Not All Management Training Is Created Equal: Evidence from the Training Within Industry Program

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Abstract: This paper examines the effects of management practices on firm performance, using evidence from the Training Within Industry (TWI) program. The TWI plan was a business training program implemented by the U.S. government between 1940 and 1945 to provide management training to firms involved in war production. Using newly collected panel data on all 11,575 U.S. firms that applied to the program, we estimate its causal effects by exploiting quasi-random variation in the allocation of instructors to firms. We find that receiving any TWI training had a positive effect on firm performance. Training in human resources management had the largest impact and was complementary to other management practices. Finally, we document substantial heterogeneity in the effects of the program depending on whether top or middle managers were trained. (*JEL:* L2, M2, N34, N64, O32, O33)

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1 Introduction

A vast literature in labor economics has documented large and persistent differences in productivity across establishments in both developed and developing countries (Syverson, 2004; Foster, Haltiwanger and Syverson, 2008; Hsieh and Klenow, 2009), which are strongly correlated with the adoption of managerial practices (Ichniowski, Shaw and Prennushi, 1997; Bloom and Van Reenen, 2007). More recent papers have shown that management has causal effects on firm performance (Bloom et al., 2013; Bruhn, Dean and Schoar, 2018; Cai and Szeidl, 2017; Giorcelli, 2019). However, most of the available evidence comes from relatively small-scale randomized controlled trials (RCTs) that teach a bundle of managerial practices, usually only to top executives or owner-managers. The small number of targeted firms might make it difficult to infer the outcome of a larger-scale implementation, to measure heterogeneous effects, or to identify spillovers onto nontargeted firms. It can also be challenging to disentangle the separate effects of each managerial practice on firm performance and to evaluate their complementarity. Moreover, little is known about whether the effects of managerial training differ when it targets lower ranked managers. Addressing these issues would inform the design of both public and private policies that intend to increase firm productivity.

This paper examines the individual and complementary effects of different managerial practices on firm performance, using evidence from a unique historical episode, the Training Within Industry (TWI) program. The TWI program was a business training program implemented by the U.S. government between 1940 and 1945 with the purpose of providing management training to firms involved in war production. It reached 11,575 U.S. firms across different economic sectors and geographical areas. The program offered in-plant training, provided separately to top and middle managers, in three main areas of business management: factory operations (OP), human resources management (HR), and inventory, order, and sales management (IO).[1]

We use newly collected panel data on the population of 11,575 U.S. firms that applied to the TWI program. For each firm, we collected balance sheets and statements of profits

[1] OP involved establishing standard procedures for industrial operations. HR involved establishing performance-based incentive systems for workers and managers. IO involved optimizing the inventory and establishing a marketing research unit. A more complete description of the content of each module can be found in Section 2.

and losses from 1935 to 1955. We matched this financial information to data on the TWI program that we digitized from the TWI program's historical records.

The identification strategy of this paper relies on idiosyncrasies in the implementation of the TWI program. First, for organizational reasons, applicant firms were divided into smaller groups, called subdistricts, based on their geographical location. Second, the ad hoc instructors that the TWI administration used to provide the in-plant management training were highly diverse in their skills and time commitment. Each TWI instructor received training in only one of the three managerial areas covered by the program. Within each practice area, instructors learned specialized material targeting either top or middle managers. Moreover, due to the budget constraints faced by the program, some of the instructors were hired part-time, while others were hired full-time. Third, instructors were allocated to subdistricts without taking into account their skills and their employment status. This assignment policy created large variation in the number of firms that the program was able to train in each subdistrict, because some locations received a disproportionate number of part-time instructors. In addition, this policy generated cross-subdistrict variation in the type of training that subdistricts could offer to applicant firms, because some locations did not receive enough instructors with diversified training. As a result, firms in the same county, operating in the same sector, which had applied to the program on the same day, but which were assigned to different subdistricts for organizational reasons, might have been treated years apart, while some of them might not have been treated at all. Moreover, they might have received a different combination of managerial trainings.

We find three main results. First, receiving any form of TWI managerial training had a positive effect on firm performance, but the magnitude of this effect depended on the area of training. Firms that received HR training increased sales, productivity, and return on assets (ROA) by between 4 percent and 5.5 percent per year after the TWI, compared to applicants that ended up never receiving treatment. IO increased the same performance metrics by between 2.5 percent and 3.8 percent per year, while OP increased them by between 1.5 percent and 2.2 percent per year. These treatment effects are large in magnitude and increasing over time.[2] We document several mechanisms that can explain this expanding pattern. Treated firms increased, over time, the rate of adoption of the best practices taught

[2] Their size is consistent with previous findings in the literature. Ten years after the program, receiving trainings in two areas increased productivity by between 15 percent and 18 percent. Bloom et al. (2013) find that management consulting increased productivity by 17 percent.

by the TWI program.[3] They became larger in size, employing more workers and acquiring other firms. They started selecting more productive upstream and downstream firms.

Second, there are complementarity effects between training in HR and training in the other two managerial areas. Receiving HR training in combination with one of the other two modules led to larger effects on firm performance for each type of training, relative to receiving them in isolation. However, we do not find any evidence of complementarity between the other two types of TWI training.

Third, we find that who was trained within a firm mattered. Moreover, it mattered differently across the three areas of training. OP training showed no heterogeneity based on whether a top or a middle manager was trained. HR was more effective when it targeted middle managers, whereas IO training had a larger effect when a top manager was trained. These findings suggest what level of management is more likely to make important business decisions in these different areas.

The contribution of this paper is threefold. First, the idea that management is correlated with the productivity of inputs dates back to Walker (1887). More recent studies have shown a positive association between management practices, or managers, and firm performance (Bertrand and Schoar, 2003; Bloom and Van Reenen, 2007; Cornwell, Schmutte and Scur, 2019). RCTs have provided causal evidence that management consulting leads to better firm outcomes (Bloom et al., 2013; Bruhn, Dean and Schoar, 2018). This paper contributes to these findings by analyzing a large-scale natural experiment that targeted more than 11,000 firms. It examines the separate effects of training in different managerial areas on firm performance and evaluates their complementarities.

Second, this paper contributes to the literature examining the effects of individual managers on firm outcomes. It has been shown that management style is correlated with manager fixed effects in performance (Bertrand and Schoar, 2003), that firms with leader CEOs are on average more productive (Bandiera et al., 2018), that firms with family CEOs are less productive than average (Lemos and Scur, 2019), and that individual managers might have exceptional characteristics that are hard to replace (Huber, Lindenthal and Waldinger, 2019). This paper contributes to these results by isolating the causal effects of training top versus middle managers in different areas.

[3] Firms started implementing best practices, but only in the areas in which they actually received training. These results suggest that the improvement in firm performance is due to the specific form of training that firms received, and not to the simple exposure to external consultants.

Finally, this paper contributes to the literature on the economic history of WWII. On the micro side, existing works have documented the effects of WWII on female labor force participation (Goldin, 1991, Acemoglu, Autor and Lyle, 2004; Goldin and Olivetti, 2013), the wage gaps between white and African-American workers (Margo, 1995; Collins, 2001), and the housing market (Fetter, 2016). On the macro side, research has focused on the impact of WWII on the postwar industrialization process (Fishback and Cullen, 2013; Jaworski, 2014; Koustas and Li, 2019; Bianchi and Giorcelli, 2019), the fiscal multiplier (Brunet, 2018), and the political economy of war production and government spending (Rhode, Snyder, Jr. and Strumpf, 2018). Our paper contributes to this literature by looking at the impact of WWII on the development of managerial practices that were later exported to western Europe (Giorcelli, 2019) and Japan (Boel, 2003).[4]

The rest of the paper is structured as follows. Section 2 describes the origin and development of the TWI program. Section 3 describes the data. Section 4 presents the empirical framework and discusses the identification strategy. Section 5 examines the effects of the TWI program on firm performance. Section 6 analyzes the mechanisms behind the main findings. Section 7 analyzes the effects of training top and middle managers. Section 8 concludes.

2 Historical Background

2.1 Set-up of the TWI Program

The Training Within Industry plan was a business training program with the purpose of providing management training to U.S. war contractors. It was established in August 1940 by the National Defense Advisory Commission after the fall of France (June 22, 1940) and was later moved to be under the jurisdiction of the Federal Security Agency to function as a part of the new War Manpower Commission, on April 18, 1942 (TWI Bulletin, 1940, 1942). It remained under the control of the War Manpower Commission until it ceased all operations in September 1945 after Japan's surrender (TWI Bulletin, 1945). Overall, the TWI maintained the same organization and functioned under the same leadership throughout its existence, in spite of the shift in jurisdiction in 1942.

[4] In Japan, the teachings of the TWI program created the basis for the development of Toyota's lean production model (Womack, Jones and Roos, 1990).

From the onset of WWII in September 1939, the Allied forces needed a large amount of war supplies. Many U.S. companies started receiving an increasing number of war-related orders, especially from France and Britain, that were well in excess of their productive capacity (TWI Bulletin, 1940). As the war escalated, it became apparent that if and when United States would join the Allies by declaring war, that event would make the situation even more critical. A great fraction of men of working age would then be called up to serve, depriving the workforce of many productive employees. The TWI program was the government's response to these concerns. It had the goal of increasing firm production and productivity to meet the increased demand. It also intended to teach U.S. firms how to train new workers and make them productive in the shortest possible amount of time.

The TWI program was set up to operate as a decentralized service. In September 1940, the TWI administration divided the U.S. into 22 geographical districts (Figure 1 and Table A.1). These districts were centered around established industrial areas, which often crossed state boundaries. Each of them had its own headquarters and was headed by a District Director.[5]

While the TWI program had the ambitious goal of offering management training to all U.S. war contractors, budget constraints and the lack of sufficient trainers made this initial plan not viable (TWI Bulletin, 1940). Therefore, the Bureau of Employment Security (BES), which managed all government workers, decided to set a target number of firms to be trained every year within each of the 22 districts (TWI Bulletin, 1943). However, even these targets were often overly optimistic. The TWI administrators repeatedly considered "reaching the number of target firms completely impractical," given "the limitation of funds and personnel" (TWI Bulletin, 1940, 1943, 1944).

To speed up implementation, the TWI administrators decided to decentralize the program even further and divided each district in smaller geographical units called subdistricts (TWI Bulletin, 1940). In total, they created 354 subdistricts, an average of 23 per district. The policy of the program was to train only firms that wanted to be part of it. As a result, the TWI program established different application windows. Each window was closed when the target number of firms per district set by the BES was reached. The only condition for applying was that firms had to be U.S. war contractors at the time of the call.[6] In total,

[5] Most District Directors were business executives who volunteered their expertise to the program. They were called "dollar-a-year" men, since they worked for free for the TWI.

[6] If a primary contractor subcontracted a part or all its production to another firm, only the former was

there were 10 application windows: one each in the years 1940, 1941, and 1945, two each in 1943 and 1944, and three in 1942. Within each subdistrict and application window, eligible firms that applied received the TWI training in the order in which they'd applied.

2.2 Content of the TWI Management Training

In designing their intervention, the leaders of the TWI service, often referred to as "The Four Horsemen" of the TWI,[7] adapted to the 1940s context a popular training program used during WWI.[8] They based the TWI management training on the three so-called J-modules (TWI Bulletin, 1940), as follows:[9]

- Factory Operations (OP). Formally called Job-Relations (J-R), this practice emphasized the concept that "people must be treated as individuals." It involved establishing standard procedures for operations, improving lighting, implementing job safety measures, keeping the factory floor tidy to reduce accidents and facilitate the movement of materials, performing regular maintenance of machines, and recording the reasons for breakdowns.[10]

- Human Resources (HR). Formally called Job-Instructions (J-I), this practice involved defining job descriptions for all workers and managers, breaking down jobs into precisely defined steps, showing each procedure while explaining its key points, and setting up a performance-based incentive systems for workers and managers.

- Inventory, order, and sales management (IO). Formally called Job-Methods (J-M), this practice involved managing the inventory to reduce unused input and unsold output, production planning, tracking production to prioritize customer orders by delivery deadline, and developing a marketing research unit.

eligible to apply to the TWI program.

[7] They were: Channing Rice Dooley (Director), Walter Dietz (Associate Director), Mike Kane, and William Conover (Assistant Directors).

[8] In 1917, the Emergency Fleet Corporation of the United States Shipping Board initiated a training program to increase the number of shipyard workers tenfold. To do so, they hired Charles R. Allen, a vocational instructor from Massachusetts. Allen's four-step system for training new workers—Show, Tell, Do, Check—was documented in his 1919 book *The Instructor, The Man and The Job*. This four-step method formed the basis for the TWI program developed over twenty years later (Appendix B).

[9] The content of the J-modules is remarkably similar to the business principles taught by modern consulting firms (see, for instance, Bloom et al., 2013).

[10] When this program was exported to Japan after the end of WWII, this module was split into two components: one was related to standard procedures for operations and maintenance of machines; the other one, called Job-Safety (J-S), focused on workers' safety.

2.3 Training of the TWI Instructors

Using a formal six-week course in Washington, DC, the TWI program trained its instructors separately for each of the ten application windows. Trained instructors were employed during a single application window with no possibility of reassignment. Moreover, the content of the training remained the same across the ten application windows (TWI Bulletin, 1940). The instructors' background was quite heterogeneous. Some of them were entrepreneurs or industry executives who took a leave of absence from their respective companies to volunteer for the TWI program either part-time or full-time.[11] Others were paid staff already working for the Department of War or for the BES. Each instructor was trained to teach only one J-module for either top or middle managers, but not both. Moreover, the training was customized for firms of a given size (in terms of number of employees) and for firms operating in a given industry. After the six-week course was completed, the instructors were sent to different subdistricts to provide in-plant management training to applicant firms. The training was performed in each firm by a group of five instructors, who visited all plants located in the same district as the firm's headquarters.

2.4 Assignment of Instructors to Subdistricts

In order to keep the quality of instruction comparable across subdistricts, the TWI administrators decided to assign the same number of instructors to each subdistrict within a district. This number changed across time and was proportional to the number of target firms in each district and application window. A different agency, the BES, had the responsibility of assigning the instructors to the subdistricts (TWI Bulletin, 1940). Probably because of a lack of communication with the TWI administration, the BES assigned instructors to subdistricts with attention paid only to the total number of instructors needed. It did so without taking into account that some of them were hired part-time and some full-time, and that each one had received training in a specific J-module for firms of a given size and sector. As a result, the characteristics of instructors assigned to each subdistrict were as good as random. This situation in turn caused a lot of variation in how fast the subdistricts

[11] As applications for the TWI service increased, the TWI program repeatedly announced its intention to prioritize serving those firms whose managers were willing to become TWI instructors (TWI Bulletin, 1941, 1942, 1944). However, we do not find any evidence of managers of U.S. war contractors serving as instructors for the TWI program.

could administer training to the applicant firms and what type of trainings they could offer.

The Subdistrict Administration and the District Directors repeatedly complained about these imbalances across subdistricts. For instance, Oscar Grothe, District 12 Representative, said, "We feel that the placing of trainers across subdistricts, too unequal not in the number, but in the composition, is the most important challenge the TWI service has to face in the upcoming years (TWI Bulletin, 1942)."[12] In spite of these complaints, the BES never adjusted the assignment procedure (TWI Bulletin, 1945). As noted earlier, the result was that firms from the same county could have ended up in different subdistricts for organizational reasons, and could therefore have received a different combination of TWI trainings. Moreover, firms that had applied to the program on the same date might have been trained years apart from one another, while some might not have been trained at all.

2.5 Implementation of the Training

When instructors were assigned to a firm, they first provided training to the managers located in the firm's headquarters. Then they visited each additional establishment in the same district to train the plant managers. The training included three parts. The first part was an analysis of the plant organization. The second part involved a twenty-hour training for each module and for either top or middle managers. Finally, there was a "program development" stage in which local managers started implementing the best practices taught by the TWI program under the instructors' supervision. The goal of this last part was to teach managers how to set up and administer training within their own facility even after the end of the TWI program. This design aimed at disseminating these practices throughout the organization without requiring the presence of the TWI instructors.

3 Data

We collected and digitized data on all firms that applied for the TWI program from the TWI Bulletins, released monthly by the War Manpower Commission between September 1940 and September 1945. The Bulletins report the list of firms that had applied to the program in each application window. For each applicant firm, they also report the subdistrict to which it was assigned, whether it eventually received the TWI training, in which of the J-modules

[12] Appendix B has additional quotations on this issue.

it was trained, and the year in which each module was delivered. They also specify whether it was top or middle managers who were trained and who the instructors were who visited the firm.

In total, 11,575 firms out of 25,646 U.S. war contractors applied for the TWI training. Out of all the applicants, 6,054 firms (52 percent) were eventually trained in at least one J-module. Among them, 44 percent got two J-module trainings, 27 percent got all three J-module trainings, while the remaining firms received only one J-module intervention (Figure A.1).

We also collected data from the plant-level surveys that the TWI administration conducted in treated firms before and after the training. Specifically, the surveys indicate whether a plant was performing each of the sixteen managerial practices covered by the TWI program (Table A.2) before the start of each J-module training, three months after the TWI training, and then each year thereafter until 1945. Since firms were asked to fill out the same survey regardless of the combination of interventions they eventually got, these data allow us to check whether plants started implementing only the best practices related to the J-modules in which they were trained.

Furthermore, we collected data on the performance of applicant firms between 1935 and 1955 from the Mergent Archives, an "online database featuring a vast collection of corporate and industry related documents."[13] Specifically, we relied on two modules of the Mergent Archives: the Mergent Historical Annual Reports and the Mergent's Full Collection of Digitized Manuals. The Mergent Historical Annual Reports are a collection of worldwide corporate annual reports since 1844 from various sources, such as Mergent's own collection, leading universities and libraries, and private providers. The Mergent's Full Collection of Digitized Manuals provides business descriptions and detailed financial statements from every Mergent/Moody's Manual published since 1918. In particular, we referred to the Industrial Manuals, the Transportation Manuals, and the Public Utility Manuals.

Using firm name and address, we uniquely matched all 11,575 TWI applicant firms to the Mergent Archives: we located 8,681 firms (75 percent) in the Mergent's Full Collection of Digitized Manuals, and the remaining 2,894 (25 percent) in the Mergent Historical Annual Reports. The Mergent Archives not only provide statements of profits and losses and balance sheets, but they also contain information on firm history, products, managers, number of

[13] https://www.mergent.com/solutions/print-digital-archives/mergent-archives. We accessed and downloaded the data in pdf format from the UC Irvine library during the summer of 2016.

employees and plants, as well as the name of upstream and downstream companies.[14]

Applicant firms were, on average, multiplant organizations, had $25.32 million in assets and $23.84 million in sales (in 2019 USD), and had been in operation for ten years. They were fairly heterogeneous in terms of employment: while the average number of employees per firm was 873, it ranged from a low of 341 to a high of 5,812 workers. Out of all TWI firms, 55 percent were operating in the manufacturing sector, 28 percent in transportation, 17 percent in services, and 5 percent in the agricultural sector (Table 1). Between 1940 and 1945, they received on average 13.1 supply contracts per year with an average value of $38,344 (Table A.4). Our sample includes a significant share of the U.S. workforce. Specifically, the applicant firms included 19,098 manufacturing establishments, equal to 10.37 percent of all U.S. manufacturing establishments reported in the 1939 Manufacturing Census. Moreover, they employed 10,101,155 workers, or 18.16 percent of the total estimated U.S. labor force in 1940.[15]

Firms whose workers were drafted between 1942 and 1945 were notified by the Selective Service System and were asked to compile the so-called replacement lists. In the replacement lists, firms described the composition of their labor force, specifically indicating the share of African-American workers and of women, as well as the average years of education and age of all their employees. Through the replacement lists, they could also ask for draft exemptions for some categories of their workers.[16] Finally, they had to propose a replacement for each of the drafted workers and indicate how long it would take for the new workers to become fully productive. We used the replacement lists to construct the labor force composition of each firm between 1941 and 1945.[17]

We also matched nonapplicant war contractors to firms in the Mergent Archives to study selection into applying to the TWI program. We were able to match 12,023 out of 14,071 nonapplicant contractors (85.45 percent).[18] Firms that applied to the TWI program were, on average, positively selected: they had more plants and employees, as well as higher sales,

[14] Details on access to this data, its digitization, and the definition of the variables can be found in Appendix C.

[15] We used the data on U.S. manufacturing establishments from the 1939 Manufacturing Census that Lee (2015) has digitized. Estimates of the U.S. labor force come from the 1940 Census.

[16] Managers were usually deferred "in support of national health, safety, or interest" (category II-A).

[17] We accessed these data at the UCLA library in July 2019. For more details, see Appendix C.

[18] While there is no formal threshold on firm size for inclusion in the Mergent Archives, publicly traded firms, firms issuing bonds, and firms with more employees are more likely to be included. The lower coverage of nonapplicant firms is due to the fact that these firms were on average smaller and less likely to issue bonds.

assets, and productivity than did nonapplicant firms (Table A.4, columns 1 and 2). We also estimated a probit model for the probability of applying to the TWI program as a function of firm characteristics. A one-percent increase in the number of employees is associated with a 1.5 percent higher probability of applying to the program (Table A.4, column 3). Similarly, a one-percent increase in assets, sales, and productivity increased the probability of applying to the TWI by between 2.6 and 3.9 percent. In contrast, firm age and sector do not appear correlated with the probability of applying.

4 Identification Strategy

4.1 Baseline Specifications

The identification strategy of this paper relies on variation in the characteristics of TWI instructors (TWI trainings they could offer, and part-time vs. full-time commitments) across subdistricts and application windows. When the BES assigned instructors to subdistricts, no consideration was given to what they could teach and how much time they could dedicate to the program; instead, the only consideration applied was how many instructors were needed to provide training for the target number of firms in each application window. Figure A.2 illustrates this fact in District 7. The average number of instructors per firm is always equal to 5 in each subdistrict and application window (panel A and C). However, the share of full-time instructors ranges between 20 and 80 percent both across all subdistricts within one application window (panel C) and within one subdistrict across all application windows (panel D).[19]

In turn, the characteristics of instructors assigned to subdistricts in each application window determined the number of firms eventually treated and the type of trainings they received. A one-percent increase in the ratio between full-time and part-time instructors increases the probability of receiving at least one TWI training by 3.9 percent and reduces the difference between the treatment year and the application year by 0.05 years (Table 2, columns 1 and 2). Similarly a one-percent increase in the percentage of instructors in OP/HR/IO increases the probability of receiving the OP/HR/IO training by 1.8 percent, 2.5 percent, and 2.0 percent, respectively (Table 2, columns 3, 4, and 5). Finally, a one-percent

[19] District 7 and the share of full-time instructors have been chosen for exposition purposes only. The graphs for other districts and other instructors' characteristics would be similar.

increase in the percentage of instructors assigned to top managers increases the probability that top managers will have received the training by 2.2 percent (Table 2, column 6).

These findings shed light on the discrepancies noted earlier, namely, the fact that the kind of TWI training—if any—that a firm ultimately received was independent of the location of the firm, the date on which it applied for the training, the firm's economic sector, or even what kind of training it would have most benefited from. We then estimate the effect on firm performance of receiving one type of managerial training with the following equation:

$$\begin{aligned} \text{outcome}_{it} \quad = \quad & \sum_{\lambda=1}^{3} \beta_{\lambda}^{1} \cdot (\text{Treatment}_{i}^{\lambda} \cdot \text{Post}_{it}) + \sum_{\lambda=1}^{3} \beta_{\lambda}^{2} \cdot \text{Treatment}_{i}^{\lambda} \\ & + \beta^{3} \cdot \text{Post}_{it} + \eta \cdot \text{Appl. Date}_{i} + \delta_{dst} + \epsilon_{it}, \end{aligned} \tag{1}$$

where the dependent variable, outcome_{it}, is one of several key performance metrics, such as logged sales, total factor productivity revenue (TFPR), and ROA of firm i in year t.[20] $\text{Treatment}_{i}^{\lambda}$ is an indicator that equals 1 if firm i received only intervention λ, where $\lambda = 1$ is OP training, $\lambda = 2$ is HR training, and $\lambda = 3$ is IO training. Post_{it} is an indicator that equals 1 for each year after which firm i received the TWI intervention.[21] The regression keeps the application date to the program (Appl. Date_{i}) fixed, because it can be correlated with unobservable characteristics affecting firm performance.[22] Sector s, district d, and year t fixed effects δ_{dst} control for nonlinear variation in outcomes over time and within sectors and districts. Standard errors are clustered at the subdistrict level. The comparison group is made up of firms operating in the same sector that applied to the program on the same date and from the same district, but which eventually did not get any training. Therefore, each coefficient β_{λ}^{1} captures the causal effect of intervention λ, compared to firms that did not receive any treatment.[23]

The main identifying assumption is that the performance of firms with and without TWI training would have been on the same trend in the absence of the TWI program.[24] Four

[20] Sales and TFPR do not include firm revenues coming from supply contracts with the government. These are analyzed separately (Table A.16).

[21] For control firms, we impute the values of Post_{it} using as a reference the geographically closest treated firm in the same county and sector and with an identical application date to the program.

[22] Early applicants might have been quicker in recognizing the value of the TWI program and, therefore, might have been better managed even before the intervention.

[23] The analysis in Section 5.6 also includes firms receiving multiple types of training, instead of restricting the sample to firms with either one or zero interventions.

[24] If the allocation of the treatment was truly quasi-random, the same assumption should hold for, say, a pair of firms that received 2 different types of TWI training.

main pieces of evidence corroborate our identification strategy. First, firm characteristics do not predict the characteristics of instructors assigned to each subdistrict in each application window. Second, the application date does not predict the probability of receiving the treatment, the exact timing of the treatment, or the type of training received. Third, the treated and comparison firms had similar observable characteristics before the TWI program. Fourth, the performance metrics of treated and control firms followed similar pre-TWI trends.

4.2 Firm Characteristics and Composition of Instructors

Here, we test whether firm characteristics can predict the characteristics of instructors assigned to subdistricts in each application window. For instance, the BES might have decided to allocate a higher fraction of full-time instructors to subdistricts with "better" firms or to firms that were considered more strategic in terms of war production.

We find that none of the firm characteristics is able to predict the ratio between full-time and part-time instructors per application window, nor the percentage of instructors trained in each J-module, nor the ratio between instructors for top and middle managers (Table 3, columns 1-5). Firm characteristics also fail to predict the lag in years between the application time and when the TWI training was received (Table 3, column 6). Similarly, the number and value of war contracts given to firms is not correlated with the instructors' characteristics (Table 3, columns 1-6).

4.3 Application Date and TWI Training

This section tests whether the application date is correlated with the probability of being treated. Specifically, we regress the probability of receiving the treatment on the application date (or on just the year) and different geographical controls (district, state, county, and subdistrict fixed effects), using both a linear probability and a probit model. When the specifications include subdistrict and application-window fixed effects, there is an expected negative correlation between application date and treatment (Table A.5, column 1, Panels A and B). Within a subdistrict and application window, firms were trained based on the order in which their applications were received. However, once we eliminate controls for the application window, this correlation disappears (Table A.5, columns 2-5, Panels A and B). These findings suggest that the variation in instructors' characteristics across subdistricts

and time is able to break the negative relationship between application date and treatment status that exists within subdistricts and application windows. These results are robust to adding a set of interaction terms between the application date and the year in which firms applied (Table A.6). In other words, this finding holds across all years in which the TWI program was active.

The lack of predictive power of the application date applies not only to the treatment status. Conditional on being treated, there is no correlation between the application date and the year in which the firm eventually got treated (Table A.7). Moreover, the application year is not correlated with the type of training that firms eventually received (Table A.8).

As a final piece of evidence, we show that the serial correlation between the characteristics of instructors in a subdistrict between year t and $t-1$ is a precisely estimated zero (Table A.9). This finding indicates that a firm's being located in a subdistrict cannot predict its treatment status across years.

4.4 Were Treated and Control Firms Comparable Before TWI?

Here we show that treated and control firms had similar observable characteristics in 1939, the year before the TWI program started. We regress firm-level characteristics and outcomes in 1939 on indicators for the type of intervention that each firm eventually received, as well as a full set of subdistrict fixed effects. None of the 33 estimated coefficients of the training variables is statistically different from zero (Table A.10, columns 1-3). Moreover, we can never reject the null hypothesis that the coefficients of receiving two or three treatments are equal to zero (Table A.10, column 4-5). We therefore conclude that these groups of firms were statistically indistinguishable with respect to observable characteristics measured the year before the TWI program started.

4.5 Were Treated and Control Firms on the Same Trend?

In this section, we use data from 1935 to 1939 to estimate differential time trends in outcomes for firms in the treated and control groups. We first estimate a model that interacts a linear time trend with an indicator for the type of training that firms eventually received. The estimated coefficients on these interaction terms are small in magnitude and never significant

(Table A.11).[25] Second, we replace the linear time trend with a full series of year dummies. In these specifications, the interactions of the year fixed effects with the treatment dummies test for the presence of nonlinear trends correlated with the provision of different types of managerial training. The estimated coefficients of the interaction terms are not statistically significant and are small in magnitude (Table A.12). Some are positive and others are negative, which confirms the lack of any consistent pattern.

Overall, these results indicate that the outcomes of treated and nontreated firms were on the same trend before the program. Moreover, the performance metrics of firms that received different types of managerial training were also on similar pre-TWI trends, indicating that the provision of the treatment was not correlated with divergent outcomes before the TWI program.

5 Effects of the TWI Training on Firm Performance

5.1 Separate Interventions and Comparison of Their Effects

Estimating equation (1) indicates that receiving any TWI training increased firm productivity and profitability. Sales of firms that received only OP training increased by 2.5 percent per year after the intervention, compared with nontreated applicants (Table 4, column 1). Similarly, their TFPR and ROA increased by 2.2 percent and 1.5 percent per year, respectively (Table 4, columns 3 and 5). After the intervention, firms that were trained only in HR increased their sales by 5.5 percent per year, their TFPR by 4.6 percent, and their ROA by 3.9 percent, relative to firms that did not receive any TWI training (Table 4, columns 1, 3 and 5). Finally, firms that received only IO training increased their sales by 3.3 percent, their TFPR by 3.8 percent, and their ROA by 2.5 percent per post-TWI year (Table 4, columns 1, 3, and 5).

When we compare the effects on firm performance of the three kinds of training, we find that HR training resulted in the largest increase in firm performance (F-stats above 60), with the effects of IO training exceeding those for OP training (F-stats above 50; Table 4).

Furthermore, we estimate event studies in which we measure yearly changes in firm productivity starting five years before and ending ten years after the training (Figure 2). The

[25] The estimated coefficients of the treatment dummies are small and not statistically significant, confirming the results from the balancing tests presented in Table A.10.

event studies show three main findings. First, as suggested by the analysis in Section 4.5, TFPR followed the same trend between treated and control firms before the TWI intervention. Second, we can unpack the difference-in-differences estimates into two separate differences, one for treated firms and one for control firms. These specifications suggest that productivity among control firms followed a flat trend throughout the period under consideration. In other words, the difference-in-differences estimates stem exclusively from an increase in productivity among treated firms. Third, the positive treatment effects continued beyond the end of WWII. Depending on the calendar year in which firms were treated, between one and five years elapsed between a firm's TWI training and the end of WWII in 1945. However, the positive effects of the program increased each year for at least ten years after the training, suggesting that they were not driven by the war itself.

5.2 Changes in Managerial Practices

In this section, we analyze what internal changes firms carried out after the TWI training. We rely on the plant-level surveys the TWI administration conducted in each treated firm before the program, three months after the program, and then each year after training until 1945.[26]

Firms that received OP training reported a drop in machine downturn time of 25 percent and a reduction in workers' injuries of 33 percent, compared to the pre-TWI period (Table 5, column 1, rows 1-2). Within this group, the share of firms that started documenting the causes for machine breakdowns increased by 75 percent (Table 5, column 1, row 3). The reduction in machine repairs, machine downtime, and workers' injuries is likely behind the higher sales and increased productivity we observed in Section 5.1. Remarkably, these firms did not report changes in the implementation of managerial practices not related to OP training, suggesting that it was the TWI training that was behind the implemented changes (Table 5, column 1, rows 4-11).

After exposure to HR training, the share of firms adopting a systematic division of jobs and tasks for managers increased by 92 percent, while the share of firms adopting these practices for all workers increased by 94 percent (Table 5, column 2, rows 4-5). Almost all firms (89 percent) exposed to HR training introduced performance-based incentives for workers and

[26]The survey data were collected only for firms that eventually got treated. As a result, the analysis in this section considers only firms that received at least one type of TWI training.

managers (Table 5, column 2, rows 6-7). Moreover, 55 percent of these firms implemented or planned to implement suggestions provided by their workers (Table 5, column 2, rows 8). These changes can all be responsible for the improved performance described in Section 5.1. A more efficient organization of labor can increase labor productivity, which in turn can positively affect sales and TFPR. As seen for the OP trainings, firms trained in HR did not report changes in managerial practices not related to the HR training (Table 5, column 2, rows 1-2 and 9-11).

Firms that received IO training reduced the amount of unused input materials by 68 percent. Within this group of firms, 89 percent started implementing production planning to prioritize customer orders by delivery deadline and 85 percent established a marketing unit (Table 5, column 3, rows 9-11). Again, managerial practices not related to IO did not change after the TWI training (Table 5, column 3, rows 1-8).

5.3 Robustness Checks

We can control more strictly for unobserved firm-level differences by including firm fixed effects. The main findings hold (Table 4, columns 2, 4, 6, 8). Moreover, we can replace the district-year fixed effects with county-year dummies, a more restrictive set of geographical controls (Table A.14, columns 1, 4, 7, 10). These specifications compare the outcomes of firms located in the same county and applying to the TWI on the same date, but which were assigned to different subdistricts and therefore differentially treated. All these estimates are close in magnitude to the baseline coefficients and precisely estimated. Similarly, we can exploit the fact that some trainers were assigned to multiple firms to estimate specifications with trainer fixed effects (Table A.14, columns 2, 5, 8, 11). In this case also, the main findings hold.

To further show how the characteristics of TWI trainers assigned to each subdistrict are the driving force behind our identification strategy, we can estimate instrumental variable specifications (Table A.15). In these regressions, the share of TWI instructors trained in OP, HR, and IO and assigned to each subdistrict instrument for the three treatment variables. The IV coefficients are between 0.1 and 1.1 percentage points larger than their OLS counterparts, suggesting that the OLS regressions might only slightly underestimate the true treatment effects.

While the main specification is estimated on the balanced sample of firms that survived

until 1955, the end of our sample, we also estimate equation (1) on the unbalanced sample that includes firms that exited the market before 1955. The treatment effects become larger, suggesting that, if anything, balancing the sample biases the results toward zero (Table A.14, columns 3, 6, 9, 12). We can also directly analyze the effect of the TWI program on firm survival by estimating a Cox survival model (Table A.13 and Figure A.4). TWI training decreased the yearly probability of shutdown by 11 to 20 percent. As highlighted by the main analysis, HR training led to the largest decrease in firm exit, IO training to the second largest, while OP training produced the smallest effects.

5.4 Additional Outcomes and Heterogeneity by Sector

A plausible concern is that the U.S. government might have given a higher number of war contracts to firms it had trained in light of their increased productivity. This, in turn, might have been a major driver behind improved firm performance. We find that sales to the government, the number and value of war supply contracts, as well as subsidies given to war contractors after WWII did not change after a firm had received any form of TWI training (Table A.16, columns 1, 3, and 4). These results show that improved outcomes are not automatically tied to trained firms having tighter economic relationships with the U.S. government. By contrast, the TFPR calculated using only revenues coming from government contracts increased for all types of training (Table A.16, column 2).[27] This finding indicates that the TWI program improved productivity by reducing the use of inputs per given output, even when sales did not change.

Firms that applied to the TWI program were mostly in the manufacturing sector, but some of them were operating in the transportation, service, and agriculture sectors (Table 1). We can therefore test whether the effect of management training depends on the sector of activity, complementing the existing evidence that is usually limited to manufacturing. While the effects of the TWI training are positive and significant in all sectors, they tend to be larger in magnitude for manufacturing firms (Table A.17). This result is not surprising since the managerial practices taught through the TWI program were designed for firms in this sector.

[27] Details on TFPR calculated using only revenues from government contracts can be found in Appendix E.

5.5 WWII Enlistment and War Production

More than half of the male population aged 18 to 45 in 1940 (50 million people) served during WWII (Jaworski, 2014). Data from the replacement lists indicate that all war contractors in our sample lost workers due to the draft, experiencing mobilization rates between 15 and 61 percent. In this section, we test whether the draft affected the impact of the TWI program.

We first show that managers of TWI applicant firms were exempted from serving in WWII. Out of all managers in applicant firms, 98 percent were deferred under category II-A of the Selective Training and Service Act of 1940 and never served. This fraction is statistically the same across firms that received different TWI interventions or were eventually not trained (p-value 0.652).[28]

We then address the main question by estimating triple difference specifications in which we interact each $\text{Treatment}_i^{\lambda} \cdot \text{Post}_{it}^{\lambda}$ regressor with the yearly logged number of firm draftees, measured as the number of workers of firm i drafted without any exemption in year t. A higher share of drafted workers significantly reduced the beneficial effects of both OP and IO training (Table A.18). By contrast, the impact of draftees on firms that received the HR training is not significant. This finding suggests that HR training, in addition to generating the largest benefits among treated firms, might have helped managers to better deal with the workforce losses.

In order to explain this result, we further investigate changes in workforce composition during WWII. The draft increased the employment of African-American and female workers in all firms.[29] However, while in firms that were trained in HR a 10-percent increase in drafted workers was associated with a 10 percent increase in African-American and female workers (5 percent each), it took more than one new worker to replace a drafted employee in firms trained in OP and IO (Table A.19).

In order to match the production thresholds required by the war effort, many U.S. war supply contractors had to change their product lines to produce war items. To test whether war production interfered with the TWI trainings, we estimate equation (1) separately for firms that did and did not change their production lines during WWII.[30] Switching to new

[28] Other deferments were given to engineers and transportation workers "because their occupations contribute directly to the war production" (category II-B). Their share was similar across all applicant firms, regardless of their actual treatment group (p-value 0.573).

[29] Collins (2001) and Margo (1995) document narrowing wage gaps between white and African-American workers during and in the aftermath of WWII.

[30] In our analysis, a firm produced the same or similar items before and during the war if the products

products decreased the effects of the TWI program for firms trained in OP and IO, compared to firms that did not switch (Table A.20). The effects on switchers and nonswitchers are more similar in magnitude for firms that received HR training. This result is another piece of evidence in support of HR management having been the most effective TWI training.

5.6 The Combined Effects of Multiple TWI Trainings

Comparing the effects of the TWI trainings delivered in isolation with those delivered in pairs can reveal whether different management areas are substitutes, complements, or independent from each other. To address this point, we estimate the following equation:

$$\begin{aligned}\text{outcome}_{it} = &\sum_{\lambda=1}^{3} \beta_{\lambda}^{1} \cdot (\text{Treatment}_{i}^{\lambda} \cdot \text{Post}_{it}^{A}) + \sum_{\lambda=1}^{3}\sum_{\mu=1}^{3} \gamma_{\lambda,\mu\neq\lambda}^{1} \cdot (\text{Treatment}_{i}^{\lambda,\mu} \cdot \text{Post}_{it}^{B}) \\ &+ \sum_{\lambda=1}^{3} \beta_{\lambda}^{2} \cdot \text{Treatment}_{i}^{\lambda} + \sum_{\lambda=1}^{3}\sum_{\mu=1}^{3} \gamma_{\lambda,\mu\neq\lambda}^{2} \cdot \text{Treatment}_{i}^{\lambda,\mu} \\ &+ \beta^{3} \cdot \text{Post}_{it}^{A} + \gamma^{3} \cdot \text{Post}_{it}^{B} + \eta \cdot \text{Appl. Date}_{i} + \delta_{dst} + \epsilon_{it},\end{aligned} \tag{2}$$

where $\text{Treatment}_{i}^{\lambda,\mu}$ is an indicator that equals 1 if firm i received intervention μ after receiving intervention λ.[31] Post_{it}^{A} is an indicator that equals 1 for each year after which firm i received the first TWI intervention; Post_{it}^{B} is an indicator that equals 1 for each year after which firm i received the second TWI intervention; all other variables are unchanged from equation (1). Each coefficient $\gamma_{\lambda,\mu}^{1}$ captures the additional effect of intervention μ after receiving intervention λ. Firms that received different TWI trainings had similar observable characteristics in 1939 (Table A.21) and had performance metrics following the same time trend before the TWI implementation (Table A.22).

The effect of receiving HR training in combination with either OP or IO training was larger than the effect of receiving HR training alone. Similarly, either OP or IO training in combination with HR training produced larger effects than either OP or IO training in isolation. For instance, HR training after IO training increased TFPR by an additional 1.9 percentage points compared to the increase in TFPR caused by HR training in isolation (Table 6, column 4). This difference is statistically significant at the one-percent level (Table

listed in the war supply contracts shared the same 3-digit SIC code (following the 1937 classification) of products produced before the war.

[31] As defined for λ, $\mu = 1$ for OP training, $\mu = 2$ for HR training, and $\mu = 3$ for IO training.

A.23), and these complementarities are unaffected by the order in which the two trainings were received.

The survey data indicate that, when HR training happens after another TWI training, firms reported larger changes in managerial practices related to both types of training. For instance, if HR training happens after OP training, there is an additional 11-percent drop in machine repairs and a 19-percent drop in workers' injuries (Table A.24, column 1). If HR training happens after IO training, there is an additional 15-percent drop in unused inputs, an additional 8-percent increase in the share of firms using production planning, and an additional 12-percent increase in the share of firms having a marketing research unit (Table A.24, column 3).

Conversely, there is no evidence of complementarities between OP and IO training. For all observed outcomes, the effects of IO training in isolation and after OP training are statistically indistinguishable (Table 6 for firm performance; Table A.24 for adoption of best practices). Similarly, the effects of OP training do not depend on whether IO training has taken place.

A separate question is whether the order of intervention matters. We find that the cumulative effects on firm performance do not depend on the order in which trainings were received (Table A.23). This result holds for all combinations of TWI trainings and all outcomes.

In summary, the analysis in this section highlights three main findings. First, HR training appears to be complementary to other types of trainings. Second, except for HR trainings, we do not find any evidence of complementarity for the other two trainings. Third, the order in which trainings are received does not affect their cumulative effects on firm performance.[32]

6 Mechanisms

In Section 5.1, we documented that managerial training had positive effects on firm performance that increased over time. In this section, we investigate the plausible mechanisms behind these results.

[32] We also investigate the effects of receiving all three TWI trainings and we find the same results (Table A.25, Table A.26, Table A.27, Table A.28, and Table A.29).

6.1 Managers vs. Management

We first examine whether the persistence of the TWI effects depends on whether the managers who received the TWI trainings continued to work at the same firm over time. Among treated firms, between 28 and 73 percent of trained managers left the company in the ten years after the program. Moreover, 93 percent of these job separations happened after the end of WWII. We therefore compare the effects of the TWI training separately for firms in which more or less than 50 percent of trained managers left the company in the ten years after the TWI, controlling for the total number of managers in a company. The results indicate that the effects of the TWI interventions on a firm's TFPR are larger for firms in which more than 50 percent of trained managers stayed after the end of the program (Figure A.3). In firms in which more than 50 percent of trained managers left, the treatment effects are positive and significant, even though they have a smaller magnitude and a flatter time profile.

These findings suggest that managers play an important role in boosting firm performance after receiving proper training. This is consistent with Bloom et al. (2018), who document a drop in the implementation of good managerial practices when managers leave the firm; and with Huber, Lindenthal and Waldinger (2019), who find that the loss of managers can harm a firm's profitability. However, the fact that our results do not entirely disappear when managers leave indicates that part of the managerial training creates firm-specific "managerial capital" (Bruhn, Karlan and Schoar, 2010) that remains within the firm.

6.2 Adoption of Management Practices over Time

We use data from the balance sheets to study whether good managerial practices continued to be implemented after the end of the TWI program. We find that the adoption of practices taught during the TWI training increased over time (Table A.30). Firms receiving OP training spent less money for machine repairs and machine replacements; these effects started five years after the end of the TWI program and increased over time. Firms that were trained in HR started investing more in on-the-job training. Moreover, a larger share of their wage bill was dedicated to performance-based compensation. These results started one year after the training and kept increasing in magnitude in the following ten years. Firms that received IO training increased their expenditures in marketing and advertising, were more likely to

launch new product lines, and decreased the size of their inventory. All these results kept increasing in the ten years after the TWI trainings.

6.3 Changes in Size and Organization

The TWI program increased firm productivity, which in turn might have affected firm size (Syverson, 2011). Consistent with this hypothesis, we document that firms that received the TWI training became bigger over time (Table A.31). Specifically, they increased their labor force by 2 to 10 percent, depending on the type of training received. Moreover, starting five years after the program, they experienced an increase in the number of plants, the acquisition of other firms, and investments in physical capital. For firms that received the HR training, we also find an increase of 13 percent in the fraction of managers and an increase of 7 percent in the fraction of white-collar workers out of the total workforce. These results suggest that these firms implemented a more top-heavy hierarchical structure over time. Finally, firms trained in HR experienced 16 percent fewer strikes, which is consistent with the idea that HR training allowed them to better manage their workers.[33]

6.4 Selection of Downstream and Upstream Firms

In this section, we examine whether trained firms were able to select better upstream and downstream firms. In order to isolate the selection effect, we consider the characteristics of the upstream and downstream firms only during the first year of their business relationship with an applicant firm. The data indicate that HR training is the only TWI intervention consistently associated with the selection of upstream and downstream firms with better performance (Table A.33).

A related question is whether preexisting upstream and downstream firms associated with treated firms became better after the TWI intervention. For this analysis, we restrict our sample to the network of upstream and downstream firms that an applicant firm already had before the program. The existence of vertical spillovers largely depends on the training received by the applicant firms (Table A.32). HR training had the largest positive effects, while OP and IO training produced smaller and less precisely estimated spillovers along the supply chain.

[33] In addition, HR training allowed them to select better workers during the war, as the replacement lists showed (Section 5.5).

6.5 Horizontal Spillovers

The improved performance of trained firms might have happened at the expense of nonapplicant war contractors. To test this hypothesis, we estimate the following equation on the sample of firms that did not apply to the TWI program:

$$\text{outcome}_{jt} = \sum_{\lambda=1}^{3} \beta_\lambda (\text{Treat Same}_i^\lambda \cdot \text{Post}_{it}) + \sum_{\lambda=1}^{3} \gamma_\lambda (\text{Treat Different}_i^\lambda \cdot \text{Post}_{it}) + \alpha_j + \nu_t + \epsilon_{jt}, \quad (3)$$

where $\text{Treat Same}_i^\lambda$ and $\text{Treat Different}_i^\lambda$ are indicators that equal 1 if applicant firm i, located in the same county as firm j, received intervention λ and was operating in either the same or a different sector than firm j. The estimates of equation (3) indicate that horizontal spillovers are very limited. While the effects of having a trained firm operating in the same sector and in the same county are negative, they are statistically significant only for HR training (Table A.34, Panel A). Even in this case, however, the magnitude of the effects is negligible. We do not find evidence of spillover effects if firms operate in different sectors (Table A.34, Panel B).

7 Effects of Treating Top vs. Middle Managers

The goal of the TWI program was to provide training to both top and middle managers in all treated firms. However, some firms received training only for their top managers, some only for their middle managers, and some for both. This variation allows us to estimate the effects of various types of business training on different management levels. We estimate the following equation:

$$\begin{aligned} \text{outcome}_{it} \quad = \quad & \sum_{\lambda=1}^{3} \sum_{\omega=1}^{2} \beta_{\lambda,\omega} (\text{Treatment}_i^\lambda \cdot \text{Type Managers}_i^\omega \cdot \text{Post}_{it}) \\ & + \eta \cdot \text{Appl. Date}_i + \phi_i + \delta_t + \epsilon_{it}. \end{aligned} \quad (4)$$

The variable $\text{Type Managers}_i^\omega$ is an indicator that equals 1 if in firm i the management type ω got treated, where $\omega = 1$ for top managers and $\omega = 2$ for middle managers. The fixed effects control for firm-specific (ϕ_i) and time-specific (δ_t) nonlinear trends. All other variables are as defined in equation (1).

The effects of OP training on firm performance show little heterogeneity based on whether

top or middle managers received the treatment.[34] This result might be due to the fact that factory operations involve basic tasks that are ultimately performed by low-skill workers. Communicating best OP practices to these employees might be sufficiently easy that the type of manager who is initially trained does not make any difference.

Conversely, HR training was significantly more effective when middle managers were treated. These findings could be explained by the fact that middle managers are closer to the nonmanagerial workforce. Therefore, they might be better at receiving their suggestions, training them, and motivating them.

The effects of IO training are significantly larger when top managers are treated. These findings might indicate that input and production management, as well as marketing decisions, are higher-level business decisions that tend to be made by top management. For example, effective sales and inventory management could require the collection of information on different products or units within a firm, a level of aggregation that is more difficult to achieve for middle managers.

In Section 5, we showed that HR training is complementary to other managerial practices. Do these complementary effects depend on the type of managers who were trained? We re-estimate equation (2), allowing for an interaction between top and middle managers.[35] Combining HR and OP training leads to effects that are larger than those observed when either of these types of training is delivered in isolation, regardless of the level of management trained (Table A.37). These complementarities are larger when middle managers are treated in HR, but do not depend on whether top or middle managers were previously trained in OP. We observe similar effects if HR training is delivered after IO training. Without HR training, we do not observe any complementarity effect.[36]

We conclude this section by showing what happens to firm performance when both top and middle managers are trained in the same area. Training top managers in OP when middle managers are already trained in it, or vice versa, does not bring any additional boost to productivity (Table A.39). In the case of HR, training middle managers substantially increases productivity, even when top managers are already trained in it. In contrast,

[34] Table 7 shows the main results on firm performance. Table A.35 tests the differences between the treatment effects. Table A.36 shows the results on the adoption of best practices

[35] The equation is $\text{outcome}_{it} = \sum_{\lambda=1}^{3}\sum_{\omega=1}^{2}\beta_{\lambda}(\text{Treatment}_i^{\lambda} \cdot \text{Type Managers}_i^{\omega} \cdot \text{Post}_{it}^{A}) + \sum_{\lambda=1}^{3}\sum_{\mu=1}^{3}\sum_{\omega=1}^{2}\gamma_{\lambda,\mu\neq\lambda}(\text{Treatment}_i^{\lambda,\mu} \cdot \text{Type Managers}_i^{\omega} \cdot \text{Post}_{it}^{B}) + \eta \cdot \text{Appl. Date}_i + \phi_i + \delta_t + \epsilon_{it}$, where all the variables are defined as above.

[36] The results do not change if firms received all three TWI trainings (Table A.38).

extending HR training to top managers brings only small benefits when middle managers have already been trained. As for IO training, it is the exact opposite of HR training. More specifically, training top managers in IO substantially increases productivity, even when middle managers have already received IO training; in contrast, extending IO training to middle managers brings only small benefits when top managers have already had that training.

8 Conclusions

This paper studies the effects of different managerial practices on firm performance, as well as their complementarities, using evidence from the Training Within Industry Program. We linked information on the participation of 11,575 firms to the TWI program to data from twenty years of balance sheets. Our identification strategy uses idiosyncrasies in the policy implementation that determined quasi-random variation in the type of managerial training that firms eventually received.

We find that receiving any type of TWI training had a positive impact on firm performance, but HR training generated the largest effects. We also document complementarities between HR management and the other two management practices. In fact, HR training enhanced the effects of other types of training, while other TWI trainings did not generate the same result. Finally, who was trained within a firm mattered, but whether training top or middle managers was more beneficial depended on the area of training.

We argue that these findings are important for both firms and policy makers. Firms routinely use internal training to improve the productivity of their workforce (Acemoglu and Pischke, 1998; Konigs and Vanormelingen, 2015). However, the effectiveness of these policies is usually evaluated over a limited time period, on relatively small samples, and usually without randomizing the content of the lectures or the type of workers trained. Our research shows that both the content and the target level of management training can change the effect of these programs on firm performance. Therefore, these factors should be taken into account to ensure the success of training plans.

Are these findings applicable to today's firms? Although production processes have evolved tremendously since WWII, we think that there are several factors supporting the external validity of our results. First, the findings are relevant for far more than just one industry,

or for a few industries that might have disappeared or shrunk in today's economy—because our sample included over eleven thousand firms, and encompassed enterprises of different sizes with operations spanning a wide range of different industries. Second, the content of the J-modules is, perhaps surprisingly, still close to modern best practices. In fact, the managerial areas covered by the TWI training are very similar to the business principles taught in recent RCTs (see, for instance, Bloom et al., 2013). For these reasons, we believe that the findings in this paper are relevant to improving firm production in today's economy.

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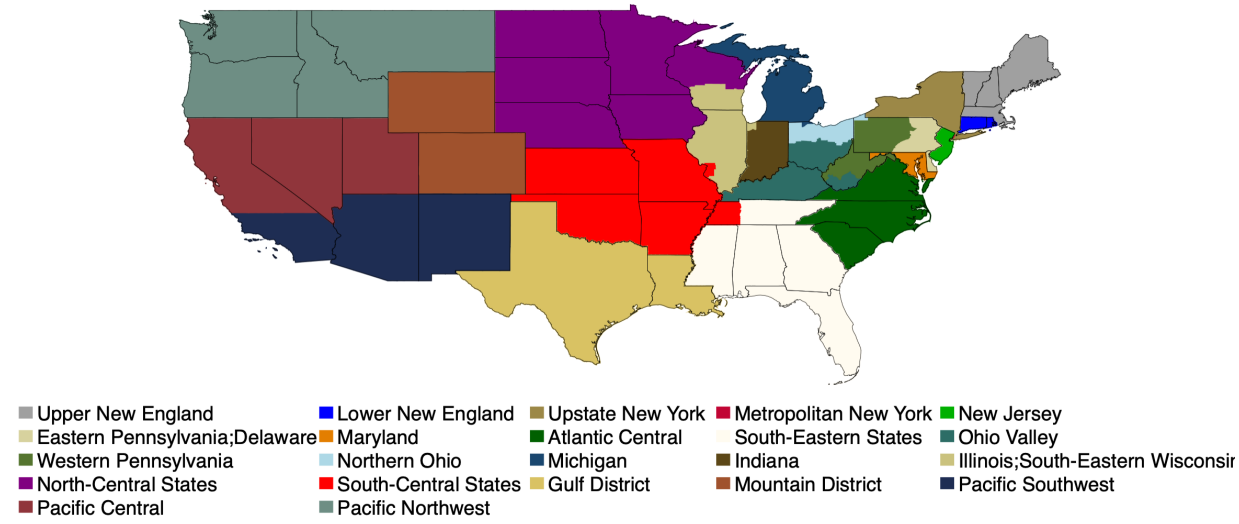
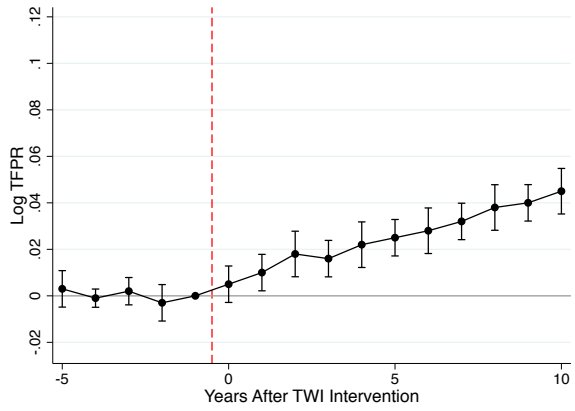
Figures and Tables

Figure 1: TWI Districts

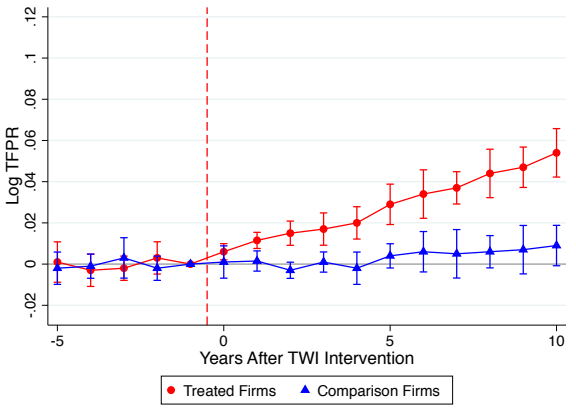


Notes. Maps of the 22 districts in which the TWI program divided the United States.

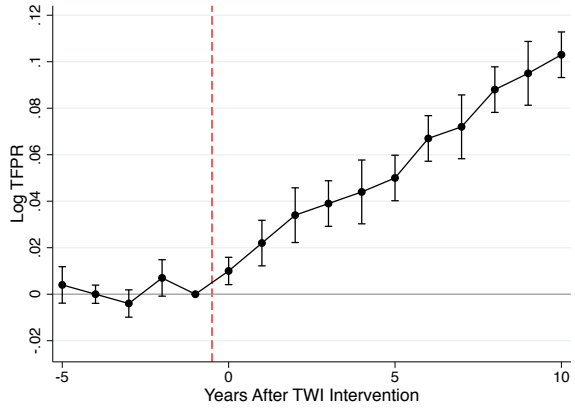
Figure 2: Event Studies, Difference-in-Differences and Single Differences



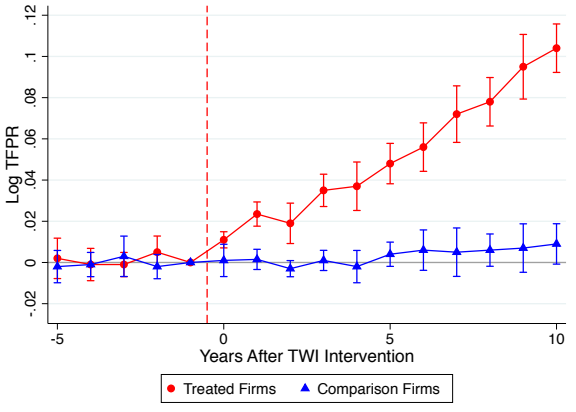
Panel A: OP, DD



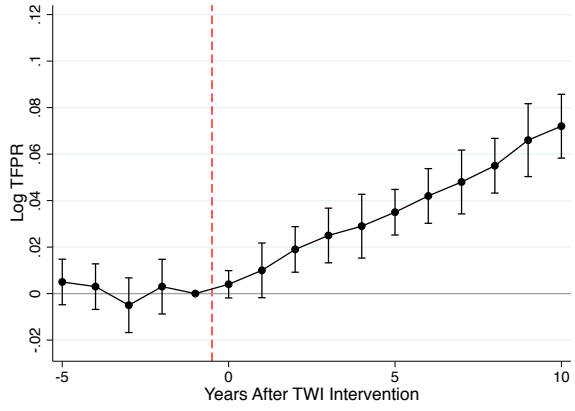
Panel B: OP, D



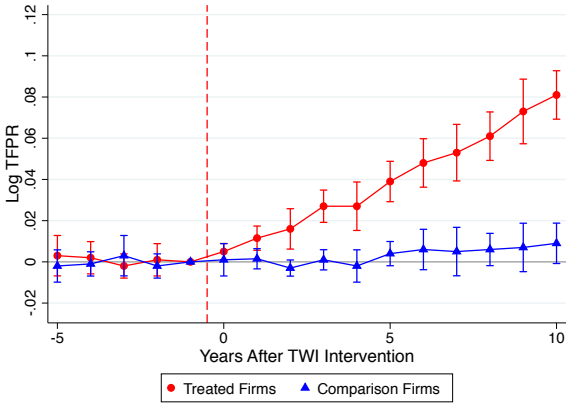
Panel C: HR, DD



Panel D: HR, D



Panel E: IO, DD



Panel F: IO, D

Notes. Panels A, C, and D show the difference-in-differences estimates from event studies. The coefficients measure the difference in log(TFPR) between firms that received a certain form of management training (OP, HR, or IO) and firms that did not receive any training, and between each year and the year just before the implementation of the TWI program (period -1). Panels B, D, and F show single differences from event studies. Here, the coefficients measure the difference in log(TFPR) between each year and the year just before the implementation of the TWI program (period -1), separately for treated and control firms. In the analysis, the distance from the TWI intervention for the control firms (the x-axis in the graphs) is imputed using the distance from the TWI intervention of participating firms in the same county and sector and with identical application date to the program. The vertical bars denote 95 percent confidence intervals. The standard errors are clustered at the subdistrict level.

Table 1: Summary Statistics in 1939 for 11,575 Applicants to the TWI Program

	All Applicant Firms				Treated Firms	Control Firms
	Mean	St. Dev.	Min.	Max.	Mean	Mean
	(1)	(2)	(3)	(4)	(5)	(6)
Plants	3.04	1.77	2	6	2.98	3.13
Employees	872.67	575.05	341	5,812	870.14	875.44
Current assets	25.32	8.90	17.89	37.65	26.78	23.23
Annual sales	23.84	10.13	15.68	43.56	22.34	25.98
Value added	8.58	5.75	5.67	14.81	9.02	7.95
Age	10.13	6.08	3	36	10.89	9.30
Productivity	3.12	0.78	1.87	4.09	3.18	3.03
Agriculture	0.05	0.06	0	1	0.06	0.04
Manufacturing	0.55	0.50	0	1	0.53	0.56
Transportation	0.26	0.28	0	1	0.25	0.26
Services	0.14	0.15	0	1	0.16	0.14
Share African-Americans	0.15	0.18	0	0.36	0.14	0.16
Share Women	0.11	0.23	0	0.28	0.10	0.12
Years of Education	9.93	3.41	6.04	12.36	10.15	9.70
Age of Workforce	28.33	5.78	25.67	38.72	27.52	29.22
Observations	11,575	11,575	11,575	11,575	6,054	5,521

Notes. Summary statistics in 1939 for the 11,575 firms that applied for the TWI program. Data are provided at the firm level. Columns 1, 2, 3, and 4 present, respectively, mean, standard deviation, minimum, and maximum of characteristics and outcomes of all the 11,575 firms. Columns 5, and 6 report the mean of the same variables, separately, for 6,054 firms that eventually got treated and 5,521 firms that eventually did not get treated. *Plants* reports the total number of plants per firm; *Employees* reports the number of employees per firm; *Current assets*, *Annual sales*, and *Value added* are expressed in million 2019 USD; *Productivity* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *Agriculture*, *Manufacturing*, *Transportation*, and *Services* are indicators that equal one if, respectively, a firm operates in agriculture, manufacturing, transportation, or services. *Share African-Americans* is the share of African-American workers out of firm total labor force; *Share Women* is the share of female workers out of firm total labor force; *Year of Education* is the average number of school education of firm total labor force; *Age of Workforce* is the average age of firm total labor force. The last for variables come from firm replacement lists and are recorded in 1942.

Table 2: Correlation Between Instructors Composition and TWI Training

	Pr (Training)	Lag Treat.	Pr (OP)	Pr (HR)	Pr (IO)	Pr (Top)
	(1)	(2)	(3)	(4)	(5)	(6)
Perc. Full-time	0.039***	-0.051***				
	(0.010)	(0.015)				
Perc. OP			0.018***	0.003	-0.002	
			(0.005)	(0.003)	(0.004)	
Perc. HR			0.004	0.025***	-0.005	
			(0.006)	(0.006)	(0.007)	
Perc. IO			0.004	-0.003	0.020***	
			(0.005)	(0.003)	(0.007)	
Top/Middle						0.022***
						(0.006)
Appl. Window FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,575	11,575	11,575	11,575	11,575	6,054

Notes. *Perc. Full-time* is the percentage of full-time instructors assigned to each subdistrict and application window. *Perc. OP* is the percentage of instructors trained in OP, *Perc. HR* is the percentage of instructors trained in HR, and *Perc. IO* is the percentage of instructors trained in IO. *Top/Middle* is the ratio between instructors for top and middle managers. Data are provided at the firm level. *Pr(Training)* is the probability of receiving at least one type of TWI training; *Lag Treat.* is the difference between the year in which training is received and the application year; *Pr(OP), Pr(HR), Pr(IO),* and *Pr(Top)* are, respectively, the probability of receiving the training in OP, HR, IO, and for top managers. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Correlation Between Firm Characteristics and Instructors Composition

	Perc. Full-time	Perc. OP	Perc. HR	Perc. IO	Top/Middle	Lag Treat.
	(1)	(2)	(3)	(4)	(5)	(6)
Number of Plants	-0.003	0.004	0.006	-0.005	0.003	-0.002
	(0.007)	(0.006)	(0.008)	(0.005)	(0.004)	(0.002)
Number of Employees	-0.009	0.010	-0.003	0.002	0.008	-0.004
	(0.012)	(0.007)	(0.004)	(0.003)	0.012	0.006
Annual sales	0.003	-0.002	0.011	0.008	-0.003	0.005
	(0.005)	(0.004)	(0.013)	(0.010)	(0.006)	(0.006)
Log TFPR	-0.004	0.005	-0.001	0.007	-0.005	0.010
	(0.006)	(0.007)	(0.004)	(0.010)	(0.007)	(0.012)
Number War Contracts	0.003	-0.005	0.004	0.007	-0.004	-0.006
	(0.006)	(0.007)	(0.006)	(0.008)	(0.008)	(0.005)
Value War Contracts	0.002	-0.003	0.005	0.004	-0.008	0.007
	(0.004)	(0.005)	(0.007)	(0.005)	(0.010)	(0.009)
Distance Railroad	0.005	0.002	0.003	-0.005	0.003	-0.002
	(0.006)	(0.003)	(0.003)	(0.007)	(0.005)	(0.005)
Distance Port	-0.004	-0.003	0.005	0.004	0.003	0.004
	(0.005)	(0.004)	(0.007)	(0.006)	(0.005)	(0.006)
Appl. Window FE	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics	1.92	0.88	2.56	2.25	3.41	1.39
Observations	11,575	11,575	11,575	11,575	11,575	6,054

Notes. Coefficients estimated from regressing the ratio between full-time and part-time instructors (column 1), the percentage of instructors in OP (column 2), percentage of instructors in HR (column 3), percentage of instructors in IO (column 4), the ratio between instructors for top and middle managers (column 5), and the difference between the year in which training is received and the application year (column 6) on firm characteristics and a set of application windows' fixed effects. Data are provided at the firm level. *Number of Plants* is the total number of plants per firm; *Number of Employees* measures the number of employees per firm; *Annual sales (m USD)* are expressed in million 2019 USD; *Log TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *Number of War Contracts* and *Value of War Contracts* are the number and the value in thousand 2019 USD of the war supply contracts assigned to a firm by the U.S. government. The bottom part of the table reports F-statistics from equality tests between all the estimated coefficients. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Effects of OP, HR and IO on Firm Performance

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(68)
OP*post	0.025***	0.024***	0.022***	0.024***	0.015***	0.016***
	(0.006)	(0.005)	(0.005)	(0.007)	(0.005)	(0.004)
HR*post	0.054***	0.056***	0.045***	0.048***	0.038***	0.036***
	(0.005)	(0.007)	(0.007)	(0.010)	(0.006)	(0.008)
IO*post	0.032***	0.030***	0.037***	0.040***	0.025***	0.022***
	(0.004)	(0.005)	(0.006)	(0.009)	(0.005)	(0.004)
Dis-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Test OP=HR	78.91	76.54	88.72	75.68	57.89	67.48
Test HR=IO	61.23	65.89	92.34	91.23	66.78	68.43
Test OP=IO	55.46	51.23	78.34	67.88	88.45	83.29
Observations	145,480	145,480	145,480	145,480	145,480	145,480

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. The bottom part of the table reports F-statistics from equality tests between the estimated coefficients. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Management Practices Adopted by Firms: Survey Data

	TWI Training Received			
	OP*post	HR*post	IO*post	Adoption Rate before Training
	(1)	(2)	(3)	(4)
(1) Intervention for Machine Repairs	-0.248***	0.005	-0.002	N.A.
	(0.059)	(0.006)	(0.004)	
(2) Worker's Injuries	-0.332***	-0.003	0.004	N.A.
	(0.065)	(0.004)	(0.005)	
(3) Register Causes of Breakdown	0.751***	-0.002	0.003	0.02
	(0.212)	(0.005)	(0.004)	
(4) Job Description Managers	0.003	0.922***	-0.002	0.02
	(0.005)	(0.234)	(0.003)	
(5) Job Description Workers	-0.005	0.943***	0.003	0.02
	(0.007)	(0.321)	(0.005)	
(6) Training for Workers	0.007	0.891***	-0.004	0.02
	(0.006)	(0.289)	(0.006)	
(7) Introduction of Bonus	0.002	0.873***	0.005	0.04
	(0.003)	(0.342)	(0.006)	
(8) Suggestions from Workers	0.003	0.556***	0.004	0.01
	(0.004)	(0.129)	(0.005)	
(9) Unused Input	-0.005	0.004	-0.678***	N.A.
	(0.006)	(0.007)	(0.003)	
(10) Production Planning	0.006	0.006	0.893***	0.02
	(0.009)	(0.005)	(0.003)	
(11) Marketing	-0.004	-0.004	0.851***	0.02
	(0.009)	(0.005)	(0.246)	
Observations	27,506	27,506	27,506	6,054

Notes. Each row represents a separate regression whose dependent variable is one of the 11 management practices listed in the first column (indicators that equal one for firms implementing that management practice). *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the plant level. These regressions also include controls for the application date and district-sector-year fixed effects. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Effects of Two TWI Trainings on Firm Performance

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
HR After OP * post	0.065***	0.063***	0.058***	0.054***	0.052***	0.050***
	(0.007)	(0.006)	(0.006)	(0.008)	(0.005)	(0.004)
OP After HR * post	0.038***	0.036***	0.033***	0.031***	0.022***	0.020***
	(0.005)	(0.006)	(0.007)	(0.010)	(0.004)	(0.005)
HR After IO * post	0.074***	0.076***	0.065***	0.068***	0.068***	0.066***
	(0.005)	(0.007)	(0.007)	(0.010)	(0.006)	(0.008)
IO After HR * post	0.049***	0.047***	0.041***	0.037***	0.053***	0.050***
	(0.005)	(0.008)	(0.007)	(0.005)	(0.006)	(0.007)
IO After OP * post	0.031***	0.029***	0.028***	0.029***	0.026***	0.023***
	(0.006)	(0.007)	(0.005)	(0.004)	(0.006)	(0.005)
OP After IO * post	0.026***	0.025***	0.019***	0.020***	0.014***	0.013***
	(0.005)	(0.006)	(0.004)	(0.005)	(0.003)	(0.004)
OP*post	0.026***	0.025***	0.021***	0.023***	0.013***	0.012***
	(0.007)	(0.006)	(0.004)	(0.005)	(0.003)	(0.004)
HR*post	0.055***	0.058***	0.047***	0.049***	0.040***	0.038***
	(0.008)	(0.010)	(0.008)	(0.009)	(0.007)	(0.005)
IO*post	0.030***	0.028***	0.035***	0.033***	0.024***	0.021***
	(0.006)	(0.005)	(0.007)	(0.006)	(0.004)	(0.006)
Dis-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Observations	198,720	198,720	198,720	198,720	198,720	198,720

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Effects of Top and Middle Managers on Firm Performance

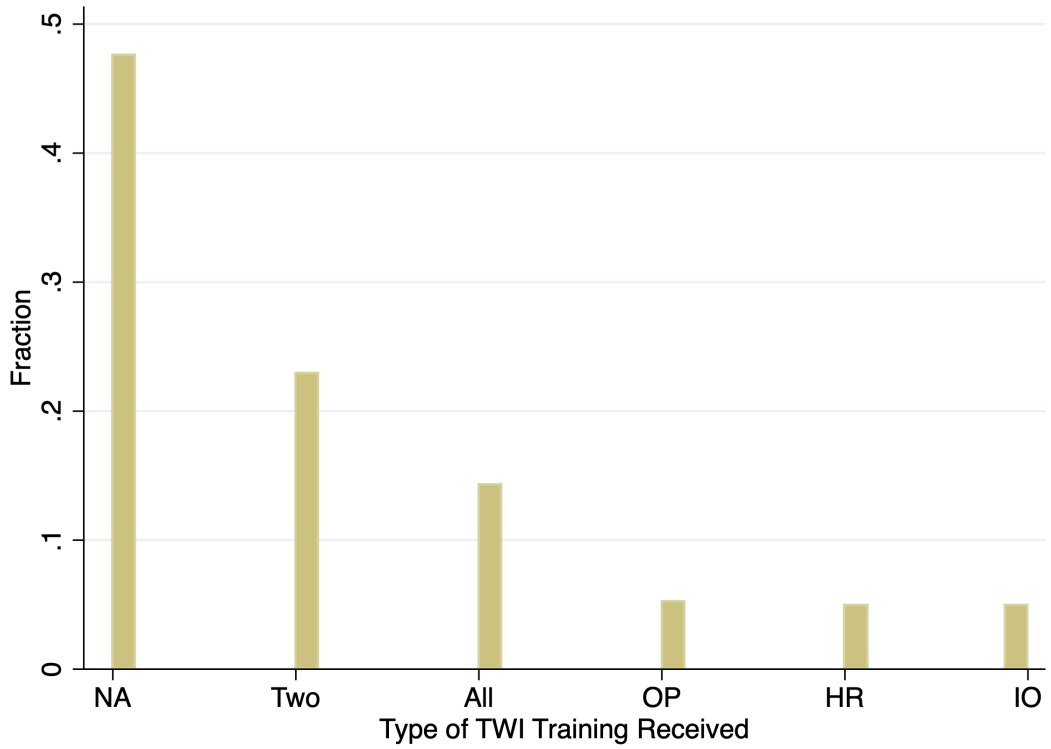
	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(7)	(8)
Top OP*post	0.022***	0.021***	0.020***	0.019***	0.014***	0.011***
	(0.005)	(0.007)	(0.004)	(0.006)	(0.003)	(0.004)
Middle OP*post	0.026***	0.022***	0.023***	0.021***	0.016***	0.013***
	(0.004)	(0.007)	(0.006)	(0.007)	(0.004)	(0.005)
Top HR*post	0.035***	0.033***	0.029***	0.027***	0.025***	0.026***
	(0.005)	(0.007)	(0.006)	(0.010)	(0.007)	(0.010)
Middle HR*post	0.067***	0.062***	0.056***	0.054***	0.045***	0.042***
	(0.010)	(0.012)	(0.008)	(0.012)	(0.009)	(0.013)
Top IO*post	0.040***	0.038***	0.043***	0.040***	0.033***	0.031***
	(0.004)	(0.005)	(0.006)	(0.009)	(0.005)	(0.004)
Middle IO*post	0.020***	0.017***	0.027***	0.025***	0.024***	0.022***
	(0.005)	(0.006)	(0.005)	(0.008)	(0.009)	(0.011)
Dis-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Observations	145,480	145,480	145,480	145,480	145,480	145,480

Notes. *Top* is an indicator variable that equals one if top managers are treated. *Middle* is an indicator variable that equals one if top managers are treated. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Online Appendix—Not for Publication

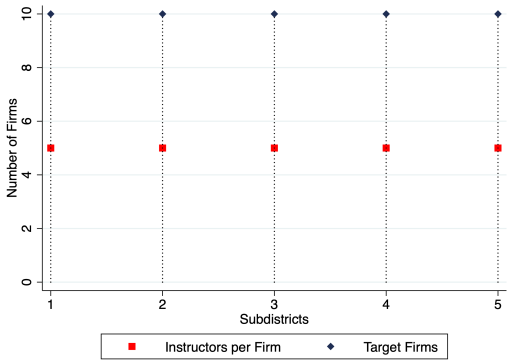
A Additional Figures and Tables

Figure A.1: TWI J-Module Trainings Received by Applicant Firms

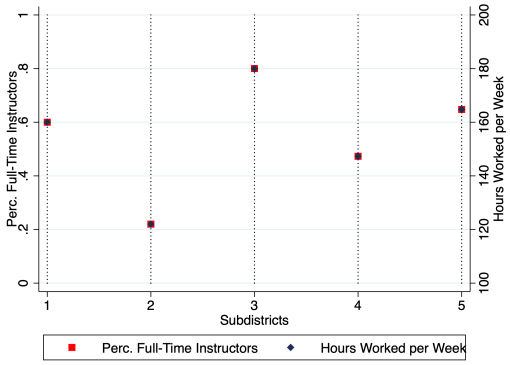


Notes. Type of training received by 11,575 firms that applied to the TWI program. *NA* is for firms that did not get any TWI intervention; *Two* is for firms that received two-module trainings; *All* is for firms that received all three-module trainings; *OP* is for firms that received Factory Operation; *HR* is for firms that received Human Resources; *IO* is for firms that received Inventory, Order, and Sales.

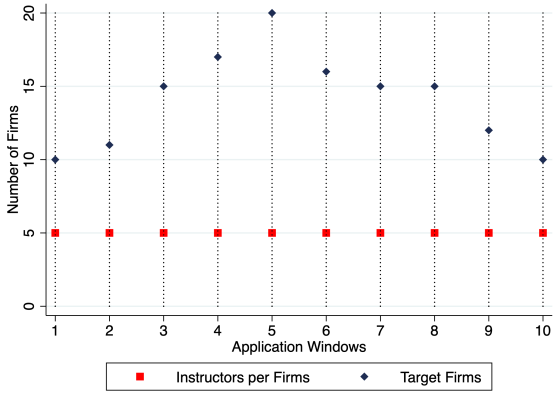
Figure A.2: Variation in Instructors Composition in Maryland (District 7)



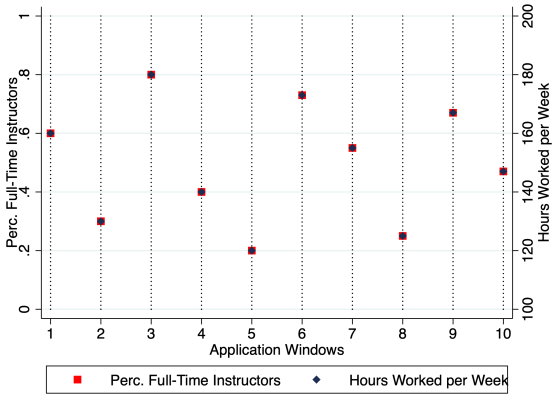
Panel A: All subdistricts, 1 application window (1940)



Panel B: All subdistricts, 1 application window (1940)



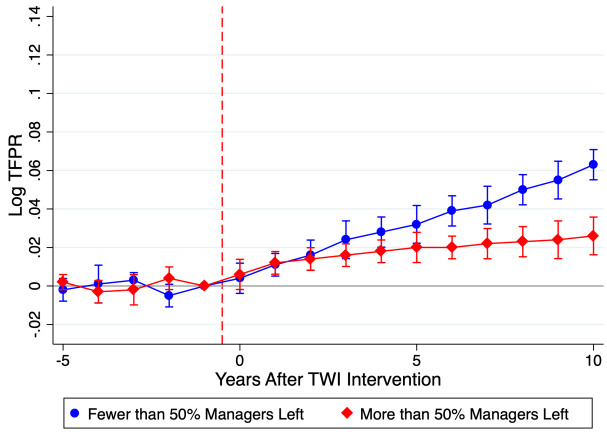
Panel C: Subdistrict 1, All application windows



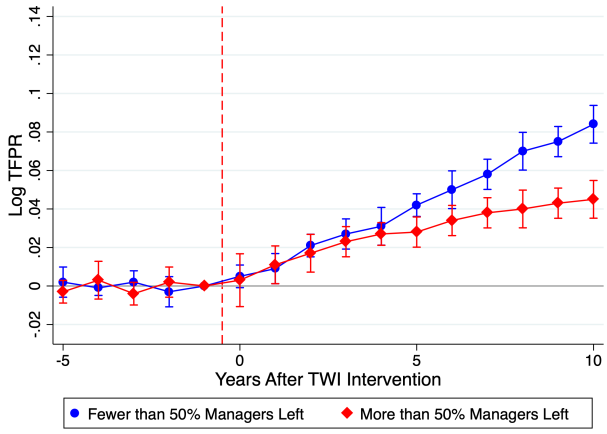
Panel D: Subdistrict 1, All application windows

Notes. Panels A and B show the number of instructors per firms, the number of target firms per subdistrict, the percentage of full-time instructors, and the number of hours instructors could work in the first TWI application window in 1940. Panels C and D show the same variables in the ten TWI application windows for Subdistrict 1.

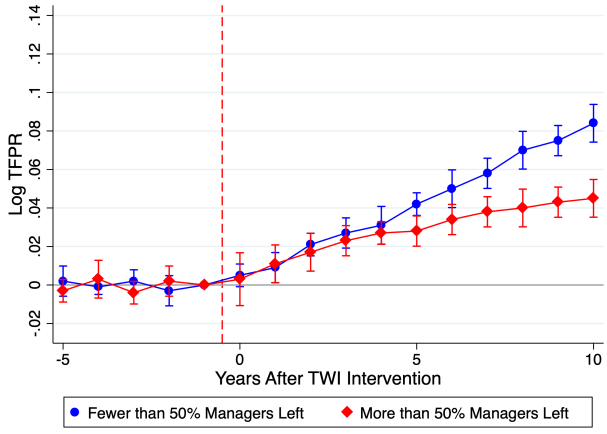
Figure A.3: Managers vs. Management



Panel A: OP



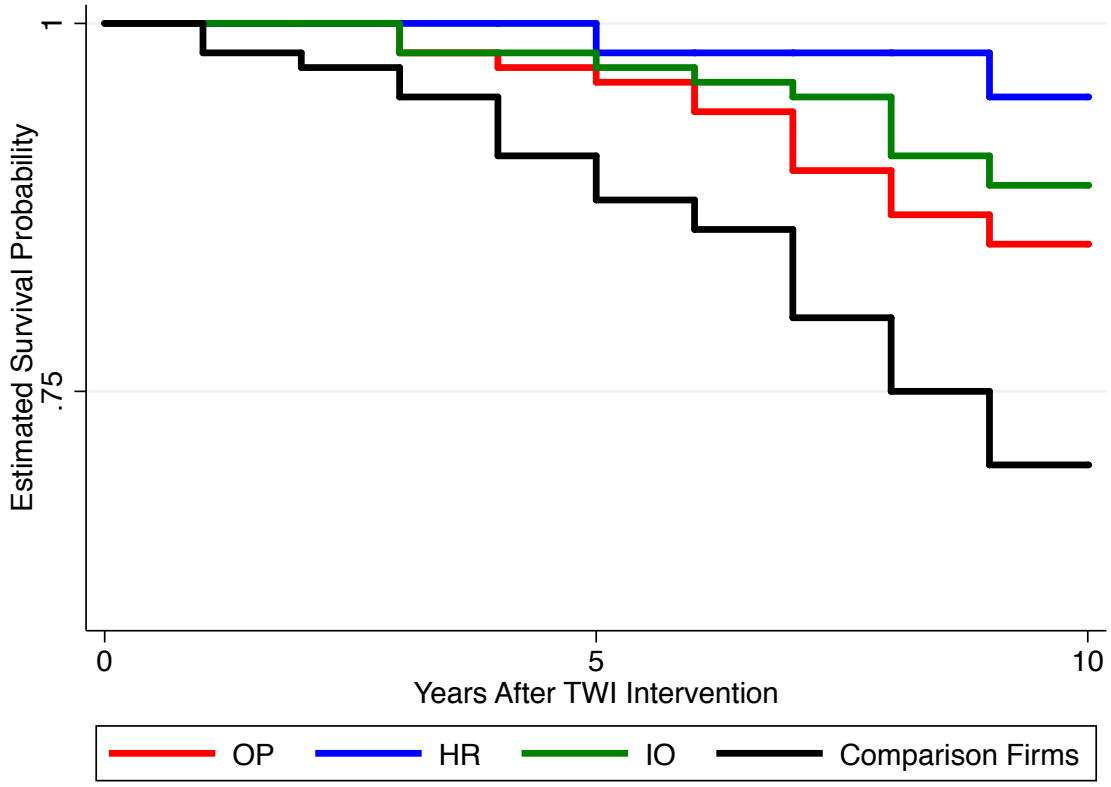
Panel B: HR



Panel C: IO

Notes. Effects of the TWI program on log TFPR, separately for firms in which less than 50 percent of trained managers left and firms in which more than 50 percent of trained managers left. Panel A is for firms that received the OP training, HR is for firms that received the HR training, and IO is for firms that received the IO training. The vertical bars denote 95 percent confidence intervals. The standard errors are clustered at the subdistrict level.

Figure A.4: Predicted Survival Probabilities, Cox Survival Model



Notes. Survival probabilities estimated from the Cox survival model $h(t) = h_0(t)\exp(\beta_1 \cdot \text{OP} + \beta_2 \cdot \text{HR} + \beta_3 \cdot \text{IO} + \epsilon)$, where $h(t)$ is the hazard of shutdown t years after the TWI intervention. The variable *OP* is an indicator that equals 1 for firms that received Factory Operation; *HR* is an indicator that equals 1 for firms that received Human Resources; *IO* an indicator that equals 1 is for firms that received Inventory, Order, and Sales.

Table A.1: List of 22 TWI Districts

District Name	States	Main Office Location
1) Upper New England	Maine; Massachusetts; Vermont; New Hampshire	Boston
2) Lower New England	Connecticut; Rhode Island	New Haven
3) Upstate New York	New York state (excluding Metropolitan New York)	New York
4) Metropolitan New York	Metropolitan New York	New York
5) New Jersey	New Jersey	Newark
6) Eastern Pennsylvania; Delaware	Eastern Pennsylvania; Delaware	Philadelphia
7) Maryland	Maryland	Baltimore
8) Atlantic Central	Virginia; North Carolina; South Carolina	Raleigh
9) South-Eastern States	Georgia; Florida; Alabama; Mississippi; Central and Eastern Tennessee	Atlanta
10) Ohio Valley	Southern Ohio; Souther West Virginia, Kentucky	Cincinnati
11) Western Pennsylvania	Western Pennsylvania (except Erie County); Norther West Virginia	Pittsburgh
12) Northern Ohio	Northern Ohio (expect Lucas County); Erie County (PA)	Cleveland
13) Michigan	Michigan; Lucas County (OH)	Detroit
14) Indiana	Indiana (except Lake and Porter Counties)	Indianapolis
15) Illinois	Illinois (except three counties adjacent to St. Louis, MO); South Wisconsin; Lake and Porter Counties (IN)	Chicago
16) North-Central States	North Wisconsin; Minnesota; North Dakota; South Dakota; Iowa; Nebraska	Minneapolis
17) South-Central States	Missouri; Kansas; Oklahoma; Arkansas; Western Tennessee; Madison, St. Clair, Monroe Counties (IL)	St. Louis
18) Gulf District	Texas; Louisiana	Houston
19) Mountain District	Colorado; Wyoming	Denver
20) Pacific Southwest	Southern California; Arizona; New Mexico	Los Angeles
21) Pacific Central	Northern California; Nevada; Utah	San Francisco
22) Pacific Northwest	Washington; Oregon; Idaho; Montana	Seattle

Notes. List of the 22 districts in which the TWI program divided the United States, with borders and headquarter location.

Table A.2: List of Managerial Practices Included in Each TWI J-Module

Type of Interventions	J-Module	List of Managerial Practices by J-Module
A. Factory Operations	Job-Relations	1) Establishing standard procedures for operation
		2) Improving lighting
		3) Implementing job safety for workers
		4) Keeping the factory floor tidy to reduce accidents and facilitate the movement of materials
		5) Regular maintenance of machines
		6) Recording the reasons for machine breakdowns
B. Human Resources Management	Job-Instructions	7) Defining job descriptions for workers
		8) Defining job descriptions for managers
		9) Breaking down jobs into closely defined steps
		10) Showing the procedures while explaining the key points
		11) Performance-based incentive systems for workers
		12) Performance-based incentive systems for managers
C. Inventory, Orders, and Sales	Job-Methods	13) Management of inventory to reduce unused input and unsold output
		14) Production planning
		15) Tracking of production to prioritize customer orders by delivery deadline
		16) Development of marketing research unit

Notes. List of the sixteen managerial practices for each of the three Job-Modules taught by the TWI program.

Table A.3: Comparison Between War Contractors that Applied and Did Not Apply to the TWI

	Applicant Firms	Non-Applicant Firms	Pr (Apply)
	(1)	(2)	(3)
Plants	3.04	1.96	0.110***
			(0.028)
Employees	872.67	512.33	0.015***
			(0.005)
Current assets	25.32	18.92	0.032***
			(0.010)
Annual sales	23.84	15.61	0.026***
			(0.012)
Productivity	3.12	1.98	0.039***
			(0.004)
Age	10.13	10.59	0.005
			(0.004)
Agriculture	0.05	0.03	-0.002
			(0.003)
Manufacturing	0.55	0.58	0.004
			(0.005)
Transportation	0.26	0.24	-0.001
			(0.002)
Services	0.14	0.15	0.003
			(0.005)
Observations	11,575	12,023	23,598

Notes. Summary statistics in 1939 for 23,598 war contractors, among which 11,575 applied for the TWI program (column 1) and 12,023 did not (column 2). Data are provided at the firm level. Column 3 reports the marginal effects of each variable computed from the coefficients of a probit model estimating the probability of applying for the TWI as a function of logged firm characteristics. *Plants* reports the total number of plants per firm; *Employees* reports the number of employees per firm; *Current assets*, *Annual sales*, and *Value added* are expressed in million 2019 USD; *Productivity* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *Agriculture*, *Manufacturing*, *Transportation*, and *Services* are indicators that equal one if, respectively, a firm operates in agriculture, manufacturing, transportation, or services.

Table A.4: WWII Supply Contracts Summary Statistics

	Average per Firm and Year						
	1940	1941	1942	1943	1944	1945	N Firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Number of War Contracts							
All War Contractors	6.39	10.30	20.29	16.99	14.85	9.76	23,598
All Applicant Firms	5.98	10.90	20.89	17.89	14.56	9.32	11,575
OP	6.78	9.56	19.85	16.23	15.89	10.87	610
HR	5.67	9.32	20.89	16.78	14.32	10.23	573
IO	4.59	13.58	25.18	21.40	11.02	10.24	570
Two Interventions	6.98	10.50	18.99	17.23	16.02	9.56	2,642
All Interventions	5.88	11.56	19.56	17.80	15.56	10.56	1,659
F-statistics	1.96	2.35	3.81	0.98	2.67	1.47	6,054
B. Value of War Contracts							
All War Contractors	28.38	31.43	67.37	51.84	34.33	17.30	21,495
All Applicant Firms	27.82	32.46	68.34	50.98	35.21	16.98	11,575
OP	29.08	30.87	66.78	52.45	33.45	17.90	610
HR	27.67	30.67	68.78	52.38	34.69	16.78	573
IO	29.45	33.01	66.78	50.98	35.12	16.01	570
Two Interventions	27.67	32.56	68.72	52.87	32.98	16.78	2,642
All Interventions	28.55	31.23	66.99	51.76	34.40	16.56	1,659
F-statistics	1.55	0.98	2.56	1.33	2.89	2.72	6,054

Notes. Panel A reports the average number of war contracts per firm and year between 1940 and 1945. Panel B reports the value of war contracts (in thousand USD) per firm and year between 1940 and 1945. *All war contractors* include 23,598 firms that received at least one war contract. *All applicant firms* include all firms that applied for the TWI program. *OP* includes firms that received Factory Operation training; *HR* firms that received Human Resources training; *IO* firms that received Inventory, Order, and Sales training. *Two Interventions* includes firms that received two-module trainings; *All Interventions* is one for firms that received all three-module trainings

Table A.5: Correlation Between Application Time and TWI Training

	Probability of Receiving the TWI Training								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. OLS									
Application Date	-0.006***	0.002	-0.003	0.001	0.004				
	(0.001)	(0.004)	(0.003)	(0.003)	(0.005)				
Application Year						0.004	-0.005	-0.003	0.002
						(0.010)	(0.008)	(0.004)	(0.004)
Panel B. Probit									
Application Date	-0.009***	0.001	-0.005	0.002	0.002				
	(0.003)	(0.002)	(0.007)	(0.004)	(0.003)				
Application Year						0.002	-0.004	-0.001	0.003
						(0.0004)	(0.005)	(0.002)	(0.005)
Observations	11,595	11,595	11,595	11,595	11,595	11,595	11,595	11,595	11,595
Subdistrict FE	Yes	Yes	No	No	No	Yes	No	No	No
App. Window FE	Yes	No	No	No	No	No	No	No	No
County FE	No	No	Yes	No	No	No	Yes	No	No
State FE	No	No	No	Yes	No	No	No	Yes	No
District FE	No	No	No	No	Yes	No	No	No	Yes

Notes. LPM and Probit regressions predicting the probability of receiving the TWI training based on the application date and year. Data are provided at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.6: Correlation Between Application Date and Probability of Receiving the TWI Training, by Application Year

	Probability of Receiving the TWI Training									
	OLS	OLS	OLS	OLS	OLS	Probit	Probit	Probit	Probit	Probit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Application Date*Year1941	-0.024***	-0.001	0.002	0.001	0.002	-0.033***	-0.002	0.003	0.003	0.004
	(0.008)	(0.002)	(0.003)	(0.001)	(0.004)	(0.011)	(0.004)	(0.004)	(0.005)	(0.006)
Application Date*Year1942	-0.046***	-0.002	0.003	-0.001	0.003	-0.048***	-0.003	0.004	-0.002	-0.003
	(0.009)	(0.002)	(0.008)	(0.002)	(0.005)	(0.0010)	(0.003)	(0.005)	(0.003)	(0.004)
Application Date*Year1943	-0.011***	0.002	0.005	-0.001	0.004	-0.016***	0.004	0.007	-0.003	0.004
	(0.003)	(0.003)	(0.007)	(0.002)	(0.006)	(0.004)	(0.005)	(0.008)	(0.005)	(0.003)
Application Date*Year1944	-0.050***	0.002	-0.004	0.004	-0.003	-0.054***	0.001	-0.002	0.005	0.002
	(0.011)	(0.004)	(0.009)	(0.010)	(0.005)	(0.013)	(0.002)	(0.004)	(0.007)	(0.004)
Application Date*Year1945	-0.010***	0.001	0.002	0.002	-0.001	-0.018***	0.002	0.003	0.005	-0.003
	(0.004)	(0.003)	(0.006)	(0.004)	(0.003)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)
Observations	11,595	11,595	11,595	11,595	11,595	11,595	11,595	11,595	11,595	11,595
Subdistrict FE	Yes	Yes	No	No	No	Yes	Yes	No	No	No
Appl. Window FE	Yes	No	No	No	No	Yes	No	No	No	No
County FE	No	No	Yes	No	No	No	No	Yes	No	No
State FE	No	No	No	Yes	No	No	No	No	Yes	No
District FE	No	No	No	No	Yes	No	No	No	No	Yes
F-statistics	37.89	2.12	0.98	3.42	1.73	57.92	2.67	1.91	3.46	2.39

Notes. LPM and Probit regressions predicting the probability of receiving the TWI training based on the application date, distinguishing by application year. Data are provided at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.7: Correlation Between Application Date and Probability of Receiving the TWI Training in a Given Year

	Treatment Year				
	1940	1941	1942	1943	1944
	(1)	(2)	(3)	(4)	(5)
Application Date, App Year=1940	0.001	0.003	0.002	-0.002	-0.003
	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)
Application Date, App Year=1941		-0.002	-0.001	-0.003	0.002
		(0.003)	(0.001)	(0.004)	(0.002)
Application Date, App Year=1942			0.003	0.002	-0.003
			(0.004)	(0.002)	(0.004)
Application Date, App Year=1943				0.004	-0.002
				(0.005)	(0.003)
Application Date, App Year=1944					0.003
					(0.004)
Observations	6,074	6,074	6,074	6,074	6,074
F-statistics	2.84	2.87	1.34	0.19	0.11

Notes. Multinomial logit model predicting the probability of receiving the TWI training in a given year, based on the application date. Data are provided at firm level. The excluded category is the probability of receiving the TWI training in 1945. *** p<0.01, ** p<0.05, * p<0.1.

Table A.8: Correlation Between Application Date and Type of Treatment Received

	Type of TWI Intervention Received				
	HR	IO	2 Interventions	3 Interventions	*F*-stat
	(1)	(2)	(3)	(4)	(5)
Application Year	-0.001	0.002	-0.006	0.003	3.57
	(0.004)	(0.004)	(0.007)	(0.004)	
Application Date, App Year=1940	-0.003	-0.004	0.002	0.001	2.12
	(0.005)	(0.011)	(0.004)	(0.002)	
Application Date, App Year=1941	0.002	0.003	0.002	-0.003	1.59
	(0.002)	(0.004)	(0.003)	(0.004)	
Application Date, App Year=1942	0.001	-0.002	-0.002	-0.002	1.59
	(0.001)	(0.003)	(0.003)	(0.003)	
Application Date, App Year=1943	-0.004	0.001	0.001	0.002	3.02
	(0.005)	(0.002)	(0.002)	(0.004)	
Application Date, App Year=1944	0.006	0.003	0.003	0.001	1.07
	(0.007)	(0.004)	(0.004)	(0.002)	
Application Date, App Year=1945	0.003	0.002	0.003	0.003	0.82
	(0.010)	(0.003)	(0.007)	(0.005)	
Observations	6,074	6,074	6,074	6,074	

Notes. Multinomial logit model predicting the probability of receiving the a specific TWI training, based on the application date. Data are provided at firm level. The excluded category is firms that received only the OP training. *** p<0.01, ** p<0.05, * p<0.1.

Table A.9: Test for Autocorrelation between Current and Past Instructors Composition per Subdistrict

	Perc. Full-Time$_t$	Perc. OP$_t$	Perc. HR$_t$	Perc. IO$_t$	Top/Middle$_t$
	(1)	(2)	(3)	(4)	(5)
Perc. Full-Time$_{t-1}$	-0.003				
	(0.004)				
Perc. OP$_{t-1}$		0.004			
		(0.006)			
Perc. HR$_{t-1}$			0.002		
			(0.003)		
Perc. IO$_{t-1}$				-0.002	
				(0.002)	
Top/Middle$_{t-1}$					-0.001
					(0.003)
Observations	2,124	2,124	2,124	2,124	2,124
Subdistrict	354	354	354	354	354
F-statistics	1.12	1.03	1.44	1.38	1.25

Notes. Autocorrelation between the current and past composition of instructors at the subdistrict level. *Perc. Full-time* is the percentage of full-time instructors assigned to each subdistrict and application window, *Perc. OP, HR, IO* is the percentage of instructors in OP, HR and IO, respectively and *Top/Middle* is the ratio between instructors for top and middle managers. The *F*-statistics tests for autocorrelation in panel data (Wooldridge test). *** p<0.01, ** p<0.05, * p<0.1.

Table A.10: Balancing Tests in 1939 for Firms that Applied to the TWI Program

	Type of Intervention Received					Test of Equality
	OP	HR	IO	2 TWI	3 TWI	p-value
	(1)	(2)	(3)	(4)	(5)	(6)
Number of Plants	-0.13	0.15	-0.09	0.08	-0.07	0.773
	(0.17)	(0.22)	(0.18)	(0.20)	(0.10)	
Number of Employees	5.67	-4.58	3.89	-5.55	3.42	0.658
	(6.89)	(5.71)	(4.89)	(5.02)	(3.73)	
Current assets (m USD)	-3.41	-3.89	4.55	4.74	3.87	0.590
	(5.89)	(4.42)	(4.01)	(4.97)	(3.98)	
Annual sales (m USD)	4.45	2.78	-3.41	-4.32	2.34	0.742
	(7.71)	(3.55)	(4.78)	(5.68)	(3.41)	
Value added (m USD)	1.89	1.75	-1.56	-1.44	1.78	0.542
	(2.13)	(3.45)	(1.90)	(2.03)	(1.83)	
Age	-0.58	0.41	0.33	-0.49	0.38	0.811
	(0.98)	(0.57)	(0.45)	(0.66)	(0.41)	
Productivity (log TFPR)	0.11	-0.13	0.09	0.10	-0.07	0.413
	(0.18)	(0.24)	(0.18)	(0.14)	(0.13)	
Agriculture	-0.02	0.01	0.04	0.03	-0.02	0.888
	(0.05)	(0.07)	(0.06)	(0.04)	(0.04)	
Manufacturing	0.04	-0.05	-0.03	0.03	0.01	0.849
	(0.06)	(0.08)	(0.02)	(0.05)	(0.03)	
Transportation	0.02	0.01	-0.05	-0.03	0.04	0.702
	(0.06)	(0.05)	(0.07)	(0.06)	(0.05)	
Services	0.02	-0.04	-0.01	0.03	0.04	0.574
	(0.03)	(0.05)	(0.07)	(0.06)	(0.04)	
Share African-Americans	0.03	-0.02	0.04	-0.05	0.01	0.872
	(0.06)	(0.03)	(0.05)	(0.04)	(0.02)	
Share Women	-0.05	0.06	-0.01	0.02	-0.03	0.628
	(0.07)	(0.08)	(0.03)	(0.05)	(0.04)	
Years of Education	1.33	-1.56	0.57	-1.93	0.88	0.733
	(1.78)	(2.03)	(1.54)	(2.38)	(1.26)	
Age of Workers	2.41	-3.17	1.27	-0.98	1.04	0.691
	(3.45)	(3.03)	(1.97)	(1.56)	(1.77)	
Observations	11,575	11,575	11,575	11,575	11,575	11,575

Notes. Column 1, 2, 3, 4, and 5 report the coefficients estimated from regressing each variable on indicators for the type of TWI intervention that firms eventually received and a set of district fixed effects. Column 6 reports the p-value for testing that all coefficients are jointly equal to zero. Data are provided at the firm level. *Number of Plants* is the total number of plants per firm; *Number of Employees* measures the number of employees per firm; *Current assets (m USD)*, *Annual sales (m USD)*, and *Value added (m USD)* are expressed in million 2019 USD; *Productivity (logged TFPR)* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *Agriculture*, *Manufacturing*, *Transportation*, and *Services* are indicators that equal one if, respectively, a firm operates in agriculture, manufacturing, transportation, or services. *Share African-Americans* is the share of African-American workers out of firm total labor force; *Share Women* is the share of female workers out of firm total labor force; *Year of Education* is the average number of school education of firm total labor force; *Age of Workforce* is the average age of firm total labor force. The last for variables come from firm replacement lists and are recorded in 1942. *** p<0.01, ** p<0.05, * p<0.1

Table A.11: Pre-TWI Differences in Time Trends between Treated and Control Firms, 1935-1939

	Plants	Employees	Assets	Sales	Value Added	Age	TFPR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time Trend x OP	-0.005	0.006	-0.004	-0.003	-0.002	0.003	-0.003
	(0.008)	(0.007)	(0.008)	(0.006)	(0.004)	(0.004)	(0.004)
OP	0.005	0.004	0.002	0.004	-0.005	-0.001	0.004
	(0.007)	(0.007)	(0.004)	(0.005)	(0.004)	(0.003)	(0.005)
Time Trend x HR	0.006	-0.003	0.005	-0.004	-0.005	-0.002	-0.004
	(0.005)	(0.009)	(0.007)	(0.006)	(0.008)	(0.005)	(0.006)
HR	0.006	0.009	-0.004	-0.006	-0.003	-0.005	-0.002
	(0.009)	(0.008)	(0.007)	(0.007)	(0.009)	(0.007)	(0.004)
Time Trend x IO	-0.004	0.003	-0.002	0.002	0.004	-0.005	0.007
	(0.006)	(0.007)	(0.005)	(0.004)	(0.005)	(0.004)	(0.009)
IO	-0.001	0.003	-0.004	-0.008	0.006	0.004	0.005
	(0.002)	(0.005)	(0.005)	(0.011)	(0.008)	(0.006)	(0.006)
Observations	43,430	43,430	43,430	43,430	43,430	43,430	43,430
County x Sector x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics	2.78	3.22	1.67	2.54	3.89	4.09	3.51

Notes. OLS regressions predicting outcomes between 1935 and 1939 for 11,575 firms that applied to the TWI program. Data are provided at the firm level. Outcomes are allowed to vary according to a linear time (year) trend. The excluded year is 1935. Standard errors are clustered at the subdistrict level. All the dependent variables are expressed in logs. *Plants* is the total number of plants per firm; *Employees* measures the number of employees per firm; *Assets*, *Sales*, and *Value Added* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method. The *F*-statistics test whether all the coefficients on the interaction terms are jointly zero. *** p<0.01, ** p<0.05, * p<0.1.

Table A.12: Pre-TWI Differences in Yearly Trends between Treated and Control Firms, 1935-1939

	Plants	Employees	Assets	Sales	Value Added	Age	TFPR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OP x 1936	0.002	-0.006	0.005	-0.004	0.005	-0.004	0.005
	(0.005)	(0.009)	(0.007)	(0.006)	(0.008)	(0.005)	(0.008)
OP x 1937	0.006	0.009	-0.004	0.006	0.003	-0.005	-0.002
	(0.009)	(0.008)	(0.007)	(0.007)	(0.009)	(0.007)	(0.004)
OP x 1938	0.001	0.003	-0.004	-0.008	0.006	0.004	0.005
	(0.002)	(0.005)	(0.005)	(0.011)	(0.008)	(0.006)	(0.006)
OP x 1939	0.007	0.005	-0.009	0.006	0.003	0.009	0.007
	(0.010)	(0.009)	(0.008)	(0.007)	(0.005)	(0.011)	(0.013)
HR x 1936	-0.008	-0.004	0.003	0.011	0.005	0.008	0.014
	(0.015)	(0.006)	(0.008)	(0.014)	(0.007)	(0.009)	(0.017)
HR x 1937	-0.001	0.005	-0.002	0.013	-0.002	0.006	-0.007
	(0.004)	(0.008)	(0.002)	(0.018)	(0.008)	(0.005)	(0.010)
HR x 1938	0.006	0.009	0.003	0.004	-0.007	-0.002	0.005
	(0.010)	(0.011)	(0.007)	(0.006)	(0.008)	(0.003)	(0.009)
HR x 1939	-0.002	0.004	-0.004	0.003	-0.002	0.006	0.005
	(0.003)	(0.006)	(0.005)	(0.007)	(0.005)	(0.010)	(0.008)
IO x 1936	0.003	0.005	-0.002	0.005	0.003	0.001	-0.004
	(0.007)	(0.009)	(0.004)	(0.008)	(0.004)	(0.002)	(0.005)
IO x 1937	-0.004	0.007	-0.005	-0.003	0.002	-0.008	0.003
	(0.004)	(0.009)	(0.006)	(0.004)	(0.004)	(0.010)	(0.008)
IO x 1938	-0.003	0.005	0.004	-0.004	0.003	-0.001	-0.004
	(0.005)	(0.009)	(0.003)	(0.005)	(0.009)	(0.002)	(0.005)
IO x 1939	-0.004	-0.005	-0.003	0.002	-0.006	-0.004	0.003
	(0.007)	(0.011)	(0.004)	(0.004)	(0.010)	(0.005)	(0.004)
Observations	43,430	43,430	43,430	43,430	43,430	43,430	43,430
County x Sector x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics	3.49	2.38	3.82	1.28	3.78	3.99	0.99

Notes. OLS regressions predicting outcomes between 1935 and 1939 for the 11,575 firms that applied to the TWI program. Data are provided at the firm level. Outcomes are allowed to vary according to a year-specific trend. Standard errors are clustered at the subdistrict level. All the dependent variables are expressed in logs. *Plants* is the total number of plants per firm; *Employees* measures the number of employees per firm; *Assets*, *Sales*, and *Value Added* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method. The *F*-statistics test whether all the coefficients are jointly zero. *** p<0.01, ** p<0.05, * p<0.1.

Table A.13: Cox Survival Model Estimation of Firm Shutdown Hazard

	Shut-Down Hazard Ratio			
	Proportional hazard ratio (1–4)			
	(1)	(2)	(3)	(4)
OP	0.887***	0.876***	0.870***	0.851****
	(0.089)	(0.091)	(0.091)	(0.082)
HR	0.822***	0.813***	0.830***	0.800****
	(0.065)	(0.061)	(0.072)	(0.070)
IO	0.854***	0.842***	0.861***	0.829****
	(0.081)	(0.083)	(0.088)	(0.085)
Observations	7,274	7,274	7,274	7,274
Failures	362	362	362	362
Subdistrict FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Pre-TWI Controls	No	No	No	Yes

Notes. Shutdown hazard ratio estimated from the Cox survival model $h(t) = h_0(t)\exp(\beta_1 \cdot \text{OP} + \beta_2 \cdot \text{HR} + \beta_3 \cdot \text{IO} + \epsilon)$, where $h(t)$ is the hazard of shutdown t years after the TWI intervention. The variable *OP* is an indicator that equals 1 for firms that received Factory Operation; *HR* is an indicator that equals 1 for firms that received Human Resources; *IO* an indicator that equals 1 is for firms that received Inventory, Order, and Sales. The hazard ratios reported in the table minus 1 measure the difference in the yearly probability of shutdown between treated (with either OP, HR, or IO training) and control firms after the TWI intervention. *** p<0.01, ** p<0.05, * p<0.1.

Table A.14: Effects of OP, HR and IO on Firm Performance with Different Controls

	Sales (1-3)			TFPR (4-6)			ROA (7-9)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
OP*post	0.023***	0.022***	0.029***	0.020***	0.019***	0.030***	0.014***	0.012***	0.020***
	(0.005)	(0.006)	(0.004)	(0.004)	(0.006)	(0.004)	(0.003)	(0.005)	(0.006)
HR*post	0.051***	0.052***	0.058***	0.042***	0.040***	0.053***	0.035***	0.032***	0.043***
	(0.007)	(0.008)	(0.006)	(0.006)	(0.007)	(0.005)	(0.007)	(0.010)	(0.010)
IO*post	0.030***	0.032***	0.035***	0.037***	0.040***	0.045***	0.022***	0.020***	0.028***
	(0.005)	(0.007)	(0.004)	(0.005)	(0.006)	(0.007)	(0.005)	(0.006)	(0.005)
County-Year FE	Yes	No	No	Yes	No	No	Yes	No	No
Dis-Sec.-Year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Trainers FE	No	Yes	No	No	Yes	No	No	Yes	No
Sample	Bal.	Bal.	Unbal.	Bal.	Bal.	Unbal.	Bal.	Bal.	Unbal.
Test OP=HR	75.43	71.64	71.85	85.67	81.43	91.54	54.62	58.93	55.61
Test HR=IO	57.89	54.32	64.32	87.73	88.76	97.63	68.76	70.93	63.41
Test OP=IO	50.98	48.77	59.73	71.34	74.72	76.56	96.54	92.21	79.84
Observations	145,480	145,480	164,542	145,480	145,480	164,542	145,480	145,480	164,542

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. The bottom part of the table reports F-statistics from equality tests between the estimated coefficients. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.15: IV Results on the Effects of OP, HR and IO on Firm Performance

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
OP * post	0.035***	0.033***	0.030***	0.028***	0.019***	0.017***
	(0.005)	(0.008)	(0.006)	(0.008)	(0.003)	(0.004)
HR * post	0.061***	0.065***	0.056***	0.059***	0.041***	0.044***
	(0.006)	(0.008)	(0.009)	(0.011)	(0.007)	(0.009)
IO * post	0.037***	0.039***	0.045***	0.048***	0.029***	0.032***
	(0.005)	(0.006)	(0.010)	(0.011)	(0.006)	(0.007)
Dis-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Observations	145,480	145,480	145,480	145,480	145,480	145,480

Notes. This table shows IV estimates. The shares of instructors trained in OP, HR, and IO assigned to each subdistrict and application window instrument for the main treatment variables (OP, HR, IO). *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. The first stage of these IV regressions is shown in Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Table A.16: Effects of OP, HR, and IO on Additional Firm Outcomes

	Government Sales	Government TFPR	N. War Contracts	Value War Contracts	Post-War Refunds
	(1)	(2)	(3)	(4)	(5)
OP*post	0.003	0.015***	-0.002	0.004	-0.003
	(0.004)	(0.006)	(0.005)	(0.007)	(0.004)
HR*post	0.002	0.032***	0.004	0.007	0.004
	(0.004)	(0.008)	(0.007)	(0.009)	(0.007)
IO*post	-0.002	0.023***	-0.003	-0.002	-0.001
	(0.005)	(0.007)	(0.005)	(0.004)	(0.002)
Dis.-Sec.-Year FE	Yes	Yes	Yes	Yes	Yes
Test OP=HR	2.34	54.31	3.87	3.12	1.34
Test HR=IO	1.97	56.44	2.78	2.09	1.99
Test OP=IO	2.45	52.98	1.03	0.87	1.56
Observations	36,370	36,370	36,370	36,370	29,096

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Inventory* are expressed in million 2019 USD*; Government sales*, expressed in million 2019 USD, are the sales made directly to the government; *Government TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method, using only revenues from government contracts; *N War Contracts* and *Value War Contracts* are the number and value of war supply contracts granted to a firm. *Post-War Refunds* are subsidies given by the government to war contractors to switch from military to civil production after WWII. The bottom part of the table reports F-statistics from equality tests between the estimated coefficients. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.17: Heterogenous Effects by Sector

	Sales	TFPR	ROA		Sales	TFPR	ROA
	(1)	(2)	(3)		(5)	(6)	(7)
A. Agriculture				C. Transportation			
OP*post	0.015***	0.012***	0.010***	OP*post	0.028***	0.025***	0.018***
	(0.005)	(0.004)	(0.004)		(0.007)	(0.006)	(0.004)
HR*post	0.030***	0.024***	0.023***	HR*post	0.056***	0.047***	0.040***
	(0.005)	(0.007)	(0.005)		(0.005)	(0.007)	(0.007)
IO*post	0.024***	0.027***	0.016***	IO*post	0.035***	0.040***	0.026***
	(0.006)	(0.005)	(0.004)		(0.007)	(0.006)	(0.005)
B. Manufacturing				D. Services			
OP*post	0.033***	0.028***	0.020***	OP*post	0.024***	0.020***	0.016***
	(0.010)	(0.007)	(0.005)		(0.006)	(0.004)	(0.005)
HR*post	0.062***	0.057***	0.045***	HR*post	0.050***	0.043***	0.035***
	(0.013)	(0.011)	(0.010)		(0.015)	(0.010)	(0.006)
IO*post	0.042***	0.048***	0.032***	IO*post	0.030***	0.034***	0.022***
	(0.014)	(0.008)	(0.006)		(0.008)	(0.010)	(0.006)
Dis.-Sec.-Year FE	Yes	Yes					

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.18: Effects of Enlistment on Firm Performance

	Sales		TFPR		ROA	
	(1)	(2)	(3)	(4)	(5)	(6)
Log number draftees*OP*post	-0.009***	-0.008***	-0.012***	-0.010***	-0.006***	-0.004***
	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)	(0.001)
Log number draftees*HR*post	-0.001	-0.002	-0.002	-0.000	-0.000	0.001
	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Log number draftees*IO*post	-0.005**	-0.004**	-0.007***	-0.008***	-0.005**	-0.005**
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)	(0.002)
OP*post	0.024***	0.022***	0.020***	0.022***	0.014***	0.015***
	(0.006)	(0.005)	(0.005)	(0.007)	(0.004)	(0.005)
HR*post	0.055***	0.053***	0.041***	0.044***	0.039***	0.037***
	(0.005)	(0.007)	(0.007)	(0.010)	(0.007)	(0.005)
IO*post	0.034***	0.031***	0.038***	0.039***	0.022***	0.024***
	(0.004)	(0.005)	(0.006)	(0.009)	(0.004)	(0.005)
Dis-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	No	Yes	No	Yes
Observations	145,480	145,480	145,480	145,480	145,480	145,480

Notes. The table shows only the main coefficients from triple-difference specification. The estimates of Log number draftees*post are not shown. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. The bottom part of the table reports F-statistics from equality tests between the estimated coefficients. *** p<0.01, ** p<0.05, * p<0.1.

Table A.19: Effects of Enlistment on Workforce Composition, 1941-1945

	Share African-American		Share Women		Log Years Education		Log Age Workforce	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log number draftees*post OP	0.013***	0.011***	0.009***	0.008***	-0.032***	-0.030***	-0.015***	-0.016***
	(0.003)	(0.004)	(0.002)	(0.002)	(0.005)	(0.006)	(0.005)	(0.006)
Log number draftees*post HR	0.005**	0.005**	0.005***	0.006**	-0.003	-0.004	-0.003	-0.002
	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.005)	(0.006)	(0.002)
Log number draftees*post IO	0.010***	0.009***	0.005***	0.004***	-0.027***	-0.023***	-0.011***	-0.008***
	(0.004)	(0.003)	(0.002)	(0.002)	(0.006)	(0.008)	(0.003)	(0.004)
OP*post	0.003	0.004	-0.002	-0.004	0.004	0.003	-0.002	-0.004
	(0.005)	(0.006)	(0.003)	(0.007)	(0.005)	(0.004)	(0.005)	(0.008)
HR*post	-0.002	-0.003	0.005	0.004	0.055***	0.052***	0.012***	0.014***
	(0.003)	(0.004)	(0.007)	(0.004)	(0.016)	(0.011)	(0.004)	(0.005)
IO*post	-0.004	-0.002	0.003	0.005	-0.003	-0.004	0.003	0.005
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.007)	(0.006)
Dis-Sec.-Year FE	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	No	Yes	No	Yes	No	Yes
Observations	24,260	24,260	24,260	24,260	24,260	24,260	24,260	24,260

Notes. The table shows only the main coefficients from triple-difference specification. The estimates of Log number draftees*post are not shown. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.20: Heterogenous Effects by Switching to War Production

	Sales		TFPR		ROA	
	Same	Different	Same	Different	Same	Different
	(1)	(2)	(3)	(4)	(5)	(6)
OP*post	0.030***	0.015**	0.026***	0.012**	0.021***	0.009*
	(0.006)	(0.007)	(0.004)	(0.006)	(0.005)	(0.005)
HR*post	0.057***	0.052***	0.051***	0.048***	0.042***	0.038***
	(0.010)	(0.012)	(0.015)	(0.013)	(0.011)	(0.010)
IO*post	0.039***	0.025**	0.045***	0.030**	0.028***	0.018**
	(0.012)	(0.013)	(0.015)	(0.014)	(0.004)	(0.009)
Dis-Sec.-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	145,480	145,480	145,480	145,480	145,480	145,480

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. *Same* refers to firms which continued producing the same or similar products as before the war. *Different* refers to firms that completely changed their products to match war needs. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.21: Balancing Tests for Treated Firms Across Different Treatments and Control Firms

	Plants	Employees	Assets	Sales	Value Added	Age	TFPR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OP	-0.002	-0.005	0.004	-0.010	0.006	0.002	-0.006
	(0.003)	(0.009)	(0.005)	(0.016)	(0.008)	(0.004)	(0.010)
HR	0.004	0.007	-0.003	0.001	0.007	0.004	0.003
	(0.005)	(0.008)	(0.007)	(0.002)	(0.008)	(0.005)	(0.004)
IO	0.003	0.005	-0.002	0.005	-0.008	-0.003	0.007
	(0.007)	(0.009)	(0.004)	(0.008)	(0.007)	(0.004)	(0.008)
OP+HR	-0.004	0.007	-0.005	-0.003	0.005	0.003	-0.002
	(0.004)	(0.009)	(0.006)	(0.004)	(0.005)	(0.006)	(0.004)
HR+OP	0.004	-0.006	0.005	-0.001	0.003	0.004	-0.007
	(0.003)	(0.005)	(0.004)	(0.002)	(0.007)	(0.003)	(0.010)
HR+IO	-0.003	0.009	-0.005	0.002	-0.004	-0.003	0.005
	(0.004)	(0.011)	(0.006)	(0.004)	(0.005)	(0.005)	(0.009)
IO+HR	0.004	0.003	-0.005	-0.009	0.008	-0.004	-0.005
	(0.005)	(0.005)	(0.007)	(0.010)	(0.007)	(0.007)	(0.011)
OP+IO	0.002	-0.005	-0.010	0.006	-0.003	-0.009	0.005
	(0.004)	(0.007)	(0.012)	(0.009)	(0.006)	(0.012)	(0.008)
IO+OP	0.008	0.006	-0.004	-0.006	0.005	-0.002	-0.005
	(0.012)	(0.008)	(0.009)	(0.008)	(0.004)	(0.004)	(0.008)
Observations	4,928	4,928	4,928	4,928	4,928	4,928	4,928

Notes. Coefficients estimated from regressing each variable in the first row on indicators for the type of TWI intervention that firms eventually received and a set of district fixed effects. *Number of Plants* is the total number of plants per firm; *Number of Employees* measures the number of employees per firm; *Current assets (m USD)*, *Annual sales (m USD)*, and *Value added (m USD)* are expressed in million 2019 USD; *Productivity (logged TFPR)* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method. *** p<0.01, ** p<0.05, * p<0.1.

Table A.22: Pre-TWI in Time Trends between Firms Treated with Different Treatments and Control Firms, 1935-1939

	Plants	Employees	Assets	Sales	Value Added	Age	TFPR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OP*Time Trend	0.002	-0.006	0.005	-0.004	0.005	-0.004	0.005
	(0.005)	(0.009)	(0.007)	(0.006)	(0.008)	(0.005)	(0.008)
HR*Time Trend	0.006	0.009	-0.004	0.006	0.003	-0.005	-0.002
	(0.009)	(0.008)	(0.007)	(0.007)	(0.009)	(0.007)	(0.004)
IO*Time Trend	0.001	0.003	-0.004	-0.008	0.006	0.004	0.005
	(0.002)	(0.005)	(0.005)	(0.011)	(0.008)	(0.006)	(0.006)
(OP+HR)*Time Trend	-0.004	-0.007	0.004	0.008	-0.003	0.004	-0.007
	(0.005)	(0.009)	(0.005)	(0.011)	(0.004)	(0.005)	(0.011)
(HR+OP)*Time Trend	0.010	0.008	-0.004	0.005	-0.008	-0.017	0.002
	(0.014)	(0.012)	(0.008)	(0.011)	(0.012)	(0.023)	(0.005)
(HR+IO)*Time Trend	0.013	0.009	0.015	0.006	-0.004	0.003	-0.005
	(0.021)	(0.014)	(0.023)	(0.006)	(0.007)	(0.006)	(0.008)
(IO+HR)*Time Trend	0.002	-0.004	0.013	0.012	-0.010	-0.014	-0.005
	(0.003)	(0.005)	(0.011)	(0.013)	(0.014)	(0.017)	(0.004)
(OP+IO)*Time Trend	-0.005	0.012	-0.001	-0.002	0.008	0.009	0.004
	(0.011)	(0.018)	(0.004)	(0.006)	(0.009)	(0.015)	(0.009)
(IO+OP)*Time Trend	0.008	0.002	0.004	0.014	0.005	0.008	-0.012
	(0.012)	(0.005)	(0.009)	(0.028)	(0.008)	(0.014)	(0.011)
Observations	43,430	43,430	43,430	43,430	43,430	43,430	43,430
County x Sector x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes. OLS regressions predicting firm outcomes in the TWI pre-period. Data are provided at the firm level. Outcomes are allowed to vary according to a linear time (year) trend and for each treatment or treatment combinations that firms received. The excluded year is 1935. Standard errors are clustered at the subdistrict level. All the dependent variables are expressed in logs. *Plants per firm* is the total number of plants per firm; *Employees per firm* measures the number of employees per firm; *Current assets*, *Annual sales*, and *Value added* are in 2019 USD; *Productivity (log TFPR)* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method. *** p<0.01, ** p<0.05, * p<0.1.

Table A.23: Effects of Two TWI Trainings on Firm Performance

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(7)	(8)
test HR=OP+HR	43.56	51.97	62.84	68.72	54.31	52.11
test OP=HR+OP	48.68	49.46	53.01	58.55	61.25	62.04
test HR=IO+HR	62.25	68.43	81.48	87.78	50.71	53.22
test IO=HR+IO	77.41	71.24	53.96	49.65	70.08	78.44
test IO=OP+IO	2.77	3.08	2.77	3.08	2.77	3.08
test OP=IO+OP	2.48	3.72	1.43	1.72	2.49	2.55
test HR+OP=OP+HR	1.11	1.40	3.49	2.46	3.51	3.72
test HR+IO=IO+HR	2.55	2.21	2.97	2.75	0.84	0.80
test IO+OP=OP+IO	1.37	1.60	3.54	3.73	3.38	3.07
District FE	Yes	No	Yes	No	Yes	No
County FE	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	198,720	198,720	198,720	198,720	198,720	198,720

Notes. *F*-statistics from equality tests between the estimated coefficients. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital.

Table A.24: Management Practices Adopted by Firms: Survey Data

	TWI Training Received					
	OP+HR	HR+OP	IO+HR	HR+IO	IO+OP	OP+IO
	(1)	(2)	(3)	(4)	(5)	(6)
(1) Machine Repairs	-0.112***	-0.240***	0.009	0.003	-0.245***	0.003
	(0.034)	(0.061)	(0.011)	(0.005)	(0.055)	(0.004)
(2) Worker's Injuries	-0.191***	-0.325***	0.004	0.005	-0.329***	-0.001
	(0.055)	(0.075)	(0.006)	(0.007)	(0.066)	(0.003)
(3) Register Causes of Breakdown	0.098***	0.726***	0.005	-0.002	0.738***	-0.002
	(0.028)	(0.199)	(0.009)	(0.008)	(0.196)	(0.005)
(4) Job Description Managers	0.931***	-0.004	0.007	-0.007	-0.002	-0.005
	(0.158)	(0.004)	(0.009)	(0.008)	(0.003)	(0.007)
(5) Job Description Workers	0.955***	-0.003	0.895***	-0.002	0.003	-0.005
	(0.234)	(0.005)	(0.123)	(0.005)	(0.005)	(0.004)
(6) Training for Workers	0.881***	0.004	0.871***	0.001	-0.004	0.003
	(0.201)	(0.006)	(0.187)	(0.002)	(0.006)	(0.005)
(7) Introduction of Bonus	0.878***	-0.004	0.912***	0.003	-0.004	0.004
	(0.254)	(0.007)	(0.128)	(0.004)	(0.006)	(0.006)
(8) Suggestions from Workers	0.865***	-0.003	0.891***	0.002	0.005	-0.002
	(0.203)	(0.004)	(0.289)	(0.004)	(0.006)	(0.004)
(9) Unused Input	-0.002	0.002	-0.151***	-0.688***	-0.673***	-0.655***
	(0.003)	(0.004)	(0.005)	(0.111)	(0.143)	(0.125)
(10) Production Planning	0.003	0.001	0.082***	0.871***	0.893***	0.893***
	(0.004)	(0.002)	(0.022)	(0.119)	(0.124)	(0.127)
(11) Marketing	0.004	0.003	0.112***	0.865***	0.855***	0.858***
	(0.006)	(0.005)	(0.122)	(0.283)	(0.246)	(0.246)
Observations	38,830	38,830	38,830	38,830	38,830	38,830

Notes. Each row represents a separate regressions whose dependent variable is one of the 11 management practices listed in the first column (indicators that equal one for firms implementing that management practice). *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the plant level. These regressions also include controls for the application date and district-sector-year fixed effects. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.25: Effects of Three TWI Trainings on Firm Performance

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
HR After (OP+IO) * post	0.087***	0.084***	0.072***	0.071***	0.088***	0.085***
	(0.010)	(0.012)	(0.008)	(0.009)	(0.011)	(0.015)
HR After (IO+OP) * post	0.085***	0.088***	0.075***	0.072***	0.085***	0.083***
	(0.011)	(0.015)	(0.009)	(0.013)	(0.012)	(0.014)
OP After (HR+IO) * post	0.031***	0.028***	0.026***	0.025***	0.024***	0.021***
	(0.008)	(0.011)	(0.006)	(0.009)	(0.008)	(0.009)
OP After (IO+HR) * post	0.034***	0.030***	0.029***	0.027***	0.023***	0.020***
	(0.009)	(0.012)	(0.008)	(0.006)	(0.005)	(0.008)
IO After (HR+OP) * post	0.050***	0.048***	0.042***	0.043***	0.055***	0.051***
	(0.010)	(0.013)	(0.008)	(0.010)	(0.007)	(0.009)
IO After (OP+HR) * post	0.052***	0.047***	0.045***	0.041***	0.052***	0.049***
	(0.010)	(0.012)	(0.009)	(0.012)	(0.011)	(0.013)
Dis.-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Observations	231,900	231,900	231,900	231,900	231,900	231,900

Notes. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.26: Balancing Tests in 1939

	Plants	Employees	Assets	Sales	Value Added	Age	TFPR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OP	0.009	0.008	0.013	0.011	0.015	0.015	0.008
	(0.011)	(0.010)	(0.015)	(0.014)	(0.019)	(0.018)	(0.010)
HR	0.011	0.009	-0.016	-0.012	0.024	0.022	-0.005
	(0.012)	(0.012)	(0.019)	(0.013)	(0.029)	(0.028)	(0.006)
IO	-0.010	-0.010	0.022	0.020	-0.013	-0.012	0.006
	(0.014)	(0.012)	(0.024)	(0.021)	(0.015)	(0.014)	(0.005)
OP+HR	0.016	0.013	-0.012	-0.011	0.013	0.011	0.011
	(0.018)	(0.015)	(0.014)	(0.013)	(0.016)	(0.015)	(0.010)
HR+OP	0.018	0.016	0.008	0.008	0.022	0.021	0.013
	(0.022)	(0.021)	(0.009)	(0.008)	(0.026)	(0.024)	(0.018)
HR+IO	0.012	0.012	-0.019	-0.015	0.011	0.009	0.020
	(0.015)	(0.013)	(0.021)	(0.020)	(0.014)	(0.012)	(0.023)
IO+HR	0.025	0.021	0.010	0.009	0.015	0.014	0.011
	(0.031)	(0.029)	(0.011)	(0.010)	(0.019)	(0.017)	(0.014)
OP+IO	0.017	0.016	-0.021	-0.019	0.008	0.006	0.018
	(0.024)	(0.022)	(0.023)	(0.020)	(0.009)	(0.008)	(0.021)
IO+OP	0.016	0.013	0.020	0.018	0.009	0.008	-0.017
	(0.022)	(0.020)	(0.027)	(0.022)	(0.010)	(0.007)	(0.025)
HR+OP+IO	-0.004	0.005	0.006	-0.009	0.011	0.012	0.007
	(0.007)	(0.008)	(0.008)	(0.009)	(0.008)	(0.021)	(0.019)
HR+IO+OP	0.006	-0.007	-0.004	0.004	0.009	0.006	0.009
	(0.008)	(0.009)	(0.005)	(0.006)	(0.008)	(0.015)	(0.025)
OP+HR+IO	0.005	0.003	-0.009	0.011	0.004	-0.009	-0.015
	(0.005)	(0.002)	(0.007)	(0.014)	(0.005)	(0.010)	(0.029)
OP+IO+HR	0.007	0.014	0.011	0.012	-0.007	0.008	-0.007
	(0.005)	(0.016)	(0.010)	(0.014)	(0.008)	(0.014)	(0.009)
IO+HR+OP	-0.004	-0.002	0.013	-0.007	0.011	0.011	0.008
	(0.007)	(0.006)	(0.016)	(0.009)	(0.014)	(0.024)	(0.013)
IO+OP+HR	0.011	0.008	-0.011	0.006	-0.015	0.021	0.022
	(0.012)	(0.010)	(0.009)	(0.008)	(0.011)	(0.033)	(0.021)

Notes. Coefficients estimated from regressing each variable on indicators for the type of TWI intervention firms eventually received and a set of district fixed effects. *Number of Plants* is the total number of plants per firm; *Number of Employees* is the number of employees per firm; *Current assets (m USD)*, *Annual sales (m USD)*, and *Value added (m USD)* are expressed in million 2019 USD; *Productivity (logged TFPR)* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method. *** p<0.01, ** p<0.05, * p<0.1.

Table A.27: Time Trends, 1935-1939

	Plants	Employees	Assets	Sales	Value Added	Age	TFPR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OP*Time Trend	-0.005	0.003	0.007	-0.009	-0.007	-0.005	0.003
	(0.007)	(0.005)	(0.008)	(0.007)	(0.009)	(0.006)	(0.005)
HR*Time Trend	0.008	0.007	-0.009	0.013	0.006	0.006	-0.006
	(0.009)	(0.006)	(0.011)	(0.014)	(0.007)	(0.004)	(0.007)
IO*Time Trend	-0.006	-0.009	0.004	-0.004	-0.005	0.002	0.008
	(0.005)	(0.009)	(0.006)	(0.007)	(0.005)	(0.003)	(0.006)
(OP+HR)*Time Trend	0.007	0.013	-0.003	0.005	0.004	0.005	-0.003
	(0.008)	(0.014)	(0.005)	(0.006)	(0.007)	(0.004)	(0.005)
(HR+OP)*Time Trend	-0.004	0.005	0.013	0.002	0.010	0.012	0.004
	(0.006)	(0.007)	(0.012)	(0.002)	(0.011)	(0.013)	(0.006)
(HR+IO)*Time Trend	-0.003	-0.004	0.007	-0.004	-0.002	0.008	0.008
	(0.004)	(0.003)	(0.009)	(0.005)	(0.004)	(0.008)	(0.009)
(IO+HR)*Time Trend	0.002	0.005	-0.003	0.006	0.006	-0.003	-0.011
	(0.003)	(0.005)	(0.005)	(0.007)	(0.007)	(0.006)	(0.013)
(OP+IO)*Time Trend	-0.011	0.006	-0.008	0.004	-0.002	0.005	-0.005
	(0.013)	(0.009)	(0.006)	(0.005)	(0.002)	(0.004)	(0.007)
(IO+OP)*Time Trend	0.005	-0.008	0.005	-0.008	-0.003	0.006	0.006
	(0.006)	(0.010)	(0.004)	(0.009)	(0.005)	(0.007)	(0.005)
(HR+OP+IO)*Time Trend	-0.018	-0.015	0.023	0.024	0.014	0.012	0.017
	(0.021)	(0.018)	(0.026)	(0.025)	(0.012)	(0.011)	(0.019)
(HR+IO+OP)*Time Trend	0.009	0.009	0.015	0.013	-0.007	0.006	-0.011
	(0.012)	(0.011)	(0.019)	(0.017)	(0.008)	(0.009)	(0.012)
(OP+HR+IO)*Time Trend	0.007	0.008	-0.003	-0.002	0.005	0.006	0.015
	(0.009)	(0.009)	(0.006)	(0.004)	(0.004)	(0.007)	(0.016)
(OP+IO+HR)*Time Trend	0.010	0.012	0.009	0.006	-0.011	-0.008	-0.011
	(0.015)	(0.014)	(0.011)	(0.009)	(0.013)	(0.012)	(0.012)
(IO+HR+OP)*Time Trend	-0.017	-0.016	0.011	0.014	0.003	0.003	0.004
	(0.021)	(0.020)	(0.015)	(0.013)	(0.007)	(0.008)	(0.005)
(IO+OP+HR)*Time Trend	0.013	0.009	0.015	0.006	-0.004	-0.004	0.007
	(0.021)	(0.014)	(0.023)	(0.006)	(0.007)	(0.006)	(0.009)

Notes. OLS regressions predicting firm outcomes in the TWI pre-period. Data are provided at the firm level. Outcomes are allowed to vary according to a linear time (year) trend and for each treatment or treatment combinations firms eventually received. Excluded year is 1935. Standard errors are clustered at the subdistrict level. All the dependent variables are expressed in logs. *Plants per firm* is the total number of plants per firm; *Employees per firm* is the number of employees per firm; *Current assets*, *Annual sales*, and *Value added* are in 2019 USD; *Productivity (log TFPR)* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method. *** p<0.01, ** p<0.05, * p<0.1.

Table A.28: Management Practices Adopted by Firms: Survey Data

	TWI Training Received					
	OP+IO+HR	IO+OP+HR	HR+OP+IO	HR+IO+OP	OP+HR+IO	IO+HR+OP
	(1)	(2)	(3)	(4)	(5)	(6)
(1) Machine Repairs	-0.144***	-0.091***	-0.004	-0.255***	0.003	-0.259***
	(0.038)	(0.026)	(0.005)	(0.063)	(0.004)	(0.078)
(2) Worker's Injuries	-0.193***	-0.109***	-0.009	-0.325***	-0.001	-0.312***
	(0.048)	(0.035)	(0.008)	(0.055)	(0.003)	(0.073)
(3) Register Causes of Breakdown	0.112***	-0.098***	0.003	0.777***	-0.002	0.742***
	(0.058)	(0.028)	(0.008)	(0.216)	(0.005)	(0.238)
(4) Job Description Managers	0.925***	0.931***	-0.002	0.005	-0.005	0.005
	(0.151)	(0.158)	(0.002)	(0.008)	(0.007)	(0.008)
(5) Job Description Workers	0.912***	0.953***	0.003	0.003	-0.005	0.009
	(0.222)	(0.229)	(0.007)	(0.009)	(0.004)	(0.011)
(6) Training for Workers	0.881***	0.901***	-0.003	0.001	-0.003	0.002
	(0.211)	(0.301)	(0.004)	(0.003)	(0.004)	(0.002)
(7) Introduction of Bonus	0.893***	0.888***	-0.004	0.006	0.004	0.004
	(0.211)	(0.234)	(0.007)	(0.008)	(0.006)	(0.006)
(8) Suggestions from Workers	0.861***	0.877***	-0.002	0.003	-0.003	0.005
	(0.211)	(0.215)	(0.003)	(0.005)	(0.004)	(0.009)
(9) Unused Input	-0.190***	-0.165***	-0.686***	0.005	-0.692***	0.007
	(0.061)	(0.015)	(0.128)	(0.007)	(0.231)	(0.009)
(10) Production Planning	0.097***	0.092***	0.843***	-0.002	0.851***	0.005
	(0.031)	(0.030)	(0.233)	(0.008)	(0.122)	(0.009)
(11) Marketing	0.142***	0.123***	0.877***	-0.004	0.869***	-0.005
	(0.049)	(0.038)	(0.246)	(0.005)	(0.291)	(0.011)
Observations	42,108	42,108	42,108	42,108	42,108	42,108

Notes. Each row represents a separate regressions whose dependent variable is one of the 11 management practices listed in the first column (indicators that equal one for firms implementing that management practice). *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the plant level. These regressions also include controls for the application date and district-sector-year fixed effects. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.29: Effects of Three TWI Trainings on Firm Performance

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
test IO+OP+HR=OP+HR	43.31	49.38	63.08	67.19	72.93	75.54
test OP+IO+HR=IO+HR	85.85	87.64	55.13	52.39	69.02	62.02
test IO+OP+HR=OP+IO+HR	2.06	2.70	1.87	1.24	2.89	3.45
test HR+OP+IO=OP+IO	74.32	76.12	64.162	65.43	77.34	75.44
test OP+HR+IO=HR+IO	1.49	1.93	2.39	2.14	2.76	2.34
test OP+HR+IO=OP+IO	48.48	49.64	50.24	56.15	70.343	72.25
test IO+HR+OP=HR+OP	1.92	1.18	2.92	2.64	2.33	2.02
District FE	Yes	No	Yes	No	Yes	No
County FE	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	231,900	231,900	231,900	231,900	231,900	231,900

Notes. *F*-statistics from equality tests between the estimated coefficients. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital.

Table A.30: Implementation of Managerial Practices Over Time

	Machine Replacement	Machine Repair	Training	Bonus	Marketing	New Product Lines	Advertising	Inventory
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OP*post1	-0.010	-0.015	0.051***	0.003	0.012	0.005	0.014	0.003
	(0.012)	(0.013)	(0.015)	(0.002)	(0.015)	(0.006)	(0.020)	(0.006)
OP*post5	-0.125***	-0.144***	0.154***	0.005	0.011	0.007	0.012	-0.005
	(0.032)	(0.027)	(0.031)	(0.006)	(0.013)	(0.009)	(0.024)	(0.007)
OP*post10	-0.189***	-0.223***	0.256***	0.003	0.015	0.010	0.016	0.003
	(0.036)	(0.044)	(0.031)	(0.005)	(0.018)	(0.012)	(0.018)	(0.005)
HR*post1	0.002	0.001	0.073***	0.010**	0.015	-0.002	0.010	0.004
	(0.004)	(0.003)	(0.022)	(0.005)	(0.017)	(0.004)	(0.009)	(0.007)
HR*post5	0.001	-0.006	0.169***	0.057***	0.019	0.008	0.020	0.003
	(0.006)	(0.006)	(0.035)	(0.019)	(0.020)	(0.010)	(0.018)	(0.005)
HR*post10	-0.005	0.003	0.328***	0.151***	0.038*	0.015	0.022	-0.005
	(0.008)	(0.005)	(0.047)	(0.045)	(0.021)	(0.016)	(0.026)	(0.007)
IO*post1	-0.003	0.004	0.002	0.002	0.020	0.003	0.025	-0.025***
	(0.005)	(0.007)	(0.003)	(0.004)	(0.015)	(0.005)	(0.033)	(0.010)
IO*post5	0.004	-0.007	0.004	-0.003	0.086***	0.079***	0.078***	-0.055***
	(0.007)	(0.010)	(0.007)	(0.005)	(0.033)	(0.026)	(0.021)	(0.012)
IO*post10	0.002	-0.011	0.007	0.005	0.156***	0.102***	0.197***	-0.091***
	(0.005)	(0.015)	(0.010)	(0.007)	(0.055)	(0.030)	(0.051)	(0.028)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	145,480	145,480	145,480	145,480	145,480	145,480	145,480	145,480

Notes. *Machine replacement* and *machine repairs* are the cost of replace and repair the machines and are expressed in million 2019 USD. *Training* is the cost of on-the-job training programs for firm employees. *Bonus* is the amount of the wage bill dedicated to paying performance-based compensation. *Marketing* and *Advertising* are the expenditures in marketing research and advertising. All these variables come from the balance sheets of U.S. war supply contractors.

Table A.31: Increase in Firm Size Over Time

	Employees	Plants	Acquisition	Investment	% Managers	% White Collars	Strikes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OP*post1	0.002	0.003	0.004	0.009	0.003	-0.002	0.003
	(0.003)	(0.005)	(0.006)	(0.009)	(0.005)	(0.004)	(0.005)
OP*post5	0.010*	0.012*	0.019	0.056***	0.005	0.003	-0.002
	(0.006)	(0.007)	(0.020)	(0.017)	(0.007)	(0.006)	(0.004)
OP*post10	0.022***	0.043***	0.026***	0.087***	0.004	0.005	0.003
	(0.008)	(0.012)	(0.010)	(0.021)	(0.005)	(0.008)	(0.005)
HR*post1	0.031	0.025	0.008	0.015	0.005	0.004	-0.002
	(0.033)	(0.030)	(0.010)	(0.020)	(0.006)	(0.007)	(0.003)
HR*post5	0.044***	0.075***	0.054***	0.123***	0.056***	0.033***	-0.069***
	(0.016)	(0.025)	(0.022)	(0.022)	(0.016)	(0.012)	(0.023)
HR*post10	0.101***	0.122***	0.078***	0.178***	0.131***	0.67***	-0.157***
	(0.032)	(0.044)	(0.022)	(0.036)	(0.027)	(0.021)	(0.035)
IO*post1	0.005	0.004	0.011	0.015	0.002	0.003	0.005
	(0.007)	(0.006)	(0.012)	(0.013)	(0.003)	(0.004)	(0.004)
IO*post5	0.027**	0.032**	0.029**	0.099***	0.012	0.009	-0.002
	(0.014)	(0.015)	(0.013)	(0.028)	(0.015)	(0.012)	(0.004)
IO*post10	0.089***	0.091***	0.067**	0.154***	0.020**	0.011	0.003
	(0.024)	(0.030)	(0.031)	(0.033)	(0.010)	(0.015)	(0.005)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	145,480	145,480	145,480	145,480	145,480	145,480	145,480

Notes. *Acquisition* is the number of firm acquisitions per firm and year. The variables in columns 1 to 6 come from the balance sheets of U.S. war supply contractors. The variable *Strikes*, which measures the number of worker strikes per firm and year, comes from the yearly Bureau of Labor Statistics' Bulletins on strikes and lookouts.

Table A.32: Vertical Spillovers: Effect of TWI on Upstream and Downstream Firms of Applicant Firms

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Top	Middle	Top	Middle	Top	Middle
A. Upstream firms						
OP*post	0.006	0.005	0.004	0.003	0.005	0.003
	(0.007)	(0.008)	(0.004)	(0.005)	(0.006)	(0.005)
HR*post	0.025***	0.018***	0.019***	0.015***	0.014***	0.010***
	(0.006)	(0.007)	(0.005)	(0.004)	(0.005)	(0.004)
IO*post	0.015***	0.010	0.012***	0.008	0.009**	0.007
	(0.005)	(0.007)	(0.005)	(0.006)	(0.004)	(0.005)
B. Downstream firms						
OP*post	0.005	0.004	0.003	0.003	0.004	0.002
	(0.005)	(0.006)	(0.003)	(0.006)	(0.005)	(0.004)
HR*post	0.022***	0.015***	0.016***	0.012***	0.011***	0.007**
	(0.007)	(0.005)	(0.006)	(0.005)	(0.004)	(0.003)
IO*post	0.010***	0.007	0.008**	0.006	0.006***	0.005
	(0.004)	(0.007)	(0.004)	(0.005)	(0.002)	(0.004)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	901,764	901,764	901,764	901,764	901,764	901,764

Notes. This table measures the existence of vertical spillovers by estimating the effect of the TWI program along the supply chain of participating firms. *OP* is an indicator variable for upstream or downstream firms of a firm that received the factory operation training; *HR* is an indicator variable for upstream or downstream firms of a firm that received the human resources training; *IO* is an indicator variable for upstream or downstream firms of a firm that received the inventory, orders, and sales training. The dummy *post* is an indicator variable that equals one after the participating firm received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.33: Effect of TWI on the Selection of Upstream and Downstream Firms

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Top	Middle	Top	Middle	Top	Middle
A. Upstream firms						
OP*post	0.002	0.004	0.003	0.005	0.003	0.002
	(0.003)	(0.005)	(0.005)	(0.007)	(0.004)	(0.003)
HR*post	0.020***	0.015***	0.017***	0.014***	0.010***	0.012***
	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
IO*post	0.012***	-0.004	0.010***	0.005	0.007***	0.002
	(0.005)	(0.006)	(0.004)	(0.007)	(0.002)	(0.004)
B. Downstream firms						
OP*post	0.002	0.003	0.006	0.005	0.003	0.004
	(0.003)	(0.005)	(0.007)	(0.007)	(0.004)	(0.005)
HR*post	0.011***	0.009***	0.007***	0.004***	0.005***	0.004***
	(0.005)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)
IO*post	0.007***	0.005	0.004***	0.002	0.003***	0.006
	(0.003)	(0.007)	(0.002)	(0.003)	(0.001)	(0.007)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	865,453	865,453	865,453	865,453	865,453	865,453

Notes. This table measures selection of upstream or downstream firms after the TWI implementation. The upstream and downstream firms are included only when they join the supply chain of an applicant firm after the beginning of the TWI program (1939) and only during their first year as an upstream or downstream firm of an applicant firm. *OP* is an indicator variable for upstream or downstream firms of a firm that received the factory operation training; *HR* is an indicator variable for upstream or downstream firms of a firm that received the human resources training; *IO* is an indicator variable for upstream or downstream firms of a firm that received the inventory, orders, and sales training. The dummy *post* is an indicator variable that equals one after the participating firm received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.34: Horizontal Spillovers: Effect of TWI on Non-Applicant Firms

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Top	Middle	Top	Middle	Top	Middle
A. Same Sector						
OP*post	-0.007	-0.006	-0.008	-0.006	-0.005	-0.003
	(0.006)	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)
HR*post	-0.005	-0.009**	-0.003	-0.005**	-0.004	-0.008**
	(0.006)	(0.004)	(0.005)	(0.002)	(0.005)	(0.004)
IO*post	-0.008	-0.010	-0.021	-0.010	-0.004	-0.006
	(0.011)	(0.013)	(0.029)	(0.025)	(0.007)	(0.012)
B. Different Sector						
OP*post	0.005	0.002	-0.002	0.004	0.005	0.002
	(0.007)	(0.006)	(0.015)	(0.005)	(0.005)	(0.003)
HR*post	0.001	0.004	-0.003	-0.005	0.004	0.002
	(0.003)	(0.005)	(0.005)	(0.006)	(0.005)	(0.003)
IO*post	0.006	-0.003	0.010	0.008	-0.005	-0.003
	(0.010)	(0.009)	(0.014)	(0.012)	(0.008)	(0.007)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	207,892	207,892	207,892	207,892	207,892	207,892

Notes. This table measures the existence of horizontal spillovers by estimating the effect of the TWI program on non-applicant firms located in the same county of applicant firms. *OP* is an indicator variable for firms located in the same county in which at least one applicant firm received the factory operation training; *HR* is an indicator variable for firms located in the same county in which at least one applicant firm received the human resources training; *IO* is an indicator variable for firms located in the same county in which at least one applicant firm received the inventory, orders, and sales training. The dummy *post* is an indicator variable that equals one after the applicant firm received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.35: Testing the Effects on Top and Middle Managers

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
test middle OP=top OP	3.61	3.44	2.04	2.48	1.27	1.81
test middle OP+top OP=top OP+middle OP	3.02	2.99	2.65	2.87	2.98	2.67
test middle HR=top HR	40.05	48.29	53.01	58.55	61.25	62.04
test middle HR+top HR=top HR+middle HR	0.88	0.97	3.36	3.78	2.91	2.37
test middle IO=top IO	60.74	61.4	41.16	46.4	50.62	54.01
test middle IO+top IO=top IO+middle IO	64.24	63.31	53.96	49.65	43.08	49.71
District FE	Yes	No	Yes	No	Yes	No
County FE	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,274	7,274	7,274	7,274	7,274	7,274

Notes. *F*-statistics from equality tests between the estimated coefficients. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital.

Table A.36: Management Practices Adopted by Firms for Top and Middle Managers Intervention: Survey Data

	TWI Training Received					
	Top OP*post	Middle OP*post	Top HR*post	Middle HR*post	Top IO*post	Middle IO*post
	(1)	(2)	(3)	(4)	(5)	(6)
(1) Intervention for Machine Repairs	-0.255***	-0.239***	0.004	0.006	-0.001	-0.003
	(0.050)	(0.052)	(0.004)	(0.005)	(0.002)	(0.003)
(2) Worker's Injuries	-0.325***	-0.341***	-0.005	-0.002	0.006	0.003
	(0.059)	(0.057)	(0.006)	(0.003)	(0.006)	(0.004)
(3) Register Causes of Breakdown	0.743***	0.758***	-0.004	-0.001	0.001	0.005
	(0.198)	(0.193)	(0.004)	(0.002)	(0.002)	(0.006)
(4) Job Description Managers	0.002	0.004	0.857***	0.948***	-0.005	-0.001
	(0.003)	(0.004)	(0.227)	(0.2221)	(0.005)	(0.002)
(5) Job Description Workers	-0.007	-0.004	0.908***	0.959***	0.002	0.004
	(0.007)	(0.006)	(0.291)	(0.301)	(0.003)	(0.006)
(6) Training for Workers	0.005	0.008	0.793***	0.951***	-0.002	-0.005
	(0.007)	(0.008)	(0.255)	(0.259)	(0.003)	(0.005)
(7) Introduction of Bonus	0.001	0.004	0.801***	0.934***	0.007	0.003
	(0.002)	(0.005)	(0.332)	(0.356)	(0.008)	(0.004)
(8) Suggestions from Workers	0.003	0.003	0.371***	0.785***	0.002	0.005
	(0.005)	(0.005)	(0.101)	(0.234)	(0.003)	(0.006)
(9) Unused Input	-0.003	-0.006	0.003	0.005	-0.856***	-0.591***
	(0.005)	(0.007)	(0.005)	(0.006)	(0.241)	(0.233)
(10) Production Planning	0.007	0.005	0.008	0.004	0.943***	0.791***
	(0.007)	(0.006)	(0.009)	(0.006)	(0.225)	(0.301)
(11) Marketing	-0.005	-0.004	-0.003	-0.005	0.923***	0.753***
	(0.006)	(0.007)	(0.004)	(0.006)	(0.278)	(0.221)
Observations	27,506	27,506	27,506	27,506	27,506	27,506

Notes. Each row represents a separate regression whose dependent variable is one of the 11 management practices listed in the first column (indicators that equal one for firms implementing that management practice). *Top OP* is an indicator variable for firms that received the factory operation training for top managers; *Middle OP* is an indicator variable for firms that received the factory operation training for middle managers; *Top HR* is an indicator variable for firms that received the human resources training for top managers; *Middle HR* is an indicator variable for firms that received the human resources training for middle managers; *Top IO* is an indicator variable for firms that received the inventory, order, and sales training for top managers; *Middle IO* is an indicator variable for firms that received the the inventory, order, and sales training for middle managers; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the plant level. These regressions also include controls for the application date and district-sector-year fixed effects. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.37: Effects of Two Interventions: Top vs Middle Managers

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
Top HR After Top OP*post	0.045***	0.041***	0.040***	0.037***	0.044***	0.042***
	(0.007)	(0.011)	(0.008)	(0.011)	(0.007)	(0.012)
Top HR After Middle OP*post	0.042***	0.037***	0.038***	0.034***	0.046***	0.043***
	(0.009)	(0.012)	(0.007)	(0.010)	(0.006)	(0.013)
Middle HR After Top OP*post	0.083***	0.078***	0.079***	0.076***	0.056***	0.054***
	(0.011)	(0.015)	(0.010)	(0.014)	(0.008)	(0.011)
Middle HR After Middle OP*post	0.087***	0.081***	0.077***	0.054***	0.055***	0.052***
	(0.010)	(0.012)	(0.008)	(0.012)	(0.009)	(0.013)
Top HR After Top IO*post	0.049***	0.047***	0.042***	0.039***	0.039***	0.031***
	(0.005)	(0.010)	(0.007)	(0.008)	(0.007)	(0.011)
Top HR After Middle IO*post	0.047***	0.047***	0.042***	0.039***	0.039***	0.031***
	(0.006)	(0.012)	(0.006)	(0.008)	(0.007)	(0.012)
Middle HR After Top IO*post	0.093***	0.087***	0.078***	0.075***	0.050***	0.048***
	(0.005)	(0.010)	(0.007)	(0.008)	(0.008)	(0.012)
Middle HR After Middle IO*post	0.087***	0.085***	0.077***	0.074***	0.052***	0.049***
	(0.007)	(0.012)	(0.010)	(0.012)	(0.009)	(0.013)
Top IO After Top OP * post	0.045***	0.040***	0.045***	0.043***	0.033***	0.031***
	(0.009)	(0.011)	(0.009)	(0.012)	(0.007)	(0.013)
Top IO After Middle OP * post	0.047***	0.043***	0.041***	0.037***	0.030***	0.029***
	(0.010)	(0.014)	(0.012)	(0.014)	(0.004)	(0.007)
Middle IO After Top OP * post	0.023***	0.021***	0.029***	0.028***	0.020***	0.019***
	(0.005)	(0.007)	(0.006)	(0.010)	(0.004)	(0.005)
Middle IO After Middle OP * post	0.019***	0.018***	0.026***	0.023***	0.019***	0.016***
	(0.004)	(0.006)	(0.005)	(0.007)	(0.005)	(0.004)
Dis.-Sec.-Year FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Year FE	No	Yes	No	Yes	No	Yes
Observations	198,720	198,720	198,720	198,720	198,720	198,720

Notes. *Top* is an indicator variable that equals one if top managers are treated. *Middle* is an indicator variable that equals one if top managers are treated. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.38: Effects of Three Interventions: Top vs Middle Managers

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
topOP+topIO+topHR	0.075***	0.071***	0.062***	0.057***	0.060***	0.059***
	(0.012)	(0.015)	(0.009)	(0.013)	(0.010)	(0.014)
topOP+middleIO+topHR	0.073***	0.070***	0.060***	0.055***	0.057***	0.055***
	(0.009)	(0.013)	(0.009)	(0.015)	(0.008)	(0.012)
middleOP+topIO+topHR	0.078***	0.077***	0.063***	0.060***	0.058***	0.054***
	(0.009)	(0.013)	(0.009)	(0.013)	(0.008)	(0.014)
middleOP+middleIO+topHR	0.079***	0.075***	0.064***	0.058***	0.061***	0.058***
	(0.011)	(0.015)	(0.009)	(0.013)	(0.011)	(0.015)
topOP+topIO+middleHR	0.112***	0.109***	0.101***	0.097***	0.085***	0.082***
	(0.012)	(0.016)	(0.012)	(0.015)	(0.012)	(0.017)
topOP+middleIO+middleHR	0.110***	0.107***	0.099***	0.096***	0.083***	0.080***
	(0.014)	(0.018)	(0.011)	(0.015)	(0.013)	(0.016)
middleOP+topIO+middleHR	0.115***	0.112***	0.107***	0.103***	0.080***	0.078***
	(0.014)	(0.019)	(0.011)	(0.016)	(0.013)	(0.019)
middleOP+middleIO+middleHR	0.113***	0.109***	0.108***	0.105***	0.082***	0.080***
	(0.010)	(0.012)	(0.008)	(0.012)	(0.009)	(0.013)
Dis.-Sec.-Year FE	Yes	No	Yes	No	No	No
Firm FE	No	Yes	No	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	Yes	Yes
Observations	231,900	231,900	231,900	231,900	231,900	231,900

Notes. *Top* is an indicator variable that equals one if top managers are treated. *Middle* is an indicator variable that equals one if top managers are treated. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.39: Complementarity Effects: Top vs Middle Managers, Same Training

	Sales (1-2)		TFPR (3-4)		ROA (5-6)	
	(1)	(2)	(3)	(4)	(5)	(6)
topOP+middleOP	0.001	-0.002	0.003	-0.001	0.002	0.004
	(0.002)	(0.004)	(0.005)	(0.002)	(0.004)	(0.006)
middleOP+topOP	0.004	0.002	0.005	0.004	0.001	-0.001
	(0.006)	(0.002)	(0.007)	(0.006)	(0.002)	(0.003)
topHR+middleHR	0.081***	0.078***	0.075***	0.072***	0.052***	0.050***
	(0.012)	(0.014)	(0.016)	(0.018)	(0.015)	(0.014)
middleHR+topHR	0.022***	0.020***	0.018***	0.025***	0.015***	0.012***
	(0.010)	(0.009)	(0.007)	(0.006)	(0.005)	(0.004)
topIO+middleIO	0.012**	0.010**	0.009**	0.008**	0.014**	0.013**
	(0.006)	(0.005)	(0.004)	(0.004)	(0.007)	(0.006)
middleIO+topIO	0.050***	0.047***	0.045***	0.040***	0.040***	0.035***
	(0.011)	(0.010)	(0.012)	(0.009)	(0.013)	(0.012)
test topOP+middleOP=middleOP	0.98	1.12	2.33	2.67	1.45	1.89
test middleOP+topOP=top OP	1.36	1.23	2.78	2.98	1.78	2.02
test topHR+middleHR=middleHR	44.91	47.67	50.89	48.76	52.31	55.49
test middleHR+topHR=topHR	56.48	58.91	60.78	61.24	65.37	63.29
test topIO+middleIO=middleIO	37.89	39.09	42.73	45.24	43.57	42.38
test middleIO+topIO=topIO	50.34	50.67	52.32	53.46	56.73	60.12
Dis.-Sec.-Year FE	Yes	No	Yes	No	No	No
Firm FE	No	Yes	No	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	Yes	Yes
Observations	43,644	43,644	43,644	43,644	43,644	43,644

Notes. *Top* is an indicator variable that equals one if top managers are treated. *Middle* is an indicator variable that equals one if top managers are treated. *OP* is an indicator variable for firms that received the factory operation training; *HR* is an indicator variable for firms that received the human resources training; *IO* is an indicator variable for firms that received the inventory, orders, and sales training; *post* is an indicator variable that equals one after firm i received a given TWI training. Data are provided at the firm level. *Sales* are expressed in million 2019 USD; *TFPR* is the logarithm of total factor productivity revenue, estimated using the Ackerberg, Caves and Frazer (2015) method; *ROA* is the return-on-assets measured as the ratio between profit and capital. All regressions without firm fixed effects also include a control for the application date to the program. Standard errors are clustered at the subdistrict level. *** p<0.01, ** p<0.05, * p<0.1.

B More Details on the TWI Program

B.1 The Origin of the TWI Method

During World War I, the Emergency Fleet Corporation of the United States Shipping Board promoted a training program to support shipyard workers "due to a ten-fold increase in

demand of the number of workers required" (Huntzinger, 2005, p.7). Because of this increase in demand, only non-experienced workers were available. Therefore, they needed to be trained to become productive in the shortest amount of time possible. Charles Allen, a vocational instructor who had developed and presented his views on industrial training prior to WWI, was asked to lead this training program.

Allen developed a 4-step method to train workers (Allen, 1919). The first step was "preparation" and focused on creating a connection between past experiences and the lesson to be taught in the learner's mind. Although the learner may have no industrial experience, a good instructor will find an analogy or story that will lead the learner to relate the present teaching objective to something he knows. Allen emphasized that even when teaching the simplest skills or jobs, preparation is key to increasing the effectiveness of instruction. The second step called "presentation" was in Allen's words: "to lead [the worker] to 'get' the new idea which the instructor desires to 'tack on' to what he (learner) already knows." Presentation imparts a piece of knowledge to the person being trained, and each piece is only a small part of a larger lesson. An effort must be made by the instructor not to give too much information at one time. This will result in focusing on the individual point to be taught. The format of the presentation step is a well-organized process established prior to the lesson with methods chosen to allow the best direction and theme of the lesson. The presentation process is selected from a variety of methods, as detailed throughout the book, based on both the type of job and the characteristics and level of the learner. The effectiveness of developing the best method of presentation is completely dependent on the skill of the instructor in the following areas: selection of the proper method, organization of the lesson points, and emphasis of the most important points. "Application" was the third step and established if the learner could "do it." Even though the learner may be in the right frame of mind (step 1) and the instructor did an excellent job of presenting the lesson (step 2), the question remains if the new knowledge can be applied. Allen stressed in step 3 that the learning contains no value unless the person can actually do it and do it correctly. The final step was "testing" and was simply allowing the learner to do the job unaided, but viewed by the instructor. If the learner fails to do the work independently, it is a result of the instructor not implementing the proper teaching method. The instruction must be improved and repeated. Allen believed that if each of the lesson steps had been carefully and properly developed and taught, the learner would not have failed during the test step

(for more details on Allen's method, see Huntzinger, 2005).

B.2 Imbalances in the Assignment of Instructors

The Subdistrict Administration and the District Directors repeatedly complained about imbalances in the characteristics of instructors across subdistricts. For instance, Henry Kerr, District 1 Representative, stated that "there is a marked increase, on the part of management of war contractors, in awareness of the need for in-plant training. Many industries in New England will benefit greatly from the TWI program, but this will require a higher proportion of full-time trainers in those subdistricts (TWI Bulletin, 1941)." Similarly, Sterling Mudge, District 4 Representative, argued that "the introduction of TWI served as a definitive vehicle for accomplishing immediate tangible results in the subdistricts with enough number of full-time trainers. There is a definite need for a continuation of such training in plants where it has not yet been introduced. However, this needs a more equal distribution of full-time trainers (TWI Bulletin, 1941, 1943)." Oscar Grothe, District 12 Representative, said: "we feel that the placing of trainers across subdistricts, too unequal not in the number, but in the composition, is the most important challenge the TWI service has to face in the upcoming years (TWI Bulletin, 1942)." Earl Wyatt, District 17 Representative, said that "the progress of in-plant training in this district has not been satisfactory. Only some subdistricts were able to train an adequate number of firms. In other subdistricts, most firms which demanded the TWI services were not trained and it is becoming evidence they might have to wait several months before receiving the TWI service. The top-managers attitude of the old-established plants has not been favorable to the in-plant training. We need a more equal distribution of full-time trainers to train firms in all districts and more trainers for top-managers to explain to them their previous methods on handling production has been completely inadequate (TWI Bulletin, 1944)." George Kirk, District 19 Representative, said that "some of our subdistricts are composed of small firms; some others of very large firms. We need to assign trainers to subdistricts based on the characteristics of firms they are going to offer consulting to (TWI Bulletin, 1942)."

Technical Appendix—Not for Publication

C Data Collection

The data collection targeted the U.S. war contractors that applied for the Training Within the Industry (TWI) program over the ten application windows between 1940 and 1945. We constructed a panel dataset gathering information from a number of different sources.

First, we retrieved and digitized the list of applicant firms from the Training Within the Industry Bulletins, released monthly by the War Manpower Commission between September 1940 and September 1945. We obtained a list of 11,575 applicant firms. For each applicant firm, we know the full name, the location (address, municipality, county and state), as well as the subdistrict to which the firm was assigned, whether it eventually received the TWI training, in which of the J-modules it was trained, the year in which each module was delivered, and whether the training was for top or middle managers. For trained firms, we also collected plant-level survey data compiled by the TWI administration before the program, three months after the TWI, and then each year thereafter until 1945. We accessed the Bulletins through interlibrary borrowing in Winter 2018.

Second, we collected firm performance data from the Mergent Archives between 1935 and 1955 (https://www.mergent.com/solutions/print-digital-archives/mergent-archives). Specifically, we rely on two modules of the Mergent Archives: the Mergent Historical Annual Reports and the Mergent's Full Collection of Digitized Manuals. The Mergent Historical Annual Reports are a collection of worldwide corporate annual reports published since 1844 and retrieved from various sources, such as Mergent's own collection, leading universities and libraries, and private providers. The Mergent's Full Collection of Digitized Manuals provides business descriptions and detailed financial statements from every Mergent/Moody's Manual published since 1918. In particular, we referred to the Industrial Manuals available since 1920, the Transportation Manuals available since 1909, and the Public Utility Manuals available since 1914. We accessed this data in Summer 2016 from the UC Irvine library. We downloaded the data in pdf format and we digitized them between the Fall of 2016 and the Winter of 2019. We checked if more firms had been included in the Mergent Archives in April 2019 from the Northwestern University library. We did not find any additional firm not included in the previous data collection.

Using firm name, address, municipality, county, and state, we uniquely matched all 11,575 TWI applicant firms to the Mergent Archives: we locate 8,681 firms (75 percent) in the Mergent's Full Collection of Digitized Manuals, and the remaining 2,894 (25 percent) in the Mergent Historical Annual Reports.

Finally, we perform the same matching between firms in the Mergent Archives and nonapplicant U.S. war contractors. We were able to match 12,023 out of 14,071 nonapplicant contractors (85.45 percent). The matching rate of nonapplicant firms is lower than the perfect matching of applicant firms. This fact is likely due to the smaller size of nonapplicant firms. The Mergent Archives define themselves as an "online database featuring a vast collection of corporate and industry related documents" from multiple sources. In other words, there is not a formal threshold on firm size that has to be met in order for a firm to be included in the Mergent Archives. In practice, however, publicly traded firms, firms issuing bonds, and firms with more employees are more likely to be included because it is relatively easier to find their balance sheets.

Firms whose workers were drafted between 1942 and 1945 were notified by the Selective Service System and were asked to compile the so-called replacement lists. In the replacement lists, according to the Local Board Release No. 158 (Jan 6, 1942), firms had to list the names of drafted employees, their job titles, and their relative ranking within the firm hierarchy. Moreover, firms included each worker's age, current Selective Service classification, family status, local board identity, and draft order number. On the replacement lists, after the space to identify each drafted worker, there were seven columns. Each of the first six columns represented a month of elapsed time after the filing and acceptance of the replacement schedule. The seventh column represented an indefinite period of time in excess of six months. The employer indicated with a check mark the length of time it would take to secure and train a replacement for each drafted worker. Firms also reported more general characteristics of their labor force, such as the share of African-American workers and women, as well as the average years of education and age of all their employees. Through the replacement lists, they could also ask for exemptions from the draft for some categories of their workers. In fact, according to the Selective Training and Service Act of 1940, men between the ages of 18 and 45 were classified into four categories: (1) men available for training and service; (2) men deferred because of occupational status; (3) men deferred because of dependents; (4) men deferred by law or who were unfit for service. The Selective

Service System, operating at a decentralized level through its 6,443 local boards, processed the exemption requests, mostly based on the information given by the draftees at the time of registering. Managers were usually deferred "in support of national health, safety, or interest" (category II-A).

Upon completion, the replacement schedule was submitted to the office of the local State Director of Selective Service. Then the local State Director of Selective Service determined if the rate of release of the vulnerable men was fair. The release or replacement period dates were amended or corrected to conform to what the State Director deemed necessary and proper. The schedule was then returned to the employer for acceptance or rejection. The replacement lists were archived by the U.S. Selective Service System annually between 1942 and 1945. We accessed this data from the UCLA library in July 2019. Since all TWI applicants had some drafted workers, they all filled at least one replacement list over time. On average, African-American workers were 15 percent of the firm workforce and women were 11 percent. The workforce had on average 10 years of education and an average age of 28 years.[37]

We digitized all the data from either physical books and pdfs with the help of freelancers hired on a popular online marketplace. To test the quality of the freelancers, we prepared a guideline document and tested their ability to transcribe the data into Excel spreadsheets. We hired only freelancers who made zero mistakes in this phase. To ensure quality of the data, we had two freelancers digitizing the same data. We then checked the two resulting datasets for discrepancies. For each difference we found, we manually checked the original document and fixed the mistake. In addition, we randomly checked 10 percent of the digitized data in which there were no differences.

[37] All the statistics from the replacement lists are in line with the data from the 1940 Census. In the Census, African-American workers were 14 percent of the workforce and women were 30 percent. Most women, however, were employed in teaching and personal services, like maids, which are not covered by our sample of firms. The ratio of women in manufacturing was only 9 percent. Moreover, the workforce in the Census had on average 9 years of education and 29 years of age.

D Description of Primary Sources

The Mergent Archives statements, which include the data on firm performance, are quite varied in their content and level of detail, since they were not regulated in the way that modern balance sheets are. We therefore had to define the variables used in the empirical analysis in a consistent way across all firms in the sample. The definitions of all variables, together with some discussion of how the underlying data was coded, are presented in Table D.1.

Table D.1: List and Definition of Variables and Their Sources

Variable	Definition	Notes
Private Sales	Firm sales NOT to the government	
Government Sales	Firm sales to the government through the war contracts	To validate this variable, we checked whether firms started separately reporting private sales and government sales after becoming war contractors. We found that this was the case for all firms. We also checked that the total amount of government sales was consistent with the value of the war contracts given by the government. The difference between the two values is between -2% and +1%.
Employment	Number of Employees	To validate this variable, we checked whether the number of employees reported in the financial statements and in the replacement lists were the same. We found that this was the case for all firms.
Productivity (TFPR)	Total Factor Productivity Revenue	Authors' calculation (see Appendix E)
Revenues	Gross Income	
Value Added	Difference between firm gross income and intermediate inputs	Authors' calculation (see Appendix E)
Profits	Difference between value added and taxes	Authors' calculation
Intermediate Inputs	Sum of costs of raw materials	
Capital	Firm capital stock	Authors' calculation (see Appendix E)
Investments	Difference between fixed gross asset at time t and time $t-1$	Authors' calculation (see Appendix E)
Fixed Gross Asset	Value of land, buildings, and machines owned by the firm	
Return-on-Assets (ROA)	Ratio between profits and capital	Authors' calculation

E Estimation of the Production Function

E.1 The Production Function

We assume the existence of a Cobb-Douglas production function:

$$Y_{it} = A_{it} K_{it}^{\beta_k} L_{it}^{\beta_l}, \tag{E.1}$$

where Y_{it} is the value added of firm i in period t, K_{it} and L_{it} are capital and labor, respectively, and A_{it} is the Hicksian-neutral efficiency level. Taking natural logs, equation E.1 results in the following linear production function:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \underbrace{\omega_{it} + \eta_{it}}_{\epsilon_{it}}, \tag{E.2}$$

where lower-case letters refer to natural logarithms, β_0 measures the mean efficiency level across firms and over time, ϵ_{it} is the time- and producer-specific deviation from that mean, which can be further decomposed into an observable (or at least predictable) component ω_{it} and an unobservable component η_{it}. ω_{it} is a productivity shock (which may include, for instance, machinery breakdown, demand shock, and managerial skills) and η_t is i.i.d. and represents unexpected deviations from the mean due to measurement error, unexpected delays, or other external circumstances.

The major econometric issue of estimating equation E.2 is that the firm's optimal choice of inputs k_{it} and l_{it} is generally correlated with the productivity shock ω_{it}, which renders OLS estimates of the β's biased.

Possible solutions for this problem include using instrumental variable estimation techniques or controlling for firm fixed effects. In practice, however, these solutions have not worked well. Natural instruments, such as input prices if firms are operating in competitive input markets, are often not observed or do not vary enough across firms; and fixed effects estimation requires the strong assumption that the unobservables are constant across time, i.e., $\omega_{it} = \omega_{it-1}\ \forall t$ (Ackerberg, Caves and Frazer, 2015). The dynamic panel literature extends the fixed effects literature to allow for more sophisticated error structures (Bond and Söderbom, 2005). For instance, it is possible to assume that ω_{it} follows an AR(1) process, i.e., $\omega_{it} = \rho\omega_{it-1} + \xi_{it}$. Since the innovation in ω_{it} (ξ_{it}) occurs after time $t-1$, it cannot be

correlated with inputs dated $t-1$ and earlier (Ackerberg, Caves and Frazer, 2015), and this is used to derive the moment conditions.[38]

Other solutions, such as those advocated by Olley and Pakes (1996) and Levinsohn and Petrin (2003), involve a more structural approach and use investment or intermediate inputs as a proxy for productivity shocks. Specifically, they assume that labor is the non-dynamic input, capital is the dynamic input, and that

$$m_{it} = f_t(k_{it}, \omega_{it}), \tag{E.3}$$

where m_{it} is defined as investment in the Olley and Pakes (1996)'s method and as intermediate inputs in the Levinsohn and Petrin (2003)'s method. It is a function of capital k_{it} and productivity shock ω_{it}.[39]

Assuming that the function f is invertible, then we can write the productivity shock as:

$$\omega_{it} = f_t^{-1}(k_{it}, m_{it}). \tag{E.4}$$

By substituting it in equation E.2, we obtain

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + f_t^{-1}(k_{it}, m_{it}) + \eta_{it}, \tag{E.5}$$

where f_t^{-1} is treated as nonparametric. The estimation consists of two steps. First, equation E.5 is estimated by using semiparametric techniques. This allows estimating β_l, but does not identify β_k, since it is collinear with the nonparametric function. Second, assuming that ω_{it} follows a first-order Markov process implies that

$$\omega_{it} = E[\omega_{it}|m_{it-1}] + \xi_{it} = E[\omega_{it}|\omega_{it-1}] + \xi_{it}, \tag{E.6}$$

where ξ_{it} is the "innovation" component of ω_{it}, such that $E[\xi_{it}|m_{it-1}] = 0$. Since capital at time t is decided at time $t-1$, $E[\xi_{it}|k_{it}] = 0$.[40] Variation in k_{it} conditional on ω_{it-1} is the

[38] In this case, the moment condition is $E\left[(\xi_{it} - \xi_{it-1} + (\epsilon_{it} - \rho\epsilon_{it-1}) - (\epsilon_{it-1} - \rho\epsilon_{it-2}))|\left\{ \begin{array}{c} k_{i\tau} \\ l_{i\tau} \end{array} \right\}_{\tau=1}^{t-2}\right] = 0.$

[39] Levinsohn and Petrin (2003) propose to use intermediate inputs rather than investment as a proxy for productivity shocks, because investment is lumpy due to substantial adjustment costs. Therefore, it might not smoothly respond to the productivity shock.

[40] Olley and Pakes (1996) also control for selection, by introducing an exit rule for firms.

exogenous variation used to identify β_k, which is estimated via GMM using the following moment conditions:

$$\frac{1}{T}\frac{1}{N}\sum_t\sum_i \xi_{it}(\beta_k)\cdot k_{it} \tag{E.7}$$

In this paper, we use the method proposed by Ackerberg, Caves and Frazer (2015), which is based on the Olley and Pakes (1996) and Levinsohn and Petrin (2003) methods, but solves the possible collinearity problem between labor and investment (or intermediate inputs). This collinearity problem may arise because labor and investment could share the same data generation process (DGP). Therefore, it is not possible to simultaneously estimate a fully nonparametric (time-varying) function of (ω_{it}, k_{it}) along with a coefficient on a variable that is only a (time-varying) function of those same variables (ω_{it}, k_{it}). The Ackerberg, Caves and Frazer (2015) method assumes that l_{it} is chosen by firms at time $t-b$ $(0<b<1)$, after k_{it} was chosen at time $t-1$, but before m_{it} is chosen at time t. In this setup,

$$m_{it} = f_t(\omega_{it}, k_{it}, l_{it})$$

In the first step of the estimation, β_l is not identified, but it is possible to estimate $\Phi_t(m_{it,}k_{it}, l_{it}) = \beta_k k_{it} + \beta_l l_{it} + f_t^{-1}(m_{it}, k_{it}, l_{it})$, which represents output net of the non-transmitted shock η_{it}. In the second stage, it is possible to solve the nonlinear dynamic problem by guessing a value for β_l and β_k, estimating the implied $\omega_{it}(\beta_l, \beta_k)$ and $\xi_{it}(\beta_l, \beta_k)$. This last component can be used to check whether the two moment conditions are met: $E\left[\xi_{it}(\beta_l, \beta_k)\cdot \begin{matrix} k_{it} \\ l_{it-1} \end{matrix}\right] = 0$. The procedure should be repeated until a couple of coefficients satisfies the moment conditions.[41]

Table E.1 reports the coefficients on labor and capital estimated by using the Ackerberg, Caves and Frazer (2015) method, separately for each manufacturing industry. To check the extent to which the Ackerberg, Caves and Frazer (2015) estimates differ from other estimates, we also report the labor and capital coefficients estimated with the OLS, the factor shares (Solow's residuals), the Levinsohn and Petrin (2003) method, and the dynamic panel

[41] Compared with the dynamic panel approach, the Ackerberg, Caves and Frazer (2015) method allows estimating ω separately from ϵ. This has two major implications: (1) in the Ackerberg, Caves and Frazer (2015)'s method, ω can follow a first-order Markov process not necessarily linear; (2) the variance of a GMM estimator is proportional to the variance of the moment condition being used, so the Ackerberg, Caves and Frazer (2015) method is more efficient. However, the GMM estimator can allow for a fixed effect α_i in addition to ω_{it}, for ϵ_{it} to be correlated over time, and for ω to follow a higher than first order Markov process, as long as this process is linear (Ackerberg, Caves and Frazer, 2015).

method. The OLS and factor shares calculations tend to underestimate the coefficients on capital compared to the Ackerberg, Caves and Frazer (2015)'s coefficients, while the Levinsohn and Petrin (2003) method tends to overestimate it. However, the coefficients are roughly comparable across the different estimation methods and in each industry we cannot reject the null hypothesis of constant return to scale.[42]

E.2 Definition of the Variables

To estimate the production function in equation E.2, we use the following variables:

- Value added: It is measured as the difference between firm deflated total income and intermediate inputs. The deflators used are the year-industry deflators provided by the Federal Reserve Bank of St. Louis with base-year 1935.
- Labor: It is measured by number of employees.
- Capital: It is measured by firm capital stock. To obtain a measure of firm capital stock from the fixed gross assets (*fga*) reported in the balance sheets, we use the Perpetual Inventory Method (PIM). First, we compute investment I as the difference between the deflated current and the lagged *fga*. Then, we use the PIM formula

$$P_{t+1}K_{t+1} = P_{t+1}(1-\delta)P_tK_t + P_{t+1}I_{t+1}, \tag{E.8}$$

where K is the quantity of capital, P is its price (set equal to the annual Federal Reserve interest rate on credit), I is investment, and δ is the depreciation rate (set equal to 5 percent, according to the average estimated life of machine of 20 years (Goldsmith, 1951). However, this procedure is valid only if the base-year capital stock (the first year in the data for a given firm) can be written as P_0K_0 , which is not the case here because in the balance sheets *fga* is reported at its historic cost. To estimate its value at replacement cost, we use the R^G factor suggested by Balakrishnan, Pushpangadan and Suresh Babu (2000):

$$R^G = \frac{[(1+g)^{\tau+1}-1](1+\pi)^{\tau}[(1+g)(1+\pi)-1]}{g\{[(1+g)(1+\pi)]^{\tau+1}-1\}} \tag{E.9}$$

[42] We measure firm output by using deflated value added, which might not reflect the ranking of firms in their productivity if they charge different markups.

where τ is the average life of machines (assumed to be 20 years, as explained in Goldsmith, 1951), π is the average capital price $\frac{P_t}{P_{t-1}}$ from 1935 to 1955 (equal to 1.044), and g is the (assumed constant) real investment growth rate $\frac{I_t}{I_{t-1}}$ from 1935 to 1955 (equal to 1.015). We multiply *fga* in the base year 1935 by R^G to convert capital to replacement costs at current prices, which we then deflate using the price index for machinery and machine tools to express it in real terms. Finally, we apply formula (E.8).

E.3 Estimating TFPR Separately for Private Revenues and Revenues from War Contracts

In order to separately estimate the effects of the TWI program on TFPR calculated using private revenues and revenues from the war contracts, we proceed as follows. First, we use firm balance sheets to know which fraction of revenues is coming from the private market and which from the US war contracts. We then impute labor and capital proportionally to the ratio between the two sources of revenues. We then use the Ackerberg, Caves and Frazer (2015)'s method to compute the two different TFPRs.

Table E.1: Estimation of Production Function

	I. Agriculture			II. Manufacturing			III. Services			IV. Transportation		
	β_l	β_k	p-value $\beta_l + \beta_k = 1$	β_l	β_k	p-value $\beta_l + \beta_k = 1$	β_l	β_k	p-value $\beta_l + \beta_k = 1$	β_l	β_k	p-value $\beta_l + \beta_k = 1$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ACF	0.60***	0.38***	0.254	0.57***	0.45***	0.342	0.53***	0.46***	0.246	0.51***	0.48***	0.452
	(0.11)	(0.12)		(0.12)	(0.10)		(0.14)	(0.11)		(0.15)	(0.14)	
OLS	0.62***	0.37***	0.325	0.54***	0.44***	0.461	0.55***	0.47***	0.358	0.50***	0.49***	0.321
	(0.14)	(0.11)		(0.11)	(0.09)		(0.11)	(0.15)		(0.16)	(0.12)	
Factor Shares	0.65	0.36		0.60	0.42		0.56	0.45		0.53	0.47	
LP	0.65***	0.37***	0.398	0.55***	0.44***	0.431	0.54***	0.46***	0.435	0.55***	0.47***	0.365
	(0.15)	(0.10)		(0.13)	(0.10)		(0.15)	(0.14)		(0.13)	(0.09)	
DP	0.61***	0.36***	0.452	0.60***	0.41***	0.298	0.56***	0.45***	0.239	0.51***	0.48***	0.455
	(0.12)	(0.12)		(0.12)	(0.11)		(0.12)	(0.15)		(0.13)	(0.14)	

Notes. Coefficients on labor (β_l) and capital (β_k) estimated with the Ackerberg, Caves and Frazer (2015) method (ACF), OLS, factor shares (Solow's residuals), Petrin, Poi and Levinsohn (2004) (LP), and dynamic-panel method (DP). Columns 3, 6, 9, and 12 report the p-value of testing constant return to scale (CRS) $\beta_l + \beta_k = 1$. The sample include 11,575 US war contractors that applied to the TWI program. Data are provided at the firm level. *** denotes 1%, ** denotes 5%, and * denotes 10% significance.