The Effects of U.S. Public R&D on Global Growth

Gustavo De Souza
Chicago Fed

Andrew J. Fieldhouse
Texas A&M

Karel Mertens
Dallas Fed, CEPR

Ishan B. Nath
Harvard, NBER

Valerie A. Ramey
Stanford, NBER, CEPR

Empirical Macro Working Group, UT Austin

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How Much of the Return to U.S. Public R&D Is Captured Abroad?

Fieldhouse and Mertens (2026): U.S. nondefense R&D shocks raise domestic TFP, with social returns of ∼140–210%

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Punchline:

- A 1% shock to U.S. federal R&D capital raises foreign TFP by ∼1% after 12 years
- Driven by nondefense R&D; non-OECD response lags ∼6 years behind the OECD
- Global social returns ≈ 2× domestic; the U.S. captures about half

What's New: An Identified Shock, Not a Calibration of Spillovers

Cross-country R&D spillovers: long-standing question, evidence mostly correlational

- Coe and Helpman (1995); Coe, Helpman, and Hoffmaister (2009)

Structural diffusion models: calibrated or lack exogenous variation

- Eaton and Kortum (2001); Comin and Hobijn (2010); Buera and Oberfield (2020)

Causal evidence on crowd-in/out from public R&D: across and within borders

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Our contribution: credibly exogenous variation in U.S. public R&D + foreign panel

→ Dynamic causal estimates that can discipline models of international diffusion

Empirical Framework

What Are the Shocks? Narrative Identification of R&D Appropriations

Narrative appropriations shocks from Fieldhouse and Mertens (2023):

1. Enacted-appropriations data for the 5 major federal R&D agencies (∼90% of federal R&D), by fiscal year, from the *U.S. Budget* ▸ Sources
2. Identify significant annual changes in real appropriations for each agency
3. Read the budgetary/legislative record; classify each change as exogenous or endogenous to U.S. macro conditions ▸ Exogeneity

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In-sample variation is geopolitical and partisan, not cyclical:

- **National security:** Soviet invasion of Afghanistan, Cold War "peace dividend," 9/11, Global War on Terror
- **Science initiatives:** Human Genome Project, International Space Station
- **Public-health crises:** HIV/AIDS, 2001 anthrax attacks
- **Partisan budget fights:** OBRA 1993, Budget Control Act of 2011, sequestration

From U.S. R&D Shocks to Foreign TFP Responses in Panel LPs

Local projections for each country i and horizon $h = 0, 1, \ldots, 15$, over 1980–2023:

$$y_{i,t+h} = \beta^0_{k,h} \hat{z}^k_t + \sum_{j=1}^{5} \beta^j_{k,h} \hat{z}^k_{t-j} + \sum_{j=1}^{2} \zeta^{j\prime}_h \boldsymbol{x}_{i,t-j} + \gamma_i + \varepsilon_{i,t+h}$$

- $y_{i,t+h}$: log foreign TFP (PWT) for country i at horizon h
- $\hat{z}^k_t$: U.S. exogenous R&D appropriations shock, $k \in \{n, d, c\}$ ▸ Shocks
- $\boldsymbol{x}_{i,t-j}$: lags of own log TFP, log real GDP per capita, U.S. TFP-U (Fernald 2012)

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- γ_i: country fixed effects; SEs clustered by calendar year, $t(J-1)$ critical values
  → The common regressor breaks the independence that country clustering assumes

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Scale factor: shock of 1% of the lagged nondefense/defense/federal R&D capital stock

▸ In Dollars

Data, Sample, and Measurement

- **PWT (11.0) outcomes:** TFP*; real GDP per capita; labor productivity
- **Sample:** 69 foreign countries, 1980–2023 ▸ Countries
- **Key cut:** 'Original' OECD, ex-USA (23) vs. Never-OECD (40)

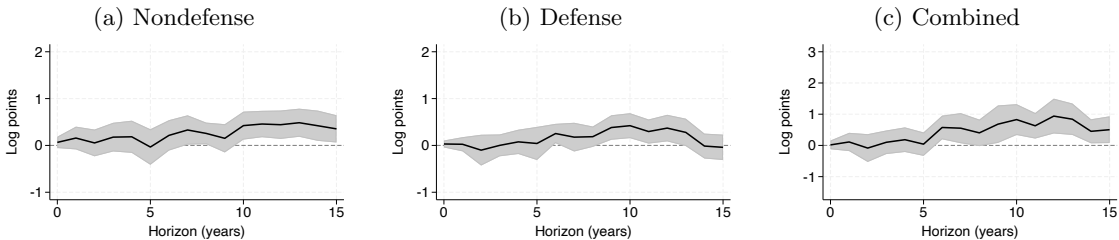
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- **OECD MSTI:** foreign R&D capital, R&D researchers

*PWT TFP is economy-wide and unadjusted; R&D is capitalized only under SNA 2008

Global TFP Spillovers from U.S. Public R&D

U.S. Nondefense R&D Raises Foreign TFP Gradually, Persistently

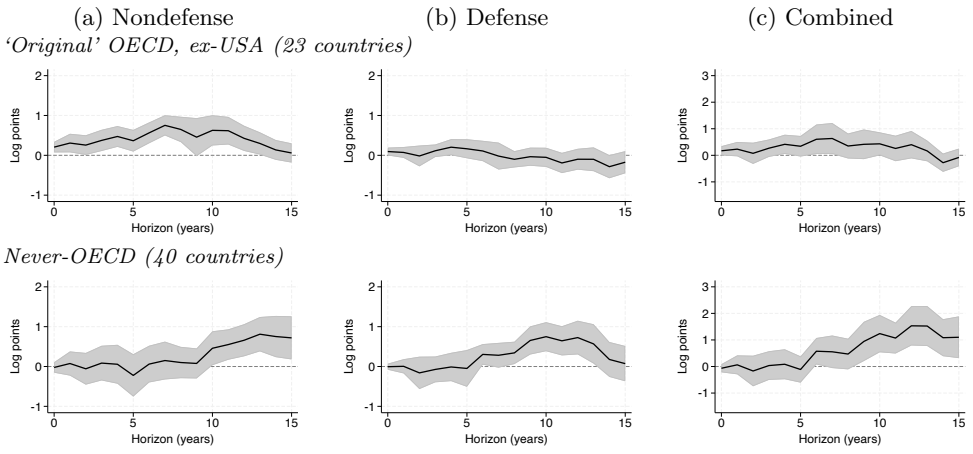


Nondefense peaks at 0.48% around $h = 13$; combined at 0.94% at $h = 12$

Full panel, ex-USA (69 countries). 95% CI, year-clustered.

▸ GDP per Capita ▸ Labor Productivity

Productivity Spillovers Reach OECD Before Never-OECD Countries

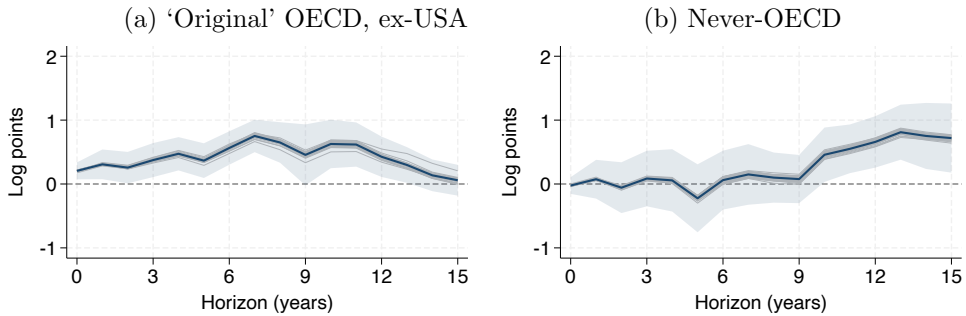


OECD peaks at 0.75% at $h = 7$ then decays; Never-OECD builds to 0.81% by $h = 13$ and holds

95% CI, year-clustered.

▸ GDP per Capita ▸ Labor Productivity

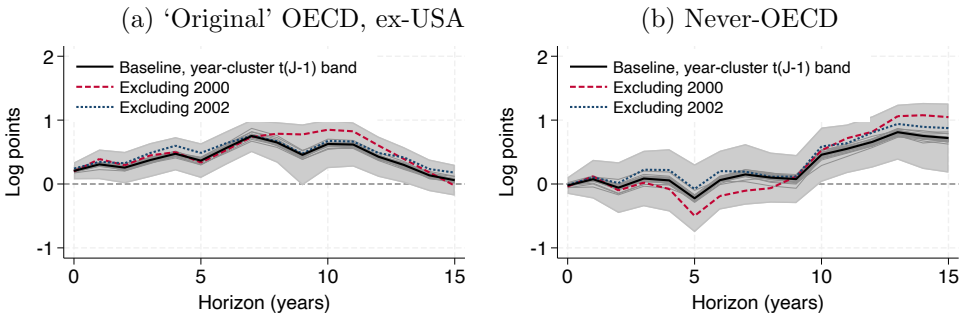
No Single Country Drives the Headline Nondefense R&D Result



Grey lines drop each country in turn; black line and 95% band are the baseline, year-clustered.

▸ Def / Combo ▸ Rolling Windows

Nor Does Any Single Appropriations Year



Nondefense shock. Grey lines drop each of the 40 shock years in turn.

▸ Def / Combo

Is This a PWT Measurement Artifact? Role of R&D Capitalization

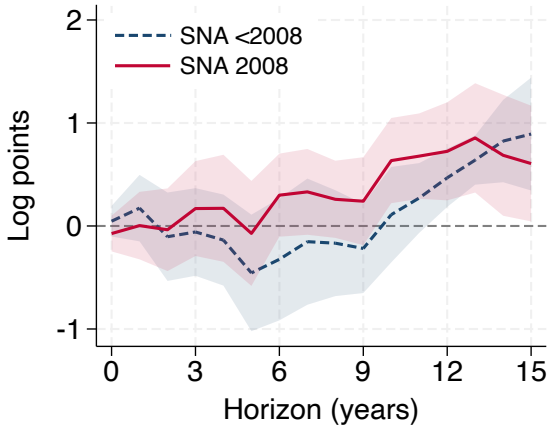
Do Never-OECD gains reflect R&D capitalization rather than diffusion?

▸ Cohorts

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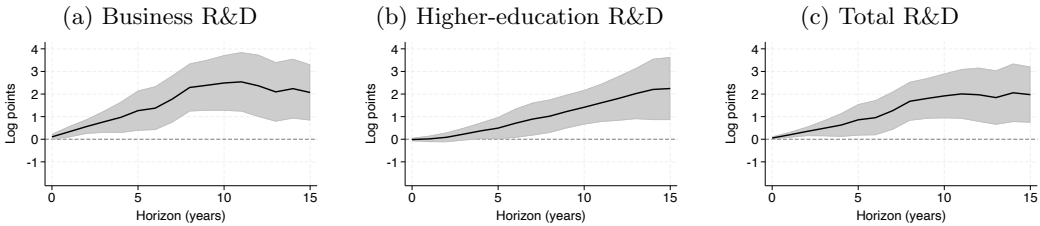
The response is significant regardless of whether R&D is capitalized out of the residual

Nondefense shock. 95% CI, year-clustered.

▸ Within SNA 2008

Free-riding?
The Response of Foreign* R&D Activity

U.S. Public R&D Crowds In Foreign R&D

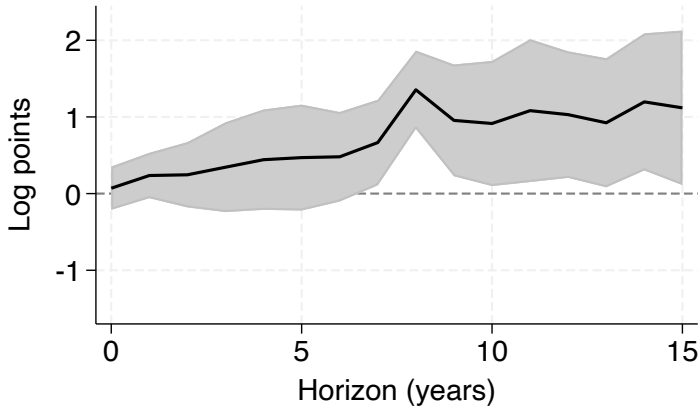


Peaks of 2.5%, 2.2% and 2.1%; significant at 15, 12 and 15 of 16 horizons

Nondefense shock; foreign R&D capital by performing sector ($\delta = 0.16$), 23 countries (ex-USA). 95% CI, year-clustered.

▸ Defense ▸ Channels

And Crowds In Foreign R&D Researchers, Not Just Capital



Researchers rise 1.4% by $h = 8$ and stay elevated, significant at 9 of 16 horizons

Nondefense shock; full-time-equivalent researchers, 14 countries. 95% CI, year-clustered.

▸ Defense

The Wedge Between Global and Domestic Social Returns to Public R&D

Global Returns ≈ 2× Domestic; the U.S. Captures About Half

U.S. R&D costs cancel in the benefit-cost ratio, so focus on the ratio of PV cumulative global to domestic benefits: $\psi = \dfrac{PV_{US} + PV_{RW}}{PV_{US}} = 1 + \dfrac{PV_{RW}}{PV_{US}}$

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	Global-to-domestic spillover wedge, ψ			U.S. share
GDP-weighting window	Discounted PV	$h = 10$	$h = 15$	of global gain
1977–79	1.73	1.61	1.25	57.8%
1994–96	1.86	1.75	1.50	53.8%
2017–19	2.11	2.09	2.31	47.4%

PV_{RW}: nondefense TFP IRFs, GDP-weighted across countries. PV_{US}: utilization-adjusted TFP response from Fieldhouse and Mertens (2026). 7% discount rate.

▸ U.S. Crosswalk

$\psi \approx 1.7$–2.1: the U.S. captures only ∼47–58% of the benefits of its own nondefense R&D

A Conservative Lower Bound and Its Implications

By design, ψ is a floor:

- Foreign gain limited by 69-country coverage
- U.S. denominator uses the *largest* U.S. TFP response (Fernald 2012)
- GDP weights favor richer economies; population weights give $\psi \approx 4.1$–4.5
- Insensitive to the discount rate

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Applied to domestic returns of 140–210% (Fieldhouse and Mertens 2026):

- Global social returns of $\sim$240–440% or higher

Takeaways

Empirical results:

- Large, persistent gains in foreign TFP
- Faster diffusion at the frontier, slower and larger spillovers in Never-OECD
- No evidence of free-riding from U.S. public R&D in OECD countries
- Global returns $\approx 2\times$ domestic; the U.S. captures about half

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For policy:

- **Underinvestment** relative to the globally efficient level
- **De-globalization:** dynamic costs may exceed static ones
- **Coordination:** complementarity, not rivalry

Next draft: Patent/citation spillovers, evidence on mechanisms

Appendix Slides

Narrative Analysis: Data Sources

Primary and secondary sources, by agency and fiscal year:

- *Budget of the U.S. Government* (appendices); Budget Message of the President
- Congressional committee reports and hearings (ProQuest); *CQ Almanac*
- Presidential signing statements, vetoes, State of the Union addresses
- *NYT*, *WaPo*, *WSJ*, CRS reports

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Are the Shocks Exogenous to Foreign TFP?

The concern is endogeneity of U.S. R&D policy w.r.t. *foreign* TFP:

- **Reverse causality?** Appropriations track U.S. politics, not foreign TFP
- **Anticipated productivity growth?** Orthogonalized to lagged U.S. stock returns
  - TFP news would be priced — surviving variation is unanticipated
- **Contemporaneous global shocks?** Orthogonalized quarterly, *before* aggregation
  - Later-quarter breakthroughs or tech news cannot contaminate
  - Geopolitical drivers absorbed by conditioning on Ramey (2016) defense news
- **Foreign-technology-motivated episodes?** Screened from the narrative record
  - Sputnik is the canonical case: U.S. R&D rose *because* of foreign progress
  - Pre-1980, so outside the estimation window in any case

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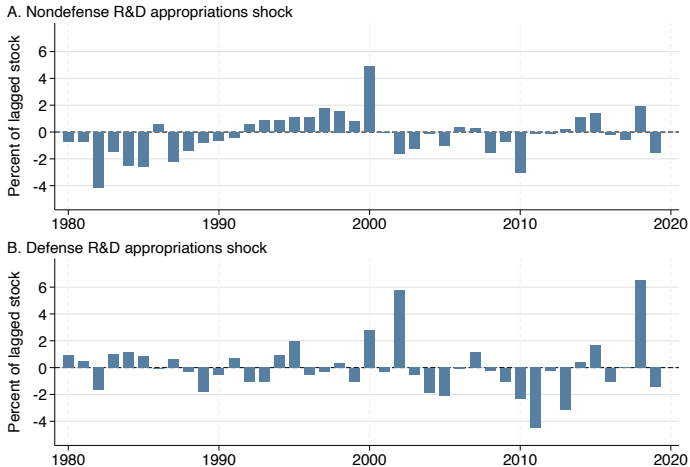
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Open: generated-IV bias; conditioning on foreign stock returns

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The Identifying Variation: Orthogonalized Appropriations Shocks



Variation is spread across four decades; the 2000 nondefense and 2002 defense bars are the high-leverage years

Appropriations years 1980–2019, each scaled by its own lagged federal R&D capital stock.

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What a 1% Shock Means in Dollars

Responses are scaled to a shock of 1% of the lagged federal R&D capital stock:

	1% of lagged stock (CY2024, $bn)	As a share of 2024 U.S. R&D investment
Nondefense	$9.8	7.8%
Defense	$3.6	4.7%
Total federal	$13.5	6.6%

Source: BEA, CY2024. A 1% shock is a large but not implausible annual appropriations change — comparable in magnitude to the swings in the narrative record.

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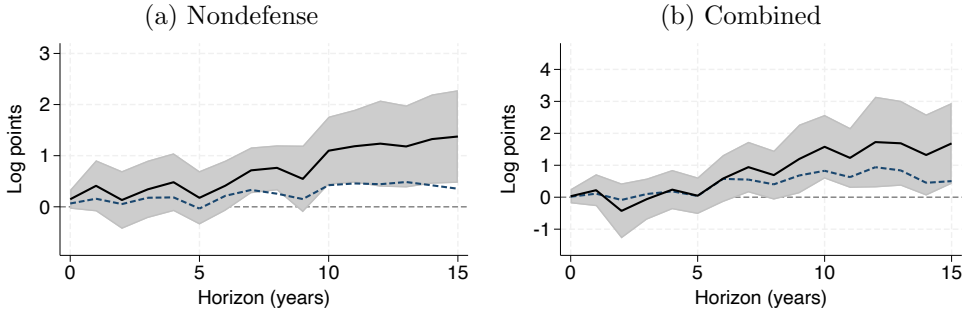
Baseline Panel: 69 Foreign Economies, 1980–2023

- **'Original' OECD, ex-USA (23):** AUS, AUT, BEL, CAN, CHE, DEU, DNK, ESP, FIN, FRA, GBR, GRC, IRL, ISL, ITA, JPN, LUX, NLD, NOR, NZL, PRT, SWE, TUR
- **Later OECD entrants (6):** CHL, COL, CRI, ISR, KOR, MEX
- **Never-OECD (40):** ARG, BFA, BOL, BRA, BRB, CHN, CIV, CMR, CYP, DOM, ECU, EGY, GTM, HKG, HND, IDN, IND, JAM, JOR, KEN, LKA, LSO, MAR, MLT, MUS, MYS, NAM, NER, PAN, PER, PHL, PRY, SEN, SGP, THA, TUN, TWN, TZA, URY, ZAF

Blue = SNA 2008 national accounts (modal vintage, 1995–2018); black = SNA 1968/1993. R&D is capitalized into the capital stock only under SNA 2008.

▸ Back: Data ▸ Back: SNA

Foreign GDP per Capita and TFP Responses: Full Panel

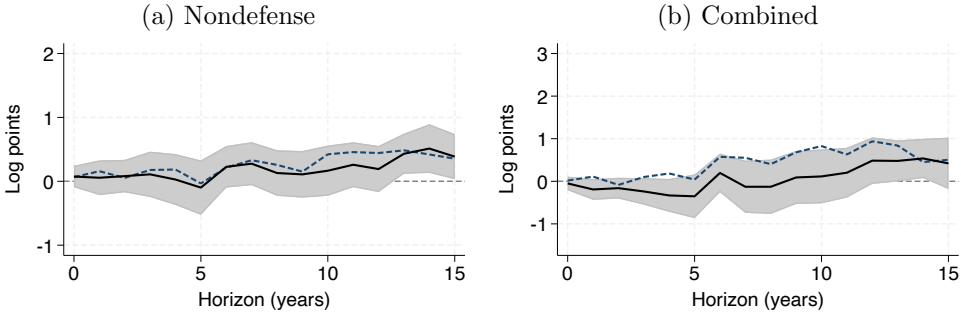


Real income per capita rises by well more than TFP at every horizon

Full panel, ex-USA (69 countries); real GDP per capita solid with 95% band, TFP point estimate dashed. Year-clustered.

Back

Foreign Labor Productivity and TFP Responses: Full Panel

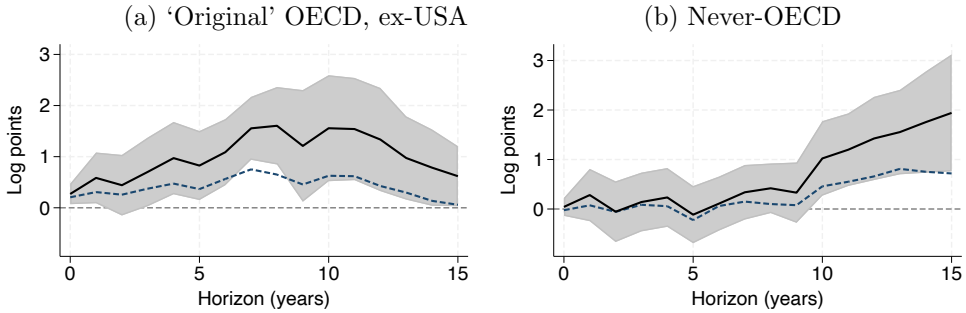


Output per hour runs below TFP at mid horizons and converges by $h = 15$

Full panel, ex-USA (69 countries); real GDP per hour solid with 95% band, TFP point estimate dashed. Year-clustered.

Back

Foreign GDP per Capita and TFP Responses: By Group

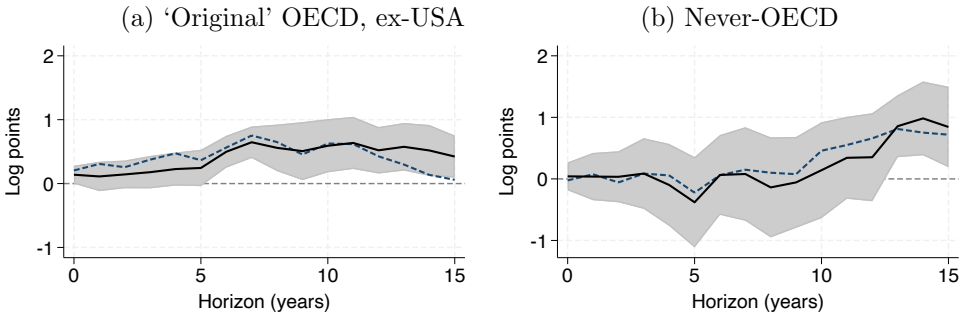


Real income per capita rises alongside and by more than TFP

Nondefense shock; real GDP per capita solid with 95% band, TFP point estimate dashed. Year-clustered.

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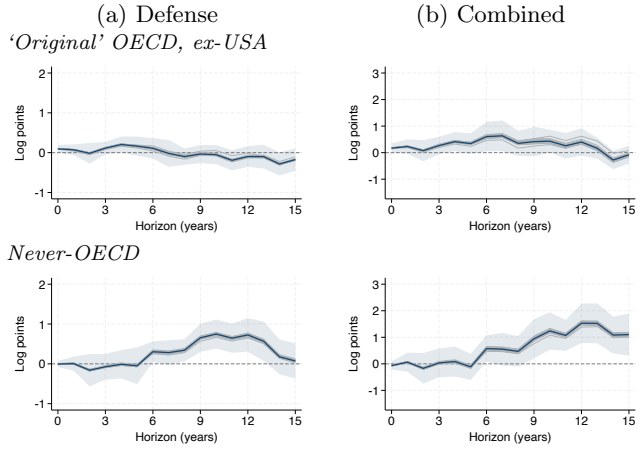


Output per hour tracks TFP closely; in the OECD it holds at 0.42% through $h = 15$ as TFP decays to zero

Nondefense shock; real GDP per hour solid with 95% band, TFP point estimate dashed. Year-clustered.

▸ Back

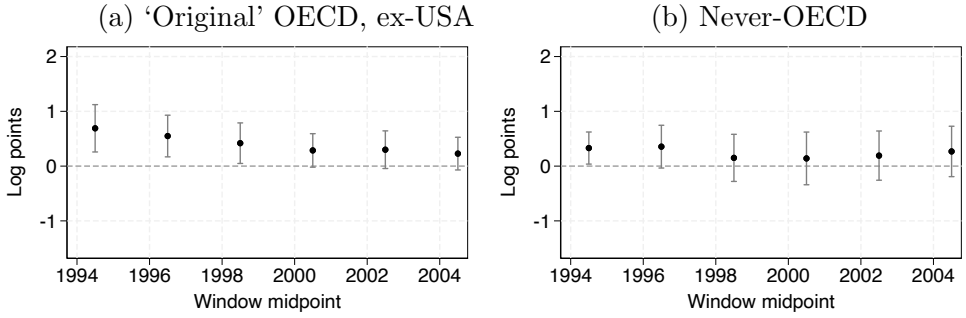
Leave-One-Country-Out: Defense and Combined Shocks



Notes: Grey lines drop each country in turn; black line and shaded 95% band are the baseline, year-clustered.

Back

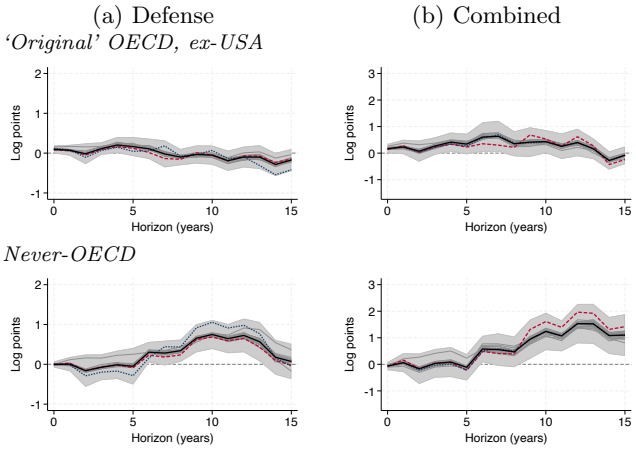
Is It a Timing Fluke? Rolling Windows at $h = 10$



Notes: Each point is the $h = 10$ nondefense TFP response estimated on a rolling subsample, plotted at the window midpoint. Bars are 95% CI, year-clustered.

Back

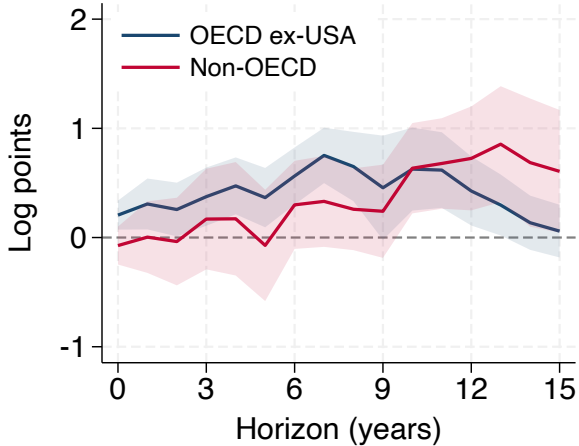
Leave-One-Shock-Year-Out: Defense and Combined Shocks



Notes: Grey lines drop each of the 40 shock years in turn; labelled lines drop the highest-leverage year. Black line and shaded 95% band are the baseline, year-clustered.

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Within SNA 2008 Countries: The Group Contrast Survives

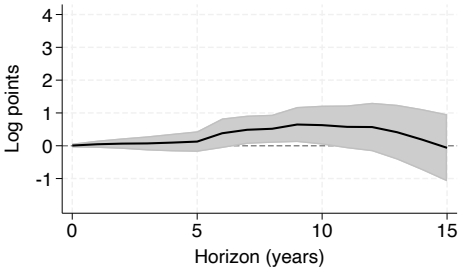


Notes: Nondefense shock, restricted to countries reporting under SNA 2008: 'Original' OECD, ex-USA (23) vs. Never-OECD on SNA 2008 (23). Shaded bands are 95% CI, year-clustered.

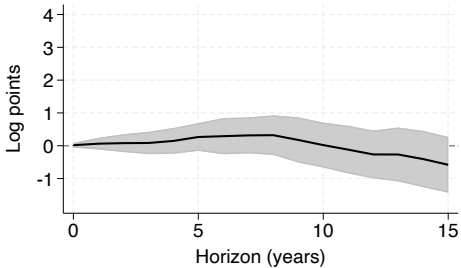
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Crowd-In of Foreign R&D Capital from U.S. Defense R&D

(a) Higher-education R&D (performer)



(b) Total R&D



Defense shocks crowd in foreign higher-education R&D; total response smaller, less persistent

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Which Channels? Preliminary Evidence on Diffusion

TFP: Our heterogeneity results to date are most consistent with diffusion through:

- Openly accessible scientific content (publications, open science)
- Capital-embodied trade (Eaton and Kortum 2001)
- Leapfrogging / imitation (Brezis, Krugman, and Tsiddon 1993)
- Each with postwar precedent (Comin and Hobijn 2010)

▸ Diffusion Lit

R&D: Does U.S. public R&D *displace* foreign R&D, or induce more of it?

- Evidence that U.S. public R&D crowds in R&D activity for OECD peers
- No aggregate evidence of displacement or poaching to date

Work-in-progress: patents and citations, trade linkages, horse-race between channels

▸ Back

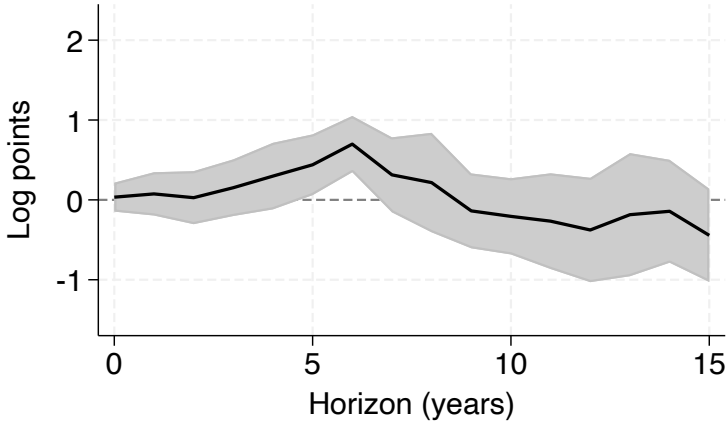
Diffusion Literature: Postwar U.S. Technology Transfer

Our net-spillover result complements a long diffusion literature:

- Comin and Hobijn (2010): postwar U.S. technology transfers (Marshall Plan, technical-assistance programs) shortened adoption lags and raised foreign TFP — consistent with the channel we identify, out of sample
- Eaton and Kortum (2001); Buera and Oberfield (2020): structural diffusion frameworks our estimates can discipline
- We provide the credibly-identified, modern-period counterpart to this largely calibrated / non-causal evidence

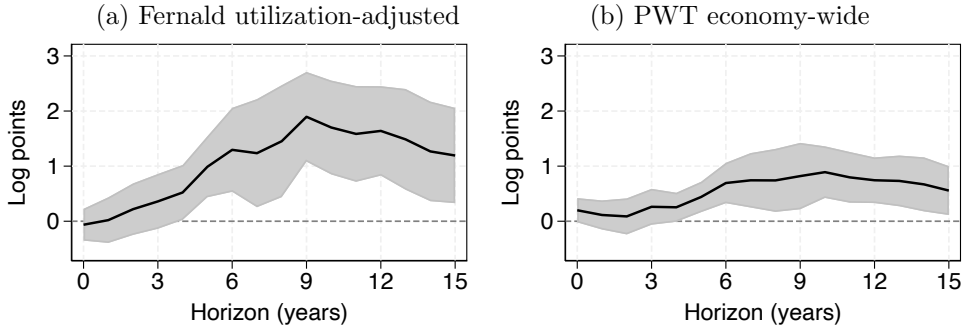
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Response of Foreign R&D Personnel to U.S. Defense R&D Shock



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The U.S. Denominator: Fernald Utilization-Adjusted vs. PWT TFP



Notes: U.S. TFP response to the nondefense shock, shock years 1980–2019. Shaded bands are 95% CI. Panels (a) and (b) correspond to the top and bottom rows of Figure 7 in the paper.

Fernald UA response is roughly twice the PWT response, so using it in the denominator lowers ψ

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Robustness of the Global-to-Domestic Spillover Wedge

GDP-weighting window	Baseline	U.S. PWT	Population	Pooled	$r = 5\%$
1977–79	1.73	2.35	4.14	1.60	1.70
1994–96	1.86	2.58	4.45	1.73	1.83
2017–19	2.11	3.05	4.54	2.04	2.10

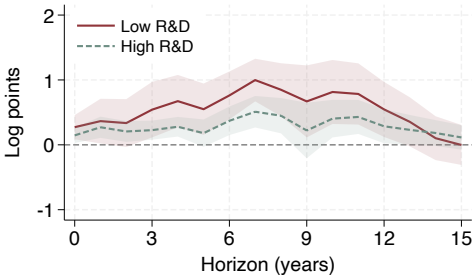
Notes: Each cell is the discounted-PV global-to-domestic spillover wedge ψ for U.S. nondefense R&D, 7% discount rate unless noted. *U.S. PWT* measures the U.S. response with PWT economy-wide TFP rather than utilization-adjusted business-sector TFP, matching the foreign measure; *Population* weights groups by PWT population rather than real GDP; *Pooled* replaces the group breakout with the pooled full-sample-ex-U.S. response; $r = 5\%$ lowers the discount rate.

Every alternative raises ψ except pooling, which is near-neutral, so the baseline is a floor

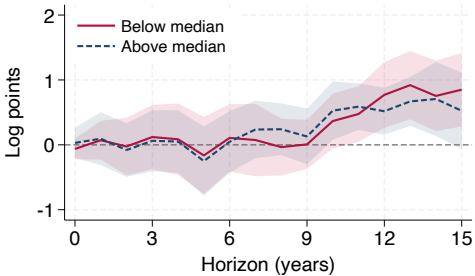
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Spillovers Are Larger Where Domestic R&D Capacity Is Lower

(a) OECD ex-USA, by R&D stock



(b) Never-OECD, by frontier distance



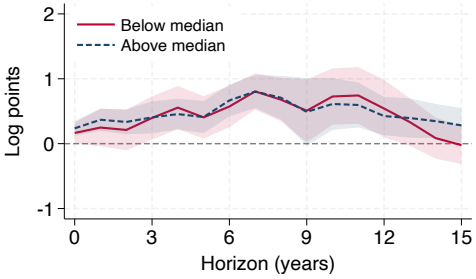
Notes: Nondefense shock; median splits within each group on PWT R&D/IPP capital (left) and relative GDP per capita (right). Shaded bands are 95% CI, year-clustered.

Gains concentrate in lower-capacity economies further from the frontier: evidence *against* Cohen and Levinthal (1990) absorptive capacity

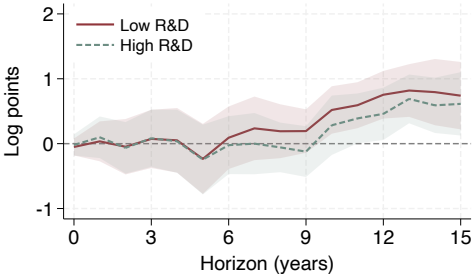
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Heterogeneity: Other Splits for Distance from Frontier, R&D Stocks

(a) OECD ex-USA, by frontier distance



(b) Never-OECD, by R&D stock

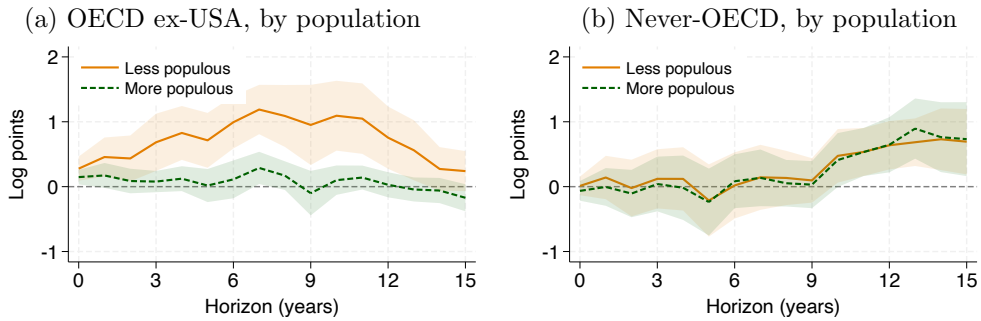


Notes: Nondefense shock; median splits within each group on relative GDP per capita (left) and PWT R&D/IPP capital (right). Shaded bands are 95% CI, year-clustered.

No evidence favoring Cohen and Levinthal (1990) absorptive capacity

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Heterogeneity: Country Size



Notes: Nondefense shock; median split within each group on population. Shaded bands are 95% CI, year-clustered.

OECD response concentrated in smaller economies; no size gradient among Never-OECD

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Implications for Theory: Which Diffusion Mechanisms Operate

- **Sharper moments to match:** identified dynamic responses — level, timing, and cross-group heterogeneity — discipline models usually calibrated to cross-sectional or long-run moments
- **Against absorptive capacity:** gains concentrate where domestic R&D capacity is *lower* — hard to reconcile with diffusion operating through formal research absorption (Cohen and Levinthal 1990)
- **Not simply catch-up:** classic catch-up hinges on the *stock* of frontier technology (Gerschenkron 1962; Abramovitz 1986); our shock delivers a *pulse* of new technology
- **Complements, not substitutes:** foreign crowd-in implies no inelastic global pool of R&D resources being reallocated or bid away by the frontier pulse

Points toward channels that do *not* require domestic R&D capacity: open scientific content, capital-embodied trade, leapfrogging

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