Agricultural Policy and Long-Run Development: Evidence from Mussolini's *Battle for Grain*[*]

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October, 2018

Abstract

This paper explores the effect of agricultural policies on industrialization and economic development over the long run. I analyze the differential effect of the *Battle for Grain*, implemented by the Italian Fascist regime to achieve self-sufficiency in wheat production, on the development path across areas of Italy. Employing time variation, along with cross-sectional variation in the suitability of land for implementing the advanced wheat production technologies, I find that the policy had unintended positive effects on industrialization and economic prosperity which have persisted until the present day. Furthermore, I find that the positive effect of the *Battle for Grain* on human capital accumulation was instrumental in this process, suggesting that the complementarity between human capital and agricultural technology may be a critical mechanism through which agricultural productivity may enhance the development of non-agricultural sectors.

Keywords: Economic Growth; Agricultural Policy; Human Capital

[*]I'm grateful to Oded Galor, Stelios Michalopoulos and David Weil for their insightful comments. I also benefited from conversations with Lint Barrage, Susanto Basu, Maria Rosaria Carillo, Antonio Ciccone, Melissa Dell, Klaus Desmet, Andrew Foster, Raphael Franck, Casper Worm Hansen, David Hemous, Daniel Keniston, Pete Klenow, Omer Ozak, James Robinson, Assaf Sarid, Paul Sharp, Andrei Shleifer, Matthew Turner, Fabrizio Zilibotti. I also thank conferences participants at ASREC 2017 Boston, the 2017 Deep-Rooted Factors in Comparative Development Conference, the 2017 Warwick conference, 2018 CEPR Growth and Inequality Conference at Tel Aviv University, and seminar participants at Brown University, UNISA, Parthenope, Universidad de los Andes, University of Naples Federico II, University of Groningen, and New Economic School for their helpful comments. Financial support from the Brown University Department of Economics and the S4 Institute is kindly acknowledged.

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1 Introduction

A significant portion of the differences in living standards across regions is rooted in pre-industrial stages of development. The predominant role of the agricultural sector over this period has motivated the study of the effect of agricultural productivity on industrialization and the long-term evolution of the economy,[1] triggering a debate about the importance of agricultural productivity in the development process.[2] The inconclusive evidence about the relationship between agricultural productivity, industrialization, and long-run development has initiated a debate about the consequences of agricultural policies, which have been central in development strategies worldwide.

While agricultural policies may stimulate agricultural productivity and enhance income in the rural regions of the world, they may also cause market inefficiencies and rent-seeking and their consequences on industrial development are ambiguous.[3] The rise in agricultural productivity may foster human capital accumulation (Foster and Rosenzweig, 1996), and reallocate labor toward industry (Bustos et al., 2016), stimulating the development process. However, if the economy is sufficiently open, it may strengthen comparative advantage in the agricultural sector, harnessing industrialization and economic growth (Matsuyama, 1992; Galor and Mountford, 2008).[4] The empirical assessment of these mechanisms has proven challenging, mainly because of the difficulty in disentangling potential terms of trade effect of agricultural policy from its impact on technological adoption.

This paper sheds light on these issues exploring the *Battle for Grain* implemented by the Italian Fascist regime to achieve self-sufficiency in wheat through subsidies to more advanced wheat production technologies and tariffs on wheat imports. While the combination of interventions resulted in a major stimulus to technological progress in agriculture, the tariff significantly raised the price of wheat. I exploit the heterogeneous exposure to these effects across areas of Italy to *(i)* provide evidence of the effects of agricultural productivity policies on local industrialization and economic growth over the course of a century and *(ii)* empirically disentangle the effect of technological progress from the tariff-induced price increase and the associated rise in local agricultural income.

[1] See Boserup (1965) Diamond (1998), Olsson and Hibbs (2005), Ashraf and Galor (2011), Nunn and Qian (2011), Vollrath (2011).
[2] See Matsuyama (1992), Baumol (1967), Foster and Rosenzweig (2007),Gollin et al. (2002), Hornbeck and Keskin (2015), Bustos et al. (2016). I review the literature in more detail below.
[3] For the debate on the effects of policy interventions, see Yifu (2013).
[4] See also Field (1978); Mokyr (1976); Corden and Neary (1982); Krugman (1987).

The *Battle for Grain* (henceforth BG) was one of the major projects undertaken by Mussolini during his dictatorship. Implemented from 1925 to 1939, it was designed to move the country toward self-sufficiency in wheat production.[5] The intervention triggered a significant technical change in wheat production by stimulating new wheat production techniques[6] —including improved wheat seeds, machines, and fertilizers— which resembled a Green Revolution.[7] Furthermore, in order to give farmers incentives to adopt the new production techniques and intensify wheat production, significant tariffs in wheat were implemented.

To perform the empirical analysis, I digitized historical records for about 7000 municipalities by decade over the course of the 20th century and beyond. The sources include the 1929 Census of Agriculture, several population and industry censuses, and historical maps. I combine these data with highly disaggregated data on educational attainment and sector-specific employment across age groups within municipalities.

In the first step of the empirical analysis, I document that areas where wheat yield increased over the years of the BG experienced an acceleration in the process of industrialization and economic growth, which emerged after implementation and persisted long after its repeal, until today. Yet reverse causality may affect the estimates. For instance, faster population growth, and the associated higher demand for food, could raise the returns from adopting the more advanced wheat production techniques and increase wheat yield.

I examine the presence of a causal link using variation in the suitability of land for the more advanced wheat production technologies that were stimulated by the BG. I use these data to build a novel index measuring the potential exposure to the policy, which I interact with time indicators in a flexible specification. The identification strategy requires that there were no other factors correlated with the suitability of land for the specific wheat production technologies stimulated by the BG that affected economic development in this period. I perform robustness tests and placebo checks in support of this assumption.

To build the index, I use crop-specific potential yields from the Global Agro-

[5] In light of Mussolini's war plans, self-sufficiency in wheat production was instrumental to reducing dependency on foreign powers (Lyttelton, 2004).

[6] Studies on the link between agricultural technical change and agricultural productivity include Kantor and Whalley (2014); Emerick et al. (2016).

[7] The Regime financially supported a scientist, Nazareno Strampelli (1866 - 1942), who was the first to use Mendel's laws to create high-yielding varieties of wheat that were eventually adopted in several other countries such as China, Argentina, and Mexico. Recently, Strampelli was referred to as "the prophet of the Green Revolution" (Salvi et al., 2013).

Ecological Zones (GAEZ) methodology developed by the Food and Agriculture Organization (FAO). These measures of potential yields are exogenous as they are determined by geographic conditions and not by actual yields. The database provides potential wheat yield under traditional and more modern techniques — improved wheat varieties, machines, and fertilizers — which are precisely those stimulated by the BG. Using the potential improvement in wheat yield relative to other crops, along with national wheat prices before and after the implementation of the policy, I build a measure of the potential increase in revenues due to *(i)* the technical change induced by the BG, and *(ii)* the increase in national price of wheat due to the tariff. I show that this measure is a strong predictor of the actual increase in wheat yield over the period of the policy.

Employing my index of the potential returns from the BG, I find that areas more exposed to the policy experienced an expansion in the density of economic activity, which emerged precisely over the period of the policy and persisted until today. In addition, they experienced faster industrialization. The estimated effects are sizable. A one standard deviation increase in the potential returns from the policy implies 22% higher contemporary population density and 12% of a standard deviation larger share of people in manufacturing in recent years, relative to the pre-policy period.

Given that the measure of the profitability of the BG is based on potential rather than actual returns, the estimates are unaffected by reverse causality. In addition, in the empirical specification, I control for municipality fixed effects and province by time fixed effects, thus accounting for time-invariant factors as well as time-varying characteristics across provinces (and regions) that caused differential patterns between the north and south of the country. Moreover, to take into account other possible shocks that occurred around the same time and that may be correlated with my measure of the policy, I control for time-invariant variables interacted with time indicators. Specifically, to ensure that the estimates reflect technological improvements rather than differences between wheat-suitable versus non-wheat-suitable places, I flexibly control for land suitability for wheat.[8] In addition, I control for ruggedness, which is a determinant of agricultural technology adoption. To take into account the efforts of the Fascist regime in agricultural production and malaria eradication, I flexibly control for land suitability for agriculture and the historical presence of malaria.

After providing evidence of the positive long-run effect of the policy on industri-

[8] While land suitability for wheat captures the potential level of wheat yield in the absence of advanced wheat production techniques, my measure of the potential exposure to the policy captures the *increase* in the potential revenues (and wheat yield) due to the technological improvements resulting from the BG.

alization and economic development, I turn to an analysis of potential mechanisms through which it operated. The importance of the complementarity between technological progress in agriculture and human capital accumulation has been extensively covered elsewhere (Griliches, 1963a; Nelson and Phelps, 1966; Foster and Rosenzweig, 1996). I build on this view and advance the hypothesis that the significant acceleration in technological progress resulting from the BG raised the returns from investing in human capital which, stimulating investment in education, triggered industrialization and long-term economic development.[9,10]

I investigate this hypothesis following two approaches. First, I employ cohort-specific data on educational attainment within municipalities in 1971. The idea is that the higher incentives to accumulate education determined by technical change should have been greater for people in their school age when the policy was implemented. My findings support this hypothesis. In particular, I observe that the larger the municipality exposure to the policy, the wider the gap in the 1971 educational attainment between people who were school-aged when the policy was implemented and older cohorts. Second, I employ educational attainment data across municipalities before and after the policy. I find that a two standard deviations increase in the potential exposure to the policy is associated with about one extra year of education in 1971. This result points toward the importance of human capital as a mechanism to explain the persistent effect of the BG on long-term economic prosperity.

I dig deeper into the mechanism empirically distinguishing between the effect of agricultural technological progress and the effect of the increase in price due to the tariff. In particular, I decompose my measure of the potential increase in revenues in its component given by the advanced wheat production technologies and that given by the increase in the relative price of wheat. Estimating the effect of each these two variables on various development outcomes I find that, while technological progress stimulated human capital accumulation and industrial development, the increase in wheat price had limited effects.

The estimates are robust to considering a host of potentially confounding factors, in-

[9] The role of human capital in economic development is underlined in unified growth theory (Galor and Weil, 2000; Galor, 2005) and documented empirically by Glaeser et al. (2004); Becker and Woessmann (2009); Caicedo (2014). On the positive effects of human capital on population growth, see for instance Moretti (2004); Duranton and Puga (2004); Dittmar (2011); Squicciarini and Voigtländer (2015); Dittmar and Meisenzahl (2016).

[10] Alternatively, the policy may have operated through the advancement of labor-saving technological change in agriculture, leading to the relocation of labor toward the manufacturing sector as well as out-migration more exposed areas (Bustos et al., 2016). However, this prediction is not supported by my findings that those areas experienced an increase in population.

cluding land reclamation of areas historically affected by malaria, the foundation of the fascist new cities, the presence of railroads, differences in land inequality, and the effect of limiting migration to cities above 25,000 inhabitants (Bacci, 2015), albeit unenforced (Treves, 1980), as well as taking into account spatial spillovers and potentially unobserved differences across distant municipalities. Furthermore, I find little significant evidence of alternative mechanisms such as specialization in manufacturing industries linked to wheat and agriculture or that were considered strategic by the regime, such as chemicals and war-related industries.[11] In addition, it has been shown that areas hit by WWII bombings, and thus larger reconstruction grants from the Marshall Plan, did not exhibit significant differences in agricultural technology and production during the Fascist period (Bianchi and Giorcelli, 2018), suggesting that they were not characterized by differential exposure to the BG. Finally, I investigate whether wheat suitability is conducive to economic development beyond Italy.[12] I find that, while across European regions outside Italy the link between wheat suitability on economic development is negative, within Italy it is positive. This finding suggests that wheat suitability may not be conducive to economic development in the absence of human capital augmenting technological progress in wheat production.

This paper contributes to three strands of the literature. First, it reconciles apparently contrasting views on the link between agricultural productivity and long-run growth. In particular, the findings suggest that even in an open economy, skill-biased technological progress can foster human capital formation and growth, having long-lasting beneficial effects.[13] In contrast, the limited local effects of the price increase provides novel evidence in line with the literature emphasizing that, in an open economy, a Hicks-neutral increase in agricultural productivity may not be conducive to economic development (Foster and Rosenzweig, 2004, 2007; Matsuyama, 1992; Galor and Mountford, 2008). Second, it provides novel evidence of the long-run effect of policy interventions. While development policies may generate inefficiencies and rent-seeking behaviors, they may also spur industrialization and economic development (Rosenstein-Rodan, 1943; Murphy et al., 1989; Alder et al., 2016). My results emphasize the importance of skill-biased technological progress for the effectiveness of development policies. Third, it

[11] It has been noticed that the Fascist regime's contractionary monetary policy (*Quota 90*) increased the exchange rate and tended to depressed domestic wheat prices, thus undoing the effect of the wheat tariffs and working against the BG (Segre, 1982). For a formal analysis of this mechanism, see Krugman (1987).

[12] On the importance of geography for economic development see Diamond (1998); Gallup et al. (1999); Pomeranz (2009); Henderson et al. (2017).

[13] For other mechanisms that highlight the positive effects of a rise in agricultural productivity on economic development, see Baumol (1967); Murphy et al. (1989); Gollin et al. (2002); Nunn and Qian (2011); Bustos et al. (2016). For a review of the literature, see below.

sheds light on the effects of transitory protectionist interventions. While conventional wisdom suggests that deviations from free trade are sub-optimal, there are exceptions to this view, such as the infant industry hypothesis (Hausmann and Rodrik, 2003; Stiglitz and Greenwald, 2014; Juhász, 2014). My findings provide evidence that short-run protection may foster long-run development when it stimulates human capital-augmenting technological progress and that such effect unfolds across sectors.

The paper is structured as follows. The next section briefly reviews the related literature. Section 3 describes the historical background and the set of interventions that define the BG. Section 4 describes the historical data. Section 5 documents the persistent positive effects of the BG on development and industrialization. Section 6 illustrates the importance of human capital accumulation as a mechanism through which the policy operated. The last section concludes.

2 Related Literature

This paper contributes mainly to three strands of the literature. First, it adds to the study of the link between agricultural productivity and economic development. Several scholars have emphasized that a rise in agricultural productivity is essential for urbanization and industrial development (Rostow, 1960; Nurkse et al., 1966) as it contributes to the provision of food to urban centers (Schultz, 1953) and enhances demand for manufacturing goods (Murphy et al., 1989; Gollin et al., 2002).[14] In contrast, Mokyr (1976); Field (1978); Wright (1979) emphasize that agricultural development may actually foster specialization in agriculture and delay the transition to industry. Matsuyama (1992) reconciles these views emphasizing that, while higher agricultural productivity may lead to industrial growth in closed economies, it may spur agricultural specialization in open economies and, as shown by Galor and Mountford (2008), may harness human capital formation.

This paper contributes to this literature emphasizing that technical change in agriculture may have a skilled bias nature and spur economic development in the long term. Thus, it differs from Foster and Rosenzweig (2004, 2007), who emphasize that technical change in agriculture may be Hicks neutral and hamper structural transformation; and from Bustos et al. (2016), who emphasize that technical change in agriculture may be labor saving and favor industrial growth. Furthermore, the focus of this paper on the human capital mechanism complements the finding by Gollin et al. (2018), who

[14] For an overview, see for instance Gollin (2010).

show in a cross-country setting that the Green Revolution reduced fertility and fostered economic growth.

By exploring the long-term effect of the introduction of multiple agricultural technologies, the paper contributes to the literature that analyzes the effect of single agricultural inputs, including Nunn and Qian (2011), who study the effect of the introduction of the potato; Hornbeck and Keskin (2015) who analyze the consequences of the availability of water sources; to Dall Schmidt et al. (2018), who examine the effect of clover adoption; to Andersen et al. (2016) who analyze the introduction of the heavy plow, and to Chen and Kung (2016), who study the introduction of maize.

While the analysis of agricultural productivity relates this paper to recent studies of the effects of weather-induced changes in agricultural productivity (Colmer, 2018; Santangelo, 2016), the emphasis on human capital in the agricultural sector links this work to Foster and Rosenzweig (1996), who employ a structural approach to investigate the complementarity between agricultural technological progress and human capital; to Fiszbein (2017), who studies the effect of agricultural diversity on human capital and industrialization; and to works indicating human capital as an important driver of city growth and urbanization in historical contexts (Dittmar, 2011; Squicciarini and Voigtländer, 2015; Dittmar and Meisenzahl, 2016).

Second, the paper contributes to the study of the long-run effects of policy interventions. Several theories have analyzed the effect of public spending for economic development. Rosenstein-Rodan (1943); Murphy et al. (1989); Azariadis and Stachurski (2005) indicate that, in the presence of positive externalities, public investment may spur economic development. A related body of works studies the consequences of industrial policies (Criscuolo et al., 2012; Aghion et al., 2015; Liu, 2017; Lane, 2017), the effect of place-based policies on local economic development (Glaeser and Gottlieb, 2008; Kline and Moretti, 2014a,b; Neumark and Simpson, 2015; Alder et al., 2016), and the effect of agricultural policy on physical capital (Marden, 2015). This paper complements these works as it casts light on the long-run effect of nationwide agricultural policies on local structural change and the role of the human capital mechanism.

Third, this work contributes to the literature on the consequences of temporary protection. Stiglitz and Greenwald (2014) underline the effectiveness of temporary protectionist interventions in presence of learning spillovers. Juhász (2014)'s empirical findings support the infant industry argument, which can be particularly effective in presence of within-sector externalities (Melitz, 2005; Rodriguez-Clare and Harrison, 2010). This paper complements this literature as it shows that transitory protection may trigger human capital-augmenting technological progress, which spills over across sectors. Furthermore, my finding of the limited local effect of the tariff-induced wheat price increase lends further credence to the hypothesis that, in the absence of technological improvements, protectionist interventions are not conducive to human capital accumulation (Bignon and García-Peñalosa, 2016).

3 Historical Background

In 1914, a journalist called Benito Mussolini formed the "Italian Fasci of Combat" — a movement composed by a group of men coming from different parties "brought together by their advocacy of Italy's entry into the war" and not linked "to any previously formed body of doctrine, social philosophy or economic interest" (Lyttelton, 2004). In 1922, Mussolini and his militia took advantage of a period of political instability to march on Rome and form the Fascist Government. In 1925, the dictatorship was formally declared.

At the onset of the rise of the dictatorship, the balance of payment was severely in deficit and wheat imports accounted for up to one fourth of the value of total imports (Segre, 1982). According to Mussolini's war principles, Italy could not depend on foreign countries for the supply of primary goods such as wheat. The trade collapse that characterized World War I, and the associated shortage of primary goods, was a fundamental motive that induced Mussolini to increase domestic wheat production and achieve self-sufficiency.

When the Regime came to power, Italian agriculture was mainly primitive[15] (Lorenzetti, 2000). In particular, seed selection was basically absent and there was scarce use of fertilizers and machines. In addition, the international price of wheat was low and domestic producers were not competitive. In 1925, the regime implemented the "Battle for Grain" (*Battaglia del Grano*) with the aim of increasing wheat yield and achieving self-sufficiency in the production of this primary crop.

A first set of interventions was introduced to stimulate wheat productivity. To solve the seed problem, public investments were made in R&D for the selection of wheat varieties that could maximize yield per hectare (Serpieri and Mortara, 1934). The Regime financed Nazareno Strampelli, a scientist who devoted his life to creating improved

[15] However, significant differences across regions existed. For instance, agriculture on the Po valley was typically more advanced than the rest of the country. I take into account these preexisting differences using province fixed effects.

wheat varieties. He was the first to apply Mendel's laws to plants and wheat breeding, and his seeds incorporated traits for rust resistance, early maturity, and short straw. Strampelli's seeds would be used in other countries such as Argentina, China, and Mexico and would become instrumental for the creation of the high-yielding varieties developed by Borlaug, contributing to the advent of the Green Revolution (Salvi et al., 2013).

In addition, wheat producers were subsidized for purchasing agricultural machinery, such as tractors and threshers. At the same time, the Regime implemented regulations that reduced the price of fertilizers. As a result, the use of commercial fertilizers rose by more than 50% in the first four years of the policy (Hazan, 1933).[16] The availability of new agricultural technology was extensively advertised through the Fascist propaganda and the "Traveling Chairs of Agriculture" (*Cattedre Ambulanti di Agricoltura*) — an institution originating in the eighteenth century to spread agricultural knowledge. Further incentives to intensify wheat production were given by an increase in the wheat price mainly due to a tariff on wheat imports that exceeded 100% of the international price of wheat (see figure 1a).[17]

The BG was effective in achieving self-sufficiency in wheat. After a substantial increase in wheat price (figure 1b),[18] a decrease in wheat imports followed (figure 1c), which were substituted by greater domestic wheat production (figure 1d).[19] Wheat production soared predominantly through increases in productivity, making the BG a productivity-oriented agricultural policy (Serpieri and Mortara, 1934; Profumieri, 1971; Cohen, 1979; Segre, 1982). Consistent with this historical literature, figure 2 shows that the increase in domestic wheat production over the period of the policy was indeed predominantly governed by the increase in wheat productivity, rather than changes in cultivated land (which is mostly constant) or in its share devoted to wheat (which displays only minor increases toward he end of the policy period). The wheat productivity increase was associated with a substantial 85% rise in the adoption of more advanced agricultural machinery[20] and unprecedented increases in the adoption of the advanced wheat seeds and fertilizers (Cohen, 1979). Finally, the BG stimulated progress in agri-

[16] Furthermore, local and national prizes were given to the most modern and productive wheat producers (Serpieri and Mortara, 1934).

[17] Simultaneous interventions to keep the wheat price high included compulsory milling — requiring the use of at least 95% of domestic wheat in any production process — and subsidies to store wheat in silos during the wheat season.

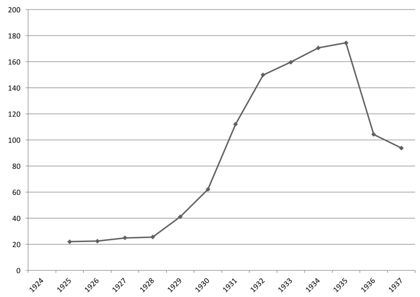
[18] The real price of wheat displays a similar pattern, as shown in figure 6

[19] There is little decrease in the imports of other commodities such as steel and oil, as depicted in figures 7 and 8, respectively

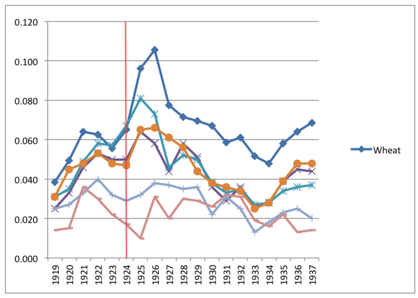
[20] A well known new piece of equipment was the 1935 tractor Landini Vélite. The name comes from the title that Mussolini gave to the farmers with outstanding wheat productivity (Benfatti, 2000).

Figure 1: The Effectiveness of the *Battle for Grain*

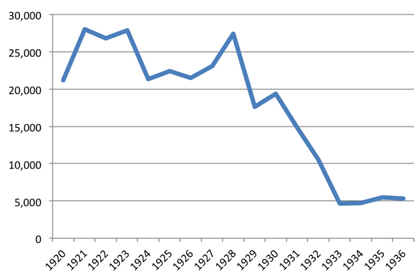
(a) Wheat Tariff Rate



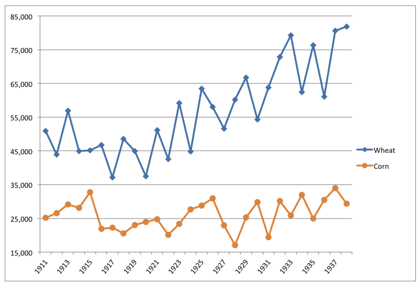
(b) Price of Wheat



(c) Wheat Imports



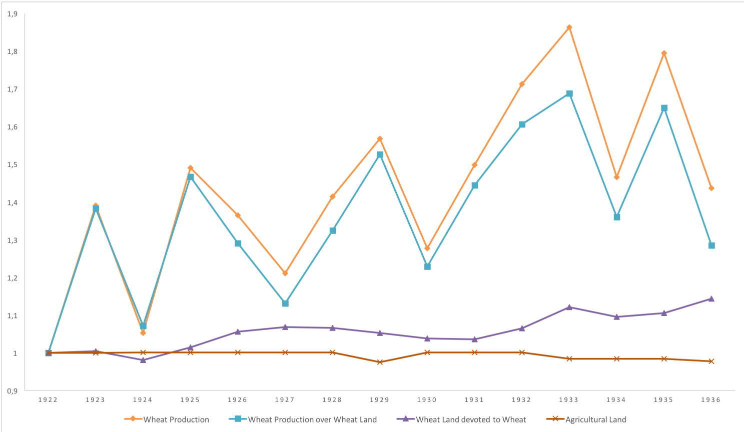
(d) Domestic Wheat



Notes: The figures show that the *Battle for Grain* was effective in boosting domestic wheat production. Figure 1a depicts the import tariff applied to soft wheat relative to its international price (similar tariffs were applied to hard wheat as shown by the similarity of their prices in appendix figure 9). Figure 1b shows the spike in wheat prices due to the tariff. Figure 1c shows that wheat imports declined (thousand of quintals, source: ISTAT), with the exception of 1928 and 1929, when the United States wheat price went down significantly which was compensated by a substantial increase in the tariff (Lorenzetti, 2000, p. 262). Figure 1d shows that, in contrast to corn, wheat production increased over the period of the policy (thousands of quintals, source: ISTAT).

cultural education and, through the work given in practical agricultural schools and universities, fostered modernization in the agricultural sector (Hazan, 1933).

Figure 2: The *Battle for Grain* and Wheat Productivity



Notes: This figure illustrates that the increase in national production of wheat over the period of the *Battle for Grain* was predominantly explained by the increase in wheat productivity. In particular, I decompose national wheat production in the product of wheat production per hectare of land devoted to wheat, land devoted to wheat over agricultural land, and agricultural land. In addition, the figure shows that during the *Battle for Grain* changes in agricultural land were negative and small in magnitude.

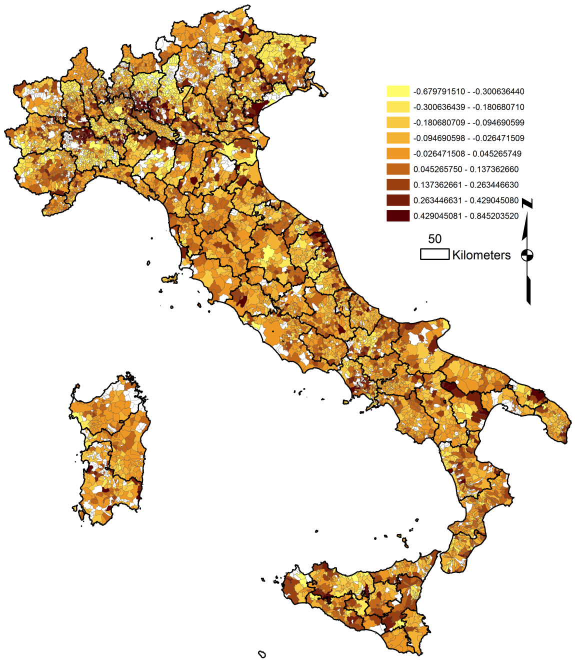
4 Data

This section describes the agricultural data employed in the empirical analysis. A more detailed description of data and sources is in appendix E. Wheat productivity data are compiled from the 1929 Italian Census of Agriculture, held at the municipality level (about 7000 in current borders). I measure the increase in wheat productivity due to the BG using the change in tons of wheat produced per hectare over the years of the policy.[21] The census provides data yields per hectare in 1929 (q^w_{29}) — four years after implementation — and average wheat yield per hectare over the years 1923-1928 ($\bar{q}^w_{23-28}$). As described in the 1929 Census of Agriculture, in the Italian peninsula, the seeding period for wheat goes from September to the beginning of January. The policy was introduced in July 1925, thus before the wheat seeding period of that year. Therefore, the first harvest after the adoption of the policy was in 1926. Which implies that $\bar{q}^w_{23-28}$ is the average wheat yield three years before and three years after the introduction of the policy.

I measure the increase in wheat yield using $\Delta q^w \equiv (q^w_{29} - \bar{q}^w_{23-28})$. Figure 3 illustrates a map of the increase in wheat yield across Italian municipalities. Panel 4a depicts a

[21] More than 87% of the municipalities increased wheat yield over the first years of the policy, suggesting that the measure is capturing the effect of the BG on wheat productivity in the country as a whole.

Figure 3: The Increase in Wheat Yield 1923-1929



Notes: Map of the increase in wheat yield per hectare over the years 1923 - 1929 across municipalities, after controlling for province-fixed effects

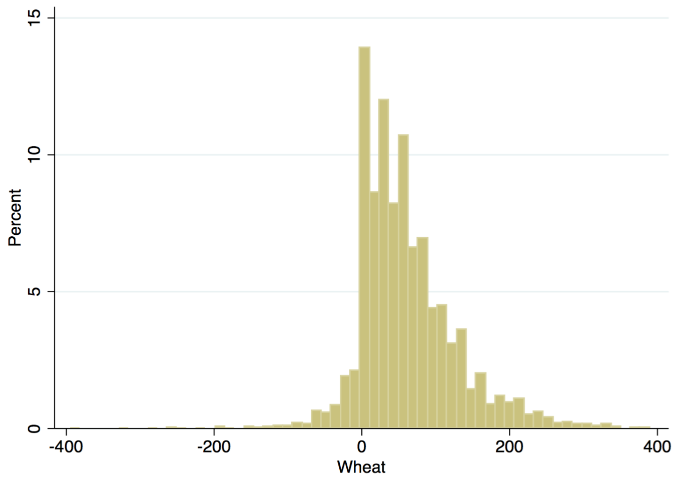
histogram of the variable expressed in units so as to be comparable with other crops, which are depicted in figure 4b. From the comparison of the two panels it clearly emerges that, in the early years of the BG, the increase in productivity was experienced mainly in wheat production.

The variable of interest, Δq^w, actually underestimates the actual change in wheat productivity for two reasons. First, because the latest period in which wheat yield is observed is 1929, ten years before the end of the BG. Second, $\bar{q}^w_{23-28}$ includes some post-policy years, in turn implying the presence of non-classical measurement error[22] which cannot be solved by an Instrumental Variable approach. Therefore, I follow Chen et al. (2005a,b) and, in section 5.2, I use an auxiliary data set from FAO's GAEZ v3 which is unaffected by measurement error and provides exogenous variation based on geographic conditions. Furthermore, I show in the appendix section F that using the variable Δq^w as as explanatory variable of interest would imply a bias in the OLS estimates which is opposite in sign to the coefficient of interest.

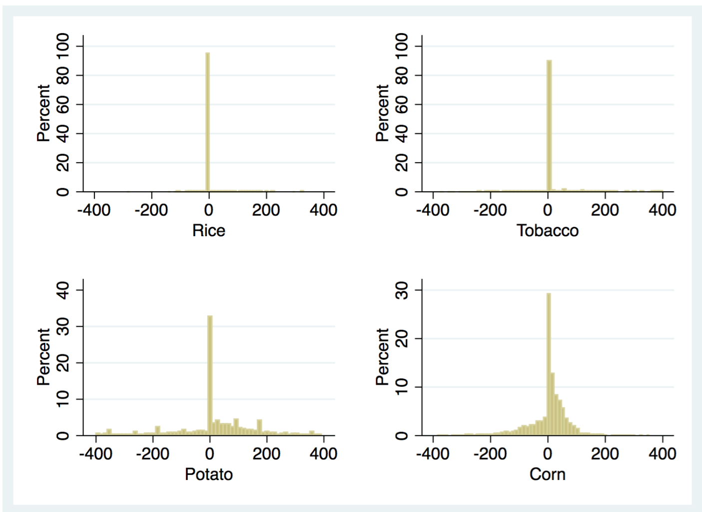
[22] The observed variable of interest can be written as the sum of the latent unobserved variable of interest and a measurement error term: $\Delta q^w = (q^w_{29} - q^w_{23}) - (\bar{q}^w_{23-28} - q^w_{23}) \equiv \Delta q^*_w - \xi$. Given that $Corr(\Delta q^*_w, \xi) \neq 0$, the observed variable of interest is affected by non-classical measurement error (see appendix section F).

Figure 4: The Change in Productivity for Wheat and Other Crops 1923-1929

(a) Increase in Wheat Yield, 1923-1929



(b) Limited Change in the Yields for Other Crops, 1923-1929



Notes: The panels show the changes in the yields per hectare for wheat and other crops. The panels are comparable as they are valued at real 1919 prices. Panel (a) shows the substantial increase in wheat yield over the first year of the policy. Panel (b) shows the limited changes in other crops. In particular, the variable represented in each plot is $\Delta\tilde{q}_i^j * P_{19}^j$ where $\Delta\tilde{q}_i^j$ is the change in yield per hectare for crop j in municipality i over the years 1923-1929, and P_{19}^j is national real price for crop j in 1919, base year 1911 *lire*. See main text and appendix for variable definition and sources.

5 Empirical Analysis

In this section, I study the long-run effects of the BG on industrialization and economic development across Italian municipalities. In section 5.1, I employ development outcomes before and after the policy to investigate the emergence and persistence of a relation between the increase in wheat productivity over the years of the BG and economic development. In section 5.2, I examine the presence of a causal link exploiting as exogenous sources of variation geographic conditions which entailed differential exposure to the BG.

5.1 Increase in Wheat Yield and Development

In the following, I document that areas where wheat yield increased over the period of the policy experienced significant expansions in economic activity and industrialization that emerged only after the introduction of the BG and persisted until today.

I estimate a flexible specification that allows the change in wheat yield to have a time varying relation with the outcome variables of interest. The estimated model is given by:

$$Y_{it} = \alpha_i + \alpha_{ct} + \beta_t \Delta q^w_{23-29,i} + \varepsilon_{it} \tag{1}$$

where Y_{it} represents an outcome variable for municipality i at time t. In particular, as outcome variables I employ the logarithm of population density, as a measure of the density of economic activity, and the share of the population working in manufacturing as a measure of industrial development. α_i are fixed effects at the level of municipality i, α_{ct} are province by year fixed effects; $\Delta q^w_{23-29,i}$ is the increase in wheat yield over the years 1923-1929 in municipality i. The coefficient of interest, β_t, is the difference in the outcome variable between year t and a reference year associated with a one standard deviation increase in $\Delta q^w_{23-29,i}$.[23] Given that β_t can change over time, my hypothesis is that β_t is approximately zero for the periods before implementation and positive afterwards.[24]

Substantial differences in economic development across Italian regions were already

[23] The reference year e in the analysis is 1911. As explained in the following, the results are not affected by the choice of the reference year.

[24] Note that, as shown in section 3, the increase in wheat productivity observed over the period of study, together the persistent availability of the agricultural technology introduced and the persistence observed in the wheat price shock, suggest that wheat yield levels are not strongly mean reverting, making the specification immune to the Ciccone (2011)'s critique.

significant before the BG and the debate about the “Southern Question” began as early as the 1870s. Therefore, to take into account differential trends across provinces (and regions), I control for province by time fixed effects using historical provinces as of 1929.[25] The focus on within-province variation takes into account unobserved factors - such as heterogeneity in culture or informal institutions - that vary across provinces and have been indicated as determinants of the Italian regional imbalances. In addition, it takes into account potential differences in the data collection process, which was performed at the level of historical provinces. Finally, I control for fixed effects at the level of the municipality, ensuring that time-invariant potentially confounding factors — such as geography and deep-rooted historical factors — are taken into account.

Figure 5, panel (a), depicts the regression coefficients from estimating equation 1 using as an outcome variable the natural logarithm of population density. It also shows the 95% confidence intervals based on robust standard errors clustered at the province level.[26] The estimated coefficients fully comply with the hypothesis of a positive effect of the policy on economic development. In particular, the estimates are small in magnitude and not statistically significant in the decades before implementation. The estimates then become positive and statistically significant in 1936, precisely when the BG was operating. In addition, the coefficients grow in magnitude in the decades after the repeal of the BG and until today. This finding is consistent with the hypothesis that the policy, in increasing wheat productivity, unexpectedly triggered a cumulative process of development that unfolded over the course of the twentieth century, the period in which the contribution of the agricultural sector to output formation diminished.

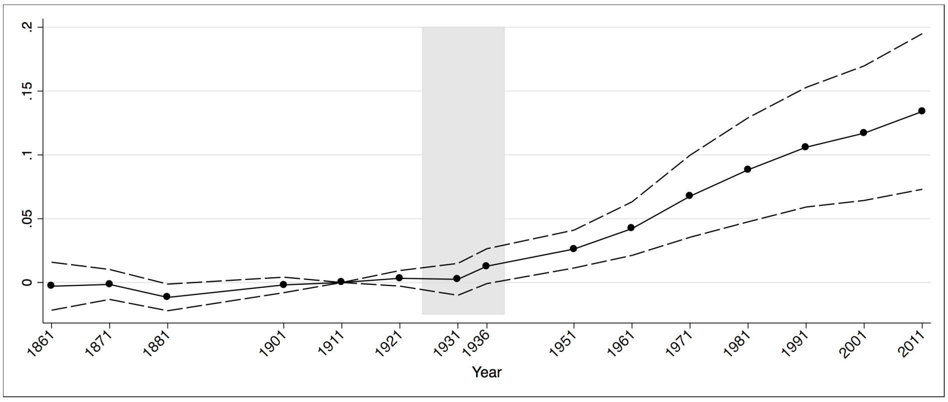
Figure 5, panel (b), uses as an outcome as an outcome the share of population in manufacturing. The figure shows that municipalities were wheat yield increased due to the BG experienced an expansion in industrial development from 1951 onward, about a decade after the end of the BG. This finding is consistent with the hypothesized effect of the BG on human capital accumulation, which was conducive to industrialization in later stages. The estimated coefficients for the year 2001 indicates that municipalities experiencing a one standard deviation larger increase in wheat yield over the period of the policy are characterized by a 13% larger population density and 8.5% of a standard deviation larger share of people working in the manufacturing sector, relative to 1911.

[25] In 1929, there were 91 provinces in current borders. Controlling for 110 provinces (NUTS 3) as of 2010 rather than the historical ones does not affect the results.

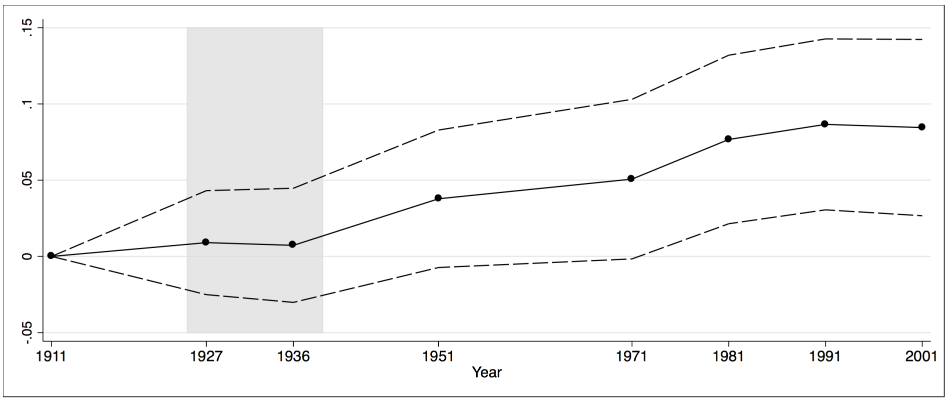
[26] This approach takes into account serial correlation within the cluster and over time. Using Conley (1999)’s methodology with cutoffs at 50, 100, and 200 kilometers, I estimate standard errors that are smaller in magnitudes than those estimated using clustered standard errors. Results available upon request.

Figure 5: The Increase in Wheat Yield and Long-Term Development: Flexible Estimates

(a) Population Density



(b) Industrialization



Notes: The figures depict the coefficient estimates from a flexible specification of the log of population density (panel (a)) and the share of manufacturing population (panel (b)) on the increase in wheat yields over the years 1923-1929. The regression includes municipality-fixed effects and province by time-fixed effects. The confidence intervals at 95% are based on province-level clustered standard errors. See appendix table A1 for the estimated coefficients. No Population Census was conducted in 1891 or 1941 See main text and appendices for variable definition and sources.

Given the use of variation within provinces, the estimates shown in this section are based on the comparison between municipalities very close to each other and thus very similar under several dimensions. However, there may be threats to identification, such as in the case of reverse causality. In the following section, I address this potential concern.

5.2 Empirical Strategy: the Potential Revenue Index

5.2.1 The Construction of the Index

In this section, I employ exogenous geographic variation to construct a variable that measures the differential exposure to the BG. The need for exogenous sources of variation to identify the causal effects of the BG on economic development is due to two reasons. The first is the presence of measurement error in the historical data, which may imply downward bias in the OLS estimates (see appendix F). The second is the potential concern for identification. For instance, areas that experienced faster economic growth over the period of study increased their local demand for agricultural goods, in turn stimulating technology adoption in wheat.

The BG entailed a technical change in wheat production due to the availability of improved wheat seeds together with subsidies for machinery and fertilizers. At the same time, the wheat tariff caused a positive shock in the national price of wheat relative to other crops, further enhancing farmers' incentives to adopt the more modern wheat production techniques. Thus my variable has to combine two sources of variation: the shock in the national wheat price caused by the BG and the *potential* increase in wheat yield due to the adoption of the new inputs as determined by geographic characteristics.

I use two sources of data. First, I employ national prices for wheat and major crops[27] I convert prices into real terms using the Consumer Price Index by Malanima (2002). Second, I use production capacity per hectare for wheat and other crops as determined by geographic characteristics from the Food and Agriculture Organization of the United Nations (FAO)'s Global Agro-Ecological Zones (GAEZ) v3.0.[28]

[27] Data source: ISTAT (*http://seriestoriche.istat.it* - Table 21.1), last access November 2015.

[28] The data are based on the average geographic characteristics over a thirty-year period. Given that geographic conditions are slow moving, these data are a plausibly exogenous source of variation to identify the shock resulting from the BG.

Production capacity is estimated assuming low and intermediate levels of inputs.[29][30] Potential yields with low input levels are based on a model developed by FAO GAEZ that considers limited seed selection and no use of machines and fertilizers. These conditions are very similar to the obsolete wheat production techniques used prior to the BG (Lorenzetti, 2000). Potential yields with intermediate input levels are based on a model that considers the use of improved varieties, mechanization, and fertilizers, which are precisely the wheat production techniques stimulated by the BG. Therefore, the improvements in the potential wheat yield from low to intermediate levels is the ideal source of cross-sectional variation to identify areas which had greater exposure to the technological progress resulting from the BG.

I use these data to construct a measure of the potential revenues of wheat relative to competing crops in a given year and for a given level of inputs, which I call the Potential Revenue Index (PRI).

The PRI before the policy (time 0) in municipality i is given by:

$$PRI_{0,i} = \sum_{c} \frac{\bar{p}_0^w \hat{q}^w_{c,(low)}}{\sum_{j \in \mathscr{C}_c} \bar{p}_0^j \hat{q}^j_{c,(low)} / |\mathscr{C}_c|} dP(c|c \in i) \text{ where } w \notin \mathscr{C}_c \tag{2}$$

where $\bar{p}_0^j$ is the average national real price of crop j over the years before the policy (i.e. $t = 0$);[31] $\hat{q}^j_{c,(low)}$ is the potential yield per hectare of crop j with low inputs in cell c (where $j = w$ refers to wheat); $\mathscr{C}_c$ is the set of productive crops in cell c that are not complementary to wheat production.[32]; $P(c|c \in i)$ is the intersection between the area of cell c and the area of municipality i.

The numerator of equation 2 represents the potential revenues per hectare from producing wheat with pre-policy national prices and technologies. The denominator is

[29] Production capacity is also estimated assuming a high level of inputs which, being based on the most modern agricultural techniques available today, is not appropriate to represent the Italian technological standards from the first half of the last century. Nevertheless, results are robust to the use of high rather than intermediate input levels (see appendix table B8 and B9).

[30] For irrigation conditions, I use rain-fed conditions as they are unaffected by the actual presence of irrigation infrastructure. See the appendix for a description of the data.

[31] Given that the policy was implemented in 1925, the years considered before the policy are between 1919 and 1924. I do not use prices before 1919 because during World War I (1914-1918) prices do not reflect market forces. I use real prices averaged over the years before the policy so as to prevent fluctuations in prices in one specific year driving the results. Pre-policy periods were characterized by *laissez faire* and, in particular, by a low degree of protectionism.

[32] Employing only productive crops ensures that the PRI is not driven by the number of crops whose productivity is close to zero, and hence by soil fertility. I consider productive crops those with potential revenues per hectare above a cutoff of one *lire* at 1911 prices.Results are unaffected by the choice of the cutoff as shown in tables B10 and B11 in the appendix.

the average potential revenues from productive crops that are potentially alternative to wheat. Thus, the *PRI* represents the potential revenues per hectare from producing wheat relative to the forgone revenues from competing crops, valued at pre-policy prices and technologies.[33]

I capture the higher profitability from producing wheat after the implementation of the BG by calculating the *PRI* with the post-policy prices and wheat production technologies. In mathematical terms:

$$PRI_{1,i} = \sum_{c} \frac{\bar{p}_1^w \hat{q}^w_{c,(int)}}{\sum_{j \in \mathscr{C}_c} \bar{p}_1^j \hat{q}^j_{c,(low)} / |\mathscr{C}_c|} dP(c|c \in i) \text{ where } w \notin \mathscr{C}_c \tag{3}$$

where p_1^j is the price of crop j after the introduction of the policy ($t = 1$).[34] $\hat{q}^w_{c,(int)}$ is the potential wheat yield per hectare with intermediate inputs in cell c.[35]

Therefore, I measure the increase in the profitability from wheat production due to the BG with the growth in the *PRI*. Expressed mathematically:

$$\Delta lnPRI_i = lnPRI_{1,i} - lnPRI_{0,i} \tag{4}$$

which is the growth in the *PRI* due to *(i)* technological improvements in wheat and *(ii)* the shock in the national wheat price due to the protectionist interventions. Figure 10 in the appendix displays a map of this variable.

I investigate whether this variable captures meaningful variation in the actual increase in wheat yield by regressing the increase in wheat yield over the years 1923-1929 on the growth in the PRI.[36] Figure 6 depicts the relationship between these two variables, the estimates are in table 1.

Column 1 shows the effect of land suitability for wheat, measured by potential wheat yield per hectare with low inputs, on the increase in wheat yield at the time of the

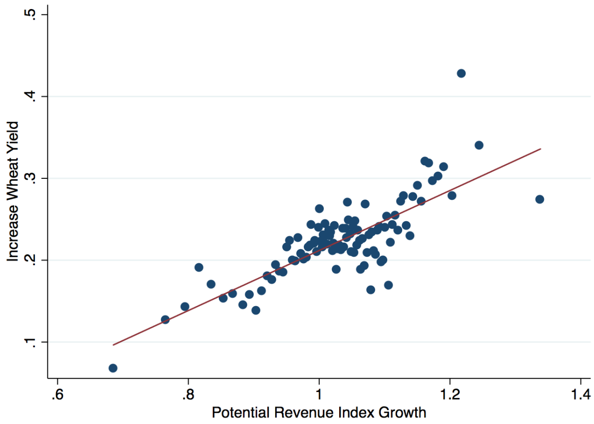
[33] Results are robust to the inclusion of complementary crops, see tables B8 and B9. Crops that are competing with wheat are Citrus, Oats, Olives, Potatoes, Tomatoes. Complementary crops are legumes, maize, rice, and tobacco (Sulieman and Tran, 2015; Allen, 2008; Berzsenyi et al., 2000), as also indicated in the 1929 Census of Agriculture, and 1936 Enciclopedia Treccani (see `http://www.treccani.it/enciclopedia/tabacco_(Enciclopedia-Italiana)`, last access April 2016).

[34] The years considered are from implementation, 1925, until 1929, so as to avoid the years of the Great Depression, which may have an independent effect on the national wheat price.

[35] Although the intermediate level of inputs seems more appropriate to capture the technological level after the technical change induced by the policy, the results are robust to the use of a high level of inputs instead of the intermediate one. See appendix tables B8 and B9.

[36] The linear-logarithm relation can be explained by risk-averse farmers (Hiebert, 1974; Foster and Rosenzweig, 2010) and uncertainty in the returns from the new wheat production technologies (or the lower degree of diversification due to farmer's investment in this crop)

Figure 6: The Exposure to the *Battle for Grain* and the Wheat Yield Increase



Notes: This figure shows a binned scatter plot of the relationship between the increase in wheat yield over the years from 1923 to 1929 and my measure of the potential returns from the Battle for Grain, conditioning on province-fixed effects. For ease of visualization, the binned scatter plot groups observations in 100 equal sized bins. See appendix figures 11a and 11b plain scatter plots with or without fixed effects.

policy, conditioning on province-fixed effects. As expected, areas more suitable for wheat experienced larger increase in wheat yield. This finding can be explained by preexisting knowledge in agricultural production that was instrumental for increasing wheat productivity during the BG.

Column 2 adds my index for the exposure to the BG. The coefficient is positive and highly significant, suggesting that, in addition to the initial geographic advantage in wheat production given by geographic suitability for wheat, my variable captures the additional increase in wheat yield due to the BG.

In the appendix section B.1, I demonstrate that both the increase in wheat prices and the improvements in the wheat production technologies are important determinants of the increase in wheat yield over the period of the policy. Furthermore, I show robustness checks in support of the validity of the *PRI* growth as a measure of the differential exposure to the BG.

5.2.2 Flexible Estimates

This section exploits the temporary nature of the BG and cross sectional variation in the PRI to estimate the effect of the policy on industrialization and population density in the long run.[37] The identifying assumption is based on the argument that the interaction

[37] A vibrant literature employs population data as a measure of economic development and urbanization during pre-industrial periods (Nunn and Qian, 2011; Dittmar, 2011; Squicciarini and Voigtländer,

Table 1: The Predictive Power of the PRI. OLS

	(1)	(2)
Dependent Variable: Δ Wheat Yield 1923-1929		
$\Delta lnPRI_{(1919-29)}$		0.1381***
		[0.042]
Wheat Suitability	0.3126***	0.2636***
	[0.074]	[0.066]
province FE	Yes	Yes
F-statistic (K-P)	-	10.91
Observations	6,662	6,662
Adjusted R^2	0.443	0.448

Notes: This table shows that the potential returns from the *Battle for Grain* ($\Delta lnPRI$) is a strong predictor of the actual change in wheat productivity over the period of the period from 1923 to 1929, even controlling for wheat suitability and province-fixed effects. Kleibergen-Paap's F-statistic refers to $\Delta lnPRI$. Robust standard errors clustered at the province level in brackets. Observations are at the municipality level. See the main text and appendices for definitions of variables and sources.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

between my measure of the intensity of the exposure to the policy, the growth in the PRI, and the time when the policy was introduced is exogenous. I support this assumption demonstrating that the measure of the exposure to the BG became economically and statistically significant only after the introduction of the policy. For this purpose, I estimate the following model:

$$Y_{it} = \alpha_i + \alpha_{ct} + \beta_t \Delta lnPRI_{(1919-29),i} + \theta_t \mathbf{X} + \varepsilon_{it} \tag{5}$$

where Y_{it} is a development outcome — log of population density or manufacturing population share — in municipality i at time t; α_i are fixed effects at the level of municipality i; α_{ct} are province-year fixed effects; $\mathbf{X}$ is a set of time-invariant controls interacted with year indicators. In particular, I control for land suitability for wheat, as well as other geographic controls that will be explained in the following. The coefficient estimates, β_t, measure the difference in the outcome between year t and a reference year associated with a one standard deviation increase in the growth of the PRI. While municipality fixed effects take into account time-invariant characteristics at the level of municipalities, province by year fixed effects control for differential time trends across

2015). Furthermore, Glaeser et al. (1995) and Gonzalez-Navarro and Turner (2016) use population data in contemporary periods as a measure of urbanization.

provinces.

Estimates are robust to the inclusion of flexible controls. During the period of study, significant progress in malaria eradication was made (Snowden, 2008). Malaria eradication might be correlated with changes in agricultural productivity and independently affect economic development. To take into account this potentially confounding factor, I flexibly control for the presence of malaria before the policy. This variable takes value one if the municipality was affected by malaria in 1870. Places naturally more suitable for agriculture may have had economic advantages that were independent of the BG. To take this element into account, I flexibly control for suitability for agriculture measured by the Caloric Suitability Index (CSI) developed by Galor and Özak (2016). The index measures the average calories per hectare that can be produced based on geographic conditions.[38] I account for geographic diversity by flexibly controlling for the standard deviation of elevation (Michalopoulos, 2012). I correct inference clustering the standard errors at the province level so as to allow the error term to be serially correlated over time and spatially correlated across municipalities within provinces.

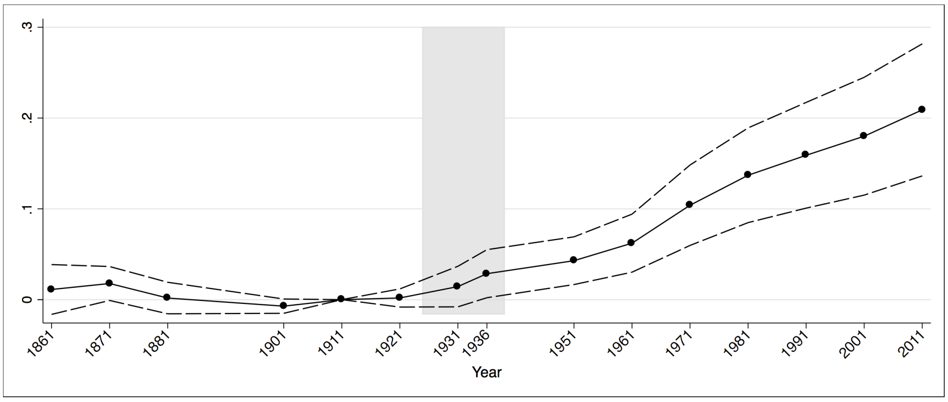
Figure 7a shows the estimated coefficients using as an outcome the natural logarithm of population density (coefficients are reported in the appendix table A2).The estimated coefficients show that the exposure to the BG had a positive effect on population that emerged precisely over the period of the policy (1925-1939). Consistent with the hypothesis that the policy triggered a cumulative effect on economic development, the estimated coefficients grow in magnitude even after the repeal of the policy. Such an effect persisted through recent times, when the contribution of agriculture to output formation was marginal (2.2% of GDP in 2014, ISTAT). The coefficient for 2011 is approximately 21%, meaning that a one standard deviation increase in the growth of the PRI can explain a 21% higher population density in 2011 compared with 1911.

Figure 7b illustrates the estimates using as an outcome the share of the population working in manufacturing (standardized). The estimates become positive and statistically significant only in 1951. The coefficient for 2001 is approximately 12%, meaning that a one standard deviation increase in my measure of the potential returns from the policy can explain a 12% of a standard deviation increase in industrialization in 2001 compared with 1911.

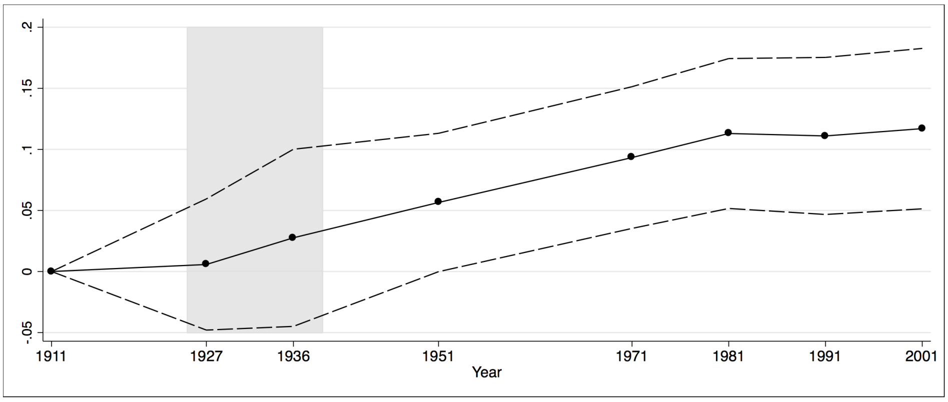
[38] It has been shown that the CSI is a measure of soil fertility superior to those previously used in the literature (Galor and Özak, 2015).

Figure 7: The *Battle for Grain* and Long-Term Development: Flexible Estimates

(a) Population Density



(b) Industrialization



Notes: The figures depict the coefficient estimates of the effect of the exposure to the *Battle for Grain*, captured by the Potential Revenue Index, on economic development in the long term. Panel (a) employs as an outcome the log of population density. Panel (b) employs as an outcome the share of manufacturing population. The regressions include municipality fixed effects, province-year fixed effects, in addition to land suitability for wheat, land suitability for agriculture (CSI), historical presence of malaria, and terrain ruggedness (each interacted with year indicators). No Population Census was conducted in 1891 or 1941. See the main text and appendices for variable definition and sources.

5.2.3 Baseline Specification

In the following, I estimate a more parsimonious model, which has two advantages. First, it allows the estimates to be independent of a reference year. Second, it allows to test for placebo timings of the policy. In particular, I estimate the following equation,

$$Y_{it} = \alpha_i + \alpha_{ct} + \beta \Delta lnPRI_{(1919-29),i} \times Post_t + \theta_t \mathbf{X} + \varepsilon_{it} \tag{6}$$

where α_i, α_{ct} are fixed effects for municipality, and province-year. *Post* is a dummy that takes value one if $t \geq$1925, the year in which the policy was implemented. **X** represents a set of controls interacted with time dummies: land suitability for wheat, presence of malaria in 1870, land suitability for agriculture (CSI), and standard deviation of elevation.

Table 2 shows the estimates from the baseline specification with population density as an outcome variable. Consistent with the hypothesis of a positive effect of the BG on long-term economic development, the coefficient is positive and statistically significant across all specifications. In all specifications, I control for province by time fixed-effects and municipality fixed effects. In column 1, I also flexibly control for land suitability for wheat, so as to compare places with similar levels in potential wheat yield with low inputs and minimizing concerns on potential time-varying effect of geographic conditions that make areas more suitable for wheat. The coefficient implies that a one SD increase in the exposure to the policy led to 11.5% higher population density after the policy.[39] In column 2, I flexibly control for suitability for agriculture. Interestingly, the coefficient slightly increases in magnitude, suggesting that the absence of this control may imply a negative bias in the estimated coefficients. In column 3, I also control for standard deviation of elevation. In this case the estimated coefficient slightly decreases in magnitude, which is possibly due to the role of ruggedness in influencing technological adoption in agriculture, in turn capturing useful variation in the index of the potential returns to the policy. In column 4, I flexibly control for the historical presence of malaria. This control increases the coefficient of interest, suggesting that areas historically affected by malaria experienced an improvement in agricultural development as a

[39] To express the coefficient in terms of tons of wheat per hectare, I employ the result in table 1, to find that a one SD deviation higher increase in wheat yield over the early years of the policy (which is about .22 tons per hectare, see table E1) is associated with 83% higher population density in the post policy period (.1152/.1381). This estimate is equivalent to the Two Stage Least Squares estimator. However, the estimate is an upper bound of the true parameter due to measurement error in the wheat yield data (see appendix F for a proof). With additional assumptions on the structure of the error term (see appendix F), the estimated parameter is approximately 63% (.1152/.1831).

consequence of the eradication but display economic performance, entailing a negative bias in the estimated coefficient. The estimates imply that a one standard deviation increase in the exposure to the policy implies on average a 10% higher population density after the introduction of the policy.

Table 3 reports similar specifications with the use of the share of population employed in manufacturing as a measure of industrialization. The coefficient of interest in column 4 implies that a one standard deviation higher exposure to the policy is on average associated with 7.65% of a standard deviation higher industrialization after the introduction of the policy.

Table 2: Baseline Specification: Population

	(1)	(2)	(3)	(4)
Dependent Variable: *Ln Population Density*				
$\Delta lnPRI_{(1919-29)} \times Post$	0.1152***	0.1181***	0.0981***	0.1001***
	[0.022]	[0.022]	[0.022]	[0.022]
Wheat Suitability	Yes	Yes	Yes	Yes
Agric. Suitab.	No	Yes	Yes	Yes
Ruggedness	No	No	Yes	Yes
Hist. Malaria	No	No	No	Yes
Observations	95,657	95,657	95,657	95,657
Adjusted R-squared	0.918	0.919	0.919	0.919

Notes: Observations are at the municipality-year level. The *Post* indicator takes value one if year takes values larger or equal to 1925. All regressions include municipality fixed effects, province-year fixed effects. Each control is interacted with year indicators. Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

It is difficult to disentangle empirically whether the estimated effect of the policy is due to changes in the steady state in growth rates, or occurs through convergence of the economy to a new steady state in levels. The baseline empirical model estimated in this section has the advantage of being simple and parsimonious. However it imposes a level-effect structure on the estimates. Therefore, in light of the flexible estimates shown in section 5.2.2, it may be argued that the policy stimulated a cumulative process of economic development that translated into different trends in the growth rates. This possibility is explored with a different empirical specification in the appendix tables A3 and A4.

Table 3: Baseline Specification: Manufacturing

	(1)	(2)	(3)	(4)
Dependent Variable: *Share of Population in Manufacturing*				
$\Delta lnPRI_{(1919-29)} \times Post$	0.0813***	0.0813***	0.0745***	0.0763***
	[0.025]	[0.025]	[0.026]	[0.025]
Wheat Suitability	Yes	Yes	Yes	Yes
Agric. Suitab.	No	Yes	Yes	Yes
Ruggedness	No	No	Yes	Yes
Hist. Malaria	No	No	No	Yes
Observations	50,547	50,547	50,547	50,547
Adjusted R-squared	0.606	0.606	0.607	0.608

Notes: Observations are at the municipality-year level. The *Post* indicator takes value one if year takes values larger or equal to 1925. All regressions include municipality fixed effects, province-year fixed effects. Each control is interacted with year indicators. Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

5.3 Placebo Timing of the Policy

Prior to the introduction of the policy there is no reason to expect a positive effect of the BG on local economic activity. Therefore, I expect the interaction between my measure of the exposure to the policy and placebo timings of the policy to be of little statistical and economic relevance. In the following, I investigate this hypothesis examining the significance of placebo cutoff breaks before the policy. Table 4 illustrates the results.

In particular, columns 1 and 2 display the estimates using the relevant timing of the policy (1925). Column 1 reports the estimates on the entire sample, from 1961 to 2011. Column 2 shows estimates on a restricted sample that covers 50 years: from 1911 to 1951. The time window analyzed is indicated in column headings. Despite the reduction in the number of observations, the estimated coefficient for the restricted period is positive and statistically significant, suggesting that the policy had a short-run effect on economic development that unfolded already by 1951.

From columns 3 to 5 estimates are based on placebo cutoffs.[40] Column 3 uses as a placebo cutoff period the year 1885. In other words, the post dummy takes value one over the year 1885 and until 1921, as indicated in the column heading. Column 4

[40] Population censuses were not conducted precisely every 10 years and the were not held at all in some years (1891 and 1941), entailing a frequency of the data that is not constant.

considers as a placebo year 1901. Columns 5 and 6 use 1881 and 1871 as a placebo cutoffs, respectively. Note that the coefficient in column 5 is negative and statistically significant, which may be due to the change in the frequency of the data given that no population census was conducted in 1891.

Table 4: Baseline Estimates: Placebo Cutoffs

Dependent Variable: *Ln Population Density*						
	Relevant Cutoff		*Placebo Cutoffs*			
	(1)	(2)	(3)	(4)	(5)	(6)
	1861 - 2011	1911 - 1951	1881 - 1921	1871 - 1921	1871 - 1921	1861 - 1901
	Post:1925	Post:1925	Post:1911	Post:1901	Post:1881	Post:1871
$\Delta lnPRI_{(1919-29)} \times Post$	0.1001***	0.0276***	0.0041	-0.0114	-0.0186**	-0.0121
	[0.022]	[0.010]	[0.007]	[0.009]	[0.008]	[0.008]
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Province-time FE	Yes	Yes	Yes	Yes	Yes	Yes
Geography Flexible	Yes	Yes	Yes	Yes	Yes	Yes
Observations	95,657	32,368	24,763	30,919	30,919	23,688
Adjusted R-squared	0.919	0.974	0.983	0.979	0.979	0.981

Notes: Observations are at the municipality-year level. The *Post* indicator takes value one if year takes values as indicated in columns headings. Columns 3 to 6 display estimates based on placebo cutoffs. All regressions include municipality fixed effects, province-year fixed effects, in addition to land suitability for wheat, land suitability for agriculture (CSI), historical presence of malaria, and terrain ruggedness (each interacted with year indicators). Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

This section illustrated that areas more exposed to the BG experienced a cumulative process of development that stimulated industrialization and population growth. Such an effect emerged only after the introduction of the policy. In addition, it persisted after the repeal of the policy and until today. The results shown in this section are robust to a host of potentially confounding factors. For instance, in appendix section B.4, I take into account land inequality as it can influence human capital accumulation (**?**), as well as potentially unobserved differences between distant municipalities, and spatial spillovers (appendix section B.2). Of course, the BG was not the only policy interventions undertaken on the Italian territory from 1925 until today. I show that spatially biased policy interventions adopted during the period of the BG — such as land reclamation, infrastructure investments and internal migration policy — do no confound the estimates (appendix section B.4). Furthermore, it has been shown that areas more exposed to the WWII bombings and the reconstruction investment associated with the Marshall plan did not exhibit differences in agricultural production or technology during the period of the BG (Bianchi and Giorcelli, 2018), in turn minimizing concerns on the potantially confounding effect of these subsequent historical events. However, in the empirical analysis of the long-term consequences of policy interventions, the estimates should be interpreted as incorporating the potentially endogenous future policy response of national or local institutions (on this point, see Kline and Moretti (2014a)).

Taken together, the evidence indicates that areas which benefited from the policy acquired an advantage that unfolded during the period of industrialization, persisting until the present day. In the following, I advance the hypothesis that human capital played a key role in explaining the effect of the BG on economic development.

6 Human Capital as a Channel of Persistence

The importance of human capital in agricultural production has been studied at least since Griliches (1963a,b, 1964). Moreover, the importance of the complementarity between human capital and technical change was first underlined by Nelson and Phelps (1966).[41] In their influential study, they observe that farmers with higher levels of education adopt new agricultural innovations more rapidly. The idea is that education increases farmers' ability to understand and evaluate new inputs and techniques. Thus, education becomes increasingly important in a fast changing environment in which there is a flow of new agricultural technologies. In other words, technical change increases the returns to human capital due to its relevance to the adoption of the new technologies that are constantly introduced. Building on this view, Foster and Rosenzweig (1996) advance the hypothesis that the technical change during the Indian Green Revolution increased the returns to education and stimulated human capital accumulation. I conjugate this view in the context of the BG to explain its persistent positive effects.

I hypothesize that the significant technological progress resulting from the BG increased the returns to education and stimulated human capital accumulation, which was conducive to industrialization and economic growth.[42,43] I investigate this hypoth-

[41] On the importance of the complementarity between technology and human capital in the process of economic development, see Goldin and Katz (1998); Galor (2005); Franck and Galor (2015).

[42] The increase in child labor observed over the period of the BG (Toniolo and Vecchi, 2007) may suggest that the increase in human capital accumulation caused by the BG operated on the intensive margin rather than through a labor-saving technical channel.

[43] The ability to adopt new innovation may come from agriculture-specific education which, in fact, surged over the period of the BG (Hazan, 1933). However, general education would still be crucial for at least two reasons. First, it increases the ability of the farmer to find the combination of inputs that is most appropriate in light of the specific geo-climatic conditions in which the farm operates (Huffman, 2001)— a concept similar to that of technology "appropriateness" (Basu and Weil, 1998). Second, education enhances managerial ability. In particular, when technical progress extends the set of production inputs (Romer, 1987, 1990), it increases managerial complexity and stimulates the returns to managerial human capital (Rosenzweig, 1980; Yang and An, 2002).

esis examining whether the BG had positive effects on education.[44] I find supporting evidence using variation *(i)* across cohorts within municipalities and *(ii)* across municipalities over time.

6.1 Cross-Cohort Analysis

If the policy had the hypothesized positive effect on human capital accumulation, such an effect would be stronger for individuals who were still in school when the policy was implemented. Therefore, the gap in educational attainment between cohorts that were at school age in 1925 and older cohorts should be larger in areas more exposed to the policy. In the following, I investigate this hypothesis. Then I complement the analysis, examining whether cohorts more exposed to the policy are more likely to be employed in manufacturing.

The Population Census of 1971 provides data on educational attainment across age groups and gender.[45] The data are aggregated in six age groups. Table 5 illustrates the structure of the data. The first column shows the 1971 age range of each group, while the second shows the range of the year of birth. The third column illustrates the age range for each group in 1925, the year in which the BG was implemented. The last column displays the number assigned to each group. I order the groups from 1 to 6, where group 1 is the oldest.

Table 5: The Cohorts Structure in the 1971 Census

Age in 1971	Year born	Age in 1925	Cohorts Group
≥65	≤1906	≥19	1
60-64	1907-1911	14-18	2
55-59	1912-1916	9-13	3
30-54	1917-1941	≤8	4
21-29	1942-1950	n.b.	5
14-20	1951-1957	n.b.	6

Notes: This table shows the cohorts structure in the Population Census of 1971. The age-group data are available aggregated in six groups. Educational attainment data are also available by gender. Groups 3 and 4 were more likely to be in school in 1925, when the policy was implemented. Groups 5 and 6 were not yet born at the time of the policy and are indicated with n.b.

While groups 3 and 4 were at school age when the policy was implemented, groups 1 and 2 were older and thus characterized by a smaller share of people in school. Groups

[44] My hypothesis is further supported by Dall Schmidt et al. (2018)'s finding of the effect of clover adoption across 17th century Danish market towns on the prevalence of folk high schools.

[45] Gender-level observations are only available for educational attainment. I employ these variation in appendix section B.6 to investigate heterogeneous effects of the policy across genders.

5 and 6 were yet to be born in 1925. I investigate whether there is a gap between school age groups (age groups 3 and 4) and older groups (1 and 2) by estimating the following model:

$$Y_{i,g} = \alpha_i + \alpha_{cg} + \beta_g \Delta lnPRI_{(1919-29),i} + \theta_g \mathbf{X} + \varepsilon_{ig} \tag{7}$$

where $Y_{i,g}$ is an outcome variable in municipality i, in age group g. For the human capital analysis, observations are by municipality, age group, and gender. Then, α_i represents municipality fixed effects, α_{cg} is province by age-group fixed-effect, β_g is the set of flexible estimates obtained from interacting growth in the *PRI* with age-group dummies, $\mathbf{X}$ is a set of controls interacted with age-group dummies, which includes land suitability for wheat, standard deviation of elevation, land suitability for agriculture, and historical presence of malaria. For the analysis on human capital, I also include gender by time fixed effects.

6.1.1 Human Capital across Cohorts

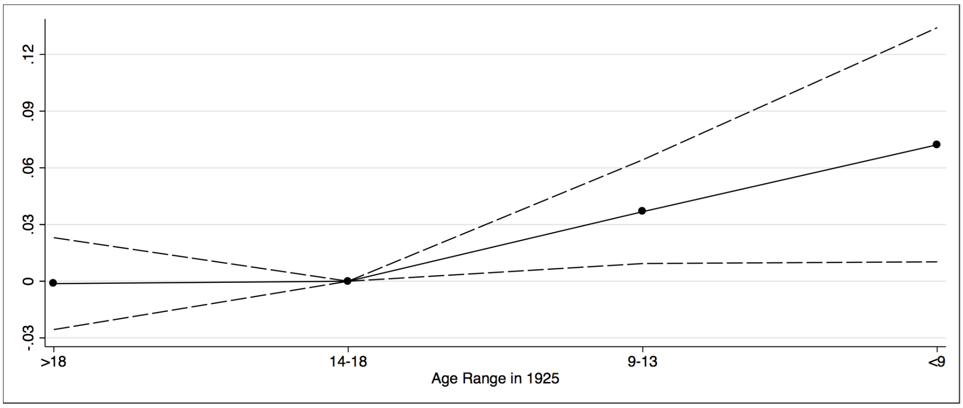
I measure human capital using average years of education. Following Barro and Lee (1993), I consider the population aged 25 or older and exclude groups 5 and 6 (see table 5). The hypothesis is that groups 3 and 4 should be more educated than groups 1 and 2, in the municipalities more exposed to the policy. Note that also in groups 1 and 2 there may be people still enrolled in school in 1925 that may have been affected by the policy in choosing their investment in education. This effect would actually reduce the magnitude of the estimated coefficients.[46]

The estimates of the flexible specification are depicted in figure 8 and illustrated in table A5. Consistent with the hypothesis advanced, in municipalities more exposed to the policy there was an increase in the average educational attainment precisely for those cohorts that were at school age when the policy was implemented. In particular, the estimated coefficients are statistically significant for cohorts aged between 9 and 13 versus those aged between 14 and 18.[47]

In the following, I examine whether the analysis across cohorts confirms the results shown above on the effect of the policy on industrialization.

[46] In the following, I employ variation across municipalities over time to get an estimate of the magnitude of the effect of the policy on education.
[47] Over the period of the BG, education was compulsory for children up to 14 years of age.

Figure 8: The *Battle for Grain* and Human Capital across Cohorts: Flexible Estimates



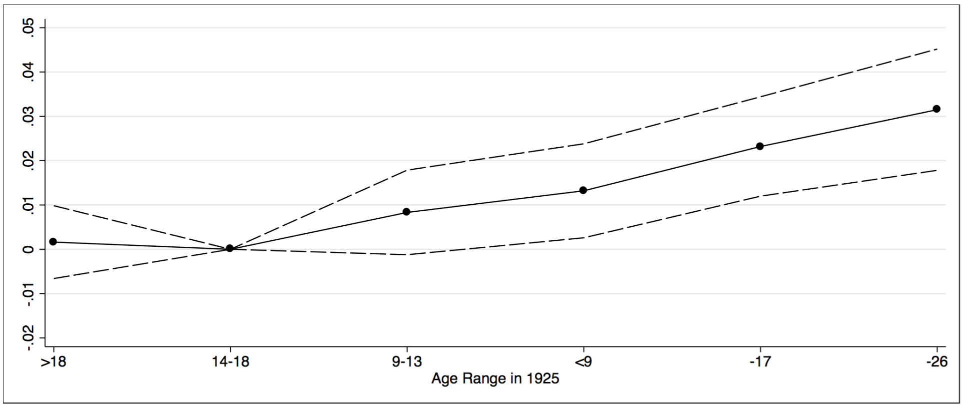
Notes: This figure depicts the coefficient estimates of (7) for the effect of the growth in the Potential Revenue Index on the average years of education across cohorts, and 95% confidence intervals based on province-level clustered standard errors. Observations are at the level of cohort-groups by gender in each municipality. Estimates are from a regression that include municipality fixed effects, province by cohort-group fixed effects, gender by time fixed effects, and flexibly controls for land suitability for wheat, land suitability for agriculture (CSI), terrain ruggedness, and historical presence of malaria. See the main text and appendices for variable definition and sources.

6.1.2 Structural Transformation across Cohorts

Figure 9 illustrates the flexible estimates using as an outcome variable the employment share of manufacturing. In this case it is appropriate to use data on manufacturing employment within younger cohorts as it is informative of the degree of industrialization. The findings across cohorts confirm those across municipalities over time. In other words, in municipalities more exposed to the policy, age groups that had yet to reach working age during the BG had a significantly larger share of manufacturing workers. In turn, this finding suggests that municipalities more exposed to the policy experienced faster growth in the manufacturing sector. The effect emerged precisely for the cohorts that reached working age during the BG. Furthermore, the effect persists for groups 5 and 6, namely for people born after the end of the policy.

Table 6 illustrates the estimates across age groups from a regression of education and employment shares by sector on the measure of exposure to the policy interacted with an indicator that takes value one if the cohort was school-aged (i.e. younger than 14) when the policy was implemented. Column 1 shows the result using the average years of education as an outcome. Column 2 illustrates the estimated coefficient using manufacturing employment share as an outcome. Consistent with the hypothesis, the coefficient estimates in columns 1 and 2 are positive and statistically significant, suggesting that the policy stimulated human capital accumulation and industrialization. Column 3 employs as an outcome the agricultural employment share. The negative coefficient in column 3 is consistent with the hypothesized effect of the BG on the speed

Figure 9: The *Battle for Grain* and Industrialization across Cohorts: Flexible Estimates



Notes: This figure depicts the coefficient estimates of (7) for the effect of growth in the growth in the Potential Revenue Index on the share of manufacturing population, and 95% confidence intervals based on province-level clustered standard errors. Estimates are from a regression that includes municipality fixed effects, province by cohort-group fixed effects, and flexibly controls for land suitability for wheat, land suitability for agriculture (CSI), terrain ruggedness, and historical presence of malaria. See the main text and appendices for variable definition and sources.

Table 6: The *Battle for Grain*, Education, and Industrialization Across Cohorts

	Dependent Variable:			
	(1)	(2)	(3)	(4)
	Avg. Years Education	Empl. Share in Manufacturing	Empl. Share in Agriculture	Empl. Share in Others
$\Delta lnPRI_{(1919-29)} \times I_{age<14}$	0.0552**	0.0181***	-0.0183***	0.0002
	[0.022]	[0.005]	[0.006]	[0.006]
Observations	54,275	40,565	40,565	40,565
Adjusted R-squared	0.902	0.840	0.812	0.543
Province-Cohorts Group FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
Geography Flexible Controls	Yes	Yes	Yes	Yes

Notes: Observations are at the level of municipality-cohort. This table illustrates that the exposure to the *Battle for Grain* positively affected average education for school-aged cohorts as of 1925 (column 1). The table also shows the positive effect on the transition to industry (column 2) and the negative effect on share of labor in agriculture (column 3). The sector "Others" includes services, commerce, transport, communications, finance, and public administration. The variable $I_{age<14}$ is a binary variable that takes value one if the cohort group is younger than 14 in 1925. In addition to indicating control variables and fixed-effects, regression in column 1 also includes gender by time fixed effects (gender data not available for the industry census in columns 2-4). Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

of the transition out of agriculture. Finally, column 4 uses as an outcome variable the employment share in all the other sectors.[48] The estimated coefficient is not statistically different from zero. The absence of a local persistent effect of the policy on the service sector across age groups can be rationalized by the presence of absentee landowners (Fujita, 1989) whose consumption does not take place locally. Thus, even enhancing the service sector at the country level, it would not be captured by the difference-in-differences specification. Taken together, table 6 suggests that the policy stimulated local accumulation human capital and was conducive to an acceleration of the exodus from agriculture towards manufacturing.

In this section, I have shown that cohorts at school age at the time of the policy experienced a more rapid increase in educational attainment in municipalities more exposed to the BG. The cross-cohorts estimates also confirm the findings of the effect of the policy on industrialization. Below, to get a sense of the magnitudes of the effects of the policy on human capital, I employ educational attainment data across municipalities over time.

6.2 Human Capital across Municipalities

In this section, I study the effect of the BG on human capital across municipalities over time. As outcome variables, I use two measures of education. First, given that elementary school was compulsory and only 2.5% of the population attained a level higher than the middle school, I use the share of people aged 14 or older with at least a middle school certificate in 1951. Second, I use the average years of education in 1951 and 1971, converted from education attainment levels by using duration of each level. I control for education before the policy using data on literacy rates in 1921, the only data available for that period.[49] However, given that literacy may be an imperfect control for pre-policy education level, I also control for a large set of geographic and socioeconomic characteristics, and for province fixed effects.

The estimated model is given by

$$Y_i = \alpha_c + \beta \Delta lnPRI_{(1919-29),i} + \beta_2^{'} \boldsymbol{X} + \varepsilon_i \tag{8}$$

where Y_i represents economic outcomes of municipality i, $\boldsymbol{X}$ is a vector of time-invariant

[48] This residual category includes services, commerce, transport, communications, finance, and public administration. Data on employment shares in each individual sector are not available.

[49] Including nonlinear effects of literacy as controls in seeking to take into account of preexisting educational attainment patterns improves the estimates.

control variables and pre-policy socioeconomic controls for municipality i, α_c is a province fixed effect, and ε_i is the error term for municipality i.

Even in this specification, I control for land suitability for wheat and the Caloric Suitability Index. In addition, I control for latitude, median elevation, standard deviation of elevation,[50] and the elevation range (the log of the differences between maximum and minimum elevation within the municipality), as well as the historical presence of malaria. Exposure to the policy may be correlated with proximity to big markets and to water trade routes, which can independently affect the process of industrialization and economic prosperity. Therefore, I control for distance to water (minimum distance from the coastline and major rivers) and minimum distance to the most populous cities as of 1921 (Milan, Naples, Palermo, Rome, and Turin). To further control for potential preexisting differences, I control for population density in 1921 in logs, thus only four years before the introduction of the BG, the standard measure of market access by Harris (1954), measured by the log of the average population in neighboring municipalities weighted by distance, and the density of ancient Roman roads.[51]

Table 7 shows that the growth in the PRI has a positive and significant effect on education. Consistent with the hypothesis advanced, column 1 shows that the potential returns from the BG has a positive and significant effect on the share of the population with at least a middle school certificate. Column 2 shows that the coefficient of interest increases in magnitude after controlling for literacy before the policy, which suggests that preexisting levels of education are negatively correlated with my measure of the BG. Columns 3 and 4 illustrate the same estimates using as an outcome the average years of education in 1951. The estimated coefficient is positive and significant. Again the coefficient increases in magnitude when literacy before the policy is taken into account. Columns from 1 to 4 show that the exposure to the policy was conducive for human capital accumulation already in 1951. In columns 5 and 6, I use as an outcome the average years of education in 1971. Even with this measure of education the estimates are positive and significant and show an increase in magnitude when pre-policy literacy is taken into account. Interestingly, the magnitude of the estimated coefficients is smaller in column 6 with respect to column 4. This suggests that migration patterns across municipalities from 1951 to 1971 do not reinforce the estimated effect of the BG on education, lending credence to the identification assumption of the cross-cohorts analysis in section 6.1. Finally, column 7 performs a placebo check where I use the

[50] Alternative controls such as standard deviation within 10 or 20 kilometers radius do not affect the results.

[51] On the importance or Roman roads for economic prosperity, see Dalgaard et al. (2018).

literacy rate in 1921 as an outcome. Reassuringly, the estimated coefficient is negative and not significantly different from zero, suggesting that the effect of exposure to the BG is not capturing differences in human capital that were already present before the introduction of the policy. It is worth noting that the coefficient for land suitability for wheat is not statistically different from zero across all specifications, which points toward the fact that, although the BG was beneficial for wheat-suitable areas, its positive local effect on human capital unfolded mainly through technological improvements. In the following, I will further investigate this hypothesis.

In addition to the stimulus to average education, the higher returns from adopting the new technologies may have stimulated investment in technical human capital. Using census data on the share of high school graduates across municipalities, I investigate this aspect in table 8.

The first column of table 8 shows that areas more exposed to the policy were characterized by a larger share of technical high schools graduates. Column 2 shows that using the share of teacher training high school graduates as an outcome the coefficient estimate is not statistically different from zero. Similarly, using the share other high school graduates as an outcome, the estimated coefficients are either statistically indistinguishable from zero or negative. These findings strongly support the hypothesis of the importance of the complementarity between agricultural technologies and technical skills, lending credence to the hypothesis of the importance of human capital accumulation in explaining the estimated effects of the BG on long-run development.

6.2.1 Technology versus Price Effect

The BG combined agricultural technical change with protection. This section investigates whether the estimated positive effect of the BG on education is driven mainly by agricultural technical change or by the wheat price shock. In particular, I split my measure of the potential returns from the policy in its part due to technical change and its part due to the increase in the relative wheat price so as to disentangle one effect from the other. Table 9 illustrates the results.

As evident from the table, while municipalities more exposed to the technological progress resulting from the BG experienced an increase in education that persisted until 1951 and 1971, those more exposed to the local effect of the increase in the national wheat price did not. This result confirms the hypothesis that the positive effect of the BG on human capital accumulation functioned through technical change, rather than an

Table 7: The *Battle for Grain* and Human Capital across Municipalities

	(1) Share Middle School 1951	(2) Share Middle School 1951	(3) Avg. Yrs of Educ. 1951	(4) Avg. Yrs of Educ. 1951	(5) Avg. Yrs of Educ. 1971	(6) Avg. Yrs of Educ. 1971	(7) Literacy 1921
$\Delta lnPRI_{(1919-29)}$	0.0895**	0.0907**	0.0928**	0.0938**	0.0773**	0.0780**	-0.0027
	[0.044]	[0.045]	[0.037]	[0.038]	[0.035]	[0.035]	[0.019]
Wheat Suit.	0.0072	0.0030	0.0018	-0.0015	-0.0079	-0.0111	0.0112
	[0.023]	[0.022]	[0.024]	[0.023]	[0.022]	[0.022]	[0.013]
Literacy 1921		0.3728***		0.2894***		0.2891***	
		[0.035]		[0.033]		[0.039]	
province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to water and cities	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pre Policy Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,165	6,165	6,165	6,165	6,181	6,181	6,192
Adj. R^2	0.333	0.357	0.310	0.325	0.407	0.422	0.820

Notes: This table illustrates estimates of the effect of the exposure to the *Battle for Grain* on education across municipalities. Observations are at municipality level. Outcome variables are denoted in column headings. All variables are standardized. Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

Table 8: The *Battle for Grain* and Human Capital Composition across Municipalites

Dependent Variable: Share of High School Graduates in 1951 by Major				
		Placebo		
	(1)	(2)	(3)	(4)
	Technical	Teacher	Classical or	Others or
VARIABLES	School	Training	Scientific	Unspecified
$\Delta lnPRI_{(1919-29)}$	0.0739**	-0.0690	-0.0005	-0.0416*
	[0.034]	[0.045]	[0.049]	[0.024]
Wheat and Agricultural Suitability	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes
Distance to water and cities	Yes	Yes	Yes	Yes
Pre Policy Controls	Yes	Yes	Yes	Yes
Observations	6,393	6,393	6,393	6,393
Adj. R^2	0.371	0.195	0.156	0.0632

Notes: This table illustrates estimates of the effect of the exposure to the *Battle for Grain* on human capital composition across municipalities. Observations are at municipality level. Outcome variables are denoted in column headings and refer to the share of the population with a high school degree in each field. The residual category "Other Schools" includes other minor as well as unspecified categories All variables are standardized. Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

Table 9: Technology versus Price effect and Human Capital

	(1)	(2)	(3)
	Share Middle School 1951	Avg. Yrs of Educ. 1951	Avg. Yrs of Educ. 1971
$\Delta lnPRI_{(1919-29)}Technology$	0.0981**	0.1035***	0.0817**
	[0.044]	[0.039]	[0.035]
$\Delta lnPRI_{(1919-29)}Prices$	-0.0342	-0.0437*	-0.0187
	[0.026]	[0.025]	[0.022]
Wheat Suit.	0.0009	-0.0040	-0.0124
	[0.021]	[0.023]	[0.022]
Literacy 1921	Yes	Yes	Yes
province FE	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes
Distance to water and cities	Yes	Yes	Yes
Pre Policy Controls	Yes	Yes	Yes
Observations	6,165	6,165	6,181
Adj. R^2	0.358	0.325	0.422

Notes: This table establishes the importance of the agricultural technical change due to the BG in stimulating education. Observations are at municipality level. Human capital variables are denoted in column headings. Standardized coefficients are reported. Robust standard errors clustered at the province level in brackets.
*** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

increase in wheat prices and the associated income effect. Indeed, areas that benefited from the policy through the increase in the relative price of wheat, rather than technology adoption, did not experience a significant increase in education. If anything, the sign of the coefficient is negative, albeit statistically insignificant. This result further supports the hypothesized skill-biased nature of the technical change resulting from the BG.

Having established the relevance of technical change in explaining the effect of the BG on human capital, I investigate its importance for development and industrialization. I employ a flexible specification, as equation (5) in section 5.2.2, in which I include the index of technical change and that of the price change. Figures 10 and 11 show the estimated effects of technical change and price change on population density and industrialization, respectively. The positive effect of technology and the limited effects of the increase in prices on economic development further confirm the finding for human capital. Interestingly, as depicted in the bottom panel of figure 11, the short run effect of the price shock on industrial development is negative and significant. Then, it dissipates over time. This finding may be interpreted as a negative short-run effect of the rise in the returns to factors in agriculture, as brought about by the wheat tariff, and suggest that, while transitory protection may spur technological progress and long-term development, its negative effects on non-protected sectors may not be long-lasting.

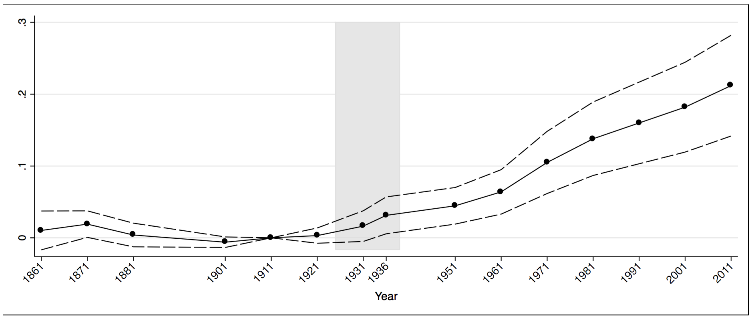
Taken together, the results of this section show that the positive shock to technological progress in agriculture resulting from the BG stimulated human capital accumulation. Instead, the increase in wheat price had limited effects on human capital accumulation, which is consistent with the literature emphasizing that a Hicks-neutral increase in agricultural productivity and the associated increase in the returns to factors in agriculture may lead to specialization in this sector, ultimately hampering human capital accumulation (Galor and Mountford, 2008) and the transition to industry (Matsuyama, 1992; Bustos et al., 2016).

7 Concluding Remarks

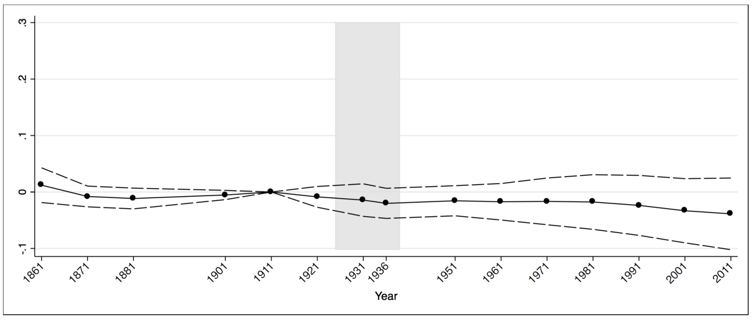
This paper studies the BG to find that agricultural development policies may have positive persistent effects on local economic activity. The heterogeneous exposure across Italian municipalities to the different interventions that compose the BG represents a unique opportunity to investigate the mechanisms through which agricultural policy may affect industrialization. The finding that the local effect of the policy is

Figure 10: Technology versus Price effect and Population Density

(a) Technology and Population Density



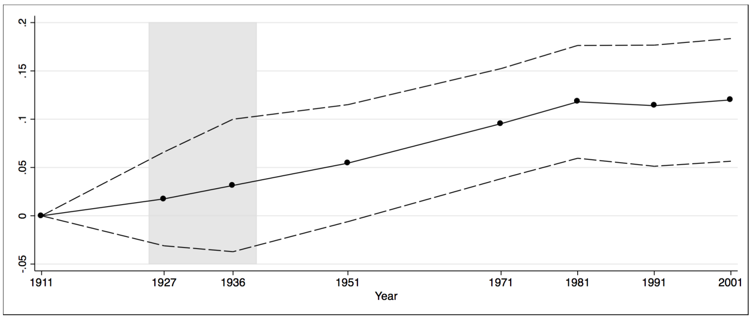
(b) Price Effect and Population Density



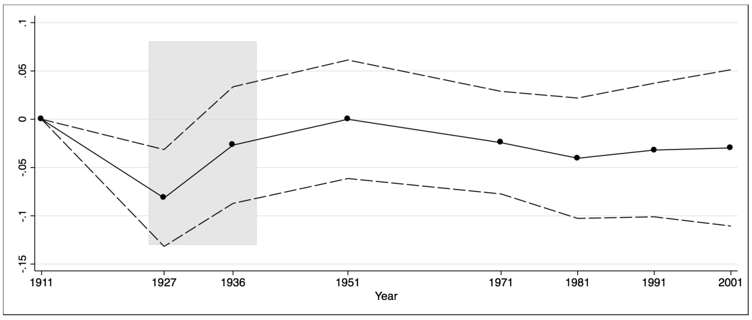
Notes: The above figures depict the coefficient estimates of (5) for the effect of growth in the Potential Revenue Index due to technical change (panel (a)) and price change on population density measured in natural logarithms. The regression includes both indexes (interacted with year indicators), municipality fixed effects, province-year fixed effects, in addition to land suitability for wheat, land suitability for agriculture (CSI), historical presence of malaria, and terrain ruggedness (each interacted with year indicators). No Population Census was conducted in 1891 or 1941. See the main text and appendices for variable definition and sources.

Figure 11: Technology versus Price effect and Industrialization

(a) Skill-Biased Agricultural Technical Change and Industrialization



(b) Price Effect and Industrialization



Notes: The above figures depict the coefficient estimates of (5) for the effect of growth in the Potential Revenue Index due to technical change (panel (a)) and price change on the share of people in manufacturing. The regression includes both indexes (interacted with year indicators), municipality fixed effects, province-year fixed effects, in addition to land suitability for wheat, land suitability for agriculture (CSI), historical presence of malaria, and terrain ruggedness (each interacted with year indicators). No Population Census was conducted in 1891 or 1941. See the main text and appendices for variable definition and sources.

explained by technological progress and its positive effects on human capital accumulation, rather than the tariff-induced increase in the wheat price, can inform the literature on the consequences and functioning of policy intervention for structural transformation.

Exploring the country-level effect of the policy lies beyond the scope of this work. Such an analysis would require a different data set and identification strategy and is left to future research. Yet, the finding that short-term agricultural policy interventions can have long-lasting effects on local economic activity offers hope that future research will cast further light on the consequences of policy, providing insights into long-term unfolding of the development process.

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