Picking Winners or Building Them? Central and Local Government Venture Capital in Chinese Semiconductors

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November 3, 2026

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Motivation

- Trade and geopolitical tensions have revived debates on the **why** of industrial policy, but evidence on the **how** remains scarce
- Failures are plenty (Krueger, 1990, Baldwin and Robert-Nicoud, 2007)
  - Governments **subsidized inefficient firms** which **did not improve**: Latin America (Hirschman, 1968, Luzio and Greenstein, 1995), Japan 1955-90 (Beason and Weinstein, 1996), Government VCs (Lerner, 2009, Brander et al., 2015)
- within the sector, which firms to target and **who should allocate**?
  - I study Chinese government venture capital (VC) investment in semiconductors.
  - Many rationales for subsidizing semiconductors: production network linkages (Liu, 2019) + learning-by-doing spillovers (Irwin and Klenow, 1994, Goldberg et al., 2024)

China Invested in a Champion. Who Built It?

- Memory chipmaker CXMT was first invested in 2016 by the Hefei city government.
- The central government's "Big Fund" & private VC "Legend Capital" followed in 2020.
  - **Was Xi the Venture Capitalist? Or the Hefei City Government?**


China | Power law

Xi Jinping, pioneering venture capitalist

CXMT's monster initial public offering is a money-maker for the state. Its success may not be repeated

ILLUSTRATION: THE ECONOMIST / GETTY IMAGES

Source: *The Economist*, 27 July 2026.

Research Question: When and How Could Government Investment Work?

- When does government venture capital do better than private capital in generating firm growth?
  - **Which level of government should allocate?**

Results Preview: Local VCs Increase Domestic Industry Size & Productivity

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4. **Quantification** via modeling VC selection + demand with import substitution:
   - Reallocating government slots to private VC lowers 2023 revenue by **11.6%**
   - Reallocating local slots to central lowers revenue 4.0%; the optimal government allocation raises it 2.1%

Contributions to the Literature

- **Government venture capital** (Beraja et al., 2024, Colonnelli et al., 2024, Chen et al., 2026, Aragoneses and Saxena, 2025), management & productivity (Bloom et al., 2013, Giorcelli, 2019)
  - This paper: government VC **reshapes management** $\Longrightarrow$ productivity $\uparrow$
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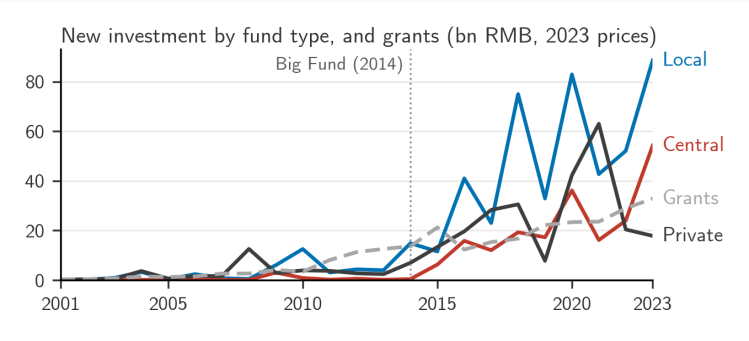
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Setting - Government Venture Capital in Chinese Semiconductors

- 2014 Integrated Circuits Plan sets up a national "Big Fund" to invest in semiconductors (Branstetter and Li, 2023)
  - Local governments run their own funds to invest in local firms
  - Local cumulative flows $\approx$ \$66bn USD, central $\approx$ \$28 bn from 2014-23 (CHIPS & Science Act $\sim$ \$52.7 bn)



Data

- Chinese business information platforms that integrate publicly available gov data
  - **shareholder history** & invested $
  - firm main personnel (**board/senior management**) history & biographies
- Chinese **firm-level balance sheet**
  - 2014-: Business information platforms (employment), Orbis (revenue, noncurrent assets, cost of goods sold)
  - National Bureau of Statistics Manufacturing Surveys (1998-2013)
- Global 1996-2024 plant-level data on capacity, process technology, construction & equipment spending from SEMI

Roadmap

✓ Setting and data

Central and local government VCs invest to maximize industry revenue

▶ **Who do government VCs target?**

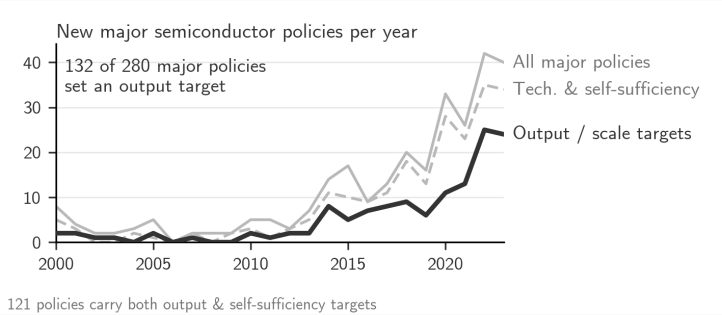
Event study: Productivity & Management

Mechanism and decomposition

Quantification

Fact 1: Central & Local Governments Maximize Industry Revenue

- National gov in 2014 National Integrated Circuit Industry Development Promotion Guidelines target **20% yearly domestic sales growth rate** as well as **70% domestic self-sufficiency rate ($\frac{\text{domestic production}}{\text{domestic demand}}$) by 2025**
- 132 out of 280 local gov documents issued since 2000 set industry revenue as policy target



121 policies carry both output & self-sufficiency targets

Misallocation Could Arise Under Decentralized Investment

- Maximizing industry revenue $\implies$ government should target firms with highest $\frac{\partial \text{ revenue}}{\partial \text{ investment}}$
- Revenue total factor productivity (TFPR) is a sufficient statistic for $\frac{\partial \text{ revenue}}{\partial \text{ investment}}$ if derivation
  1. Gov investment only adds firm physical capital
  2. Constant returns to scale
  3. $E(TFPR_{t+1}|TFPR_t)$ strictly increasing in $TFPR_t$
  4. Convex investment costs $C(I,K) = Kc(\frac{I}{K}), c'' > 0$
- Provinces could fund unproductive firms if **regions are not equally productive**
  - National total sales $\uparrow$ if the central gov reallocates investment from less productive to more productive provinces
  - The National Development and Reform Commission, Oct 2020: "some localities "launch projects blindly" ... duplicating redundant investment in low-technology projects."

Measuring Productivity

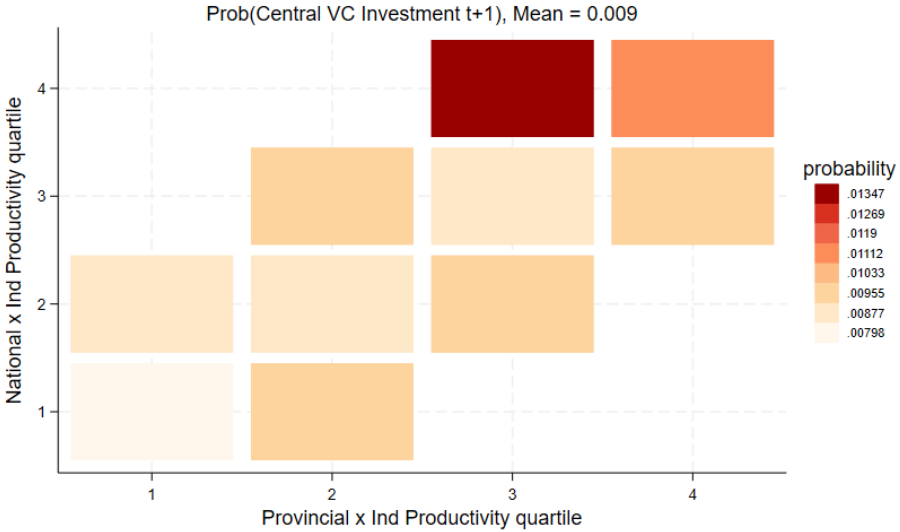
I estimate a Cobb-Douglas revenue production function for firm i in year t,

$$\ln R_{it} = \omega_{it}^{R} + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \epsilon_{it},$$

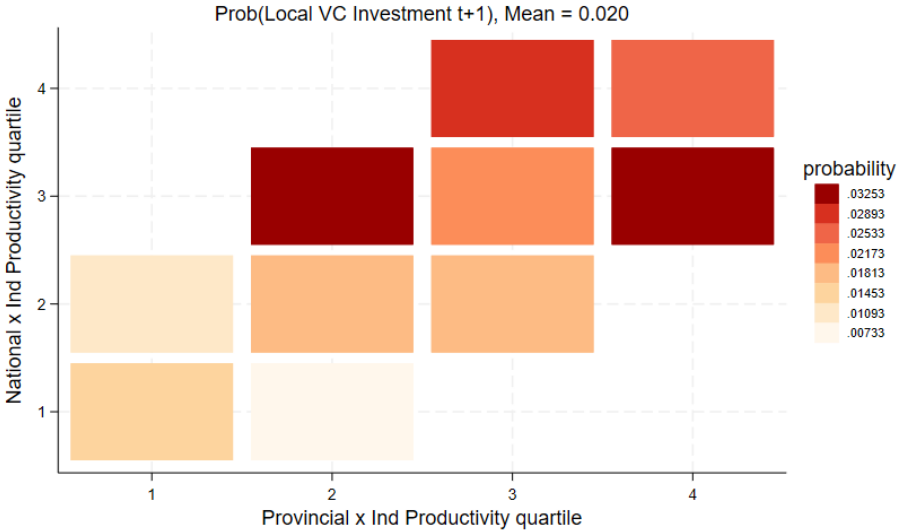
for each of 6 4-digit semiconductor sectors via Ackerberg et al. (2015) with investment proxy

- R deflated revenue, K fixed assets, L employment
- Estimates consistent with constant returns Estimates
- Corr $= 0.75$ with value-added productivity ω_{it}^{VA} on the smaller sample with value-added $VA_{it} = R_{it} -$ cost of goods sold$_{it}$ Value-added Estimates
  - ω_{it}^{R} = physical productivity + markup − materials price Derivation

Fact 2a: Central selects top National Quartile (Y-axis)



Fact 2b: Provinces select top Provincial Quartile (X-axis)

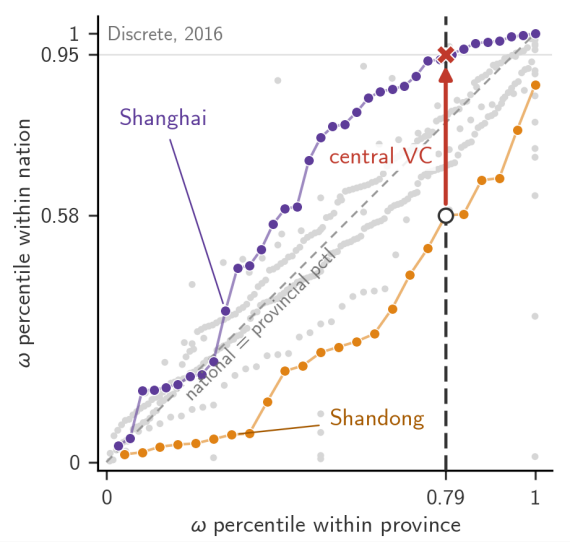


Fact 2: Local VCs Select Provincial Rank, Central & Private Invest in Top National Firms

Conditional Logit

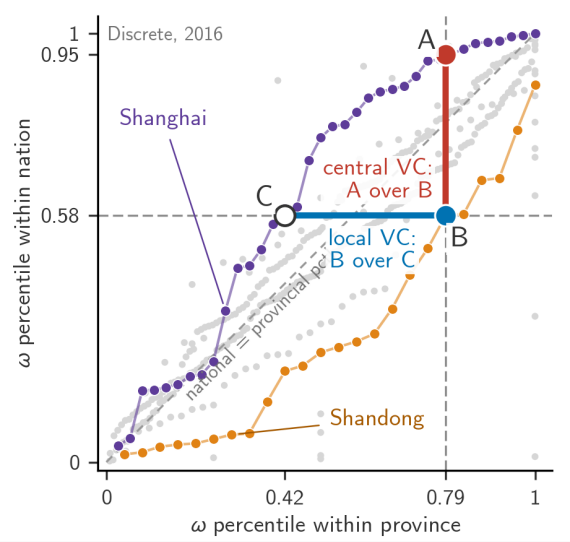
	Central VC		Local VC		Private VC	
	(1)	(2)	(1)	(2)	(1)	(2)
National TFPR percentile (0–1)	**0.012****	**0.012****	-0.004	-0.005	**0.018*****	**0.018*****
	(0.006)	**(0.005)**	(0.006)	(0.006)	**(0.007)**	**(0.006)**
Provincial TFPR percentile (0–1)	-0.006	-0.008	**0.014****	**0.010***	0.006	0.002
	(0.005)	(0.005)	**(0.006)**	**(0.006)**	(0.006)	(0.006)
Mean outcome	0.01	0.01	0.02	0.02	0.01	0.01
N	22,533	22,472	23,964	23,902	20,874	20,874
R^2	0.04	0.04	0.04	0.05	0.02	0.04
Clusters (prov. × ind.)	175	175	177	177	174	174
Ind. × year FE	Y	Y	Y	Y	Y	Y
Firm and policy controls	N	Y	N	Y	N	Y

Central Favors the More Productive Province; Local Picks Home Champion



- Discrete devices, 2016: a random Shanghai firm outranks a random Shandong firm 77% of the time
- **Fixing ω provincial pctl $\approx$ 0.79**: Shanghai's firm is at national pctl 0.95, Shandong's at 0.58. Central VC picks the Shanghai firm

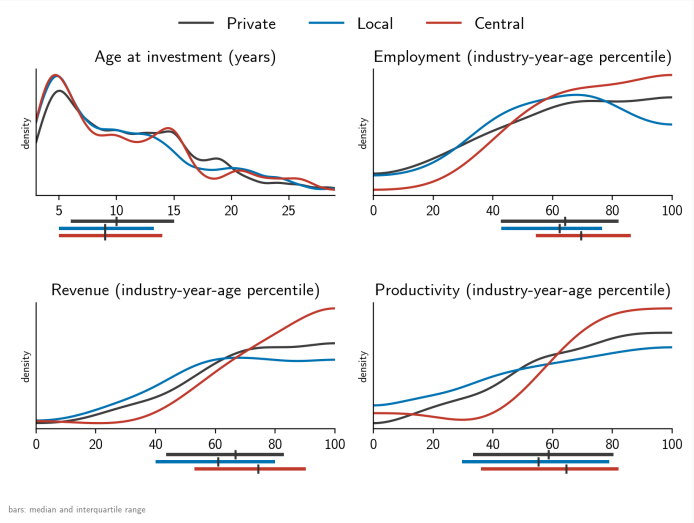
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- **Fixing ω national pctl $\approx$ 0.58**: two similarly productive firms, but the Shandong firm ranks higher at home (0.79 vs 0.42) and gets provincial investment

Local VCs Target Smaller & Less Productive Firms

$ Invested & Share Similar



Selection: Discussion

- Central VCs invest in productive national champions, local gov VCs target provincial leaders
- **Gov VCs target efficient firms in their jurisdictions**, consistent with their mandates
- But productivity differs across provinces $\implies$ local VCs target **less productive** firms than private & central VC invested firms money invested at entry is similar
  - $\implies$ Misallocation **if local governments do not make firms more efficient**

Roadmap

✓ Setting and data

Central and local government VCs invest to maximize industry revenue

✓ Who do government VCs target?

Private & Central Gov VCs invest in top national firms; local invests in smaller & less productive local champions

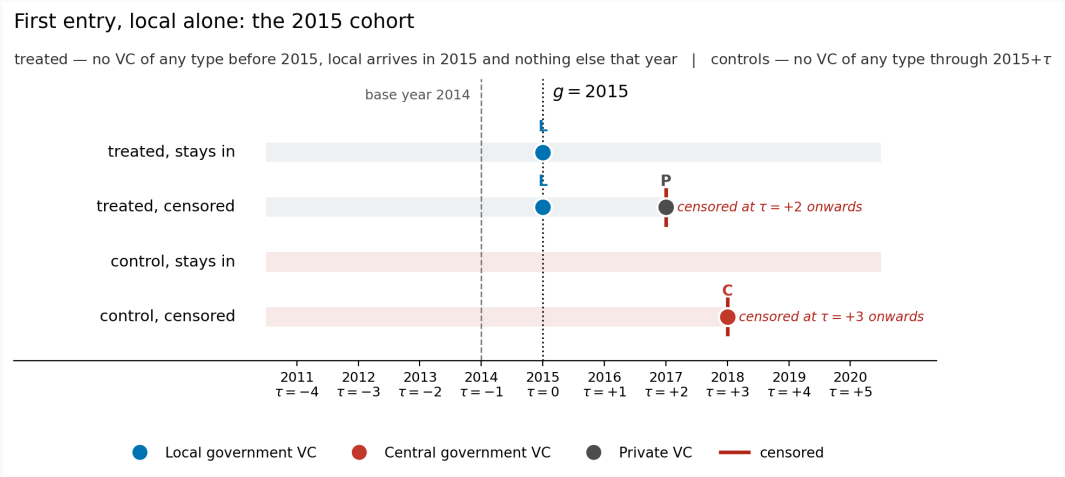
▶ **Event study: Productivity & Management**

Mechanism and decomposition

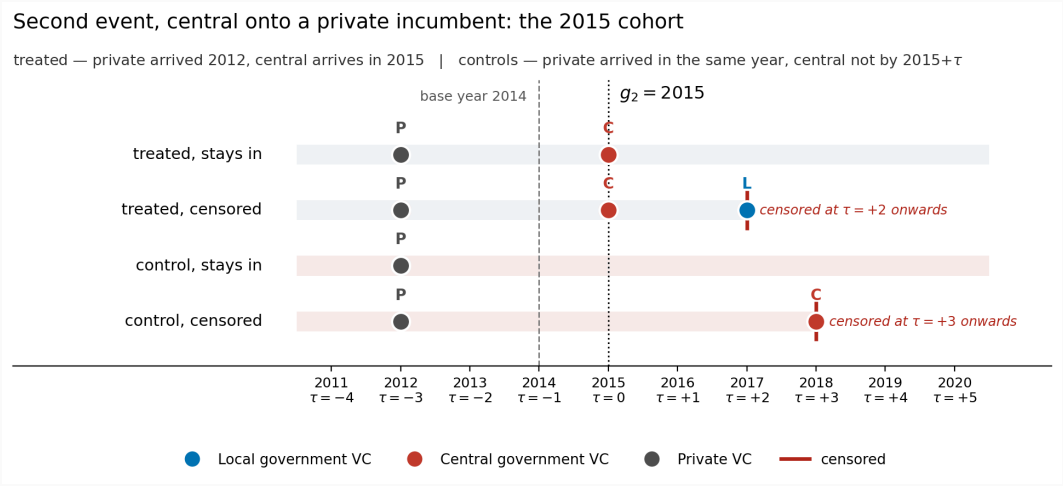
Quantification

- Challenge: firms receive **three staggered treatments** (local in year $G_{\mathrm{L}i}$, central $G_{\mathrm{C}i}$, private $G_{\mathrm{P}i}$)
- I implement de Chaisemartin and D'Haultfœuille (2023): for firms invested by local in each year $g = 2003 \sim 2023$, estimate differences-in-differences from $g-1$ to $g+\tau$, $\tau = 0, 1, 2, .., 5$, where:
  - Treated: invested by local in year g
  - Control: **not-yet-invested** by local by year $g+\tau$
  - **Treated and control share the same treatment history**: central and private VCs invested in the same years in or before g — including none
  - No other investor arrives between g and $g+\tau$
- I report treated unit-weighted average coefficient for each cell of $g \times \{\text{treatment histories}\}$ for each τ.
  - Interpretation: the **average change in outcome** from the VC's investment, over actually invested firms

DiD Strategy - First Entry

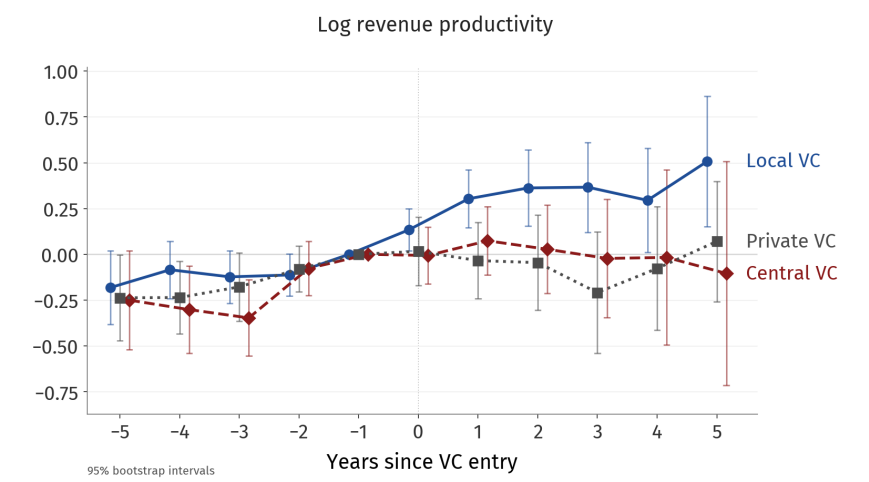


DiD Strategy - Subsequent Entry



Productivity Rose 34% after Local VC Investment

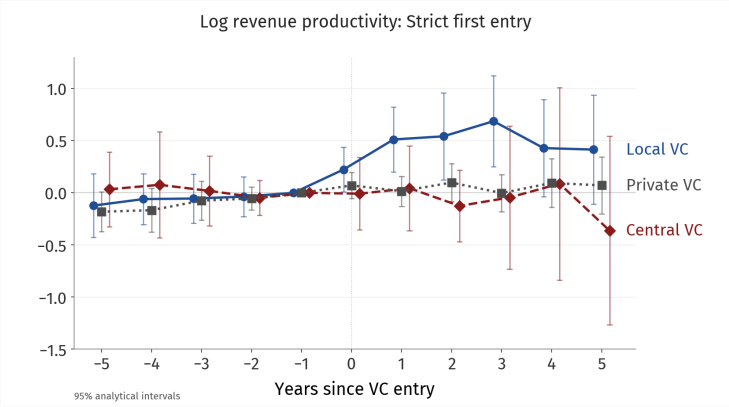
Central-Local



Testing ATT Differences | Pre-trend Sensitivity

Productivity Effects by First VC Type

Subsequent Entry | Decomposition

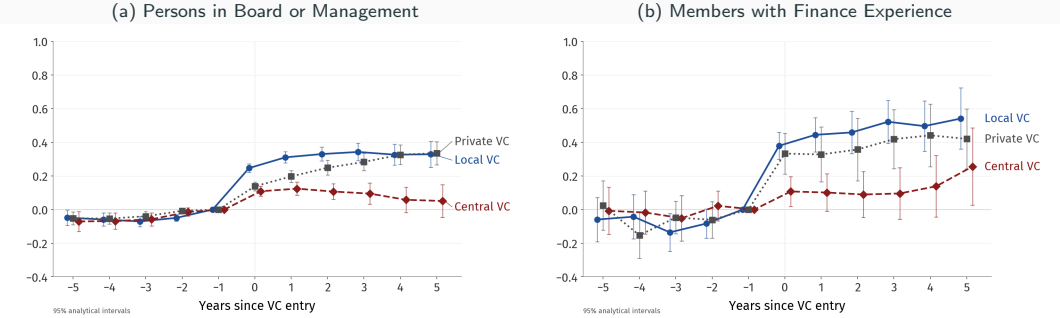


- Treated: firms receiving their **first VC investment** from a single investor type (510 local, 72 central-only, 933 private)
- Control: same-sector firms with **not yet any VC investment**

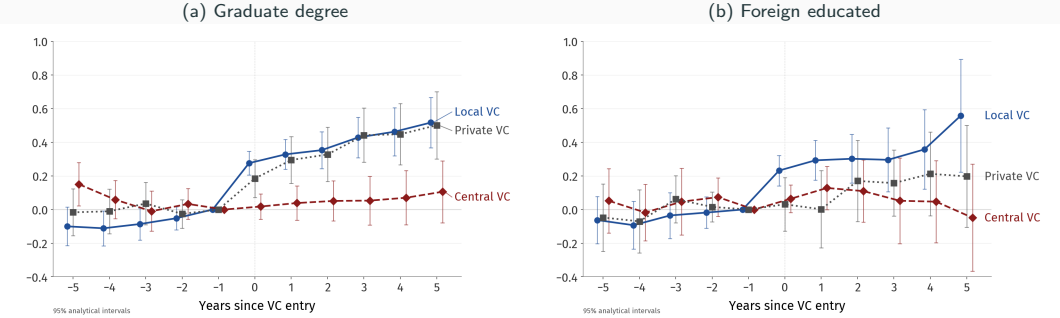
Productivity: Summary

- Local VC-invested firms **grew 34% more productive** post investment relative to controls, while central government & private VC-invested firms grew $\approx 0\%$
- Local VC-invested firms' revenue grew faster than their capital: revenue $+69\%$ vs. capital $+27\%$ three years after investment (central: capital $+43\%$) revenue capital sales per worker
- Local VC firms increased patents and chip designs faster IP / patents, all VC invested firms upgraded semiconductor manufacturing process process node
- What could drive the local-central differences? Local govs are more active in corporate governance

Average local-invested firm's board expands 30% after investment



Local VCs Add Board Members with Foreign & Grad Education



Board: Summary

- Local government-invested firm **expanded management/board size by about 30%** (central 10.8%)
  - Personnel **w. finance experience by 56.5%** (central 11.7%)
  - **W. foreign education by 29.4%** (central 8%)
  - **Graduate education by 42.4%** (central 4%)
- Local governments materially changed corporate governance
  - An understudied industrial policy tool that facilitates **monitoring & active management**
- Central government VC added less personnel, why?
  - **Larger portfolios & longer distance** from invested firms

Roadmap

✓ Setting and data
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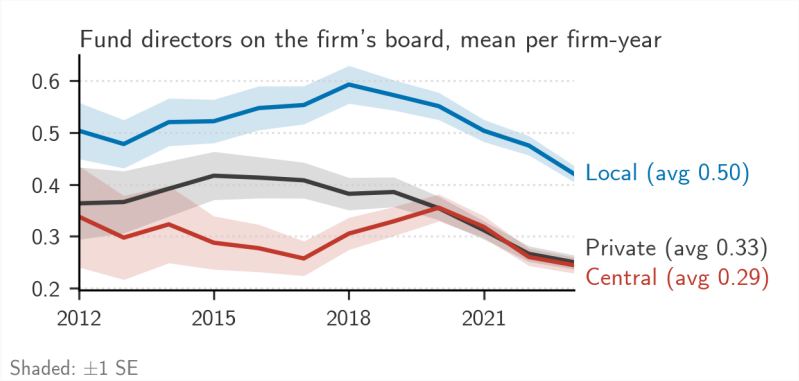
✓ Who do government VCs target?
Private & Central Gov VCs invest in top national firms; local invests in smaller & less productive local champions

✓ Event study: Productivity & Management
Local-invested firms +34% productivity, private & central ≈ 0; Local +30% board & management

▶ **Mechanism and decomposition**

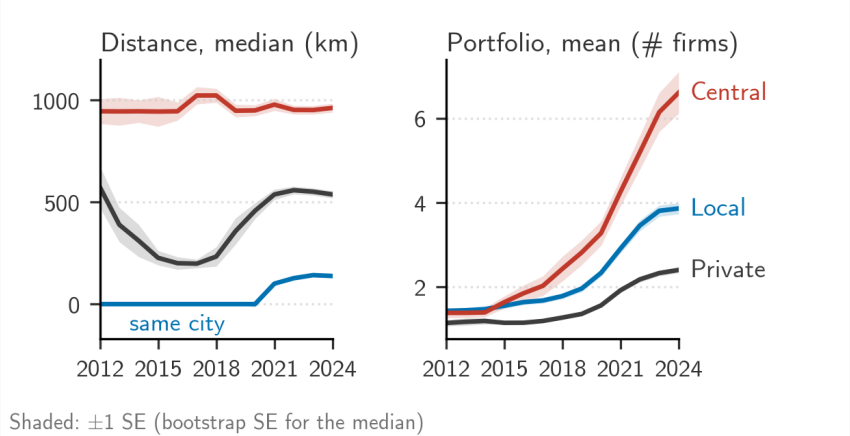
Quantification

Local Gov VCs Manage More



Local Gov VCs Closer to their Firms and Have Smaller Portfolios

- Median local-invested firm is in the fund's own city (within about 150 km since 2021); the central fund is about 1,000 km away. Local VCs oversee fewer firms each than the central fund.



Shaded: ±1 SE (bootstrap SE for the median)

Distance & Portfolio Size Predict Less VC Management

OLS | Slope by fund type

	Dep. var.: # people on both the firm's and the fund GP's rosters	
	Poisson, firm FE	Poisson, fund-GP FE
Firm–fund distance (1000 km)	-0.290^{***}	-0.233^{**}
	(0.060)	(0.102)
No. of firms in portfolio	-0.015^{***}	-0.010^{**}
	(0.004)	(0.004)
Fund equity stake (%)	$+0.030^{***}$	$+0.020^{***}$
	(0.004)	(0.005)
# pre-investment ties	$+0.003^{**}$	$+0.022^{***}$
	(0.001)	(0.005)
Firm TFPR percentile at entry	—	-0.377
		(0.247)
Firm size at entry (log employment)	—	-0.017
		(0.063)
Firm age at entry (years)	—	-0.021^{*}
		(0.013)
N (firm–fund GP years)	23,013	8,545
Pseudo R2	0.28	0.32
Fixed effects	year, firm	year, fund GP
Firm controls	Y	Y
Fund and firm board size	Y	Y

Taking Stock

- Local VC firms' Δ productivity & innovation $\uparrow$ associated with **active management**:
  - Local funds put managers on boards and add technical, educated personnel
  - Local governments **geographically proximate, smaller choice sets** $\Longrightarrow$ lower intervention cost
  - Decomposition exercise: board & management 44% of the local-central gap; observables account for 60.1% of the local productivity effect Decomposition
- Why private VC did not build firms? **Private exit faster** exit hazard

Roadmap

✓ Setting and data

Central and local government VCs invest to maximize industry revenue

✓ Who do government VCs target?

Private & Central Gov VCs invest in top national firms; local invests in smaller & less productive local champions

✓ Event study: Productivity & Management

Local-invested firms $+34\%$ productivity, private & central ≈ 0; Local $+30\%$ board & management

✓ Mechanism and decomposition

Local VCs manage more due to proximity and smaller portfolios; board & management account for 44% of the central–local gap

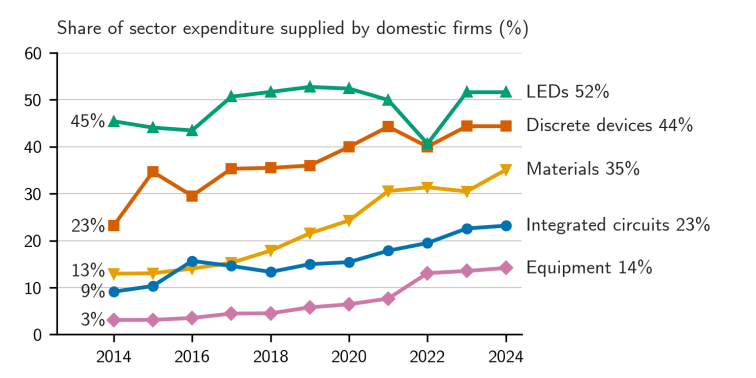
▶ **Quantification**

Revenue Gains from Gov Investment Can Come From Imports

- The event studies estimate **relative differences** of invested vs. uninvested firms
  - productivity ↑, Q ↑, price ↓: invested firms take away uninvested firms' sales
- But **the DiD in sales can come from imports** and not domestic rivals
  - In 2025, integrated circuits ($ 424.33 B) is by far China's largest category of imports, Crude/Petroleum 2nd at $296.51B
  - Crowding out from subsidies is large for untraded products and small for traded ones (Rotemberg, 2019)
- Via trade data + a model with demand, quantify: **by how much did Chinese government VC increase total domestic sales?**

Domestic Share of Expenditures is Low, But Rising

- Domestic expenditure shares $= \frac{\text{firm sales - exports}}{\text{firm sales + imports - exports}}$
- Firm panel + UN Comtrade data: Integrated circuits 9% $\rightarrow$ 23%, equipment 3% $\rightarrow$ 14%, materials 13% $\rightarrow$ 35%; higher for less advanced Discrete/Optoelectronic devices



Quantification: Which Government Should Allocate?

Goal: How would 2023 industry sales change if we

(1) **remove government VC**: its investments reallocated to to private investors (extreme crowd-out)

(2) or **centralize**: local investments go to the central government

Model blocks:

- **VC selection**: VC Block
  - Each type $k \in \{\mathrm{C}, \mathrm{P}\} \cup \{\mathrm{L}_r\}_{r \in \mathcal{R}}$ (central, private, local fund of province r) funds N_{kt} firms a year Deal Size by Investor
  - a selection model predicts firms' likelihood of investment
- **Demand**: CES demand with import competition Demand
- **Firm production**: Cobb-Douglas with productivity & capital dynamics + flexible labor Firm Block
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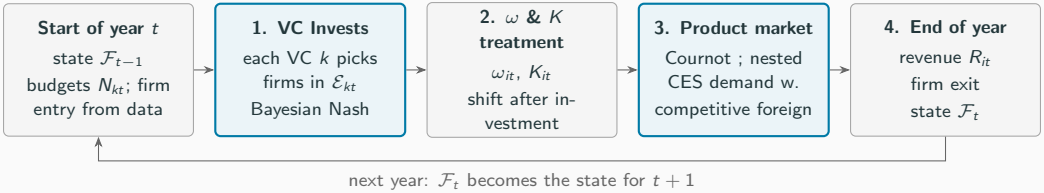
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Model Timing Within a Year

Equilibrium Simulation



- Investors act on $\mathcal{F}_{t-1} \equiv \{\omega_{it}, K_{it}, \underbrace{\mathbf{x}_{it}}_{\text{firm characteristics}}, \underbrace{\{G_{ki}\}_k}_{\text{investment history}}\}_{i \in \mathcal{J}_t}$ and budgets N_{kt}
- Firms take VC investment as given, maximize static profit, so the two equilibria (blue) are solved in sequence

VC Block I: Budget and Investor Preference

Return

- **Each VC** $k \in \{\mathrm{C}, \mathrm{P}\} \cup \{\mathrm{L}_r\}_{r \in \mathcal{R}}$ **each invests in** N_{kt} **firms simultaneously** among its "choice set" $\mathcal{E}_{kt}$ (firms it has not yet invested in). Annual budgets
- VC k's propensity to invest in each $i \in \mathcal{E}_{kt}$ is represented by the index:

$$u_{kit} = \mathbf{x}'_{ki,t-1}\gamma_k + \underbrace{\mathbf{conn}'_{ki,t-1}}_{\substack{\text{firm-fund board} \\ \text{alumni connections}}} \boldsymbol{\kappa}_k + \sum_{k' \neq k} \psi_{k \leftarrow k'} \underbrace{\mathbb{1}\{G_{k'i} \leq t-1\}}_{\substack{\text{whether i is already invested} \\ \text{by another VC k'}}} + \sum_{k' \neq k} \phi_{k \leftarrow k'} \underbrace{\pi_{k'it}}_{\substack{\text{eq. probability that} \\ \text{k' invests in i in year } t}} \tag{1}$$

VC Block II: Investment Selection

Return

- $\lambda_{kt}(N_{kt})$: fixed cost of engaging in a deal, given count budget N_{kt}
- investor k draws for each firm $i \in \mathcal{E}_{kt}$ iid standard logit error ξ_{kit}, representing unobserved investment benefits net of costs.
- k invests in i if and only if $u_{kit} + \xi_{kit} \geq \lambda_{kt}(N_{kt})$, generating choice probability

$$\pi_{kit} \equiv \mathbb{P}(k \text{ invests in i} | \mathcal{F}_{t-1}, N_{kt}) = \frac{\exp(u_{kit} - \lambda_{kt}(N_{kt}))}{1 + \exp(u_{kit} - \lambda_{kt}(N_{kt}))} \tag{2}$$

- $\lambda_{kt}(N_{kt})$ is such that the budget clears in expectation:

$$\sum_{i \in \mathcal{E}_{kt}} \pi_{kit} = N_{kt} \tag{3}$$

VC Block III - Estimation

Return

- Given parameters Θ and each k's probabilities of investment $\boldsymbol{\pi}$, the log-likelihood of the observed investments, $G_{ki} = t$, is

$$\ell(\Theta, \boldsymbol{\pi}) = \sum_t \sum_k \sum_{i \in \mathcal{E}_{kt}} \Big[\mathbb{1}\{G_{ki} = t\} \log \pi_{kit}(\Theta, \boldsymbol{\pi}) + \big(1 - \mathbb{1}\{G_{ki} = t\}\big) \log\big(1 - \pi_{kit}(\Theta, \boldsymbol{\pi})\big) \Big] \tag{4}$$

- **Step 1**: use reduced form logit estimates as initialized probabilities of VC investment $\widehat{\boldsymbol{\pi}}$. Initialize Θ from the maximizer of $\ell(\Theta, \widehat{\boldsymbol{\pi}})$.
- **Step 2 (equilibrium consistency)**: the equilibrium condition is

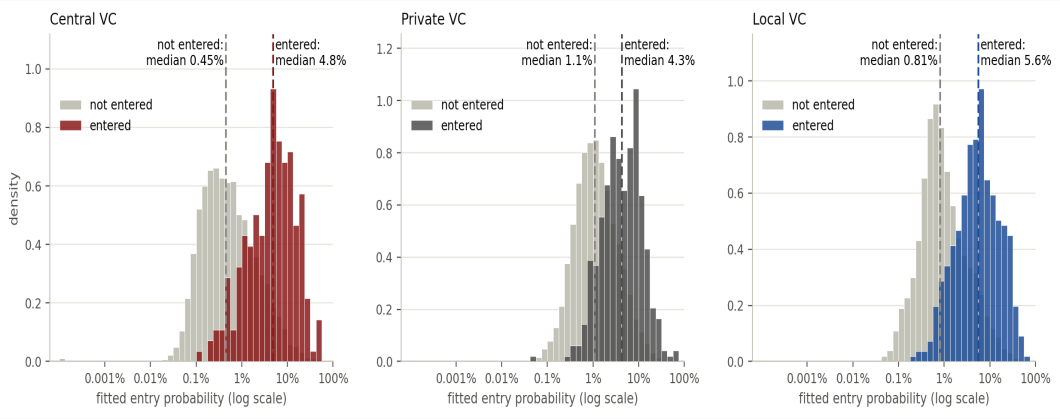
$$\hat{\Theta} = \arg\max_{\Theta} \ell(\Theta, \boldsymbol{\pi}(\hat{\Theta}))$$

where $\boldsymbol{\pi}(\hat{\Theta})$ is each VC k's probability of investment implied by Θ. For each iteration of estimate $\Theta^{(n)}$, we estimate

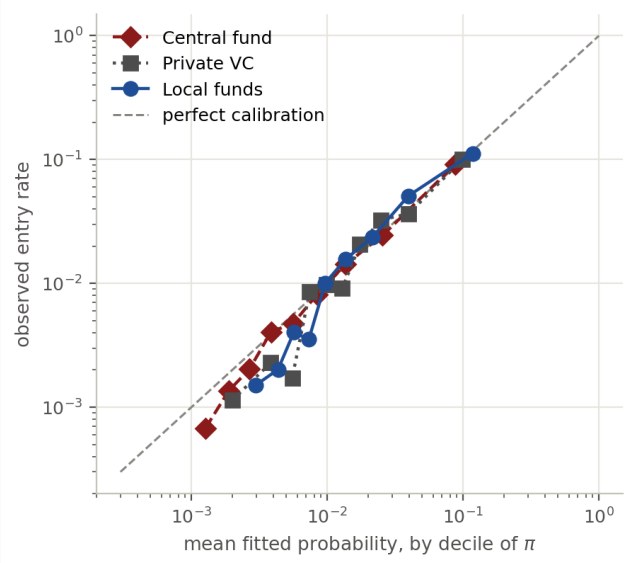
$$\Theta^{(n+1)} = \arg\max_{\Theta} \ell(\Theta, \boldsymbol{\pi}(\Theta^{(n)}))$$

until convergence. uniqueness (Rosen, 1965) ϕ ψ

VC Block Fit: Predicted Probability Predicts Actual Entry



VC Block Fit: Fitted Probabilities $\sim$ Empirical Probabilities



Demand Block: Fixed Expenditures on Domestic & Foreign Varieties

- Exogenous expenditures $\mathcal{X}_{st}$ (Expenditures Model) on sector s semiconductor output:

$$\mathcal{Q}_{st} = \left[\left(\underbrace{Q^D_{st}}_{\text{domestic composite}} \right)^{\frac{\zeta-1}{\zeta}} + \left(\underbrace{Q^F_{st}}_{\text{foreign composite}} \right)^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta}{\zeta-1}}$$

  - $Q^D_{st} = \left(\sum_{i \in \mathcal{J}_{st}} q_{it}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$ aggregates quantities of $\mathcal{J}_{st}$, set of domestic firms in sector s
  - $\sigma > \zeta > 1$: Domestic varieties substitute more easily for each other than for imports

- given endogenous domestic price $P^D_{st} = \left(\sum_{i \in \mathcal{J}_{st}} p_{it}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$ and exogenous foreign price P^F_{st}:
  - Domestic expenditure share $s^D_{st} \equiv \frac{P^D_{st} Q^D_{st}}{\mathcal{X}_{st}} = \frac{(P^D_{st})^{1-\zeta}}{(P^D_{st})^{1-\zeta} + (P^F_{st})^{1-\zeta}}$, domestic quantity $Q^D_{st} = \frac{s^D_{st} \mathcal{X}_{st}}{P^D_{st}}$
  - Each firm i faces **the demand curve**: $q_{it} = Q^D_{st} \left(\frac{p_{it}}{P^D_{st}} \right)^{-\sigma}$

Firm Block I: Demand to Firm Revenue Production Function

CES demand for firm i is $p_{it} = P_{st}^D \left(\frac{Q_{st}^D}{q_{it}}\right)^{1/\sigma}$, thus firm revenue is

$$R_{it} \equiv p_{it} q_{it} = P_{st}^D \left(\frac{Q_{st}^D}{q_{it}}\right)^{1/\sigma} q_{it} = P_{st}^D (Q_{st}^D)^{1/\sigma} q_{it}^{\rho}$$

Physical production $q_{it} = A_{it} K_{it}^{\alpha_K} L_{it}^{\alpha_L}$, substituting gives **the revenue production function**

$$\log R_{it} = \underbrace{\log P_{st}^D + \frac{1}{\sigma} \log Q_{st}^D + \rho \log A_{it}}_{\equiv \omega_{it}} + \underbrace{\rho \alpha_K}_{\equiv \beta_K} \log K_{it} + \underbrace{\rho \alpha_L}_{\equiv \beta_L} \log L_{it}, \qquad \rho \equiv \frac{\sigma - 1}{\sigma}$$

where

$$\omega_{it} = \underbrace{\log P_{st}^D + \frac{1}{\sigma} \log Q_{st}^D}_{\text{common sector demand}} + \rho \underbrace{\log A_{it}}_{\substack{\text{physical} \\ \text{productivity}}} .$$

Firm Block II: Markups, Labor & Revenue

- i's domestic revenue share $h_{it} \equiv \frac{R_{it}}{\sum_{i' \in \mathcal{J}_{st}} R_{i't}}$
- price elasticity of domestic Q: $\eta^D_{st} \equiv -\left.\frac{\partial \log Q^D_{st}}{\partial \log P^D_{st}}\right|_{\mathcal{X}_{st},\, P^F_{st}} = 1 + (\zeta - 1)(1 - s^D_{st})$.
- Atkeson and Burstein (2008): firm i's markup under Cournot is

$$\mu_{it} \equiv \frac{p_{it}}{MC_{it}} = \left[1 - \frac{1 - h_{it}}{\sigma} - \frac{h_{it}}{\eta^D_{st}}\right]^{-1}.$$

- Given capital and wage w_{st}, optimal labor choice from the FOC:

$$w_{st} L^*_{it} = \frac{\alpha_L}{\mu_{it}} R^*_{it} \quad \Longrightarrow \quad L^*_{it} = \frac{\alpha_L}{\mu_{it} w_{st}} R^*_{it}.$$

- Substitute optimal labor into the revenue production function, we have

$$\log R^*_{it} = \frac{\omega_{it} + \beta_K \log K_{it} + \beta_L \log\left(\frac{\beta_L}{\rho \mu_{it} w_{st}}\right)}{1 - \beta_L}.$$

Firm Block III: Productivity & Capital Evolution

Return

- Absent VC investment, productivity is first-order Markov: $\log A_{i,t+1} = f_A(\log A_{it}) + \epsilon^A_{i,t+1}$.
- Let $\tau_{kit} \in \{0, 1, 2, 3, 4+\} \cup \{\emptyset\}$ track the years since VC k first invested in firm i.
- Let $\theta^\omega_k(\tau)$ be VC k's effect on ω τ years after investment, $\theta^\omega_k(\emptyset) \equiv 0$

$$\rho \log A_{it} = \underbrace{\rho \log A_{it}(\emptyset)}_{\substack{\text{No investment} \\ \text{counterfactual}}} + \sum_k \theta^\omega_k(\tau_{kit})$$

  - A DiD of ω within sector s identifies θ^ω_k: all firms share equilibrium P^D_{st}, Q^D_{st}
- Capital evolves according to the policy

$$\log K_{it} = f_K(\log K_{i,t-1}, \omega_{i,t-1}, \mathbf{x}_{i,t-1}, \{\tau_{kit}\}_{k \in \{\mathrm{C,L,P}\}})$$

Capital estimates Productivity estimates

Firm Equilibrium I: Counterfactual Firm Sales

Return

- Denote a VC allocation as $\mathbf{G} = \{G_{Ci}, G_{Li}, G_{Pi}\}_{i \in \mathcal{J}_{st}}$, where G_{ki} is the year of k's first investment in i.
- For any variable X, $d \log X \equiv \log[X(\mathbf{G})] - \log[X(\mathbf{G}^0)]$ is the difference of log X at VC allocation $\mathbf{G}$ vs baseline $\mathbf{G}^0$
- Let $\Delta_{it}^{\omega} \equiv \sum_k \left[\theta_k^{\omega}(\tau_{kit}(\mathbf{G})) - \theta_k^{\omega}(\tau_{kit}(\mathbf{G}^0))\right]$ and $\Delta_{it}^{K} \equiv d \log K_{it}$
  - the change in direct treatment effects on productivity and capital from $\mathbf{G}^0$ to $\mathbf{G}$.
- **Revenue change of i from $\mathbf{G}^0$ to $\mathbf{G}$** is then:

$$d \log R_{it}^{*} = \underbrace{\frac{\Delta_{it}^{\omega} + \beta_K \Delta_{it}^{K}}{1 - \beta_L}}_{\text{direct treatment}} + \underbrace{\frac{\rho \, d \log P_{st}^{D} + \sigma^{-1} d \log R_{st}^{D}}{1 - \beta_L}}_{\text{sector demand}} - \underbrace{\frac{\beta_L}{1 - \beta_L} d \log \mu_{it}}_{\text{markup adjustment}}. \tag{5}$$

Firm Equilibrium II: Summing Up

Step 1. For a **candidate change in industry sales** $d \log R_{st}^D$, **update change in domestic prices**:

Domestic Price Index

$$d \log P_{st}^D = \frac{-d \log R_{st}^D + \log(1 - s_{st}^{D,0} \exp(d \log R_{st}^D)) - \log(1 - s_{st}^{D,0})}{\zeta - 1}.$$

Step 2. **Firm sales and markups update:** By (5), change in firm sales

$$d \log R_{it}^* = \frac{\Delta_{it}^{\omega} + \beta_K \Delta_{it}^K}{1 - \beta_L} + \frac{\rho \, d \log P_{st}^D + \sigma^{-1} d \log R_{st}^D}{1 - \beta_L} - \frac{\beta_L}{1 - \beta_L} d \log \mu_{it}.$$

- updated firm shares h_{it} + updated domestic share s_{st}^D & domestic price elasticity $\eta_{st}^D \implies$ updated markup μ_{it} Markup.

Step 3. **Equilibrium closure:** firm sales add up to industry sales.

$$d \log R_{st}^D = \log \sum_{i \in \mathcal{J}_{st}} \underbrace{h_{it}^0}_{\text{baseline sales share}} \exp(d \log R_{it}^*).$$

- Adjust $d \log R_{st}^D$ until market shares sum to 1: $\sum_{i \in \mathcal{J}_{st}} h_{it}(d \log R_{st}^D) = 1$.

Calibration & Estimation

Return

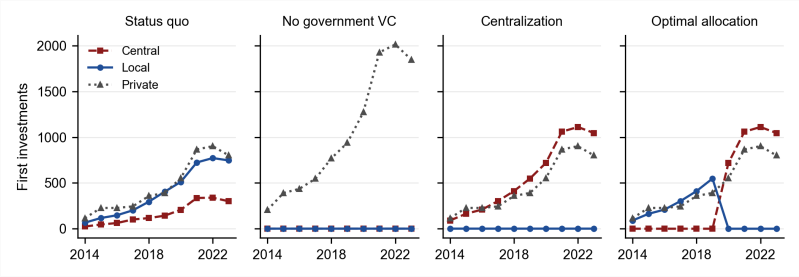
Ingredient	Object	Value	Source
Selection	selection parameters $\{\gamma, \kappa, \psi, \phi\}$	estimated	VC block entry model
Treatment	$\theta_k^{\omega}(\tau)$, $\theta_k^{K}(\tau)$, $k \in \{\mathrm{C}, \mathrm{L}, \mathrm{P}\}$	event-study paths, years 0–5 theta calibration	three-treatment DiD (de Chaisemartin and D'Haultfœuille, 2023, Callaway and Sant'Anna, 2021)
	β_K, β_L by sector	pf estimates	production function (Ackerberg et al., 2015)
Demand closure	$s_{st}^{D,0}$	data domestic share	domestic-owned firm revenue and customs flows
	ζ	3 [2, 3.5]	U.S. electronics home–import estimates: 2.40–3.48 (Feenstra et al., 2018)
	σ	5 [4–6]	Chinese export demand: median 4.57 (Amiti et al., 2020), 4.82/5.48 (Fan et al., 2020)

- Counterfactual equilibria are solved using exact hat algebra (Costinot and Rodríguez-Clare, 2014).
- Wages, foreign prices and sector expenditures are held fixed; domestic prices, expenditure shares and Cournot markups adjust jointly, adapting Atkeson and Burstein (2008).

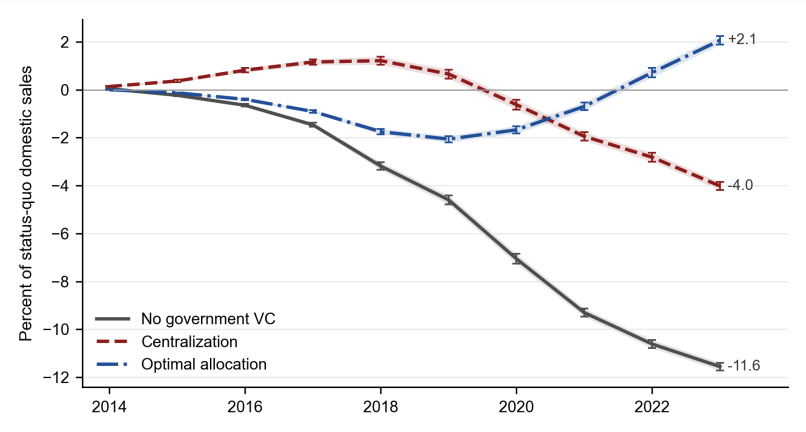
Counterfactuals

Simulation Steps

- **No government**: transfer every government slot to private VC.
- **Centralization**: transfer every local slot to central.
- **Optimal Allocation**: search over central and local slots $k \in \{\mathrm{C}\} \cup \{\mathrm{L}_r\}_{r \in \mathcal{R}}$ to maximize expected 2023 revenue; **retain investor preferences**.



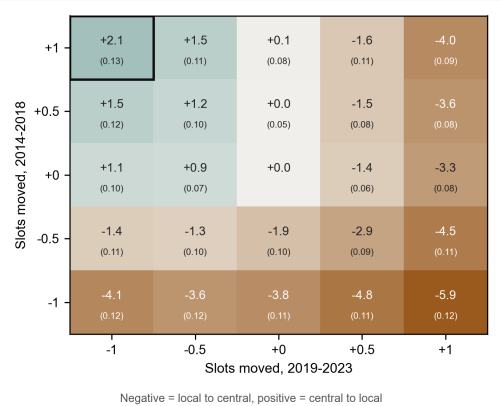
No Government VC & Centralization Lower Revenue



Centralization **raises sales slightly at first** (at most +1.2%, in 2018); the decentralized status quo is ahead **every year from 2020** and by 4.0% in 2023.

Optimal Allocation Raises Revenue

Decomposition



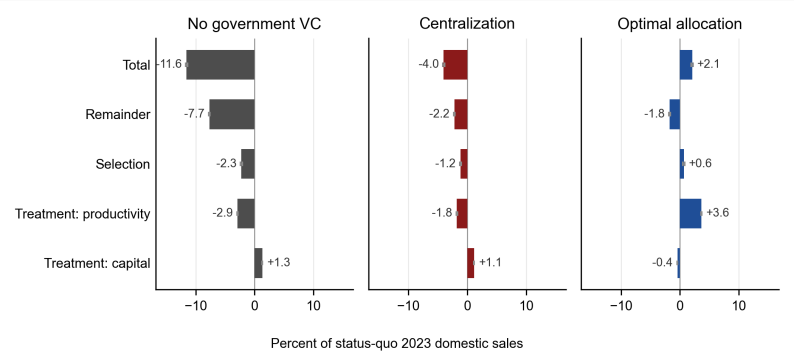
Best schedule searched: all central deals to local funds in 2014–2018, all local deals to the central fund from 2019: +2.1% 2023 sales

Allocation map

Selection and Treatment: Productivity and Capital

Return

- Decompose revenue differences into **selection vs. treatment** on **revenue & capital**
  - compare 2023 revenue under {modeled VC selection, random selection} × {uniform treatment, VC-specific treatment} × $\{\omega, K\}$ Implementation Details
- Selection: who receives the deals; treatment: investors' different effects on productivity and capital; remainder: how many firms are funded, in which sectors and years



Conclusion: Local Governments Picked Weaker Firms, Then Built Them

- **Picking**: central and private VCs fund the nation's most productive firms; local VCs fund weaker home champions
- **Building**: local-invested firms become 34% more productive; central and private ≈ 0
  - local funds are nearby, hold small portfolios and staff the board: board & management account for 44% of the local–central gap
- **Numbers**: local government VC raised 2023 domestic sales
  - giving its deals to private VC: -11.6%; centralizing: -4.0%; optimal allocation: $+2.1\%$
  - if local gains came only from local funds knowing which firms would grow, centralizing still lowers 2023 sales by 1.1%
  - channels: productivity treatment outweighs giving capital to big & productive firms
- **Lesson**: industrial policy effectiveness depends on who allocates, accounting for incentives & treatment technology

Roadmap

✓ Setting and data

Central and local government VCs invest to maximize industry revenue

✓ Who do government VCs target?

Private & Central Gov VCs invest in top national firms; local invests in smaller & less productive local champions

✓ Event study: Productivity & Management

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✓ Mechanism and decomposition

Local VCs manage more due to proximity and smaller portfolios; board & management account for 44% of the central–local gap

✓ Quantification

Reallocating government slots to private VC lowers 2023 sales 11.6%; the optimal government allocation raises sales 2.1%

What Could Also Predict Investment? Personal Connections

- With coded personnel biographies of directors of firms + government funds, I measure whether each distinct pair of firm and government fund persons is "connected" by
  - undergrad + postgrad education: whether they share the same education institution at some time
  - work: past work experience (including in academia, & academia + student pairs)
- Links typically formed in prestigious universities Most frequent pairs-local

Most common pairs: firm-local fund

Return

#	Institution	Pairs	Top pair types
1	Tsinghua U	12,689	postgrad-undergrad 29% / academic-postgrad 24% / postgrad-postgrad 16%
2	Fudan U	4,787	academic-postgrad 48% / postgrad-postgrad 16% / postgrad-undergrad 16%
3	Peking U	4,661	academic-postgrad 32% / postgrad-undergrad 21% / postgrad-postgrad 21%
4	Zhejiang U	3,926	academic-postgrad 34% / academic-undergrad 28% / postgrad-undergrad 13%
5	SJTU	3,204	academic-postgrad 30% / academic-undergrad 25% / postgrad-undergrad 17%
6	SUFE	2,691	academic-postgrad 27% / postgrad-undergrad 27% / postgrad-postgrad 17%
7	Renmin U	2,011	academic-postgrad 33% / postgrad-postgrad 26% / postgrad-undergrad 18%
8	XJTU	1,831	academic-postgrad 44% / academic-undergrad 22% / postgrad-undergrad 14%
9	Nanjing U	1,680	academic-postgrad 35% / postgrad-undergrad 20% / postgrad-postgrad 20%
10	Shenzhen Capital Group	1,616	work-work 100%
	Total unique pairs	89,837	

Note. Pairs are distinct firm-person/fund-person dyads sharing an institution. Pair-type percentages are within institution; types are unordered. Totals include all institutions.

Most common pairs: firm-central fund

Return

#	Institution	Pairs	Top pair types
1	Tsinghua U	7,276	postgrad-undergrad 31% / postgrad-postgrad 27% / academic-postgrad 26%
2	Peking U	2,474	academic-postgrad 30% / postgrad-postgrad 24% / postgrad-undergrad 21%
3	Renmin U	2,155	postgrad-postgrad 34% / academic-postgrad 27% / postgrad-undergrad 21%
4	Fudan U	1,753	academic-postgrad 33% / academic-undergrad 25% / postgrad-undergrad 18%
5	Zhejiang U	1,113	academic-postgrad 42% / academic-undergrad 29% / postgrad-undergrad 13%
6	SJTU	901	academic-undergrad 40% / academic-postgrad 29% / postgrad-undergrad 14%
7	XJTU	763	academic-postgrad 36% / postgrad-undergrad 23% / academic-undergrad 18%
8	SUFE	732	postgrad-undergrad 25% / undergrad-undergrad 22% / academic-undergrad 20%
9	Wuhan U	615	academic-postgrad 30% / postgrad-undergrad 26% / postgrad-postgrad 22%
10	ZTE	556	work-work 100%
Total unique pairs		41,925	

Note. Pairs are distinct firm-person/fund-person dyads sharing an institution. Pair-type percentages are within institution; types are unordered. Totals include all institutions.

Revenue Production Function (Ackerberg et al. (2015))

correlates | value-added | Return

ACF Gross Output Estimates

	Full				Private Only			
Sector	β_K	β_L	RTS	Obs.	β_K	β_L	RTS	Obs.
Assembly & Testing	0.338 (0.037)	0.754 (0.049)	1.091 (0.018)	2039	0.318 (0.059)	0.722 (0.084)	1.040 (0.037)	1109
Design	0.293 (0.013)	0.759 (0.017)	1.052 (0.010)	5222	0.249 (0.017)	0.778 (0.022)	1.026 (0.015)	2609
Discrete	0.307 (0.017)	0.638 (0.019)	0.945 (0.008)	5604	0.288 (0.021)	0.587 (0.020)	0.876 (0.012)	3381
Equipment	0.335 (0.015)	0.725 (0.019)	1.059 (0.008)	3408	0.322 (0.024)	0.673 (0.028)	0.995 (0.015)	1884
IC Manufacturing	0.227 (0.047)	0.852 (0.078)	1.079 (0.040)	1470	0.245 (0.051)	0.760 (0.073)	1.005 (0.043)	590
Materials	0.321 (0.011)	0.704 (0.015)	1.025 (0.007)	5565	0.356 (0.017)	0.648 (0.021)	1.003 (0.010)	3679
Optoelectronics	0.307 (0.019)	0.724 (0.024)	1.031 (0.011)	2532	0.229 (0.036)	0.784 (0.045)	1.014 (0.025)	1490

Notes. "Full" and "Private Only" report ACF elasticities of gross output with respect to K and L, estimated with the baseline (unconditioned) first stage on the whole sample and on the sample of private domestic firm-years (pre-investment). RTS is the returns to scale, $\beta_K + \beta_L$; its standard error accounts for the estimated covariance between $\hat{\beta}_K$ and $\hat{\beta}_L$. Standard errors in parentheses. Capital is rebuilt at a uniform 9 per cent depreciation rate.

Value Added Production Function (Ackerberg et al. (2015))

correlation with KL | Revenue PF

ACF Value-Added Estimates

	Full				Private Only			
Sector	β_K	β_L	RTS	Obs.	β_K	β_L	RTS	Obs.
Assembly & Testing	0.416 (0.046)	0.610 (0.053)	1.026 (0.032)	1664	0.367 (0.042)	0.547 (0.053)	0.915 (0.028)	880
Design	0.217 (0.020)	0.783 (0.037)	0.999 (0.028)	3346	0.225 (0.019)	0.729 (0.040)	0.954 (0.033)	1746
Discrete	0.262 (0.023)	0.643 (0.037)	0.905 (0.027)	4321	0.323 (0.020)	0.455 (0.031)	0.778 (0.024)	2601
Equipment	0.268 (0.032)	0.764 (0.052)	1.031 (0.031)	2338	0.306 (0.026)	0.578 (0.049)	0.883 (0.038)	1283
IC Manufacturing	0.450 (0.050)	0.438 (0.096)	0.888 (0.064)	1210	0.249 (0.090)	0.665 (0.164)	0.914 (0.097)	559
Materials	0.427 (0.020)	0.578 (0.032)	1.005 (0.020)	4819	0.504 (0.020)	0.390 (0.032)	0.894 (0.021)	3291
Optoelectronics	0.363 (0.033)	0.626 (0.052)	0.989 (0.030)	2133	0.367 (0.039)	0.579 (0.071)	0.946 (0.041)	1287

Notes. "Full" and "Private Only" report ACF elasticities of value-added with respect to K and L, estimated with the baseline (unconditioned) first stage on the whole sample and on the sample of private domestic firm-years (pre-investment). RTS is the returns to scale, $\beta_K + \beta_L$; its standard error accounts for the estimated covariance between $\hat{\beta}_K$ and $\hat{\beta}_I$. Standard errors in parentheses. Capital is rebuilt at a uniform 9 per cent depreciation rate.

What the Capital–Labor Residual Measures

Back

Gross output with a flexible material M (silicon) at sector-year price P^M_{st}; CES demand with elasticity σ, $\rho \equiv 1 - 1/\sigma$, A_{it} physical productivity, Q^D_{st} sector quantities:

$$\ln R_{it} = \omega_{it} + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_M \ln M_{it} + \rho \ln \epsilon_{it}, \qquad \omega_{it} = \ln P^D_{st} + \tfrac{1}{\sigma} \ln Q^D_{st} + \rho \ln A_{it}$$

- Materials chosen after ω_{it}; the firm keeps share θ^y_{it} of sales. FOC: $P^M_{st} M_{it} = \beta_M \, \theta^y_{it} \, \mathbb{E}_t \, R_{it}$ (constant share)

  $$\Rightarrow \ln M_{it} = \frac{\omega_{it} + \beta_K \ln K_{it} + \beta_L \ln L_{it} - \ln P^M_{st}}{1 - \beta_M} + c(\theta^y_{it})$$

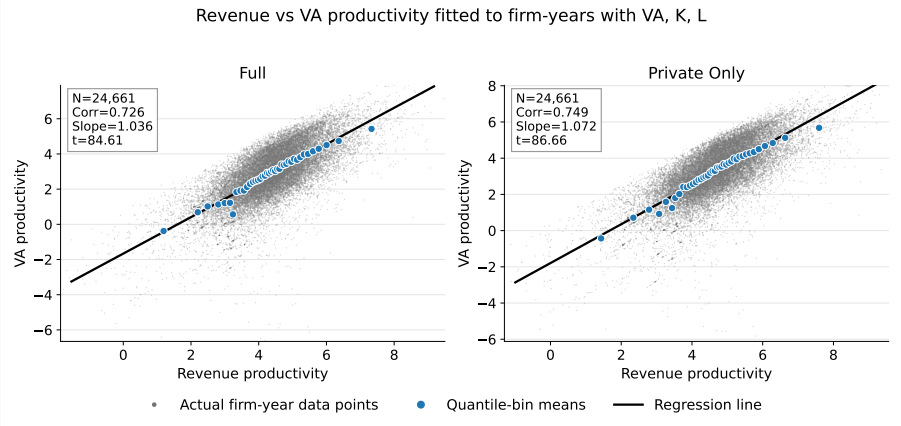
- Substitute M out: $\ln R_{it} = \tilde{\beta}_K \ln K_{it} + \tilde{\beta}_L \ln L_{it} + \omega^R_{it} + \rho \ln \epsilon_{it}$, with $\tilde{\beta} = \beta/(1 - \beta_M)$ and

$$\boxed{\omega^R_{it} \;=\; \frac{\ln P^D_{st} + \frac{1}{\sigma} \ln Q^D_{st} + \rho \ln A_{it}}{1 - \beta_M} \;-\; \frac{\beta_M}{1 - \beta_M} \ln P^M_{st} \;+\; \frac{\beta_M}{1 - \beta_M} \ln \theta^y_{it}}$$

- ω^R: the firm's persistent capacity to turn fixed K, L into revenue — markup-scaled physical productivity, demand and prices, net of the materials price, scaled by Domar-factor $\times \, 1/(1 - \beta_M)$.
- With $P^D_{st}, Q^D_{st}, P^M_{st}$ common within sector-year (imported, competitively priced inputs), within-sector-year variation is $\rho \ln A_{it}/(1 - \beta_M)$ plus the support wedge
- Check on the COGS subsample: Domar-inflating the K–L–M elasticities ($\beta_M = 0.66$–0.90) gives returns to scale 0.70–0.96, vs. 0.88–1.03 estimated from K–L alone

Correlation of Productivities

Return



TFPR as a Sufficient Statistic (1/3): Sales per Unit of Capital

Back

Constant-returns revenue function ($\beta_K + \beta_L = 1$), capital predetermined, labor chosen after ω_{it} is observed at the sector wage w_{st}:

$$R_{it} = e^{\omega_{it}} K_{it}^{\beta_K} L_{it}^{\beta_L}, \qquad \text{FOC: } \beta_L\, e^{\omega_{it}} K_{it}^{\beta_K} L_{it}^{-\beta_K} = w_{st} \;\Rightarrow\; L_{it}^{*} = K_{it}\left(\frac{\beta_L e^{\omega_{it}}}{w_{st}}\right)^{1/\beta_K}$$

Substituting labor out, optimized sales are **linear in capital**:

$$\widetilde{R}_{it} = K_{it}\, R^{K}(\omega_{it}, w_{st}), \qquad R^{K}(\omega, w) \equiv \left(\frac{\beta_L}{w}\right)^{\frac{\beta_L}{\beta_K}} e^{\omega/\beta_K}, \qquad \frac{\partial \widetilde{R}_{it}}{\partial K_{it}} = R^{K}(\omega_{it}, w_{st})$$

- R^K is strictly increasing in ω given w: sales per unit of capital, with labor re-optimized, rise with TFPR
- The wage bill is $\beta_L \widetilde{R}$ by the FOC, so static profit is $\Pi_{it} = \beta_K K_{it} R^{K}(\omega_{it}, w_{st})$ — also linear in K
- One yuan of government equity I_{it}^{G} buys $1/P_i^K$ units of capital, $\partial K_{it}/\partial I_{it}^{G} = 1/P_i^K \Rightarrow$ **current** marginal sales per yuan $= R^{K}(\omega_{it}, w_{st})/P_i^K$

$\Rightarrow$ with a common wage and a common price of capital P_i^K, the static ranking of candidates is the MPK = TFPR ranking. The dynamic ranking needs the investment response next

TFPR as a Sufficient Statistic (2/3): When Is the Investment Rate Increasing in TFPR? Back

Firm problem with adjustment cost homogeneous in capital, $C^I(I,K) = K\,c(I/K)$, $c'' > 0$ (the quadratic $c_0 I^2/K$ is the standard case), discount δ_f, depreciation δ:

$$V(K,\omega) = \max_{\iota}\ \beta_K K R^K(\omega,w) - Kc(\iota) + \delta_f\ \mathbb{E}\left[V\left((1-\delta+\iota)K,\,\omega'\right)\,\middle|\,\omega\right]$$

Linearity in K of profit, cost and transition gives $V(K,\omega) = K\,v(\omega)$ with

$$v(\omega) = \max_{\iota}\ \beta_K R^K(\omega,w) - c(\iota) + \delta_f(1-\delta+\iota)\ \mathbb{E}[v(\omega')\mid\omega], \qquad \text{FOC: } c'(\iota(\omega)) = \delta_f\ \mathbb{E}[v(\omega')\mid\omega]$$

Implicit function theorem:

$$\iota'(\omega) = \frac{\delta_f\,\partial_\omega\,\mathbb{E}[v(\omega')\mid\omega]}{c''(\iota(\omega))}\ \geq\ 0$$

Sufficient conditions for $\iota'(\omega) \geq 0$:

1. **Convex, capital-homogeneous adjustment cost**
2. **Stochastically increasing TFPR**
3. **v increasing in ω**
4. Common wage w_{st}, depreciation, discount factor and the TFPR process shared by firms within an industry-year

Then capital compounds as $K_{i,t+1} = m(\omega_{it})K_{it}$ with $m(\omega) = 1-\delta+\iota(\omega)$, $m' \geq 0$ next

TFPR as a Sufficient Statistic (3/3): Discounted Marginal Sales per Yuan

Back

Assume each government yuan invested at t buys $1/P_i^K$ units of capital: along a productivity path,

$$\frac{\partial K_{i,t+h}}{\partial I_{it}^G} = \frac{1}{P_i^K} \prod_{\ell=0}^{h-1} m(\omega_{i,t+\ell})$$

A yuan generates for government G with discount rate β_G

$$\mathcal{M}_{it}^G = q_G(\omega_{it})/P_i^K, \qquad q_G(\omega) \equiv \mathbb{E}_t \Big[\sum_{h \geq 0} \beta_G^h \Big\{ \prod_{\ell=0}^{h-1} m(\omega_{i,t+\ell}) \Big\} R^K(\omega_{i,t+h}, w_{s,t+h}) \Big]$$

which satisfies the recursion

$$\boxed{q_G(\omega) = R^K(\omega, w) + \beta_G \, m(\omega) \, \mathbb{E}\big[q_G(\omega') \mid \omega\big]}$$

- R^K and m are increasing in ω and ω is stochastically increasing, so the right-hand side maps increasing functions into increasing functions; with $\beta_G m(\omega) < 1$ it is a contraction, hence q_G is **increasing in current TFPR**

$\Rightarrow$ For a jurisdiction maximizing discounted within-jurisdiction sales, **current TFPR is a sufficient statistic for the marginal return to a yuan of equity**, within an industry-year, given a common price of capital P_i^K: it should fund its candidates in TFPR order

Local Funds Chase Provincial Rank & Connections, Central Invests in Top National Firms

Conditional Logit | productivity only

	Central VC		Local VC		Private VC	
	(1)	(2)	(1)	(2)	(1)	(2)
National TFPR percentile (0–1)	**0.012****	**0.012****	-0.004	-0.005	**0.018*****	**0.018*****
	(0.006)	**(0.005)**	(0.006)	(0.006)	**(0.007)**	**(0.006)**
Provincial TFPR percentile (0–1)	-0.006	-0.008	**0.014****	**0.010***	0.006	0.002
	(0.005)	(0.005)	**(0.006)**	**(0.006)**	(0.006)	(0.006)
# directors tied to central GP	0.002*	0.001	-0.003*	-0.003**	-0.001	-0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
# directors tied to same-province local GP	0.001	0.001	**0.005*****	**0.005****	-0.000	-0.002*
	(0.001)	(0.001)	**(0.002)**	**(0.002)**	(0.001)	(0.001)
# directors tied to private GP	0.000	-0.001	0.003***	-0.001	0.003***	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Mean outcome	0.01	0.01	0.02	0.02	0.01	0.01
N	22,533	22,472	23,964	23,902	20,874	20,874
R^2	0.04	0.04	0.04	0.05	0.02	0.04
Clusters (prov. × ind.)	175	175	177	177	174	174
Ind. × year FE	Y	Y	Y	Y	Y	Y
Firm and policy controls	N	Y	N	Y	N	Y

Who Do Funds Target? Conditional Logit LPM

	Central government VC		Local government VC		Private VC	
	(1)	(2)	(1)	(2)	(1)	(2)
National TFPR percentile (0–1)	**1.438*** **	**1.186** **	-0.003	-0.126	**1.060*** **	**1.111*** **
	(0.549)	**(0.583)**	(0.364)	(0.369)	**(0.318)**	**(0.348)**
Provincial TFPR percentile (0–1)	-0.610	-0.552	**0.847*** **	**0.641** **	0.446	0.230
	(0.514)	(0.514)	**(0.318)**	**(0.318)**	(0.318)	(0.325)
# directors tied to central GP	0.061	0.004	-0.094***	-0.106***	-0.028	-0.059
	(0.038)	(0.043)	(0.033)	(0.035)	(0.049)	(0.050)
# directors tied to same-province local GP	0.011	0.026	**0.128*** **	**0.114*** **	-0.009	-0.054
	(0.029)	(0.029)	**(0.031)**	**(0.029)**	(0.032)	(0.034)
# directors tied to private GP	0.025	-0.081***	0.085***	-0.046**	0.108***	-0.012
	(0.029)	(0.031)	(0.018)	(0.023)	(0.036)	(0.042)
Mean outcome	0.01	0.01	0.02	0.02	0.01	0.01
N	14,818	14,778	19,924	19,870	17,514	17,514
Clusters (ind. × year)	77	77	109	109	110	110
Industry × year groups	Y	Y	Y	Y	Y	Y
Firm and board controls	N	Y	N	Y	N	Y
Subsidy and procurement controls	N	Y	N	Y	N	Y

The Order of Investments

Return

Investor set and order	# Firms
One investor type	
Local only	211
Central only	25
Private only	340
Central and local (50)	
Local first	18
Central first	7
Same year	25
Local and private (563)	
Local first	119
Private first	199
Same year	245
Central and private (54)	
Central first	11
Private first	22
Same year	21

All three (579)	# Firms
Local or private first (no central)	329
Central first or tied (not all three)	89
All three same year	161
Never invested	3,576
Total	5,398

- Private & local government VC invest first usually, a few firms received central VC investment first or only

Handling Multiple Staggered Treatments

Return

A semiconductor firm can be backed by a local fund, a central fund, and a private fund — in any order, or in the same year.

Why TWFE fails: If VC investment across years has heterogeneous effects, regressing Y_{it} on leads and lags of all three entries contaminates the coefficients via:

- across cohorts, already-treated firms on heterogeneous paths serve as "forbidden" controls for later-treated ones (Goodman-Bacon, 2021, de Chaisemartin and D'Haultfœuille, 2020, Sun and Abraham, 2021);
- across investor types, the local coefficient absorbs whatever central and private entry did to the same firm (de Chaisemartin and D'Haultfœuille, 2023).

The fix. Condition on other investor treatment histories for each primitive DiD comparison. Estimate one 2-by-2 DiD at a time holding the **other** investors' entry years fixed, then average those DiDs.

Notation: One Treatment Cohort per Investor

Return

Entry years. For firm i and investor type $k \in \{\mathrm{C}, \mathrm{L}, \mathrm{P}\}$,

$$G_{ki} = \text{first year } i \text{ receives investment from type } k, \qquad G_{ki} = \infty \text{ if never invested.}$$

The rival investors' history, as seen at year t. Censor other VCs' investment event year at t:

$$G_{k'i}(t) = \begin{cases} G_{k'i}, & G_{k'i} \le t \quad (k' \text{ already in}), \\ \infty, & G_{k'i} > t \quad (k' \text{ not yet in}), \end{cases} \qquad \mathbf{G}_i^{-\mathrm{L}}(t) = \big(G_{\mathrm{C}i}(t),\, G_{\mathrm{P}i}(t)\big).$$

Why censor: Under no anticipation, what matters at the focal entry year g is $\mathbf{G}_i^{-k}(g)$, i.e. who is **already** invested. Who arrives afterwards is not anticipated: conditioning on the full future history would throw away usable controls.

We Need Assumptions 7–9 of de Chaisemartin and D'Haultfœuille (2023)

Return

For each VC k and each entry year g:

1. No anticipation. Today's productivity does not respond to an investment that has not happened yet.

2. Parallel trends absent treatment. Absent **any** VC entry, firms' outcomes' trends are identical

3. Parallel trends following earlier treatment. Among firms that received k's money in the same year g, the dynamic effect evolves identically.

Assumption 3 does the work for central VCs, which typically arrive **after** a local or private VC investor.

- We can compare central-invested firms against not-yet-central invested firms invested by other VCs in the same year prior to central investment.

The Primitive DiD Comparison

Return

Fix an investor k, a focal entry year g, an industry s, an other VC incumbent history $\mathbf{g}^{-k}$, and a horizon τ. The treated group is

$$\mathcal{T}_{k,s}(g, \mathbf{g}^{-k}, \tau) = \left\{ i : \; G_{ki} = g, \;\; \mathbf{G}_i^{-k}(g) = \mathbf{g}^{-k}, \;\; s(i) = s, \;\; G_{k'i} \notin (g,\, g+\tau] \;\; \forall k' \neq k \right\}.$$

The control group is the not-yet-k firms with the **same** industry and the **same** incumbent history:

$$\mathcal{C}_{k,s}(g, \mathbf{g}^{-k}, \tau) = \left\{ i : \; G_{ki} > g+\tau, \;\; \mathbf{G}_i^{-k}(g) = \mathbf{g}^{-k}, \;\; s(i) = s, \;\; G_{k'i} \notin (g,\, g+\tau] \;\; \forall k' \neq k \right\}.$$

The last condition $G_{k'i} \notin (g,\, g+\tau] \;\; \forall k' \neq k$ **drops observations:** no other investor may walk in between g and $g+\tau$, for treated or control firms. Never-invested firms qualify as controls through $G_{ki} = \infty$.

Estimating One Cell Return

Take the long difference around the focal entry, $\Delta_\tau Y_i \equiv Y_{i,g+\tau} - Y_{i,g-1}$, and difference treated against control:

$$\widehat{ATT}_{k,s}(g,\tau \mid \mathbf{g}^{-k}) = \overline{\Delta_\tau Y}(\mathcal{T}_{k,s}) - \overline{\Delta_\tau Y}(\mathcal{C}_{k,s}).$$

For count outcomes (board seats, patents), DiD is the log $\frac{\text{treated growth}}{\text{control growth}}$:

$$\widehat{ATT}^{\text{Pois}}_{k,s}(g,\tau \mid \mathbf{g}^{-k}) = \log\left(\frac{\bar{Y}_{g+\tau}(\mathcal{T}_{k,s}(g,\mathbf{g}^{-k},\tau))/\bar{Y}_{g-1}(\mathcal{T}_{k,s}(g,\mathbf{g}^{-k},\tau))}{\bar{Y}_{g+\tau}(\mathcal{C}_{k,s}(g,\mathbf{g}^{-k},\tau))/\bar{Y}_{g-1}(\mathcal{C}_{k,s}(g,\mathbf{g}^{-k},\tau))}\right),$$

Aggregating to Event-Time Coefficients

Return

Event-time coefficients $\widehat{\theta}_k(\tau)$ are treated unit weighted $\widehat{ATT}_{k,s}(g, \tau \mid \mathbf{g}^{-k})$:

$$\widehat{\theta}_k(\tau) = \sum_{(g,\, \mathbf{g}^{-k},\, s)} w_{g,\mathbf{g}^{-k},s,\tau}\, \widehat{ATT}_{k,s}(g, \tau \mid \mathbf{g}^{-k}), \qquad w_{g,\mathbf{g}^{-k},s,\tau} = \frac{n_T(g, \mathbf{g}^{-k}, s, \tau)}{\sum n_T}.$$

where n_T counts treated firms observed at both $g-1$ and $g+\tau$.

Interpretation: the average additional effect of k's entry τ years after investment relative to not invested, averaged over other VCs' treatment histories.

Inference: What Each Firm Contributes

Return

Let $c = \{g_c, \mathbf{g}_c^{-k}, s_c\}$ index a primitive DiD comparison of focal entry year g_c, other VC history $\mathbf{g}_c^{-k}$, and industry s_c. n_{Tc} is the number of treated firms in cell c.

At horizon τ, $\mathcal{D}_k(\tau)$ collects every cell with at least one treated **and** one control firm, and $n_{k,\tau} = \sum_{c \in \mathcal{D}_k(\tau)} n_{Tc}$ counts their treated firms.

ΔY_{ic} is firm i's long difference, measured at cell c's own endpoints:

$$\Delta Y_{ic} = Y_{i,\, g_c+\tau} - Y_{i,\, g_c-1}.$$

One firm carries a **different** ΔY_{ic} in each cell it joins, because the endpoints move with g_c. Set $\Delta Y_{ic} = 0$ when $i \notin \mathcal{T}_c \cup \mathcal{C}_c$ — bookkeeping, not imputation.

Inference: Analytical SEs

Contrast Test Return

Sum every use of firm i — treated in one cell, control in another — into a single number:

$$U_{i,k}(\tau) = \frac{n}{n_{k,\tau}} \sum_{c \in \mathcal{D}_k(\tau)} \left[\mathbb{1}\{i \in \mathcal{T}_c\} - \tfrac{n_{\mathcal{T}c}}{n_{\mathcal{C}c}} \mathbb{1}\{i \in \mathcal{C}_c\} \right] \Delta Y_{ic}, \qquad \frac{1}{n} \sum_{i=1}^{n} U_{i,k}(\tau) = \widehat{\theta}_k(\tau).$$

Stack all reported coefficients into $\widehat{\boldsymbol{\theta}}$ and each firm's contributions into $\mathbf{U}_i$:

$$\widehat{V}_U = \frac{1}{n^2} \sum_{i=1}^{n} (\mathbf{U}_i - \widehat{\boldsymbol{\theta}})(\mathbf{U}_i - \widehat{\boldsymbol{\theta}})', \qquad \widehat{\mathrm{se}}_k(\tau) = \sqrt{\left[\widehat{V}_U\right]_{kk}}.$$

Decomposing the productivity effect by treatment history

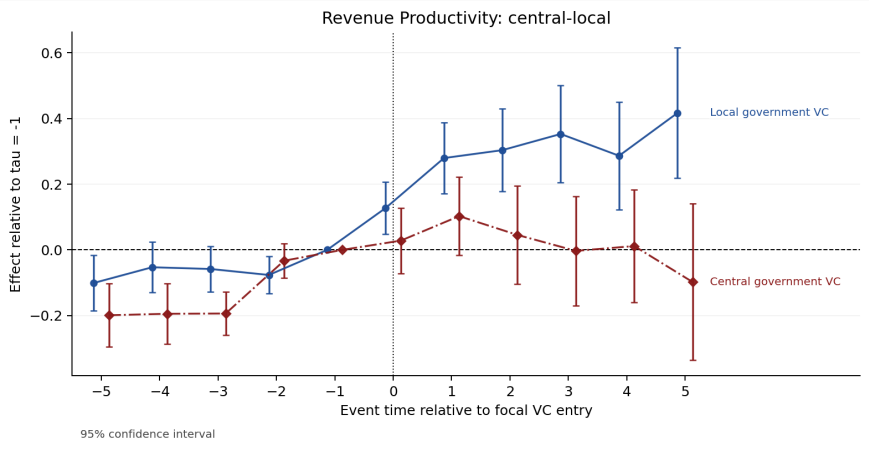
Return

$\widehat{\theta}_k(\tau)$ averages the value k adds **given the investors a firm already had**, weighted by where k's deals actually are. Post-period average, $\tau = 0, \ldots, 5$:

	Local VC		Central VC	
When the investor arrives	share of weight	effect	share of weight	effect
Firm already had an investor	49%	0.17	68%	0.09
Same year as the other government fund	5%	0.52	16%	−0.26
First; other government fund follows later	7%	0.20	7%	0.20
First; other government fund never	39%	0.35	9%	0.09
All deals	100%	**0.26**	100%	**0.04**

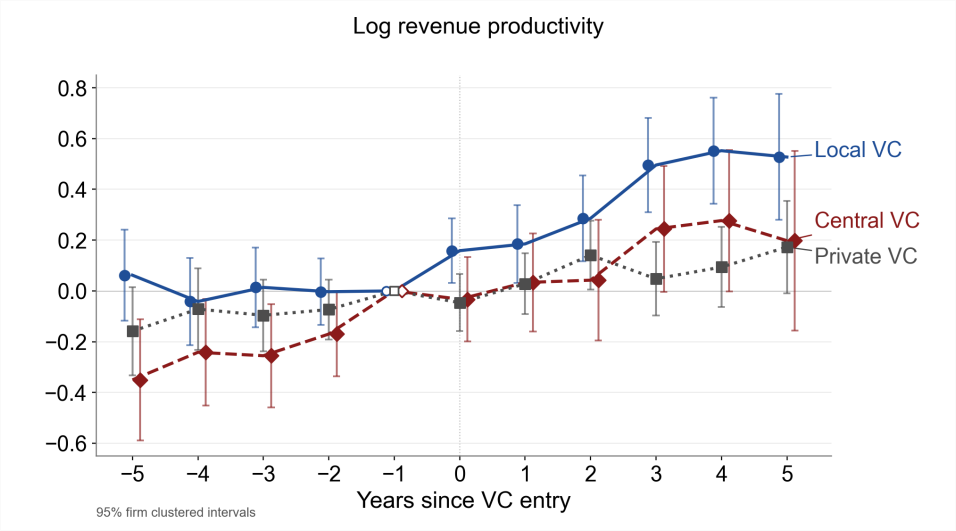
- Local's average comes from first investor deals; central's is mostly deals that join an existing investor
- As the first investor: local 0.33, central 0.14.

Productivity: Central vs Local



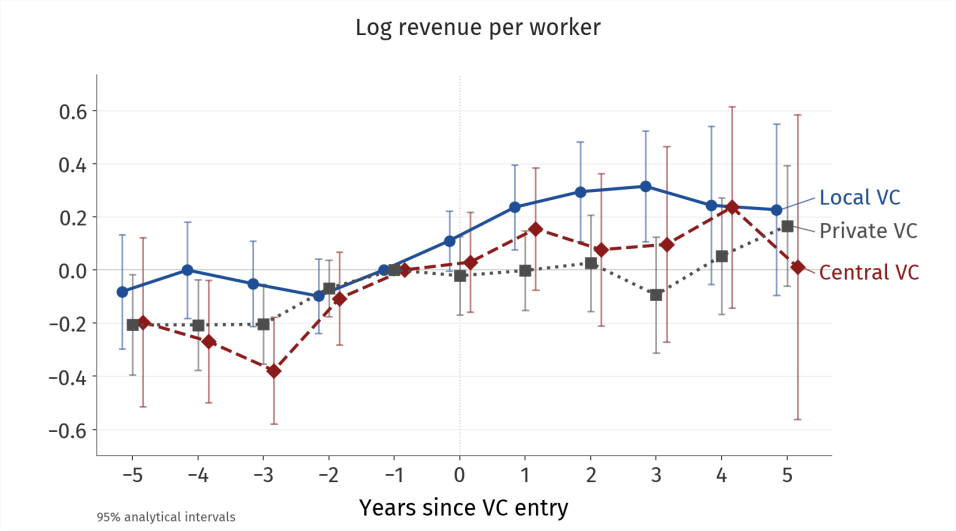
Productivity (TWFE)

Callaway & Sant'Anna '21 | Sales per worker



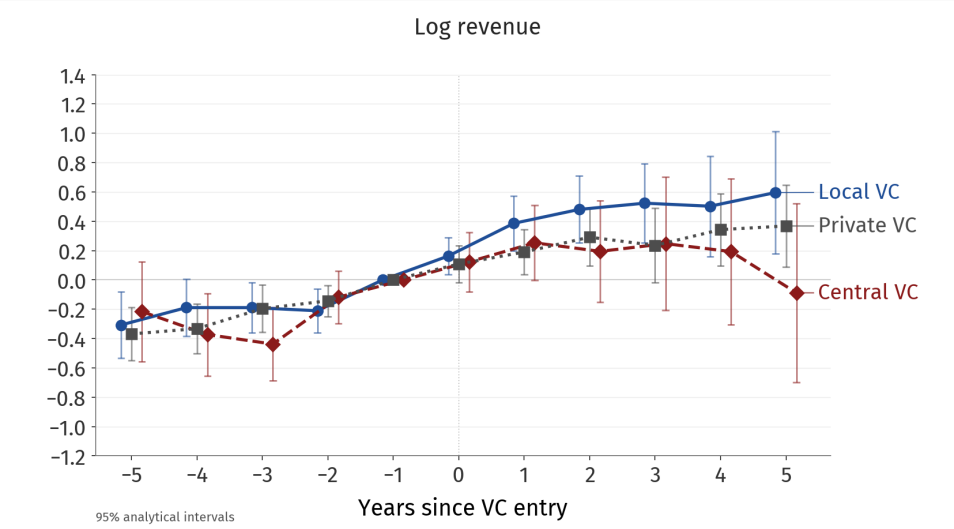
Revenue per Worker

Productivity | Revenue | Return



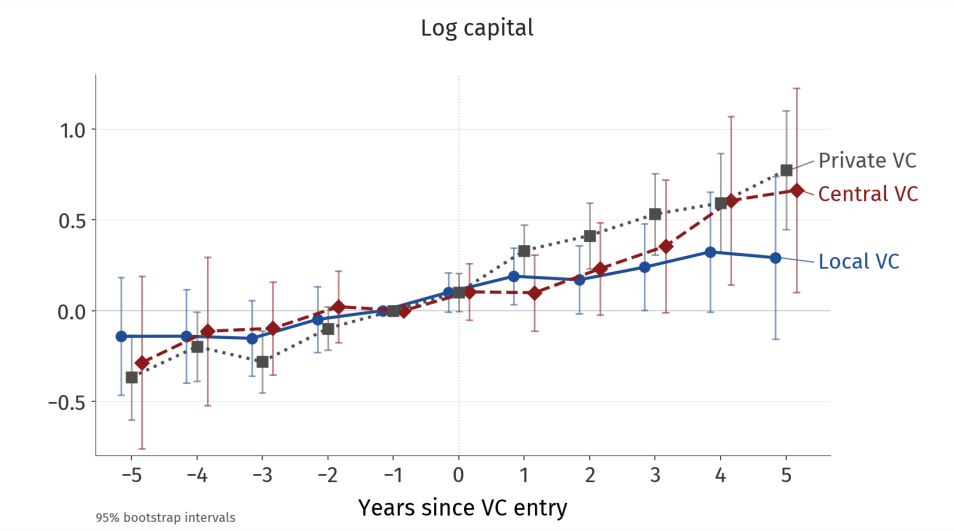
Revenue

Productivity | Return



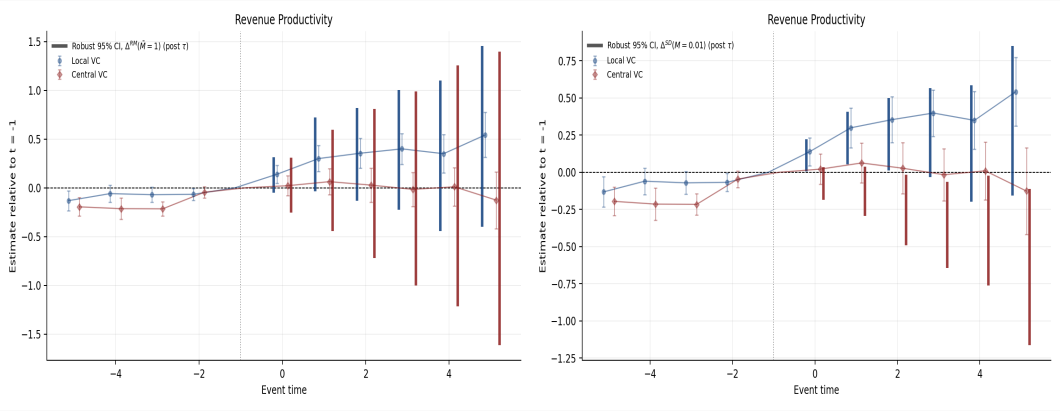
Capital

Productivity | Return



Sensitivity to Pre-trends (Rambachan and Roth, 2023)

Return



Relative magnitudes restriction

Smoothness restriction

Estimated post-treatment local effects are large enough to survive the worst observed pre-treatment trend.

Subsequent Entry Effects More Muted

First Entry

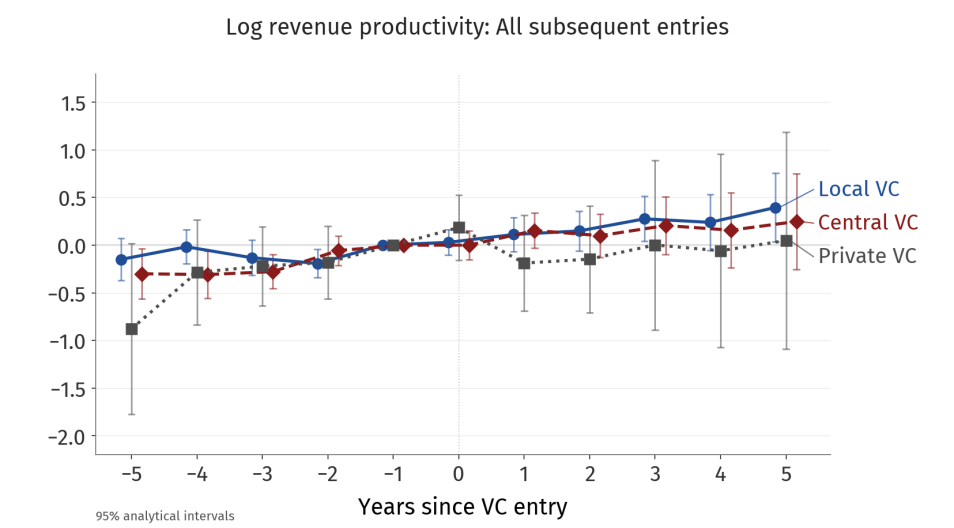
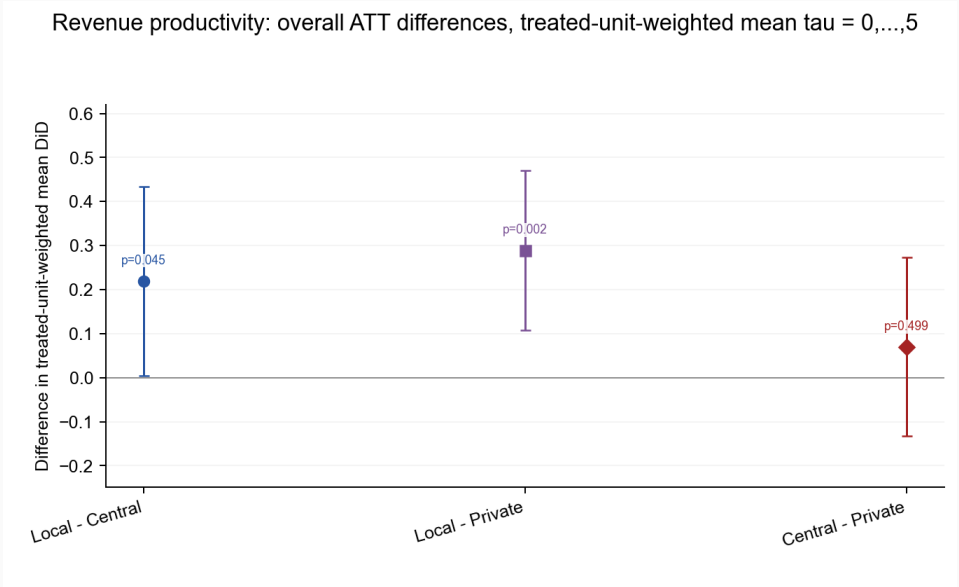


Figure 1: Productivity, Event Study Estimates of Subsequent Entering VC

Differences in Post-Treatment Coefficients

Implementation Return



Analytical Inference: One Firm's Contribution

Post Contrast Return

Let $c \in \mathcal{D}_k(\tau)$ index a supported cohort–history–industry comparison for investor k at event time τ. Write

$$\Delta Y_{ic\tau} \equiv Y_{i,g_c+\tau} - Y_{i,g_c-1}, \qquad \widehat{\delta}_{kc\tau} = \overline{\Delta Y}_{Tc\tau} - \overline{\Delta Y}_{Cc\tau},$$

and aggregate cells using their treated counts:

$$\widehat{\theta}_{k,\tau} = \frac{\sum_{c\in\mathcal{D}_k(\tau)} n_{Tc}\widehat{\delta}_{kc\tau}}{n_{k,\tau}}, \qquad n_{k,\tau} \equiv \sum_{c\in\mathcal{D}_k(\tau)} n_{Tc}.$$

Firm i's influence contribution to this event-time coefficient is

$$\widehat{\mathrm{IF}}_{k,\tau i} = \frac{1}{n_{k,\tau}} \sum_{c\in\mathcal{D}_k(\tau)} \left[\mathbb{1}\{i \in \mathcal{T}_c\} \left\{ \Delta Y_{ic\tau} - \overline{\Delta Y}_{Tc\tau} + \widehat{\delta}_{kc\tau} - \widehat{\theta}_{k,\tau} \right\} - \frac{n_{Tc}}{n_{Cc}} \mathbb{1}\{i \in \mathcal{C}_c\} \left(\Delta Y_{ic\tau} - \overline{\Delta Y}_{Cc\tau} \right) \right].$$

- $\Delta Y_{ic\tau} - \overline{\Delta Y}_{Tc\tau}$: firm i changes its treated-cell mean.
- $-\frac{n_{Tc}}{n_{Cc}}(\Delta Y_{ic\tau} - \overline{\Delta Y}_{Cc\tau})$: a faster-growing control raises counterfactual growth and lowers the DiD.
- $\widehat{\delta}_{kc\tau} - \widehat{\theta}_{k,\tau}$: increasing a treated firm's weight also increases the weight on its cell.

Numerical example. With treated changes $(0.3, 0.5)$ and control changes $(0.0, 0.2)$, $\widehat{\theta} = 0.3$ and

$$(\widehat{\mathrm{IF}}_1, \widehat{\mathrm{IF}}_2, \widehat{\mathrm{IF}}_3, \widehat{\mathrm{IF}}_4) = (-0.05,\ 0.05,\ 0.05,\ -0.05), \qquad \sum_i \widehat{\mathrm{IF}}_i = 0.$$

Testing Investor Differences

Step 1: Average the six post-treatment coefficients using observed support.

$$\widehat{\bar{\theta}}_k^n = \frac{\sum_{\tau=0}^{5} n_{k,\tau}\widehat{\theta}_{k,\tau}}{n_k}, \qquad n_k \equiv \sum_{\tau=0}^{5} n_{k,\tau}.$$

A firm observed at multiple horizons contributes multiple firm–horizon observations, so sparsely supported later coefficients receive less weight.

Step 2: Propagate coefficient and horizon-weight uncertainty. Let $m_{k,\tau i}$ count firm i's supported treated membership at horizon τ. Its influence contribution to the post-treatment average is

$$\widehat{\mathrm{IF}}_{ki} = \underbrace{\sum_{\tau=0}^{5} \frac{n_{k,\tau}}{n_k}\widehat{\mathrm{IF}}_{k,\tau i}}_{\text{event-time coefficient uncertainty}} + \underbrace{\frac{1}{n_k}\sum_{\tau=0}^{5} m_{k,\tau i}\left(\widehat{\theta}_{k,\tau} - \widehat{\bar{\theta}}_k^n\right)}_{\text{horizon-weight uncertainty}}.$$

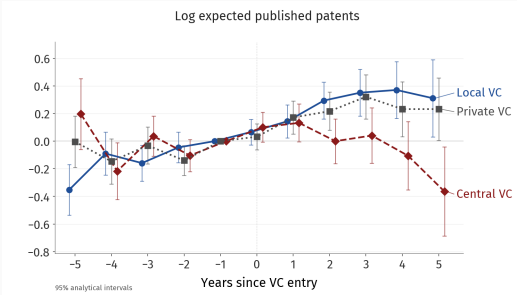
Step 3: Difference firm contributions before computing the variance. For investor types k and k',

$$\widehat{\Delta}_{k-k'}^n = \widehat{\bar{\theta}}_k^n - \widehat{\bar{\theta}}_{k'}^n, \qquad \widehat{\mathrm{IF}}_{k-k',i} = \widehat{\mathrm{IF}}_{ki} - \widehat{\mathrm{IF}}_{k'i},$$

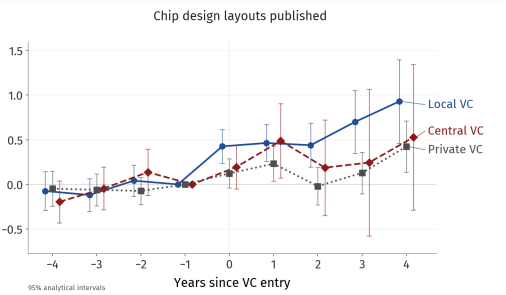
$$\widehat{\mathrm{se}}\left(\widehat{\Delta}_{k-k'}^n\right) = \left[\frac{n}{n-1}\sum_{i=1}^{n}\widehat{\mathrm{IF}}_{k-k',i}^2\right]^{1/2}, \qquad p = \text{two-sided normal } p\text{-value of } \widehat{\Delta}_{k-k'}^n/\widehat{\mathrm{se}}.$$

Intellectual Property: Local Increased More than Central's

Return



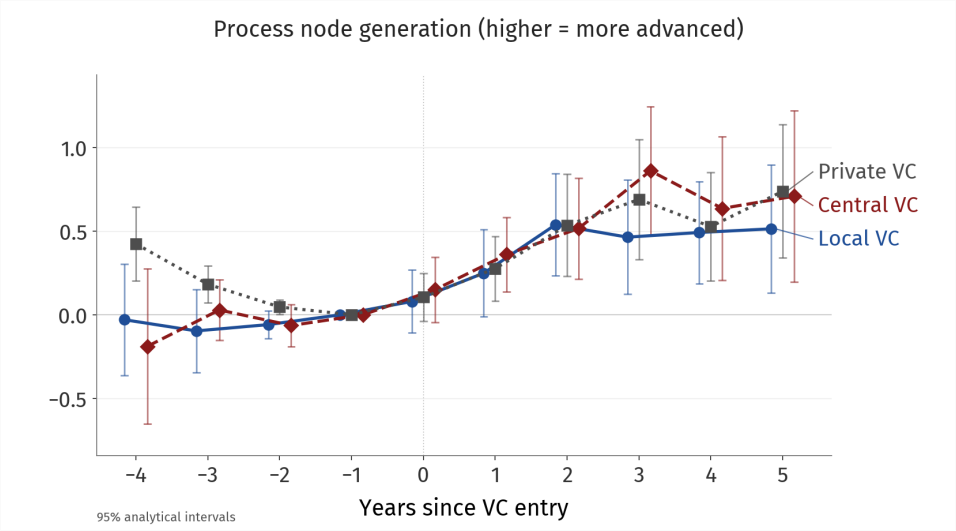
Newly published patents



Newly published chip-design layouts

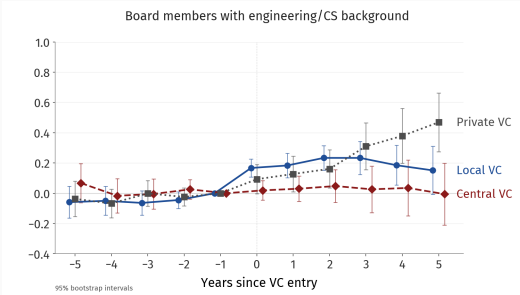
Process Node Generation

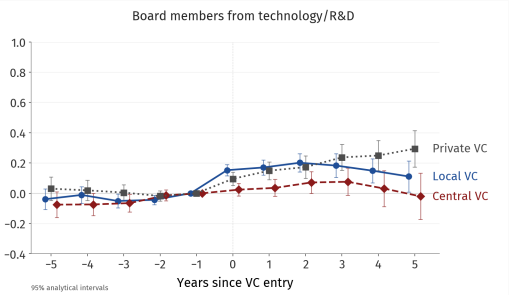
IP / Patents | Return



Engineering/Tech

finance Return





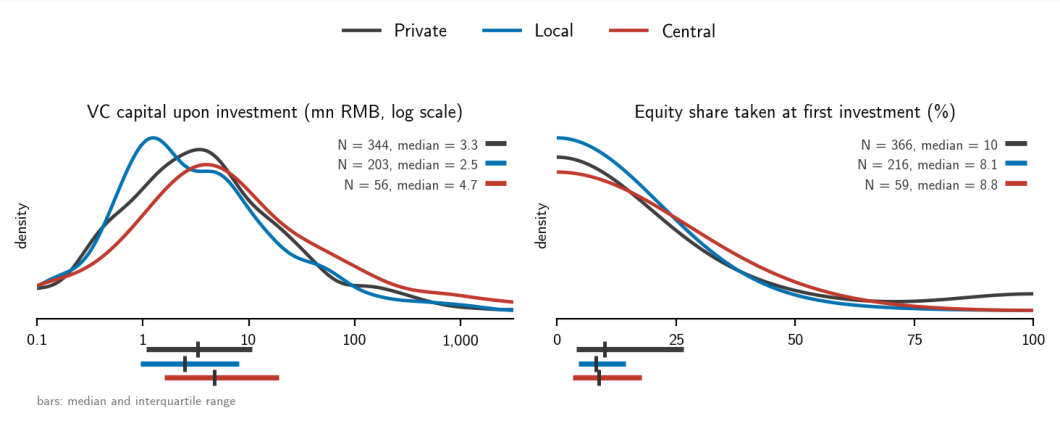
Fund Directors: OLS

Back

	Dep. var.: # people on both the firm's and the fund GP's rosters	
	OLS, firm FE	OLS, fund-GP FE
Firm–fund distance (1000 km)	-0.040^{***}	-0.013
	(0.008)	(0.009)
No. of firms in portfolio	-0.002^{***}	$+0.001$
	(0.000)	(0.001)
Fund equity stake (%)	$+0.018^{***}$	$+0.011^{***}$
	(0.002)	(0.003)
# pre-investment ties	$+0.002^{*}$	$+0.008^{**}$
	(0.001)	(0.004)
Firm TFPR percentile at entry	—	-0.011
		(0.025)
Firm size at entry (log employment)	—	$+0.001$
		(0.009)
Firm age at entry (years)	—	-0.003^{**}
		(0.001)
Mean outcome	0.209	0.175
N (firm–fund GP years)	33,071	24,456
Fixed effects	year, firm	year, fund GP
Firm controls	Y	Y
Fund and firm board size	Y	Y

Similar Money Invested & Share Upon Entry

Return



Fund Directors: Do the Slopes Differ by Fund Type? Back

	Local	vs central	vs private	p equal
Firm–fund distance (1000 km)	-0.185^{**}	-0.248	-0.116	0.317
	(0.090)	(0.170)	(0.125)	
No. of firms in portfolio	-0.021^{***}	$+0.013^{*}$	$+0.007$	0.170
	(0.005)	(0.007)	(0.009)	
Fund equity stake (%)	$+0.027^{***}$	-0.005	$+0.024^{**}$	0.075
	(0.004)	(0.009)	(0.011)	
# pre-investment ties	$+0.003^{***}$	$+0.034^{***}$	$+0.037^{***}$	0.000
	(0.001)	(0.009)	(0.010)	
All interactions jointly				0.000
N (firm–fund GP years)				23,013

Poisson. Local funds are the omitted type, so columns 2–3 are differences from the local slope. Year and firm FE, firm controls, SEs clustered at firm. p is a Wald test that the slope is the same across all three types. OLS

Decomposing the Productivity Effect

Return

What drove local firms' productivity: management or money invested? A Gelbach (2016)-style decomposition:

Step 1: fit each channel m's slopes inside the DiD cells. For investor k and horizon τ, over firms i in primitive cell c,

$$\Delta_\tau \omega_{ic} = \underbrace{\mu_c + \alpha_c \mathbb{1}\{\text{treated}_{ic}\}}_{\text{cell} \times \text{arm intercepts}} + \beta'_{k,\tau} \underbrace{\Delta^\star_\tau \mathbf{M}_{ic}}_{\substack{\Delta \text{ procurement: } g-1 \to g+\tau \\ \Delta \text{ all others: } g-1 \to g+\tau-1}} + u_{ic}.$$

Step 2: multiply each slope by that channel's own DiD. For a block of channels $\mathcal{B}$,

$$\widehat{A}_{k,\mathcal{B}} = \frac{1}{3} \sum_{\tau=3}^{5} \sum_{m \in \mathcal{B}} \underbrace{\widehat{\beta}_{k,m,\tau}}_{\substack{\text{partial slope of } \Delta_\tau \omega \\ \text{on } \Delta^\star_\tau m}} \cdot \underbrace{\widehat{\delta}_{k,m,\tau}}_{k\text{'s DiD on } \Delta^\star_\tau m}$$

Board & Management 44% of Central-Local Difference

Return

	Local effect $\overline{\widehat{\theta}}_{\mathrm{L}} = 0.324$ (ages 3–5)	**Local − Central gap** $\widehat{\Delta}_{\mathrm{LC}} = 0.350$
Board and management	+0.086 (26.4%)	+0.153 (43.7%)
Shareholder paid-in capital	+0.027 (8.4%)	−0.011 (−3.3%)
Procurement	≈ 0 ($\approx 0\%$)	+0.029 (8.2%)
Non-equity subsidy	+0.041 (12.5%)	+0.035 (9.9%)
Patents / intellectual property	+0.042 (12.9%)	+0.011 (3.0%)
All recorded channels	+0.195 (60.1%)	+0.215 (61.6%)
Residual	+0.129 (39.9%)	+0.134 (38.4%)

- Board composition is the largest channel: technical directors, board size and turnover account for 44% of the Local−Central gap.
- Oaxaca (1973)-Blinder (1973) decomposition: the gap is 90% differences in personnel provided, local-central firms' productivity slopes to personnel are similar decomposition

Does Local Do More, or Get More From It? Return

An Oaxaca–Blinder (1973) decomposition of each mediator's contribution to the Local−Central gap:

$$\underbrace{\widehat{\beta}_{\mathrm{L},m}\widehat{\delta}_{\mathrm{L},m} - \widehat{\beta}_{\mathrm{C},m}\widehat{\delta}_{\mathrm{C},m}}_{\text{central-local gap}} = \underbrace{\bar{\beta}_m\left(\widehat{\delta}_{\mathrm{L},m} - \widehat{\delta}_{\mathrm{C},m}\right)}_{\text{response: L,C differences in DiD of the mediator}} + \underbrace{\bar{\delta}_m\left(\widehat{\beta}_{\mathrm{L},m} - \widehat{\beta}_{\mathrm{C},m}\right)}_{\text{slope: L, C differences in productivity-mediator slope}}$$

with $\bar{x}_m = \frac{1}{2}(\widehat{x}_{\mathrm{L},m} + \widehat{x}_{\mathrm{C},m})$ (Reimers, 1983)

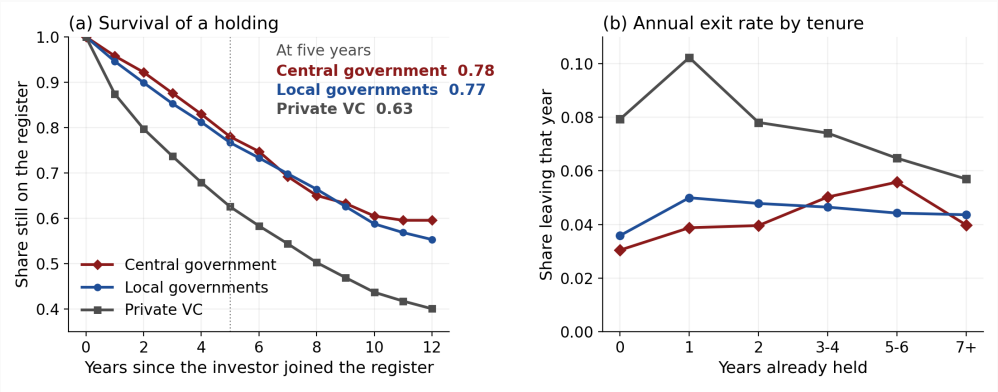
Channel	Gap contribution	Response	Slope
Technical / foreign / finance personnel	+0.099	+0.097	+0.002
Board size, joined, departed	+0.054	+0.046	+0.008
Shareholder paid-in capital	−0.012	+0.007	−0.018
Procurement	+0.029	+0.018	+0.011
Non-equity subsidy	+0.035	+0.013	+0.021
Patents / intellectual property	+0.011	+0.015	−0.004
All recorded channels	+0.215	+0.196	+0.020
as % of the 0.350 gap	61.6%	56.0%	5.6%

- **The gap is 90% differential DiD response**: local funds change firms more, especially via management.

Government VCs Stay Longer; Private VCs Exit Early

Return

Five years after entry, 78% of central gov, 77% of local gov, and 63% of private VCs stay as shareholders.



Other VCs follow local VC

Return

	Following (VC entering at t)		
VC invested at $t-1$	Central gov.	Local gov.	Private
Panel A. Linear probability model			
Central-government VC	–	0.025***	0.002
		(0.009)	(0.010)
Local-government VC	0.017***	–	0.021***
	(0.004)		(0.007)
Private VC	0.004	0.016***	–
	(0.003)	(0.005)	
N	22,472	23,902	20,874
Panel B. Conditional logit			
Central-government VC	–	0.340	-0.004
		(0.219)	(0.300)
Local-government VC	0.848***	–	0.613***
	(0.202)		(0.192)
Private VC	0.329*	0.620***	–
	(0.194)	(0.113)	
N	14,778	19,870	17,514

Notes. Full controls + industry × year fixed effects. Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Two Equilibria Each Year, Solved in Sequence

Interpretation Return

	VC block: investors $k \in \{\mathrm{C}, \mathrm{P}\} \cup \{\mathrm{L}_r\}$	**Firm block**: domestic firms in sector s
Choice	firms in $\mathcal{E}_{kt}$, given count budget N_{kt}	quantity q_{it}, labor L_{it}; imports a competitive fringe
Information	$\mathcal{F}_{t-1}$ common; logit shocks ξ_{kit} private	complete; A_{it}, K_{it} predetermined
Equilibrium	**Bayesian Nash**: beliefs = equilibrium entry probabilities, $\boldsymbol{\pi}_t = \Psi(\boldsymbol{\pi}_t; \mathcal{F}_{t-1}, \mathbf{N}_t)$; λ_{kt} clears budgets	**Cournot–Nash** (Atkeson–Burstein): markups $\mu_{it}(h_{it}, \eta^D_{st})$; firm sales add up to industry sales
Held fixed	preferences $(\gamma, \kappa, \psi, \phi)$; budgets per scenario	wage, import price, expenditure: partial equilibrium
Unique?	yes at the estimates, $\bar{\phi} = 1.12 < 4$ Proposition	yes for any $\sigma > \zeta$
Over time	Markov in $\mathcal{F}_{t-1}$; future values enter only through the index	productivity and capital follow calibrated Markovian laws of motion

The Entry Equilibrium Is Unique at the Estimates

Proof ϕ ψ

Return

Proposition (Uniqueness)
Let $\Phi_{kk'} = \phi_{k \leftarrow k'}$ collect the coordination coefficients. If some diagonal $W \succ 0$ satisfies

$$4W - \tfrac{1}{2}\big(W\Phi + \Phi' W\big) \succ 0, \quad \textit{equivalently} \quad \bar{\phi} \equiv \min_{W} \lambda_{\max}\big(W^{-1/2}\,\mathrm{sym}(W\Phi)\,W^{-1/2}\big) < 4,$$

then each year's belief equilibrium $\boldsymbol{\pi}$ is unique, for any covariates, budgets N_{kt} and choice sets $\mathcal{E}_{kt}$.

- At the NPL estimates $\bar{\phi} = 1.12 < 4$: **unique in all 18 years** Certificate
- Holds in 98.8% of draws from the estimates' sampling distribution, and in the counterfactuals

Proof (1/2): Each Investor's Response Is Co-coercive

Return

- **Equilibrium.** In year t, $\boldsymbol{\pi}_k = \bar{\Lambda}_k\big(u_k(\boldsymbol{\pi})\big)$ for every investor k, where $u_{ki}(\boldsymbol{\pi}) = u_{ki}(\mathbf{0}) + \sum_{k'} \Phi_{kk'}\pi_{k'i}$ for $i \in \mathcal{E}_{kt}$ and

$$\bar{\Lambda}_k(u) = \sum_n q_n \Lambda\big(u - \lambda_n(u)\big), \qquad \lambda_n(u) : \ \sum_{i\in\mathcal{E}_{kt}} \Lambda\big(u_i - \lambda_n(u)\big) = N_n,$$

  averaging over budget draws N_n with probabilities q_n (one draw $N_n = N_{kt}$).

- **Lemma.** $\bar{\Lambda}_k = \nabla V_k$ for a convex V_k whose gradient is $\frac{1}{4}$-Lipschitz.
  - $\Lambda(u - \lambda_n(u))$ maximizes $u'p + \mathrm{Ent}(p)$ over $p \in [0,1]^n$, $\mathbf{1}'p = N_n$, with Ent the binary entropy (first-order condition: $u_i - \lambda = \log\frac{p_i}{1-p_i}$). So it is $\nabla V_{k,n}(u)$ for the convex $V_{k,n}(u) = \max_p\{u'p + \mathrm{Ent}(p)\}$.
  - $-\partial^2\mathrm{Ent}/\partial p_i^2 = 1/[p_i(1-p_i)] \geq 4$: $-\mathrm{Ent}$ is 4-strongly convex, and the conjugate of a 4-strongly convex function has a $\frac{1}{4}$-Lipschitz gradient. Averaging over n keeps both properties.

- **Co-coercivity** (Baillon–Haddad): for all u, v,

$$\big\langle \bar{\Lambda}_k(u) - \bar{\Lambda}_k(v),\, u - v \big\rangle \ \geq \ 4\,\big\|\bar{\Lambda}_k(u) - \bar{\Lambda}_k(v)\big\|^2.$$

Proof (2/2): Two Equilibria Coincide

Return

- Let $\boldsymbol{\pi}, \boldsymbol{\pi}'$ be equilibria, $D = \boldsymbol{\pi} - \boldsymbol{\pi}'$, and $D_i = (D_{ki})_k$ the differences at firm i ($D_{ki} = 0$ if $i \notin \mathcal{E}_{kt}$). Beliefs enter linearly and only at the same firm, so $u_{ki}(\mathbf{0})$ cancels: $u_{ki}(\boldsymbol{\pi}) - u_{ki}(\boldsymbol{\pi}') = \sum_{k'} \Phi_{kk'} D_{k'i}$.

- Apply the lemma to each investor, weight by $W_{kk} > 0$, sum over k and regroup by firm:

$$\sum_i D_i' W \Phi D_i \;\geq\; 4 \sum_i D_i' W D_i \quad\Longleftrightarrow\quad \sum_i D_i' \big(4W - \mathrm{sym}(W\Phi)\big) D_i \;\leq\; 0.$$

- If $4W - \mathrm{sym}(W\Phi) \succ 0$, every term is ≥ 0 (also each principal submatrix, whatever the choice sets), so $D_i = 0$ for all i: $\boldsymbol{\pi} = \boldsymbol{\pi}'$. □

- **Remarks.**
  - Not a contraction argument: the best-response Jacobian has complex eigenvalues of modulus up to 1.6 (C ← P > 0 > P ← C rotates). Rotation is skew-symmetric and drops out of the quadratic form; $W_{\mathrm{CC}}/W_{\mathrm{PP}} = -\phi_{\mathrm{P}\leftarrow\mathrm{C}}/\phi_{\mathrm{C}\leftarrow\mathrm{P}}$ cancels it.
  - Sufficient, not necessary: $p(1-p) \leq \frac{1}{4}$ is the worst case. The condition involves Φ only, so it covers any budgets and any subset of investors (counterfactuals).

The Certificate at the Estimates

Return

Coordination coefficient	NPL estimate	(s.e.)	certified range (one at a time)	in robust s.e.
Central ← private VC	6.21	(0.40)	$[-5.91,\ +\infty)$	$[-30.1,\ +\infty)$
Private VC ← central	−2.71	(0.74)	$(-\infty,\ 2.58]$	$(-\infty,\ +7.1]$
Central ← local funds	0.11	(0.25)	$[-4.14,\ 1.57]$	$[-17.0,\ +5.8]$
Local fund ← central	0.54	(0.55)	$[-3.53,\ 5.33]$	$[-7.3,\ +8.6]$
Private VC ← local funds	−1.47	(0.28)	$(-\infty,\ 0.22]$	$(-\infty,\ +6.0]$
Local fund ← private VC	3.87	(0.29)	$[-0.57,\ +\infty)$	$[-15.2,\ +\infty)$
Local fund ← other locals	excluded (0)		$[-4.00,\ 0.22]$	

- $\bar{\phi} = 1.12$ with weights C 0.75, P 1, each local 0.31 (equal weights: 6.06); certified for all of Φ scaled by up to $3.6\times$
- 98.8% of 400 draws from $N(\hat{\phi}, \hat{V}_{\text{robust}})$ certified; at the two-step estimates $\bar{\phi} = 6.2$ (not automatic)
- Numerically: largest real eigenvalue of the belief map ≤ 0.16 and index $+1$ in every year; in 2021–24, Newton from 10 starts and deflated Newton find one equilibrium

Following: A Rival Already Owns the Firm ($t-1$) Return

Entering $k \leftarrow$ owner k' at $t-1$	$\hat{\psi}_{k \leftarrow k'}$ (s.e.)	odds ratio	% of choice set	% of first entries
Central $\leftarrow$ private VC	2.49*** (0.13)	12.1	12	57
Central $\leftarrow$ local fund[a]	-0.07 to 0.46	0.9–1.6	9	50
Private VC $\leftarrow$ central	0.27 (0.19)	1.3	1	7
Private VC $\leftarrow$ local fund[a]	0.42 to 1.27***	1.5–3.6	5	23
Local fund $\leftarrow$ central[a]	-0.10 to 0.34	0.9–1.4	5	24
Local fund $\leftarrow$ private VC[a]	1.61 to 1.85***	5.0–6.3	16	60
Local fund $\leftarrow$ other local[a]	-0.26 to 0.17	0.8–1.2	12	44

- Private VC ownership is the strongest pull: central and local funds follow it into firms
- Following carries central's selection: 43% of its index variance; dropping it cuts pseudo-R^2 from 0.21 to 0.08 (locals 0.19 $\rightarrow$ 0.14; private 0.16 $\rightarrow$ 0.15)
- Caveat: ψ also absorbs persistent unobserved firm quality — not a causal follow-on effect

[a] Range over the six province groups. NPL estimates, firm-clustered robust s.e. The % columns: share of the entering investor's firm-years at risk, and of its first entries, with that owner at $t-1$.

Coordination: Rivals' Expected Same-Year Entry

Return

Entering $k \leftarrow$ rival k'	NPL $\hat{\phi}_{k \leftarrow k'}$ (s.e.)	two-step	+1 s.d. of $\pi_{k'it}$, log-odds
Central $\leftarrow$ private VC	6.21^{***} (0.40)	4.40^{***}	+0.43
Central $\leftarrow$ local funds	0.11 (0.25)	-0.86^{*}	+0.01
Private VC $\leftarrow$ central	-2.71^{***} (0.74)	-8.03^{***}	−0.07
Private VC $\leftarrow$ local funds	-1.47^{***} (0.28)	0.15	−0.11
Local fund $\leftarrow$ central	0.54 (0.55)	−0.31	+0.02
Local fund $\leftarrow$ private VC	3.87^{***} (0.29)	2.86^{***}	+0.29
Local fund $\leftarrow$ other locals	excluded (score test at the two-step: $p = 0.42$)		

- Public funds go where private VC is expected; private VC avoids where public funds are expected
- Identified by exclusions: rivals' portfolio fit, partner ties, home province, budgets; about 30% of each $\pi_{k'it}$'s variation is independent of k's own regressors
- NPL vs two-step: first-stage beliefs attenuate C $\leftarrow$ P and exaggerate P $\leftarrow$ C

NPL estimates (equilibrium beliefs), firm-clustered robust s.e.; two-step uses first-stage logit beliefs. Last column: coefficient $\times$ s.d. of the rival's equilibrium entry probability over k's firm-years at risk.

Downstream Demand (1): Households and Electronics Makers

Back

A household with quasi-linear preferences, demand shifter Ξ_t and elasticity σ_E, buys electronics E_t:

$$E_t = \Xi_t \left(P_t^E\right)^{-\sigma_E}, \qquad P_t^E E_t = \Xi_t \left(P_t^E\right)^{1-\sigma_E}$$

Competitive electronics sector combines the semiconductor bundle H_t with other inputs V_t to produce E_t, CES production w. elasticity σ_H & productivity A_t^E:

$$E_t = A_t^E \left[\beta_H^{\frac{1}{\sigma_H}} H_t^{\frac{\sigma_H - 1}{\sigma_H}} + \beta_V^{\frac{1}{\sigma_H}} V_t^{\frac{\sigma_H - 1}{\sigma_H}}\right]^{\frac{\sigma_H}{\sigma_H - 1}}$$

- the semiconductor cost share is $h_t = \beta_H (P_t^H / \Gamma_t)^{1-\sigma_H}$
- price of electronics is competitive: with marginal cost $\Gamma_t = \left[\beta_H (P_t^H)^{1-\sigma_H} + \beta_V (P_t^V)^{1-\sigma_H}\right]^{\frac{1}{1-\sigma_H}}$, electronics price $P_t^E = \frac{\Gamma_t}{A_t^E}$
- Demand Ξ_t, productivity A_t^E and other-input prices P_t^V are exogenous Markov processes

Downstream Demand (2): The Semiconductor Bundle and Sector Expenditure

Back

The semiconductor bundle combines the composites across semiconductor sector s with elasticity σ_S, technology demand shifters b_{st}: $H_t = \left[\sum_s b_{st}^{\frac{1}{\sigma_S}} \mathcal{Q}_{st}^{\frac{\sigma_S-1}{\sigma_S}}\right]^{\frac{\sigma_S}{\sigma_S-1}}$, with semiconductor price $P_t^H = \left[\sum_s b_{st} (\mathcal{P}_{st}^T)^{1-\sigma_S}\right]^{\frac{1}{1-\sigma_S}}$ and sector price $\mathcal{P}_{st}^T = \left[(P_{st}^D)^{1-\zeta} + a_F (P_{st}^F)^{1-\zeta}\right]^{\frac{1}{1-\zeta}}$. Expenditures on sector s, $\mathcal{X}_{st}$, are:

$$\mathcal{X}_{st} \equiv \mathcal{P}_{st}^T \mathcal{Q}_{st} = \underbrace{h_{st}}_{\text{sector's share of the semi spending}} \times \underbrace{h_t}_{\text{semi share of electronics cost}} \times \underbrace{\Xi_t (P_t^E)^{1-\sigma_E}}_{\text{electronics sales}}$$

where

$$h_{st} = \frac{b_{st} (\mathcal{P}_{st}^T)^{1-\sigma_S}}{\sum_r b_{rt} (\mathcal{P}_{rt}^T)^{1-\sigma_S}}$$

- Given Ξ_t, A_t^E, P_t^V and b_{st}, semiconductor prices enter only through $\mathcal{P}_{st}^T$ and P_t^H
- Exogenous to a domestic firm: the largest CN firm supplies 1–4% of its sector's absorption (8% for the largest LED maker), so it takes $\mathcal{P}_{st}^T$ and P_t^H as given and $\mathcal{X}_{st}$ is a Markov state

Cournot versus Bertrand: Perceived Demand Elasticities

- **Cournot firms hold other domestic quantities fixed.** Their inverse demand elasticity averages the within-domestic and domestic-composite inverse elasticities:

$$\frac{1}{\epsilon_{it}^{\mathrm{C}}} = \frac{1 - h_{it}}{\sigma} + \frac{h_{it}}{\eta_{st}^{D}}.$$

- **Bertrand firms hold other domestic prices fixed.** Their demand elasticity is

$$\epsilon_{it}^{\mathrm{B}} = \sigma(1 - h_{it}) + h_{it}\eta_{st}^{D}, \qquad \mu_{it}^{a} = \frac{\epsilon_{it}^{a}}{\epsilon_{it}^{a} - 1}, \quad a \in \{\mathrm{C}, \mathrm{B}\}.$$

- **Both approaches give higher markups to larger firms.** Illustration: $\sigma = 4$, $\zeta = 3$, $s^{D} = 0.25$, $h_i = 0.20$ imply $\eta^{D} = 2.5$.

	Demand elasticity	Markup
Atomistic benchmark	4.000	1.333
Cournot	3.571	1.389
Bertrand	3.700	1.370

- **This adapts the Atkeson–Burstein mechanism to our demand closure.** We retain fixed P_{st}^{F}, wages and sector expenditure.

Calibrating Treatment Effects

Return

- Calibrate $\theta_k^\omega(\tau), \theta_k^K(\tau)$ for $\tau \in \{0, 1, 2, 3+\}$ to match event study paths:
  1. Let $\text{DiD}_k^\omega(\tau)$ be the empirical event study estimate of k at τ
  2. for candidate parameters $\boldsymbol{\theta}^\omega$, $\text{DiD}_k^\omega(\tau; \boldsymbol{\theta}^\omega)$ is the corresponding DiD estimated from simulating (46) fixing VC investments.

$$\widehat{\boldsymbol{\theta}}^\omega = \arg\min_{\boldsymbol{\theta}^\omega} \sum_{k \in \{\text{C},\text{L},\text{P}\}} \sum_{\tau \in \{0,1,2,3+\}} \underbrace{n_{k,\tau}}_{\text{treated unit weights}} \left[\text{DiD}_k^\omega(\tau) - \text{DiD}_k^\omega(\tau; \boldsymbol{\theta}^\omega)\right]^2 \quad (6)$$

- θ^K calibrated analogously.

Estimates

Firm Equilibrium I: Domestic Aggregates' Price-Sales Relationship

Return to Eq.

- **Fixed expenditures** $\mathcal{X}_{st}$ imply total domestic sales $R_{st}^D \equiv P_{st}^D Q_{st}^D = s_{st}^D \mathcal{X}_{st}$,

$$d \log R_{st}^D = d \log s_{st}^D \implies s_{st}^D = s_{st}^{D,0} \exp\Big(d \log R_{st}^D\Big). \tag{7}$$

  $s_{st}^{D,0}$ is domestic share under $\mathbf{G}^0$.

- Holding foreign prices P_{st}^F fixed,

$$\frac{s_{st}^D/(1-s_{st}^D)}{s_{st}^{D,0}/(1-s_{st}^{D,0})} = \left(\frac{P_{st}^D}{P_{st}^{D,0}}\right)^{1-\zeta} \tag{8}$$

- Taking logs of (8) and substituting (7) gives a relationship of **change in domestic sales vs price**:

$$d \log P_{st}^D = \frac{-d \log R_{st}^D + \log(1 - s_{st}^{D,0} \exp(d \log R_{st}^D)) - \log(1 - s_{st}^{D,0})}{\zeta - 1}. \tag{9}$$

Firm Equilibrium II: Domestic Market Shares and Markup

Return to Eq.

- Firm's domestic market share h_{it} update from baseline h_{it}^0:

$$h_{it} = h_{it}^0 \exp\Big(d\log R_{it}^* - d\log R_{st}^D\Big) \tag{10}$$

- Domestic demand becomes less elastic (elasticity $\eta_{st}^{D,0} \to \eta_{st}^D$) as domestic expenditure share rises from $s_{st}^{D,0}$ to $s_{st}^D = s_{st}^{D,0}\exp\big(d\log R_{st}^D\big)$:

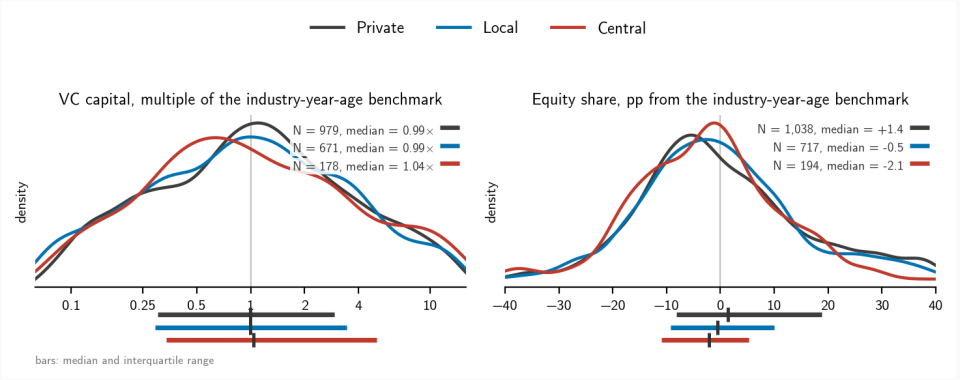
$$\eta_{st}^{D,0} \equiv 1 + (\zeta - 1)(1 - s_{st}^{D,0}), \qquad \eta_{st}^D = 1 + (\zeta - 1)(1 - s_{st}^D)).$$

- Then **change in markups** is

$$d\log \mu_{it} \equiv \log \frac{\mu_{it}}{\mu_{it}^0} = \log\left[\frac{1 - \frac{1-h_{it}^0}{\sigma} - \frac{h_{it}^0}{\eta_{st}^{D,0}}}{1 - \frac{1-h_{it}}{\sigma} - \frac{h_{it}}{\eta_{st}^D}}\right]. \tag{11}$$

Same Deal Terms Within Industry, Year and Firm Age

Return



- Deals: each type's first investment in a firm (joint entries included); VC capital = the type's paid-in registered capital that year
- plot e_i, the residual of $y_i = a_{\text{ind} \times \text{year}} + b_{\text{age group}} + e_i$, with $y = \log_{10}$ capital or share (%)

Annual simulation sequence

1. Firm entry fixed from data. Set each investor's count budget to the counterfactual.
2. Update eligible firms for each investor. Calculate probability of investment according to estimated, then choose recipients according to probability until budget exhausted.
3. Update productivity and capital response. Solve sector revenue with import substitution multiplier.
4. Firm exit depending on ω and K.

Return

Calibrated Capital Response Paths

- **Target:** capital SDID estimates using four pre-treatment years.
- **Calibration:** investor-specific log-capital responses, common across cohorts and jointly accounting for overlapping VC histories.

Investor	$\tau = 0$	1	2	3	4+
Central	0.1806	0.2240	0.2322	0.2498	0.4458
Local	0.0352	0.1340	0.1715	0.2720	0.3035
Private	0.1609	0.3007	0.4215	0.6274	0.3919

Entries are $\theta_j^K(\tau)$: total log-capital level effects, including capital responses operating through productivity.

The constant 4+ response is calibrated to the average event-year 4 and 5 ATT moments.

Return

Calibrated Revenue-Productivity Response Paths

- **Target:** original $g-1$ DiD estimates for ω_{acf}.
- **Calibration:** investor-specific revenue-productivity responses, common across cohorts and jointly accounting for overlapping VC histories.

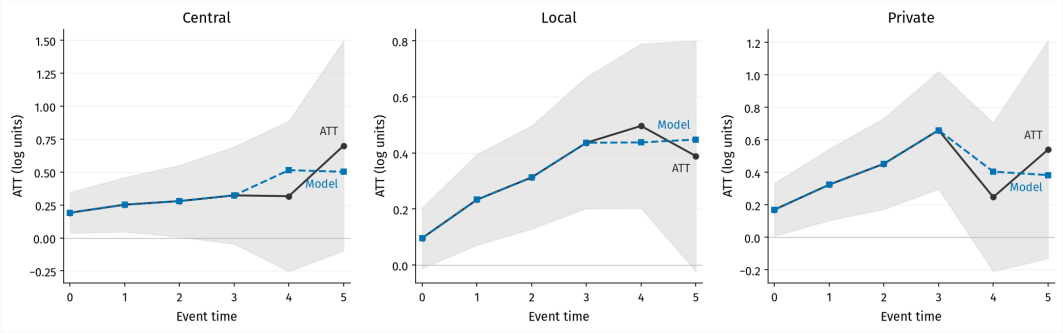
Investor	$\tau = 0$	1	2	3	4+
Central	-0.0047	0.1232	0.0594	0.0375	-0.0408
Local	0.1428	0.3307	0.3624	0.4286	0.3868
Private	0.0315	-0.0750	-0.0572	-0.3116	-0.0533

Entries are $\theta_j^{\omega}(\tau)$: level effects in the native revenue-productivity residual, holding common sector demand fixed.

The constant 4+ response is calibrated to the average event-year 4 and 5 ATT moments.

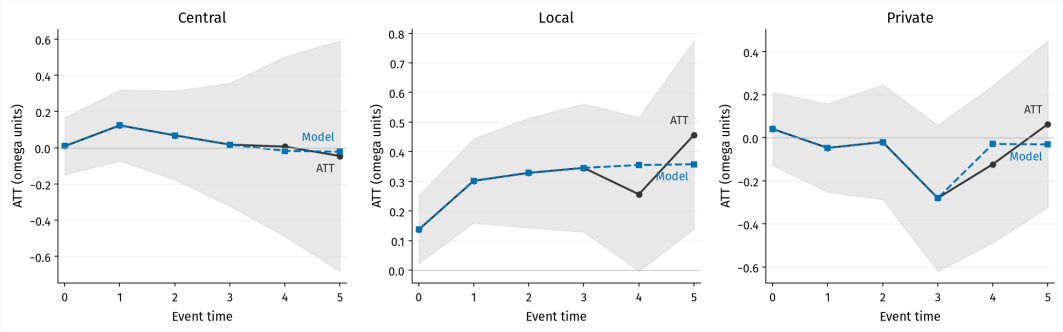
Return

Capital ATT and model-implied moments



return

Productivity ATT and model-implied moments



return

Decomposing Selection and Treatment

Return

Define $V_{ab} \equiv 100 \frac{\mathbb{E}[R_{ab}^{CF} - R_{ab}^{0}]}{\mathbb{E}[R_{11}^{0}]}$ under the scenarios

- $a \in \{\text{Modeled Selection, Random Selection}\}$
- $b \in \{\text{Same VC treatment, VC-specific treatment}\}$ on $x \in \{\omega, K\}$
- R_{11}^{0} is decentralized status quo revenue, R_{ab}^{0} is decentralized revenue under ab, and R_{ab}^{CF} is the counterfactual revenue under ab

	same treatment on x	VC-specific treatment effect on x
Random selection	V_{00}^{x}	V_{01}^{x}
Modeled selection	V_{10}^{x}	V_{11}^{x}

- For each $x \in \{\omega, K\}$, define

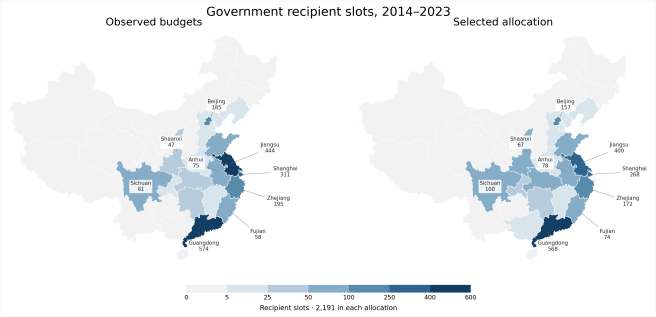
$$\text{Selection}_x = \tfrac{1}{2}\left[(V_{10}^{x} - V_{00}^{x}) + (V_{11}^{x} - V_{01}^{x})\right],$$
$$\text{Treatment}_x = \tfrac{1}{2}\left[(V_{01}^{x} - V_{00}^{x}) + (V_{11}^{x} - V_{10}^{x})\right].$$

$$V_{11}^{x} = V_{00}^{x} + \text{Selection}_x + \text{Treatment}_x, \qquad V_{ab} = V_{ab}^{\omega} + V_{ab}^{K}.$$

Optimal Allocation Broadens the Recipient Distribution

Return

- **Investments reallocated to inland provinces**: Sichuan +38, Shaanxi +21, Fujian +15.
- **546 central / 1,645 local** to **350 / 1,841**.
- Assumption: Firm locations are fixed and exogenous; all local gov VCs have the same effects.



Bibliography i

Ackerberg, D. A., K. Caves, and G. Frazer (2015): "Identification Properties of Recent Production Function Estimators," **Econometrica**, 83, 2411–2451.

Alonso, R., W. Dessein, and N. Matouschek (2008): "When Does Coordination Require Centralization?" **American Economic Review**, 98, 145–179.

Amiti, M., M. Dai, R. C. Feenstra, and J. Romalis (2020): "How Did China's WTO Entry Affect U.S. Prices?" **Journal of International Economics**, 126, 103339.

Aragoneses, M. and S. Saxena (2025): "Industrial Policy via Venture Capital," Working paper, posted on SSRN.

Atkeson, A. and A. Burstein (2008): "Pricing-to-Market, Trade Costs, and International Relative Prices," **American Economic Review**, 98, 1998–2031.

Bai, C.-E., C.-T. Hsieh, and Z. Song (2020): "Special Deals with Chinese Characteristics," **NBER Macroeconomics Annual**, 34, 341–379.

Bibliography ii

Baldwin, R. E. and P. R. Krugman (1988): "Market Access and International Competition: A Simulation Study of 16K Random Access Memories," in **Empirical Methods for International Trade**, ed. by R. C. Feenstra, Cambridge, MA: MIT Press, 171–197.

Baldwin, R. E. and F. Robert-Nicoud (2007): "Entry and Asymmetric Lobbying: Why Governments Pick Losers," **Journal of the European Economic Association**, 5, 1064–1093.

Banares-Sanchez, I., R. Burgess, D. László, P. Simpson, J. Van Reenen, and Y. Wang (2026): "Ray of Hope? China and the Rise of Solar Energy," Working Paper 34893, National Bureau of Economic Research.

Barwick, P. J., S. Cao, and S. Li (2021): "Local Protectionism, Market Structure, and Social Welfare: China's Automobile Market," **American Economic Journal: Economic Policy**, 13, 112–151.

Bibliography iii

Barwick, P. J., M. Kalouptsidi, and N. B. Zahur (2025): "Industrial Policy Implementation: Empirical Evidence from China's Shipbuilding Industry," **The Review of Economic Studies**, rdaf011.

Beason, R. and D. E. Weinstein (1996): "Growth, Economies of Scale, and Targeting in Japan (1955–1990)," **Review of Economics and Statistics**, 78, 286–295.

Beraja, M., W. Peng, D. Y. Yang, and N. Yuchtman (2024): **Government as Venture Capitalists in AI**, University of Chicago Press.

Besley, T. and S. Coate (2003): "Centralized versus Decentralized Provision of Local Public Goods: A Political Economy Approach," **Journal of Public Economics**, 87, 2611–2637.

Blinder, A. S. (1973): "Wage Discrimination: Reduced Form and Structural Estimates," **Journal of Human Resources**, 8, 436–455.

Bibliography iv

Bloom, N., B. Eifert, A. Mahajan, D. McKenzie, and J. Roberts (2013): "Does Management Matter? Evidence from India," **The Quarterly Journal of Economics**, 128, 1–51.

Brander, J. A., Q. Du, and T. Hellmann (2015): "The Effects of Government-Sponsored Venture Capital: International Evidence," **Review of Finance**, 19, 571–618.

Brandt, L., F. Jiang, Y. Luo, and Y. Su (2022): "Ownership and Productivity in Vertically Integrated Firms: Evidence from the Chinese Steel Industry," **The Review of Economics and Statistics**, 104, 101–115.

Brandt, L., J. Van Biesebroeck, and Y. Zhang (2012): "Creative Accounting or Creative Destruction? Firm-Level Productivity Growth in Chinese Manufacturing," **Journal of Development Economics**, 97, 339–351.

Branstetter, L. and G. Li (2023): **The Challenges of Chinese Industrial Policy**, University of Chicago Press, 77–113.

Branstetter, L. G., G. Li, and M. Ren (2023): "Picking Winners? Government Subsidies and Firm Productivity in China," **Journal of Comparative Economics**, 51, 1186–1199.

Callaway, B. and P. H. Sant'Anna (2021): "Difference-in-Differences with Multiple Time Periods," **Journal of Econometrics**, 225, 200–230, themed Issue: Treatment Effect 1.

Chen, J., R. K. Gong, and J. Li (2026): "Industrial Policy in a New Era: Government Venture Capital in the U.S.-China Trade War," **Journal of Development Economics**, 178, 103599, previously entitled "Coming to Rescue? Government Venture Capital in the U.S.-China Trade War". Presented at ABFER 9th Conference 2022 and AMES 2022 Shenzhen.

Chen, Y., M. Igami, M. Sawada, and M. Xiao (2021): "Privatization and productivity in China," **The RAND Journal of Economics**, 52, 884–916.

Choi, J. and A. A. Levchenko (2025): "The Long-Term Effects of Industrial Policy," **Journal of Monetary Economics**, 103779.

Colonnelli, E., B. Li, and E. Liu (2024): "Investing with the Government: A Field Experiment in China," **Journal of Political Economy**, 132, 248–294.

Costinot, A. and A. Rodríguez-Clare (2014): "Trade Theory with Numbers: Quantifying the Consequences of Globalization," in **Handbook of International Economics**, ed. by G. Gopinath, E. Helpman, and K. Rogoff, Elsevier, vol. 4, chap. 4, 197–261.

Criscuolo, C., R. Martin, H. G. Overman, and J. Van Reenen (2019): "Some Causal Effects of an Industrial Policy," **American Economic Review**, 109, 48–85.

de Chaisemartin, C. and X. D'Haultfœuille (2020): "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects," **American Economic Review**, 110, 2964–2996.

——— (2023): "Two-Way Fixed Effects and Differences-in-Differences Estimators with Several Treatments," **Journal of Econometrics**, 236, 105480.

Fan, H., Y. A. Li, S. Xu, and S. R. Yeaple (2020): "Quality, Variable Markups, and Welfare: A Quantitative General Equilibrium Analysis of Export Prices," **Journal of International Economics**, 125, 103327.

Fang, H., M. Li, and G. Lu (2025): "Decoding China's Industrial Policies," Working Paper / Technical Report –, University of Pennsylvania; Chinese University of Hong Kong, Shenzhen, using large-language models (LLMs) to extract data from 3 million government documents (2000–2022).

Feenstra, R. C., P. Luck, M. Obstfeld, and K. N. Russ (2018): "In Search of the Armington Elasticity," **The Review of Economics and Statistics**, 100, 135–150.

Gelbach, J. B. (2016): "When Do Covariates Matter? And Which Ones, and How Much?" **Journal of Labor Economics**, 34, 509–543.

Giorcelli, M. (2019): "The Long-Term Effects of Management and Technology Transfers," **American Economic Review**, 109, 121–52.

Goldberg, P. K., R. Juhász, N. J. Lane, G. Lo Forte, and J. Thurk (2024): "Industrial Policy in the Global Semiconductor Sector," Working Paper 32651, National Bureau of Economic Research.

Goodman-Bacon, A. (2021): "Difference-in-Differences with Variation in Treatment Timing," **Journal of Econometrics**, 225, 254–277.

Hirschman, A. O. (1968): "The Political Economy of Import-Substituting Industrialization in Latin America," **Quarterly Journal of Economics**, 82, 1–32.

Hsieh, C.-T. and P. J. Klenow (2009): "Misallocation and Manufacturing TFP in China and India," **The Quarterly Journal of Economics**, 124, 1403–1448.

Irwin, D. A. and P. J. Klenow (1994): "Learning-by-Doing Spillovers in the Semiconductor Industry," **Journal of Political Economy**, 102, 1200–1227.

Kalouptsidi, M. (2017): "Detection and Impact of Industrial Subsidies: The Case of Chinese Shipbuilding," **The Review of Economic Studies**, 85, 1111–1158.

Krueger, A. O. (1990): "Government Failures in Development," **Journal of Economic Perspectives**, 4, 9–23.

Lane, N. (2025): "Manufacturing Revolutions: Industrial Policy and Industrialization in South Korea," **The Quarterly Journal of Economics**, 140, 1683–1741.

Lerner, J. (2009): **Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed—and What to Do About It**, Princeton, NJ: Princeton University Press.

Lian, L. and J. Zhang (2026): "Allocative Implications of Government Investment in Private Sector," **Journal of Development Economics**, 179, 103616.

Liu, E. (2019): "Industrial Policies in Production Networks*," **The Quarterly Journal of Economics**, 134, 1883–1948.

Luo, K., S. Wang, and D. Y. Yang (2025): "Laboratories of Autocracy: Landscape of Central-Local Dynamics in China's Policy Universe," Working Paper 34219, National Bureau of Economic Research.

Luzio, E. and S. Greenstein (1995): "Measuring the Performance of a Protected Infant Industry: The Case of Brazilian Microcomputers," **Review of Economics and Statistics**, 77, 622–633.

Oates, W. E. (1999): "An Essay on Fiscal Federalism," **Journal of Economic Literature**, 37, 1120–1149.

Oaxaca, R. (1973): "Male-Female Wage Differentials in Urban Labor Markets," **International Economic Review**, 14, 693–709.

Rambachan, A. and J. Roth (2023): "A More Credible Approach to Parallel Trends," **Review of Economic Studies**, 90, 2555–2591.

Reimers, C. W. (1983): "Labor Market Discrimination Against Hispanic and Black Men," **The Review of Economics and Statistics**, 65, 570–579.

Rosen, J. B. (1965): "Existence and Uniqueness of Equilibrium Points for Concave *N*-Person Games," **Econometrica**, 33, 520–534.

Rotemberg, M. (2019): "Equilibrium Effects of Firm Subsidies," **American Economic Review**, 109, 3475–3513.

Song, Z. and W. Xiong (2026): "The Mandarin Model of Growth," **American Economic Review**, accepted for publication.

Sun, L. and S. Abraham (2021): "Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects," **Journal of Econometrics**, 225, 175–199.

Wang, S. and D. Y. Yang (2023): "Policy Experimentation in China: the Political Economy of Policy Learning," Working Paper 29402, National Bureau of Economic Research.