

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

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2020 NBER Summer Institute
Development of American Economy
July 9, 2020

Motivation

Large productivity spread across time and within countries and sectors

- ▶ Correlated to managerial practices (Bloom and Van Rensselaer, 2007)
- ▶ Causal effects of training / consulting (Bloom et al., 2013; Bruhn et al., 2018)
- ▶ Persistent over time (Bloom et al., 2018; Giorcelli, 2019)

Dynamics of the effects

- ▶ Continuous improvements upon managerial practices adoption
- ▶ Complementarities among practices
- ▶ Depreciation of managerial capital

Spillover effects

- ▶ Managerial knowledge diffusion
- ▶ Increased competition and business stealing
- ▶ Little evidence of very large firms

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
- ▶ Firms divided in 364 geographical units (“subdistricts”)
- ▶ Could apply in 10 application windows

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)

Identification Strategy

Training provided by TWI instructors assigned to subdistricts over time

- ▶ Limited resources
- ▶ Hired full-time or part-time
- ▶ Specialized in only one J-module to speed up program delivery

Sources of variations:

- ▶ Within subdistrict across time; Across subdistricts within time
- ▶ Full- vs part-time instructors and J-module training
- ▶ Not correlated with firm or county characteristics

Delivery of TWI training to firms “as good as random”

- ▶ Being trained vs eventually not being trained
- ▶ Specific type (“J-module”) of training
- ▶ Multiple type of trainings

Effects of TWI Training on Firm Performance

Large and persistent effects on firm performance and structure

- ▶ 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., Bloom et al., 2020; Giorcelli, 2019; 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* → Sample 1 to 2 orders of magnitude larger
- ▶ *Measuring spillovers* → Large firms + data for vert./horiz. spillovers
- ▶ *Measuring trajectories over longer periods* → 10 years of levels/growth
- ▶ *Testing which elements of content matter* → 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., Garin, 2020; Koustas and Li, 2019; Brunet, 2019; Rhode et al., 2018; Fetter, 2016; Jaworski, 2014; Goldin and Olivetti, 2013; Collin, 2001; Acemoglu, Autor, and Lyle, 2004; Goldin, 1991)

First firm-level comprehensive analysis of the TWI

Outline

- ▶ Historical Background
- ▶ Data
- ▶ Empirical Specification
- ▶ Dynamic Effects of Management Training
- ▶ Spillover Effects
- ▶ Conclusions

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The Training Within Industry Program

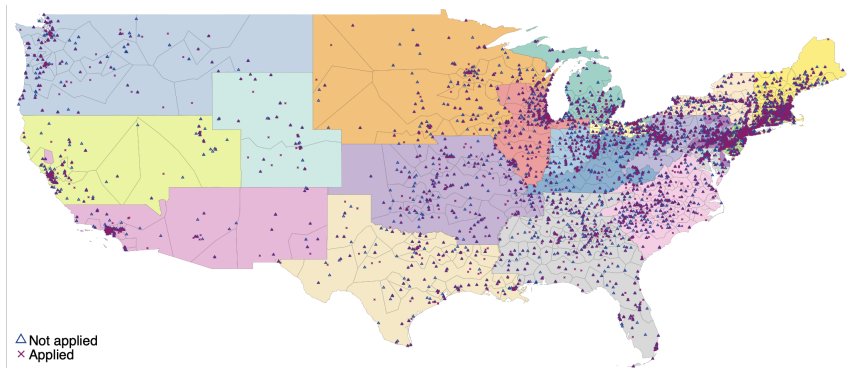
Management training program for US war contractors

- ▶ From August 1940 to September 1945
- ▶ Increasing firm production and productivity
- ▶ Training new workers to be immediately productive

Decentralized and voluntary program

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

11,575 Applicant and 11,536 Nonapplicant Firms



Notes: Applicant and nonapplicant US war contractors (1940-1945).

Content and Resources of TWI Program

Job-Instruction (J-I): → today factory operations

- ▶ 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.

Job-Relations (J-R): → today human resources management

- ▶ Better relations with workforce, job division, more funds allocated to on-the-job training, performance-based incentive systems

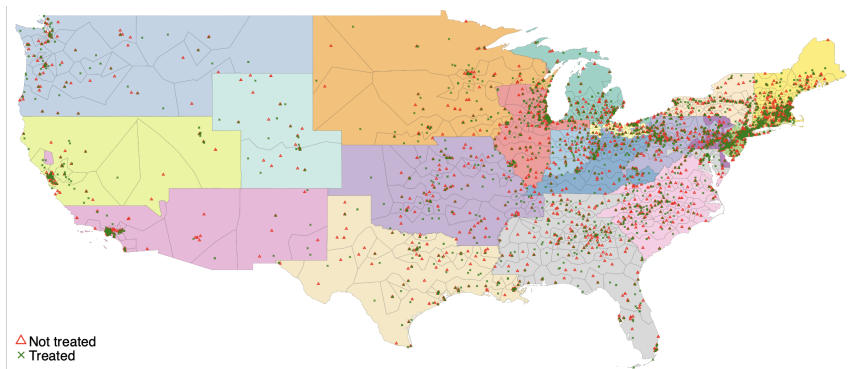
Job-Methods (J-M): → today inventory, sales, and order management

- ▶ Reduction of inventory, production planning, better prioritization of orders, more emphasis on marketing

Delivered at firm-level by TWI instructors:

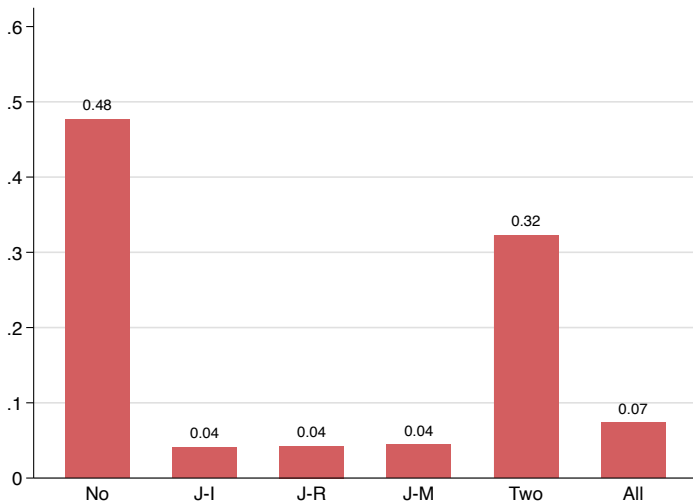
- ▶ Limited resources
- ▶ Hired full-time or part-time
- ▶ Specialized in only one J-module to speed up program delivery

Too Few Instructors → 52% of Applicant Firms Treated



Notes: 6,054 treated and 5,521 nontreated applicant US war contractors (1940-1945).

Specialized in one J-Module → Different Treatment Type



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

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Data Collection

War supply contracts from 1940 to 1945 (Koustan 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 manufacturing
- ▶ 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 (Akerberg et al., 2015).

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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
- ▶ Balanced panel from -5 to 10 years before/after TWI program
- ▶ Standard errors clustered at subdistrict-application window level

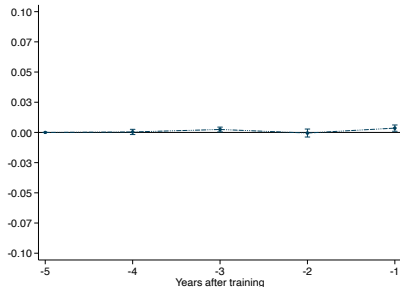
Testing the Identification Assumption

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

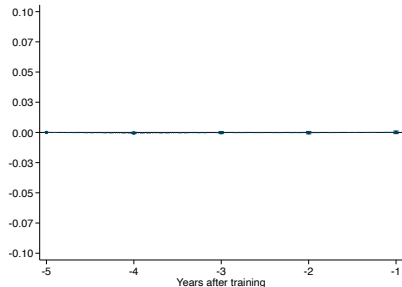
Not directly testable, but we can show:

1. Parallel trends before TWI program
2. Pre-TWI firm
3. County characteristics in 1940, 1930 and 1920 do not predict TWI training
4. 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.

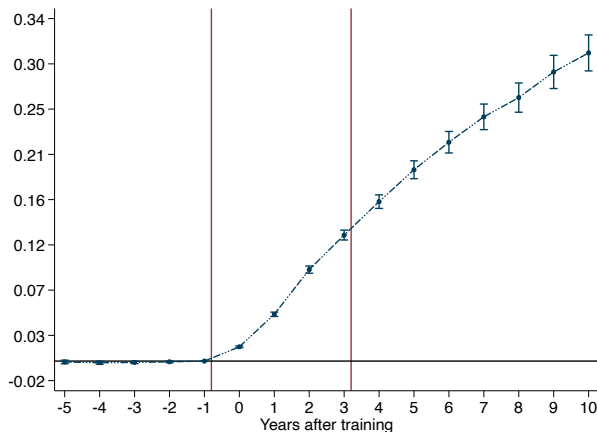
2) Pre-TWI Firm and County Characteristics Do Not Predict Training

	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 TFP, 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).

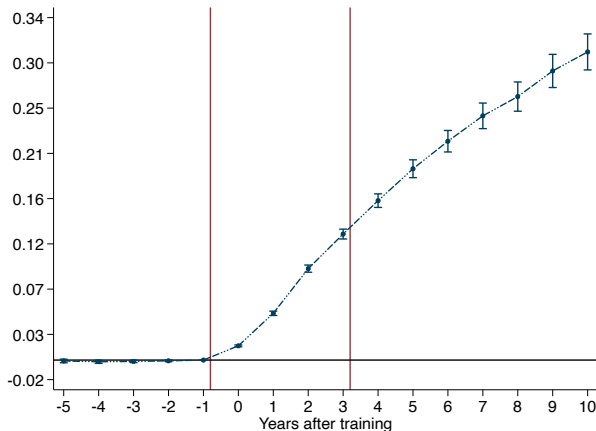
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Large and Persistent Effects: TFPR + 4.8% Year 1



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

Large and Persistent Effects: TFPR + 36% Year 10



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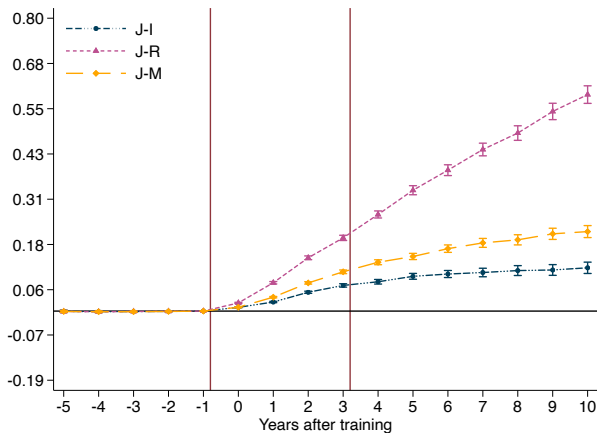
Change in Firm Structure

	Log sales	Log plants	Log employees	Log managers	Log subsidiaries
	(1)	(2)	(3)	(4)	(5)
Treatment x Period 1	0.028*** (0.005)	0.001*** (0.0003)	0.014*** (0.001)	0.012 (0.008)	-0.010 (0.009)
Treatment x Period 5	0.138*** (0.006)	0.026*** (0.002)	0.072*** (0.002)	0.050*** (0.008)	0.016* (0.009)
Treatment x Period 10	0.149*** (0.010)	0.062*** (0.003)	0.127*** (0.003)	0.109*** (0.008)	0.050*** (0.010)
Observations	67,472	67,472	67,472	67,472	67,472
R ²	0.186	0.144	0.150	0.142	0.136

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

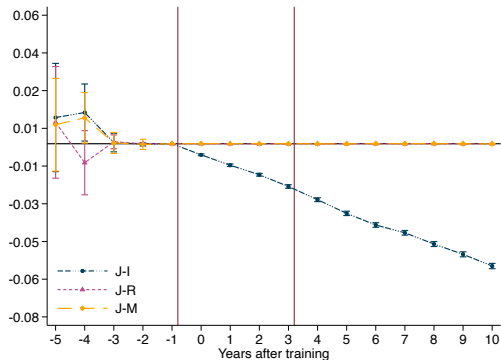
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Heterogenous Effects in TFPR Effects J-Modules



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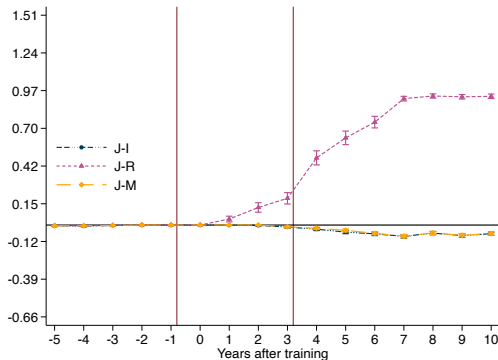
Changes in Mgmt Practices: J-I → Better Operations



Logged Machine Repairs

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.

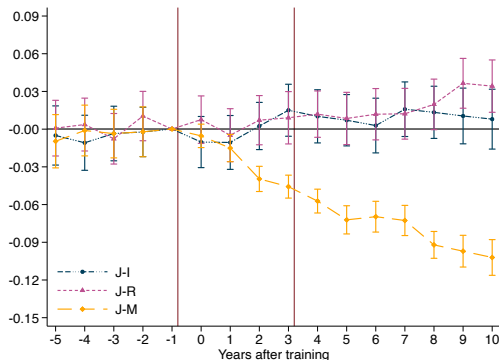
Changes in Mgmt Practices: J-R → More Worker Training



Pr of Reporting 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 \rightarrow More Efficiency



Logged Inventory

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Evidence of Complementarities

- ▶ Adoption of multiple practices easier → Toyota Way
- ▶ Additional effect of multiple J-modules

	Log repairs (1)	Log maintenance (2)	Log injuries (3)	Log bonus (4)	Log strikes (5)	Prob training (6)	Log inventory (7)	Log product lines (8)	Prob marketing (9)
J-I + other J x Post	0.006* (0.003)	-0.013*** (0.002)	0.007 (0.005)	0.002 (0.004)	0.107*** (0.003)	0.015*** (0.004)	-0.011** (0.005)	0.005 (0.005)	0.014*** (0.004)
J-R + other J x Post	0.000 (0.004)	-0.007*** (0.002)	0.004 (0.005)	-0.012*** (0.004)	-0.101*** (0.005)	0.026*** (0.009)	-0.006 (0.005)	-0.006 (0.005)	0.011*** (0.004)
J-M + other J x Post	0.004 (0.003)	0.006*** (0.002)	-0.004 (0.005)	-0.005* (0.003)	0.107*** (0.003)	0.029*** (0.004)	-0.007 (0.006)	0.066*** (0.006)	0.027*** (0.009)
Observations	134,288	134,288	134,288	134,288	134,288	134,288	134,288	134,288	134,288
R ²	0.101	0.098	0.101	0.210	0.177	0.615	0.395	0.552	0.627

Notes: The regressions also include the training variables in isolation, as well as fixed effects for county-sector-period combinations, the application window, and the number of days between the opening of the window and the firm application. The sample includes all applicant firms. Standard errors are clustered at the level of subdistricts and application windows.

- ▶ Historical Background
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- ▶ Identification Strategy
- ▶ Dynamic Effects of Management Training
- ▶ Spillover Effects
 - ▶ Vertical Spillovers
 - ▶ Horizontal Spillovers
- ▶ Conclusions

Positive 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 TFPR	0.076*** (0.027)	0.055** (0.025)	0.060*** (0.016)
Log Repairs	0.048 (0.065)	0.033 (0.056)	0.026 (0.046)
Pr Training	-0.052* (0.027)	0.431*** (0.082)	-0.035* (0.020)
Log Inventory	-0.025 (0.044)	-0.022 (0.021)	-0.413*** (0.093)

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

Some Evidence of Changes in Practices

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

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

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

Become More Productive over Time

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

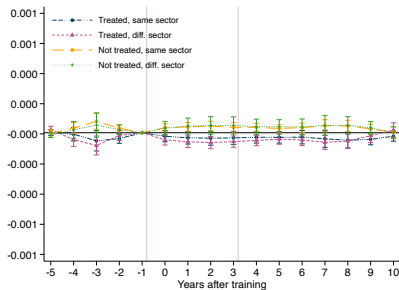
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Outline

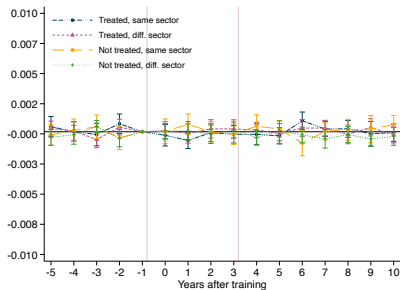
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No Horizontal Spillover Effects

- ▶ Sample: nonapplicant US war contractors
- ▶ Regress firm outcomes on (log) distance of applicants



Logged Annual Sales



Logged TFPR

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

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Persistent effects of management training on firm performance

- ▶ Change in firm structure + adoption of 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 effects of management training on firm performance

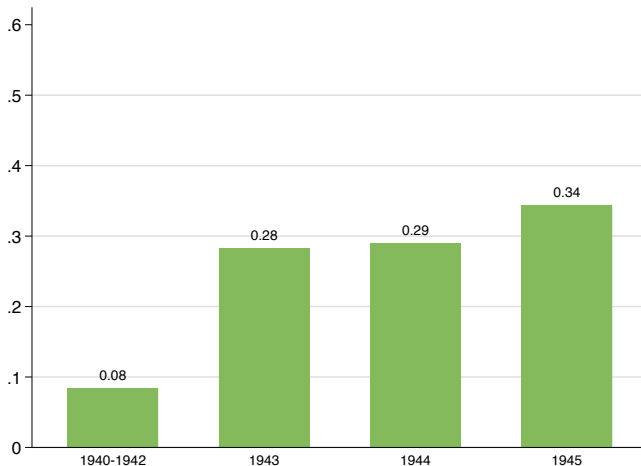
- ▶ Change in firm structure + adoption of practices
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Additional results

- ▶ Summary Statistics ▶ Results
- ▶ Identification ▶ Results
- ▶ Ruling Out Other Explanations ▶ Draft ▶ Managers ▶ Switch ▶ Government
- ▶ Magnitude of the Effects ▶ Results
- ▶ Heterogenous Effects ▶ Geography ▶ Sector ▶ Year
- ▶ Robustness checks ▶ FE ▶ Cluster ▶ Unbalanced ▶ Kaplan-Meyer ▶ TFPR

-UP SLIDES

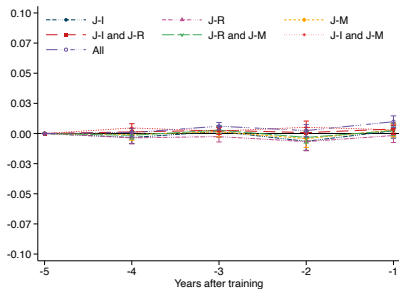
Distribution of Years of Treatment



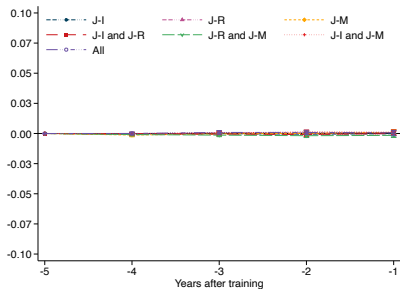
Notes. Distribution of 11,575 applicant firms by year of training.

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Pre-Trends by Treatment Types



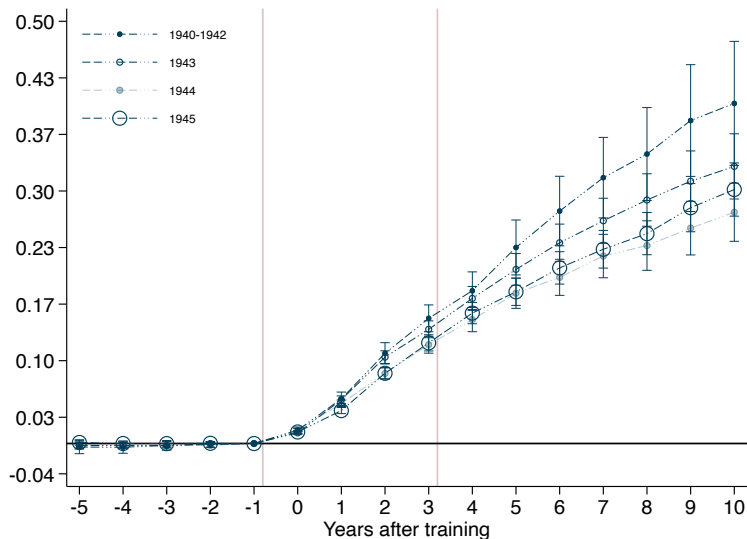
Logged Annual Sales



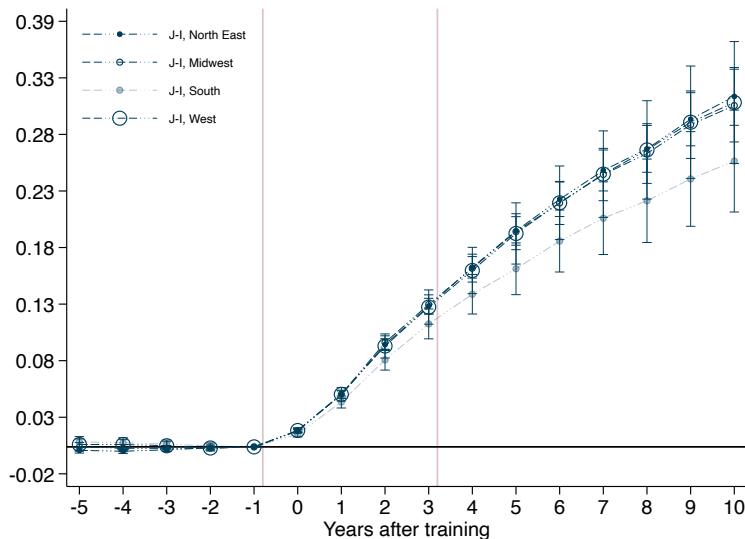
Logged TFPR

◀ Back

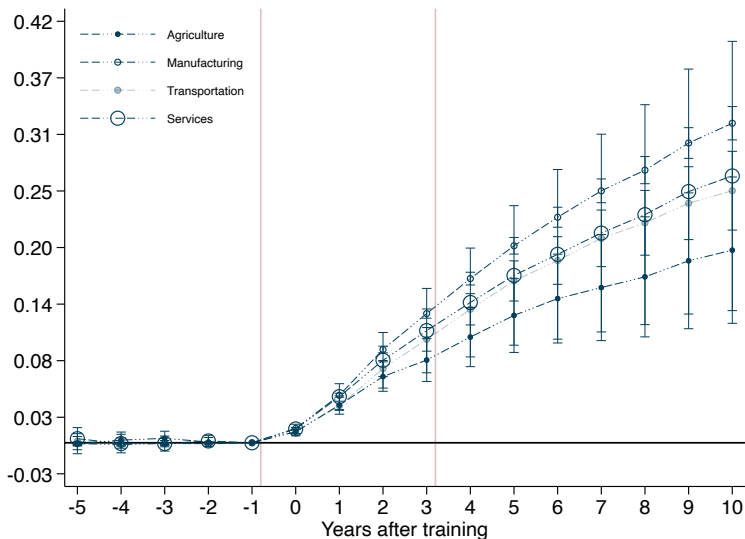
Heterogenous Effects: by Years



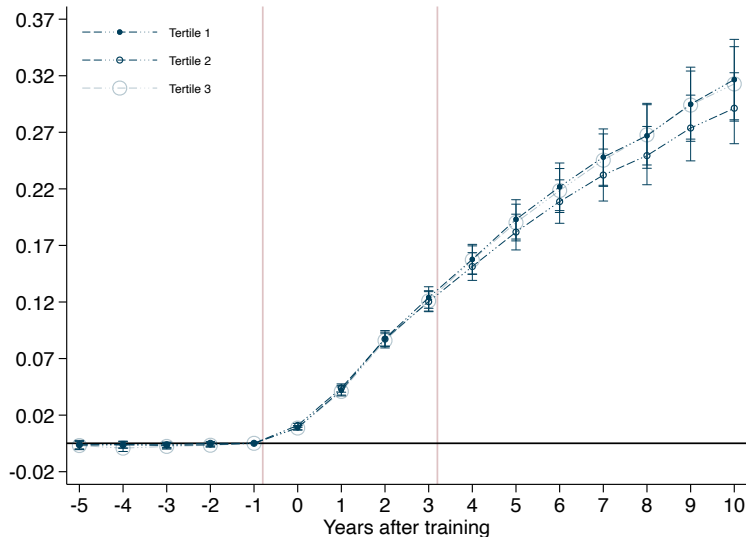
Heterogenous Effects: by Geography



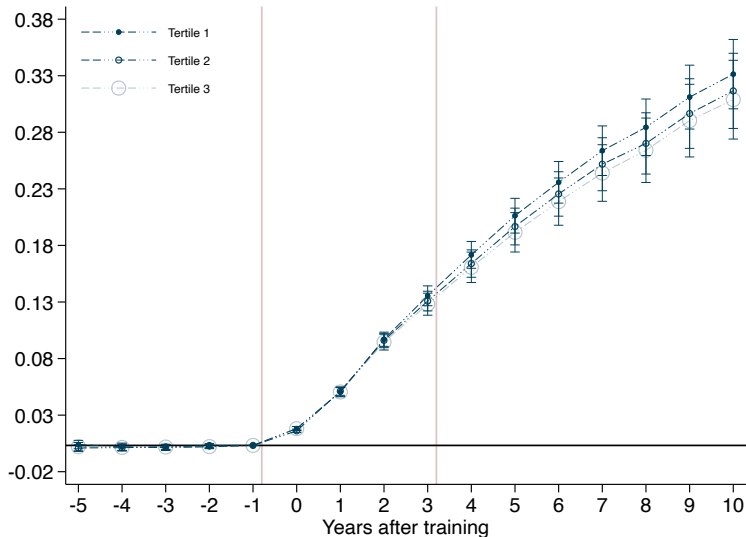
Heterogenous Effects: by Sector



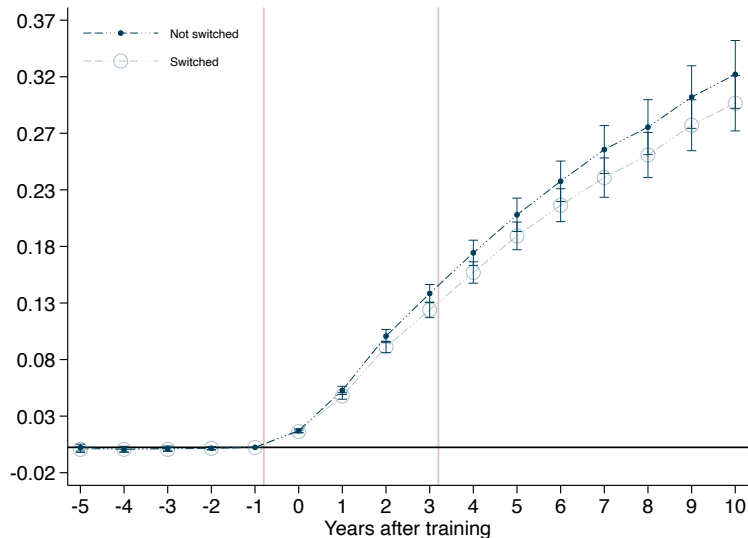
Heterogenous Effects: by Drafteres



Heterogenous Effects: by Managers



Heterogenous Effects: by Switch to War Production

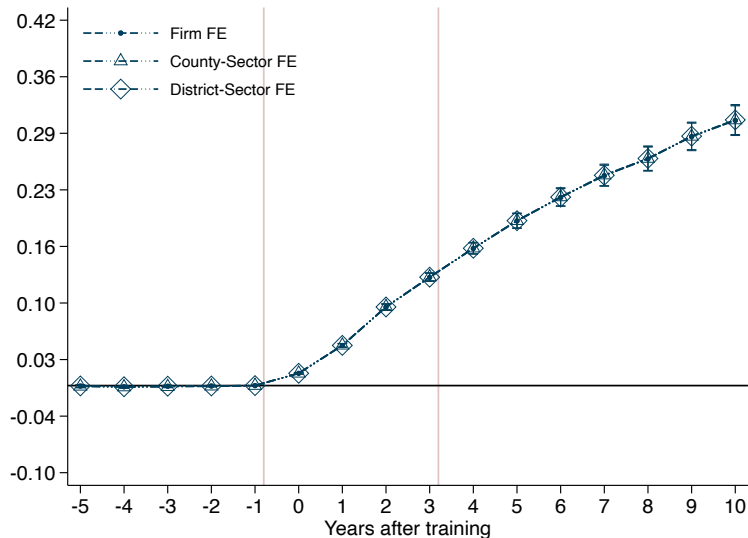


War Contracts and Post-WWII Refunds

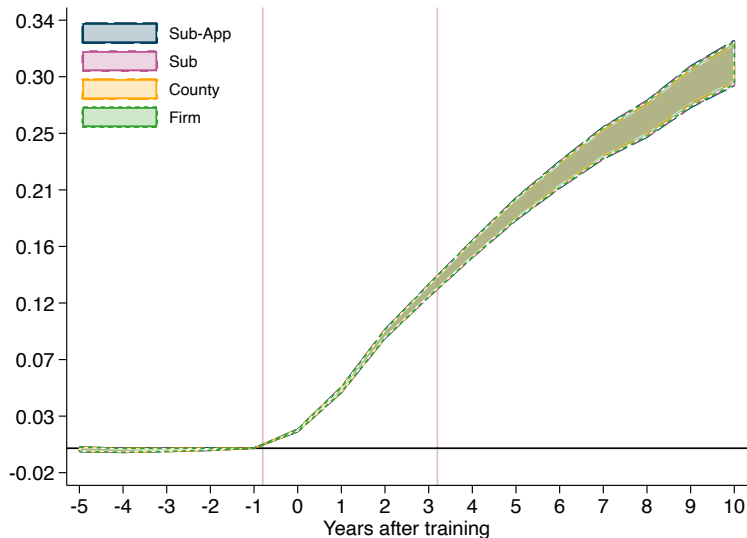
	Value contracts	Number contracts	Non-govt. sales	Non-govt. TFPR	Postwar refunds
	(1)	(2)	(3)	(4)	(5)
TWI x Post	-0.1278 (0.0906)	-0.0074 (0.0258)	0.0613*** (0.0102)	0.0502*** (0.0095)	
TWI					-0.0000 (0.0000)
Observations	7,207	7,207	16,636	16,636	20,388
R-squared	0.1882	0.2002	0.1631	0.1453	0.1310

◀ Back

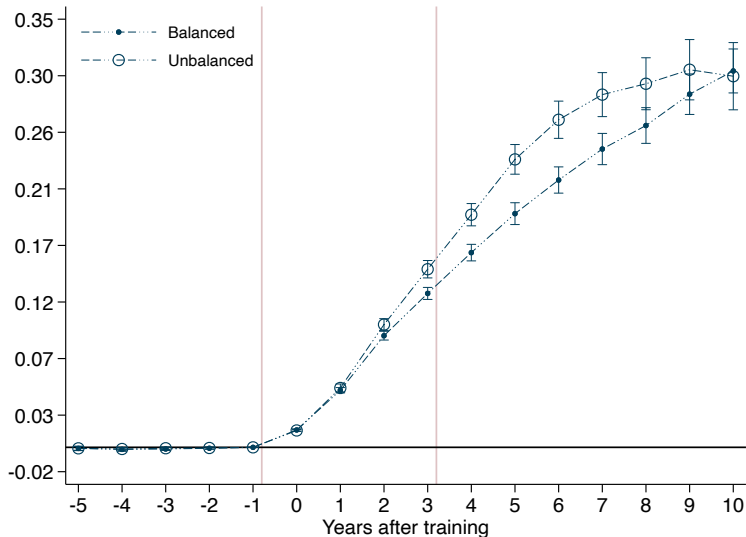
Alternative Fixed Effects



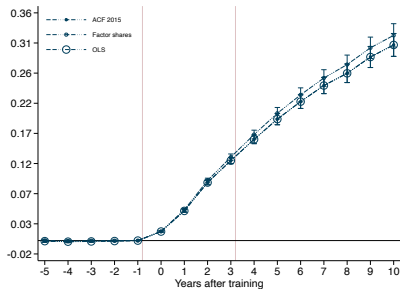
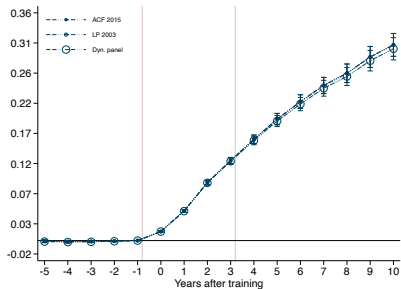
Alternative Clustering



Unbalanced Panel

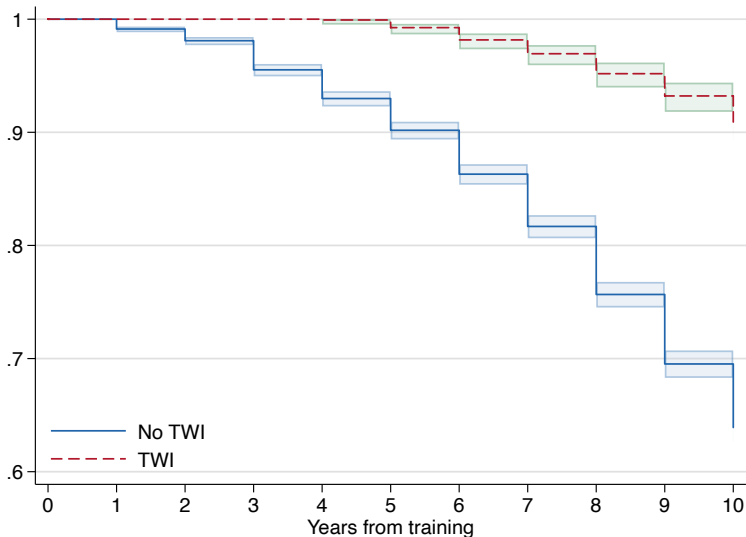


Different TFPR Estimation Methods

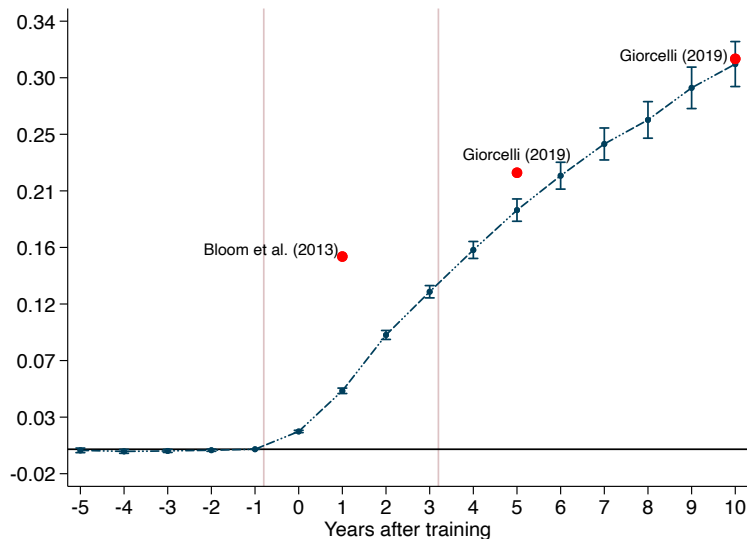


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Kaplan-Meier Survival Function



Comparison of Results Magnitude: TFPR



Comparison of Results Magnitude: Sales

