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

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July 31, 2026

Large Domestic Returns to U.S. Public R&D → Spillovers Abroad?

Starting point:

- Fieldhouse and Mertens (2026): exogenous shocks to U.S. nondefense R&D appropriations raise *domestic* TFP; *domestic* social returns of ∼140–210%

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Our research questions:

- How large are the *international* productivity responses to U.S. public R&D?
- Which *diffusion channels* are consistent with this causal evidence?
- What share of the *global* social returns to U.S. public R&D is captured abroad?

First Causal Estimates of the Global Returns to U.S. Public R&D

What we do:

- Apply the Fieldhouse and Mertens (2023) narrative U.S. R&D appropriations shocks to a panel of 69 foreign economies over 1980–2019, via panel local projections (LPs)
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- Spillovers driven by nondefense R&D; concentrated in Never-OECD economies
- Global social returns are ∼2× the domestic returns; the U.S. captures only 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); Buera and Oberfield (2020); Comin and Hobijn (2010)

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. Build enacted-appropriations data for the 5 major federal R&D agencies (∼90% of federal R&D), by fiscal year, from the *U.S. Budget*

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This paper: additionally orthogonalize to lagged U.S. macro, financial conditions

- Residual instruments for 'nondefense' (n), 'defense' (d), and 'combined' (c) R&D shocks
- Guards against global shocks driving U.S. R&D *and* foreign TFP

The Shocks Are Driven by Geopolitics and Policy, Not the Economy

The exogenous variation comes from idiosyncratic policy preferences and geopolitics:

- **National security:** Sputnik/ICBM race, Soviet invasion of Afghanistan, Cold War "peace dividend," 9/11, Global War on Terror
- **Science initiatives:** Moon landing, Human Genome Project, International Space Station
- **Public-health crises:** War on Cancer, HIV/AIDS
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Key for identification: None of these are responses to *foreign* productivity

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 1980–2019:

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

- $y_{i,t+h}$: foreign TFP (PWT) for country i at horizon h
- $\hat{z}^k_t$: U.S. exogenous R&D appropriations shock, $k \in \{n, d, c\}$, *common* across countries
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- $\boldsymbol{x}_{i,t-j}$: two lags of own log TFP, real GDP growth, U.S. TFP-U (Fernald 2012)
- γ_i: country FE, SEs clustered by country

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Responses scaled to a shock of 1% of the lagged nondefense/defense/federal R&D capital stock

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- **Panel structure:** country FE, SEs clustered by country

Open: generated-IV bias; cross-country residual correlation; conditioning on foreign stock returns

Data, Sample, and Measurement

- **PWT (11.0) outcomes:** TFP* (`rtfpna`); real GDP per capita (`rgdpna/pop`)
- **Sample:** 69 foreign countries, 1980–2019 ▸ Countries
  - Avoid post-WWII reconstruction and political transition dynamics, Covid-19
  - Exclude petro states/heavy resource extraction (e.g., Saudi Arabia)
  - Exclude former Soviet-bloc transition economies (e.g., Poland)
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- **Crowd-in/out:** foreign R&D capital and personnel responses, from OECD MSTI
  - R&D capital by performing sector (business / higher-ed / govt), 23 countries
  - R&D personnel, full-time equivalent employment, 14 countries

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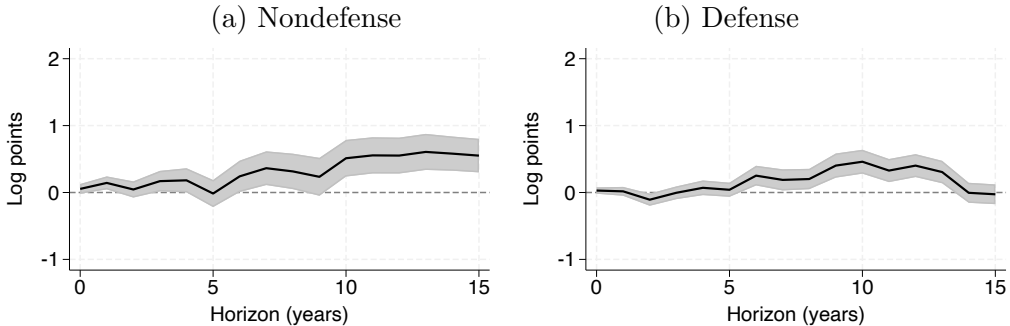
*PWT TFP is economy-wide, not utilization-adjusted, and the aggregate capital stock includes a capitalization of R&D+IPP for some (SNA '08) but not others (SNA '68, '93)

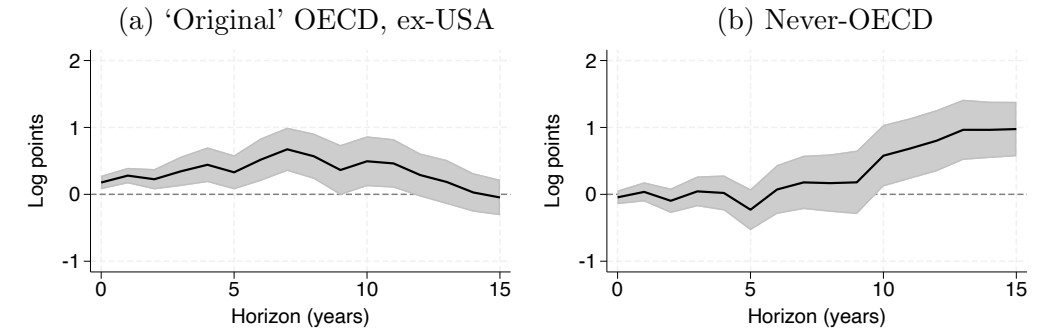
Global TFP Spillovers from U.S. Public R&D

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



Notes: Pooled estimates for the full panel, ex-USA (69 countries). Shocks are scaled to 1% of the respective lagged federal R&D capital stock. Shaded bands are 95% CI (country-clustered SEs).

Nondefense R&D Spillovers Concentrated in Never-OECD Economies



Notes: Pooled estimates for Original OECD, ex-USA (left) and Never-OECD (right). Shocks are scaled to 1% of the lagged federal nondefense R&D capital stock. Shaded bands are 95% CI (country-clustered SEs).

OECD: response peaks mid-horizon then decays → frontier-to-frontier diffusion

Never-OECD: larger, and builds through h=15 → catch-up / leapfrogging

▸ Def / Combo ▸ GDP per Capita

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

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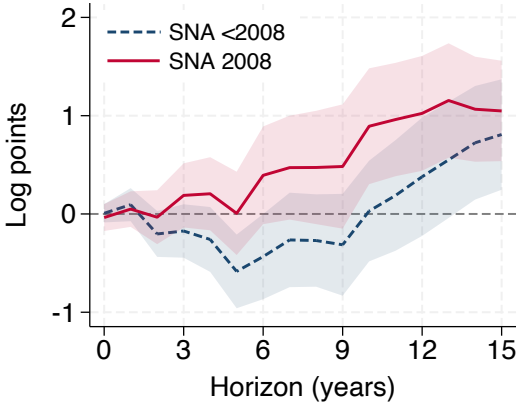
- Concern: Never-OECD response could reflect differential measurement, not diffusion
- Test: split Never-OECD responses by modal SNA vintage, for nondefense: ▸ Cohorts

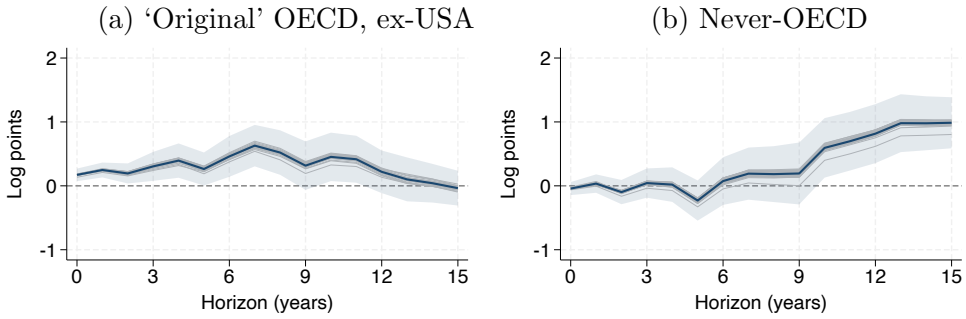


▸ Within SNA 2008

→ Larger effect for SNA 2008 countries w/ IPP capitalization, contrary to measurement concern

Other Robustness Concerns: Outlier and Window Sensitivity?

No single country: nondefense results are robust to leave-one-out exercises

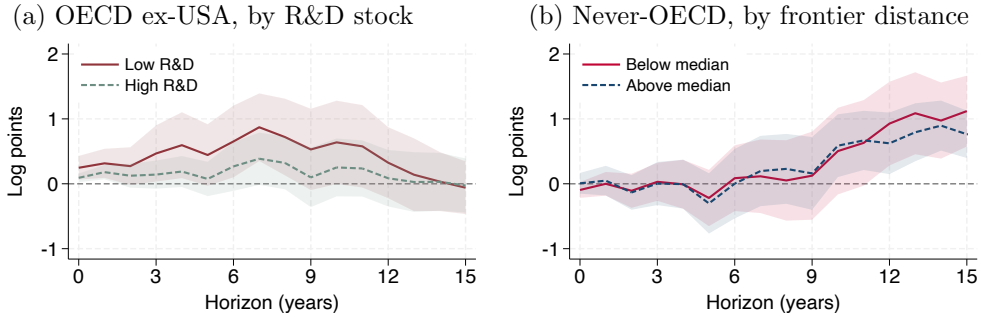


No single window: robust to rolling estimation within 1980–2019

▸ Rolling

Where the Spillovers Go: Heterogeneity and Mechanisms

Spillovers Are Larger Where Domestic R&D Capacity Is Lower



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 (country-clustered SEs).

Gains concentrate in lower-R&D-capacity economies and countries further from the frontier → evidence *against* the Cohen and Levinthal (1990) absorptive capacity hypothesis

▸ Other Splits

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)

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- Evidence that U.S. public R&D crowds in R&D activity for OECD peers
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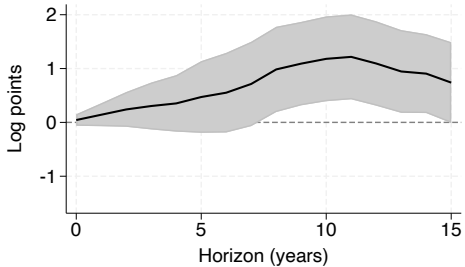
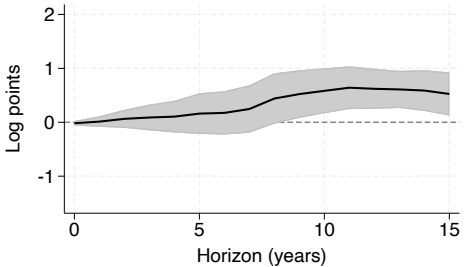
Work-in-progress: patents and citations, trade linkages, horse-race between channels, related lit

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

(a) Business R&D (performer)



(b) Total R&D

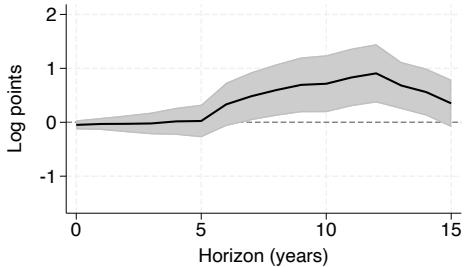


→ U.S. nondefense R&D crowds *in* foreign R&D (complements, not substitutes); no crowd-out

▸ Personnel

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

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



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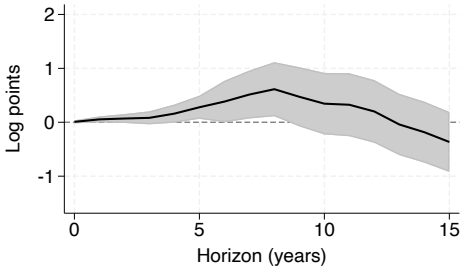

→ Defense shocks crowd in foreign higher-education R&D; total response smaller, less persistent

▸ Personnel

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

From IRFs to a Global-vs-Domestic Wedge

Ratio between global and domestic benefits-to-costs → U.S. R&D costs cancel in ratio → focus on ratio between PV of cumulative global relative to domestic benefits:

$$\psi = \frac{PV_{US} + PV_{RW}}{PV_{US}} = 1 + \frac{PV_{RW}}{PV_{US}}, \tag{1}$$

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

▸ U.S. Crosswalk

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

Table 1: Wedge Between Global and Domestic Social Returns to U.S. Nondefense R&D

	Global-to-domestic spillover wedge, ψ			U.S. share
Weighting window	Discounted PV	$h = 10$	$h = 15$	of global gain
1977–79	1.77	1.64	1.49	56.6%
1994–96	1.91	1.81	1.84	52.3%
2017–19	2.22	2.25	2.93	45.0%

Notes: The spillover wedge is the ratio of the global to the domestic social return to a U.S. nondefense R&D appropriations shock, computed as a GDP-weighted ratio of TFP impulse responses. The U.S. response uses Fernald (2012) utilization-adjusted business-sector TFP and the foreign responses use PWT economy-wide TFP. Countries are partitioned into the United States, 29 modern OECD members excluding the United States, and 40 non-OECD economies. Weights are average annual real GDP at chained PPPs (PWT `rgdpo`) over the indicated three-year window. The discounted present value applies a 7% annual discount rate to the impulse-response path through $h = 15$; the snapshot columns evaluate the wedge at a single horizon. The U.S. share equals the inverse of the discounted-PV wedge.

$\psi \approx 1.8$–$2.2 \rightarrow$ the U.S. captures only ∼45–57% of the benefits from its own nondefense R&D

A Conservative Lower Bound and Its Implications

By design, ψ is meant as a conservative lower bound:

- Panel: Foreign gain in numerator limited by 69-country coverage
- U.S. gain in denominator measured with utilization-adjusted TFP (Fernald 2012): the *largest* U.S. TFP response (and the appropriate measure)
- GDP-weighting down-weights high-response poorer economies: population weighting $\rightarrow \psi \approx 4.6$–$5.1$
- Results *insensitive* to discount rate and to pooled estimate vs. subgroups ▸ Robustness

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Applied to structural estimates of 140–210% for domestic returns (Fieldhouse and Mertens 2026)
→ global returns of ∼250–460% or higher for U.S. public R&D

Conclusion

Summary: Preliminary Empirical Takeaways

- U.S. public R&D generates large, persistent increases in foreign TFP
- TFP spillovers are stronger for nondefense R&D, larger in Never-OECD countries
- U.S. R&D crowds in foreign R&D in OECD countries: complements, not substitutes
- Global social returns are $\sim 2\times$ domestic; U.S. captures only about half of gains

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

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

Implications for Policymakers and Policy Coordination

- **Underinvestment:** countries capturing only a fraction of the benefits to their public R&D will underinvest relative to the globally efficient level (the country-level analog of the standard market-failure motivation for public R&D)

- **De-globalization costs:** given gradual + persistent TFP spillovers, tariffs, export controls, and migration limits risk dynamic growth costs exceeding static costs

- **Coordination:** complementarity → scope for coordinated public-research expansion among advanced economies (e.g., CERN, HGP, ISS)

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Next steps: expanded mechanisms in Section 5 (second draft later this fall)

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

Back

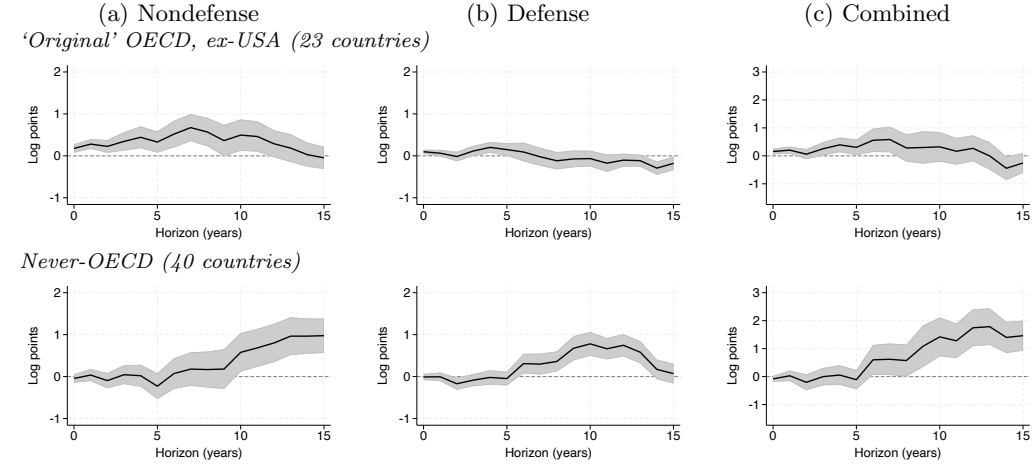
Baseline Panel: 69 Foreign Economies, 1980–2019

- **'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

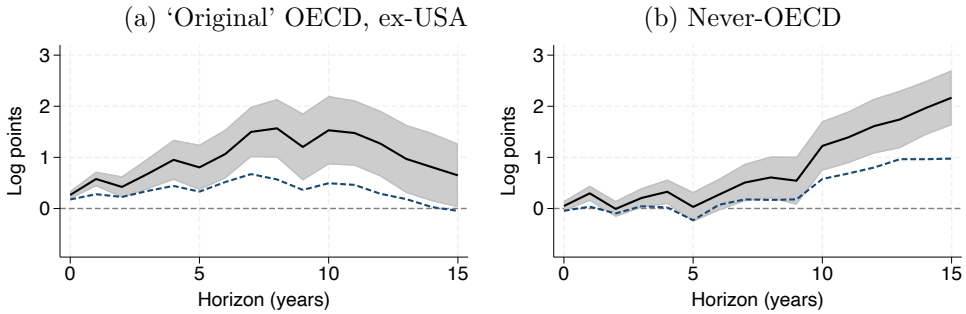
Foreign TFP Responses: All Shocks by Country Group



Notes: Pooled estimates for 'Original' OECD, ex-USA (top) and Never-OECD (bottom). Shocks are scaled to 1% of the respective lagged federal R&D capital stock. Shaded bands are 95% CI (country-clustered).

▸ Back

Foreign GDP per Capita and TFP Responses

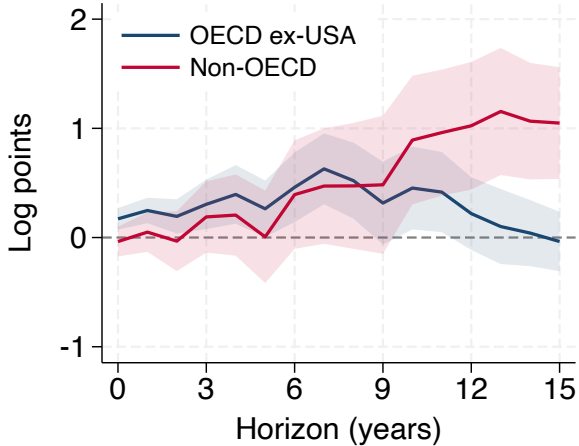


Notes: Nondefense shock; each panel plots the real GDP per capita and TFP responses for the same group. Shaded bands are 95% CI (country-clustered SEs).

→ Real income per capita rises alongside and by more than TFP — the response is not an artifact of TFP measurement

▸ Back

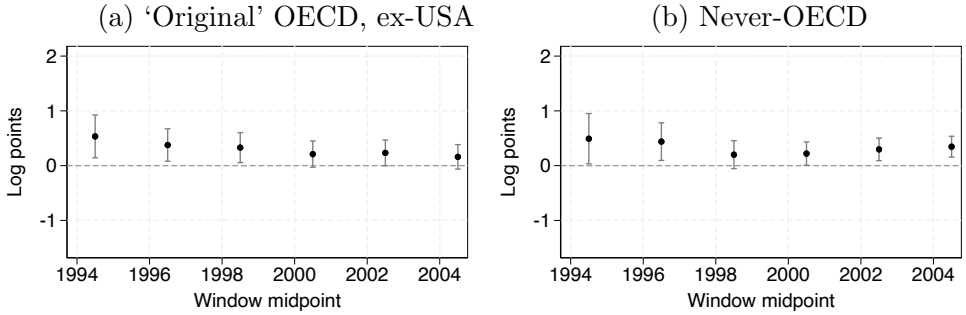
Within SNA 2008 Countries: The Group Contrast Survives



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 (country-clustered SEs).

Back

Rolling Windows: Nondefense TFP Response at $h = 10$

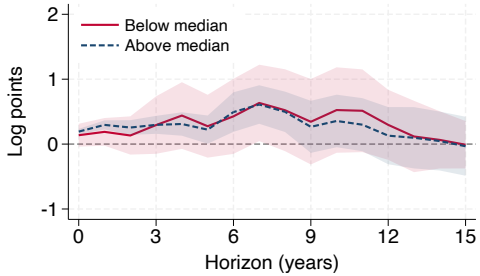


Notes: Each point is the $h = 10$ nondefense TFP response estimated on a rolling subsample, plotted at the window midpoint. Bars are 95% CI (country-clustered SEs).

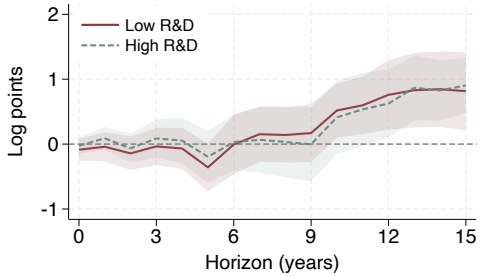
Back

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

(a) OECD ex-USA, by frontier distance



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

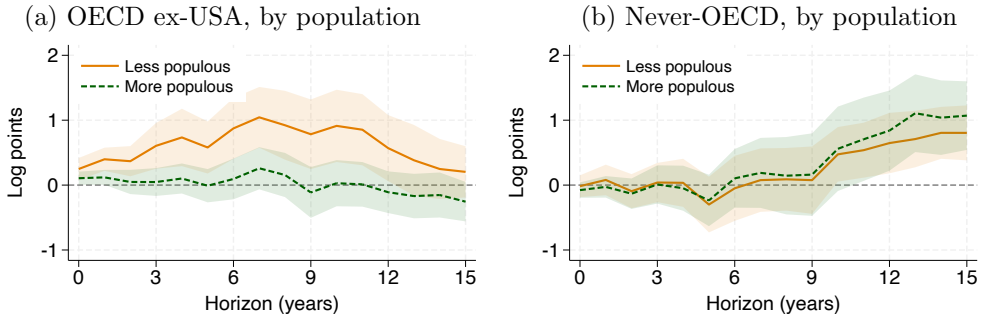


Notes: Nondefense shock; median splits within each group on relative GDP per capita (left) and PWT R&D/IPP capital (right). Shaded bands are 95% CI (country-clustered SEs).

→ No evidence favoring the Cohen and Levinthal (1990) absorptive capacity hypothesis

Back

Heterogeneity: Country Size



Notes: Nondefense shock; median split within each group on population. Shaded bands are 95% CI (country-clustered SEs).

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

Back

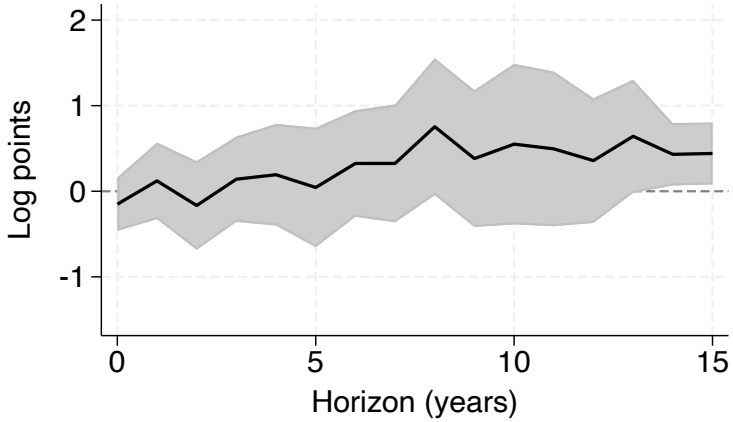
Diffusion Literature: Postwar U.S. Technology Transfer

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

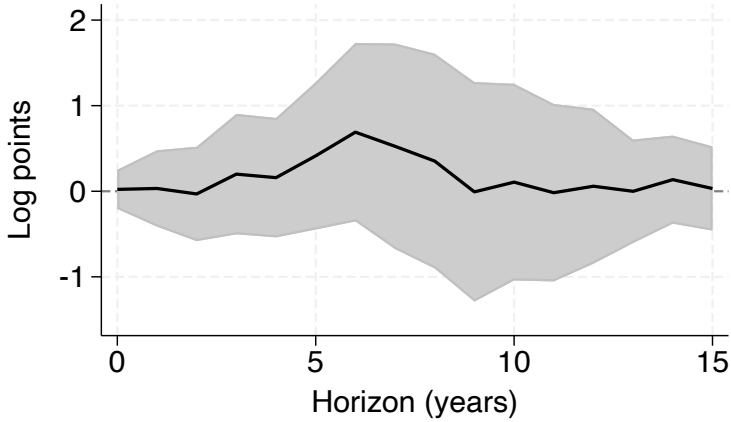
Back

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



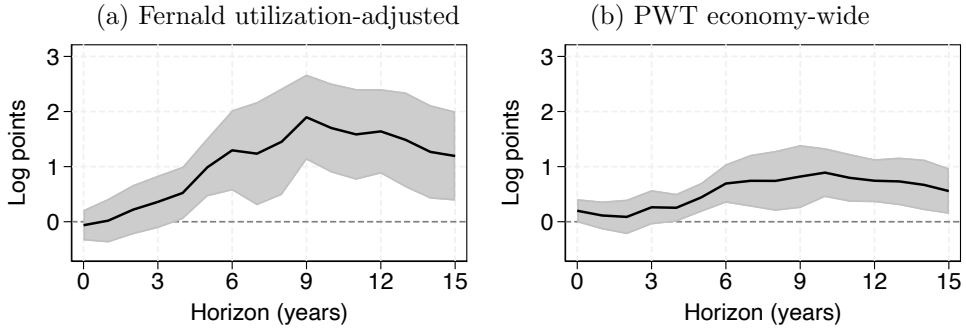
Back

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



Back

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



Notes: U.S. TFP response to the nondefense shock, 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 → using it in the denominator → $\psi \downarrow$

▸ Back: Setup ▸ Back: Bound

Robustness Results: Global-to-Domestic Spillover Wedge

Table B.1: Robustness of the Global-to-Domestic Spillover Wedge

Weighting window	Baseline	U.S. PWT	Population	Pooled	$r = 5\%$
1977–79	1.77	2.42	4.60	1.71	1.74
1994–96	1.91	2.68	4.98	1.87	1.89
2017–19	2.22	3.26	5.09	2.24	2.23

Notes: Each cell is the discounted present-value global-to-domestic spillover wedge ψ for U.S. nondefense R&D, as in Table 1, using a 7% discount rate unless noted. The first column reproduces the Table 1 baseline (Fernald (2012) utilization-adjusted U.S. response, GDP-weighted modern-OECD/non-OECD breakout, 7% rate). Each remaining column changes one modeling assumption: *U.S. PWT* measures the U.S. response with PWT economy-wide TFP rather than utilization-adjusted business-sector TFP, matching the foreign TFP measures; *Population* weights country groups by PWT population rather than real GDP; *Pooled* replaces the breakout with the pooled full-sample-ex-U.S. response applied to total foreign GDP (the top row of Figure 1); and $r = 5\%$ lowers the discount rate from 7% to 5%.

Back