Public Procurement, the Nature of Innovation, and Growth: Firm-Level Evidence from Germany

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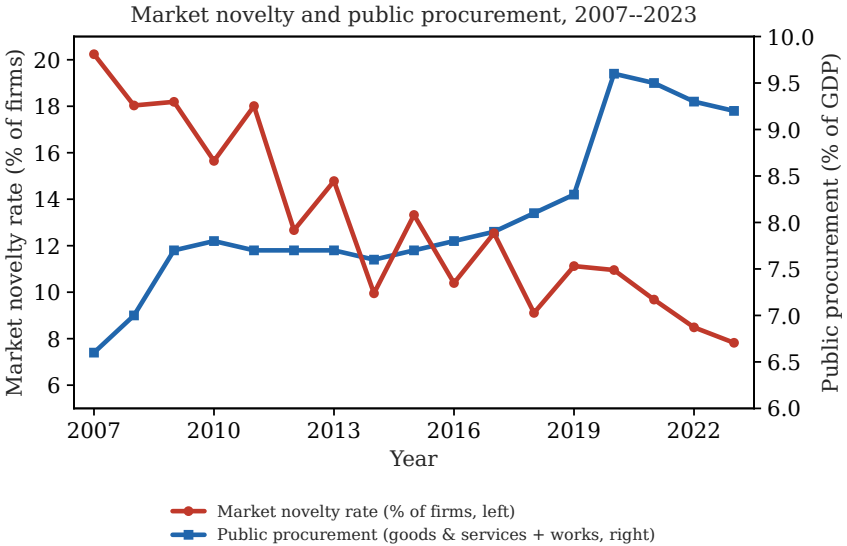
Public Procurement Has Risen as Market Novelty Has Fallen



Appendix: by industry

Can Public Demand Shape What Firms Build?

- Government contracts come with requirements: technical standards, compatibility, certification, delivery schedules.
- Winning often depends on reliable compliance, not on having the newest idea.
- Firms in those contracts build toward requirement-compliant products, not necessarily the frontier.
- Winning expands their scale, reinforcing the shift toward existing products.

What we do and what we find

- **Measure the innovation margin shaped by public demand**
  - Combine German firm innovation histories with public-contract award records.
  - Ask whether firms in more exposed industries report a different innovation mix.
  - Use contract cases to check the mechanism.
  - Find that higher procurement exposure is associated with **less frontier innovation** and **more incremental innovation**.

- **Quantify the growth tradeoff with an endogenous growth model**
  - Quality-ladder model where firms choose frontier and incremental innovation.
  - Estimate the model by GMM using the firm-level micro moments.
  - Disciplines scale gains against the cost of shifting innovation composition.
  - An R&D tax credit raises growth by **10.18 bp/yr** and welfare by **1.55%**.

Related literature

Outline

We Link Contracts to Firm Innovation

- **MIP:** firm innovation outcomes, 2009–2023 (80,028 firm-years, 23,547 firms).
- **TED:** German public contract awards by industry and year (271,713 records mapped to MIP industries).
- **ORBIS:** winner scale and productivity outcomes (126,700 firm-years, 15,493 firms).
- **BHP:** establishment entry/exit records, 2009–2023 (22.5M establishment-years, 5.07% annual exit hazard).

Three Contracts, Read Closely

Vaccine regulator, 2020: microscope upgrade (EUR 539K)

Detail: required patented imaging technology sold by only one manufacturer.

Story fits: the requirement rules out every other supplier by design, won by Leica.

Agricultural research institute, 2020: new lab building (EUR 1.07M)

Detail: required licensed fire-safety and utilities engineers, provided by few firms.

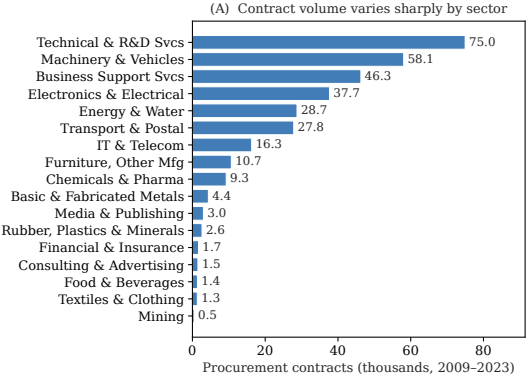
Story fits: a narrow technical requirement, won by M+M.

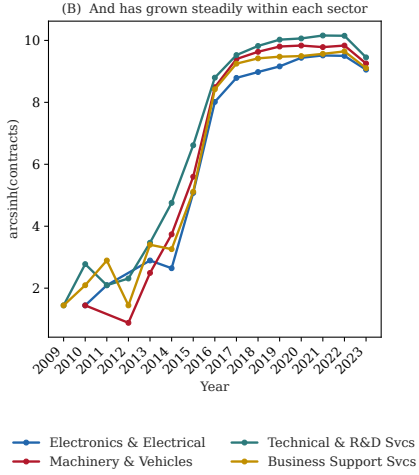
Cybersecurity agency, 2021: AI for factory-network security (EUR 216K)

Detail: 5,000 words on risk, but universities, security firms, and research labs could all bid.

Story does not fit: detailed requirements, but a wide, competitive field, won by Fraunhofer.

Procurement Exposure Varies Across Sectors and Time





Appendix: by industry

We Compare Firms as Sector Procurement Exposure Changes

$$Y_{ist} = \alpha_i + \delta_t + \beta \operatorname{arcsinh}(\text{contracts}_{s,t}) + \varepsilon_{ist}$$

- Firm fixed effects compare each firm to itself across survey waves. Year fixed effects absorb aggregate German innovation shocks.
- β summarizes how outcomes move with sector-year contract exposure.

Outcome	**Margin**
Market novelty	New to the market, not just to the firm
Existing-product revenue	Turnover share from unchanged products
Cost-reduction revenue	Turnover share from cost-cutting changes

Procurement Exposure Is Linked to *What* Firms Innovate

	(1) Mkt novelty	(2) Exist.-prod. rev.	(3) Cost-red. rev.
Proc. exposure	-0.199^{*}	0.379^{**}	-0.047^{*}
	(0.101)	(0.137)	(0.024)
+1 SD assoc. (pp)	-0.709	1.352	-0.162

Within-firm OLS, firm and year FEs; SEs (parentheses) clustered by MIP sector (21 clusters). Treatment: arcsinh(contract count) in the firm's MIP sector-year, 2009–2023. Col. 2 is the turnover share from unchanged products; col. 3 is the share from cost-reducing innovations. N: 66,980 / 25,962 / 40,635. $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

By type/buyer Winner outcomes

Outline

Standard Quality-Ladder Model with Endogenous Innovation Direction

- Consists of firms with a production and innovation choice, households, and a government that procures incremental lines.
- Firms choose how much effort to put into R&D and what share of that effort to direct toward frontier vs. incremental innovation.
- The government sets a procurement demand for incremental lines, which raises their profits and shifts the direction of innovation.
- The model is set in continuous time and solved on the steady-state.

Household details

Firms Choose Effort and Direction

$$y_j = q_j \, \ell_j^P$$

$$q_j \xrightarrow{\text{rate } x} \begin{cases} \lambda_I q_j & \text{share } 1-\mu \text{ (incremental)} \\ \lambda_F q_j & \text{share } \mu \text{ (frontier)} \end{cases} \qquad \lambda_F > \lambda_I > 1$$

$$\Phi(x) = c_x x^\zeta w, \qquad \Psi(\mu) = \frac{\kappa}{\eta}\mu^\eta$$

- Each line j has quality q_j and production labor ℓ_j^P; a firm is a portfolio of lines.
- Effort x sets how often a line improves; direction μ sets share on the frontier.
- $\Phi(x)$ and $\Psi(\mu)$ are the costs of effort and direction.

Government Demand Rewards Incremental Lines

$$T = (1 - \mu^*)G$$

- Procurement is financed by a lump-sum tax.
- G is government demand per incremental line.
- Procurement raises profits on requirement-compliant incremental lines:

$$\pi_I(G) = \bar{\pi}_I(1 + G), \qquad \pi_F(G) = \bar{\pi}_F, \qquad \bar{\pi}_k = \frac{\lambda_k - 1}{\lambda_k}$$

Firm Value Trades Off Effort and Direction

$$\underbrace{(r+\tau)v_k}_{\text{value}} = \underbrace{\pi_k(G)}_{\text{profits}} - \underbrace{\left[\Phi(x)+\Psi(\mu)\right]}_{\text{innovation costs}} + \underbrace{x\,\mathbb{E}[v]}_{\text{new-line value}}, \qquad k \in \{I,F\}$$

$$c_x \zeta x^{\zeta-1} w = \mathbb{E}[v]$$

$$\kappa \mu^{\eta-1} = x\,(v_F - v_I)$$

- Effort responds to the expected value of a new line.
- Direction responds to the value premium of a frontier line.
- Free entry pins down $\mathbb{E}[v] = wh_E$.

Equilibrium Definition

- A **balanced-growth equilibrium** is a set of allocations $(v_I, v_F, x^*, \mu^*, \tau^*)$ and a wage w^* such that:

  1. Firms maximize value: (v_I, v_F, x^*, μ^*) solve the Bellman equations given w^* and government demand G.
  2. Households maximize utility given w^* and the procurement tax T, pinning down $r = \rho + g$.
  3. Free entry holds: $\mathbb{E}[v](\mu^*; G) = w^* h_E$.
  4. Labor markets clear: $\bar{L} = L_P + \ell_R + h_E(\tau^* - x^*)$.
  5. The economy grows at a constant rate $g = x^*[(1-\mu^*)\log\lambda_I + \mu^* \log\lambda_F]$.

Procurement Changes What Firms Build

$$v_F(G) - v_I(G) = \frac{\bar{\pi}_F - \bar{\pi}_I(1+G)}{r+\tau}$$

- Higher G raises the payoff to incremental lines.
- The frontier premium narrows.
- Firms choose a lower frontier share:

$$G \uparrow \quad \Rightarrow \quad \mu^*(G) \downarrow$$

- With fixed labor, more production demand can also reduce R&D labor.

Growth Depends on Scale and Composition

$$g = x[(1-\mu)\log\lambda_I + \mu\log\lambda_F], \qquad \lambda_F > \lambda_I$$

- **Composition channel:**

$$G \uparrow \Rightarrow \mu^* \downarrow \Rightarrow g \downarrow$$

- **Scale channel:**

$$G \uparrow \Rightarrow x^* \uparrow \Rightarrow g \uparrow$$

- Quantification asks which channel dominates in equilibrium.

Outline

Strategy Overview

- Take some parameters from the literature and national accounts, and estimate the main drivers of innovation composition and growth.
- Use the estimated model to quantify the effects of procurement on growth and innovation composition.
- Analyze counterfactuals that redirect procurement support to R&D, relax requirements, or roll back procurement to historical levels.

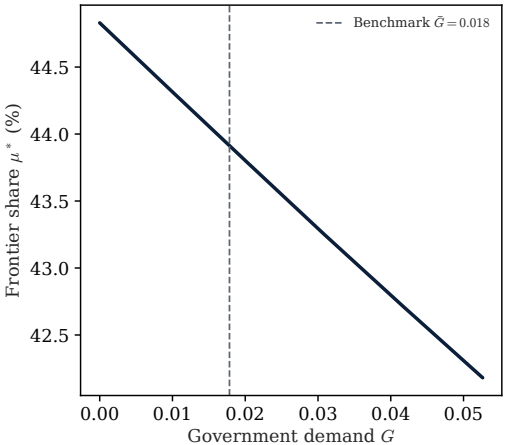
The Model Matches Five Targeted Moments

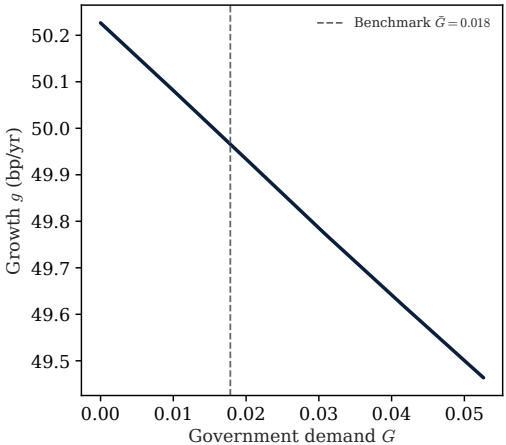
Moment	Data	(SE)	Model
Frontier share among innovators (%)	42.7	(0.5)	43.9
Frontier revenue share, new products (%)	58.2	(0.5)	56.9
Large-firm share (%)	10.4	(0.3)	9.3
Creative-destruction rate (%)	5.1	(0.6)	5.8
R&D personnel share (%)	2.9	(0.1)	3.5

The Estimates Put Frontier Steps Above Incremental Steps

Parameter		Estimate (SE)	Interpretation
Jointly estimated (GMM, 5 moments, 4 parameters)			
λ_F	frontier quality step	1.165 (0.003)	raises quality 16.5% per event
λ_I	incremental quality step	1.090 (0.003)	raises quality 9.0% per event
κ	direction cost	0.055 (0.004)	cost of steering effort to the frontier
h_E	entry labor cost	1.338 (0.021)	labor per unit of creative destruction
Implied and calibrated			
$\bar{\pi}_F$	frontier per-line profit	0.142	Bertrand markup, from λ_F
$\bar{\pi}_I$	incremental per-line profit	0.083	Bertrand markup, from λ_I
$\bar{G}$	benchmark government demand	0.018	Vergabestatistik / Destatis
$\bar{g}$	target growth rate	0.005	German TFP growth, literature

Raising Procurement Lowers Frontier Innovation and Growth





The Largest Gains Come From Redirecting Support to R&D

- **R&D tax credit:** redirect the procurement budget to a proportional R&D credit, sized to 2020 policy (25% of R&D costs). (Dechezleprêtre et al. 2023)
- **Requirement realignment:** keep spending fixed, but let frontier and incremental lines compete on open performance criteria. (Howell et al. 2025; Edquist & Zabala-Iturriagagoitia 2020)
- **Historical rollback:** scale government demand back to its 2008 share of GDP (1.3% vs. 1.8% now). (OECD national accounts)

Scenario	$\Delta\mu^*$	$\Delta\ell_R$ (%)	Δg (bp/yr)	CEV (%)
R&D tax credit	0.059	+18.64	+10.18	1.55
Requirement realignment	0.013	0.99	0.38	0.09
Historical rollback	0.002	0.21	0.07	0.015

Outline

Procurement Policy Has an Innovation-Composition Tradeoff

- German firm microdata show that higher procurement exposure is associated with less frontier innovation and more incremental innovation.
- A standard quality-ladder model with endogenous innovation direction and effort rationalizes the mechanism and quantifies the growth tradeoff.
- We estimate the model using the same microdata as moments and discipline the scale of government demand with national accounts.
- The counterfactuals show that redirecting procurement support to R&D raises growth and welfare more than requirement realignment or historical rollbacks.

Thanks! You can send me any comments or suggestions at joharav@umich.edu

Outline

5 Appendix

Where We Sit in the Literature

- **Innovation composition and growth:** (Garcia-Macia, Hsieh & Klenow 2019; Acemoglu, Akcigit & Celik 2022). We add a procurement-demand margin that shifts the direction of firm innovation.
- **Demand-side innovation policy:** (Krieger, Prüfer & Strecke 2024; Czarnitzki, Hünermund & Moshgbar 2020). Procurement redirects composition, distinct from subsidies that raise R&D levels.
- **Procurement contract design:** (Howell, Rathje, Van Reenen & Wong 2025; Clemens & Rogers 2026). We quantify the same design margin in general equilibrium.

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Appendix: Winners Scale Up Without Clear Productivity Gains

	(1) Employment	(2) Turnover	(3) Labor prod.	(4) Return on capital
Contracts won	0.025^{***}	0.029^{***}	0.007	0.001
	(0.002)	(0.007)	(0.007)	(0.001)
Effect of +1 SD (pp)	0.023	0.028	0.006	0.001

Within-firm OLS on arcsinh(contracts won), firm and year FEs; SEs (parentheses) clustered by NACE section (20 / 19 / 19 / 19 clusters). Employment, turnover, and labor productivity are in logs; labor productivity is turnover per employee; return on capital is pretax profit over total assets. Sample: ORBIS winner panel, 2009–2023, 15,493 firms matched to procurement awards. N: 88,706 / 38,690 / 33,994 / 28,584.

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The Association Varies by Purchase Type and Buyer

	(1) Mkt novelty	(2) Exist.-prod. rev.	(3) Cost-red. rev.
Supplies & services	-0.211^{**}	0.393^{***}	-0.046^{*}
	(0.099)	(0.137)	(0.023)
Works	-0.010	0.180	0.024
	(0.142)	(0.120)	(0.022)
Central government	-0.291^{**}	0.518^{**}	-0.045
	(0.131)	(0.194)	(0.037)

Each row is a separate within-firm OLS regression, firm and year FEs; SEs (parentheses) clustered by MIP sector (21 clusters). Treatment: arcsinh(sector-year contract count) for the indicated contract type (supplies & services, works) or buyer category (central government). N: 66,980 / 25,962 / 40,635.

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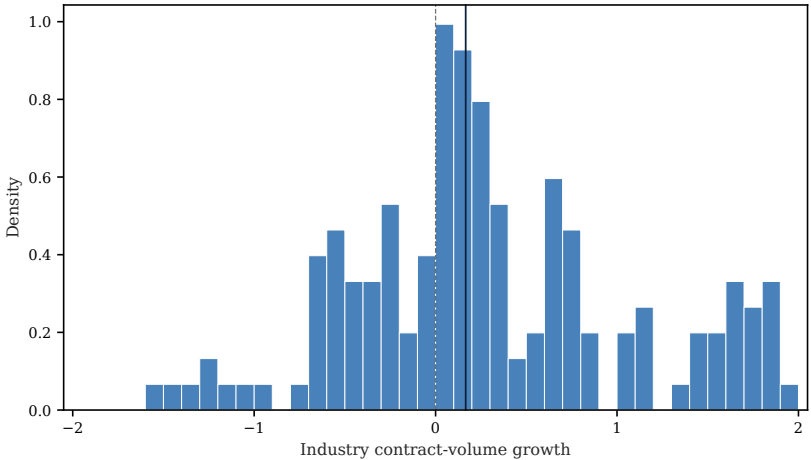
Appendix: Contract Growth Is Uneven Across Industries



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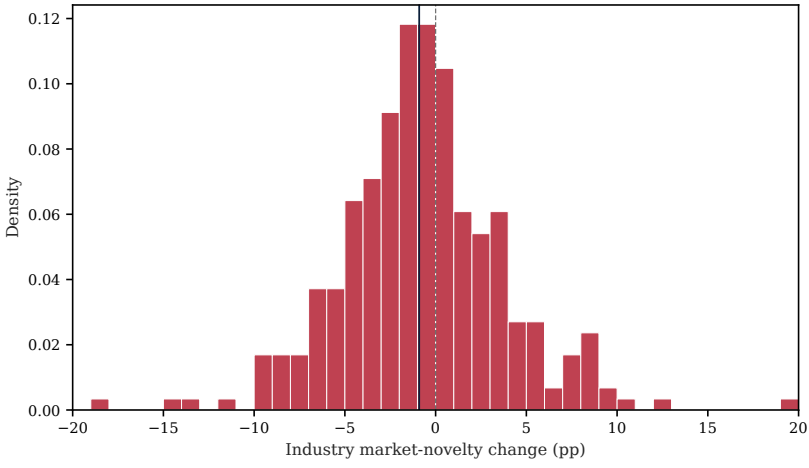
Appendix: Market Novelty Moves Across Industries



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Appendix: Model Details (Households)

$$\int_0^\infty e^{-\rho t} \log C_t \, dt$$

- Households supply labor inelastically and own all firms.
- Private expenditure is the numeraire.
- On the balanced-growth path:

$$r = \rho + g$$

- Initial consumption satisfies:

$$C_0 = w(L_P + \ell_R) + \Pi_{\text{net}} - T$$

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