Dynamic and Spillover Effects of Management Interventions: Evidence from the Training Within Industry Program

Nicola Bianchi, Kellogg and NBER
Michela Giorcelli, UCLA and NBER

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Motivation

Large productivity spread across time and within countries and sectors

- "Hard" technological innovations: patents, ICTs, etc...
- "Soft" technologies: management (Bloom and Van Reneen, 2007)

Causal effects of management interventions

- RCTs on training / consulting (Bloom et al., 2013; Bruhn et al., 2018)
- Persistent over time (Bloom et al., 2018; Giorcelli, 2019)

Open questions

- Dynamics of the effects: continuous improvement vs depreciation
- Spillover effects: knowledge diffusion vs increased competition

The Training Within Industry (TWI) Program

In-plant management training program between 1940-1945

- To US firms involved in war production
- In 3 management areas:
  - Job Instruction (J-I): standard procedures for operations
  - Job Relations (J-R): human resources management
  - Job Methods (J-M): how to improve procedures

Organization of the program

- Decentralized at the level of geographical units called subdistricts
- Voluntary basis, 10 application windows
- Trained following application order, separately per window

Training provided by TWI instructors

- Trained in one management area
- Hired either full or part-time due to budget constraint

Data and Identification Strategy

Data on 11,575 that applied to the program

- WWII war contracts (1940-1945)
- TWI monthly reports + plant survey (1940-1945)
- Balance sheets and statement of profits and losses (1935-1955)

Delivery of TWI training to firms "as good as random"

- Variation in full- vs part-time instructors and J-module training
- Within subdistrict across time; Across subdistricts within time
- Not correlated to firm or county characteristics
- Compare 2 firms in the same county, applying on the same day, but located in different subdistricts

Effects of TWI Training on Firm Performance

Large and persistent effects on firm performance

- Heterogenous across different type of trainings
- Changes in practices related to type of trainings
- Complementarities across practices

Effects on other firms

- Positive vertical spillovers
  - Upstream and downstream firms become more productive
  - Better selection of upstream and downstream firms
- No evidence of horizontal spillovers

Contributions to the Literature

1. Managerial interventions and firm performance (e.g., Giorcelli, 2019; Bloom et al., 2018; Bruhn et al., 2018; Higuchi et al., 2016; Bloom et al., 2013)

McKenzie and Woodruff (2014) have the following suggestions for future work:

- *Analyzing larger samples* $\rightarrow$ Sample 1 to 2 orders of magnitude larger
- *Measuring spillovers* $\rightarrow$ Large firms + data for vert./horiz. spillovers
- *Measuring trajectories over longer periods* $\rightarrow$ 10 years of levels/growth
- *Testing which elements of content matter* $\rightarrow$ Complementarities

2. Managers and firm performance (e.g., Huber et al., 2019; Bandiera, Prat, Sadun, 2013; Perez-Gonzalez, 2006; Bertrand and Schoar, 2003)

Mgmt training and loss of human capital (managers leaving + WWII draft)

3. Economic effects of WWII: (e.g., Bianchi and Giorcelli, 2019; Brunet, 2019; Koustas and Li, 2019; Rhode et al., 2018; Fetter, 2016; Jaworski, 2014)

First firm-level comprehensive analysis of the TWI

Outline

- Historical Background
- Data
- Identification Strategy
- Dynamic Effects of Management Training
- Spillover Effects
- Conclusions

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The Training Within Industry Program

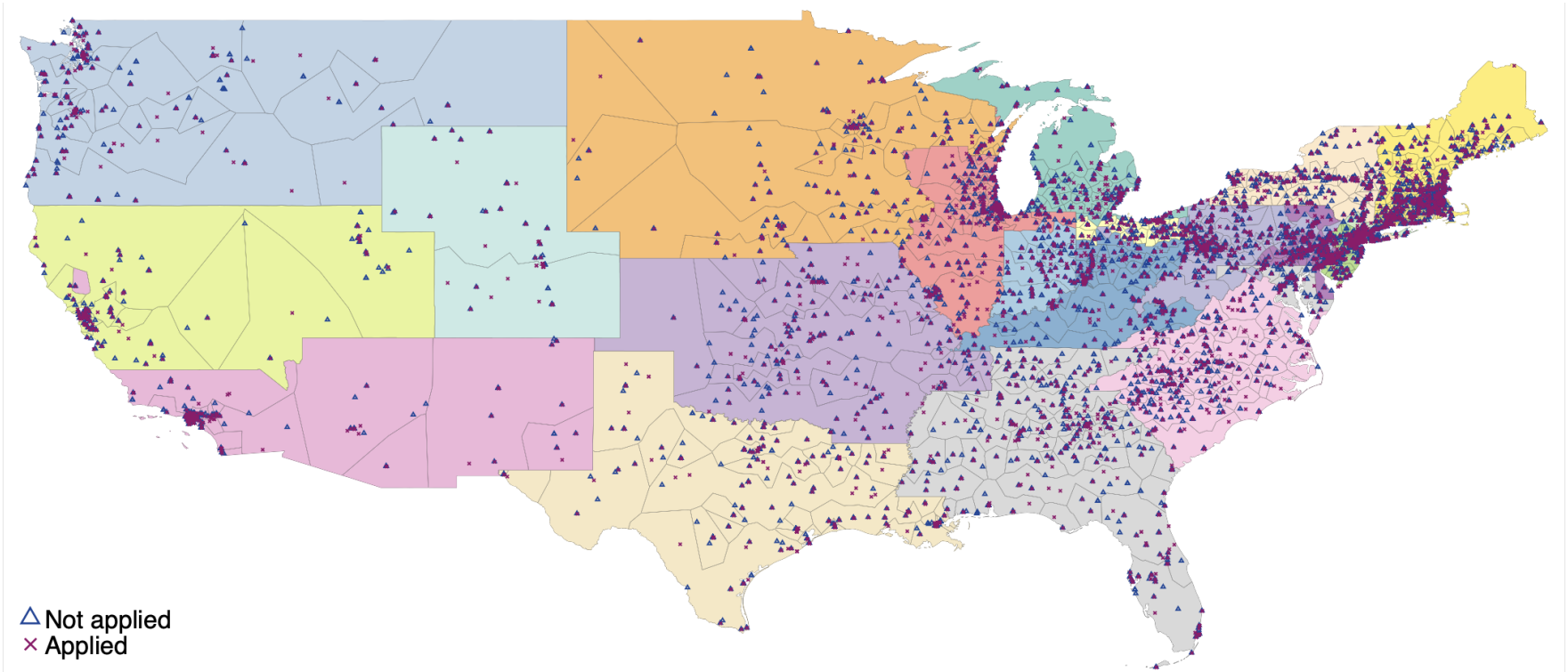
Business training program for US war contractors

- From August 1940 to September 1945
- One of the 1st emergency services after the Fall of France (June 1940)
- US as the "Arsenal of Democracy" (Franklin D. Roosevelt, 12/29/1940)
  - Increasing firm production and productivity
  - Training new workers to be immediately productive

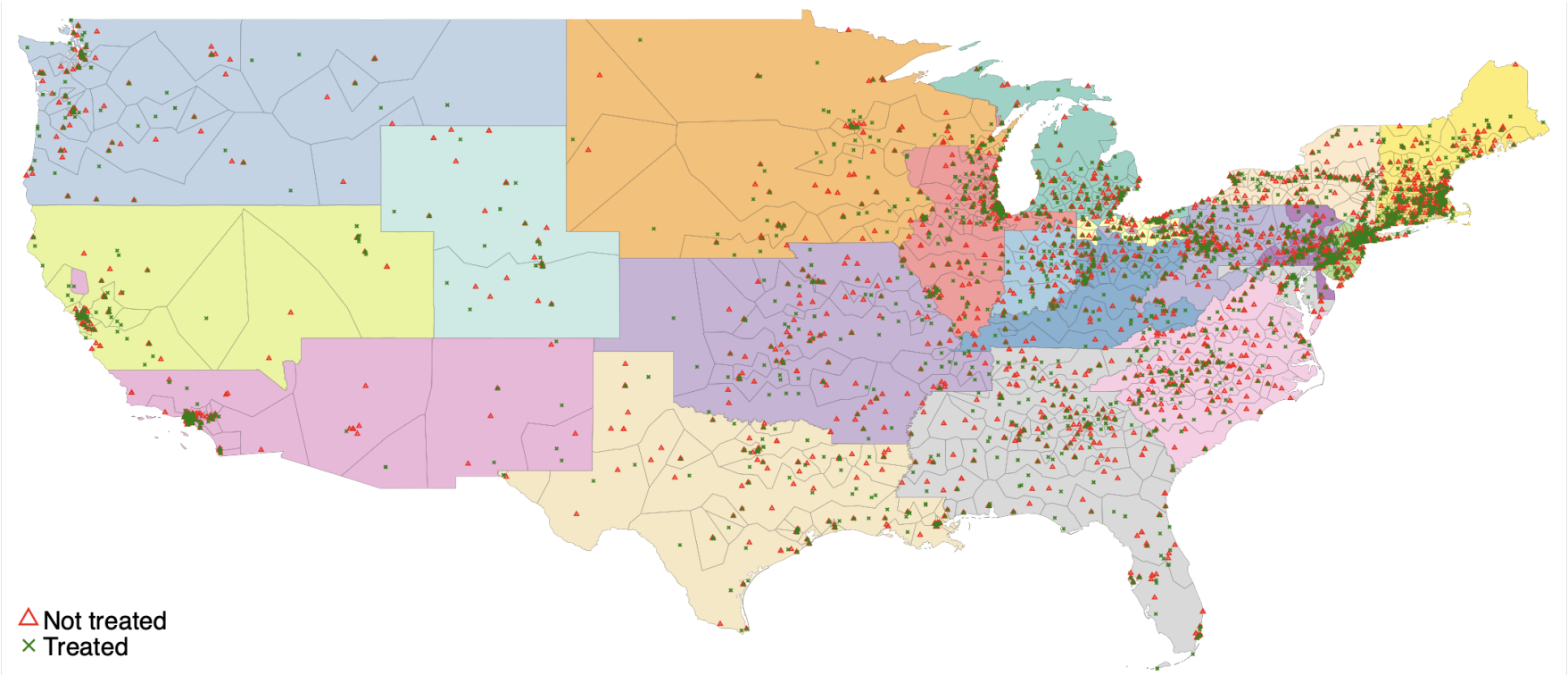
Decentralized and voluntary program

- Initial goal to train all war contractors unfeasible
- TWI divided US in 22 districts and 364 subdistricts
- 10 application windows per subdistrict
- Condition to apply: being US war contractor
- Delivery at subdistrict-app. window level in descending order of application

11,575 Applicant and 11,536 Nonapplicant Firms



6,054 Treated and 5,521 Nontreated Applicants



Content of TWI Program: The J-Modules

Job-Instruction (J-I)

- Establishing standard procedures for operations, improving lighting, implementing job safety for workers, keeping the factory floor tidy, regular maintenance of machines and recording the reasons for breakdowns.
- Today $\rightarrow$ factory operations

Job-Relations (J-R)

- Better relations with workforce, job division, more funds allocated to on-the-job training, performance-based incentive systems
- Today $\rightarrow$ human resources management

Job-Methods (J-M)

- Reduction of inventory, production planning, better prioritization of orders, more emphasis on marketing
- Today $\rightarrow$ inventory, sales, and order management

The Delivery of the J-Modules

TWI Instructors:

- Prepared through 50-h class (*TWI Institute*)
- Hired either full-time or part-time
- Specialized in only one J-module
- Trained applicant firms in only one window and subdistrict

Key features of TWI trainings

- Standardized program:
  - 10h x 5 sessions
  - Frequent audits
  - Teach at least once every 90 days
- Small class size: $[9, 11]$ managers
- Simplicity + Usability (Dinero, 2005)
  - Each J-module summarized in 4-step instruction card
  - In-class presentations

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Data Collection

War supply contracts from 1940 to 1945 (Koustas and Li, 2019)

- Compiled by the Civilian Production Administration, 1946
- List of 25,393 companies eligible to participate in the TWI program

TWI program monthly records from 1940 to 1945

- Date of application, type and year of intervention
- Plant survey before and after the training

Replacement schedule from 1941 to 1945

- Information on drafted workers compiled by the Selective Service System
- Information on upstream and downstream firms

Firm performance from 1935 to 1955

- Balance sheets and income of profits and losses
- Additional information on number of workers and managers

Summary Statistics for 11,575 Applicant Firms in 1939

	Mean	St. Dev.
	(1)	(2)
Plants	6.08	1.90
Employees	1,038.32	378.53
Agriculture	0.03	0.16
Manufacturing	0.86	0.34
Transportation	0.09	0.29
Services	0.02	0.14
Sales	191.78	77.12
Total assets	351.42	151.12
War contracts	0.51	3.32
Value contracts	15.87	299.69

- Multiplant firms
- Large workforce
- Mostly in manufcaturing
- High revenues and assets

Notes. All monetary values are expressed in 2020 million USD.

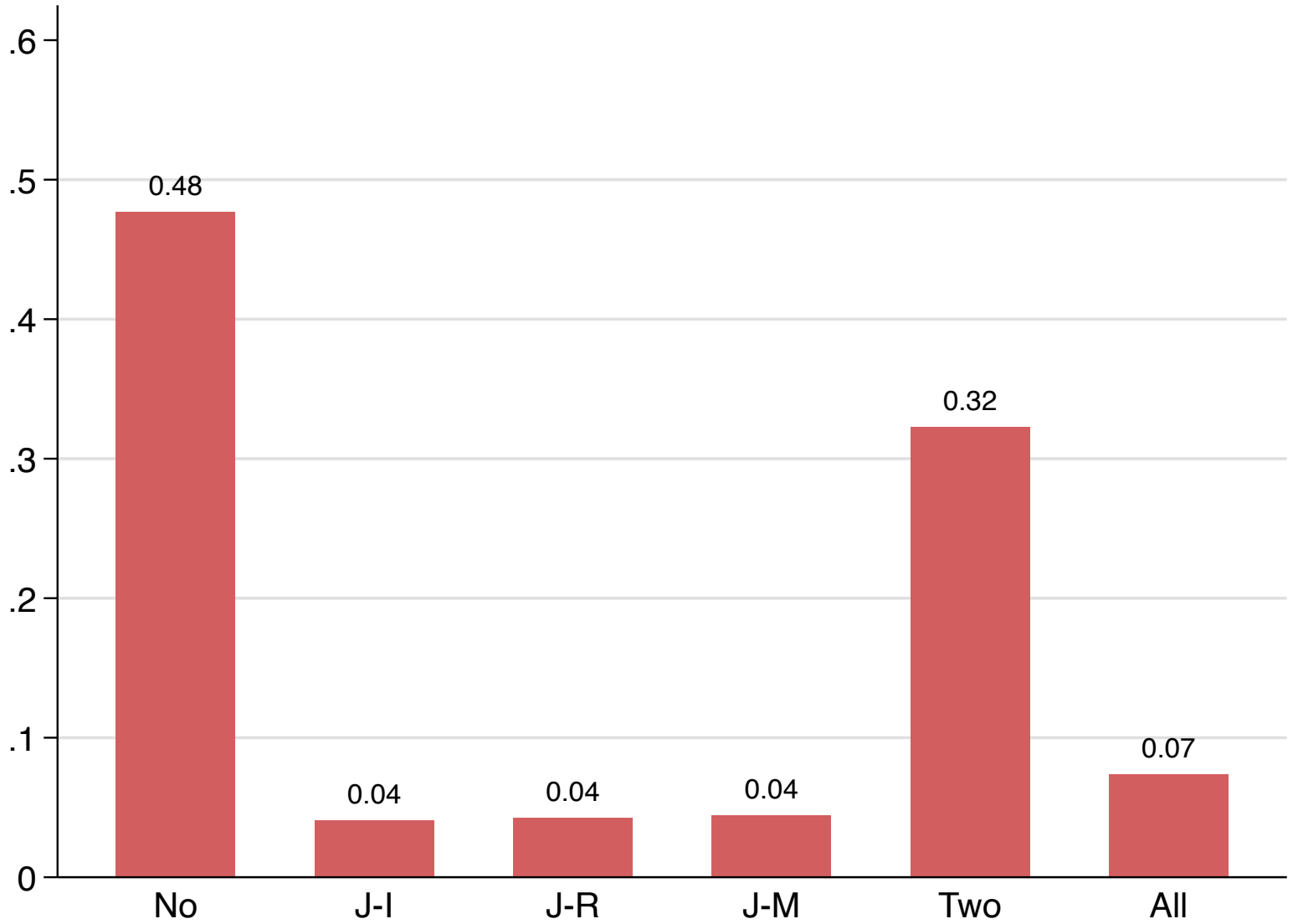
Room for Improvement

	Mean	St. Dev.
	(1)	(2)
TFPR	1.75	0.61
ROA	0.03	0.01
Inventory	15.37	6.24
% drafted workers	0.21	0.05
War production	0.56	0.50

- Low productivity and profitability
- Massive inventory (80% current assets)
- Disruption from WWII
  - $>$ 20% of workers drafted
  - $>$ 50% switch production

Notes. All monetary values are expressed in 2020 million USD. TFPR is log total factor productivity revenue (Ackerberg et al., 2015).

Distribution of Training Across 11,575 Applicants



Notes. Distribution of 11,575 applicant firms by type of training received.

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Event-study D-i-D Regressions

$$\begin{aligned} \text{outcome}_{it} &= \sum_{t=-5}^{10} \beta_t (\text{Training}_i \cdot \text{Year After Training}{=}\tau_{it}) \\ &+ \alpha \cdot \text{Training}_i + \text{Appl. Date}_i + \delta_{cst} + \epsilon_{it} \end{aligned}$$

- outcome_{it}: sales, TFPR, ROA
- Training_i is one for firms which received *one* training
- $\text{Years After Training}_{it} = 1$ τ year before/after receiving training
- Appl. Date_i: application window FEs + days from opening FEs
- δ_{cst}: county-sector-year fixed effects
- Standard errors clustered at subdistrict-application window level

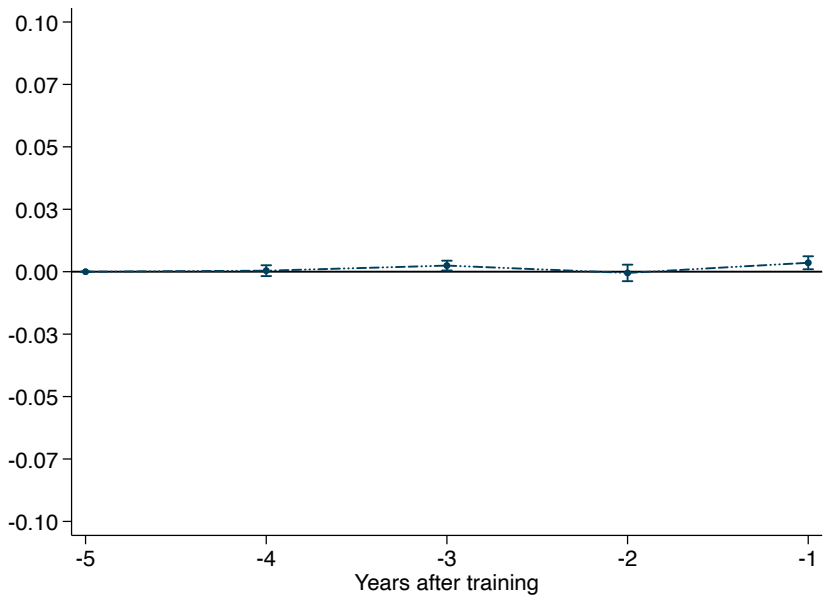
Testing the Identification Assumption

Main assumption: *Conditional on county-sector and application date, trained firms on a parallel trend than comparison firms without TWI program*

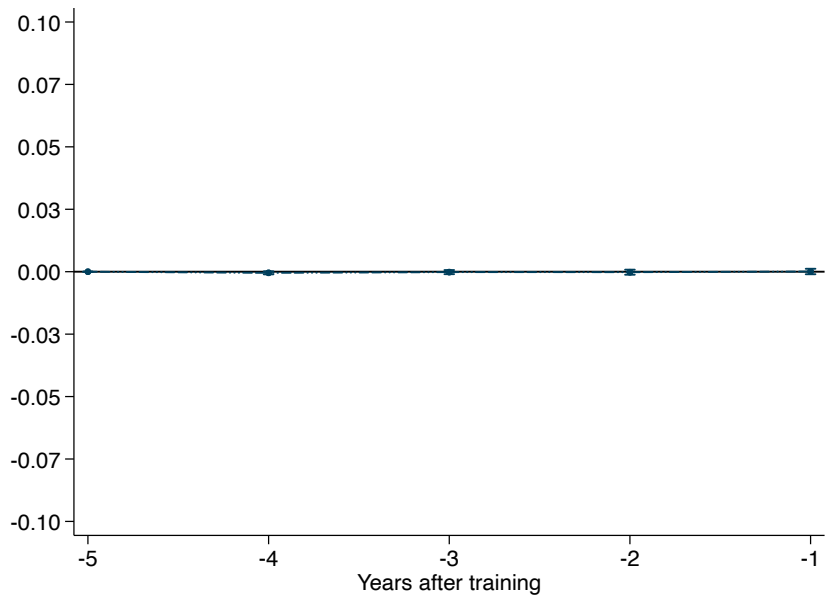
Not directly testable, but we can show:

1. Parallel trends before TWI program
2. Pre-TWI firm and county characteristics do not predict TWI training
3. No subdistrict-level autocorrelation in TWI trainings

1) Parallel Pre-TWI Trends



Panel A: Logged Annual Sales



Panel B: Logged TFPR

Notes. These graphs show the coefficients of the interactions between the treatment variables and pre-TWI period dummies. The omitted period is -5, five years before the delivery of the TWI training to treated firms.

2) Pre-TWI Firm and County Characteristics Do Not Predict Training

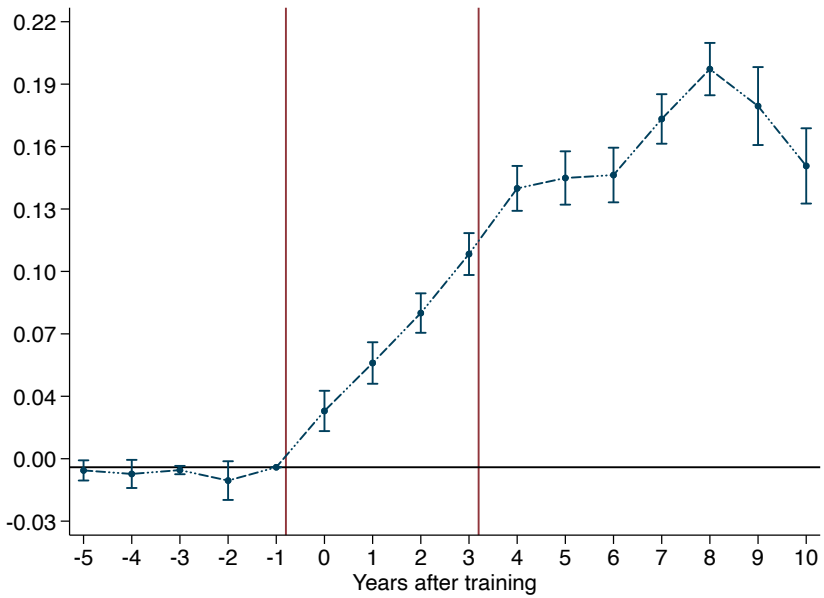
	Firm-Level	County-Level		
	Time t-1	1940	1930	1920
	(1)	(2)	(3)	(4)
p-value of joint significance	0.300	0.170	0.440	0.280
Observations	11,571	11,443	11,148	11,160

Notes. Firm-level variables are: log of TFPR, of sales, of employees, of ROA, of value added, of plants, of inventory, of capital, of current assets, of strikes, of subsidiaries, foundation year, and distance to nearest port. Standard errors are clustered at the subdistrict-application window level. County-level variables are: log of population, of area, of manufacturing value added, of manufacturing establishments, of manufacturing employees, of manufacturing wage, of total expenses in manufacturing, of value of manufacturing production, farms per capita, unemployment share (only in 1930 and 1940), population per square mile, share of male residents, of black population, of urban population, share of illiterate population (only in 1920 and 1930).

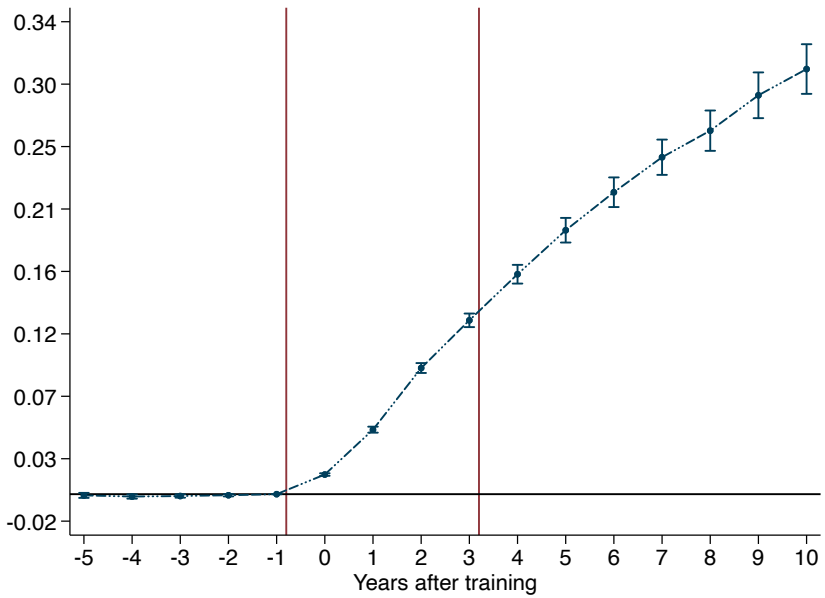
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Large and Persistent Effects of TWI Program



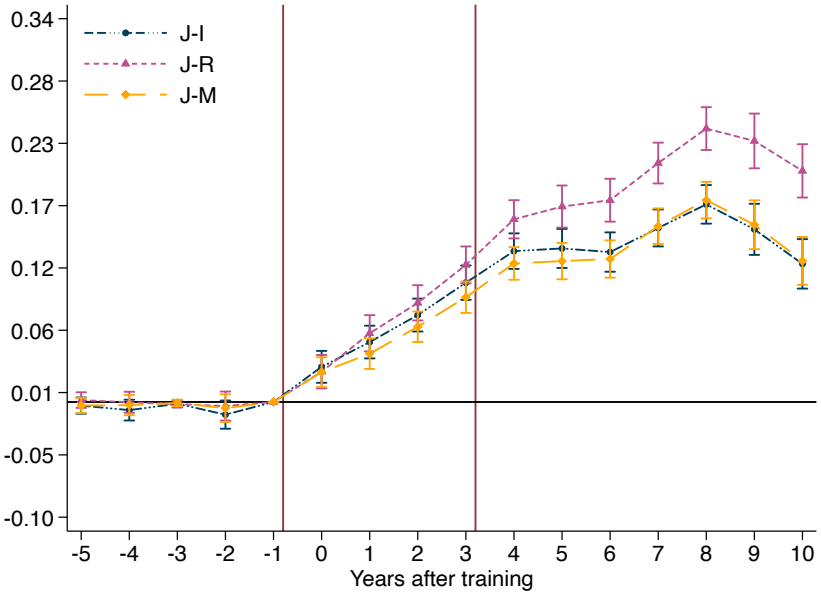
Logged Annual Sales



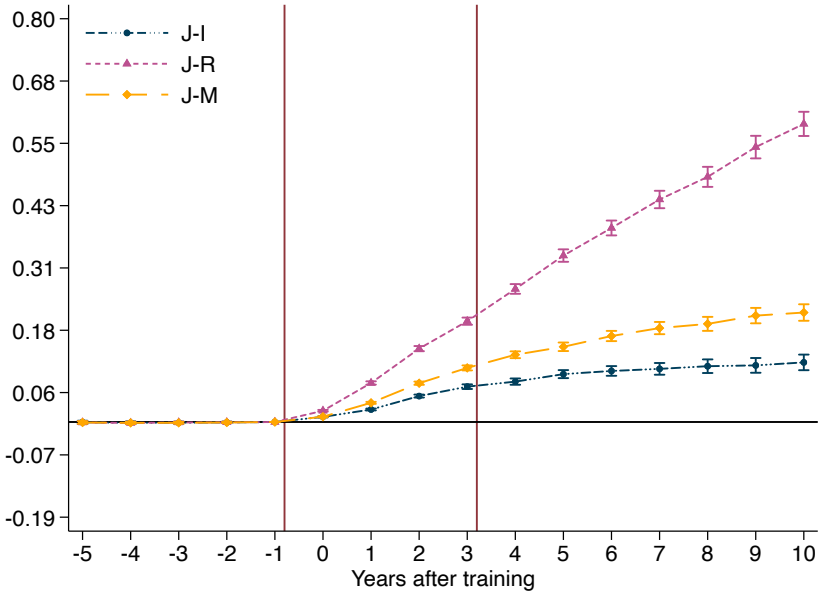
Logged TFPR

Notes. The sample used for these graphs includes applicant firms that either received only one TWI training or no training at all. The vertical bars denote 95 percent confidence intervals. The first vertical red line identifies the beginning of the TWI program. The second vertical red line identifies the end of World War II for most applicant firms (only 241 firms were still in the war period in period 4). The standard errors are clustered at the subdistrict-application window level.

Heterogenous Effects Across J-Modules



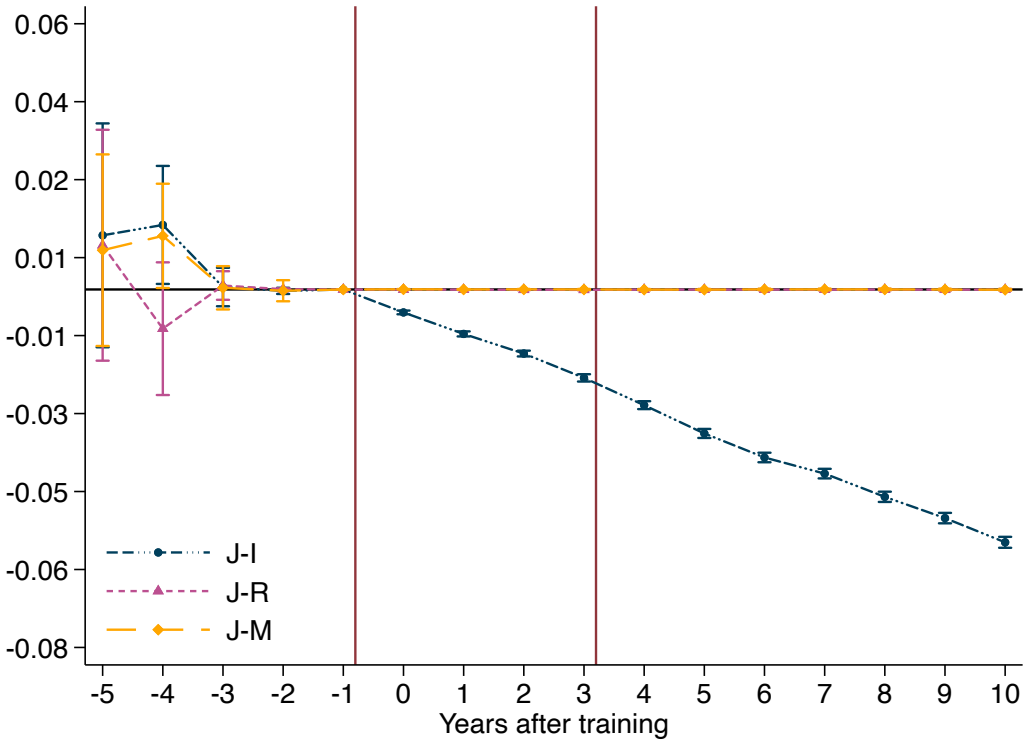
Logged Annual Sales



Logged TFPR

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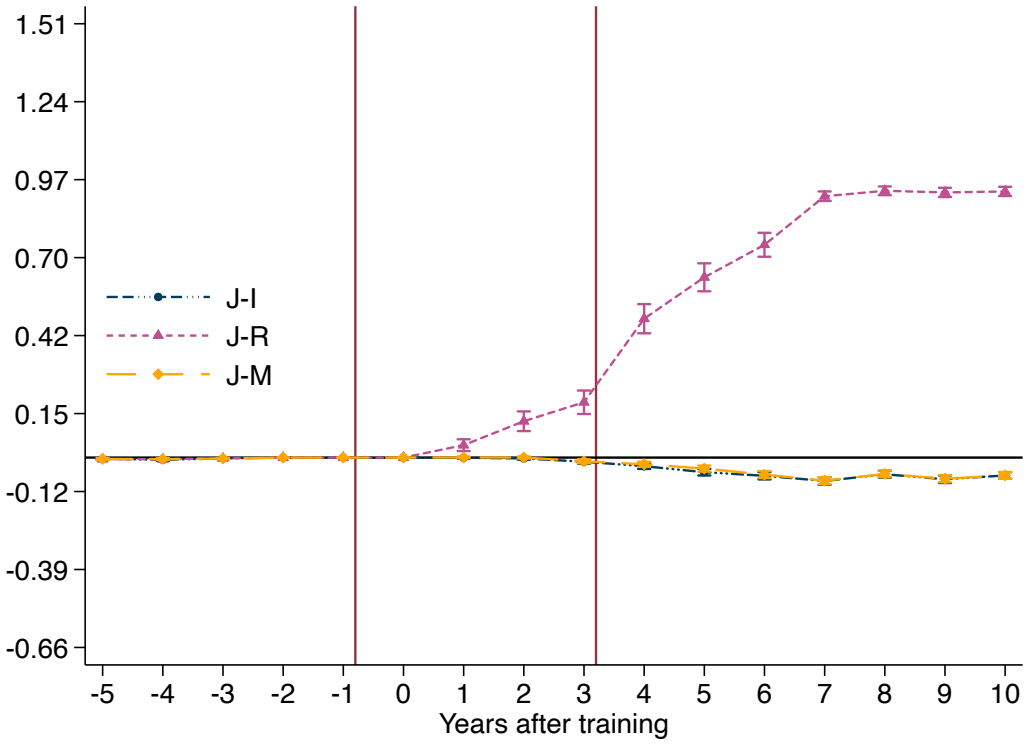
Changes in Mgmt Practices: J-I $\rightarrow$ Better Operations



Logged Machine Repairs

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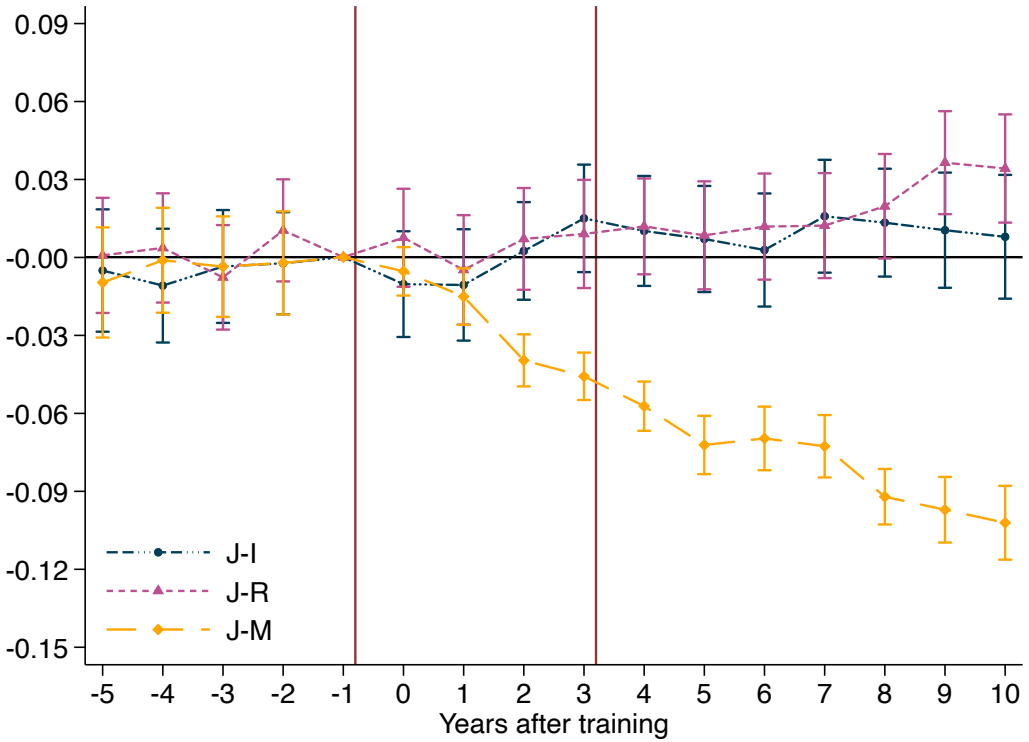
Changes in Mgmt Practices: J-R → More Worker Training



Logged Cost of Training

Notes. The sample used for these graphs includes applicant firms that either received only one TWI training or no training at all. The vertical bars denote 95 percent confidence intervals. The first vertical red line identifies the beginning of the TWI program. The second vertical red line identifies the end of World War II for most applicant firms (only 241 firms were still in the war period in period 4). The standard errors are clustered at the subdistrict-application window level.

Changes in Mgmt Practices: J-M → More Efficiency



Inventory

Notes. The sample used for these graphs includes applicant firms that either received only one TWI training or no training at all. The vertical bars denote 95 percent confidence intervals. The first vertical red line identifies the beginning of the TWI program. The second vertical red line identifies the end of World War II for most applicant firms (only 241 firms were still in the war period in period 4). The standard errors are clustered at the subdistrict-application window level.

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Effects on Firms *Already* in Supply Chain

	Firms in Supply Chain before TWI		
	J-I x Post	J-R x Post	J-Mx Post
	(1)	(2)	(3)
Log Sales	-0.001	0.009	0.005
	(0.011)	(0.012)	(0.012)
Log TFPR	0.076***	0.055**	0.060***
	(0.027)	(0.025)	(0.016)
Log Repairs	0.048	0.033	0.026
	(0.065)	(0.056)	(0.046)
Pr Training	-0.052*	0.431***	-0.035*
	(0.027)	(0.082)	(0.020)
Log Inventory	-0.025	-0.022	-0.413***
	(0.044)	(0.021)	(0.093)

Notes. The sample used for these graphs includes applicant firms that either received only one TWI training or no training at all. The standard errors are clustered at the subdistrict-application window level.

Better Selection of Firms in Supply Chain

	Log Sales	Log TFPR	Log ROA	Log Plants	Log Employees
J-R	0.016***	0.330***	-0.009	0.098***	0.099***
	(0.001)	(0.029)	(0.047)	(0.015)	(0.011)
J-I	0.018***	0.299***	0.002	0.0914***	0.092***
	(0.001)	(0.029)	(0.039)	(0.015)	(0.011)
J-M	0.018***	0.301***	-0.061	0.111***	0.112***
	(0.001)	(0.029)	(0.044)	(0.016)	(0.012)
Observations	686	686	686	686	686
R-squared	0.534	0.409	0.265	0.339	0.150

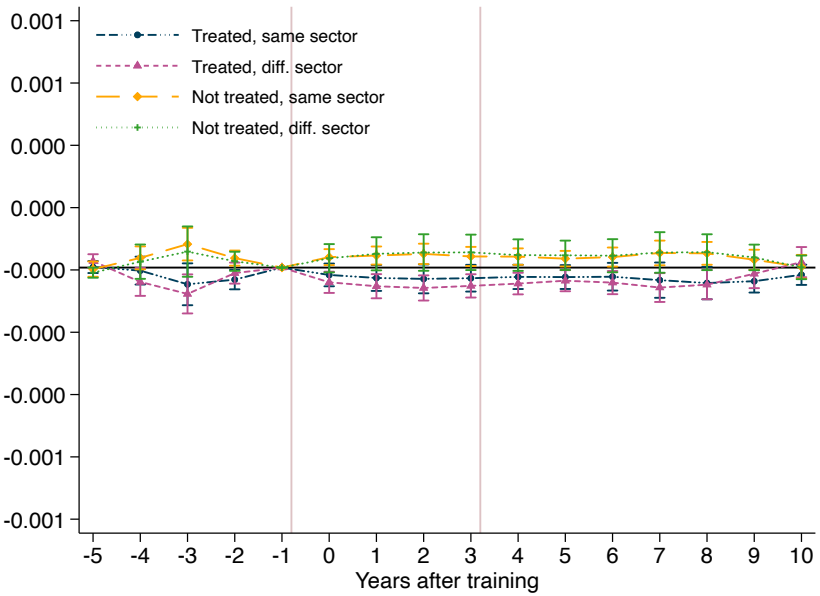
Notes. The sample used for these graphs includes applicant firms that either received only one TWI training or no training at all. The standard errors are clustered at the subdistrict-application window level.

Additional Improvements over Time

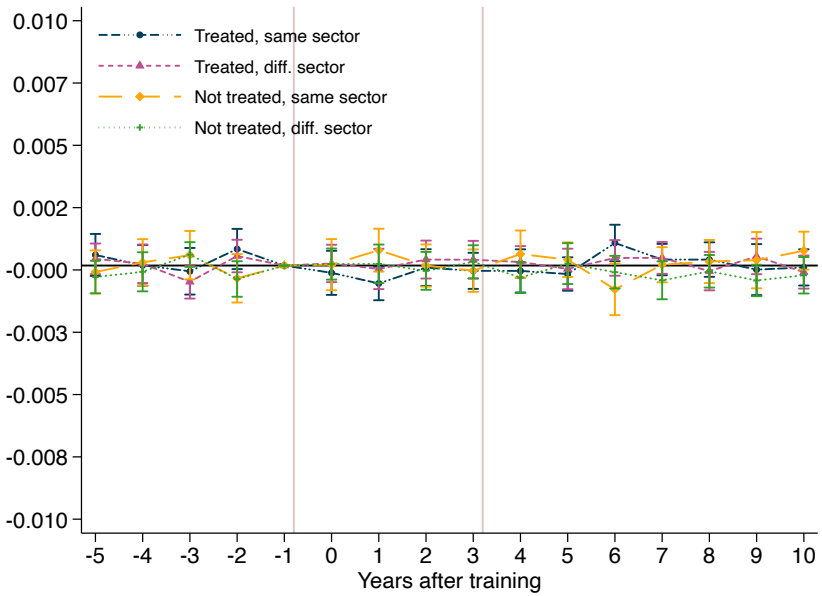
	Firms Entering Supply Chain after TWI		
	J-I x Post	J-R x Post	J-Mx Post
	(4)	(5)	(6)
Log Sales	-0.003	-0.001	-0.001
	(0.004)	(0.004)	(0.003)
Log TFPR	0.032**	0.052***	0.058***
	(0.014)	(0.015)	(0.012)
Log Repairs	-0.014	-0.006	0.003
	(0.042)	(0.038)	(0.039)
Pr Training	-0.040	0.536***	-0.029
	(0.052)	(0.062)	(0.036)
Log Inventory	-0.080**	-0.027	-0.523***
	(0.032)	(0.038)	(0.110)

Notes. The sample used for these graphs includes applicant firms that either received only one TWI training or no training at all. The standard errors are clustered at the subdistrict-application window level.

No Horizontal Spillover Effects



Logged Annual Sales



Logged TFPR

Notes. Standard errors are clustered at the subdistrict-application window level.

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Conclusions

Persistent effect of management training on firm performance

- Persistent adoption of different mgmt practices
- Vertical spillover effects
- No horizontal spillovers

External validity

- Business training programs largely used in developing countries
- Different sectors, not just heavy industry
- TWI program influenced post-WWII management training

Paper in a Nutshell and Additional Results

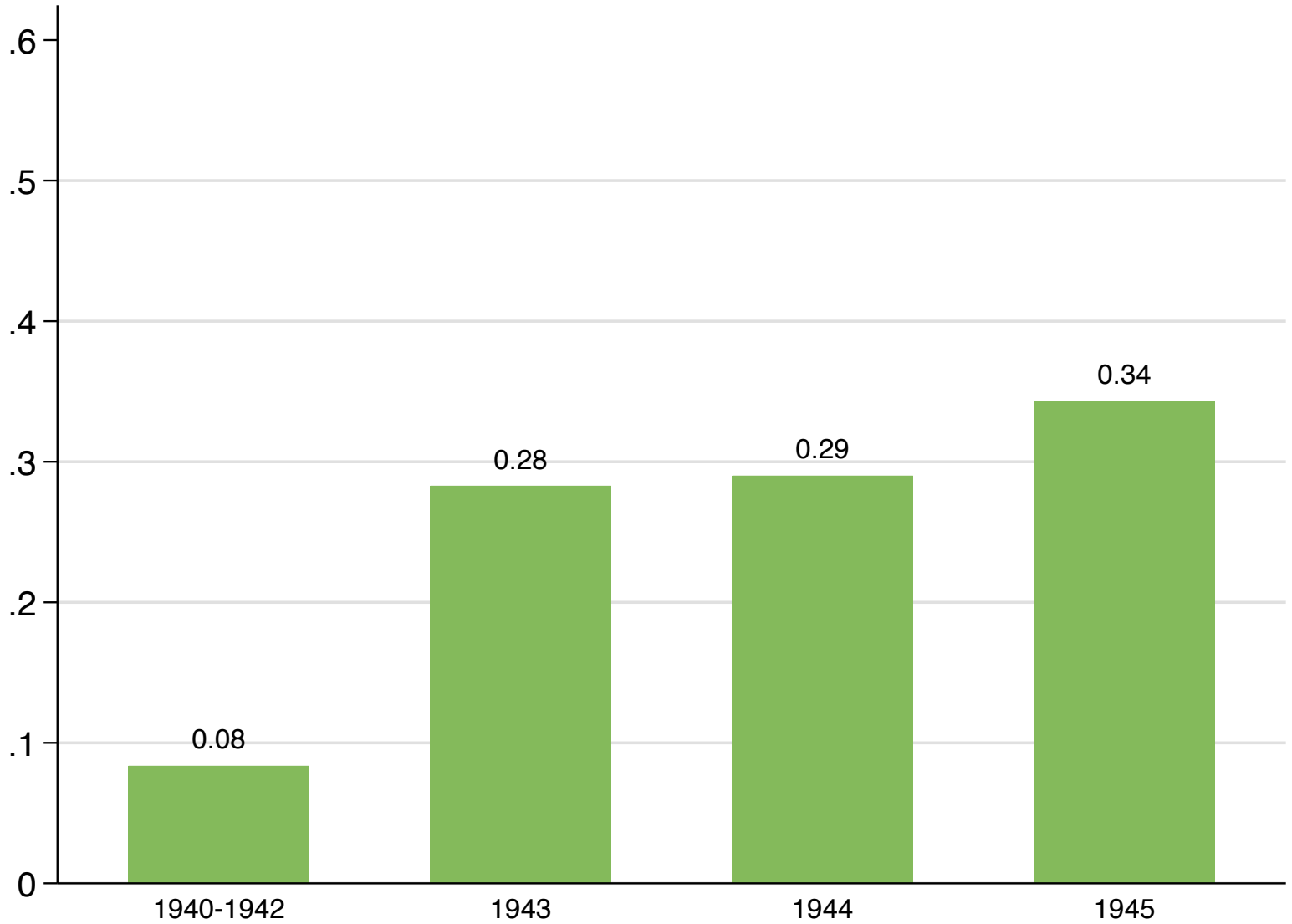
Persistent effect of management training on firm performance

- Persistent adoption of different mgmt practices
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Additional results

- Summary Statistics ▸ Results
- Identification ▸ Results
- Heterogenous Effects ▸ Results
- Robustness checks ▸ Results

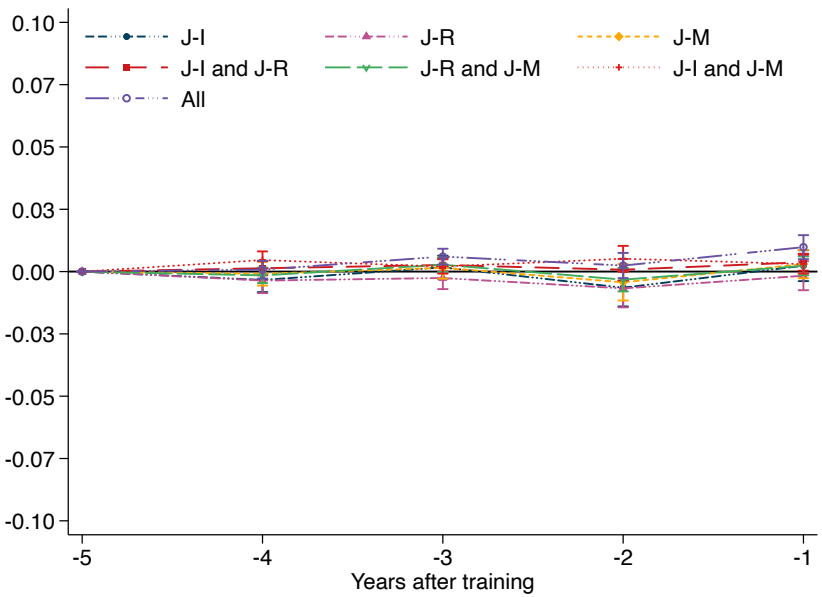
Distribution of Years of Treatment



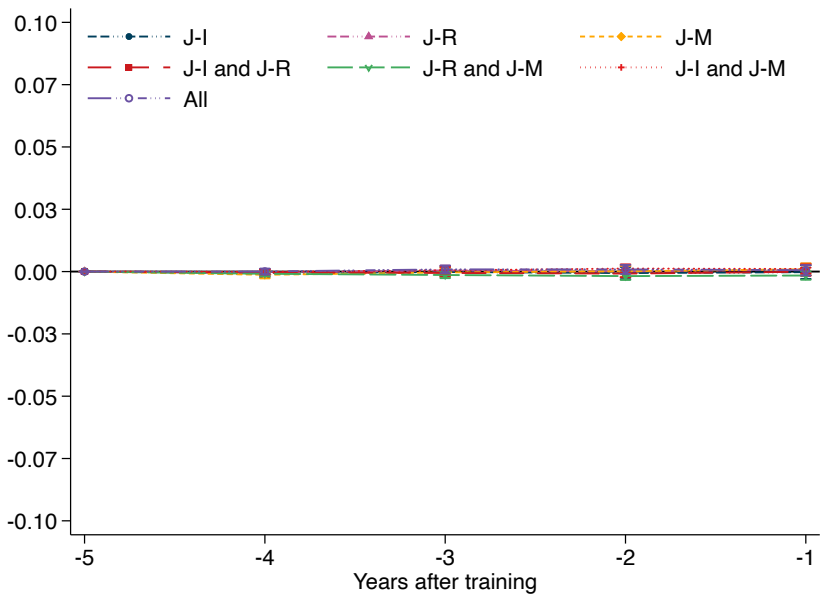
Notes. Distribution of 11,575 applicant firms by year of training.

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Pre-Trends by Treatment Types



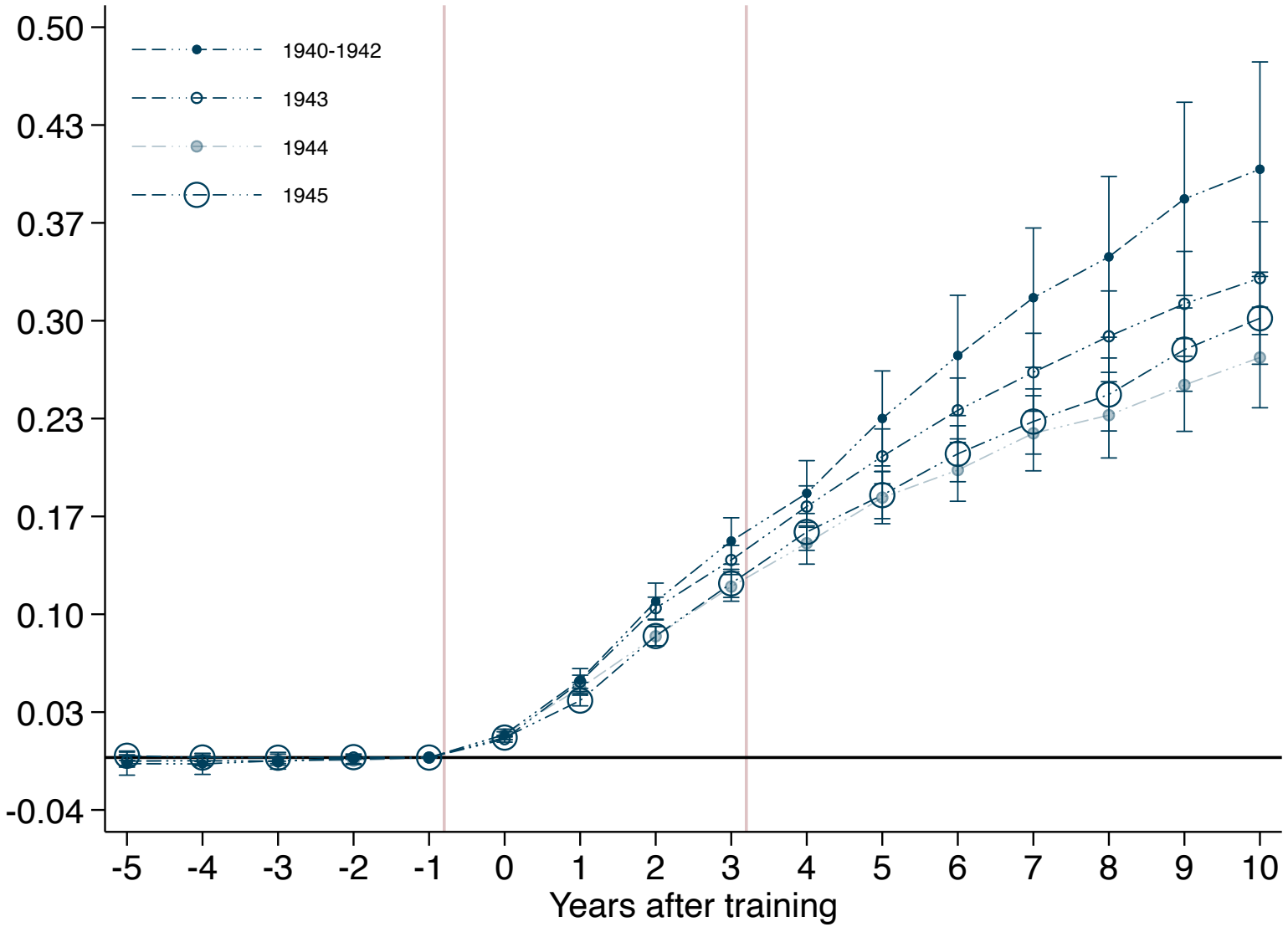
Logged Annual Sales



Logged TFPR

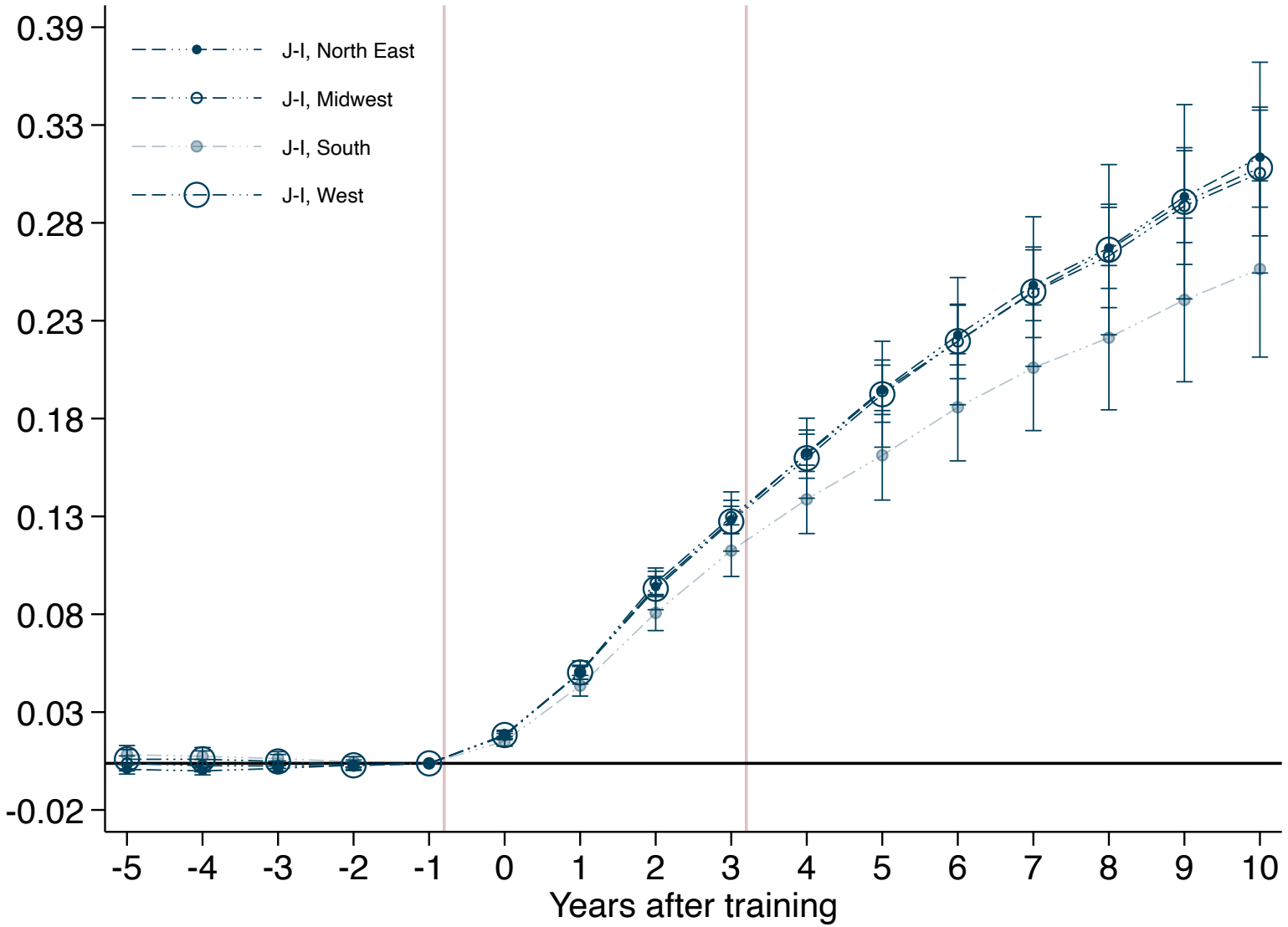
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Heterogenous Effects: by Years



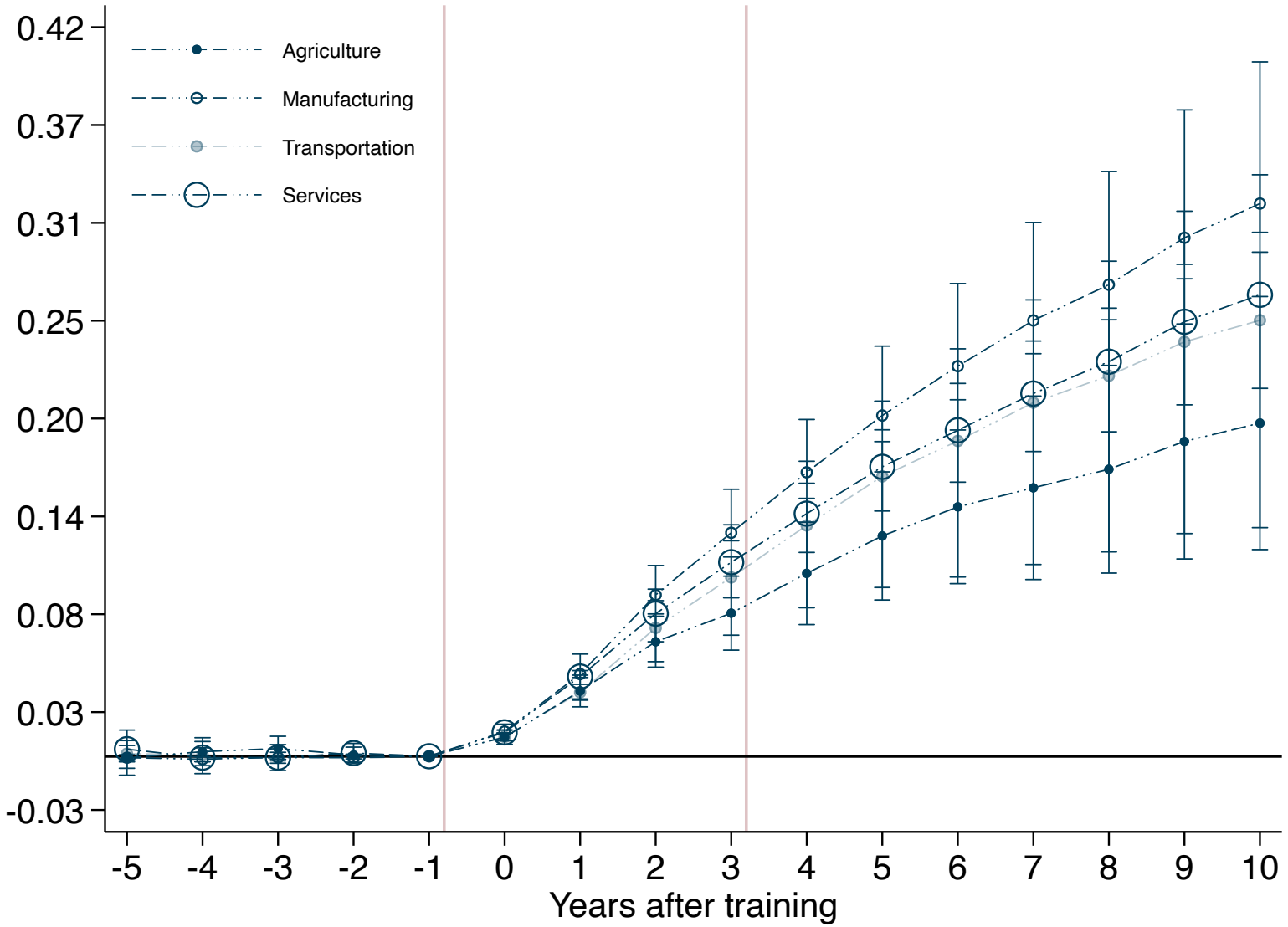
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Heterogenous Effects: by Geography



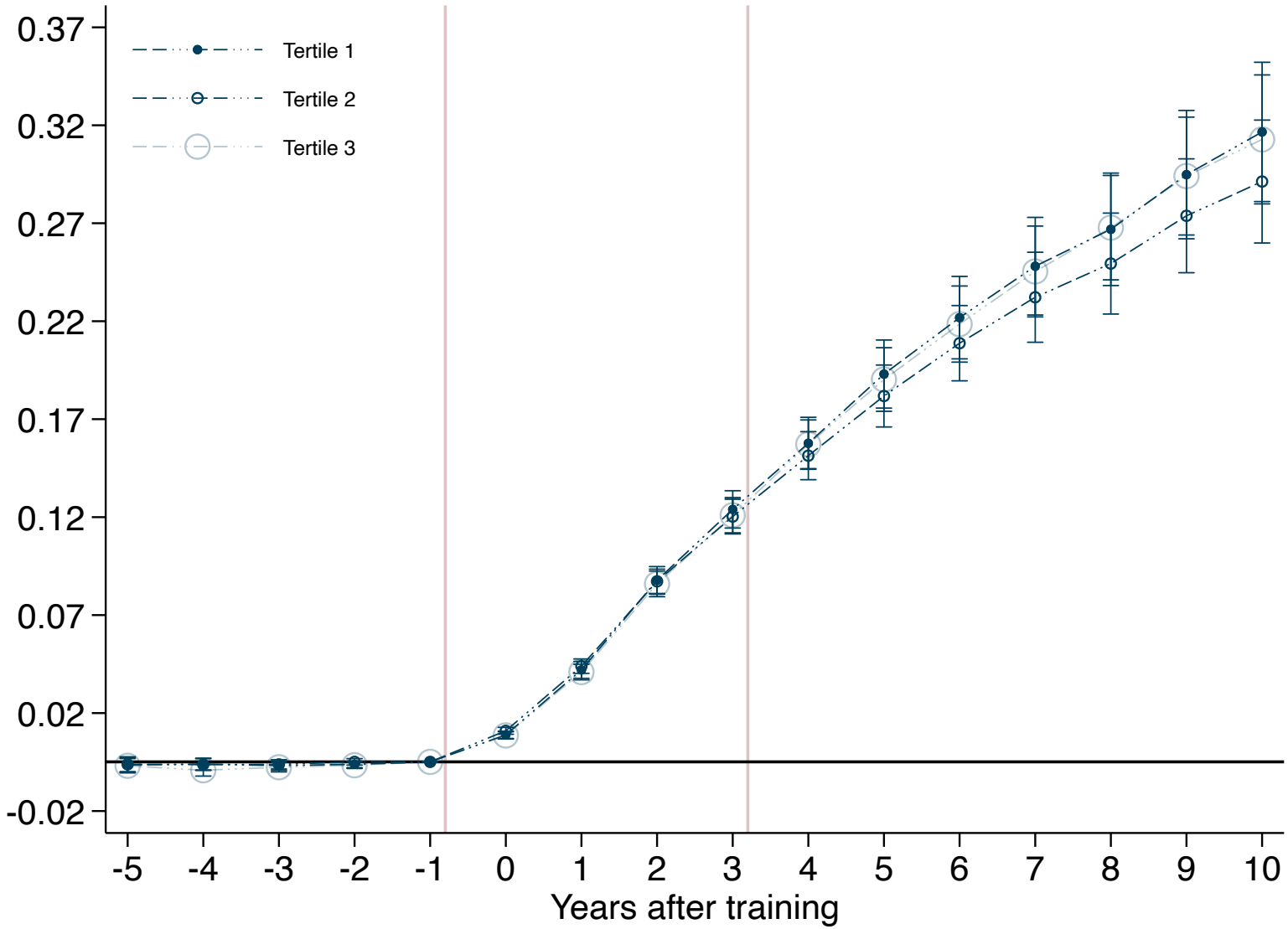
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Heterogenous Effects: by Sector



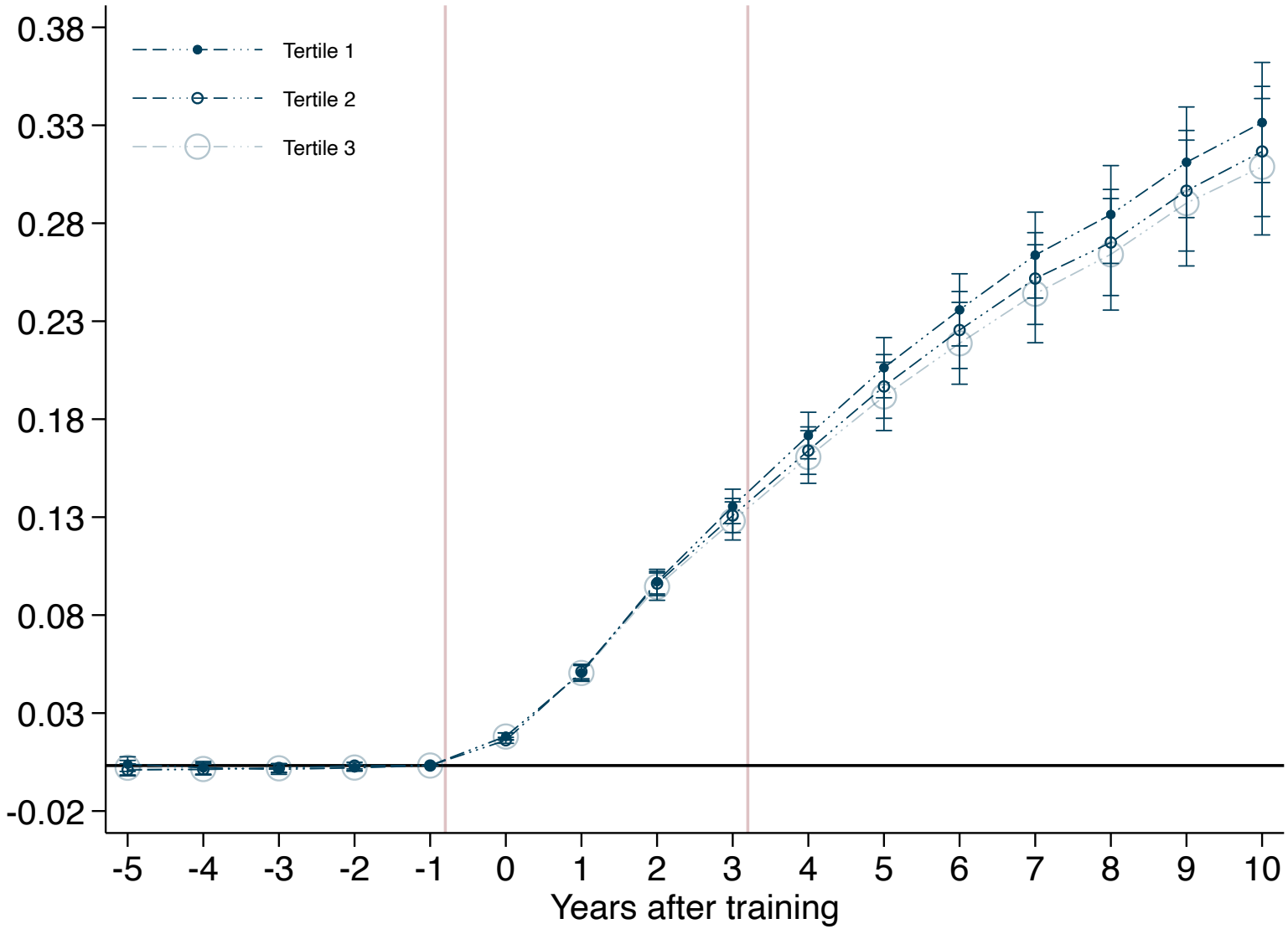
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Heterogenous Effects: by Draftees



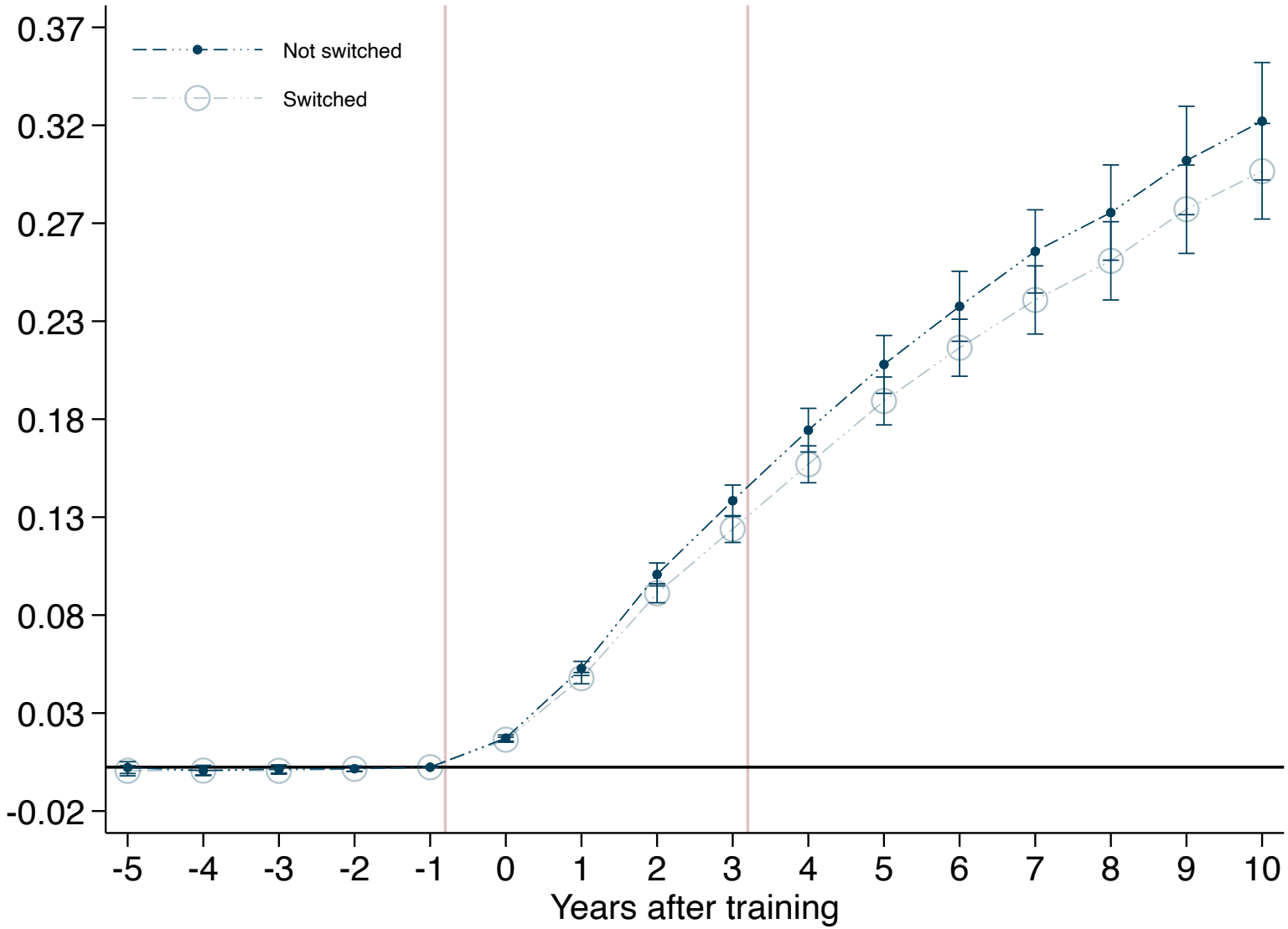
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Heterogenous Effects: by Managers



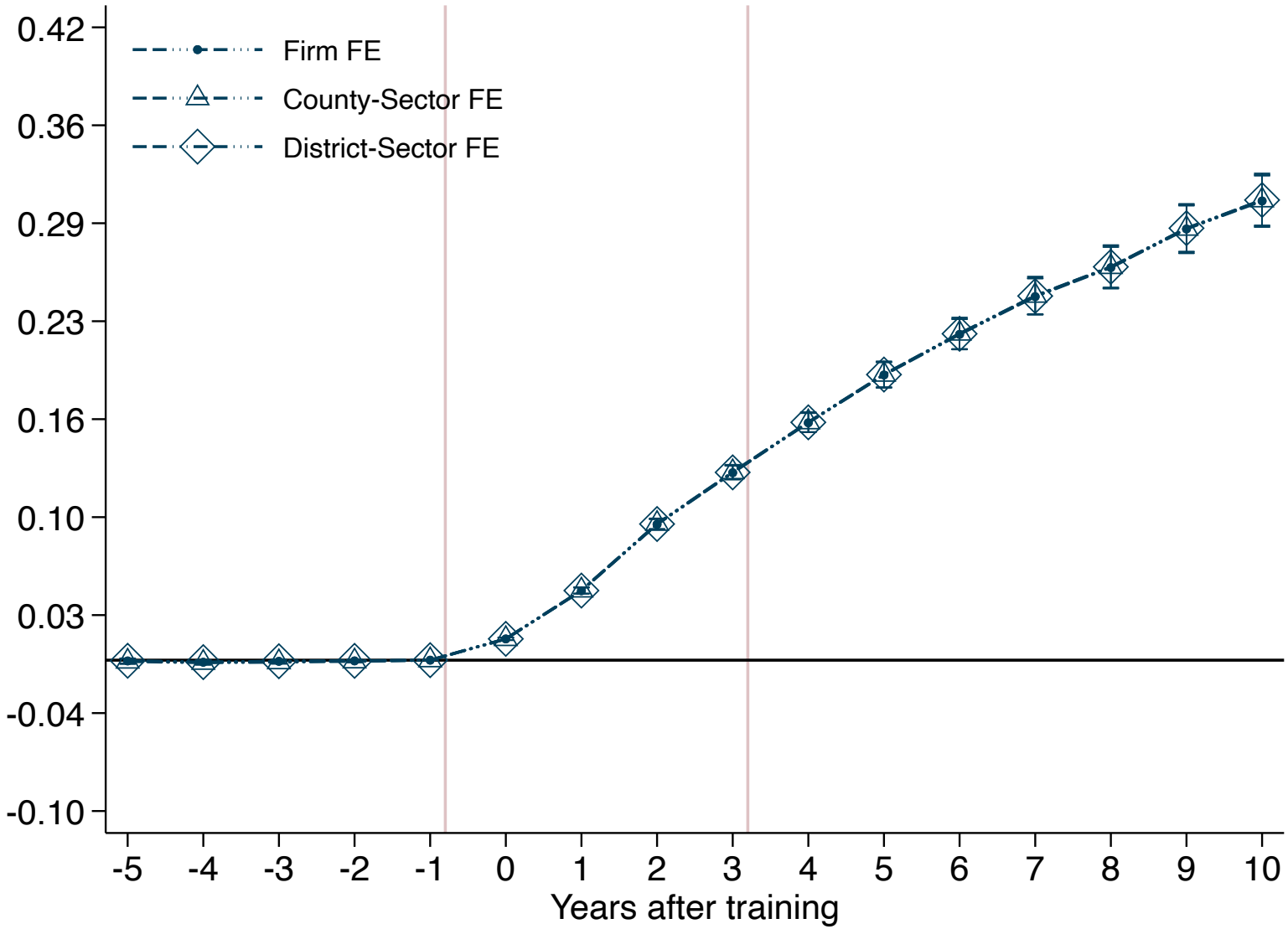
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Heterogenous Effects: by Switch to War Production



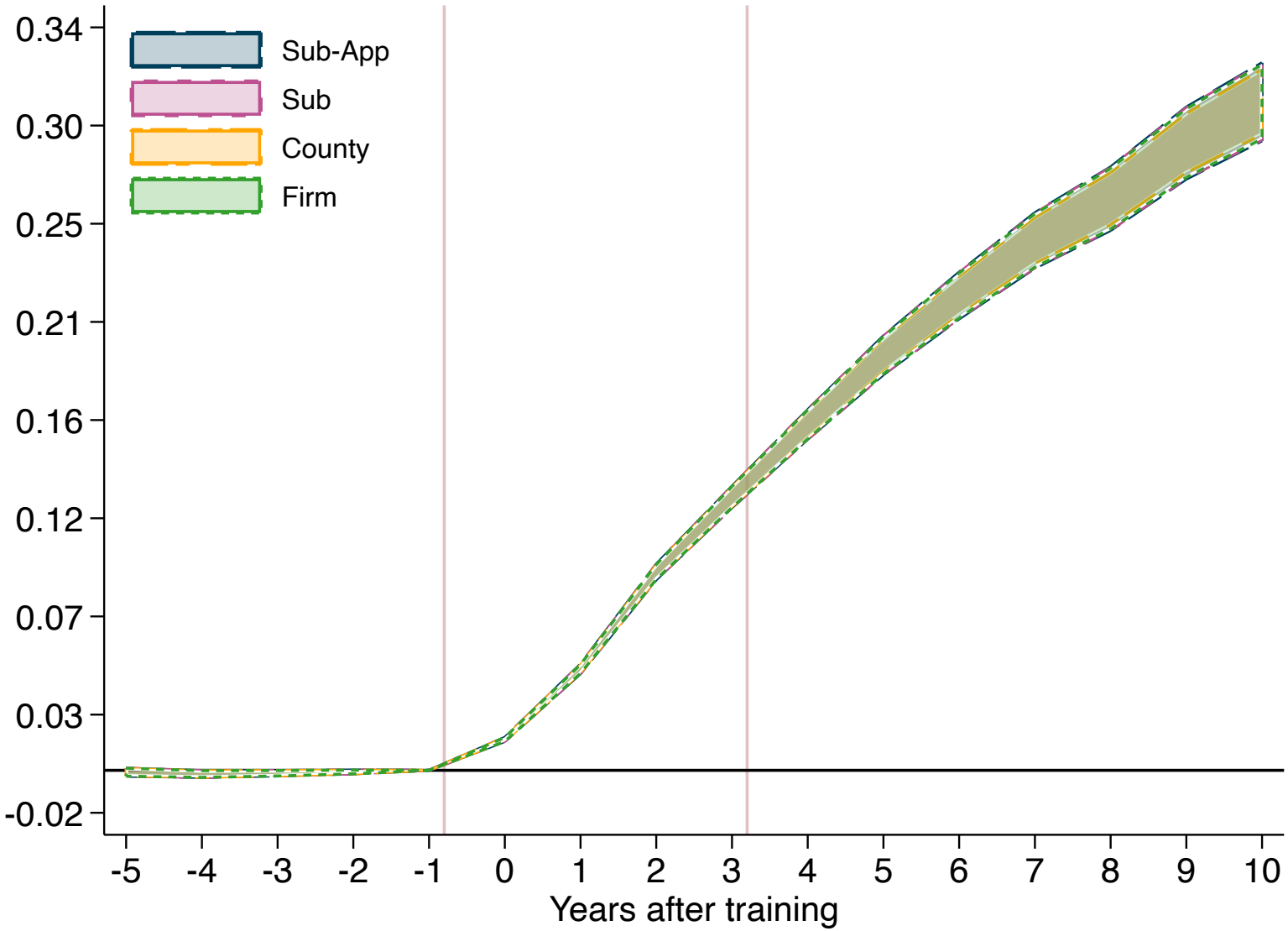
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Alternative Fixed Effects



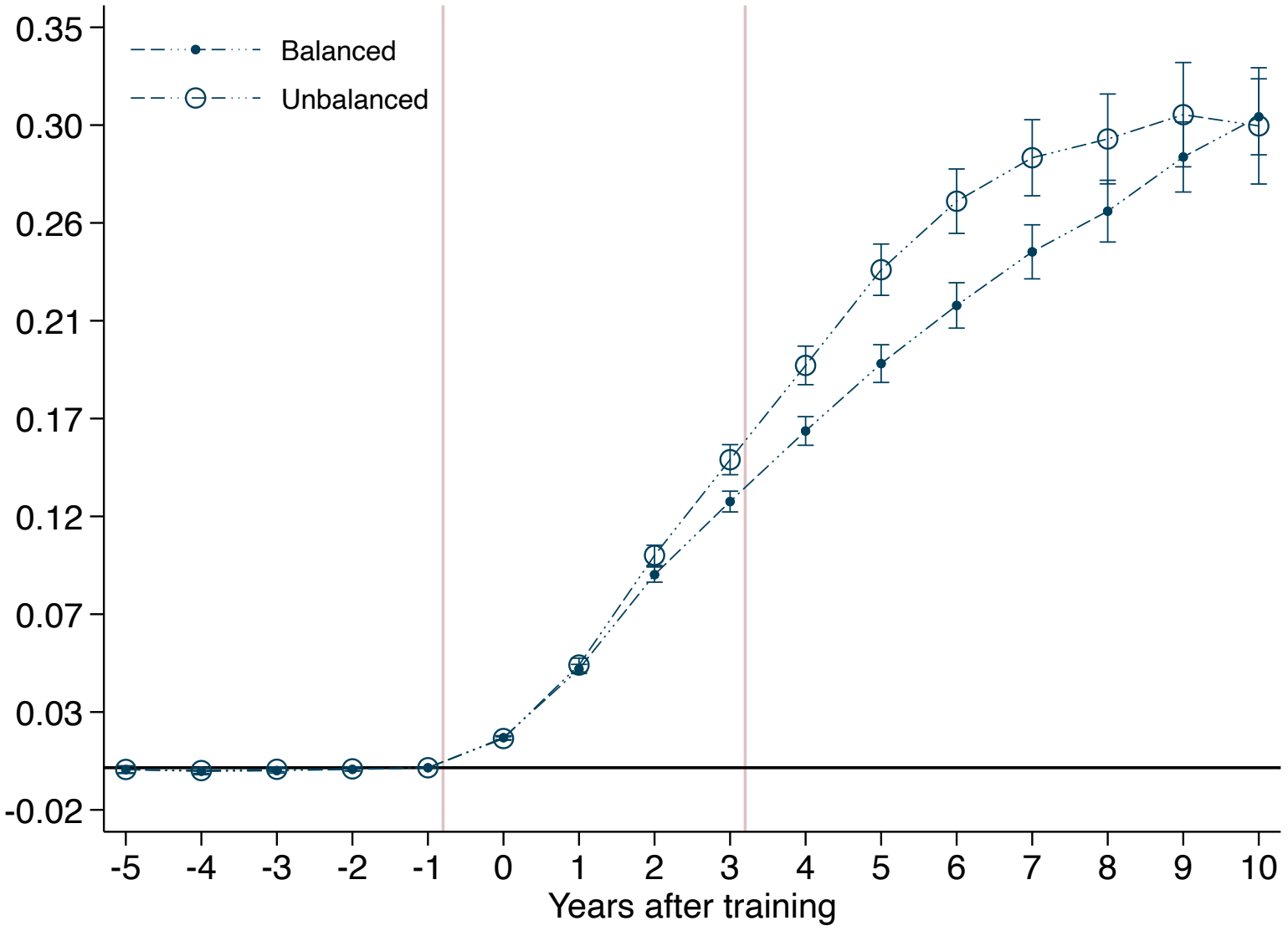
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Alternative Clustering



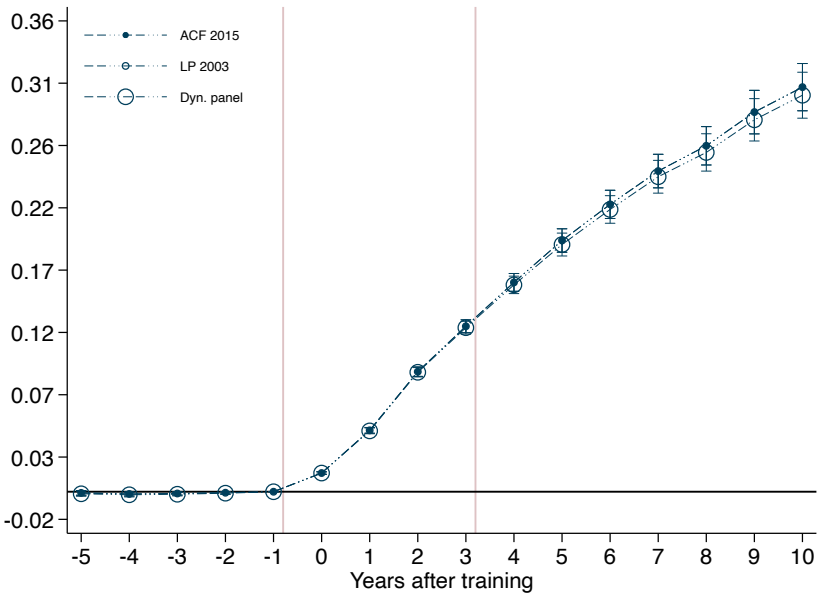
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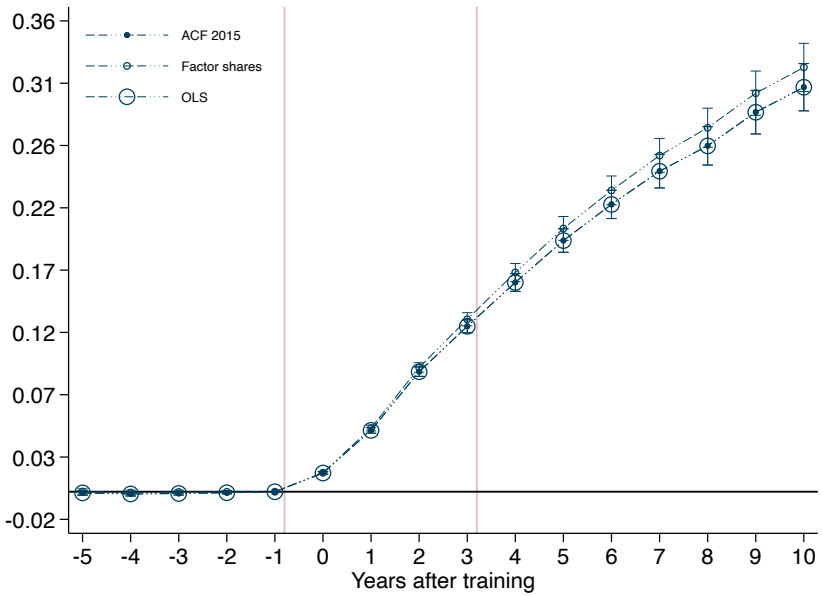
Unbalanced Panel



Back

TFPR


ACF 2015
LP 2003
Dyn. panel
0.36
0.31
0.26
0.22
0.17
0.12
0.07
0.03
-0.02
-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Years after training


ACF 2015
Factor shares
OLS
0.36
0.31
0.26
0.22
0.17
0.12
0.07
0.03
-0.02
-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
Years after training

◂ Back