Productivity and Knowledge Transfer: Evidence from Prisoner Employment*

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Abstract

Worker mobility can facilitate the transmission of knowledge and ultimately increase productivity. Yet isolating such productivity effects is challenging because of worker sorting, labor market adjustments, and assimilation processes. We exploit quasi-experimental variation arising from the temporary employment of Italian prisoners of war in agricultural production in Australia during World War II to isolate the effects of worker mobility on productivity. We find that this inflow of workers increased agricultural output in the short run and generated productivity gains that persisted after the workers' departure. Examining mechanisms, we show that the employment of foreign workers led to greater mechanization and to a shift toward crops better suited to local conditions in areas that received workers from Italian provinces where such technologies and crops were more common. Our findings point to the transfer of origin-specific know-how as a key channel through which worker mobility generates lasting productivity gains in the host economy.

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1 Introduction

A long-standing literature in economics debates the effects of worker mobility across countries, or across regions within a country, on destination economies. Most of this literature focuses on the impact of increased labor supply, resulting from worker mobility, on labor markets and the subsequent adjustments in production processes (e.g., Card, 1990; Borjas et al., 1997; Card, 2001). Less is known about whether an inflow of workers also affects productivity *per se*, independently of adjustments induced by labor markets, and, if so, whether these productivity effects outlast the workers who originated them. Such persistent effects may arise through the transfer of origin-specific skills (Bazzi et al., 2016) or technology know-how (e.g. Bloom et al., 2013) that new workers may bring with them, which are valuable in the destination economy but otherwise difficult to transfer.

Isolating the productivity effects of a labor inflow is challenging in most settings for several reasons. First, workers may select destinations according to their skills (Obolensky et al., 2024), creating an identification problem that is challenging to address. Second, even when workers are allocated to regions independently of their skills, changes in labor supply typically induce shifts in the relative cost of labor versus other production inputs, which themselves influence production and productivity (e.g., Lewis, 2011; Ottaviano and Peri, 2012; Ottaviano et al., 2013). Third, workers often remain in the destination economy for long periods, so that productivity effects may be shaped by long-run factors such as immigrant assimilation into society and production (e.g., Abramitzky and Boustan, 2017).

This paper isolates the causal effects of knowledge transfer stemming from an inflow of labor on agricultural productivity. We draw on newly digitized data linking agricultural productivity to detailed records of Italian prisoners of war (POWs) held in Australia during World War II and exploit the variation arising from the POWs employment program. The unique features of this program, in which workers were quasi-randomly allowed to work only in certain areas and only temporarily until the end of the war, allocated independently of their farming skills, and paid wages and hours set by the government to match those of local workers, allow us to overcome the challenges that typically arise when isolating the effects of knowledge transfer through worker mobility on productivity. We find that the inflow of wartime foreign workers increased both agricultural production and productivity. While output gains peaked when foreign labor utilization was highest, productivity gains persisted after their departure, indicating longer-lasting effects. By linking workers' provinces of origin in Italy to pre-war Italian agricultural data and Australian soil characteristics, we show that farms employing these workers experienced greater mechanization and a shift toward crops better suited to local conditions. These productivity-enhancing adjustments were

concentrated in areas that received workers from Italian regions where such crops were more common and mechanization was more advanced before the war. Overall, the evidence points to the transfer of origin-specific know-how as a key mechanism through which temporary labor inflows can generate lasting productivity improvements.

The Australian POW employment program serves as an ideal setting for our study for several reasons. First, detailed historical agricultural and prisoner records allow us to measure productivity at a fine (parish) geographic level and link farm outcomes to pre-war agricultural conditions in prisoners' Italian provinces of origin, enabling us to study both effects and mechanisms. Second, the rule restricting POW employment to farms within 40 kilometers of the nearest prisoner camp generates plausibly exogenous variation in labor inflows across areas. Third, within farms, prisoners faced no restrictions on tasks or production methods, closely resembling regular agricultural employment, while wages and hours were fixed by the government to match those of local workers, isolating productivity effects from local labor-market price adjustments. Forth, most Italian prisoners had prior agricultural experience, yet assignment to farms was independent of origin-specific skills, allowing us to identify skill transfers. Finally, because all prisoners were repatriated after the war, the program offers an uniquely clean setting to test whether productivity gains persist once the workers who generated them are no longer present.

We focus our analysis on the Australian state of Victoria, where complete records from all relevant sources are available. Victoria hosted the majority of Italian prisoners during WWII and accounted for the second largest share of the nation's cultivated area. We are the first to digitize and analyze these historical records, thereby overcoming data limitations that have hindered previous research on the impact of POW labor. While the features of the Australian prisoner employment program and data make it particularly well-suited for our analysis, thousands of POWs were employed in agriculture across Allied countries during World War II, including in the United States and the United Kingdom, making the results of our analysis potentially relevant to other contexts too.[1]

Our empirical strategy employs a difference-in-differences design comparing agricultural outcomes in parishes located within a 40-kilometer radius of the nearest POW camp to those in parishes outside that radius. Because many camps were established before prisoner employment was permitted, in 1943, we assume that outcomes in parishes within the radius that later received prisoners (the treatment group) and those that did not (the control group) would have evolved similarly in the absence of the POW employment program.

[1]See, for instance, Moore (1997) and Custodis (2012) for discussions of POW employment in agriculture in the UK, Ward (2007) for a discussion of POW labor on cotton plantations in the US, and Moore and Fedorowich (2002) for a discussion of Italian POW employment across the British Empire.

Consistent with this assumption, we find no significant differences between treatment and control parishes in pre-war agricultural production or productivity trends, nor in labor shortages, proxied by enlistment numbers. Moreover, consistent with prisoners being allocated to camps before their employment was planned, we find no significant relationship between crops cultivated or technologies used in destination parishes and those prevalent in prisoners' provinces of origin before the war.

In the first part of our analysis, we examine the effects of POW labor on agricultural output and productivity. If prisoners had merely contributed to production without leaving a more lasting impact, any effects would be expected to disappear once they were repatriated after the war. While we observe a sharp increase in production when POW employment was at its peak, productivity remains higher in parishes that hosted prisoners years after their departure. Specifically, we estimate that production rose by 28% of the pre-war mean in treatment relative to control parishes in 1944–45, before declining in 1946–47 and 1950–51, after the prisoners left Australia. In contrast, productivity—measured as output per worker—increased by 42% during POW employment and remained 20% higher than the pre-war mean in treated parishes in 1950–51.

These longer-lasting productivity gains raise the question of which changes in production methods generated them. In the second part of the analysis, we investigate potential channels. First, we explore whether the employment of prisoners led to a greater use of new production technologies. Specifically, we focus on tractors, the most productivity-enhancing form of farm capital during the war. We find larger increases in tractor use in parishes in the treatment group relative to the control group after the start of the POW employment program. This rise in tractor use persists after the POWs left Australia. Using information on the Italian provinces of origin of prisoners, we find that the increased use of advanced machinery is concentrated in parishes that hosted a higher share of prisoners from Italian regions where tractors were already widely used before the war. This finding points to the transfer of technology-specific know-how as a key factor underpinning the use of new technologies.

Second, we investigate whether employing prisoners altered the crop mix in ways that increased productivity. We find that POW labor led treated parishes to shift toward potato production, which was better suited to local soils, and away from maize, which was relatively less suitable. This reallocation toward more productive crops was concentrated near camps that hosted a higher share of prisoners from Italian provinces where potatoes or maize were among the leading crops. These findings point to the transfer of origin-specific knowledge about crops as a key mechanism that helped address mismatches between the most suitable crops and those actually cultivated in Victoria, thereby leading to longer-lasting effects on

productivity.

The findings so far leave open the question of how, in practice, knowledge was transferred from prisoners to farmers, particularly given language barriers. To investigate this further, we conduct two complementary analyses. First, we examine whether the effects were stronger near camps that hosted a larger share of internees, individuals already in Australia at the time of the war who were deemed socially dangerous and imprisoned but not employed in agriculture outside the camps. Because internees were more likely to speak English, they may have facilitated language learning among POWs. Second, we test whether the effects were greater near camps that held a higher share of prisoners from regions with higher literacy rates. These prisoners, likely endowed with greater human capital, may have been better able to learn English and thus transfer know-how. Consistent with the hypothesis that language skills and human capital facilitate knowledge diffusion, we find stronger effects in parishes located near camps with higher shares of internees or literate prisoners.

Our findings have several implications for the design of modern development policy. First, exposure to workers from regions with different production practices catalyzed enduring improvements, suggesting the importance of leveraging skill diversity when designing migration programs for agricultural workers, such as seasonal-worker schemes or short-term farmer-to-farmer exchanges. Second, productivity gains are more likely to persist when paired with appropriate capital investments; credit lines or matching grants for machinery and complementary inputs can help lock in benefits once new techniques are introduced. Third, peer learning may play an important role in supporting productivity improvements, especially in contexts where traditional top-down training struggles to transmit tacit skills. Policies that promote horizontal knowledge diffusion, such as demonstration plots run by experienced farmers or community mechanization centers, may therefore serve as effective tools to boost agricultural productivity.

This paper contributes to multiple strands of the existing literature. First, we contribute to the literature on the effects of worker mobility on productivity.[2] Previous studies have shown that migrants' skills have large positive effects on agricultural and manufacturing productivity, pointing to the transfer of origin-specific skills as an important channel (Bazzi et al., 2016; Hornung, 2014; see also Abramitzky and Boustan, 2017 for a historical overview). Relative to these studies, our setting and data allow us, first, to isolate the productivity effects of worker mobility that arise directly from workers themselves from those induced by changes in labor costs that may affect production processes and productivity; and second, to show

[2]See for instance, Giorcelli, 2019 for worker mobility across countries, Toews and Vézina, 2025 for mobility across regions within a country, Labanca et al., 2024 and Stoyanov and Zubanov, 2012 for mobility across firms.

that the productivity gains and knowledge transfer associated with worker mobility persist even after the workers who brought those skills are no longer present in the destination region. In other settings previously analyzed, such aspects could not be studied because immigrants permanently settled in the destination region, and their wages and hours of work were endogenously determined in the labor market rather than exogenously set.

Second, to the best of our knowledge, this is the first study to causally estimate the economic effects of employing prisoners of war in the host country. While the existing literature documents that wartime imprisonment can have significant consequences for prisoners, as well as their families, across dimensions such as health and labor market outcomes (e.g., Costa and Kahn, 2007; Costa et al., 2018),[3] little is known about the effects of prisoners' economic activities on the regions where they were detained.[4] We provide causal evidence of sizable and persistent impacts of prisoner employment on agricultural output and productivity. Delving into underlying mechanisms, we show that the transfer of crop- and capital-specific knowledge plays an important role in sustaining these gains, with direct implications for policies aimed at enhancing agricultural productivity and, ultimately, development.[5]

Similar to much of the literature on the effects of forced migration (see Becker and Ferrara, 2019 for a review), we study a forced labor supply shock and its consequences for the local economy. Unlike most studies in this literature, we focus on a temporary shock to labor supply, which allows us to abstract from many longer-run migration-induced adjustments in labor markets. Relative to the limited set of studies on temporary migration episodes (e.g., Dustmann et al., 2017; Labanca, 2020) and to the related literature on labor supply reductions driven by out-migration (e.g., Hornbeck and Naidu, 2014; Clemens et al., 2018; Lee et al., 2022; Lin and Peri, 2025), our setting features heavily regulated employment conditions. Prisoners' work was tightly controlled, and wages and hours were set by the government. These features effectively limit, if not eliminate entirely, the labor mar-

[3] A separate but related literature examines civilian internees, similarly focusing on the effects of internment on internees and their families (e.g., Chin, 2005; Arellano-Bover, 2022; Grossman et al., 2025). Unlike POWs, who could be required to work under the 1929 Geneva Convention, internees could not be forced to work and were deemed potentially dangerous. As a result, their wartime employment was very limited and confined to internment camps.

[4] Outside the economics literature, views among historians are mixed. Some historians emphasize the substantial contribution of prisoners of war to the wartime economy (e.g., Moore, 1997; Custodis, 2012), while others portray POWs as a liability for their captors (e.g., Davis, 1977). These discussions are typically based on qualitative or descriptive evidence.

[5] While one may consider these findings as related to the literature on the economic effects of coerced labor (see, for instance, Fogel and Engerman, 1977; Beckert, 2014; Naidu, 2020 on allocative efficiency in slave markets, and Bleakley and Rhode, 2024; Hornbeck and Logan, 2023 on the negative effects of slavery on economic performance), important institutional differences limit the extent to which our findings can talk to this literature. In our setting, prisoner employment was tightly regulated and conducted under working conditions comparable to those of local workers, with government-set wages and hours.

ket competition between new and existing workers that is central to much of the migration literature. As a result, we are able to study both the short- and long-run effects of labor mobility on production and productivity while abstracting from potentially confounding labor market dynamics. Our data and setting further allow us to provide evidence on mechanisms underlying these productivity effects. In particular, evidence on the role of origin-specific agricultural skills in generating productivity gains helps rationalize recent findings in Lin and Peri (2025), which show that the relocation of Japanese American agricultural workers to detention camps on the U.S. West Coast during World War II was associated with a deterioration in agricultural outcomes in affected regions.

The remainder of the paper is organized as follows. Section 2 provides historical background and describes the prisoners' employment program. Section 3 introduces the data. Section 4 outlines the empirical strategy. Section 5 presents the main results. Section 6 explores underlying mechanisms. Finally, Section 7 concludes.

2 Historical Background

On June 10, 1940, despite opposition from the Foreign Minister and his military leaders, dictator Benito Mussolini took Italy into the Second World War on the side of the Axis powers and against the Allied forces. The substantial lack of preparation of Italian troops led to a large number of soldiers being captured during the first few years of the conflict that followed. Between December 1940 and May 1941 alone, approximately 122,000 Italian soldiers were captured or surrendered to Allied forces.[6] The growing number of prisoners rapidly became a logistical and administrative concern for the Allies.

Because the 1929 Geneva Convention, which served as the legal framework governing prisoner detention, recognized the British Empire as a single legal entity, the Allies were permitted to relocate prisoners across former British territories, including Australia. In March 1941, faced with mounting numbers of POWs, the British War Office submitted a requests to Australian authorities for assistance in urgently relocating POWs. On April 30, 1941, the Australian War Cabinet approved the British request for prisoner transfers. However, Canberra insisted that only a small number of Germans be included. Behind this request was the "well-entrenched stereotype that Italian POWs were docile, less demanding than their more ideologically driven German allies and either possessed simple tastes or had lower expectations while in captivity" (Moore and Fedorowich, 2002). Over the following

[6]In January 1941 alone, the North African campaign saw the surrender of around 40,000 Italian soldiers at the Battle of Bardia. This was preceded by 38,000 captured at Sidi el Barrani in December 1940 and followed by another 25,000 at the Battle of Tobruk later that same month. Additionally, approximately 19,000 Italian soldiers were captured in East Africa at Amba Alagi (Abyssinia) in May 1941.

years, Australia received a total of 18,432 Italian and 1,651 German POWs, as well as 5,637 Japanese prisoners captured after Japan entered the war in late 1941.[7]

Although the Geneva Convention permitted the employment of prisoners in non-military activities, security concerns in 1941 and 1942 led Australian authorities to restrict prisoner labor to within camp boundaries. Some of these camps were located at pre-existing military sites, many originally built during the First World War. As prisoner numbers increased, new camps were added to the network. Their locations were chosen primarily for security, favoring inland areas far from the coast, but also for practical considerations such as access to water, electricity, sewage infrastructure, and existing structures that could be quickly adapted for camp use (Moore and Fedorowich, 2002).

By the end of 1942, the labor shortage caused by the enlistment of Australian citizens and the increased demand for food from Allied troops fighting in the Pacific led to growing pressure to allow prisoner labor outside of camps, particularly in agriculture. In response, the Australian government established a committee that, in April 1943, recommended that, under certain conditions, private citizens should be allowed to employ unguarded prisoners beyond the confines of POW camps. In May 1943, the War Cabinet accepted the recommendations of the committee formally starting the prisoner employment program in Australia (Moore and Fedorowich, 2002; Fitzgerald, 1981).

One key condition was that prisoners could only be employed within a 40-kilometer radius of an army-administered POW control camp, a central feature of the program that we exploit for identification. Another condition was that prisoners had to be carefully screened to ensure they posed no security risk. In practice, this meant that nearly all prisoners selected for unguarded work outside of prisoner camps were Italians, as Germans and Japanese were considered more ideologically committed and therefore greater security risks.[8] For this reason, our analysis focuses on Italian POWs. While the program formally allowed for the use of prisoner labor on national works, such as infrastructure projects, in practice, nearly all prisoners employed unguarded and outside camps worked in agricultural production.

The working hours for POWs had to align with those ordinarily worked in the relevant industry. In agriculture, this typically meant a six-day workweek. Pay rates were to be negotiated between employers and the Department of Labour and National Service, with the general principle that employers should contribute the standard award rate (i.e., the industry's collective labor agreement rate) for a fully capable prisoner. This policy was designed

[7]National Archives of Australia, Canberra, Series number: A7711/1.

[8]In particular, Japanese prisoners were not permitted to work outside POW camps, while approximately 1,400 German soldiers were allowed to work "under guard in firewood production and other projects at or near their camps" (War Cabinet Agendum 79/45, POWs – Transfer to and Employment of in Australia, March 1945, Forde, Minister for the Army).

to protect local workers from prisoner labor competition while allowing some flexibility to deviate from market wages when justified, for example, due to severe local labor shortages or if the prisoner was not capable of performing work at the full award level.[9]

Despite initial concerns about the suitability of employing POWs, their unguarded employment proved particularly successful among local farmers. The number of prisoners employed rose sharply between 1943 and 1945, reaching a peak of 13,000 in March 1945, equivalent to 84% of all Italian prisoners held at the time. Overall, it is estimated that 14,000 Italian POWs were employed during the war, significantly increasing the local labor supply in affected areas, as detailed in the next section.[10]

Although the repatriation of Italian prisoners had been debated since Italy's surrender in September 1943, it was not seriously considered until early 1945, when the liberation of northern Italy, the part still under Nazi control, was in sight. In November 1945, at a meeting of the Allied Control Commission, it was agreed that Italians held outside Italy should be repatriated. As a result, Italian POWs in Australia were gradually withdrawn from farms, a process completed by May 1946, effectively ending the prisoner employment program. Due to a shortage of suitable ships, repatriation only began in October 1946 and was completed in January 1947, when the last Italian POW left Australia.

2.1 Internees in Australia

When Italy declared war in 1940, Australia, like Britain and other Allied countries, responded swiftly by interning members of its Italian community who were believed to be ideologically aligned with the Italian regime and thus considered a potential risk to Australian society. While the largest group of internees consisted of Italian-born individuals, some Australian-born citizens of Italian descent were also interned. Of the estimated 33,000 Italian-born residents in Australia in 1939, 4,727 were interned, with numbers peaking at 3,836 in December 1943 (Moore and Fedorowich, 2002).

Unlike prisoners of war, who were permitted to be employed in non-military work under the Geneva Convention, internees could not be forced to work under international law. Voluntary work was allowed, but due to the above-mentioned legal limitation, and the perception that internees were more ideologically committed and therefore posed a greater security risk

[9]Where no pay award existed, employers were required to pay £1 (Australian) per week, plus keep. Additional conditions were established to avoid the congregation of prisoners. First, no more than three prisoners could be assigned to a single farm. Second, on Sundays, prisoners were allowed to move freely up to 1.6 kilometers from the farm, provided they wore POW clothing, but they were not permitted to enter any village, town, shop, or house (NAA, MP729/6, item 6/3/401/666, "Report of inter-departmental conference chaired by McCahon", 12 Feb. 1943; NAA CRS A1308/1, item 712/1/11, "War Cabinet Agendum no. 118/1943", 14 March 1943).

[10]For figures on Italian Prisoner employment see NAA Series A7711/1.

than POWs, relatively few were employed in rural areas. For this reason, in what follows, we focus primarily on the effects of prisoner labor and return to the topic of internee labor at the end of the paper when discussing mechanisms.

3 Data

We combine several new datasets for the analysis, collected and digitized from primary sources. First, we use newly digitized individual-level records of Prisoners of War detained in Australia during WWII. Second, we draw on newly digitized data from the Agricultural Census in Australia to construct parish-level measures of agricultural production, productivity, labor and capital use. Third, we use newly digitized pre-war census data on agricultural production in Italy. Finally, we use parish-level data on soil suitability in Australia, which we newly assemble by combining existing sources.

3.1 Prisoners of War

For the analysis of the effects of POW employment, we draw on detailed individual-level data on Italian prisoners of war available in the Australian National Archives, which we retrieved and digitized for the first time. We focus on Italian prisoners, excluding Germans and Japanese, because Italians made up by far the largest group detained in Australia during WWII, accounting for 90% of all POWs and virtually the totality of those employed outside prisoner camps.

The individual records consist of two forms for each prisoner.[11] The first, titled "Report on Prisoner of War" contains demographic information, including previous occupation and address in Italy. The second, titled "Service and Casualty Form" provides a complete record of the prisoner's movements across camps during detention. This information allows us to identify the number and type of POWs present at each camp in any given year.[12] To match the available agricultural data, we restrict the analysis to Italian prisoners who were detained in Victoria.

Table 1 presents demographic characteristics of the prisoners in our sample with available information. A total of 7,413 prisoners were detained in Victoria during the war, more than in any other state (see Panel A). Panel B reports these characteristics separately for prisoners held in Victoria and those held elsewhere. Prisoners were relatively young, with an average

[11] Both forms were compiled by the Australian Military Forces and are now part of the National Archives of Australia series MP1103/1 and MP1103/2. See Appendix B for details.

[12] When prisoners were transferred between camps within a year, we assign them to the camp where they spent the most time.

age of 30. Most (about 60%) were unmarried, and, as explained in Section 2, the majority were captured in 1941. Relevant to this study, approximately half reported being employed in agriculture prior to the war. Agricultural work was by far the most common pre-war occupation (see Appendix Figure A.1 for the full distribution), suggesting that prisoners may have brought relevant skills for their employment under the Australian POW program. Based on these characteristics, prisoners held in Victoria were remarkably similar to those held in the rest of Australia.

Appendix Figure A.2 shows that Italian prisoners originated from nearly all provinces across Italy. Given the diversity of agricultural production and expertise across Italian regions (Bianchi and Giorcelli, 2023), this suggests that prisoners brought with them an heterogeneous set of agricultural knowledge. In Section 6 we draw on this variation to investigate the mechanisms behind the effects of POW employment.

Finally, it is worth noting that while our baseline analysis focuses on prisoners of war, the archival records also include individual files for internees. We digitized these records (see Appendix B.1.1) and, as discussed in the following sections, use information on their displacement across POW camps to explore mechanisms underlying the effects of prisoner labor.

3.2 Agricultural Data from Historical Australian Censuses

Historical data on inputs and outputs of agricultural production were obtained from the Australian Agricultural Census, which was collected by the Commonwealth Bureau of Census and Statistics separately for each Australian state. We retrieved and digitized this information to produce the first digital version of an agricultural census in Australia. We did so for the state of Victoria, the only state for which data are consistently available both before and after the war at a detailed geographical level.[13] Victoria hosted the relative majority of prisoners during WWII and accounted for the second largest share (21.4%) of cultivated area in Australia prior to the war.

Within Victoria, the agricultural census is organized in volumes, each containing information on a specific county. There are 37 counties in total. We focus our analysis on the years 1935–36, 1939–40, 1944–45, 1946–47, and 1950–51, for which complete volumes were available for all counties.[14] Each county comprises, on average, 55 parishes. For the vast majority of parishes (97.7%), data can be tracked consistently over the five census years,

[13] Specifically, we use data from the National Archives of Australia series MP570/1: "Summaries of agricultural, dairying and pastoral statistics obtained from police collectors' books in Victoria". For more details, see Appendix B.2.

[14] In other years, data for some counties were missing from the National Archives of Australia and could not be retrieved from the archives of the Commonwealth Bureau of Census and Statistics.

yielding a total of approximately 1,680 parishes (8,400 parish-year observations). For reasons that will become clear in the next sections, we geolocated each parish in Victoria using centroid coordinates provided by the National Library of Australia, and integrated WWII enlistment information into the agricultural census using counts from the Department of Veterans' Affairs.[15]

The agricultural censuses contain rich information for each parish. Relevant to our analysis, they report agricultural output for the main crops—primarily cereals—which we harmonize across crop types and years to construct a consistent measures of agricultural production in tons (see Appendix B.2 for details). For crops where output is not directly measured, we use the area cultivated as a proxy for production. Regarding inputs, the census provides information on the number of workers in all years and on the number of tractors used in production in all years except 1944–45. Only in 1944–45, at the peak of prisoner employment, the census also report the number of prisoners employed in each parish. Productivity in each crop, or group of crops, is calculated as the ratio of output to the number of workers employed.

Table 2 presents descriptive statistics for the agricultural census variables used in our analysis. On average, parishes employ about 56 workers. In 1944–45, prisoners of war accounted for roughly 12% of the pre-war workforce in parishes that employed at least one prisoner, suggesting that the labor supply increase due to the employment program was sizable and comparable to other well-known labor supply shocks (e.g., 7% in Card, 1990, 10% in Dustmann et al., 2017). Tractors were used in production but not uniformly: while 72% of parishes had at least one tractor in 1939, 55% had more than one.[16]

3.3 Prisoner-of-War Camps

To identify the areas affected by the presence of POWs, we retrieved the full list of military facilities in Australia from the Footprints of Italian Prisoners of War archive.[17] We then geolocated each POW camp and we matched this information with the geolocation of parishes to determine their closest camp. Appendix Figure A.3 shows the locations of the 45 POW camps relevant to our analysis (black dots), along with the parishes that, based on 1944–45 agricultural census, reported employing at least one prisoner (19% of all parishes,

[15] WWII enlistment data are available at https://nominal-rolls.dva.gov.au/ww2; see Appendix B.3 for more details.

[16] Consistent with the uneven adoption of this technology, cross-sectional entry-level data within parishes—possibly capturing records for individual farms or groups of farms—indicate that 43% of entries had no tractors in 1939.

[17] We thank Joanne Tapiolas for collecting and making this data available through her Footprints of Italian Prisoners of War website (https://italianprisonersofwar.com/), as explained in Appendix B.4.

blue dots).[18] As expected, these parishes are located near POW camps.

To examine this spatial relationship more systematically, Panel (a) of Figure 1 displays the cumulative distribution of POWs in 1944–45 as a function of the distance between each parish and the nearest camp. In line with the rules surrounding the employment of prisoners, approximately 95% of prisoners were employed within 40 kilometers of the closest camp. Panel (b) of Figure 1 further confirms this pattern, showing that the number of prisoners is highest in parishes located 10 to 20 kilometers from the nearest camp, and drops substantially as the distance approaches the 40-kilometer threshold, falling to nearly zero beyond 50 kilometers. The presence of some prisoners beyond the 40-kilometer limit may reflect the fact that we calculate distances using centroids—the only available measure—for both parishes and camps. This may introduce measurement error if the legal working distance was computed from the camp's boundaries rather than its center. In the next section, we discuss how this data limitation informed our choice of the empirical strategy.

3.4 Historical Italian Agricultural Data

We combine the above datasets with two additional sources of data. First, to retrieve information on the local agricultural expertise of Italian POWs at baseline, we digitize the 1930 Italian Agricultural Census from the historical archive of the Italian Statistical Office (ISTAT). This is the last available census before the war to record agricultural output by province for each crop produced in Italy. We extract the top crop cultivated in each province, along with the corresponding output levels. We then match this information to individual prisoner records based on province of residence, which is available for most prisoners (70%) in our sample.

Appendix Figure A.4 displays the distribution of crops across and within prisoner camps in our sample. In the figure, the importance of each crop is determined by the share of prisoners originating from provinces where that crop ranked first according to 1930 production. The figure reveals considerable diversity-both within and across camps—in the crops prisoners were likely familiar with. [19]

Following the same approach, we link prisoner records to data on tractor use by province from the 1936 Census of Agricultural Machinery—the last available before the war—sourced from Bianchi and Giorcelli (2023). This allows us to proxy the extent to which each prisoner was likely exposed to this form of capital at baseline.

[18] We include in our data all camps located within 40 kilometers of a Victorian parish, including a few just outside the borders of Victoria.

[19] Two notable exceptions are camps number 44 and 45, which host only 2 and 1 prisoners respectively, which explains the limited crop variation.

4 Empirical Strategy

Our empirical strategy employs a difference-in-differences (DiD) approach that compares outcomes in parishes where prisoners were allowed to work with those where they were not. Since prisoner employment was authorized simultaneously across all camps in Australia, we use a non-staggered DiD design.[20] Our baseline estimating equation takes the following form:

$$y_{prt} = \alpha_p + \lambda_{rt} + \sum_t \beta_t \, pow_{pr} \times \lambda_t + \upsilon_{prt}, \tag{1}$$

where y_{prt} denotes the outcome of parish p in region r measured in year t. The variable pow_{pr} equals 1 if parish p in region r is located within 40 kilometers of the nearest POW camp, and 0 if it is more than 60 kilometers away, while λ_t takes the value 1 in year t and zero otherwise. We include parish fixed effects (α_p) and region-by-year fixed effects (λ_{rt}) to control for parish-specific characteristics that are constant over time, and for differences across Victoria's diverse regions that may vary over time.[21]

The coefficient of interest in equation (1), β_t, captures the average difference in outcome y between parishes in the treatment and control group in year t. To avoid collinearity, we exclude the last year of data before the start of the war, 1939–40, from the analysis. As a result, all effects are measured relative to this reference year.

Our choice of the treatment group is motivated by the features of the prisoner employment program in Australia, which allowed prisoners to work only within a 40-kilometer radius of the nearest camp. The choice of the control group is guided by two main considerations. First, the probability of employing at least one prisoner in 1944–45 is close to zero (1.6 percent) for parishes located more than 60 kilometers from the nearest camp, making it unlikely that these parishes were affected by the program. This probability is higher (10 percent) for parishes located between 40 and 60 kilometers, possibly due to measurement error in the recorded distances from the main camps, as discussed in earlier sections. Second, even abstracting from measurement error, parishes farther from the 40-kilometer threshold are less likely to be indirectly affected by prisoner employment through spillovers from treated parishes. In a robustness check, we vary the minimum distance required for a parish to be included in the control group and find similar results (see Section 5.2).

Our main outcome variables of interest are agricultural output and productivity. If prisoners simply increased the supply of labor, we would expect output to rise while prisoner

[20] In doing so, we abstract from the robustness checks and alternative estimators required in staggered difference-in-differences settings (e.g. Roth et al., 2023).

[21] Following the standard classification, we consider the following five regions: *Melbourne Metropolitan Area, Western Victoria, Northwestern Victoria, Eastern Victoria, Northeastern Victoria.*

labor was available, after 1943, and to fall again following their repatriation in 1946-47. In this case, productivity effects would be null after the prisoners leave and ex-ante ambiguous during their employment, depending on whether output increased more or less than proportionally to prisoner labor. By contrast, if prisoner labor had longer-lasting effects, we would expect productivity to remain high even after the direct contribution of POW labor to output ended with their repatriation.

An alternative to the difference-in-differences approach described in equation (1) would be to use a spatial regression discontinuity design (RDD). This approach is not best suited for our context for multiple reasons. First, the distance measure is subject to measurement error, making a sharp RDD around the 40-kilometer cutoff unreliable. Second, even abstracting from measurement issues, the presence of potential spillovers across parishes on either side of the employment cutoff could bias the estimated effects. Third, the number of parishes located near the cutoff is limited, resulting in noisy estimates that are sensitive to bandwidth selection.

4.1 Identification

Causal identification in equation (1) relies on the parallel trends assumption: in the absence of the prisoner employment program, parishes where prisoner employment was allowed and those where it was not would have followed similar trends in output and productivity. We conduct several tests to assess the plausibility of this assumption.

First, following standard practice in the DiD literature, we test for differences in trends in the years preceding the war and find no evidence of significant pre-trends in the outcomes of interest (see Figure 2).

Second, we examine whether parishes were selected into the prisoner program based on the extent of wartime labor shortages. While the absence of pre-trends in outcome variables is reassuring in ruling out systematic differences before the war, labor shortages could still threaten identification if they were induced by the war itself, for instance, through differential enlistment levels between treatment and control parishes. Reassuringly, Appendix Table A.2 shows no significant differences in enlistment counts between treatment and control parishes, suggesting that labor shortages are unlikely to bias identification in our setting.

Third, and most relevant for the mechanism analysis in Section 6, one may worry that prisoners were allocated to parishes based on their farming expertise in crops or technologies particularly useful in those areas. Reassuringly, we find that neither the use of tractors nor the share of land cultivated with crops widely grown in Italy in 1939, the two set of variables central to our mechanism analysis, predicts the extent to which prisoners allocated to the

nearest camp were knowledgeable about these technologies and crops (see Appendix Table A.3). We refer to Section 6 and the notes to Appendix Table A.3 for further details on how we measure prisoners' knowledge.[22]

Taken together, this evidence is consistent with the institutional features of our setting in which the location of many prisoner camps and the allocation of prisoners to camps were determined primarily by security considerations well before the employment program began, and the 40-kilometer rule was applied uniformly across camps. These features make it unlikely that prisoner labor was systematically targeted toward particular parishes.

Forth, in Section 5.2, we perform two additional sets of tests, following recent developments in the DiD literature, to assess the sensitivity of our results to violations of the parallel-trends assumption. We first examine whether the absence of pre-trends in our baseline estimates could reflect limited power to detect them. We then conduct sensitivity analysis with respect to potential violations of parallel trends. We find that our main results are robust to these tests. We refer to Section 5.2 for the details.

Finally, while parishes may not have been directly targeted for the prisoner program, we cannot rule out a priori that some farms were established closer to prisoner camps in anticipation to prisoner labor becoming available. Although our data do not allow us to track individual farms over time, we observe the number of entries recorded for each parish in every census year. To the extent that these entries capture farms or groups of farms, we can test whether the number of entries changed as a result of the prisoner employment program. Appendix Figure A.5 presents the results of this analysis. Reassuringly, we find no significant changes in the number of entries per parish, suggesting that this is unlikely to be a concern in our setting.

Overall, these findings consistently support the plausibility of the parallel trends assumption in our setting.

5 Results

This section presents our main findings. First, we show that POW employment led to sizable increases in agricultural output in the short run and to persistent gains in productivity. Then, we show that these findings are robust to a range of robostness checks.

[22] In the cross-sectional regressions reported in column 3 of Appendix Table A.2 and in Appendix Table A.3, we control for parish-level characteristics that are fixed over time. These characteristics are absorbed by the parish fixed effects in the baseline equation (1).

5.1 Prisoner Labor: Output and Productivity Effects

Figure 2 presents causal estimates for (a) output and (b) productivity, measures as output per worker, obtained from equation (1). We report β_t for all years in our sample, using the year before the start of the war, 1939–40, as the reference year. The figure shows no significant differences between parishes where prisoner employment was allowed and those where it was not in the years leading up to the war, followed by substantial increases in both output and productivity in parishes where prisoners were allowed to work in 1944–45, when prisoner labor was most prevalent. In that year, we estimate that output increased by 28% in treated parishes relative to the average of control parishes, while productivity increased by 42% (see Panel A in Table 3 for the point estimates).

After 1944–45, output declined immediately following prisoner repatriation in parishes that had benefited from prisoner labor, returning over time to pre-war levels. In contrast, productivity effects appear more persistent. Although smaller and not statistically significant immediately after repatriation, productivity gains remain positive and increase again by 1950–51—four years after prisoners were repatriated. Across all post-war years in our sample, we find that output was not significantly affected by prisoner employment, while output per worker remained 20% higher in parishes that had employed prisoners compared to those that had not (see Panel B in Table 3).

Overall, these findings indicate a short-run loss in output and, to a lesser extent, in productivity due to the reduced availability of labor immediately after prisoner repatriation, followed by a rebound in productivity over time. While Figure 2 focuses on wheat, oats, barley, and fodder (referred to as main grains), for which output can be consistently measured and harmonized across crops and years, we obtain similar results using a broader measure of output that, under additional assumptions, includes other crops (see columns 3 and 4 in Table 3 and the related note for details on these assumptions).

5.2 Robustness Checks

One potential concern with our results is their sensitivity to the choice of the control group, which is defined based on distance from the closest POW camp. Appendix Figure A.6 specifically tests for this sensitivity by reporting the effects obtained when varying control selection in 250-meter intervals, starting at 40 kilometers and up to 80 kilometers.[23] Panel (a) presents the effects on output while Panel (b) investigates the sensitivity of the effects on productivity. In both cases, the sign and significance of the estimates remain unchanged

[23] Beyond 80 kilometers, constructing a reliable control group becomes challenging as the number of parishes in the control group is smaller and less comparable to the treatment.

across alternative control groups. If anything, the positive effects on output in the short run and on productivity in both the short and longer run become larger in magnitude when controls are drawn from distances greater than those used in our baseline analysis.

Another potential concern, emphasized in recent developments in the DiD literature, is that pre-trends, which are central to our identification diagnostics, may go undetected because of limited power to test for pre-trends rather than the absence of actual trends. To investigate this possibility, we apply the approach of Roth (2022) and conduct power calculations for pre-trend tests in our setting. Specifically, we ask: how large would a violation of parallel trends need to be in order to be detected at least 50% of the time? Following Roth (2022), we measure the violation as the slope of a potential linear pre-trend. Panel A of Table 3 (last row) presents the results. Across all specifications, we estimate that the slope of the pre-trend would need to be about one-third of the 1944–45 effect to be detected half of the time. This relatively limited violation suggests that sizeable pre-trends are unlikely to remain undetected in our setting.

Based on the results of the previous paragraph, one may worry that relatively small pre-trends could go undetected. In that case, one may question whether our main conclusions would remain valid under violations of the parallel-trends assumption. To investigate this possibility, we employ the methodology introduced by Roth et al. (2023), which estimates treatment effects and standard errors under varying degrees of deviation from parallel trends. The degree of violation is measured relative to the maximum pre-treatment deviation.

Appendix Figure A.7 presents the results of this analysis. We report estimated effects and standard errors at varying degrees of parallel trends violation, denoted as *Mbar* in the figure. Panel (a) shows short-run output effects (1944–45), while Panel (b) reports long-run productivity effects (1944–51). Reassuringly, our main findings are robust to relatively large violations of parallel trends: output effects remain significant up to violations 4.5 times as large as the maximum pre-treatment deviation, and productivity effects up to 3 times as large. This suggests that our main conclusions are unlikely to change under plausible departures from the parallel-trends assumption.

6 Mechanisms

The results from the previous section leave open the question of what factors may have contributed to the persistence of productivity gains after prisoner repatriation, and how these factors are linked to prisoner employment. In what follows, we focus on two main mechanisms: the adoption of more advanced technologies that may have helped to address labor shortages while increasing productivity, and a shift toward more productive crops. For

each of these factors, we first examine whether they were affected by the prisoner employment program, and then investigate whether any such effects can be linked to relevant agricultural knowledge that prisoners may have brought with them.

6.1 Mechanization

One hypothesis for why prisoner employment may have led to a persistent increase in productivity is that it changed the type of inputs used in production. Specifically, farms affected by the repatriation of prisoners, when faced with a decline in available labor, might have responded by expanding the use of labor-saving technologies. These technological improvements may have, over time, translated into higher productivity. This hypothesis is consistent with predictions from models in which firms endogenously respond to labor shortages by innovating (e.g., Acemoglu, 2010), as well as with empirical evidence from other settings showing increased mechanization in response to labor shortages (e.g., Clemens et al., 2018; Hornbeck and Naidu, 2014). To the extent that technologies take time to be deployed in production, this mechanism may also explain the temporary decline in productivity observed in the year following repatriation in parishes that had previously employed prisoner labor.

In the analysis that follows, we focus on the use of tractors, which at the time represented the main labor-saving technology available in agricultural production in Australia. In line with the above-mentioned hypothesis, Panel (a) in Figure 3 shows that the number of tractors used in production, while following similar trends in the years leading up to the war, increased substantially in parishes that employed prisoners relative to control parishes in the years following prisoner repatriation.[24] Across all post-repatriation years in our sample, we estimate that the number of tractors rose by approximately 5 units in treated parishes, a 50% increase relative to the control group average (see Table 4 for point estimates). A similar pattern emerges when considering tractors per 100 hectares, although with some pre-trends, suggesting that results are not only driven by parishes with greater land area (see Panel (b) of Figure 3)

Was the effect of prisoner employment on technology adoption solely a response to the labor shortages caused by repatriation, or was it also facilitated by relevant know-how that prisoners might have transferred to local farmers while in Australia? The latter mechanism would be consistent with models in which technology use and know-how transfer via labor complement each other, as documented in other settings (e.g., Giorcelli and Li, 2021).

To investigate this hypotheses, we use detailed information from prisoner records matched

[24] Data on tractors were not recorded in the 1944–45 Agricultural Census, and this year is therefore omitted from the analysis (see also Section 3).

to Italian agricultural census data. Specifically, we match each prisoner to his province of residence in Italy and, through this, to data on tractor use in that province prior to the war (1936). For each prisoner camp, we calculate the average number of tractors used before the war across the provinces of residence of the prisoners held in that camp. This serves as a proxy for the prisoners' familiarity with the technology. Using this measure, we classify camps as having above- or below-median levels of technological knowledge and re-estimate the main effects, distinguishing between parishes whose nearest prisoner camp was above versus below the median in tractor-related know-how.

Columns 3 and 4 in Table 4 present the results of this analysis. Consistent with the hypothesis that prisoner know-how facilitated technology adoption, we find that the number of tractors used in production increased significantly only in parishes that employed prisoners from Italian provinces where tractors were more widely used prior to the war. This finding underscores the importance of knowledge diffusion through worker mobility in fostering productivity growth, even when such growth is driven by increased capital use.

6.2 Crop Mix Adjustments

A second potential mechanism for the long-lasting effects of prisoner employment is a change in the type of output produced on affected farms, favoring crops that were more productive. Evidence from other settings shows that farmers may adjust the mix of crops in response to reductions in available labor (see, for instance, Clemens et al., 2018; Hirsch, 1967). In our setting, if such a shift occurred and was driven by knowledge transfer from prisoners, it would likely be concentrated in crops with which prisoners were relatively more familiar (Moscona and Sastry, 2025).

To investigate this hypothesis, we estimate the impact of prisoner employment on the cultivation of Italian crops in Victoria. We focus on wheat, maize, potatoes, grapes, and beet, which are the five most produced crops in Italy in 1930. Because Victorian census data do not report production quantities for all of these crops, we use the share of total area devoted to each crop within a parish as a proxy for production. This share-based measure is also well suited to capturing shifts in production across crops.

Panel A Table 5 shows the results of this analysis. We find a substantial increase in the share of area devoted to the cultivation of potatoes, which went up by 71% relative to the pre-war mean. At the same time we observe a sizable decrease of Maize cultivation, which went down by 50% relative to the pre-war mean. Beet cultivation is also negatively affected in a significant and sizable way (100% relative to the pre-war average), although it accounts for a very limited share (0.01%) of total area so the likely impact was small. We do not find

significant effects of the prisoner program on wheat or grapes cultivation.

In order to investigate whether the shift from maize and, to a lesser extent, from beet to potatoes documented in Panel A, might have improved productivity, Panel B of Table 5 compares the average area cultivated under each crop prior to the war with the suitability of land for each crop in treated parishes. If land use were already aligned with productivity potential, we would expect no mismatch between the ranking of crops by cultivated area and the ranking of crops by the suitability index. Whenever the two rankings differ, meaning that some crops are more suitable to local soil but cultivated to a lesser extent, adjustments toward more suitable crops will enhance productivity. In this analysis we exclude grapes, for which no suitability index is available in the GAEZ data.

Panel B shows that wheat is both the most suitable and the most cultivated of the four crops considered. Moving down the ranking, potatoes are more suitable than maize, yet prior to the war a smaller area was cultivated with potatoes relative to maize. In light of this, the post-war shift from maize to potatoes induced by the prisoner program contributed to reduce a mismatch between land suitability and crop choice, likely enhancing productivity. A similar logic applies to the shift away from beet, although, as already noted, this change was of limited practical importance.

The evidence so far suggests that prisoner employment led to a productivity-enhancing shift from less suitable crops (maize) to more suitable ones (potatoes). To investigate whether this shift was facilitated by specific knowledge that prisoners might have brought with them, in Panel C of Table 5 we estimate effects separately for parishes that employed prisoners who were likely more or less familiar with potatoes and maize. Specifically, we match each prisoner to his province of residence in Italy and, through this, to data on potato and maize production in that province in 1930. For each prisoner camp, we calculate the share of prisoners from provinces where potatoes (or maize) was the main crop produced prior to the war. Using these measures, we classify camps as having above- or below-median levels of potato or maize knowledge and re-estimate the main effects, distinguishing between parishes whose nearest prisoner camp was above versus below the median in crop-specific knowledge.

In line with the hypothesis that knowledge transfer may have facilitated, if not enabled, the shift toward more suitable crops, we find stronger effects in parishes that employed prisoners who were likely more familiar (above the median) with potatoes or maize. For potatoes, the effects in parishes with likely more knowledgeable prisoners are more than twice as large as those in parishes with less knowledgeable prisoners. For maize, the difference is even larger: the point estimate is about eleven times greater, and the effects are almost entirely driven by parishes with larger shares of prisoners familiar with the crop. Overall, this evidence, which is is consistent with what we found for technology use, supports the

view that knowledge transfer from prisoners to farmers played an important role in enabling the productivity-enhancing adjustments induced by prisoner employment.

6.3 Pathways of Knowledge Transfer

The discussion so far leaves open the question of what factors may have facilitated the transfer of know-how from prisoners to farmers, especially in light of potential language barriers. Although the type of knowledge transferred was likely practical and thus arguably transmissible without full command of English, it is plausible that lower language barriers eased this process.

Unfortunately, the available data do not provide prisoner-level information on English proficiency. To explore this hypothesis, we exploit two sources of variation that may proxy for lower barriers. First, we consider the presence of internees. As discussed in Section 2, internees were already residing in Australia when Italy entered WWII and thus presumably had greater English proficiency. While they were not employed in agriculture outside camps, they may have helped prisoners in the same camp learn English. Panel A of Table 6 reports this analysis. Columns 1 and 2 split the mechanization effects from column 3 of Table 4 by whether the nearest camp had an above- versus below-median share of internees. Columns 3 to 6 apply the same approach to the crop-mix results of columns 1 and 3 in Panel C of Table 5. Consistent with the hypothesis, effects are stronger in parishes employing prisoners with higher expertise when internees made up a larger share of the nearest camp.

Second, we examine whether knowledge transfer effects are amplified in parishes whose prisoners came from provinces with higher literacy rates. Prisoners were allowed, and often supplied with, books in detention (see Morel, 1944; Moore and Fedorowich, 2002). Literacy may therefore have facilitated English learning. We assign to each prisoner the 1936 literacy rate of his home province, average these values within each camp, and classify camps as above or below the median of this literacy measure.[25] Panel B of Table 6 presents the results of this analysis. Mirroring Panel A, columns 1 and 2 show tractor use, while columns 3 to 6 show effects on crop mix. In line with the hypothesis, parishes employing prisoners with higher relevant expertise show stronger effects when those prisoners came from higher-literacy provinces.

Taken together, these findings suggest that lower barriers, through the presence of internees or higher human capital, favored the transfer of relevant knowledge.

[25]Data on literacy rates by Italian provinces are from Bertazzini and Giorcelli (2025).

7 Conclusion

This paper explores the effects of prisoner of war employment on agricultural production and productivity. Using newly collected data and the fitting setting of the Australian prisoner employment program during WWII, we show that prisoner labor not only increased agricultural output in the short run but also generated persistent productivity gains over the longer run. We provide evidence consistent with greater mechanization and shifts toward more suitable crops, facilitated by prisoner know-how, as channels for the observed productivity improvements.

Overall, our findings underscore the importance of knowledge diversity in fostering productivity growth. Future research could extend our analysis by studying the effects of prisoner employment on the places of origin of the prisoners. In fact, prisoners may have acquired skills and know-how while working abroad that might have enhanced productivity at home upon repatriation. Whether this was indeed the case remains an open question for future empirical investigation.

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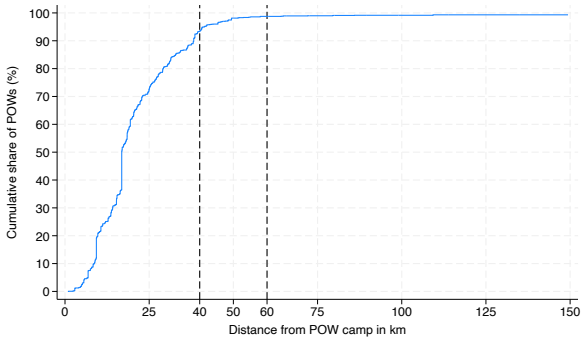
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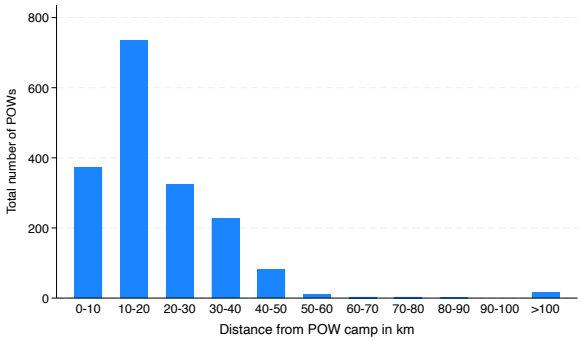
Figures

Figure 1: POW Employment as a Function of Distance to the Nearest Camp

(a) Cumulative Distribution of POW



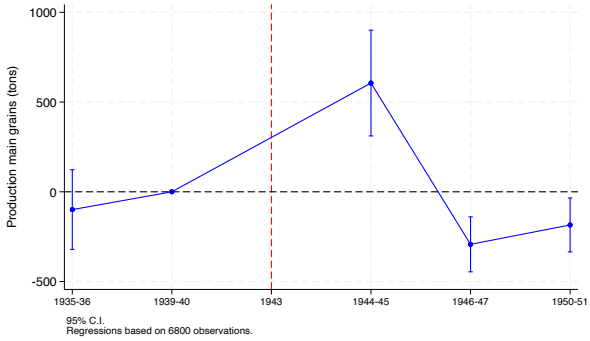
(b) Distribution of POW in 10 km Bins



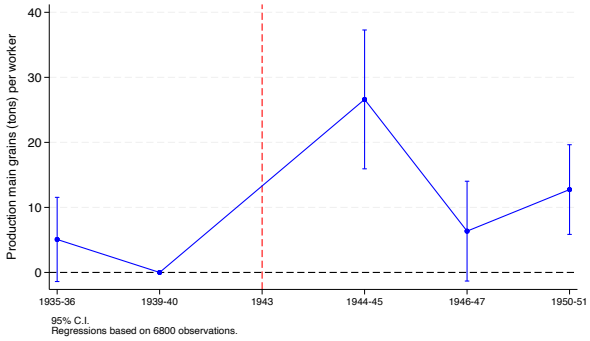
Notes. Panel (a) plots the cumulative distribution of prisoners of war as a function of distance from the closest POW camp. Panel (b) plots the number of prisoners of war employed, binned in 10-kilometer intervals, as a function of distance from the closest POW camp.
Source. Agricultural census of Victoria in 1944, which reports the number of prisoners of war employed per parish.

Figure 2: Output and Productivity Effects of Prisoner Employment

(a) Output



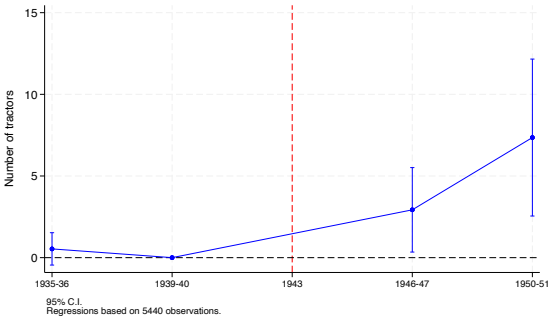
(b) Output per worker



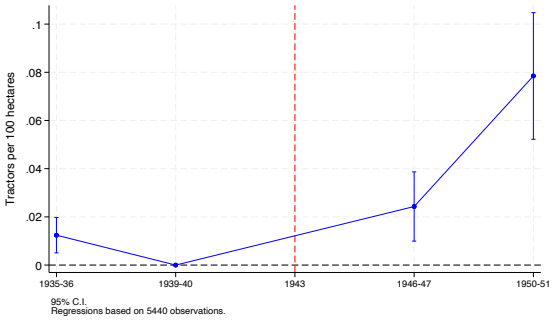
Notes. Point estimates of β_t obtained from equation (1) with 95% confidence intervals. Robust standard errors are clustered at parish level. Panel (a) plots estimates using production output of main grains, measured in tons, as the outcome variable. Main grains include wheat, oats, barley, and fodder. Panel (b) plots estimates using production of main grains per worker as the outcome variable.
Source. Agricultural census of Victoria, 1935-1951.

Figure 3: The Effects of Prisoner Employment on Mechanization

(a) Number of Tractors



(b) Number of Tractors per 100 hectares



Notes: *Notes*. Point estimates of β_t obtained from equation (1) with 95% confidence intervals. Robust standard errors are clustered at parish level. Robust standard errors are clustered at parish level. Panel (a) plots estimates using number of tractors as the outcome variable. Panel (b) plots estimates using number of tractors per 100 hectares as the outcome variable.
Source. Agricultural census of Victoria, 1935-1951.

Tables

Table 1: Descriptive Statistics: Prisoners of War

Panel A: Distribution by state

	Frequency	%	Cum.
Victoria	7,803	42.69	42.69
New South Wales	6,972	38.14	80.83
Western Australia	1,731	9.47	90.30
Other	1,048	5.73	96.03
Queensland	7,26	3.97	100.00
Total	18,280	100.00	

Panel B: Demographic characteristics

	Victoria			Rest of Australia		
	Obs.	Mean	St. Dev.	Obs.	Mean	St. Dev.
Age	7,757	30.26	6.07	10,419	29.60	7.30
Weight (kg)	7,558	65.14	7.23	10,326	64.97	7.78
Height (cm)	7,753	165.97	7.78	10,387	168.38	8.16
Single	7,795	0.58	0.49	10,471	0.60	0.49
Employed in Agriculture	7,803	0.48	0.50	10,477	0.45	0.50
Captured by 1941	7,742	1.00	0.04	10,270	0.95	0.22

Notes: This table presents descriptive statistics on Italian prisoners of war detained in Australia. Panel A reports the states in which POWs were first detained, while Panel B presents descriptive statistics separately for prisoners detained in Victoria and those detained in other states. We present statistics for all prisoners for whom records are available. In Appendix Table A.1, we restrict the sample to prisoners for whom all characteristics are consistently recorded. "Other" includes: New Caledonia, New Guinea, Middle East, Straits Settlement, United Kingdom, Australia, South Australia, Darwin, POWs with missing internment state. Tasmania does not appear among the states because it hosted only internees and no POW. The original records are from the National Archives of Australia, Series MP1103/1 and MP1103/2.

Table 2: Descriptive Statistics: Victorian Agricultural Census

	Obs.	Mean	St. Dev.
Total employment	1,680	55.66	82.41
Number of POWs	1,680	0.908	3.597
POWs relative to 1939 employment (parishes with $\geq$1 POW)	277	0.121	0.201
Number of tractors	1,680	8.777	14.24
Tractors per 100 hectares	1,680	0.113	0.515
At least one tractor before the war (share)	1,680	0.720	0.391
Two or more tractors before the war (share)	1,680	0.555	0.442
Production main grains (tons)	1,680	1207.5	1847.4
Production main grains per worker	1,680	33.19	43.04
Total Production (tons)	1,680	9594.1	17571.4
Production per worker	1,680	266.7	421.7
Production wheat (acres)	1,680	1616.5	3129.0
Production maize (acres)	1,680	16.74	68.18
Production potato (acres)	1,680	30.13	162.0
Production grapes (acres)	1,680	25.67	605.9
Production beets (acres)	1,680	1.279	20.20
Wheat (% of total area)	1,680	5.825	9.555
Maize (% of total area)	1,680	0.0924	0.323
Potato (% of total area)	1,680	0.214	0.993
Grapes (% of total area)	1,680	0.0750	1.367
Beet (% of total area)	1,680	0.00433	0.0657

Notes: This table presents averages and standard deviations for the agricultural census variables used in our main analysis. Unless otherwise noted, averages are calculated over the entire sample period, 1935–1951. The original records are from the National Archives of Australia, Series MP570/1.

Table 3: The Effects of Prisoner Employment on Production and Productivity

	Production Main Grains (1)	Prod. Main Grains Per worker (2)	Total Production (3)	Total Prod. Per worker (4)
	Panel A: Panel A: Year-by-year Estimates			
T × 1935	11.2	5.01	-83.0	4.15
	(69.4)	(3.31)	(71.9)	(3.47)
T × 1944	626.2***	26.5***	604.1***	25.7***
	(151.6)	(5.45)	(153.9)	(5.61)
T × 1946	-272.6***	6.24	-265.2***	5.30
	(79.2)	(3.92)	(81.4)	(4.14)
T × 1950	-164.5**	12.6***	-160.9**	11.3***
	(77.2)	(3.52)	(79.4)	(3.80)
Observations	6,800	6,800	6,800	6,800
R^2	0.82	0.78	0.82	0.77
Mean D.V. control group	2120.63	62.00	2174.62	63.54
Mean D.V. in 1939	1730.26	58.52	2040.79	65.13
Pre-trend slope (Roth 2022)	194.55	9.26	201.37	9.72
	Panel B: DiD Estimates			
Treated × Post	57.4	12.6***	100.7	12.0***
	(69.6)	(3.07)	(70.2)	(3.18)
Observations	6,800	6,800	6,800	6,800
R^2	0.82	0.78	0.82	0.77
Mean D.V. control group	2120.63	62.00	2174.62	63.54
Mean D.V. in 1939	1730.26	58.52	2040.79	65.13
Region by Year FEs	*Yes*	*Yes*	*Yes*	*Yes*
Parish FEs	*Yes*	*Yes*	*Yes*	*Yes*

Notes: This table presents estimates obtained from equation (1). Panel A reports estimates of β_t for each year in our sample. Panel B reports DiD estimates that combine post- and pre-treatment years. Columns 1 and 2 use production of main grains for which a consistent measure of output in tons exists. Main grains include wheat, oats, barley, and fodder. Columns 3 and 4 consider a broader measure of production that includes all crops for which output could be measured. Output measures across crops are harmonized as described in Data Appendix B. Robust standard errors clustered at the parish level are reported in parentheses (*** significant at 1%, ** significant at 5%, * significant at 10%).

Table 4: The Effects of Prisoner Employment on Mechanization

	Number of Tractors	Tractors per 100ha	Number of Tractors Above Median POW Expertise	Number of Tractors Below Median POW Expertise
	(1)	(2)	(3)	(4)
Treated × Post 1939	4.90**	0.045***	9.78**	-0.31
	(2.10)	(0.011)	(3.98)	(0.58)
Observations	5,440	5,440	2,696	2,744
R^2	0.72	0.67	0.69	0.81
Mean D.V. control group	9.80	0.09	9.46	10.14
Mean D.V.in 1939	5.95	0.06	6.15	5.76
Region by Year FEs	*Yes*	*Yes*	*Yes*	*Yes*
Parish FEs	*Yes*	*Yes*	*Yes*	*Yes*

Notes: This table presents the estimated DiD effects of prisoner employment on tractor use. Column 1 reports effects on the number of tractors used in production, and Column 2 on the number of tractors per 100 hectares. Columns 3 and 4 break down the effects from Column 1 depending on whether the parish is located near a prisoner camp whose prisoners, on average, came from provinces with an above- versus below-median number of tractors. Tractor numbers in the provinces of origin are obtained from the 1930 Italian Agricultural Census. Robust standard errors clustered at the parish level are reported in parentheses (*** significant at 1%, ** significant at 5%, * significant at 10%).

Table 5: The Effects of Prisoner Employment on Crop Mix

Panel A: DiD Estimates

	D.V.: Percent of Total Area				
	Wheat	Maize	Potato	Grapes	Beet
	(1)	(2)	(3)	(4)	(5)
Treated × Post 1939	0.014	-0.059***	0.093***	-0.080	-0.010**
	(0.20)	(0.021)	(0.020)	(0.070)	(0.0049)
Observations	6,798	6,798	6,798	6,798	5,438
R^2	0.94	0.61	0.84	0.93	0.54
Mean D.V. control group	11.920	0.021	0.074	0.009	0.000
Mean D.V. in 1939	6.53	0.12	0.13	0.09	0.01
Year FEs × Region FEs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Parish ID FEs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Panel B: Crop Production vs Suitability

		Suitability Index		Area Cultivated (1939)	
	Obs.	Mean	Std. Dev.	Mean	Std. Dev.
Wheat	881	5681.1	1345.2	716.7	1885.0
Potato	881	4288.6	1057.9	22.93	109.8
Beet	881	3766.2	764.0	3.843	44.70
Maize	881	2347.2	1128.2	32.96	110.8

Panel C: Crop Shift and Crop Knowledge

	D.V.: Share of Total Area			
	Potato		**Maize**	
	Above Median	Below Median	Above Median	Below Median
	(1)	(2)	(3)	(4)
Treated × Post 1939	0.11***	0.053***	-0.13***	-0.011*
	(0.033)	(0.017)	(0.048)	(0.0064)
Observations	3,304	3,494	3,194	3,604
R^2	0.85	0.81	0.60	0.77
Mean D.V. control group	0.08	0.07	0.04	0.00
Mean D.V. in 1939	0.21	0.06	0.19	0.06
Year × Region FEs	*Yes*	*Yes*	*Yes*	*Yes*
Parish ID FEs	*Yes*	*Yes*	*Yes*	*Yes*

Notes: Panel A of the table presents the estimated DiD effects of prisoner employment on the percentage of area cultivated under wheat, maize, potatoes, grapes, and beet. Panel B reports averages and standard deviations of the suitability index and cultivated area for wheat, potatoes, beet, and maize. Suitability index measures are based on GAEZ pixel-level data, aggregated at the parish level by averaging crop suitability within a 15-kilometer radius around each parish centroid. Suitability index measures for grapes are not available. Panel C reports separate DiD estimates for the share of area cultivated under potatoes (columns 1 and 2) and maize (columns 3 and 4), depending on whether the parish is located near a prisoner camp whose prisoners came from Italian provinces with above- versus below-median familiarity with the specific crop. For each prisoner camp, we calculate the number of prisoners from provinces where potatoes or maize was the main crop produced prior to the war. Using these measures, we classify camps as having above- or below-median levels of potato or maize knowledge and re-estimate the main effects, distinguishing between parishes whose nearest camp was above versus below the median in crop-specific knowledge. Robust standard errors clustered at the parish level are reported in parentheses (*** significant at 1%, ** significant at 5%, * significant at 10%).

Table 6: Internees and Literacy as Pathways of Knowledge Transfer

	Panel A: Share of internees in the camp					
			% of Total Area			
	N. of Tractors		Potato		Maize	
Literacy rate:	Above Median	Below Median	Above Median	Below Media	Above Median	Below Median
	(1)	(2)	(3)	(4)	(5)	(6)
Treated × Post 1939	11.1***	9.06	0.28***	-0.0085	-0.063	-0.0013
	(2.64)	(5.81)	(0.071)	(0.026)	(0.061)	(0.0042)
Observations	1,272	1,424	1,670	1,634	1,670	1,634
R^2	0.77	0.68	0.76	0.90	0.68	0.85
D.V. Mean (C.G.)	10.79	8.44	0.03	0.10	0.06	0.01
D.V. Mean (1939)	7.24	5.17	0.14	0.29	0.22	0.08
Year × Region FEs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Parish ID FEs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

	Panel B: Literacy rate at origin					
			% of Total Area			
	N. of Tractors		**Potato**		**Maize**	
Literacy rate:	Above Median	Below Median	Above Median	Below Media	Above Median	Below Median
	(1)	(2)	(3)	(4)	(5)	(6)
Treated × Post	16.1*	5.17***	0.23**	-0.0061	-0.063	-0.0013
	(8.86)	(1.99)	(0.095)	(0.020)	(0.041)	(0.024)
Observations	1,328	1,368	1,459	1,845	1,459	1,845
R^2	0.67	0.79	0.84	0.89	0.70	0.79
D.V. Mean (C.G.)	4.20	13.46	0.12	0.07	0.03	0.02
D.V. Mean (1939)	3.77	8.46	0.34	0.11	0.19	0.12
Year × Region FEs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Parish ID FEs	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

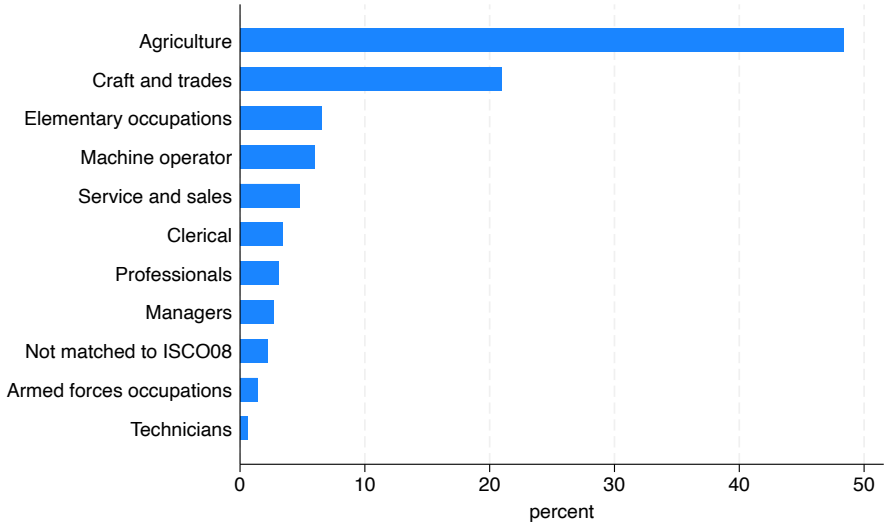
Notes: Panel A of the table reports separate DiD estimates for the number of tractors present in a parish (columns 1 and 2) , the share of area cultivated under potatoes (columns 3 and 4) and maize (columns 5 and 6), depending on whether the parish is located near a prisoner camp with above- versus below-median share of internees present in the camp. For each prisoner camp, we calculate the share of internees relative to the total number of prisoners in the camp. Using these measures, we classify camps as having above- or below-median share of internees and re-estimate the main effects splitting the sample accordingly. Panel B reports separate DiD estimates for the number of tractors present in a parish (columns 1 and 2) , the share of area cultivated under potatoes (columns 3 and 4) and maize (columns 5 and 6), depending on whether the parish is located near a prisoner camp whose prisoners came from Italian provinces with above- versus below-median literacy rates. For each prisoner camp, we assign to each prisoner the literacy rate of their province of origin in Italy, and compute a camp-level average literacy rate across all prisoners in the camp. Using these measures, we classify camps as having above- or below-median literacy rates and re-estimate the main effects splitting the sample accordingly. Robust standard errors clustered at the parish level are reported in parentheses (*** significant at 1%, ** significant at 5%, * significant at 10%).

ONLINE APPENDIX
"Productivity and Knowledge Transfer: Evidence from Prisoner Employment"

A Results Appendix

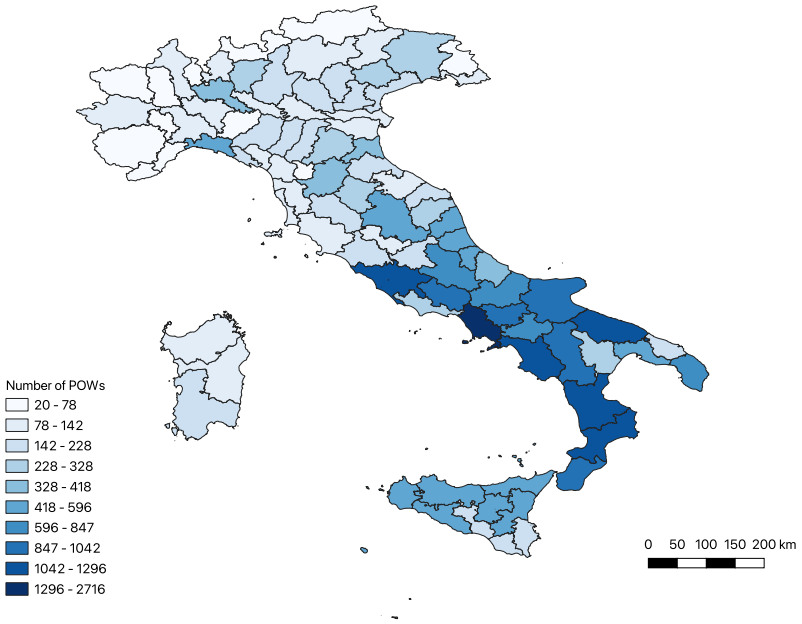
A.1 Appendix Figures

Figure A.1: Distribution of Pre-war Occupations among Prisoners of War



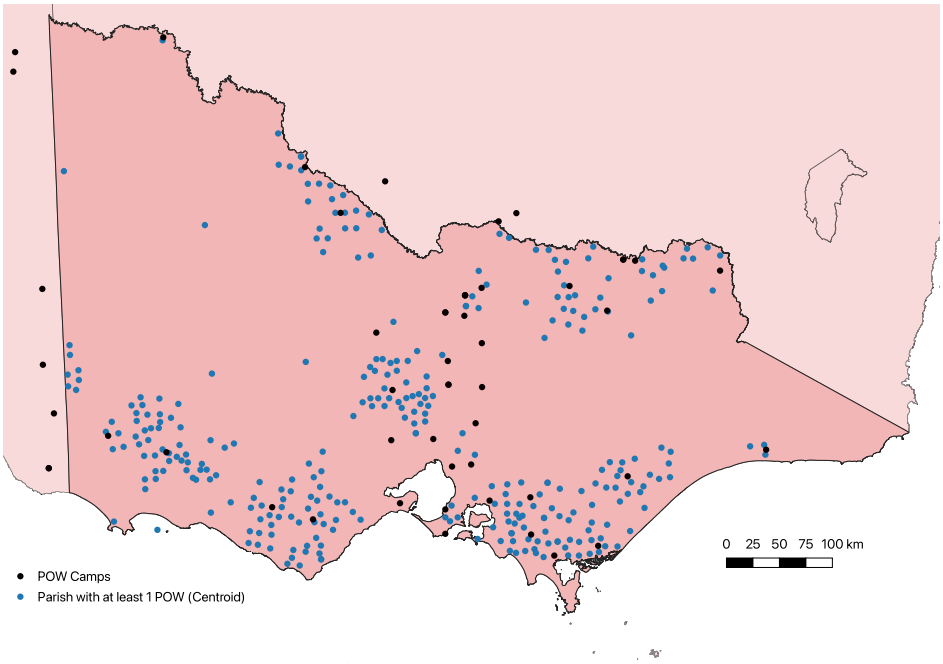
Notes: This figure shows the distribution of prisoners of war occupations prior to the war. We first digitized, then cleaned and aggregated occupations following the ISCO08 classification.

Figure A.2: Province of Origin of Prisoners of War



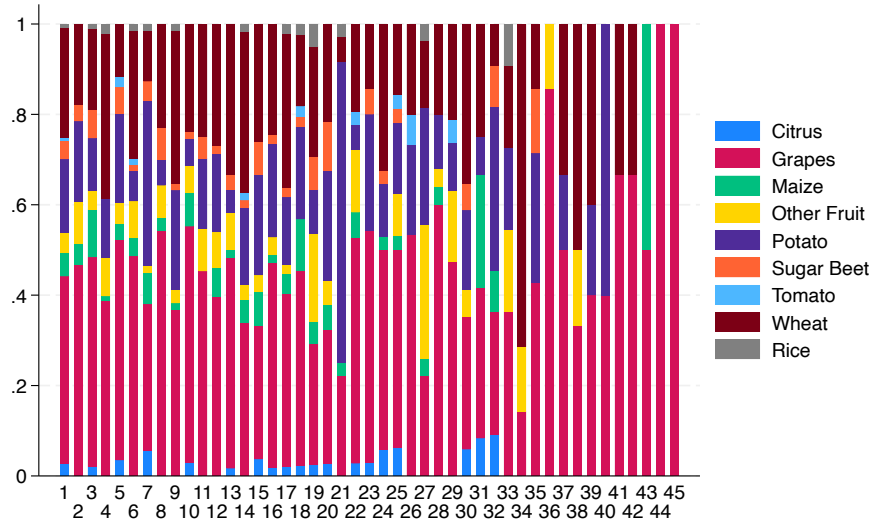
Notes: This figure shows the distribution of prisoners by province of residence in Italy prior to the war.

Figure A.3: POW Camp Locations and Parishes Employing POWs (1944-45)



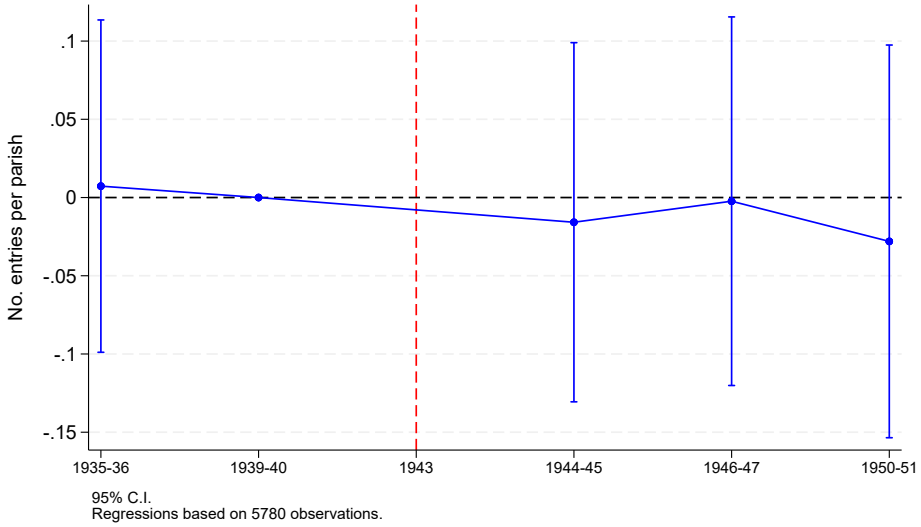
Notes: This figure shows the geographical location of POW camps (black dots) and parishes that report employing at least one prisoner in 1944–45 (blue dots). The locations of both POW camps and parishes are based on centroids.

Figure A.4: Distribution of Top Crops from Provinces of Origin within POW Camps



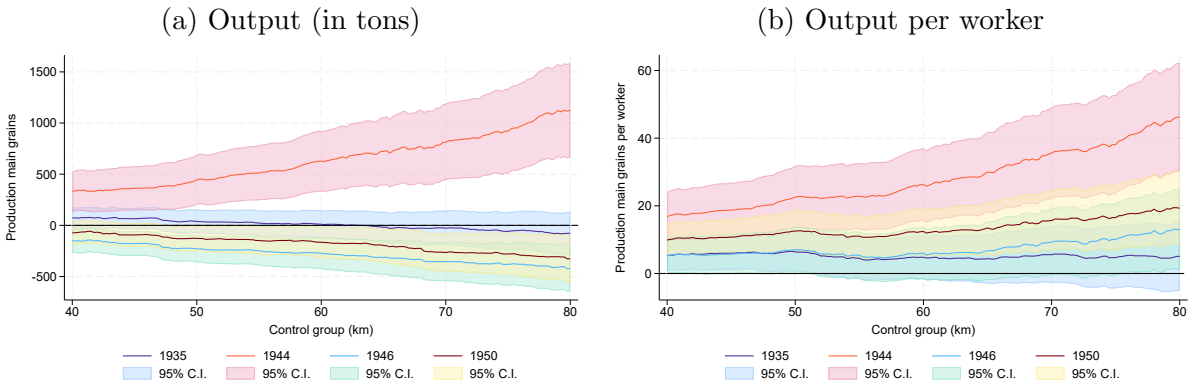
*Notes:*The figure shows the distribution of prisoners across camps by the main crop produced in their province of residence before the war. Each number in the figure represents a camp. The analysis is restricted to prisoner camps located in Victoria.

Figure A.5: Number of Census Entries per Parish



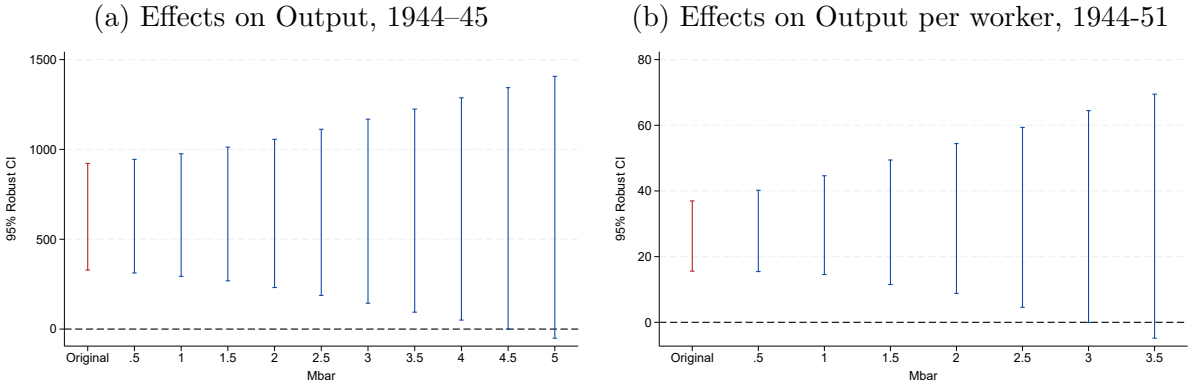
*Notes:*This figure plots point estimates and 95% C.I. of β_t obtained from equation (1), using as the outcome variable the number of entries recorded for each parish in the Victorian Census data (National Archives of Australia, Series MP570/1: Summaries of agricultural, dairying and pastoral statistics obtained from police collectors' books in Victoria).

Figure A.6: Effects of POW Employment with Alternative Control Groups by Distance



Notes: Panel (a) plots point estimates and 95% C.I. bands of β_t obtained from equation (1), using production of main grains as the outcome variable. Panel (b) plots estimates of β_t obtained from the same equation, using production of main grains per worker as the outcome variable. In both panels, for each year in our sample we show estimated effects based on varying control group selections in 250-meter intervals from 40 to 80 kilometers.

Figure A.7: Effects of POW Employment under Varying Violations of Parallel Trends



Notes: This figure shows point estimates and associated standard errors obtained following Roth et al. (2023), under varying degrees of violation relative to the maximum pre-treatment violation observed in the data. The degree of violation of parallel trends is reported on the x-axis. Panel (a) plots the estimated effects on 1944–45 production of main grains. Panel (b) plots the estimated effects on 1944–51 production of main grains per worker.

A.2 Appendix Tables

Table A.1: Descriptive Statistics: Prisoners of War

Panel A: Distribution by state

State	Frequency	%	Cum.
Victoria	7,413	43.65	43.65
New South Wales	6,681	39.34	82.98
Western Australia	1,604	9.44	92.43
Queensland	711	4.19	96.61
Abroad	538	3.17	99.78
South Australia	34	0.20	99.98
Australia	3	0.02	100.00
Total	16,984	100.00	

Panel B: Demographic Characteristics

	Victoria			Other states		
	Obs.	Mean	St. Dev.	Obs.	Mean	St. Dev.
Age	7,413	30.35	5.76	9,999	29.61	7.23
Weight (kg)	7,413	65.14	7.23	9,999	64.98	7.78
Height (cm)	7,413	166.21	6.55	9,999	168.41	8.03
Single	7,413	0.57	0.49	9,999	0.60	0.49
Year of capture	7,413	1940.71	0.46	9,999	1940.86	0.47
Modal year of capture	7,413	1941	0	9,999	1941	0
Share previously employed in agriculture	7,413	0.48	0.50	9,999	0.46	0.50

Notes: This table presents descriptive statistics on Italian prisoners of war detained in Australia. We restrict attention to prisoners for whom all characteristics are uniformly recorded. The table is otherwise identical to Table 1. XX. In Panel A, we exclude from the sample 538 prisoners who were detained in other countries, such as New Guinea or New Caledonia, or in territories, such as the Straits Settlements, which were not formally part of Australia during WWII. Tasmania does not appear among the states because it hosted only internees and no POW.XX The original records are from the National Archives of Australia, Series MP1103/1 and MP1103/2.

Table A.2: Enlistment Count: Treated vs Control Parishes

	Enlistment		
	(1)	(2)	(3)
Treated	-132.2	-85.0	-64.2
	(82.6)	(96.9)	(101.2)
Latitude			96.6
			(99.2)
Longitude			16.7
			(32.6)
Distance from State Capital			0.14
			(0.48)
Observations	1,360	1,360	1,360
R^2	0.02	0.04	0.06
D.V. Mean	396.78	396.78	396.78
Region FEs	*No*	*Yes*	*Yes*

Notes: This table presents the association between treatment status and enlistment in World War II at the parish level. The dependent variable measures cumulative WWII enlistment based on residents' enlistment records. Similar results are obtained when using the number of enlistees by parish of birth. Robust standard errors, clustered at the SA2 zone level, are reported in parentheses (*** significant at 1%, ** significant at 5%, * significant at 10%).

Table A.3: Pre-war Parish Characteristics and POW Expertise

	No. of POWs experts in:				No. Tractors in POW	
	Potato		Maize		Province of origin	
	(1)	(2)	(3)	(4)	(5)	(6)
Potato in 1939 (% of total area)	1.20	1.49				
	(0.90)	(1.20)				
Maize in 1939 (% of total area)			0.95	1.38*		
			(0.76)	(0.75)		
No. of Tractors in 1939					-0.026	-0.62
					(0.68)	(0.46)
Observations	881	881	881	881	881	881
R^2	0.00	0.08	0.00	0.08	0.00	0.10
D.V. Mean	22.38	22.38	5.74	5.74	350.29	350.29
Region FEs	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Geo controls	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*

Notes: This table shows the association between pre-treatment (1939) share of area cultivated under potato or maize, number of tractors, with prisoners' knowledge about potatoes (columns 1 and 2), maize (columns 3 and 4), tractors (columns 5 and 6), respectively. Geographic controls include: latitude, longitude, distance from Melbourne. Robust standard errors in parentheses clustered at POW camp level (*** significant at 1%, ** significant at 5%, * significant at 10%).

B Data Appendix

This Data Appendix describes the data collection procedures behind our paper more in detail. It describes the primary sources, their coverage, and provides additional details about the resulting dataset.

B.1 Italian POWs in Australia

The first step of data collection consisted of gathering information on Italian prisoners of war detained in Australia during World War II. These data were obtained from the online portal of the Australian National Archives (NAA).[1] Specifically, we searched for series number MP1103/1, which contains the *Service and Casualty Forms* (Form A112) of enemy prisoners of war and internees held in camps in Australia between January 1, 1939, and December 31, 1947. The *Service and Casualty Form* was compiled for every prisoner of war (dead or alive) captured by the Australian Military Forces or an Allied force and transported to camps in Australia. It contains detailed individual-level information, including identification number, name, date and place of capture, date and place of birth, occupation, religion, nationality, marital status, name and address of next of kin, hair and eye color, and any distinctive marks. In addition, the form records information on the period of detention, including hospitalizations, disciplinary proceedings, transfers between camps, release, and—crucially for our purposes—repatriation to Italy. An example of these records is shown in Figure B.1.

We downloaded all files labeled *PWI* that refer to Italian POWs.[2] This process yielded 18,501 records, which were digitized with the assistance of a data entry company. Some records were duplicates; after their removal, the final dataset comprises 18,225 unique POWs. This figure covers over 98% of the 18,432 Italian POWs held in Australia during WWII, according to official government statistics (NAA Series A7711/1, p. 106), also echoed by secondary sources (Fitzgerald, 1981, p. 172; Moore, 1997, p. 72).

For most POWs (97%), two additional forms were compiled: the *Report on Prisoner of War/Internee* (Form A111) and the *Property Statement – Prisoner of War/Internee* (Form A114), contained in NAA series number MP1103/2. The *Report on Prisoner of War/Internee* contains, in addition to the identification number and name, further demographic information such as height, weight, and skin color, POWs address, as well as the

[1] The relevant files were downloaded from https://recordsearch.naa.gov.au/ in July 2020.

[2] The following labels refer to Italian prisoners of war: (i) PWI: Italian POWs held on behalf of the United Kingdom; (ii) PWI USA: Italian POWs held on behalf of the United States; (iii) PWIM Italian: Italian POW merchant seamen held on behalf of the United States; (iv) PWIA Italian: Italian POWs held by the Commonwealth; (v) PWIX Italian: Italian POWs who were captured in various places and arrived to Australia via India.

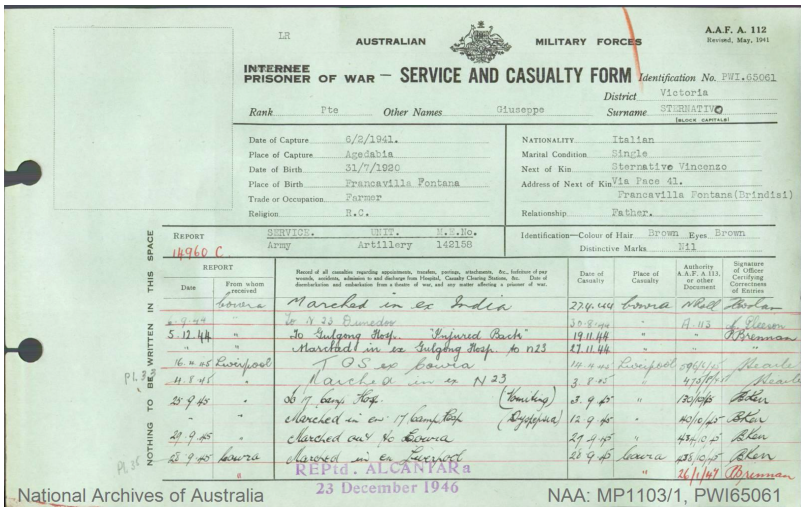
place and date of capture, the date and port of embarkation and disembarkation, and the internment camp and date (Figure B.2). The *Property Statement* reports the property owned by the prisoner; in most cases, this consists of small amounts of cash and a few personal items, such as blankets and pillows (Figure B.3).

B.1.1 Italian Internees

We also collected data on Italian internees. For the great majority, they were Italian-born individuals living in Australia, but some were Australian-born citizens of Italian descent.

Files in NAA collection MP1103/1 referring to Italian internees are labeled as *PW* followed by a letter indicating the state of internment.[3] We downloaded and digitized this data, a procedure that returns 4,777 internees.

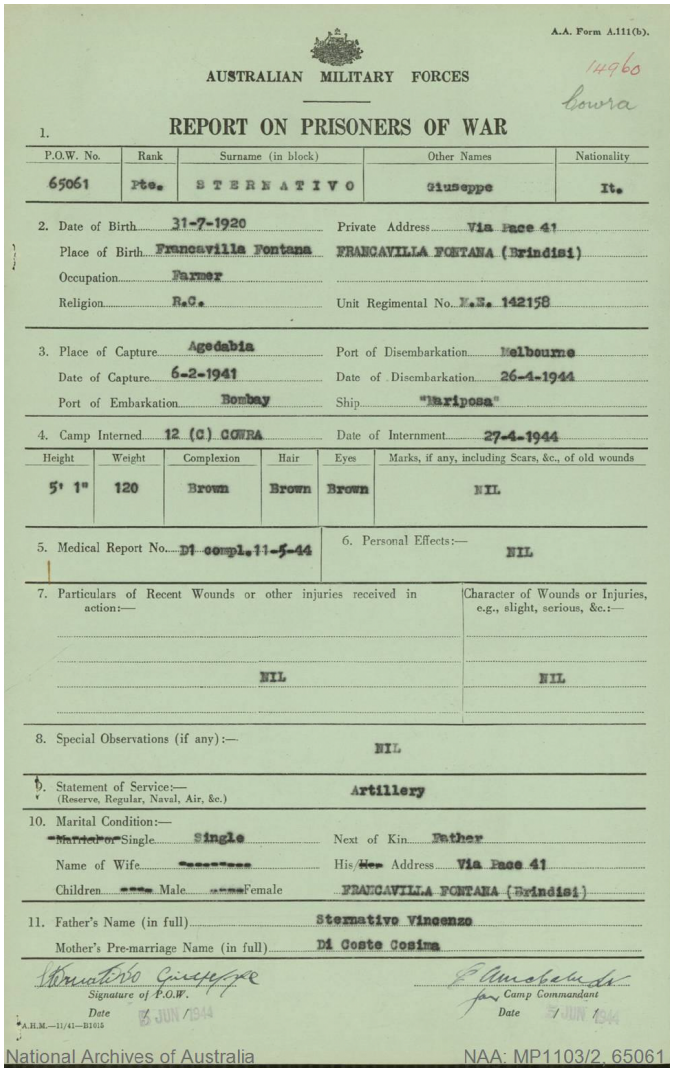
Figure B.1: Example of *Service and Casualty Form*



Notes. This figure shows an example of the *Service and Casualty Form* (Form A112) for an Italian POW. The form reports, among other information, POW first and last name, identification number, date and place of capture, date and place of birth, occupation, religion, nationality, marital status, name and address of next of kin, hair and eye color, and any distinctive marks, movements across camps while in Australia, and repatriation date.
Source. NAA Series Number MP1103/1.

[3]The states of internment were: i) Q - Queensland; ii) N - New South Wales; iii) V - Victoria; iv) S - South Australia; v) W - Western Australia; vi) T - Tasmania; vii) D - Darwin; and viii) NG - New Guinea.

Figure B.2: Example of *Report on Prisoner of War*



A.A. Form A.111(b).

AUSTRALIAN MILITARY FORCES

1496
Cowra

1. REPORT ON PRISONERS OF WAR

P.O.W. No.	Rank	Surname (in block)	Other Names	Nationality
65061	Pte.	S T E R N A T I V O	Giuseppe	It.

2. Date of Birth 31-7-1920 Private Address Via Pace 41
Place of Birth Francavilla Fontana FRANCAVILLA FONTANA (Brindisi)
Occupation Farmer
Religion R.C. Unit Regimental No. M.E. 142158

3. Place of Capture Agedabia Port of Disembarkation Melbourne
Date of Capture 6-2-1941 Date of Disembarkation 26-4-1944
Port of Embarkation Bombay Ship "Mariposa"

4. Camp Interned 12 (C) COWRA Date of Internment 27-4-1944

Height	Weight	Complexion	Hair	Eyes	Marks, if any, including Scars, &c., of old wounds
5' 1"	120	Brown	Brown	Brown	NIL

5. Medical Report No. D1 compl. 11-5-44 6. Personal Effects:— NIL

7. Particulars of Recent Wounds or other injuries received in action:— NIL
Character of Wounds or Injuries, e.g., slight, serious, &c.:— NIL

8. Special Observations (if any):— NIL

9. Statement of Service:— (Reserve, Regular, Naval, Air, &c.) Artillery

10. Marital Condition:— ~~Married or~~ Single Single Next of Kin Father
Name of Wife ~~———~~ His/~~Her~~ Address Via Pace 41
Children ~~——~~ Male ~~——~~ Female FRANCAVILLA FONTANA (Brindisi)

11. Father's Name (in full) Sternativo Vincenzo
Mother's Pre-marriage Name (in full) Di Coste Cosima

Signature of P.O.W. Camp Commandant
Date 13 JUN 1944 Date 7 JUN 1944

A.H.M.—11/41—B1015

National Archives of Australia NAA: MP1103/2, 65061

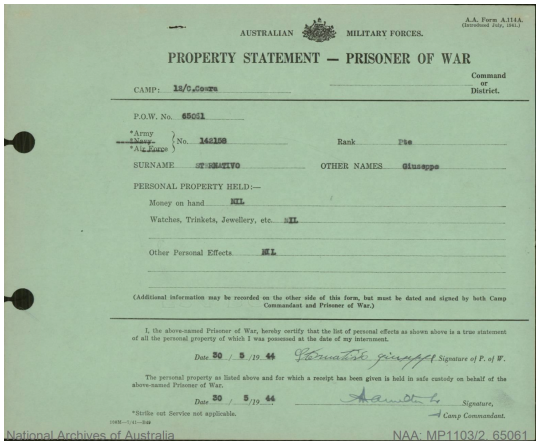
Notes. This figure shows an example of the *Report on Prisoner of War* (Form A111) for an Italian POW. The form reports, among other information, POW first and last name, identification number, date and place of capture, date and place of birth, occupation, religion, place and date of capture, date and port of embarkation and disembarkation, internment camp and date, height, weight, completion, hair and eyes color, and marks. *Source.* NAA Series Number MP1103/2.

B.2 Agricultural Census Data in Victoria

We collected information on agricultural inputs and outputs from the *Australian Agricultural Census* for the state of Victoria. We focus on Victoria because, to the best of our knowledge, it is the only state that systematically collected these data both before and after World War II. Although the Agricultural Censuses were compiled by the Commonwealth Bureau of Census and Statistics separately for each Australian state, repeated attempts to locate comparable data for other states were unsuccessful.

The Victorian Agricultural Censuses belong to series MP570/1, "Summaries of agricul-

Figure B.3: Example of *Property Statement*



Notes. This figure shows an example of the *Property Statement* (Form A114) for an Italian POW.
Source. NAA Series Number MP1103/2.

tural, dairying and pastoral statistics obtained from police collectors' books in Victoria," which we physically collected from the National Archives of Australia (NAA) in Melbourne in October 2020. We focus on the years 1935–36, 1939–40, 1944–45, 1946–47, and 1950–51, as these are the only years for which complete volumes exist for all counties. In other years, data for some counties are missing from the NAA and could not be located despite extensive correspondence with NAA staff. These five years nonetheless provide strong coverage for our analysis: two years before POW arrivals, two years during POW employment, and one year after their departure.

The Victorian Agricultural Censuses consist of county-level summaries of agricultural, dairying, and pastoral statistics. Each of the 37 counties is assigned a unique registration number (e.g., Bourke is county number 1, see Figure B.8), and agricultural data are recorded in separate booklets for each county. For any given census year, the structure of these booklets is uniform across counties. Although the same entry identifiers are used across years, the set of agricultural variables changes between the 1939–40 and 1944–45 censuses, while remaining consistent in the years before and after this break.

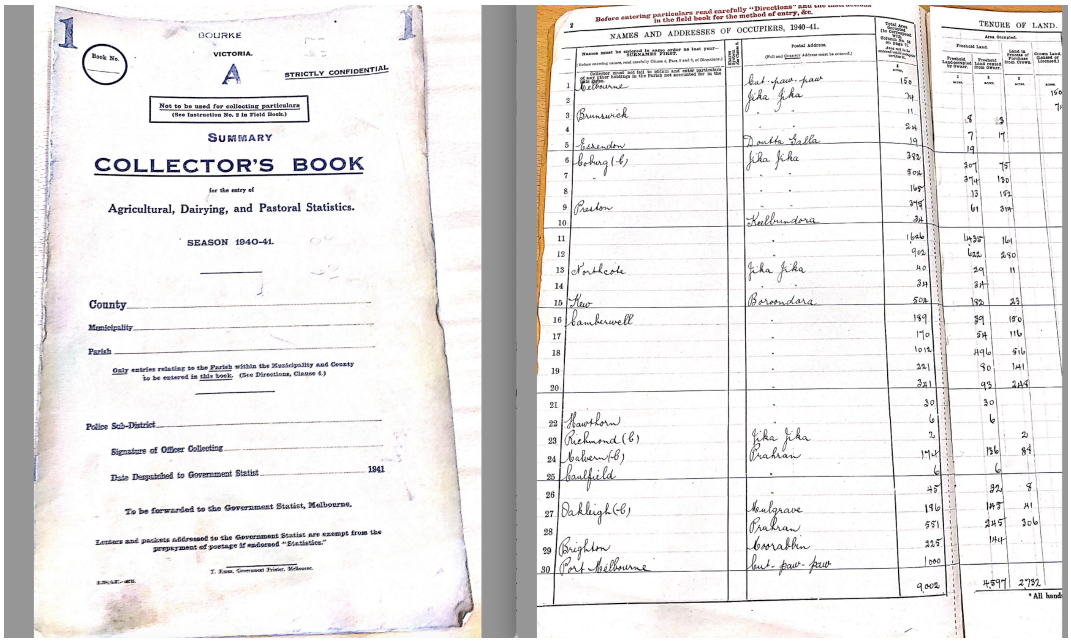
For the 1935–36 and 1939–40 seasons, the censuses report statistics on the following categories: Tenure of Land; Hands Employed—by Use; Cereal, Hay, and Fodder Crops—Acreage; Cereal, Hay, and Fodder Crops—Production; Root Crops, Orchards, and Vineyards—Acreage; Land in Fallow, Pastures, Ensilage, etc.; Horses; Farm Machinery; and Wheat and Oat Growers.[4] For the 1944–45, 1946–47, and 1950–51 seasons, the categories collected are: Number

[4]The Victorian Agricultural Censuses also include extensive information on husbandry. For example, in 1935–36 these sections cover Dairy Cattle; Pigs; Sheep; Shearing and Wool Production; Lambing; Slaughtering and Mortality of Stock; Butter and Cheese; Bees; Ensilage; Chaff; Straw; Fodder Consumed; Manure

of Persons Working on Holdings; Cereal, Hay, and Fodder Crops—Acreage; Root Crops, etc. and Orchards—Acreage; Vineyards and Other Crops; Land in Fallow—Acreage; Cereal, Hay, and Fodder Crops—Production; All Other Crops—Production; Horses; Artificial Fertilizers; and Machinery. The "Machinery" section is not available for the 1944–45 census.

Each census entry corresponds to either a single holding or a group of holdings. Because consistent identifiers for holdings over time are unavailable—and because it is not possible to determine whether an entry refers to one or multiple holdings—we aggregate the raw data to the parish level to obtain a consistent unit of observation across years. The parish is the most disaggregated unit that remains time-consistent. To match observations across census years, we use the following variables: county identifier, county name, book letter, line number, shire/municipality name, and parish name. This procedure allows us to consistently match 97.7% of parishes across the five census waves. The final sample comprises 1,680 parishes, yielding 8,400 parish-year observations.

Figure B.4: Example of Victorian *Agricultural Census* Records



Notes. This figure shows an example of the Victorian *Agricultural Census* for the county number 1 of Bourke.
Source. NAA Series Number MP570/1.

Used; and Cowkeepers and Pigkeepers. Husbandry statistics are reported less consistently across seasons. Because our analysis focuses on agriculture, we describe in detail only the agriculture-related components of the data.

B.3 Enlistment Data

We collected data on Australian enlistment from the Australian Government Department of Veteran's Affairs, which has published nominal rolls list members of Australia's defense forces who served during World War Two, Korean War, Vietnam War and First Gulf War.[5] We downloaded data on the 63,288 soldiers resident in Victoria who served during WWII and for whom enlistment location was available. We used enlisted individuals' place of residence to construct a measure at the Standard Administrative 2 (SA2) zone level on WWII enlistment, the most disaggregated geographical level available. SA2 zone-level enlistment data are then matched to the agricultural parish-level data using the shire of belonging of each parish reported in the agricultural censuses. Shires are matched to SA2 zones based on names and on overlapping polygons when names don't match.

In total, an average of 510.38 individuals per SA2 were enlisted in Victoria. Enlistment varies substantially, ranging from 0 to 3,647 soldiers enlisted per SA2.

Enlistment: summary statistics

	Obs.	Mean	St. Dev.	Min	Max
Enlistment	129	518.907	732.477	0	3,647

B.4 POWs Camps

We retrieved the full list of military facilities in Australia that were used as POWs camps during WWII from the Footprints of Italian Prisoners of War archive.[6] These data were, in turn, collected and digitized from the NAA series A7711 "Report on the Directorate of Prisoners of War and Internees of Army Headquarters," located in Melbourne, by Joanne Tapiolas, who kindly shared them with us and whom we warmly thank.

POWs camps could be of three types: i) Prisoner of War and Internment Camp (PW &I Camps), which were administrative and parent camps; ii) Prisoner of War Control Hostels (PWCH), which worked as small camps and were created for specific projects; and iii) Prisoner of War Control Centre: Without Guard (PWCC), where Italian POWs working in the farms were placed.

Overall, Australia had 187 POWs camps. We geolocated the centroids of these camps using historical camp maps and Google maps. 41 camps were located in Victoria, while 2 in New South Wales and 2 in Southern Australia employed POWs from Victoria, for a total of 45 camps used in our analysis, as shown in Figure A.3.

[5]https://nominal-rolls.dva.gov.au/ww2 accessed in January 2022.
[6]https://italianprisonersofwar.com/pow-camps-in-australia/ accessed in October 2020.

Most Victoria POWs camps operated between 1943 and 1946. The first POWs camp to open was Murchison in June 1941.[7] The last ones to close in January 1947 were Seymour, Puckapunyal, Attwoods-Broadmeadows, and the two Tatura camps. On average, camps could host almost 400 individuals but were fairly heterogeneous in size. The largest one, Murchison, could host up to 4,000 people, while the smallest one, Corryong, only 25.

Victoria POW camps: summary statistics

	Obs.	Mean	St. Dev.	Min	Max
Capacity	39	396.641	672.765	25	4,000

B.5 GAEZ Data

To measure crop suitability to the Australian soil, we used the Global Agro-Ecological Zones (GAEZ) database, developed jointly by the Food and Agriculture Organization (FAO) and the International Institute for Applied Systems Analysis (IIASA).[8] This data provides spatially detailed information on the agro-ecological suitability and potential productivity of land for a wide range of crops under varying input and climate scenarios. They also include biophysical characteristics such as climate, soil, topography, and land cover, as well as crop-specific agronomic requirements.

For all available crops in the FAO-GAEZ data, we downloaded the corresponding suitability index raster data for Australia. To compute a measure of crop suitability that does not capture any human intervention, we select the variable "Suitability index range (0 – 10000); all land in grid cell", computed based on climatic data for the period 1961-1999 – the earliest available, water supply is set to "rainfed", input level to "low", and fertilization to "without CO2 fertilization". Using this specification of the suitability index, we compute the average suitability index in a radius of 5, 10, 15 km of the parish centroids and use the resulting value as a measure of crop suitability at the parish level.

B.6 Italian Census Data

We collected and digitized data on Italian agricultural outcomes from the 1930 *Agricultural Census*, the last available year before the war, compiled by the Italian Statistical Office (ISTAT). More specifically, we retrieved information on the top 3 crops cultivated in each

[7] Two camps, Tatura and Rushworth, opened in September 1940 but they initially only hosted internees and eventually did not host Italian POWs.

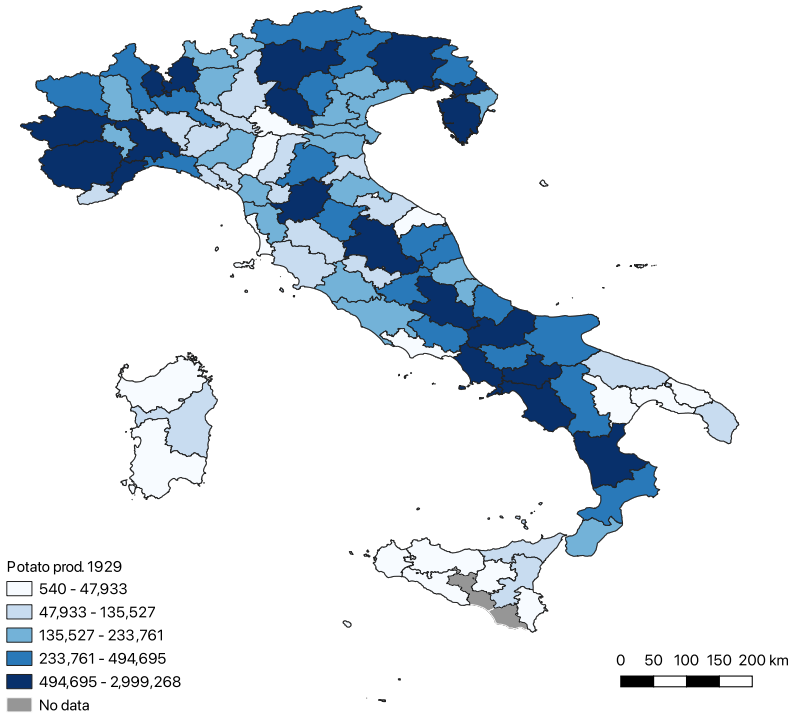
[8] We downloaded the latest released version (GAEZ v4) in Fall 2021 from "Suitability and Attainable Yield" section available at https://gaez.fao.org/pages/data-viewer-theme-4

province. We then match this information with POWs' province of origin, an information available for around 70% POWs in our sample.

In principle, one could match prisoner and census data at the municipality rather than the province level. We opted for province-level matching for three main reasons. First, municipality of residence is more often missing in the prisoner records than province information. Second, using municipality-level census data would require digitizing crop information for over 7,000 municipalities, a resource-intensive task. Finally, provinces are relatively small in size in Italy, and agricultural conditions and expertise tend to be similar across municipalities within a province.

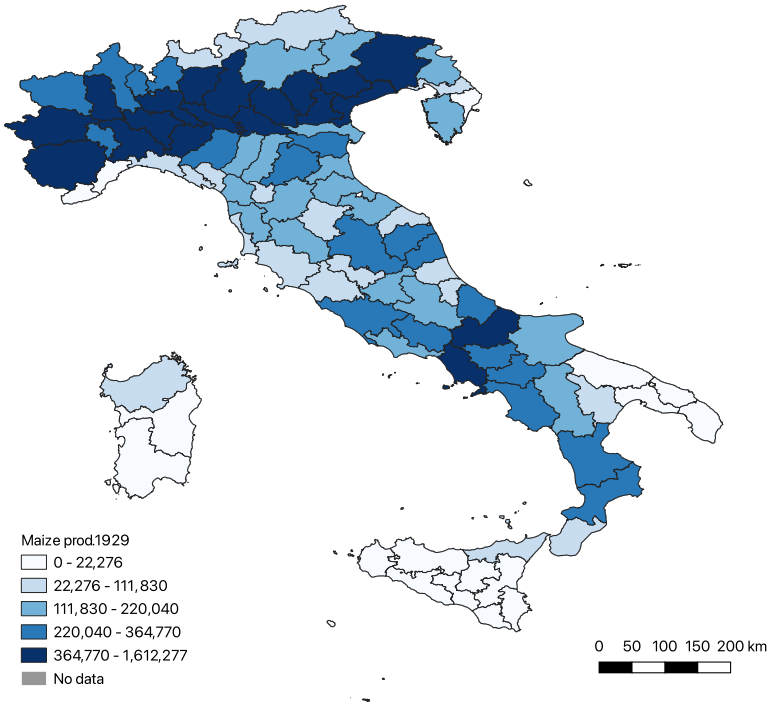
Finally, we complement this data with the province-level information on the number of tractors, retrieved from Bianchi and Giorcelli (2023), which were in turn collected from the *Annuario di Statistica Agraria* (Annals of Agricultural Statistics) in 1938, the last available year before WWII. We also use data on province-level literacy rate from the 1936 Italian Census, previously collected and digitized by Bertazzini and Giorcelli (2025).

Figure B.5: Italian potato production in 1929



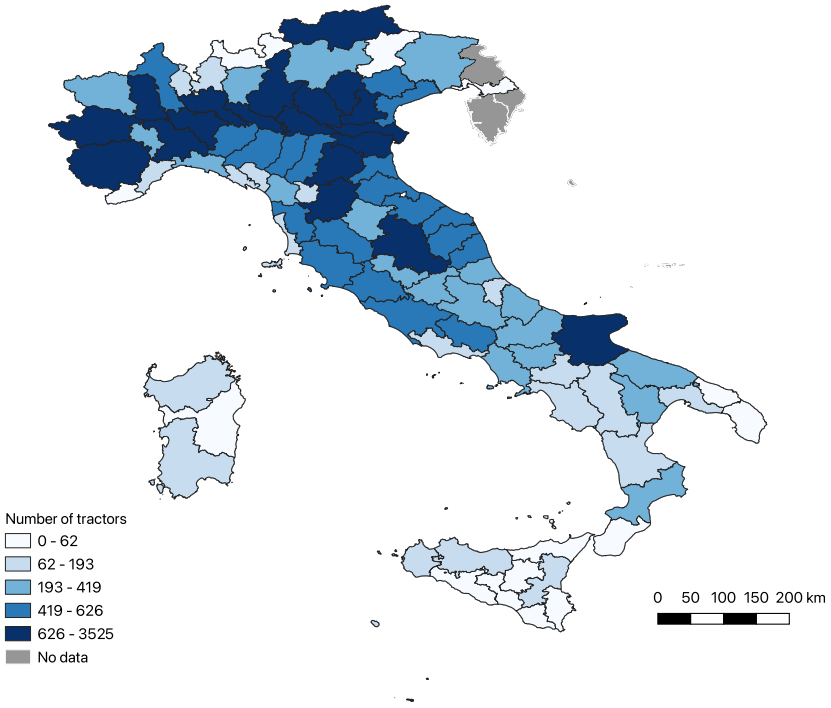
Notes. Distribution of potatoes production in Italian provinces in 1929. *Source:* 1930 Italian Agricultural Census.

Figure B.6: Italian maize production in 1929



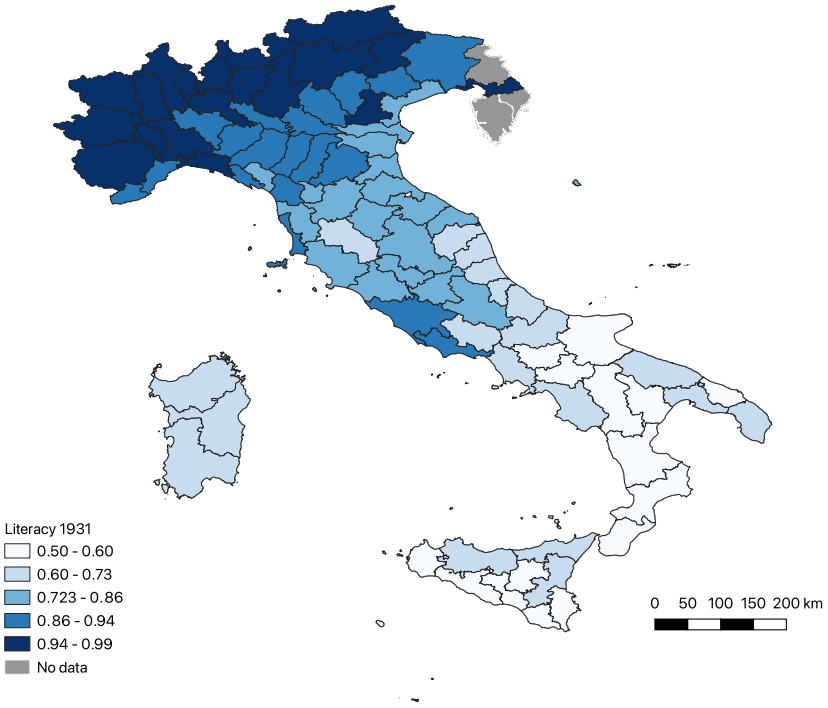
Notes. Distribution of corn production in Italian provinces in 1929. *Source:* 1930 Italian Agricultural Census.

Figure B.7: Italian number of tractors in 1938



Notes. Distribution of tractors in Italian provinces in 1938. *Source:* Bianchi and Giorcelli (2023).

Figure B.8: Italian literacy rates in 1931



Notes. Distribution of literacy rate in Italian provinces in 1931. *Source:* Bertazzini and Giorcelli (2025).