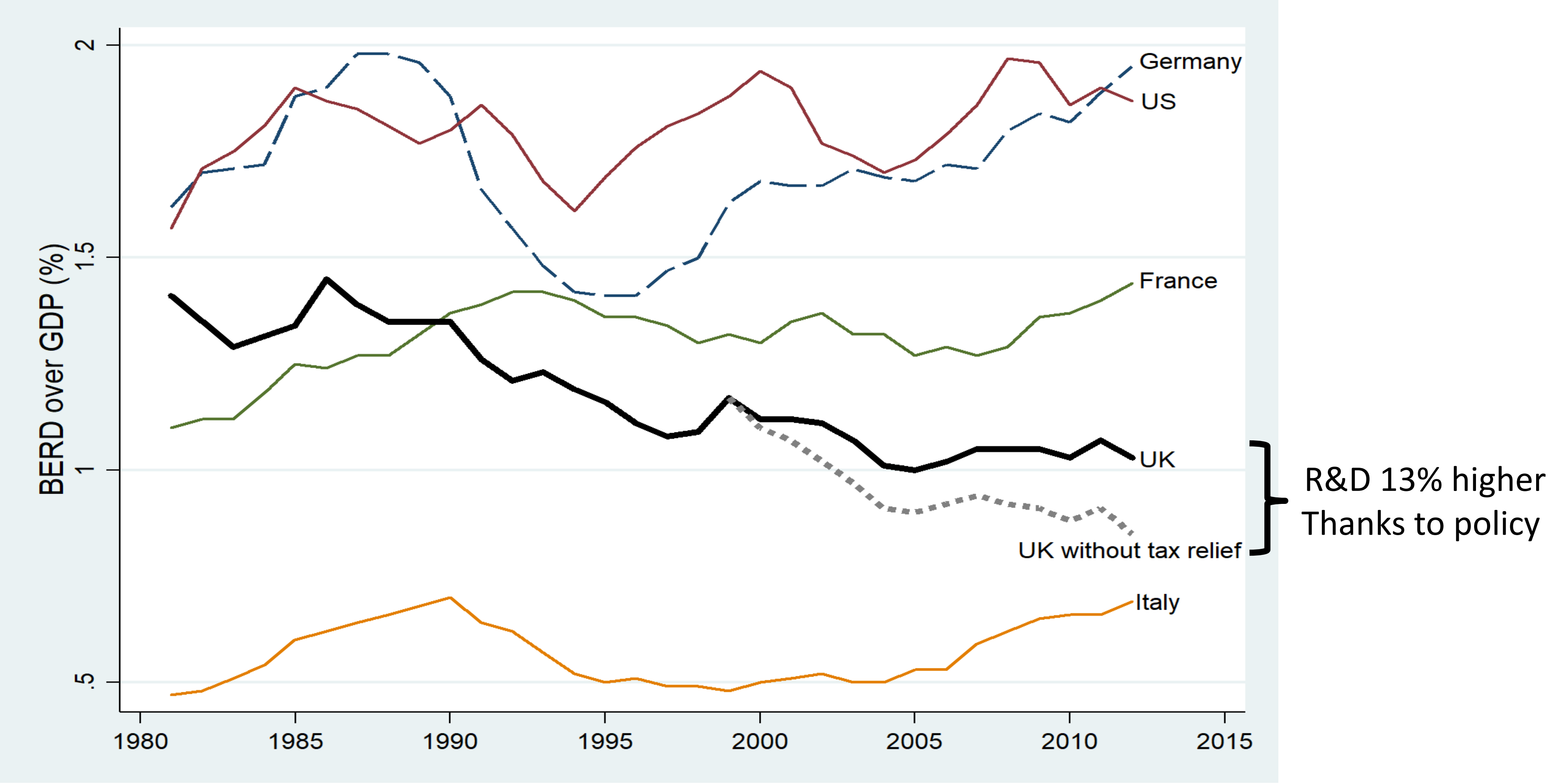
Source: Dechezlepretre et al (2022); **Notes:** 5,888 observations. Assets from FAME based on SME assets threshold (€86m) definition. R&D is from CT600. Sample of firms with €25m above & below the threshold. Outcome is average number of patents filed between 2009 and 2013.

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.

Putting this all together:
UK Business R&D/GDP ratio about 13% higher due to R&D tax policy since 2000



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.

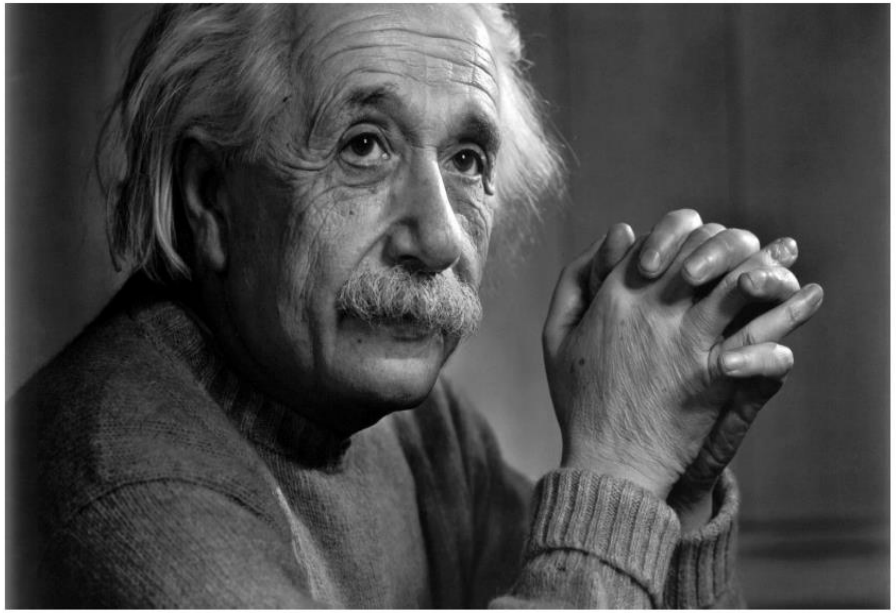
Innovation Policies II: Human Capital

- 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 II

- 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

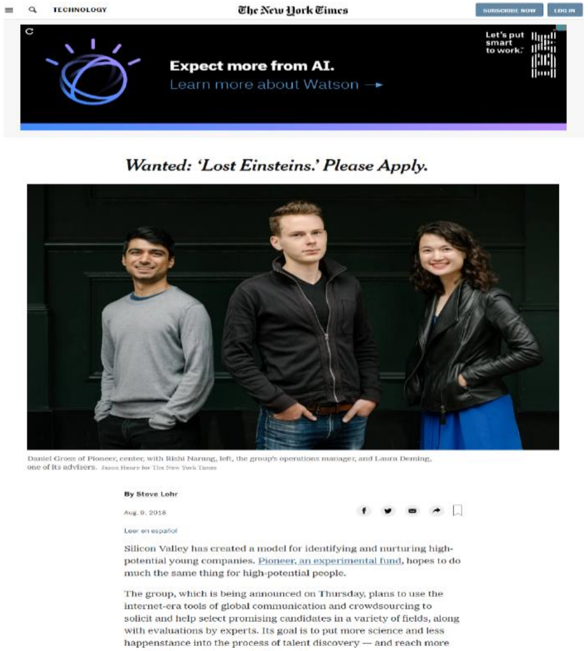
Successful Innovation Policies II



- 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

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)



TECHNOLOGY

The New York Times

Expect more from AI.
Learn more about Watson →

Let's put smart to work.

Wanted: ‘Lost Einsteins.’ Please Apply.

Daniel Gross of Pioneer, center, with Rishi Narang, left, the group's operations manager, and Laura Deming, one of its advisers. Jason Henry for The New York Times

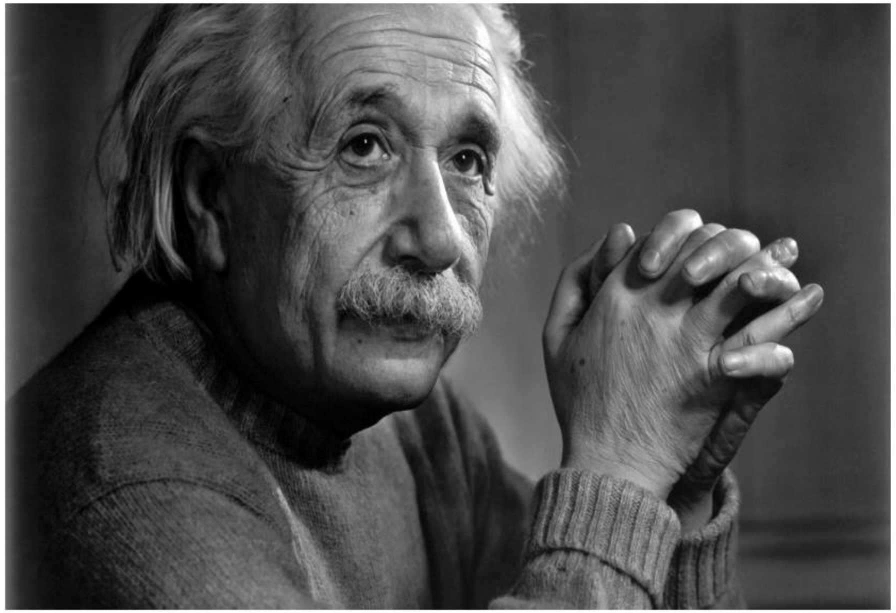
By Steve Lohr

Aug. 9, 2018

Leer en español

Silicon Valley has created a model for identifying and nurturing high-potential young companies. Pioneer, an experimental fund, hopes to do much the same thing for high-potential people.

The group, which is being announced on Thursday, plans to use the internet-era tools of global communication and crowdsourcing to solicit and help select promising candidates in a variety of fields, along with evaluations by experts. Its goal is to put more science and less happenstance into the process of talent discovery — and reach more



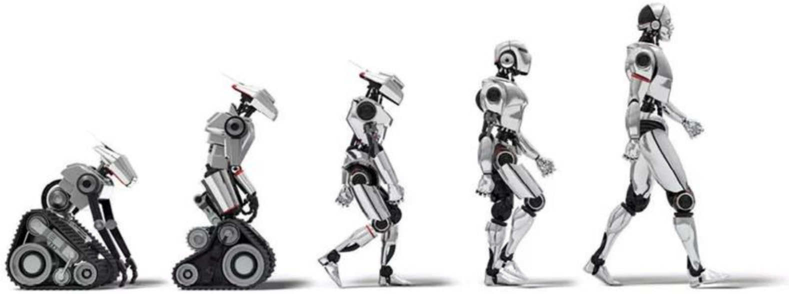
OUTLINE OF TALK

Threats and Opportunities

Productivity:

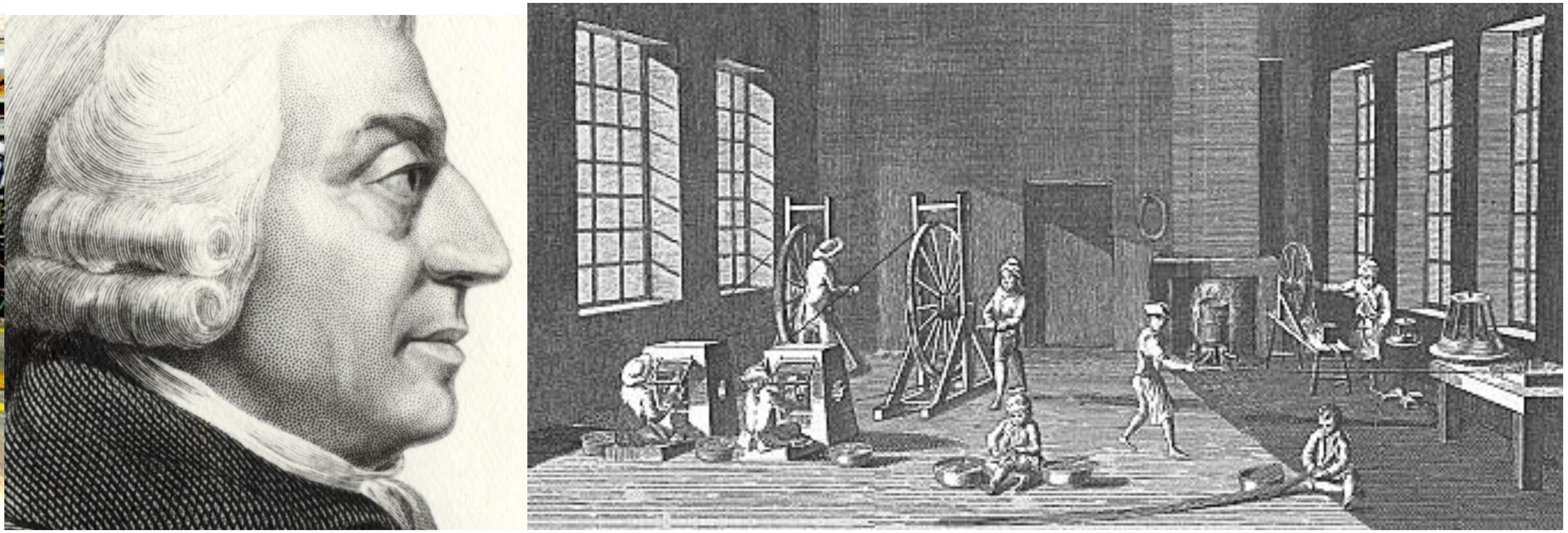
1. **Innovation Policies**
2. Diffusion Policies

Two fundamental aspects of diffusion



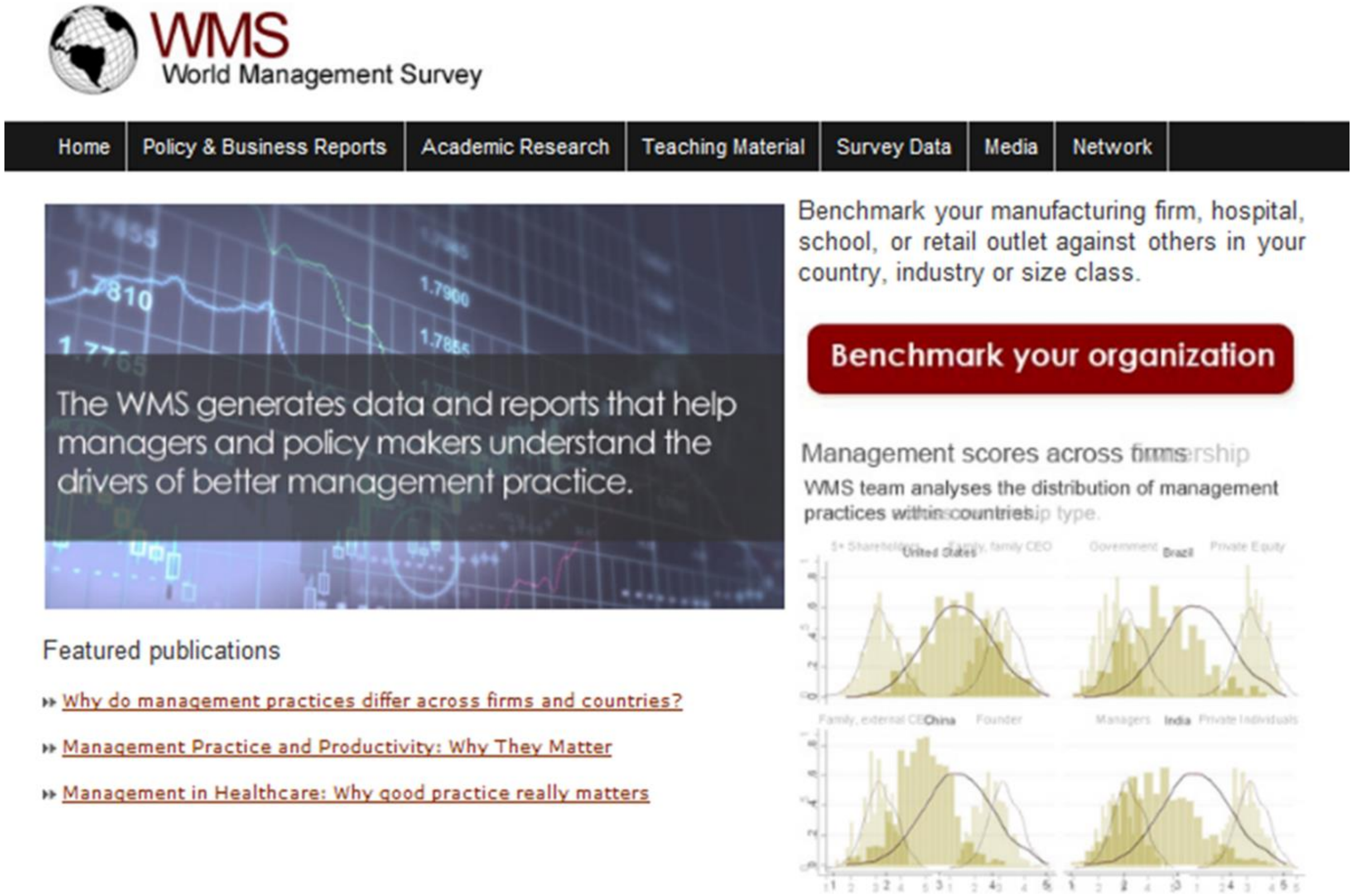
- **Technology**
- **Management practices** (focus here today)

Toyota Plant



Adam Smith and the Pin Factory

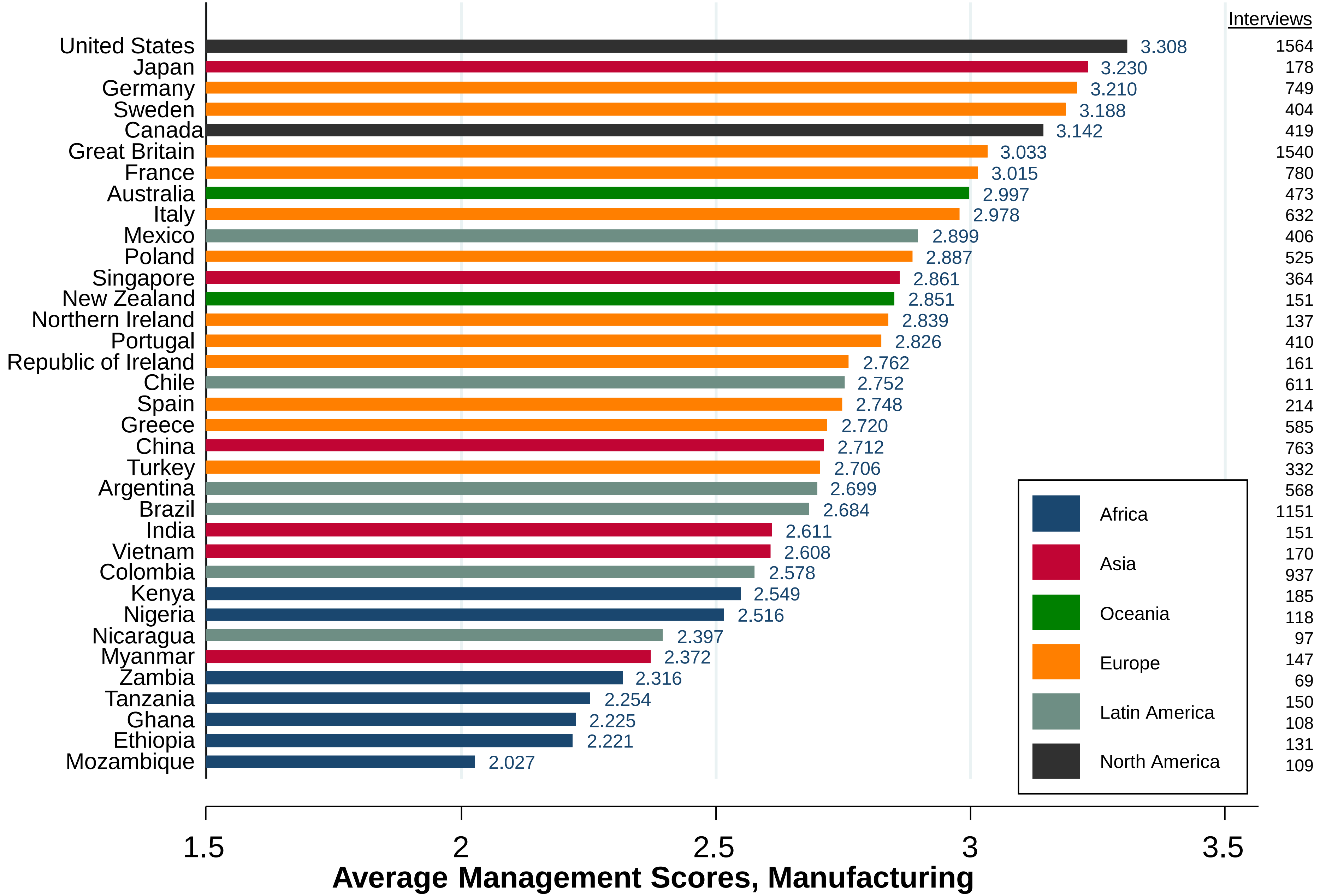
<u>World Management Survey</u> (~20,000 interviews, 4 major waves: 2004, 2006, 2009/10, 2013/14; [2022]; 34 countries)



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

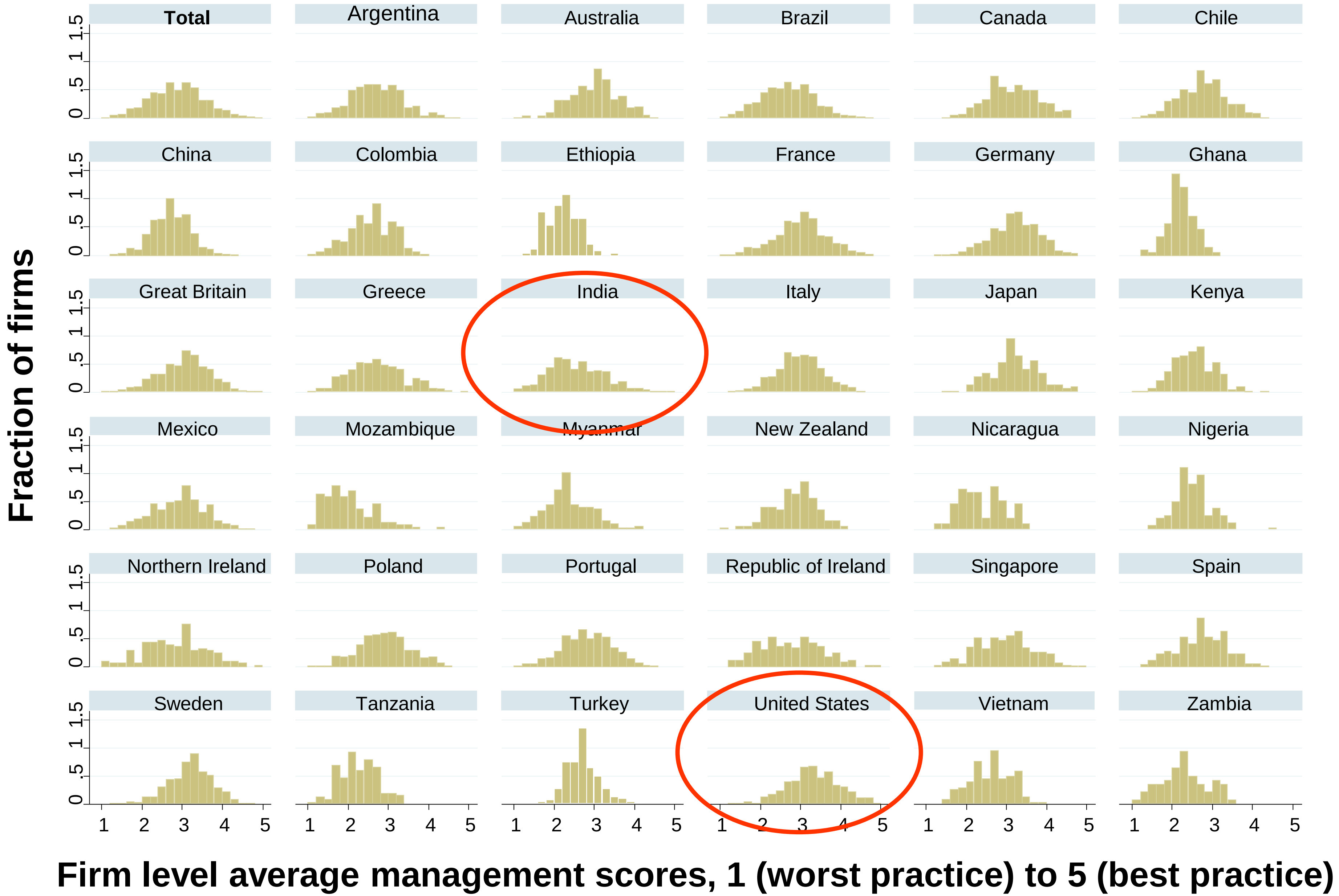
Now extended to Hospitals, Retail & Schools [& more]

Average Management Scores by Country



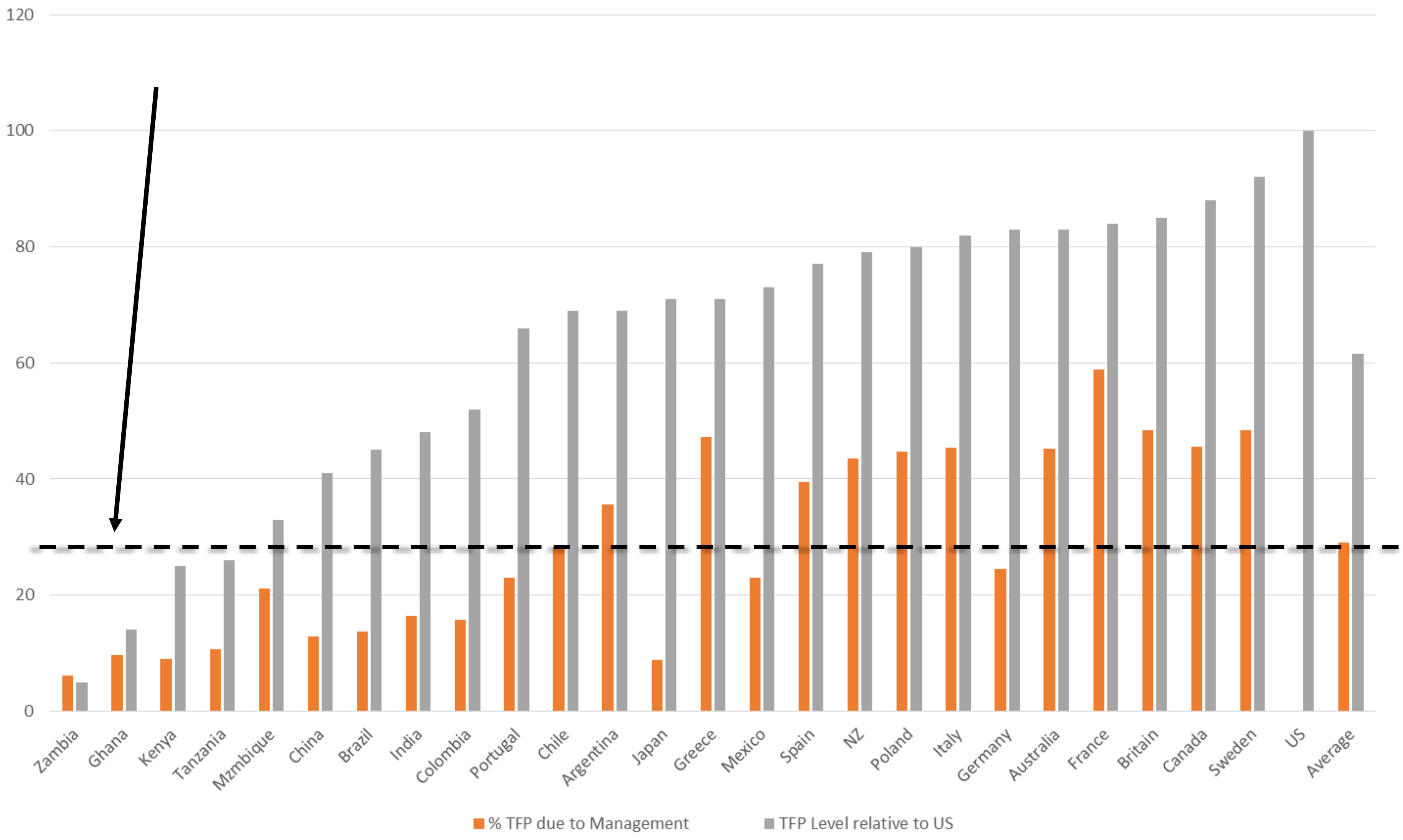
Source: Bloom, Sadun & Van Reenen (2020). **Note:** Unweighted average management scores; # interviews in right column (total = 15,489); all waves pooled (2004-2014)

Management also varies heavily within countries



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

Globally Management accounts for a third of TFP Gap with US



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

Management policies Toolkit

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	❂❂❂❂½	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)

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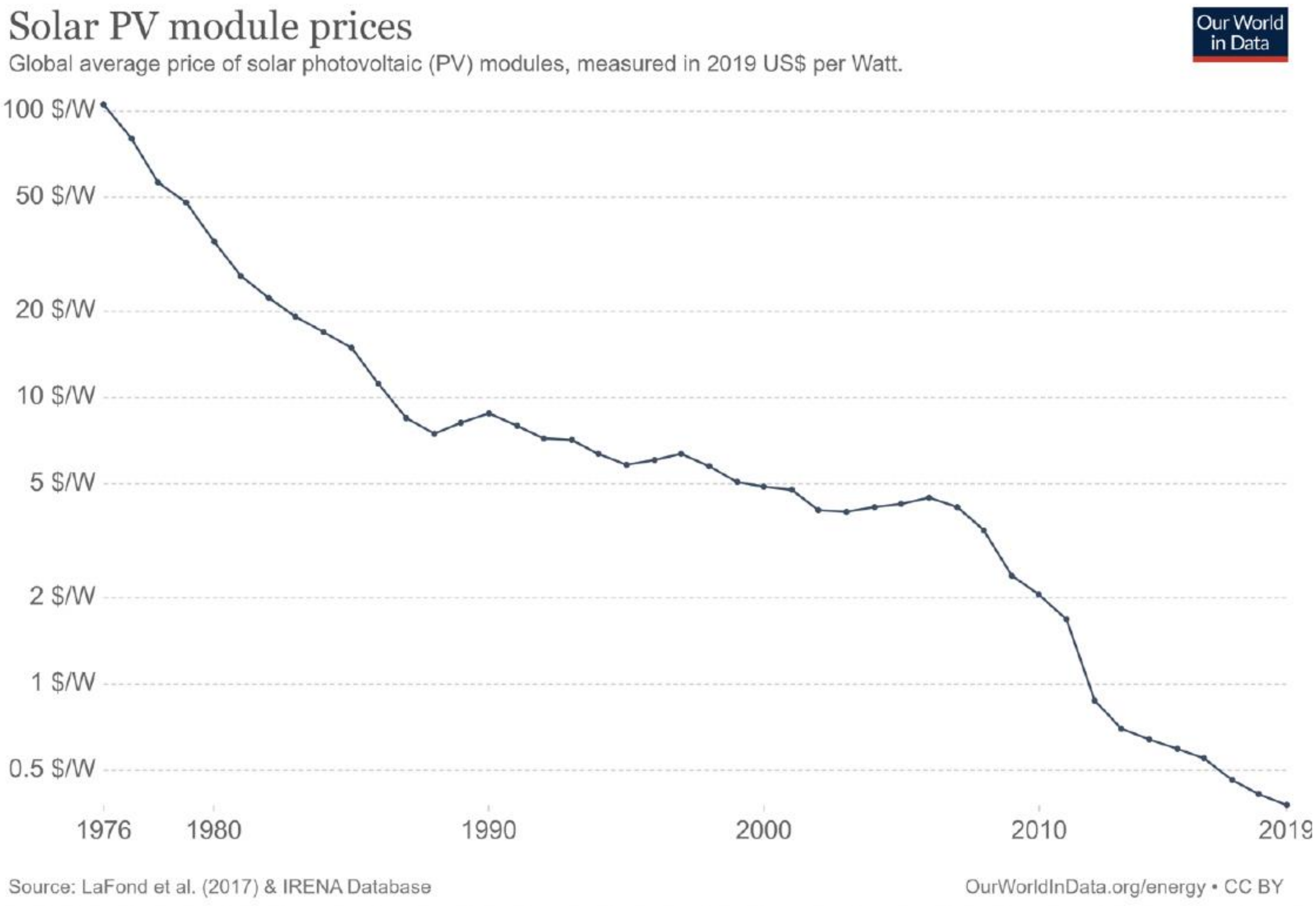
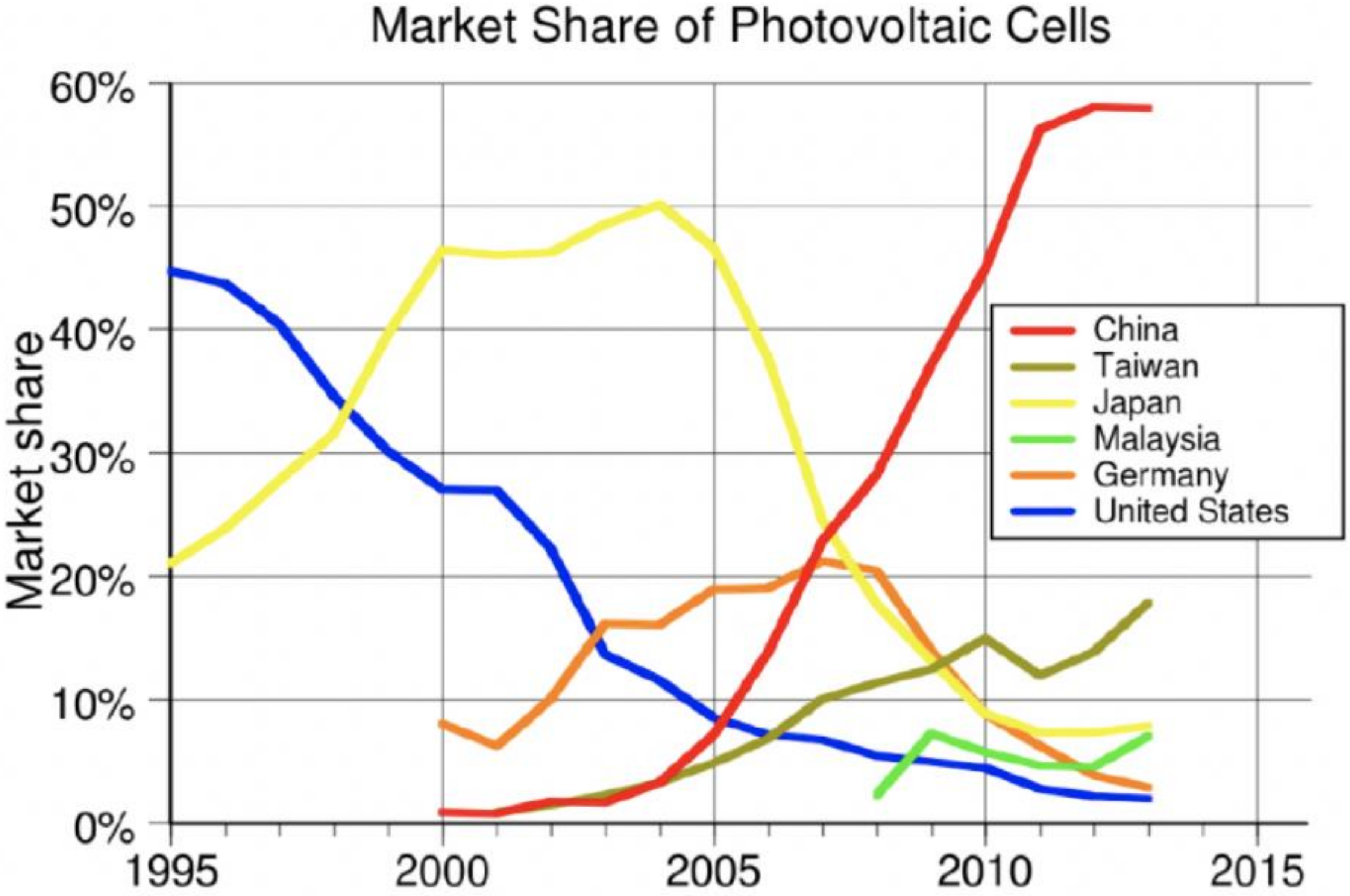
Climate Change policies

- All countries want to reduce emissions, but incentives to free-rise off efforts of others
- Similar to (global) under-investment in R&D problem
- And need green innovation as carbon tax + regulation insufficient (even if they were politically feasible)
- Policies **<u>can</u>** stimulate clean innovation (Directed Technical Change):
  - Acemoglu et al (2012, 2016): clean energy
  - Dechezleprêtre et al (2016): Electric cars & fuel price
  - Acemoglu et al (2022): Shale Gas
  - Burgess and Van Reenen (2022): **Solar Energy**

Some Good news: The rapidly falling cost of solar energy

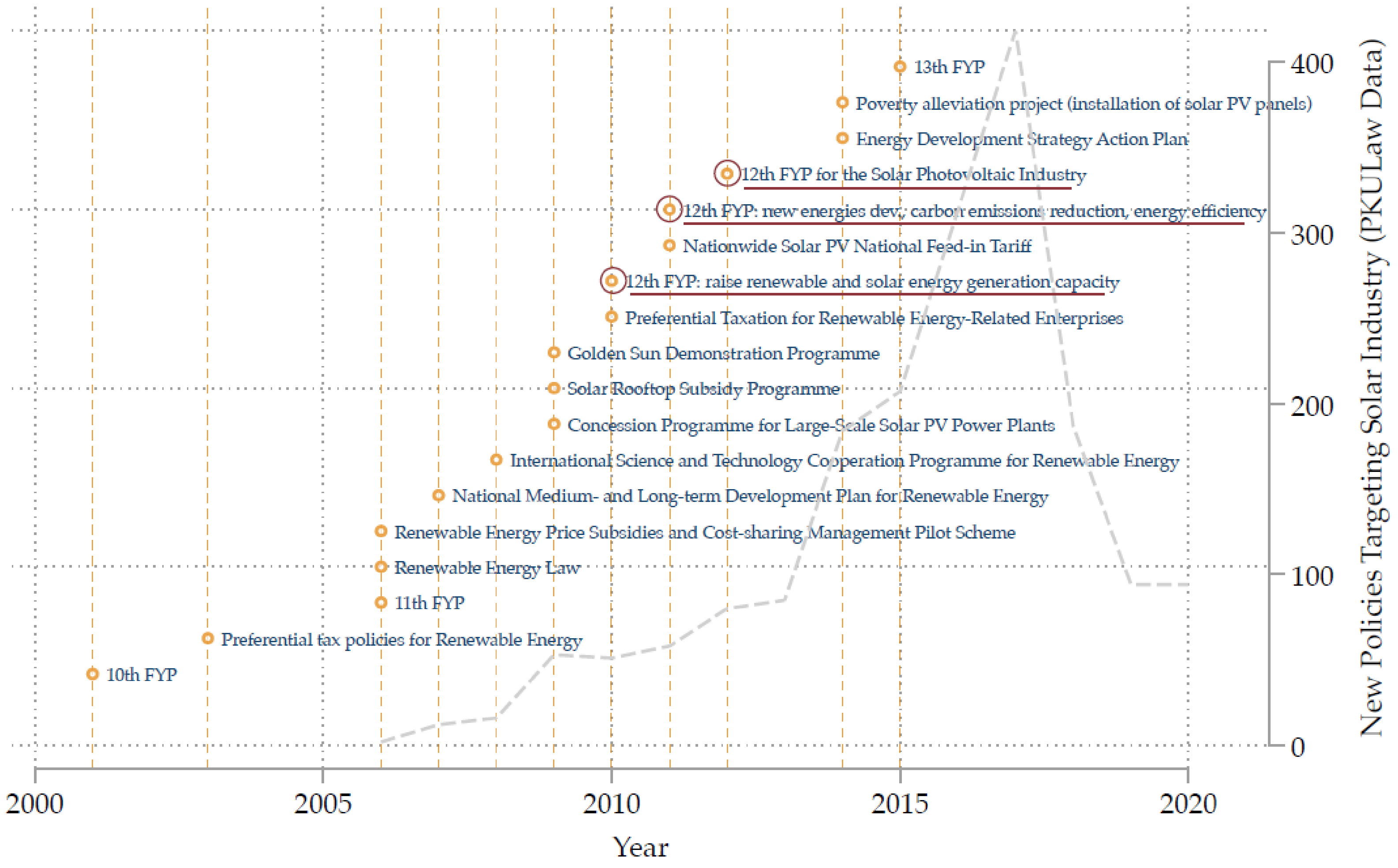


Rapid Growth in importance of China



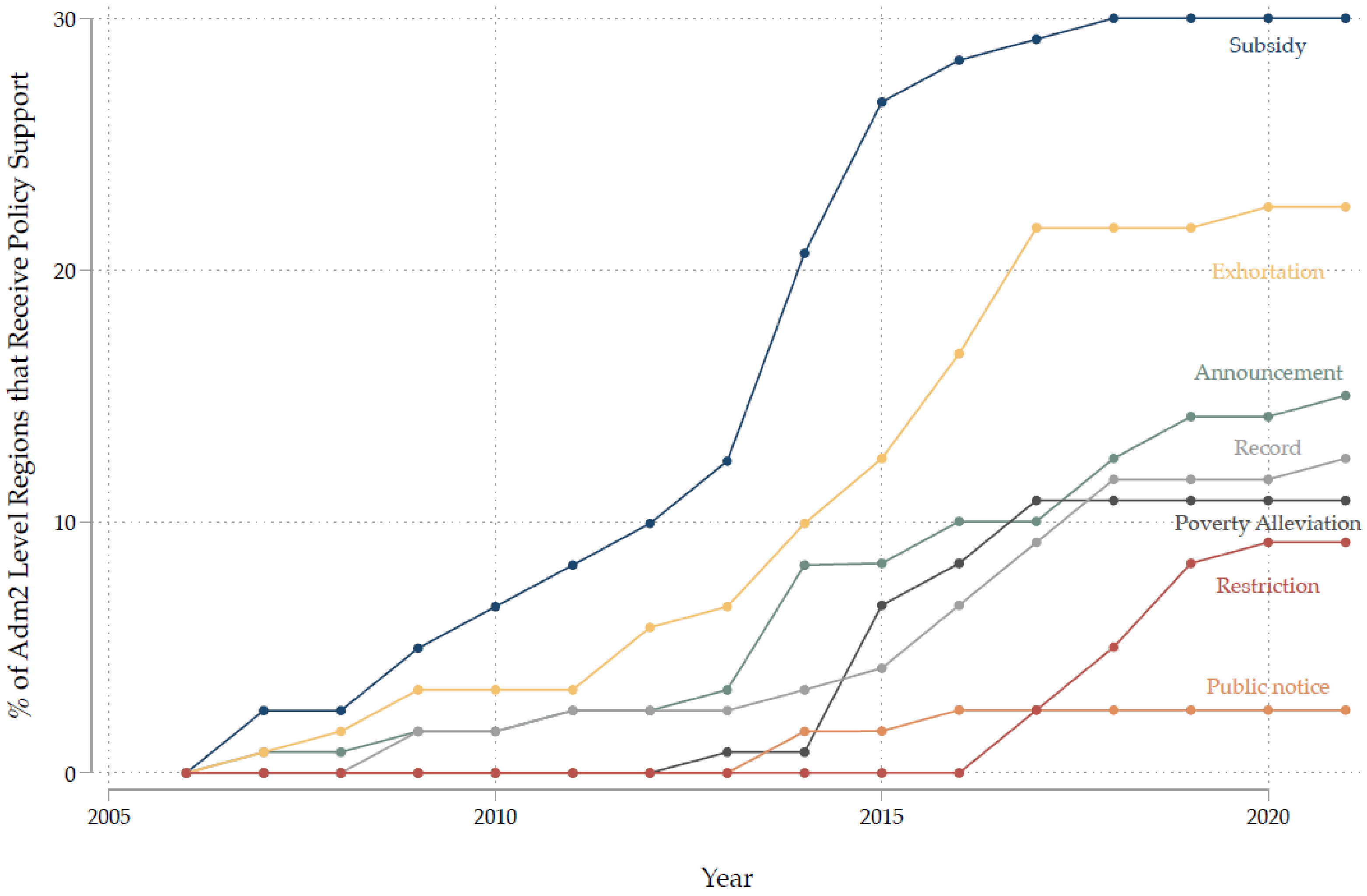
Source: World's largest solar PV producers: China, Taiwan, US, Japan, Germany, & Malaysia (1995-2013). Data sources are IEA-PVPS and Earth Policy Institute

Big policy efforts towards solar in China



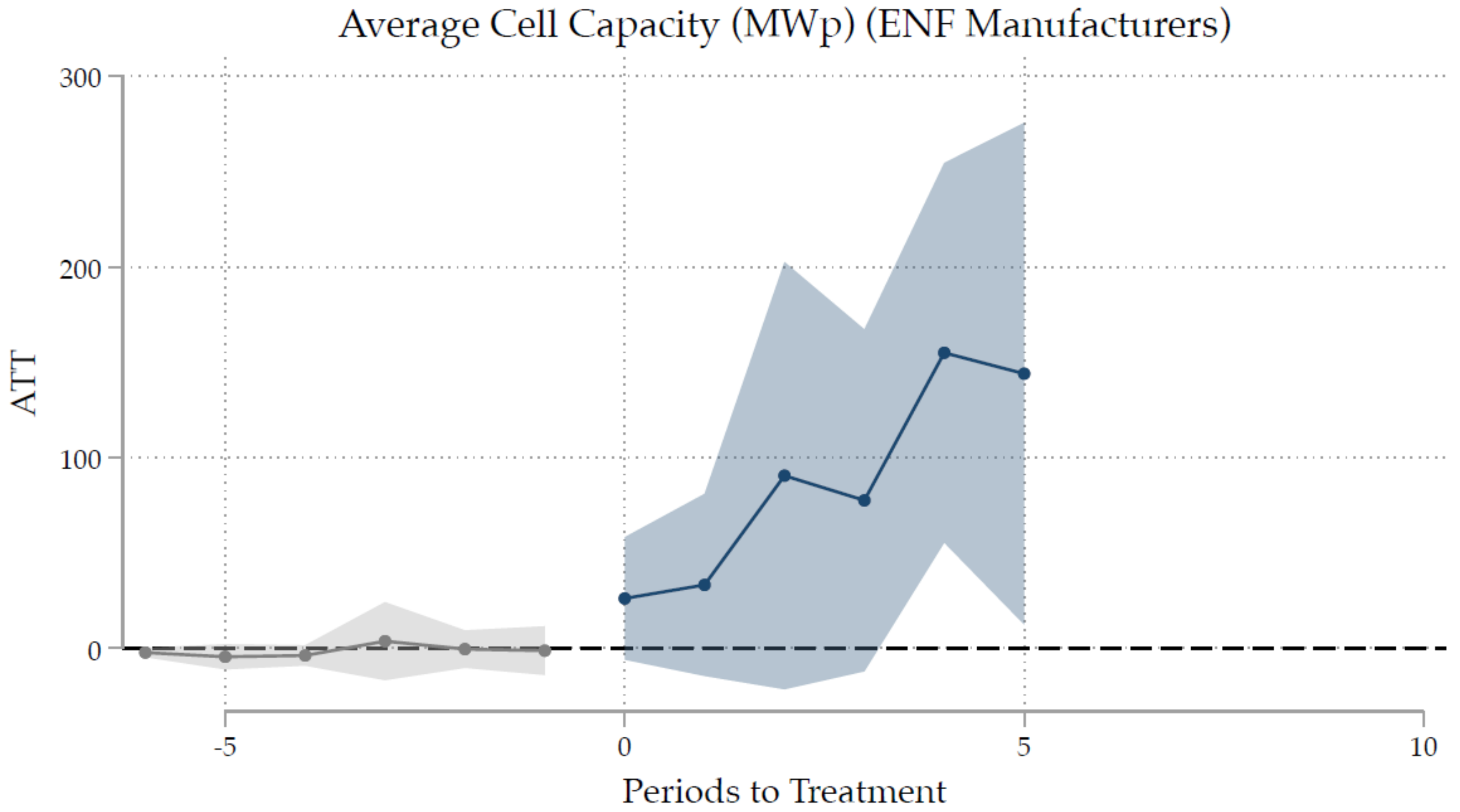
Note: Policy support time series in gray comes from PKULaw dataset. Highlighted main policies are from (Shubbak, 2019)

Fraction of Chinese city-regions with Solar subsidy policies



Note: *Source: PKULaw laws & regulations dataset; out of 120 adm2 regions with any Solar firms*

Solar policies raise Solar production (and patenting): Diff-in-Diff Event Study (Callaway & Sant'Anna, 2021, method)



Notes: Difference in Differences; outcomes at the admin2 level (120 cities where ENF firms are located); The mean of the dependent variable is 31.13 MWp; We conduct the estimation on all ENF firms (solar panel and/or cell producers); The number of observations is 1,126; Cell Capacity data is from 2004-2014; Possible year of treatment goes from 2007-2018; We estimate the dynamic ATT's, using all periods relative to the period of the first treatment, across all cohorts; Control group uses only "never treated"; Multiple periods; Callaway and Sant'Anna (2021) estimator; 95% confidence intervals shaded.

Source: Burgess and Van Reenen (2022), Preliminary

Implications

- Solar policies around the world influence innovation incentives (e.g. German feed-in tariffs in 2000s)

- Chinese Industrial policy massively increased supply, lowered prices and subsidized innovation

- If it benefited China as well as world, then helps overcome policy free riding

- Lessons for other clean technologies: Wind, Hydrogen, etc.?

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Successful Innovation Policies: 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 ‘22 use **defense shocks** across ~30 year period:
  - Industry-country AND French firm level panel data
  - Find 10% more public R&D stimulates ~5% more private sector R&D in long-run
- But **nature** of R&D procurement matters

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

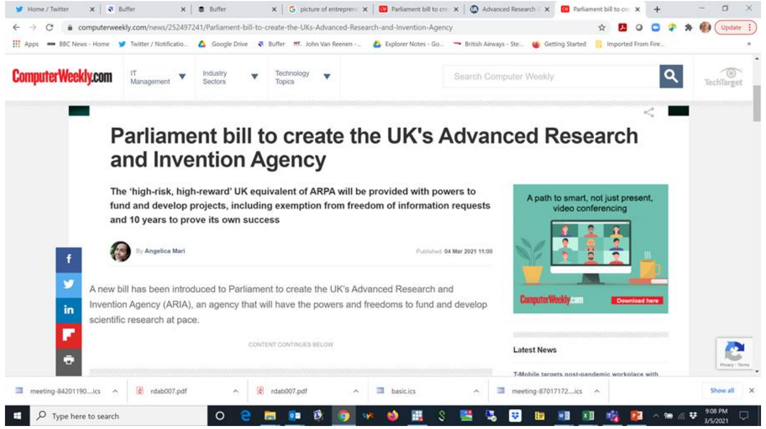
Sabrina Howell (NYU), Jason Rathje (US Air Force),
John Van Reenen (LSE and MIT) and Jun Wong (Chicago)

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Programme on Innovation and Diffusion

Why is defense R&D interesting?

- US Dept. of Defense: world's largest R&D supporting entity (6% of global R&D)
  - **Dual-use** aspect of frontier defense technology: large spillovers to private sector (e.g. GPS, cryptography, nuclear power, jet engines, Internet,..)
  - Often lauded as successful Mission-Oriented Industrial Policy from case studies (e.g. Mazzucato and Semieniuk, 2017)
  - But we show that slowdown in US defense innovation even worse than rest of economy



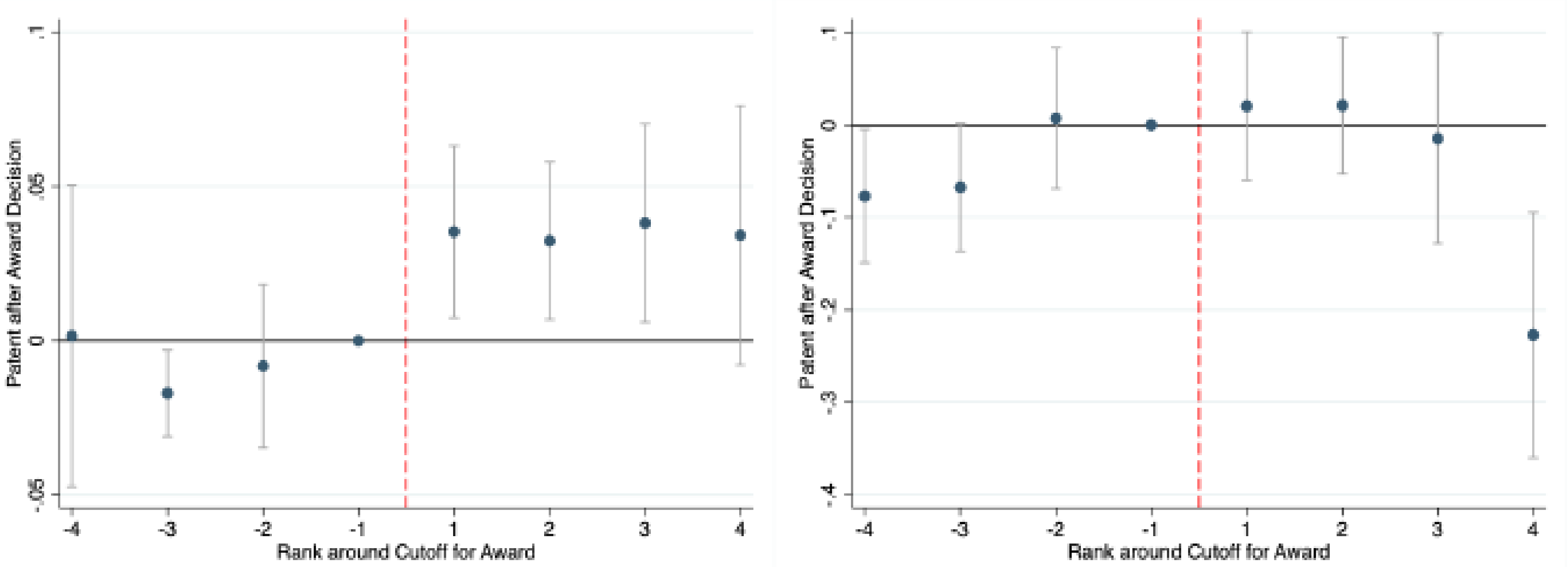
Successful Innovation Policies II: R&D Grants

- In response US Air Force (USAF) launched OPEN reforms to military innovation procurement in SBIR
- Conventional program took centralized top-down approach: tightly specified calls like:
  - *“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 Regression Discontinuity Design

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.

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 causal 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”)

Policy Lessons

- There will big increase in military spending following Russia’s invasion of Ukraine

- Some of this spending should be focused on innovation as civilian spillovers can be large

- Structure R&D procurement in a more decentralized way to crowdsource new ideas like OPEN program

OUTLINE OF TALK

Threats and Opportunities

Productivity

Climate Change

Defense

Health

The Political Challenge

Broad Points

- Healthcare is huge and growing industry: 18% of US GDP
- Despite being high skilled and high tech, much inefficiency
  - Can learn a lot from attempted reforms (e.g. Propper & Van Reenen; Bloom et al, 2016; Cooper et al, 2019)
- Huge potential for new technologies, but generally disappointing results. e.g. on digital, EHR (see survey by Bronsoler, Doyle and Van Reenen, 2022)
- Rapid development of COVID Vaccines an example of what can be achieved by public and private sector co-operation
  - Massive R&D investment
  - Govt. policy to remove regulatory barriers throughout supply chain (planning permission to drug approvals)

OUTLINE OF TALK

Threats and Opportunities

Productivity

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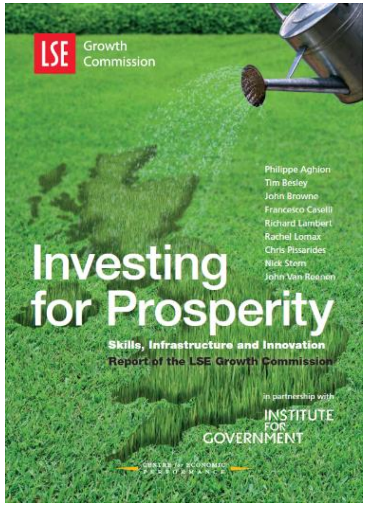
The Political Challenge

A New Marshall for Growth

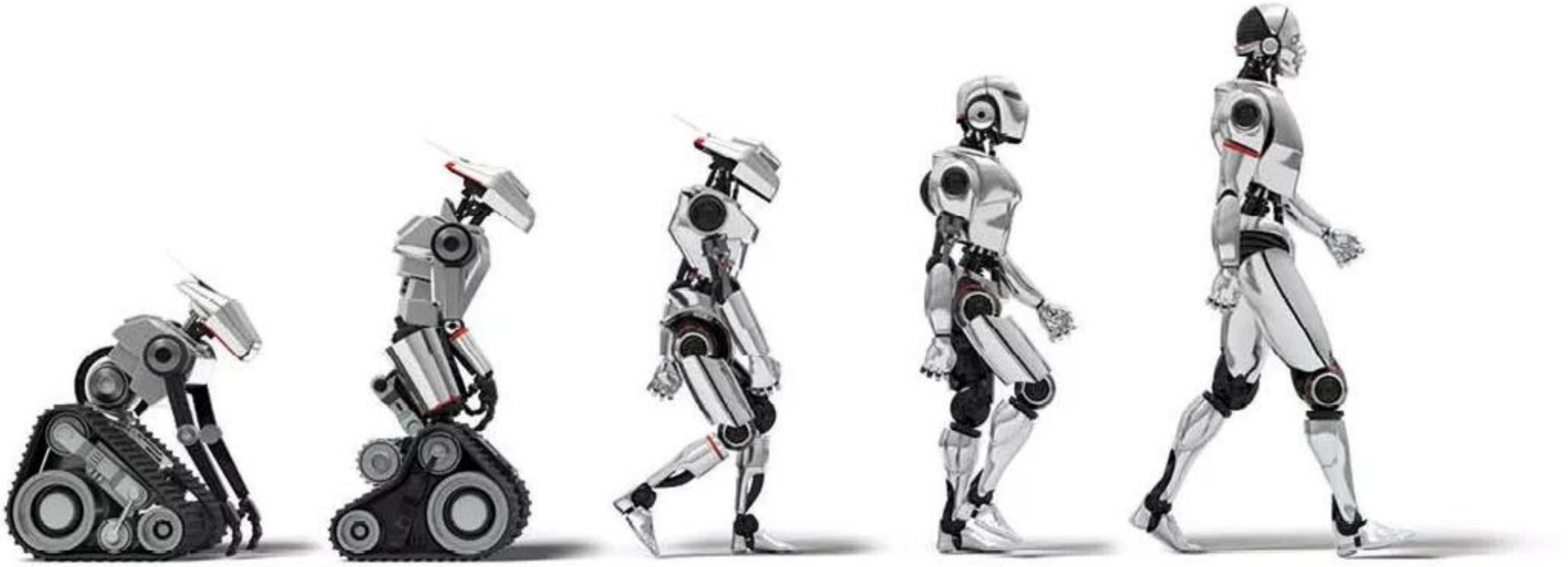
- Big threats, but also opportunities for creative policies, especially around innovation
- We know much about what can be achieved evidence: e.g.:
  - *Structural* (**competition**, trade, skills, tax & subsidies; infrastructure, etc.)
  - *Direct* (e.g. management information and training)
- Country-specific plans based on best evidence:
  - Toolkits for innovation & management policy
- Bind together in a **mission**:
  - Climate Change; Defense; Healthcare



Major Challenge is Political rather than Economic

- Productivity challenge requires long-run policy plans
- Governments suffer Policy Attention Deficit Disorder (PADD)
- Lurch to populism has made this worse (e.g. Brexit and Trump)
- Importance of national & international institutions that can “lean in” against this tendency
  - Independent Central Banks; Competition Authorities, Fiscal Councils, Health regulators
  - Examples of infrastructure reforms in LSE Growth Commission
- And of course, OECD itself!

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