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Doctoral Thesis

The economic impact of Italian colonial investments in Libya and in the Horn of Africa, 1920-2000

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Declaration

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A mio nonno Pierfranco

Abstract

This dissertation examines the micro-level effects of Italian colonial investments in Libya, Somalia, Eritrea, and Ethiopia, and sheds light on both their short and long-term impact. It focuses on two flagship projects, launched by the dictator Benito Mussolini during the 1930s, namely the construction of a modern road network in the Horn of Africa and the settlement of Italian farmers in Libya. The contributions are twofold. First, this thesis focuses on types of colonial investment that have not been studied before, while looking at a group of colonies that have previously been neglected by the cliometrics revolution in African economic history. Thus, it enhances our understanding of the effect of colonialism in general and, on Africa, in particular. Second, by exploiting a set of quasi-natural experiments from the history of Italian colonialism to explore the micro-effect of specific policies, this thesis also contributes to the economic geography and development literatures that have looked at the determinants of agglomeration and productivity in developing countries.

It is structured around three substantive chapters. The first one studies the effect of Italian road construction in the Horn of Africa on economic development and shows how locations that enjoyed a first-mover advantage in transportation thanks to the Italian road network are significantly wealthier today. The second substantive chapter assesses the effect of Italian agricultural settlement on indigenous agriculture in Libya at the end of the colonial period and pinpoints an adverse effect of Italian presence on Libyan productivity. Finally, the third substantive chapter studies the effect of the expulsion of Italian farmers from Libya after World War II and finds a reduction in agricultural commercialization in affected districts following the shock.

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Chapter 1

Introduction

This thesis examines the micro-level effect of Italian colonial investments in Libya and the Horn of Africa and looks at both their short and long-term impact on spatial inequality and productivity across the territories of erstwhile colonies. By applying quantitative spatial analysis, this research studies the effect of two key investment policies that were implemented by the fascist government of Benito Mussolini during the 1930s, namely the construction of an extensive road network in the Horn of Africa, following the occupation of Ethiopia in 1936, and the settlement of Italian farmers in Libya.

Formal colonialism, namely the capacity of a handful of nations to impose political control on oversea territories, has been, without doubt, one of the most influential phenomena that affected societies on a global scale. Besides inflicting a certain degree of cultural change on the colonized peoples and being responsible for some of the worst atrocities recorded in human history, colonial activities have also significantly altered the distribution of wealth both between and within countries, at times persistently.

Scholars have dedicated a substantial amount of writing to the analysis of the channels through which colonialism has impacted erstwhile colonies. Especially after the publication of the seminal paper by Acemoglu, Johnson, and Robinson (2001), a lively, multidisciplinary debate has arisen. Despite having to deal with an endemic lack of suitable counterfactual scenarios (Heldring and Robinson, 2012), academics have provided complementary evidence on different mechanisms through which the European expansion has affected the developmental trajectory of former colonies. Some of the central factors that the literature has emphasized in relation to colonialism and its economic legacy are the export of institutions of different quality (Acemoglu, Johnson, and Robinson, 2001; Mamdani, 1996), improvements in human

capital (Glaeser et al., 2004), investments in welfare and transport infrastructure (Huillery, 2009; Jedwab and Moradi, 2016) and extractive policies, such as labor coercion (Dell, 2010).

This thesis makes contributions on two distinct levels, one more general and one more investment-specific. On the one hand, by looking at a handful of countries (Ethiopia, Libya, Somalia and Eritrea) and at types of colonial investments, such as roads and European agricultural settlement, that have been scarcely researched before it enhances our knowledge of African economic history, in general, and of the Italian colonial one, in particular. On the other hand, by exploiting the quasi-experimental nature of the investments implemented by the Italian government in the colonies, it studies the economic effect of specific investments in transport and agriculture. Thus it contributes to those bodies of literature that have sought to explain the determinants of the unequal distribution of economic activity and the differences in agricultural productivity across space and over time.

This concise introduction places the three substantive papers into context while emphasizing both the unifying themes of this research and its context-specific implications. Firstly, it discusses the motivations for this study, both on a context-specific level and within a more comparative framework. Secondly, it presents the thesis' contributions in more detail and with reference to the literature, both on a general level and a by-paper basis, and it provides a summary of the three substantive chapters. Finally, it outlines the structure of the thesis.

1.1 Why Italian colonialism?

The Italian colonial experience presents some unique features that make it a particularly fascinating chapter in the history of European activities in Africa, both from a context-specific and a more comparative perspective.

1.1.1 Country-specific motivations

As mentioned before, both the areas affected by Italian colonial occupation, namely Libya and the Horn of Africa, and the influence of their colonial past on their post-colonial development are largely understudied. Apart from this fact, which is not in itself a motivation to undertake extensive research on the subject, former Italian colonies are also important players in the economic and political life of the African continent, which further motivates historical research on the determinants of their current level of development.

Figure 1.1: The Italian African colonies in 1936

Libya, for instance, despite having a small population, started playing a central role in African politics and on the international scene thanks to the oil revenues that began to pour into the government's coffers from the late 1950s (Allan, McLachlan, and Penrose, 1973, p. 9-10). This export-led growth made Libya a relatively wealthy country by international standards and an extremely affluent one relative to the African average (real GDP per head reached 40,000 2011 $ in 1980 (Bolt et al., 2018)) and, consequently, a regional power. Mainly due to the anti-western initiatives of Muammar Gaddafi, who seized power in a coup in 1969, Libya started to play a central role in African politics, both by supporting armed groups across the continent and by pushing her anti-Western, pan-African political agenda from within the African Union (The Economist, 1999). Unfortunately, little empirical evidence exists on the transformation of the Libyan economy after World War II and, specifically, on how the end of colonialism and the expulsion of Italian settlers affected agricultural productivity across the country. Moreover, the recent civil war that hit the country, following the "Arab spring" revolution of 2011, brought regional tensions and tribal fighting back, which calls for further research on the determinants of spatial inequality across the country. Colonial agricultural policies are an essential starting point for such an investigation.

Ethiopia is perhaps an even more compelling case. As it is well-known, the Ethiopian empire was the only African country to maintain its independence during the Scramble for Africa[1], as it was able to deflect the attempts of imperialistic and military penetration, perpetrated by the French, British and Italian governments (the battle of Adwa between Italy and the Ethiopian empire remains the harshest defeat of a European power in the African continent (Labanca, 2002, p. 84-85)). The brief Italian occupation and the substantial investment plans implemented by the Italian government, therefore, offer the possibility to study the effect of colonial investments in a country that was otherwise unaffected by colonialism, had a long-lasting history of state centralization and was at the time implementing independent development plans (Zervos, 1936; Pankhurst, 2012). Moreover, despite a long post-colonial history of political authoritarianism that hampered development (The Economist, 2010), the Ethiopian economy achieved sustained economic growth in the past two decades (Moller and Wacker, 2017), which lifted many out of poverty but also created striking inequality across regions. Looking at the historical roots of the contemporary distribution of economic activity

[1]Liberia also remained independent during the Scramble, but her history is very particular as it was predominantly populated by freed slaves from the US (Gardner, 2014, p. 1092)

is of paramount importance to make sense of past Ethiopian development, as well as to inform future policy-making.

1.1.2 Italian colonialism in comparative perspective

From a comparative perspective, the study of the effect of Italian colonial policies offers important insights into the broader issue of the effect of colonialism in Africa. Due to the particular pattern of colonial occupation, in fact, erstwhile Italian African territories experienced significantly different developmental policies compared to other African countries. The timing and the implementation of development plans in Italian Africa offer some clean quasi-natural experiments that allow to shed light on the effect of types of investments whose impact is difficult to identify and measure elsewhere in the continent.

Italy was a latecomer and a weak player in the Scramble for Africa. A latecomer because she annexed her main colonies relatively late compared to the timing of the expansion of other European countries in Africa, which was basically concluded by the beginning of the 20th century (Michalopoulos and Papaioannou, 2016). Libya and Ethiopia, the two most valuable Italian colonies, were only conquered in 1912 and 1936, respectively, and were pacified even later. It was a weak player because she only managed to take the leftovers of other colonial powers (Labanca, 2002, p. 15-33). Eritrea and Somalia, that had become Italian colonies in 1882 and 1905 after short periods under the control of chartered companies (Labanca, 2002, pp. 49-51; Del Boca, 1976, pp. 801-2), were extremely poor territories with little to offer in terms of natural resources and perspectives for agricultural development (Podestà, 2004, pp. 11-3). When Libya was incorporated into the Italian colonial empire in 1912, the situation did not improve significantly as also her territories were poor of resources (oil had not been discovered) and completely lacking economic infrastructure (Segré, 1974, p. 26). Although mostly unknown to Italian officials, Ethiopia was undoubtedly a more promising territory in terms of potential for economic development (estimates of the indigenous population were in the order of 8 million people, against the combined population of Libya, Eritrea, and Ethiopia that totalled 2,2 million only in 1931 (Regno d'Italia, 1931, p. 12)). The short duration of the Italian occupation (1936-1941), however, prevented the completion of any organic economic plan and even a more comprehensive understanding of the developmental potential of the region. In this sense, the Italian colonial expansion did not guarantee the availability of resources and export markets that, for instance, Britain and France could muster across their

colonial territories (Federico, 1998). Because of these reasons, investments in agriculture, transportation and, more generally, colonial development were hardly justified and remained very limited until the fascist dictatorship started to attach increasing importance to the Italian African territories, for political reasons, in the late 1930s.

The second peculiarity of Italian colonialism is precisely the sudden and unprecedented implementation, especially during the late 1930s, of large-scale developmental policies under Fascism, serving strategic goals that were mostly unrelated to the actual economic potential of targeted regions. Despite the scarcity of natural resources, Mussolini attached great importance to colonial development. On the one hand, this new approach was linked to propagandistic purposes, and namely the regime's need to complete prestigious projects to please and impress the public opinion after having promised a bright economic future for Italians in Africa ("A place in the sun") (Labanca, 2002). On other hand, the grandiose development projects also had a contingent strategic purpose and were to play a role in the autarchic economic system envisaged for Italy by Mussolini. In his plan, the African colonies should have operated as preferential outlets for low-skilled migrants that could find new land to farm and, at the same time, should have created a protected market for metropolitan manufactured products in the medium-term (Segré, 1974, pp. 82-3). This project never materialized due to the abrupt end of the Italian occupation of the region. Yet, the character of urgency that the fascist regime attached to colonial development due to this peculiar economic thinking and to the propagandistic aims described above, still led to pharaonic investments serving short-term metropolitan economic needs and contingent military purposes.

For instance, the construction of a modern road network in the Horn of Africa was initially instrumental in achieving a tighter control over the territory and in connecting the major Ethiopian towns with the coast during the first years of occupation, which were characterized by a fierce Ethiopian resistance and guerrilla warfare (Cobolli-Gigli, 1937, p. 1480). In the minds of the planners, this network should have become pivotal towards fostering trade in the area, but only at a later stage and after serving its primary strategic purpose. Similarly, the intensification of the demographic settlement schemes in Libya and, in particular, in the eastern part of the country (Cyrenaica) during the late 1930s were also a measure conceived to strengthen the Italian strategic position in the event of a war against Britain. The presence of a large Italian farming community could provide readily available food supply to the troops stationed in Libya (Cresti, 2011, pp. 230-1). Investments, although at times erratic and often

linked to political objectives rather than targeted to realistic economic ones, were nevertheless substantial. As the rest of this thesis will show, the Italian government pumped significant funds into road building in the Horn of Africa and agricultural development in Libya, on a scale capable of altering economic dynamics significantly and, at times, permanently.

For this study, the described peculiarities of the Italian colonial history matter for two main reasons. On the one hand, the economic irrelevance of Italian possessions (and the lack of territorial continuity in the Horn of Africa before 1936) led to very conservative investment policies before the 1930s. In fact, unlike in British and French colonies, where extensive railroad construction was carried out to connect the coast with the hinterland (Jedwab and Moradi, 2016), only small railways existed around the capitals of the Italian dominions. Similarly, Italian farming never took off despite minor and largely unsuccessful attempts in Eritrea and Tripolitania, before 1930. On the other hand, large-scale undertakings, often driven by political and military-strategic considerations unrelated to local economic potential, were implemented during the fascist regime. This combination of events offers a series of case studies that can be exploited as quasi-natural experiments. In other words, the specific characteristics of Mussolini's colonial policies offer the possibility to identify their micro-level effect more effectively as, thanks to their discontinuity with previous colonial developmental policies and their peculiar placement unrelated to the pre-existing economic potential of targeted regions, they help in solving the standard issue of the endogenous placement of colonial investments.

This particular setting is insightful, in a comparative perspective, as it allows to study the impact of investments that were also implemented in British and French colonies, but whose effect is more difficult to study due to the sounder economic reasoning behind their implementation. A more careful and gradual planning, in fact, would take economic potential more clearly into account, thus yielding a problem of endogeneity that would make the identification of causal effects difficult. Moreover, the Italian rule ended abruptly only a few years after the completion of the major investments analyzed in this thesis. Thus, the case studies are even neater as the experiments are expunged from the potentially confounding effects that a prolonged colonial era could generate, such as exposure to European institutions and human capital formation. In this sense, the Italian case study can shed light on the effect and the mechanisms in place in other colonial settings with similar characteristics. Moreover, in the extent to which the studied quasi-natural experiments offer results with general validity, the analysis of the effect of Italian investments in Libya and the Horn of Africa allows to shed light

on the effect of developmental policies that goes beyond the described colonial context-specific motivations.

1.2 Contribution

1.2.1 General contribution

This research primarily contributes to the literature that has focused on the economic history of Africa and the legacy of colonialism, and it does so through four key features.

First, this thesis examines a set of countries that have been largely overlooked by the literature on African history and colonialism. Partially due to a lack of quantitative information on Libya, Ethiopia, Somalia and Eritrea, in fact, the economic history of these regions and, in particular, the link between their colonial history and their post-colonial development patterns have been scarcely researched. The economic history literature on comparative development and colonialism in Africa has mostly focused on the big players in the "scramble", namely Britain and France. Therefore, while several influential contributions have analyzed the economic legacy of colonialism in former British and French colonies, little is known about the effect of colonial policies in former Italian territories. The historical literature on Italian colonialism does provide a comprehensive qualitative analysis of the phenomenon, but this stream of the literature tends to look at the issue from either a business (Podestà, 2004), a political or a cultural history perspective (Labanca, 2002). Those few contributions that have studied the Italian agricultural investments in Libya (Segré, 1974) and Ethiopia (Larebo, 1994) do not employ quantitative information systematically, nor they seek to establish causal links or to explore the short, medium and long-run effects of these investments. To fill this gap in the literature is thus essential both with respect to the qualitative history of Italian colonialism and the quantitative economic history of the African continent.

Second, Italian colonial history offers the possibility to study the causal effect of developmental policies that were implemented elsewhere in Africa but have not been thoroughly studied. By examining the effect of road construction on agglomeration in the Horn of Africa and of the settlement of Italian farmers along the Libyan shores on agricultural productivity, this thesis also contributes to the literature by studying types of colonial investments that have not been systematically researched in other colonial contexts, thus enhancing our understanding of the effect of colonial investments in general. Scholars have looked at the ef-

fect of colonial railroads (Jedwab, Kerby, and Moradi, 2017), schools and hospitals (Huillery, 2009), missionary activities (Cagé and Rueda, 2016), forced labor (Dell, 2010) and plantations (Lowes and Montero, 2018a). However, to the best of my knowledge, empirical evidence is lacking on the effect of paved roads on the distribution of economic activity in former colonies. Similarly, the impact of European agricultural settlement in Africa, a feature that Libya had in common with other former colonies such as Algeria, Tunisia, Zimbabwe, and Kenya, is not well researched, especially with respect to its influence on the traditional indigenous agricultural sector in the colonial period and the expulsion of white farmers in the post-colonial one.

Third, this research studies the effects of investments at a micro-level, thus examining within-country heterogeneity. It employs particularly granular units of observations, namely 10x10km grid-cells (to study agglomeration dynamics in the Horn of Africa), villages (to look at the effect of Italian settlement on productivity in colonial Libya) and districts (to estimate the effect of the expulsions of the Italian farmers on the Libyan agricultural sector). This fine, albeit demanding, level of data collection allows us to identify spatial patterns with high precision, thus enabling us to capture localized effects that it would not be possible to study at a larger level of aggregation. In this sense, this research follows the tendency in the disciplines of African economic history and development economics of employing historical micro-level data to unveil the effects of policies and their persistence. Jedwab and Moradi (2016) pioneered the use of grid-cells to study the effect of transport infrastructure in Ghana, Dell and Olken (2017) analyze the effect of colonial sugar plantation systems in Java at a village level, while the literature on missionary activities emphasizes the need to consider very localized effects to identify how Christian missioners affected African traditional societies (Jedwab, Meier zu Selhausen, and Moradi, 2018). From a methodological perspective, therefore, this thesis is in line with these recent contributions and also highlights the importance, despite the challenges posed by the substantial data limitations in African economic history, of looking at the micro-level effect of colonial policies.

Lastly, the data collection effort in itself constitutes a significant and original contribution of this thesis. As mentioned before the study of the colonial and post-colonial history of former Italian colonies suffers from a particularly severe shortage of reliable quantitative data. This limitation is due to various factors. The short duration of the colonial occupation of certain territories, coupled with the poor preservation of the archives during World War II and the

high cost of collecting granular-level data prevented a systematic construction of quantitative databases for erstwhile Italian colonies. Each substantive chapter of the thesis constructs a novel dataset by collecting and combining archival and primary printed sources to analyze the effect of the different Italian policies at a micro-level. The first paper reconstructs the distribution of Italian governmental facilities in 1939 and the location of all existing villages and towns for 1925, 1935, 1938 and 1939 across Italian territories in the Horn of Africa. Facilities include the location of roads, railroads, schools, hospitals and both administrative districts and capitals. The second paper employs a village-level database containing information on grain yields, total output, and population for both Libyan and Italians in Libya in 1939. This dataset also includes firm-level data on the factors of production for all Italian farms in Libya for 1937 and information on the location of transport infrastructure and markets. Finally, the third paper gives a substantial contribution to data collection for post-colonial Libya by digitizing district-level data on agricultural production and population from the Libyan agricultural censuses of 1961 and 1974. Altogether, the collected data constitute an extensive micro-level database on former Italian colonies and these will be made available to other researchers.

1.2.2 The substantive papers and their contribution

The thesis is structured around three substantive papers. Each of them looks at a particular aspect of the Italian colonial policies in Libya and the Horn of Africa and contributes to a specific sub-field.

1.2.2.1 The long-term impact of Italian colonial roads in the Horn of Africa, 1935-2000.

The existing literature on transport infrastructure has thoroughly studied the effects of railroads on both market integration (Donaldson, 2018) and agglomeration (Jedwab and Moradi, 2016) in developing countries. Empirical work on paved roads, instead, is scarcer despite the importance of roads in providing farmers and firms with easier access to markets in impoverished areas of the world. The literature has shown the positive effect of rural roads on consumption and schooling in India (Aggarwal, 2018) and Africa (Dercon et al., 2009) and also the effect of market integration on city growth in post-colonial Africa (Storeygard, 2016), but has not specifically addressed the effect of paved roads on agglomeration. Suitable em-

pirical settings that allow studying the effect of roads on the distribution of economic activity are rare, due to the tendency of policy-makers to place infrastructure in areas with higher levels of development or growth potential. The construction of Italian roads in the Horn of Africa offers an ideal setting to study the long-lasting effect of a first-mover advantage in transportation on the distribution of economic activity, which I do in the first substantive chapter of the thesis.

This article performs a grid-cell level analysis across the territories of Ethiopia, Eritrea and former Italian Somalia. After the occupation of Ethiopia in 1936, Mussolini decided to build an extensive road network across the Horn of Africa to secure control over the main cities of the area and to facilitate trade between them. The paper exploits the fact that the road network connected locations between termini for exogenous reasons, namely the fact of being located on the least cost path between major urban centers, to establish a causal link between proximity to Italian paved roads and a set of contemporary development indicators. Causality is established through an instrumental variable approach that instruments proximity to Italian transport infrastructure with the least-cost paths connecting termini and through a placebo test that compares finished and unfinished arteries.

The results show that Italian roads triggered a substantial increase in population density, urbanization, light density, and living standards indicators within 10km from them. The faster process of urbanization that took off during the post-colonial period in the proximity of Italian roads explains the persistence of the effect. In fact, the higher levels of population density that are observable next to road infrastructure by the end of the colonial period coordinated the location of factors in the post-colonial one, thus determining a persistent higher density equilibrium. The latter was not subsequently altered by the substantial expansion of the road network that took place from the 1960s.

1.2.2.2 Cultivating the "Fourth Shore": The effect of Italian farming in colonial Libya, 1920-1942

The settlement of European farmers affected a number of countries both in North and sub-Saharan Africa during the colonial era. The phenomenon was one of the most controversial chapters of the history of colonialism and had a long-lasting effect well into the post-colonial era. Leading intellectuals, such as Sartre, condemned these regimes as exploitative, due to the extraction of resources operated by the settlers through seizing the best land and forcing

indigenous people to work for low wages (Sartre, 1964). The literature on African economic history, however, has not provided quantitative evidence on the effect that white settlement had on indigenous agriculture, nor has pointed out the mechanisms through which this has happened.

The existing research on settler colonialism, in fact, has taken a more qualitative approach based on selected case studies. This exercise has portrayed a mixed picture. On the one hand, several contributions have emphasized how the creation of African homelands, characterized by the lower quality of land and more difficult access to markets led to a fall in indigenous productivity and a consequent worsening of African living standards (Arrighi, 1967; Palmer and Parsons (eds.), 1977). More recently, Lowes and Montero (2018a) have employed econometric techniques to identify the negative consequences of rubber plantations in Congo, but similar research for settler agriculture is still missing. A selected group of scholars has even contradicted the view that portrayed a uniformly negative effect of European settlement on African peasants by showing how indigenous farming elites managed to take advantage of the new economic opportunities offered by settler economies to increase their income (Shutt, 2002; Heywood, 1987) In the same vein, the seminal research by Mosley (1983) suggests that additional competition for resources in the homelands raised productivity. However, the more efficient farmers, he argues, crowed out less productive ones, who had to enter the low-wage labor market forcefully.

Furthermore, it is difficult to reconcile the literature that has pinpointed an adverse effect of European farming on African societies with the economic history and development economics literatures that portray positive spillovers from more advanced to more traditional farmers (Parman, 2012; Conley and Udry, 2010), a situation that, despite the described discriminatory policies, could have materialized in colonial settings where white farmers employed African workers systematically. In the attempt to reach a consensus based on richer micro-data and to bridge these discrepancies in the literature, further evidence on the effect of European colonial farming in Africa is, therefore, essential.

More specifically, by studying the effect of Italian settlement in Libya in the 1930s, the second substantive chapter of this thesis contributes to the literature in two ways. First, although Libya is characterized by particular geographical and historical features that do not necessarily allow to draw general conclusions for other colonies (especially sub-Saharan ones characterized by different environmental conditions), this case study enhances our understand-

ing of the effect European farming in Africa by offering new empirical evidence that allows to identify the causal effect of European settlement and to shed light on the mechanisms more clearly. Second, the analysis of the spatial spillovers of European settlement on agricultural productivity also adds to the literature that has looked at the determinants of innovation in agriculture. A dual economy characterized by a certain level of segregation between groups is a revealing setting to study whether spatial spillovers materialize when inequality between groups is particularly high.

Two features make Libya a particularly suitable setting to study the effect of European agricultural settlement. First, Italian farmers were not allowed to settle on land that was under permanent cultivation before their arrival, which practically confined them to the land in the surroundings of traditional centers of intensive Libyan farming. This characteristic allows isolating the effect of Italian settlement and activities from the one that, in other colonial contexts, was exerted through the expropriation of the best land and the marginalization of African farmers into peripheral areas. Second, the colony was not entirely under Italian control until the 1930s, which forced the settlers to locate in places that had been under Italian control for longer and were thus safer. The combination of these two peculiar dynamics, on the one hand, makes the endogenous placement of Italian colonists less worrisome and, on the other, provides an identification strategy through an instrumental variable that relies on the constraints to Italian agricultural settlement.

The article performs village-level regression analysis on 182 Libyan villages to study how Italian presence affected agricultural productivity both within villages of Italian settlement and in their surroundings. Out of the 182 villages recorded by the sources, roughly 60 were affected by Italian settlement, and 60 were located within 50km from them. Proximity to Italian villages is captured by a 50km dummy variable, while causation is established by instrumenting distance from Italian clusters with distance from the Italian strongholds that were controlled by the army in the early 1920s.

The results show that Italian presence induced a significant productivity drop (as measured by cereal yields) in neighboring Libyan villages that became significantly less productive than their counterparts in the control group. These results are explained by the widespread employment, on Italian farms, of Libyan workers and camels. This redistribution of resources, which drew capital and labor away from the most fertile areas onto Italian lands, forced traditional farmers to switch to land-extensive cultivation techniques, thus reducing yields

and arguably living standards, relative to the pre-colonial period.

1.2.2.3 Leaving the "Fourth Shore": The effect of Italian farmers' expulsions from post-colonial Libya, 1930-2005

A second, critical, characteristic of colonies affected by European settlement is that white farming elites often had to endure forced expulsions after the end of colonialism. In these cases, their land was seized and re-distributed to African farmers. One famous example of recent land expropriations against white farmers recently took place in Zimbabwe (The Economist, 2000), while radical proposals for land reforms are systematically debated in South Africa (The Economist, 2004). While the literature has looked at the effect of expulsions and forced migrations of productive minorities on the economic performance of both sending (Chaney and Hornbeck, 2016) and receiving countries (Fourie and Von Fintel, 2014), little is known about the effect of European settler's expulsions on the performance of erstwhile colonies and, specifically, on their agricultural sectors. By studying the effect of the removal of the Italian farmers from post-colonial Libya, the third substantive article of this thesis contributes to the literature in this sense as, to the best of my knowledge, it is the first quantitative work that estimates the effect of white expulsions from former colonies. Moreover, by isolating the effect of the removal of Italian farmers from other confounding factors it also contributes to the literature on the determinants of agricultural productivity which, due to endogeneity concerns, struggles to isolate the role of human capital from other factors, especially in developing countries.

Similarly to the first two substantive chapters of the thesis, apart from being a significant event in itself, the case of the Italian expulsion from Libya was also selected as a case study due to two peculiar historical characteristics that make it suitable to identify its causal effect in a quasi-experimental framework. First, Italian farmers settled across Libya relatively fast, over a period of 10-15 years between 1925 and 1940. This process had similar characteristics across the country and, as mentioned before, it did not systematically affect the best agricultural land that often remained in the hands of the Libyans cultivators. Second, and unlike other comparable settings, Italians were expelled in two steps, due to political events that were unrelated to the performance of the agricultural sector, namely the occupation of the Eastern region of Cyrenaica by the British in 1942 and the unilateral expulsion, implemented by Gaddafi, of all remaining Italian citizens in 1970.

The paper looks at 46 districts, which are observed over four years (1939, 1960, 1974 and 2005) and exploits the described setting to run a triple difference estimation that allows to compare the performance of Italian districts that were affected by an expulsion with both Italian areas unaffected by the same shock (because located in a different part of the country) and Libyan districts in the same region, thus providing an estimation of the causal effect of the expulsions.

The results show how, on the one hand, both expulsions caused a reduction in the level of commercialization of affected districts, as measured by the share of commercial crops (defined as ground-crops different from traditional subsistence crops) over the total. On the other hand, those Italian districts that were affected by the 1970 expulsion, which coincided with the oil boom (and therefore with better market opportunities), showed a marked increase in cereal yields, which unveils the responsiveness of indigenous farmers in reacting to market incentives. The analysis of the mechanisms points at a central role of human capital in explaining the reduction in commercialization.

1.3 Structure

The thesis is structured around the described three substantive articles and proceeds as follows. Chapter 2 provides a more comprehensive review of the related literature. This is followed by the three substantive papers, in Chapters 3, 4, and 5. Chapter 6 draws the main conclusions and discusses both the limitations of the study and avenues for future research.

Chapter 2

Literature review

2.1 Introduction

While focusing specifically on the economic impact of Italian colonial investments, this research contributes to several strands of the literature. In this review, I will provide a survey of the relevant contributions by field, and I will describe how my work fits into this framework. Section 2.2 describes the comparative development literature that has examined the determinants of the unequal development across the globe and, more specifically, the historical literature on the effects of colonialism in Africa. Scholars disagree whether geography, pre-colonial institutions, or colonialism played a more central role in determining the growth trajectory of African countries. My thesis contributes to this strand of the literature by studying the micro-level effect of particular types of colonial investments in some understudied parts of the African continent, thus providing further evidence on the mechanisms through which colonialism has affected development in the long-run. Section 2.3 reviews the economic geography literature that discusses how man-made advantages can alter spatial equilibria. By looking at how colonial investments affected the distribution of economic activity across space, in fact, my work also contributes to this body of research. Third, Section 2.4, discusses the literature that has examined the role of agriculture in historical development and the drivers of productivity in the primary sector, again with a particular focus on African economic history and settler colonies. By studying the effect of Italian agricultural development policies in Libya, in fact, Chapters 4 and 5 add to our understanding of the determinants of productivity in agriculture in developing countries and of the mechanisms through which European farming affected the African primary sector in settler colonies. Finally, Section 2.5 describes

how this thesis contributes to the historical literature on the history of Italian colonialism.

2.2 Comparative development and colonialism

By looking at the effect of specific colonial investments on economic development, namely roads and agricultural settlement, my research relates to the literature that has explored the origins of comparative development, with a specific focus on Africa. Scholars disagree on the underlying causes of economic divergence between continents and countries. Many contributions point to colonialism to explain underdevelopment in some areas of the African continent but disagree on the mechanisms through which this would have shaped development across the globe. My work adds to this literature in three main ways. First, it focuses on a set of countries (Libya, Ethiopia, Eritrea, and Somalia) that have been largely neglected by the literature. Second, it looks at selected investments (road building and agricultural settlement) that have not been systematically studied elsewhere. Third, in line with the more recent contributions in the field, it examines within-country effects, thus allowing to study the patterns of change more precisely as well as to identify causal links between variables. The literature on the subject is considerable, and a complete review is beyond the scope of this section. Extensive surveys of comparative development, persisting effect of historical legacies on African economic development and African economic history more generally are provided by Spolaore and Wacziarg (2009), Michalopoulos and Papaioannou (2018) and Fourie (2016), respectively.

2.2.1 Pre-colonial institutions and geography

Several contributions look at factors that pre-dated colonialism to explain current levels of inequality across Africa and the globe. While my thesis emphasizes the importance and the long-lasting impact of specific colonial activities and their capacity to alter the pre-existing economic landscapes in Italian colonies, it also calls for further research on how these interacted with pre-colonial conditions.

A first strand of this literature, while accepting the importance of institutions in general, questions the extent to which changes brought about by colonial systems managed to alter the social, economic and cultural traits of traditional African societies and has emphasized the resilience of pre-colonial institutions and cultural norms. Gennaioli and Rainer

(2007) and, especially, Michalopoulos and Papaioannou (2013; 2014) find strong and positive causal relationships between the level ethnic groups' centralization in pre-colonial Africa and contemporary levels of development (proxied by living standards and light density at night respectively). In particular, by exploiting variation in light density at the ethnic homeland-level and discontinuities across borders of adjacent ethnic groups, Michalopoulos and Papaioannou (2013) plausibly identify the long-term, positive effect of pre-colonial centralization on economic development. Bandyopadhyay and Green (2016), consistently with this line of research, provide evidence from Uganda on the persistent association between pre-colonial centralization and contemporary wealth, but suggest this might be due to the accumulation of private wealth rather than the provision of public goods. These quantitative studies are consistent with the narratives offered by Herbst (2000) and Boone (2003) who also pinpoint the resilience of pre-colonial local institutions throughout the colonial and post-colonial periods and the link between accountability in pre-colonial polities and quality and efficiency of local post-colonial institutions. Mamdani (1996) famously proposed the link between indirect rule regimes, set up by the colonial governments across Africa, and despotic institutions in the post-colonial era.

In the same vein, more recent research finds a persistence of ethnic life-ways and cultural traits using disaggregated data. Michalopoulos, Putterman, and Weil (2018), for instance, trace individual economic success back to the mainstream economic activities of ancestral ethnicities and find that descendants of farmers perform better than herders today. Lowes et al. (2017) also find evidence of persisting pre-colonial cultural norms and show how people living in the former territories of the highly centralized Kuba Kingdom rely more on formal enforcement mechanisms today. Giuliano and Nunn (2013) show the persistence of democratic behaviors between the pre-colonial era and today across a sample of more than 1,200 ethnicities. Similarly, Acemoglu, Reed, and Robinson (2014) emphasize the role of the interaction between pre-colonial sub-national institutions and colonial administrative preferences in shaping post-colonial patterns of growth for the case of Sierra Leone. A growing and recent strand of the literature echoes these works on the persistence of pre-colonial cultural traits and their influence on contemporary behavior and gender norms (Alesina, Brioschi, and La Ferrara, 2016; Moscona, Nunn, and Robinson, 2017). Finally, Frankema (2010b) emphasizes the importance of pre-colonial institutions in explaining levels of land inequality. He argues that the level of centralization that the colonizers had found in place forced them to adapt the

newly created institutions accordingly, which ultimately led to different levels of inequality in land distribution.

Ethnic fractionalization is an essential factor in explaining economic success and pre-colonial institutions largely account for ethnic edges still today. While the role of ethnic fractionalization in hampering African growth was first stressed by the seminal country-level investigation of Easterly and Levine (1997), the persistent effect of pre-colonial institutions on violence is today well-established thanks to within-country analyses. The literature, however, provides two complementary but somewhat opposite mechanisms. On the one hand, it stresses how power struggles between ethnicities are conducive to a higher incidence of conflicts and violence (Montalvo and Reynal-Querol, 2005) and also how pre-colonial ethnic conflicts determine the intensity of fighting later in history (Besley and Reynal-Querol, 2014). On the other hand, Heldring (2019) shows how strongly centralized pre-colonial states can lead to more systematic and capillary violence against civilians, as in the case of the Rwandan genocide.

A second crucial aspect of African history that preceded formal colonialism and that severely affected the economic development of the African continent was the slave trade. In a seminal paper, Nunn (2008) shows how those African regions that have experienced more warfare and kidnapping to supply the European slave trade perform worse today in terms of economic development and living standards indicators. Nunn and Wantchekon (2011) find that people living in areas more intensively affected by the trade are less likely to trust institutions and each other today, which in turn undermines economic performance. Following these pioneering contributions on the subject, a growing literature has proposed several alternative mechanisms through which the slave trade could affect growth patterns in the long run. A first stream of research points to the negative effect of the trade on levels of centralization and quality of institutions. Green (2013) and Whatley and Gillezeau (2011) unveil the link between the slave trade and low levels of functional ethnic consolidation that was chiefly due to the limits to between-groups cooperation, in the context of the trade. In fact, not only did the trade hamper the formation of polities with critical masses sufficient to exploit minimal scale economies, but it also made the existing ones more despotic (Whatley, 2014). Finally, evidence exists on how the trade persistently altered gender ratios (in the direction of a larger share of the female population) (Lovejoy, 2011), thus inducing the spreading of polygamy, which is a detrimental factor for economic development (Fenske, 2015). A high incidence of

the slave trade also led to a lower provision of public goods in education and human capital accumulation (Obikili, 2016) and reduced access to credit mainly due to the negative effect that this had on societal cohesion and trust (Levine, Chen, and Xie, 2017).

An alternative and influential view emphasizes the importance of geography and factor endowments in explaining the different patterns of growth and in shaping institutions. This strand of the literature takes inspiration from the pioneering work of Diamond (1999), which shows the long-lasting legacy of initial environmental conditions and natural barriers to trade and technological diffusion. Sokoloff and Engerman (2000)'s seminal paper builds on this intuition to explain the different development levels of the United States and Latin America by pointing out the effect that diverse climates and soils had on colonial institutions. According to their view, Latin America is endowed with geographical conditions that made its territories suitable for large plantations and labor-intensive productions. Colonial institutions, therefore, developed in a way that facilitated labor extraction and land expropriation. Conversely, in North America, where factor endowments were more favorable to small and middle-size farms, more democratic institutions developed. In their view, colonial institutions are not exogenously determined but rather adapt to local factor endowments and environmental conditions. Gallup, Sachs, and Mellinger (1999) also stress the importance of geography and, in particular, of the way different human societies responded to diverse climatic conditions in terms of modes of production and transportation technology.

More recently and with a narrower focus on African development, Alsan (2014) pinpointed the importance of considering geography when explaining institutional development and, ultimately, economic growth. She shows how African regions that experienced endemic Tse Tse fly presence during the pre-colonial and colonial periods were less likely to develop plow agriculture (due to the high mortality rates of animals) and, as a consequence, centralized states that could extract a surplus from sedentary farmers. Fenske and Kala (2015) show how climatic conditions influenced the slave trade, by providing evidence on the lower levels of slaves supply to the main European commercial outposts in warmer years, when mortality was higher and more labor was required for African agriculture. In the same vein, Depetris-Chauvin and Weil (2018) and Gallup and Sachs (2001) study the burden that the high incidence of malaria has imposed on African historical development. Nunn and Puga (2012) underscore the long-lasting positive association of ruggedness and development indicators in Africa, due to the initial advantage that a rugged territory provided during the warfare linked to en-

slavement during the slave trade. Finally, Fenske (2014a) has looked at the determinants of state formation in pre-colonial Africa (or lack of thereof) and has found a positive association between ecological diversity and centralization due to higher incentives to trade.

Finally, several contributions have stressed the importance of natural resources in shaping patterns of growth in post-colonial Africa (Ross, 2012a; Fenske and Zurimendi, 2017). The general agreement is that natural resources are both a blessing and a curse due, chiefly but not exclusively, to rising inequality, increased incidence of conflicts and international price volatility (see Frankel (2010) and Ross (2015) for extended reviews on the topic).

2.2.2 Colonialism

The described literature has influenced the way we think about comparative development and, in particular, about Africa's "growth tragedy". A large body of research, however, contends that colonialism had the remarkable capacity to affect erstwhile colonies deeply and persistently, despite the relatively short duration of the occupation and the resilience of pre-colonial characteristics. This body of the literature is here divided between the strand that has considered the role of institutions and the one that has examined colonial investments in a broad sense. My work complements this literature by reinforcing the view that colonialism had a long-lasting impact and that micro-level studies are necessary to capture the within-country and long-term economic legacies of European policies. However, it departs from it by looking at Italian colonies, which have been largely neglected before, and by studying types of investments that have not been researched in other contexts.

2.2.2.1 Institutions

A first group of scholars, who followed the seminal work of North, Wallis and Weingast (North, 1990; North, Wallis, and Weingast, 2006), has underscored the importance of institutions in shaping economic behavior and long-term economic performance. This influential view supports the hypothesis that colonialism has influenced long-term development through institutional channels, namely by exporting qualitatively different sets of institutions across the globe, some more extractive and some more inclusive and, therefore, conducive to economic growth.

In a seminal article on the subject, which was later significantly expanded by the same authors (Acemoglu, Johnson, and Robinson, 2002; Acemoglu and Johnson, 2005; Acemoglu

and Robinson, 2012), Acemoglu, Johnson, and Robinson (2001) unveil the link between the settlement of Europeans abroad and the establishment of more inclusive institutions that were in turn conducive to higher levels of economic development in the long-run. This paper was criticized on two main fronts. First, Austin (2008b) points out the danger of "compressing history", thus stressing the risk of oversimplification when, through empirical analysis, scholars try to recognize one leading cause within complex, diversified, and stratified processes. A second criticism from Albouy (2012) rests on a more technical ground and challenges explicitly the methodology used by Acemoglu, Johnson, and Robinson (2001). Among other problematic operations of data editing, he also shows that the mortality rate data used in the instrumental variable estimation are not reliable and suffer from selection bias.

Notwithstanding these criticisms, the institutional approach has profoundly influenced the following literature. Bertocchi and Canova (2002) further stress the importance of the identity of the colonizers in explaining the patterns of growth that were experienced by the former colonies after independence. For India, the work of Banerjee and Iyer (2005) shows that those districts where a local landlord was in charge of collecting taxes from the agricultural sector have performed poorly in the long-run, compared to districts where the British Raj had set up a system of direct administration that guaranteed the property rights of local farmers. In the same vein, Iyer (2010) provides evidence that indirectly administered districts experienced higher levels of expenditures on welfare in the post-colonial period, which in turn translated into better long-term performances in education, healthcare, and agricultural productivity. Feyrer and Sacerdote (2009) study the link between duration of the colonial regime and contemporary levels of income and find a positive association for a sample of islands outside Africa.

With respect to Africa, some key contributions have identified an essentially negative effect of extractive colonial institutions that hampered medium and long-run growth and social stability through excessive taxation and forced labor (Bruhn and Gallego, 2012; Huillery, 2014; Van Waijenburg, 2018). These findings are in line with the results of Dell (2010), who finds a persistent reduction in levels of welfare due to the Mita forced labor regime in Peru. Besides forcing people to work and taxing heavily to support their administration, colonial powers also drew artificial borders that severely affected the growth prospects of erstwhile colonies by creating dysfunctional states (Alesina, Easterly, and Matuszeski, 2011; Michalopoulos and Papaioannou, 2014). In particular, Michalopoulos and Papaioannou (2016) highlight how the

partitioning of ethnic groups by colonial borders led to a spiral of violence that hampered the growth prospects of several countries in the post-colonial period. This effect was linked to the higher likelihood of minority groups, on the one hand, of being discriminated by the central government and, on the other, of being able to seek assistance from beyond the border and revolt. By seeking to extract resources, colonial institutions, and artificial states were also conducive to unequal economic growth and urbanization, which at times led to the mushrooming of informal settlements (Fox, 2014). Fors and Olsson (2007) provide evidence on how colonial institutions continued to affect development after independence by giving post-colonial political elites incentives to maintain weak property rights to be able to continue extracting rents.

Several contributions have explicitly looked at the process of state formation in Africa, with a particular emphasis on the transition between traditional African statehoods, colonial states, and post-colonial ones. These can be broadly split between those positing that the colonial state had a severe, long-lasting and negative impact on African societies (Mamdani, 1996; Mamdani, 2001; Sartre, 1964) and those that undermine the role played by colonialism in changing traditional African societies and emphasize the persistence of traditional African institutions instead (Herbst, 2000; Hopkins, 2000). Bates looks explicitly at the political economy of the marketing of agricultural products in colonial and post-colonial states. He argues that the illiberal trade policies that were set up by European colonial governments hampered African production and that these patterns persisted in the post-colonial era (Bates 1983; 2014). Gardner (2012) explores the building of colonial public finance in British Africa, thus expanding earlier work by Frankema that looked at fiscal regimes in colonial Africa (Frankema, 2010a; Frankema, 2011; Frankema and Van Waijenburg, 2014).

A key issue that emerged from the work of Mamdani (1996) is the long-lasting effect of indirect rule, that created weak central states and strong informal institutions in the post-colonial period. In this vein, Lange (2009), Acemoglu, Reed, and Robinson (2014) and Lechler and McNamee (2018) find evidence that empowerment of local chiefs in the colonial period had long-lasting, negative effects on state capacity. Also consistent with the institutional approach and with the latter strand of the literature is the work by Ali et al. (2015), which provides convincing evidence on the relationship between British indirect rule and weaker state reach in the post-colonial period.

2.2.2.2 Colonial activities and investments

The debate on the role of colonial institutions has stimulated new avenues of research, that go beyond the institutional approach and try to narrow the mechanisms down more precisely by looking at colonial activities, often at a within-country level. My work is in line with this strand of the literature but adds to it by emphasizing the importance of considering other types of colonial investments, namely road construction and European agricultural settlement, which have not been studied in other colonial settings and, at the same time, by focusing on the history of Italian colonialism.

Havinden and Meredith (1993) explore the development plans implemented by the British in their former colonies and cover a period spanning from the first half of the 19th century up to the 1960s. Their research highlights the shortcomings of colonial development policies that struggled to implement profitable investments in a vast empire, and can be seen as complementary to the work by Davis and Huttenback (1986), which investigates the profitability of the empire for Britain. A growing body of research has, after these two contributions, looked more specifically and using data with a more granular level of disaggregation at the long-term effect European colonial investments and economic policies. While it is difficult to evaluate the aggregate effect of colonial undertakings due to the lack of suitable counterfactual settings that allow to establish what the development pattern of independent African states would have been in the absence of colonialism (Heldring and Robinson, 2012), numerous scholars have pinpointed how colonial activities had a significant and long-lasting effect on African development.

A handful of contributions has attempted to estimate the effect of colonialism on African living standards by looking at the few available indicators. Data on urban real and nominal wages show upward trends during the colonial era, but leave room for uncertainty due to questions about the representativeness of the employed urban wages. Frankema and Van Waijenburg (2012) look at urban real wages for several British African colonies between 1880 and the 1960s and find that African wages increased throughout the period. By contrast, De Zwart (2011) computes real wages for South Africa in the nineteenth century and shows stagnating wages for the "coloured" population and rising inequality between ethnic groups. Moradi (2009) employs anthropometric techniques to study changes in African well-being in Kenya before and after colonial occupation and finds an overall improvement in nutritional

standards (measured by height) during the colonial period, despite significant regional disparities. In this section, I will consider the main contributions that examined the effect of colonialism on colonized societies through human capital formation and investments. A more in-depth discussion of the agglomeration effects of investments in transport infrastructure and agricultural policies can be found in Sections 2.3.2 and 2.4, respectively.

While scholars have suggested the importance of different underlying determinants in shaping long-run patterns of development, such as culture (Guiso, Sapienza, and Zingales, 2006; Tabellini, 2010), legal origins (La Porta, Lopez de Silanes, and Shleifer, 2008; Djankov et al., 2003) and genetic differences (Ashraf and Galor, 2013; Spolaore and Wacziarg, 2009), consensus has formed on the key role played by human capital in fostering innovation and growth (Squicciarini and Voigtländer, 2015). For the colonial setting, Glaeser et al. (2004) famously challenged the institutional view by pinpointing the paramount role of human capital brought by the European settlers in shaping the growth perspective of erstwhile colonies. While this feature of European colonialism could be considered more as an unintended consequence rather than as a policy, this view was later reinforced by several contributions. Putterman and Weil (2010) link historical migrations of individuals with common sets of skills with long-run patterns of growth. Rocha, Ferraz, and Soares (2017) show how those Brazilian regions that attracted more educated economic migrants performed better in the long-run relative to comparable areas. Fourie and Von Fintel (2014) support this view through a country-specific study for the African context, by showing that wine-making skills imported by Huguenots to the Cape Colony boosted wine output.

While the latter strand of the literature suggests how higher level of human capital generated by European migrations were conducive to better economic outcomes, convincing empirical evidence also exists on the long-lasting and positive effects of missionary activities on indigenous human capital formation and their persistence. Gallego and Woodberry (2010) highlight the positive effect that competition between catholic and protestant missioners had on educational outcomes. The authors argue that those regions that experienced colonial regimes that prevented either the Catholic or the Protestant missioners from providing education perform poorly in terms of present-day measures of education. By contrast, where missioners were free to compete, higher literacy and numeracy levels can be measured today. Woodberry (2012) provides evidence about the positive causal relationship between protestant missioners' activity, economic development and "democratization" today.

While recent evidence pinpoints how the effect of missions did not persist equally across the globe, but could instead be influenced by post-colonial policies (Chaudhary and Garg, 2015), there is general agreement on the positive effect of missions on various indicators of long-run development even when looking at within-country effects (see Jedwab, Meier zu Selhausen, and Moradi (2018) for a review on the effect of missionary activities). Cagé and Rueda (2016), for instance, find a positive causal relationship between proximity to a historical mission with a printing press, contemporary levels of literacy and political participation. In the same vein, Nunn (2014) highlights the positive, long-lasting effect of the exposure to missionary activities on development. Meier Zu Selhausen and Weisdorf (2016) and Meier Zu Selhausen, Van Leeuwen, and Weisdorf (2018) study the long-lasting impact of missionary activity and find compatible results, namely a positive association between human capital formation in the colonial times and social mobility. Higher levels of education linked to missionary activity are also related to better health outcomes in India today (Calvi and Mantovanelli, 2018) and to a reduction in polygamy in French West Africa (Fenske, 2015). Jedwab, Meier zu Selhausen, and Moradi (2018) criticize the data employed by the majority of the studies that link missions' locations and present-day development indicators. They show how the employed standard locations of missions suffer from endogenous placement and survival selection bias, which would undermine some studies that find a large positive effect of missions. Research by Fourie and Swanepoel (2015) goes in this direction and shows how missions were placed according to pre-existing characteristics across the Cape Colony.

Governmental provision of education and healthcare in colonial times also matters for long-run development. Cogneau and Moradi (2014) exploit the case study offered by the division of German Togo between the French and the British following World War II. By showing higher levels of literacy on the British side following the partition, they pinpoint the importance of investments in education during the colonial era to explain present-day inequalities in living standards, school attainment, and democratic participation. By looking at variation across countries, Bolt and Bezemer (2009) reinforce this view and show how the long-run economic performance of African countries is driven by heterogeneity in human capital formation during the colonial era more than by institutional differences. In the same vein, Wantchekon, Klašnja, and Novta (2015) underscore the positive effects of colonial schools in Benin across different generations. Huillery (2009) and Wietzke (2015) estimate the long-term impact of colonial investments in education, healthcare, and, more in general, human capital on long-

term development. In her paper, Huillery finds that districts that received more teachers and medics from the government during the colonial period in French West Africa continued receiving more investments in the later period, which translated into higher living standards at present. Fenske (2015) shows that the provision of education in French Africa reduced the incidence in polygamy and schooling in the long-run. Lowes and Montero (2018b) show that quality, as well as the quantity, of public goods, mattered in the colonial setting. Collateral effects of medical campaigns in French Central Africa had negative consequences for people's trust in health initiatives today.

The second, significant aspect that the literature has considered when studying the impact of colonialism is the effect of transport infrastructure. Scholars have mostly analyzed the role of railways in erstwhile colonies, and they have done so with different methodologies and approaches. A first strand shows how railroads that were built by the colonial governments increased market access in the hinterland, thus opening up large fertile areas for commercial agriculture and fostering agglomeration. Jedwab and Moradi (2016) provide evidence on how colonial railroads in Ghana significantly contributed to the export-driven cocoa production boom. Similarly, Jedwab, Kerby, and Moradi (2017) study the effect of railway construction in Kenya where, similarly to Ghana, colonial infrastructure opened the highlands to commercial cultivation in this case in favor of European settlers. In both cases, railroad construction led to fast urbanization along the tracks, and the effect persisted until present despite the demise of the networks and, in the case of Kenya, the expulsion of the settlers. Okoye, Pongou, and Yokossi (2019) point out how, although an agglomeration effect of railroads can also be identified for colonial railroads in Nigeria, this was heterogeneous across the area, with land-locked areas showing larger coefficients and coastal ones displaying more marginal effects.

A few studies have looked at the economic effect of colonial infrastructural development in Africa through social savings methodology, which was pioneered by Fogel's work on the US railway network (Fogel, 1964). Chaves, Engerman, and Robinson (2014) measure the advantage brought about by the introduction of railroad transportation in British West Africa. They find that the introduction of wheeled transportation did translate into substantial social savings for the region, but that this technology was not introduced before the colonial era due to the impossibility for the African states to obtain the necessary capital to finance the initial investments. Bogart and Chaudhary (2013) estimate Total Factor Productivity (TFP) and social savings for Indian railroads during the colonial period and find a significant and

positive impact of transport infrastructure on these two indicators. With a similar approach, Herranz-Loncán and Fourie (2018) look at the effect of railways on the Cape Colony's economy and find a significant role of transport infrastructure in raising labor productivity as well as the profitability of the mining sector.

Finally, a few works look at the role that colonial transport facilities played in fostering market integration across European oversea dominions. In his seminal paper on this topic, Donaldson (2018) shows the role of British railways in fostering price convergence in India. In the same vein, Burgess and Donaldson (2010) offer some evidence on the relieving effect that railroads provided during the occurrence of famines in colonial India. Andrabi and Kuehlwein (2010) also find a significant and negative effect of colonial railroad construction on price dispersion, although, they argue, this was relatively small if compared with the effect of political unification.

2.3 Economic geography and transportation

By looking at the effect of Italian roads in the Horn of Africa in Chapter 3, this research relates to the literature that studies the determinants of the distribution of economic activity across space and over time and, more specifically, to the one that has looked at the effect of transportation infrastructure in historical perspective. This thesis contributes to this strand of the literature by studying the agglomeration effects of paved roads. Related works, in fact, have either looked at the long-lasting effect of railroad construction on the distribution of economic activity, or of rural roads on market integration and welfare. Little research exists on the medium and long-term impact of paved roads on agglomeration in poor countries.

2.3.1 The *first vs second nature advantage* debate

By looking at the effect of transport infrastructure, my work relates more generally to the literature that has debated the relative importance of location fundamentals and man-made advantages. While it is apparent how economic activity spreads unevenly across space (Rosés and Wolf (eds.), 2019), in fact, scholars debate the determinants of this unequal distribution. The challenge is to understand the relative importance of location fundamentals *vis á vis* agglomeration and congestion forces, as well as their interaction with man-made facilities (Partridge, 2010). In other words, the extent to which *first nature* advantages can be altered

by *second nature* ones, if one follows the categorization proposed by Krugman (1993).

Rappaport and Sachs (2003), for instance, highlight the importance of the "coastal effect" in explaining the distribution of the economic activity across the United States. Being located along the coast, they argue, raises both the productivity and the quality of life thus fostering agglomeration. In the same vein, a recent series of papers has highlighted the rapid recovery of economic activity in locations that were heavily bombed in Japan, Germany, and Vietnam, thus suggesting a predominant role of location fundamentals in shaping economic geography and in allowing a remarkable resilience of the spatial equilibrium to large negative shocks (Davis and Weinstein, 2002; Brakman, Garretsen, and Schramm, 2004; Miguel and Roland, 2011). By using granular settlement data from nineteenth-century Saxony, Ploeckl (2012) formally studies the relative importance of location fundamentals and changes in market access and shows a predominant role of geography, thus emphasizing the substantial persistence of urban location.

To the other end of the spectrum, a second strand of the literature has looked at sources of exogenous variation to emphasize how man-made advantages and temporary policies can persistently alter the distribution of economic activity. This strand of the literature has mostly followed the theoretical framework provided by the New Economic Geography theory (NEG), developed by Fujita (1988), Krugman (1991) and Venables (1996), to account for the persistence of temporary shocks. This model combines concepts from economic geography and trade theory to explain the distribution of economic activity across space. In particular, Krugman's seminal paper (Krugman, 1991) proposes a two-region model to incorporate the interplay between centripetal and centrifugal forces in shaping industrial location when trade connections are in place and transport costs are low. One key implication of the model is that due to productivity advantages linked to specialization and economies of scale, agglomeration would trigger increasing concentration despite congestion costs. The model allows for the existence of different spatial equilibria in the distribution of economic activity, which might lead to permanent changes if exogenous shocks or targeted policies provide a small advantage to specific locations that can subsequently be reinforced by agglomeration dynamics.

A series of papers that exploits the dismemberment of Germany after World War II as a "quasi-natural experiment" shows how temporary shocks can re-organize economic activity persistently. In fact, both the relocation of Germany's main airport hub from Berlin to Frankfurt (Redding, Sturm, and Wolf, 2011) and the construction of the Berlin wall (Ahlfeldt

et al., 2015) led to persistent long-term effects on air traffic and house prices, respectively. Redding and Sturm (2008) look at the decline in the market potential that the drawing of the West-East Germany border imposed on cities located next to it and find a significant and persistent impact on population growth rates. In line with this strand of the literature, Bleakley and Lin (2012) show how agglomeration forces and, more specifically, the capacity of existing cities to coordinate the concentration of new activities, can create path dependency and thus maintain higher levels of economic activity even after the specific geographical advantage that had made settlement thrive in the first place (in their case portage sites next to waterfalls in the US) has become obsolete. Henderson et al. (2017) look at the economic geography of more and less recently developed countries and find significant differences between the two groups. Countries that experienced structural transformation after the transport revolution tend to show higher spatial inequality, a result that further stresses the role of second nature advantages in shaping the distribution of economic activity. Complementary to this contribution is the work by Michaels and Rauch (2018) that compares urban re-organization in Britain and France after the end of the Roman occupation of the British isles. They show how path dependency might trap people in places with obsolete location fundamentals, in line with Nunn and Puga (2012) and Bleakley and Lin (2012). Other than being resilient to economic shocks, cities play a pivotal role in reinforcing agglomeration economies through positive externalities and productivity spillovers (Venables, 2011; Duranton, 2015; Combes et al., 2012, see also Melo, Graham, and Noland (2009) for a review of the literature), while population density is generally associated with higher productivity, as pointed out by Ciccone and Hall (1996).

The importance of agglomeration forces in shaping the economic landscape is further stressed by regional studies that look, in historical perspective, at the initial determinants of manufacturing locations. Since the seminal work of Harris (1954), scholars have tried to disentangle the relative importance of factor-endowment driven comparative advantage in a pure Hecksher-Ohlin framework *vis á vis* the role of market access according to the New Economic Geography model. Rosés (2003) and Martinez-Galarraga (2012) pinpoint how access to markets and increasing return to scale played a key role, alongside factor endowments in shaping regional industrialization in Spain. Similarly, Klein and Crafts (2012) emphasize the predominant role of market potential in determining the industrial location in the US, while Missiaia (2016) links market access to regional development in Italy.

2.3.2 Transport infrastructure

By reducing transport costs and, thus, making the exploitation of economies of scale possible, transport infrastructure, for instance roads and railroads, plays a central role in shaping the distribution of economic activity across countries and regions. Several contributions have studied this issue from different angles, but mostly relying on reduced-form equations that explain economic concentration through different proxies for access to transport infrastructure. Redding and Turner (2015) describe the theoretical model and review the literature.

Importantly for my research, development through transport infrastructure was arguably the most critical investment policy that was implemented consistently by the different colonial powers across the globe (Chaves, Engerman, and Robinson, 2014). Colonialism and infrastructural development are, therefore, tightly linked. While adding to our understanding of the economic effects of colonialism, Chapter 3 also more narrowly contributes to this body of research. In fact, it exploits the quasi-random placement of Italian roads in the Horn of Africa to study the causal effect of road infrastructure on agglomeration in developing countries, an issue which has not been adequately addressed by the literature.

Markets must be integrated to allow an efficient allocation of resources that exploits the comparative advantage of each region. The degree of integration is revealed the level of price convergence (O'Rourke and Williamson, 2001; Shiue and Keller, 2007; Federico, 2007). Transport infrastructure plays a pivotal role in the process of market integration. Burgess and Donaldson (2010) have focused on the impact of railways construction in colonial India. They employ district-level panel analysis to measure the effect that improved inter-district connection had on limiting the outbreak of famines and find that districts connected by railways were less likely to be severely affected. Always looking at colonial India, Donaldson (2018) finds that railroads fastened the process of market integration and increased the levels of income, while Andrabi and Kuehlwein (2010) object that the impact of railroads on the reduction of price dispersion across the Indian subcontinent was relatively small and that the stronger market integration was instead related to the political unification that took place in coincidence with the building of the network. Roads also have a substantial effect on market integration as measured by price elasticities and city growth (Limao and Venables, 2001; Storeygard, 2016).

By reducing transport costs, access to infrastructure (and markets) can foster agglomer-

ation and change the specialization of connected locations. Chandra and Thompson (2000) examine the effect of the US highway network on earnings and find a positive association between access to infrastructure and income. Michaels (2008) shows that the expansion of the US highway system triggered an increase in trade-related activities in counties that were connected by the network, thus testing the predictions of the Hecksher-Ohlin model. His empirical approach deals with the potential endogenous placement of the road infrastructure by exploiting random placement between termini, a strategy that has been largely employed by the later literature. Allen and Arkolakis (2014) also consider the effect of the US interstate highway system and find a positive effect of connectivity on welfare. Gibbons et al. (2019) study the effect of the improvement of pre-existing road infrastructure in contemporary Britain and find a positive effect of improved transport facilities, industrial establishments, rates of employment, and labor productivity in connected locations.

While attracting economic activity from non-connected locations and spurring faster urban growth, highway networks can also lead to a substantial relocation between sites along the network. Baum-Snow (2007) looks at how existing cities crossed by the US highway network fared in terms of growth rates relative to similar urban centers that were not connected and finds a substantial reduction in growth rates due to suburbanization. In related work on China, Baum-Snow et al. (2017) find a similar centrifugal effect of highway systems on urbanization, with firms relocating farther away from the city center, a result mirrored by empirical evidence from the Spanish highway network (Garcia-López, Holl, and Viladecans-Marsal, 2015). In the same vein but with almost opposite results, research by Faber (2014) reveals how the highway network in China triggered de-industrialization in areas that happened to be connected by the network because situated between targeted poles.

With respect to countries in an early phase of development, convincing evidence also exists on the agglomeration effects of railroads. The link between access to railroads, faster urbanization and persistently higher levels of economic activity after the "first mover" advantage in transportation was lost has been established for the United States (Atack et al., 2010), Sweden (Berger and Enflo, 2017) and Prussia (Hornung, 2015), respectively. Tang (2014) looks at nineteen century Japan and shows a redistributive effect of the railway network in terms of location of the manufacturing activity, as well as a differentially higher increase in the share of jobs in manufacturing in those peripheral areas that were populous but located at a greater distance from the industrial core of the country. Donaldson and Hornbeck (2016) build on

these contributions by directly measuring changes in market access linked to the expansion of the US railway network and find that access to the network led to a substantial increase in land prices in treated locations. These empirical findings echo those presented in related work on India, where Donaldson (2018) finds a significant increase in income in districts connected by the colonial railway network.

With respect to the colonial context and, more specifically, the African one, only a few contributions have examined the impact of transportation infrastructure. The recent work by Jedwab, Kerby, and Moradi is a noticeable exception, and the most closely related to my research. Jedwab and Moradi (2016) find that railways that were built in Ghana during the colonial period triggered population growth and urbanization along the new lines due to the boom in the cultivation of cocoa, whose marketing was facilitated by the new infrastructure. Their research also reveals how the new spatial equilibrium persisted until present due to the coordination effect on subsequent investments, that the old railroad network exerted despite its demise in the post-colonial period. Exploiting a similar setting, Jedwab, Kerby, and Moradi (2017) find comparable results for Kenya, where the denser spatial equilibrium along the railway network that formed during the colonial period survived the expulsion of the settlers and the demise of the network, thanks to colonial sunk investments and to cities that acted as coordination devices for the location of factors in the post-colonial period.

Finally, if colonial railroads have received some attention, not much has been written about the impact of roads, and specifically colonial ones, in developing countries. Although research on the medium and long-run effects of road infrastructure and explicitly focusing on agglomeration effects is lacking, some evidence exists on the economic effect of roads in developing countries. Bogart (2009) studies the effect of proximity to improved roads on land prices and finds a positive association for nineteen-century England. Research in development has looked at the effect of rural roads in improving living standards (Dercon et al., 2009). Ghani, Goswami, and Kerr (2016) find a positive association between highway construction and the growth of the manufacturing sector in India. In the same vein and context, Aggarwal (2018) exploits a rural road construction plan in contemporary India to study the effect of rural paved roads on well-being. He finds a positive effect of rural paved roads on a variety of development indicators and, most interestingly, educational attainment. Storeygard (2016) examines the effect of being connected to the road network in post-colonial Africa and finds a substantial effect of lower transport costs (proxied by proximity to the network) on urban

and income growth across a sample of countries. Banerjee, Duflo, and Qian (2012) look at the economic effect of proximity to roads on GDP growth in China and find a moderate positive effect of transportation infrastructure on economic development.

2.4 Agriculture

Chapters 4 and 5 examine the effect of the settlement and removal of Italian farmers in and from Libya, respectively. Thus, they engage with both the economics literature on agricultural development and the historical one on African agriculture. I contribute to these two strands in three main directions. First, by shedding light on the consequences of the settlement of Italian farmers and of their removal on the Libyan agricultural sector, I add to the economic history of the region. Second, by using Libya as a case study to unveil the effect of the settlement and the removal of European farming minorities from erstwhile colonies, I expand our understanding of the more general history of settler colonialism. Third, I also add to the literature on the determinants of agricultural productivity by using the Libyan case study as a quasi-natural experiment to identify the effect of the settlement and removal of farming elites from a developing country, in this way shedding light on the role of human capital and spatial spillovers in agricultural development.

2.4.1 Causes and consequences of agricultural productivity

The literature highlights the link between agricultural innovation, productivity gains, and structural transformation (Federico, 2005). My thesis adds to the literature on agricultural development by providing evidence on the effect of the settlement and removal of farming elites. In particular, Chapter 4 examines spatial productivity spillovers in a context of high inequality among farmers, while Chapter 5 focuses on the expulsion of Italian settlers thus plausibly identifying the impact of a negative shock in human capital. As the body of work on the subject is extensive and multidisciplinary, this section only reviews the main works relevant to the economic history of agricultural innovation in developing countries.

Allen (2009), for instance, describes how productivity gains in agriculture provided the labor surplus that was needed to fuel the first example of modern economic growth, namely the British industrial revolution. Federico (2005) provides an overview of the economic history of agriculture. He describes the drivers of agricultural innovation and structural transformation

in the long-run. This contribution gives useful context for the study of Italian agricultural policies in Africa as well as insights on methodological issues. In their seminal book, Hayami and Ruttan (1985) develop a theoretical framework to study the determinants of productivity gains in agriculture in developing countries and stress the importance of induced labor-saving technological innovation in achieving high efficiency. Along the same lines, several other contributions put the accent on the link between technological innovation in agriculture and the ignition of the process of structural transformation (Bustos, Caprettini, and Ponticelli, 2016; McArthur and McCord, 2017), although Foster and Rosenzweig (2004) warn from generalizations as they find that agricultural innovation did not foster industrialization in rural India, due to the skill-biased characteristics of technical change in the primary sector. Along the same lines, Hornbeck and Keskin (2015) contend that increased agricultural productivity does not necessarily lead to a localized increase in non-agricultural activities. Fiszbein (2017) complements these works by showing the link between agricultural diversification, complementaries with the manufacturing sector and structural transformation.

Human capital plays a central role in agriculture by facilitating the adoption of new technological innovations and thus leading to higher productivity (Lin, 1991; Wozniak, 1993; Abdulai and Huffman, 2005). Capacity to adopt new technologies is often proposed as the main channel through which education affects the primary sector (Huffman, 2001). By looking at the case of the US at the beginning of the 20th century, Parman (2012) offers historical micro-level evidence of the effect of schooling on agricultural productivity in Iowa and also shows positive productivity spillovers among neighbors, thus stressing the role of imitation in the spreading of agricultural practices. Diffusion of technology and agricultural practices is, in fact, another fundamental aspect of agricultural development alongside the drivers of initial adoption. Conley and Udry (2010) show that farmers in Ghana are more likely to adopt new agricultural techniques and technology if they observe successful implementation by their neighbors, while Bandiera and Rasul (2006) study the effect of social networks in technological adoption in Mozambique and find heterogeneous effects by proximity in the network and level of individual education. Fourie and Von Fintel (2014) describe how the wine-making skills imported by the French Huguenots to the Cape Colony improved the performance of the local wine industry, in line with the literature that has emphasized the link between human capital and productivity (see for instance Hornung (2014)). These contributions are consistent with the evidence provided by Foster and Rosenzweig's seminal work on the link

between human capital and agricultural productivity, and more specifically with the idea of the existence of increasing returns to education in periods of rapid technological change (Foster and Rosenzweig, 1996; Foster and Rosenzweig, 1995). By looking at India and, specifically, at the migration of skilled farmers after the partition of India and Pakistan as a source of exogenous variation, Bharadwaj and Ali Mirza (2019) show that districts that received more educated migrants performed better in terms of adoption of new technologies and agricultural productivity after independence.

The literature has also emphasized the importance of mechanization and the determinants of its successful adoption in determining productivity differentials both within and between countries. Olmstead and Rhode (2001) look at the systematic introduction of mechanized agriculture in the United States and the productivity gains that this allowed. In more recent joint work, however, they also emphasize the pivotal role of biological innovation in boosting the production of wheat in the 19th century US (Olmstead and Rhode, 2002). Libecap and Hansen (2002b), always looking at the US, study the adoption of dry-farming cultivation techniques on the frontier and stress the difficulties of adapting agricultural practices to new climatic conditions. Hornbeck and Naidu (2012) add to our understanding of the determinants of machinery adoption by showing how the cheap black labor available in the South of the United States and the downward pressure on wages that this exerted slowed down mechanization and technical innovation significantly, thus identifying the role of factor prices. Significant contributions have also examined the importance of quality of land tenure systems in developing countries and, in particular, African ones in explaining the pace of technological innovation in agriculture. Consistently with the described literature, these works emphasize the positive link between the two (Deininger and Jin, 2006; Gebremedhin and Swinton, 2003).

A second strand of the literature has looked more closely at the structural causes of agricultural productivity and, namely, at access to markets. Kopsidis and Wolf (2012) and Martinelli (2014) explore the relationship between size of and proximity to urban markets and agricultural productivity. These contributions find, for Prussia and Italy respectively, that a Von Thunen model incorporating the demand for agricultural products (measured by market potential) largely explains the variation in agricultural productivity across regions. In the same vein, Vandercasteelen et al. (2018) show a positive impact of proximity to urban markets on agricultural productivity in Ethiopia. Consistently with this model, several contributions pinpoint the link between agricultural productivity and access to transportation facilities. For

instance, Aggarwal (2018) shows the positive impact of access to all-weather roads and the adoption of better agricultural technology, while Donaldson and Hornbeck (2016) point out how the expansion of the railroad network in the United States increased the value of the land in better connected counties. Finally, a few empirical studies have attempted to specifically unveil the dynamics of Ethiopian agricultural production in relation to transportation and marketing opportunities. Dercon et al. (2009) analyze the impact of road building, technological innovation, and the capacity to alleviate the effects of famines, while Shiferaw et al. (2015) emphasize the importance of having access to transportation infrastructure for agricultural production.

2.4.2 African agricultural history and the effect of colonialism

With respect to the historical literature on agricultural development in Africa and, in particular, to those contributions that have looked at the pre-colonial and colonial periods, it should be noted that the empirical work is very limited mostly due to the scarcity of the available data (see Michalopoulos and Papaioannou (2018) for a review). The effect of colonial agricultural policies on the indigenous farming sector is not well understood, and quantitative research on the subject is lacking. The Libyan case study sheds some light on the transformations brought about by colonial policies and, in particular, by the settlement and removal of European farmers.

A few contributions have provided insights on the agricultural and economic history of pre-colonial Africa, with a particular focus on West Africa. Cappelli and Baten (2017) look at legitimate trade in Senegambia and find a positive relationship between market opportunities (provided by the legitimate trade between Europeans and African polities) and human capital accumulation. In his work on the relation between factor endowments and economic activity in West Africa, Austin (2008a) confirms Hopkins (1973) theory on how factor-ratios and, specifically labor scarcity *vis á vis* relative land abundance, explain the peculiar economic and institutional developmental path of the region that was characterized by labor-saving cultivation techniques. Austin also emphasizes the great flexibility in the employment of labor in both agriculture and manufacturing and the use of extensive agriculture as a labor-saving technique to compensate for labor scarcity. A very influential work that reflects on the relationship between the density of factors and productivity in agriculture from a historical perspective is the research by Boserup (1965) that pinpoints the effect of demographic pressure on farm-

ing intensity and yields. Lovejoy (2011) addresses the issue of the extensive employment of African slaves in local plantations after the abolition of the trade, in 1807, and the further transformations brought about by formal colonialism. Roberts (1987), while reconstructing the economic history of the Niger valley, sheds some light on the relationship between the slave trade, its abolition, and the consequent transformations in the African modes of production, with a particular focus on the changes that the abolition of slavery caused in terms of labor supply and production techniques in agriculture. Pankhurst has produced a complete account of the economic and agrarian history of Ethiopia from the middle age up to the Italian invasion of 1935 (Pankhurst, 2012). McCann (1995) describes the agricultural history of Ethiopia between 1800 and 1990 by focusing on selected case studies. This contribution builds on his previous research on the relationship between agricultural modes of production and famines between 1900 and 1935 (McCann, 1987). Other contributions that examine the topic of agricultural production and reform in modern and contemporary Ethiopia are the works by Bekele (1995) and Zewde (2001).

The transformations driven by colonial policies in the African agricultural sector have been studied more systematically. Austin looks at the development of cash crop agriculture in West Africa (Austin, 2005; Austin, 2009; Austin, 2014) and emphasizes the link between the abolition of the slave trade, colonial land-tenure systems and the take-off of cash crop production, in particular of cocoa in Ghana. In the same vein, De Haas (2017) shows how the systematic adoption of cotton cultivation in colonial Uganda allowed local farmers to maintain relatively high standards of living until the early post-colonial period. Tadei (2018) finds a positive association between the gap in international prices and producer prices paid throughout the colonial period in West African on long-run development, thus testing the famous hypothesis by Bates (1983) on the extractive nature of colonial and post-colonial trade institutions. Havinden and Meredith (1993) analyze in detail some of the grand agricultural schemes implemented by the British imperial government, such as the Tanganyika groundnut scheme. In a series of papers, Fenske has explored more specifically the role of property rights in agricultural production in West Africa during the colonial period and has found a positive association between more secure property rights and the development of commercial agriculture (Fenske, 2014b; Fenske, 2014c; Fenske, 2011). Finally, Woods studies cocoa production in Ivory Coast (Woods, 2003), and Ghana (Woods, 2004) and identifies a positive correlation between the profitability of the commercial agricultural sector and rent-seeking behaviors of

the local elites.

Two recent papers have employed micro-level data to study the long-lasting effects of colonial extractive plantation systems on development and are, therefore, methodologically and thematically more closely related to my own work on Libya. Lowes and Montero (2018a) show that rubber concessions in Congo, where indigenous farmers were exploited and no productive investments were implemented, caused a significant and persistent worsening of African welfare in the affected areas. They find that the effect runs through three main mechanisms, namely, the appointment of chiefs, which led to the persistence of despotic local institutions, violent practices and coerced labor that were employed by the European personnel. Dell and Olken (2017) look at the case of sugar plantation (and processing) in Dutch Java. Despite looking at a different continent, their work is relevant to my research in that it studies the effect of colonial agricultural schemes that also entailed some form of capital investment alongside the exploitation of the local population, a situation somewhat comparable to colonial Libya. They find that, as the colonists had to invest in manufacturing plants and transport infrastructure to make the business profitable, this led to a positive long-term effect on several development indicators, notwithstanding the widespread use of coerced labor.

2.4.3 Settler agriculture

By looking at the effect of Italian agricultural settlement in colonial Libya, my study focuses decisively on a settler economy, in other words, an African country that experienced substantial European settlement (see Cavanagh and Veracini (eds.) (2017) for an overview of the phenomenon). Thus, my research contributes specifically to the literature that has looked at similar contexts across Africa. In fact, little empirical work exists on the effect of white farming, and even less is known about the consequences of large-scale expulsions of European farmers in the post-colonial era. By adding some quantitative evidence on the effects and the mechanisms set in place by Italian settlement in Libya, therefore, this thesis contributes to the existing literature on the agricultural history of African settler colonies.

A first attempt to rationalize the relationship between the establishment of settler agriculture and the performance of the traditional African one was attempted by Arrighi who, in a series of essays on the subject, emphasized how the colonial state openly implemented policies targeted at diminishing indigenous farmers' productive capacities (and thus obtaining

cheap labor) by pushing them onto peripheral, infertile land in colonial Zimbabwe (Arrighi, 1967; Arrighi and Saul, 1973). In this sense, Arrighi's work echoes the description of the French exploitative land policies in colonial Algeria, provided by Sartre (1964). Bundy (1979) and Palmer and Parsons (eds.) (1977) emphasize the fall in living standards that followed the process of land expropriation and the creation of reserves for black South Africans. These contributions significantly influenced subsequent research, which often identified a causal relationship between the resource extraction operated by the settlers and the drop in the productive capacity of the African peasants.

Mosley's comparative book on Kenya and Zimbabwe (Mosley, 1983) partially departs from this strand of the literature. The author questions whether colonial policies in settler colonies actually diminished yields in the African reserves by invoking Boserupian dynamics linked to population density increases and labor-intensive production techniques. However, he also maintains that the political economy of settler colonialism was chiefly targeted at providing cheap labor for the colonists. In both countries, he argues, the white elites actively used political power to reduce indigenous productivity and increase the labor supply to remain competitive in the internal and external markets at the expense of African producers. The works by Phimister (1988) on Zimbabwe and Feinstein (2005) on South Africa are complementary to Mosley's research and show how both colonies put restrictions to land access and labor mobility for African cultivators in place to guarantee a steady and cheap labor supply to the white mining and agricultural sectors.

A few country-specific studies emphasize the capacity of groups of African farmers to take advantage of the market opportunities offered by settler economies, thus creating a wealthy class of commercial farmers, despite the described discriminatory policies. Heywood (1987) argues that, in central Angola, Ovimbundu maize farmers managed to achieve high levels of profitability in the early twentieth century. Shutt (2002) emphasizes how the thriving land market in combination with the flexible production strategies allowed the African smallholders in the Purchase Areas of colonial Zimbabwe to take advantage of the peculiar factor ratios and market incentives to increase their wealth.

Some recent studies have deepened our understanding of country-specific agricultural history further and, specifically, have enhanced our understanding of the settlement process of white minorities. Frankema, Green, and Hillbom (2016) look at the case studies of Tanganyika, Nyasaland, Zimbabwe, and Kenya and find that the success or failure of white farm-

ing was endogenous to the local environmental conditions that affected the first settlement attempts. In the same vein, Maravall Buckwalter (2019) describes the process of adaptation of both institutions and agricultural cultivation techniques that French settlers in Algeria had to adopt to cope with changing factor endowments during the expansion of the frontier. By stressing the role of local conditions in determining the type of agricultural system in place, these works remind of those contributions that have emphasized the role of factor endowments and geography in shaping the long-term institutional (Sokoloff and Engerman, 2000) and land inequality (Frankema, 2010b) trajectories.

Hodge (2007) focuses on the last two decades of the British colonial rule in Africa and analyzes the work and the limits of the agrarian experts that tried to implement agricultural schemes in the colonies. Rupert (1998) describes the history of tobacco farming in Zimbabwe during the colonial period, whereas Curtis (2003) focuses on the relationship between peasants and colonial administration in Tanganyika. A few papers (Green, 2007; Bolt and Green, 2015; Orr, 2000; Palmer, 1985), have looked at the case of settler farming in Malawi and the economic dynamics that led to the failure of settler farming in the region. With respect to Kenya, two contributions by Anderson are essential for the understanding of the modes of production during the colonial period (Anderson, 2000) and for the analysis of the effect of the depression of the 1930s in East Africa (Anderson, 1984). Makana (2009) sheds light on the constraints imposed by the colonial institutions on indigenous coffee cultivation in Kenya, in the attempt to favor white colonists. Finally, Larebo (1994) provides an insightful study on the agricultural practices adopted by the Italians during the 5-year occupation of Ethiopia and emphasizes the high degree of flexibility of the process that involved several examples of share-cropping arrangements between Italian and Ethiopian farmers despite the clear-cut distinction proposed by the fascist regime's propaganda.

2.5 Historiography of Italian Colonialism

The historiography of Italian colonialism did not take part in the described cliometric revolution in African studies. Moreover, with only a few noticeable exceptions, the scholars who have worked on the subject approached it from either a political or a cultural angle. The economic history of Libya and the Horn of Africa was, therefore, largely ignored by Italian scholars as it was the evaluation of the effect of Italian policies on the erstwhile colonies. In

other words, data are largely missing from the debate. My research brings Italian colonialism into the cliometric literature on African history where it should belong and concerns itself with evaluating the effect of the flag policies of fascist Italy in Africa. Moreover, my work adds to this body of literature by identifying and measuring with quantitative methodologies some aspects of the economic legacy of Italian colonialism in Libya and the Horn of Africa.

The development of a modern historiography on Italian colonialism was a long process due to the entanglement between African studies and state colonialism that characterized the Italian experience. Politics, in fact, influenced the studies on the subject from early on. The early contributions on the various aspects of the Italian colonial experience in Africa had a strong propagandistic flavor both in the "liberal" (1882-1922) and "fascist" (1922-1943) eras of Italian colonial expansion. During these successive periods, an array of pseudo-scientific works were published by a number of scholars from different disciplines. Although some of these contributions were the product of careful research based on the available data (and to a certain extent reach a level of detail that was not achieved by the post World War II historiography), most of them tend to be severely biased in favor of the Italian colonizing effort and to uncritically present colonial policies under a good light. This tendency was particularly exacerbated during the government of Benito Mussolini (1922-1943), who used colonial studies as a propagandistic tool. Often, these works were published by public institutes or the army, always with the more or less explicit approval of the government. Nevertheless, if expunged of their propagandistic tone, these works constitute valuable resources for the study of the subject, especially considering the rich cartographic material they contain and the fact that they often rely on archival data that have often been lost due to the vicissitudes underwent by the Italian colonial archives during World World II.

Without trying to provide a comprehensive report of the entire body of literature that was published throughout the "active" phase of Italian colonialism (a more comprehensive survey can be found in Labanca (2002)), some critical contributions employed in this study deserve attention both because of their cultural significance and their value as primary sources.

2.5.1 The colonial period

The early phases of the Italian colonial expansion in Africa were covered with particular attention for its political and military history and for the ethnographic and geographical characteristics of the new colonies. The monograph collecting the periodical bulletin of the

Italo-Ethiopian war of 1885-7 (Various, 1896) is an excellent example of this new approach that aimed to satisfy the growing demand for narrative accounts of the Italian expansion in Africa. Other notable works from this period featured regional studies on the individual colonies (see for instance Rossetti (1920) on Somalia, Cecchi (1911) on Eritrea).

Sillani and Pistolese's work (1932) on the progressive occupation of Libya and Stefanini's historical overview (1929) of the Italian presence in Africa are examples of retrospective studies of the early phases of the colonial expansion, dating from the fascist period. Besides the narrative accounts on the occupation process and the regional studies of individual colonies, a rich literature also exists that stemmed from the long-standing tradition of Italian geographical and ethnographic studies. The volume "L'Africa Italiana" (Reale Societá Geografica Italiana, 1936), edited by the Royal Geographic Society, presents a comprehensive summary of the exploration activities and the publications that were carried out by Italian explorers and researchers in Africa. Cipriani's work (1936) provides a review of the ethnographic studies by Italian authors and focuses chiefly on the Horn of Africa.

Furthermore, and with a narrower focus on one of the central topics of this thesis, several interesting pieces of research were published from early on, to explore the potential for agricultural development in Libya. Good examples of this latter type of publications are the surveys of Franchetti (1914), Nitti (eds.) (1912) and Bertolini (1913) that provide a comprehensive first-hand analysis of agricultural production in Tripolitania in the immediate aftermath of the Italian occupation. The later work by De Cillis (1920) draws from these contributions and adds to them by portraying the situation a few years after occupation. The salient element that emerges from these studies that preceded the array of publications that coincided with the period of fascist agricultural development of Libya (and, to a lesser extent, in Oriental Italian Africa) is the level of complexity and diversification in the Libyan agricultural sector that undoubtedly exceeded the denigratory descriptions proposed by later authors with the explicit intention of making a case for Italian farming against indigenous one.

The growing interest for agricultural development in Libya and, ultimately, the invasion of Ethiopia in 1935-6 triggered an additional expansion in the editorial activity on the subject. The tradition of agronomic research continued in the 1930s with the contributions of Morgantini, Maugini, and Piccioli. Morgantini's work (1934; 1938) on the state of the Tripolitanian agriculture at the beginning of the 1930s remained a vital source also for the later research carried out under the British military administration. Maugini's monograph on the indigenous

agriculture represents a valuable addition to the early surveys cited above (Maugini, 1931). Finally, in his books "La rinascita della Tripolitania" (Piccioli, 1926) and "La nuova Italia d'Oltremare" (Piccioli, 1934), Angelo Piccioli describes with great level of detail and several maps the public works completed and the progress made in terms of settlement of white farmers in both Cyrenaica and Tripolitania. Manetti's work on Ethiopia attempts a similar analysis of the opportunities for agricultural development in the newly acquired Ethiopian empire (Manetti, 1936). In the last years of the Italian agricultural settlement schemes in Libya, many short and typically celebratory publications of the government's action in fostering intensive agricultural settlement appeared, mostly coupling data collected from the above-mentioned studies with new information on the agricultural villages developed within the framework of the phase of "demographic colonization" (see for instance Ballico (1939)). The latter was probably the only initiative that received also significant attention from abroad (Moore, 1940), with the only relevant exception of educational policies in the Horn of Africa (De Marco, 1943).

The literature on the Horn of Africa had a specular expansion following the occupation of Ethiopia in 1936. These new publications largely served a propagandistic purpose and praised the achievements of the fascist regime while emphasizing how the new territories would bring significant economic advantages to Italy. The work by Sillani (1937), Cobolli-Gigli's monograph on the construction of roads in the Horn of Africa (Cobolli-Gigli, 1938), along with the monographs by Badoglio (1937) and Graziani (1938) are representative examples of this strand of the literature and provide excellent qualitative descriptions of the road construction undertaken by the Italian army during and after the Ethiopian war. Other important works containing interesting cartographic material are the publications of the "Instituto Geografico Militare" (1939), the "Reale Societá Geografica Italiana" (1936) and Corni's work on Somalia (1937).

Periodicals also represented an important outlet for a more technical discussion of the progress made by Italian colonists in Africa and contain important information. The series "Gli Annali dell'Africa Italiana" (Piccioli (eds.), 1937–1943) is probably the most significant of this type of publications. This magazine was a quarterly publication of the Ministry of the Colonies, it was directed by Angelo Piccioli and was published between 1937 and 1943. In particular, the issues three & four from 1939 and one & two from 1940 contain the most coherent attempt to list and describe, albeit with a robust propagandistic purpose, the

investments made by Italians in the Horn of Africa, with particular emphasis on public works, investments in education and agricultural projects.

The series "Rassegna Economica delle Colonie" (Ufficio Studi, 1928–1937), from 1937 on "Rassegna Economica dell'Africa Italiana" (Ufficio Studi, 1937–1943), also constitutes a valuable source. Besides the statistical bulletin, the periodical features some articles of particular relevance for my research. Some contributions are, in fact, important for the understanding of the agricultural policies implemented in both Libya and Horn of Africa. Particularly interesting to this end are the articles by Moreno (1937), and Prinzi (1937a; 1937b). Some other contributions look at the development of new plantations and the programmatic settlement of white farmers (Stefanini, 1938), while a few articles provide an overview of the execution and planning of the major infrastructural works in AOI and their value (Nava, 1938; Cobolli-Gigli, 1937; Marchitto, 1940; Saitta, 1941).

A third important periodical source is the "Bollettino Statistico dell'Africa Italiana" (Ufficio Studi, 1938–1943), which contains prices, quantities of traded commodities, and demographic information at the municipal level, with particular detail for Libya. Other periodicals, also mostly focusing on Libya, were printed by the local governments to spread agricultural knowledge across the Italian African territories. Examples are the "Notiziario economico della Tripolitania" (Governo della Tripolitania, 1928–1932?) and the "Il lavoro coloniale" (Comitato Coloniale Intersindacale, 1935–1943?), which provide rich information on the economic life in the colonies.

2.5.2 The historiographical debate after World War II

After the end of World War II, there was a tendency to continue the study of the history of Italian colonialism from a benevolent perspective. This propensity was due to the cultural hegemony that the former colonial establishment played during the early phase of the republican regime. Due to the peculiarly late development of the Italian colonial empire, in fact, the most significant events related to the Italian expansion in Africa had been strongly filtered by the fascist propaganda, which made both the public and the academic opinions particularly favorable to the Italian colonial enterprise. Moreover, the only group of scholars that had direct access to the archives was the old colonial establishment, which had little interest in sharing information that could have brought about criticisms on their life-time work. They were, therefore, willing to continue, in a somewhat anachronistic way, the tradition that linked

colonial studies with the colonial elite and the state.

Several works were published by members of the former Ministry of the Colonies to support the Italian claims on the former colonies. For instance, the series published by the "Istituto Agricolo Coloniale", sometimes in English, to bluntly advertise the positive effect that the Italian rule supposedly brought about in erstwhile possessions, falls into this category. These materials were published both in form of an overview (Istituto Agricolo Coloniale 1945b; 1946d) and with a specific by-country focus (Istituto Agricolo Coloniale 1946b; 1946a; 1946c; 1945a). Other examples of this apologetic view are the influential work of Ciasca (1938) which was still adopted in many universities after the war, along with the series "L'Italia in Africa", a publication in several volumes funded by the Ministry of Foreign Affairs that indirectly celebrated the initiatives of the Italian government in Africa (see for instance Maugini (1969)). Several other publications, mainly funded by the ministry of the colonies in the context of the Italian fiduciary administration of Somalia, also shared this benevolent perspective (Meregazzi, 1954).

Starting from the early 1970s, a few authors opposed this mainstream institutionalized view and started producing an analysis of the Italian process of colonization more systematically based upon sound historiographical methodologies. However, the intellectual struggle that this new generation of academics had to undertake against the conservative colonial establishment and parts of the public opinion, both very reluctant to give up the myth of Italian benevolent colonial rulers ("Italiani brava gente"), also led to cultural bias, albeit of a different type. The majority of the contributions from this second phase, in other words, sought to unveil the shortcomings and the atrocities committed by the Italians in Africa, in opposition to the apologetic position of the former colonial establishment. While this topic certainly deserves attention, this tendency left a serious discourse on the economics of colonialism and its consequences out of the picture.

Giorgio Rochat's main publications date from the 1970s (1971; 1973) and somewhat anticipated the more general interest for the subject. Especially his book, "Il Colonialismo Italiano" had a substantial impact on the following literature, being the first research to critically describe the intrinsic contradictions of the Italian colonial experience and the violent actions of the colonial government. Angelo del Boca's work is undoubtedly a second cornerstone of the historiography of Italian colonialism. His research is not only crucial for being the first to employ hitherto unpublished sources (from the Archive of the Ministry of the Italian

Africa and the Historical Archive of the Ministry of Foreign Affairs, declassified only during the 1970s) but also because of the several research branches that stemmed from it. In the first of his four volumes on the Italian colonial enterprise in the Horn of Africa "Gli Italiani in Africa Orientale", the author describes the early phase of the Italian colonialism between 1882 and the 1922 (Del Boca, 1976), while the second volume portrays the colonial fascist policy between 1922 and 1935 and the Italian-Ethiopian war of 1935-6 (Del Boca, 1979). The third volume "La caduta dell'impero" is undoubtedly the most important for my research as, before addressing the issue of the British-Italian war of 1940-1, it carries out a synthetic but insightful analysis of the administrative and economic organization of Italian Oriental Africa (Del Boca, 1986a). The fourth volume, instead, deals with the issue of the post-war cultural legacy and with the shock that the loss of the colonial possessions created in the Italian public opinion (Del Boca, 1992). Del Boca completed his analysis of the Italian colonial history by publishing a study in two volumes on the Italian colonization of Lybia, "Gli Italiani in Libia" (Del Boca, 1986b), which provides a similarly compelling political history alongside rich information on the functioning of the colonial society in the "Fourth Shore".

For Libya, Claudio Segré's contributions to its political history (Segré, 1978) and its peculiar agricultural settlement dynamics (Segré, 1974) opened new avenues of research, while providing a first detailed account of the history of the Italian agricultural settlement in the colony. Sbacchi (1985) looks specifically at the economy and the society in the Horn of Africa between 1936 and 1941. In this research, the author produces a readable overview of the colonization policies implemented in Ethiopia during the period of the Italian occupation. He highlights the peculiarities and the shortcomings of this ambitious colonization project and reaches an extremely detailed analysis, especially with respect to the agricultural colonization initiatives. By using both printed and archival sources from the Ministry of Italian Africa, he also accounts for the various stages of the Ethiopian warfare against the occupation and some key episodes of the Italian retaliation. The other significant contribution dating back to the early 1980s is the work by Goglia and Grassi (1981). As the authors themselves acknowledge, this book was intended to be a university-level manual for courses on the history of Italian colonialism. For this reason it does not reach the levels of the detailed analytical narrative of Del Boca or Sbacchi but, on the other hand, it provides an excellent explanation of the administrative system set in place by the Italian colonial administration in both Libya and Italian Oriental Africa, along with an interesting collection of essential documents.

While the work of these forerunners is of capital importance for the historiography of Italian colonialism, it is only during the late 1990s and 2000s that a real take-off of the discipline could take place. The few contributions to the economic history of the Italian colonial experience belong to this era. However, the poor state of preservation of the colonial archives, the lack of extensive data due to the relative short colonial occupation and the general tendency, in the field's tradition, to focus on the cultural and political history rather than the economic one prevented any forms of quantification of the effect of Italian policies.

A first research stream has focused on the war crimes committed by the Italian regular and irregular troops during the invasion of Ethiopia and the suppression of the patriots' resistance between 1936 and 1938. This branch, that stemmed from Del Boca's book "La guerra d'Abissinia 1935-1941" (Del Boca, 1966) is a clear reaction to the traditional hagiographic view. This publication was followed by "I gas di Mussolini: il Fascismo e la guerra d'Etiopia", which features a complete description of the systematic use of mustard-gas bombs during the war (Del Boca, 1996). Del Boca's latest work "Italiani Brava Gente?" (Del Boca, 2011) also engages with the issue of the violence committed by the Italian settlers in different scenarios. A small body of literature has followed Del Boca in studying the crimes committed by the Italian government in the colonies (Dominioni, 2008b; Randazzo, 2006; Ryan, 2015).

A second group of scholars has looked at the cultural history of Italian colonialism, for both colonized and settlers. The work of Alessandro Triulzi emphasizes the importance of looking at the facts from a more Africa-centric perspective (Triulzi et al., 2002), whereas Gianpaolo Calchi-Novati takes a more anthropological approach to the issue of the Italian colonial experience and its cultural history (Calchi Novati, 2011; Calchi Novati, 1999). Ghezzi (2003) studies the cultural and institutional background of the settlers that moved to Eritrea. More recently, Alessandro Pes has looked more closely at the cultural history of the colonial experience, especially during the Fascist period and the invasion of Ethiopia, and has pinpointed the importance of the regime's propaganda in shifting the public opinion's perception of the colonial reality (Pes, 2012). Several other contributions have explored the Italian colonial ideology and its cultural legacy in both Libya and Horn of Africa from different angles (Andall and Duncan, 2005; Lombardi-Diop and Romeo, 2012; Fuller, 1992; Ertola, 2017c; Ertola, 2017b; Ertola, 2017a; Barrera, 2003).

A third group of scholars has focused on the diplomatic and political history of the Italian colonial experience. The works of Baer (1976) and Bandini (1971) point in this direction

and provide evidence of the interest that the destabilizing aggressive decisions of Mussolini (such as the invasion of Ethiopia) raised in the academic environment. Rossi (1980), instead, looks at the post-colonial diplomatic relations that led to the independence of the former Italian colonies of the Horn of Africa. Other important works on the diplomatic history and, more generally, on the expansion of the Italian colonial possessions are Aruffo's "Storia del colonialismo Italiano: da Crispi a Mussolini" (Aruffo, 2003), which provides a brief account of the history of the Italian colonialism, as well as the more substantial works of Bottoni (2008), Pes (2011) and Labanca (2002). Both Bottoni and Labanca's books contain essential parts that look at the economic and social environment created after the fascist occupation of Ethiopia, both in terms of economic activity and administration. Another contribution that more specifically addresses the issue of the colonial administration of the Italian colonies is Dore's "Governare l'oltremare: istituzioni, funzionari e societá del colonialismo italiano" (Dore, 2013), which looks at the institutional framework and the cultural background of the administrative personnel.

From the literature reviewed so far, it is possible to notice how the majority of the contributions focus on either the political, diplomatic, or cultural history of Italian colonialism. A handful of scholars have, however, looked at specific aspects of the Italian colonial experience and their work constitutes the relevant background for this study. Toniolo (1980), in particular in chapter six, analyzes the economic history of the Italian colonial experience from a macro-perspective, thus placing Mussolini's overseas investments into the broader context of Italian autarchic policies during the fascist dictatorship. Federico (1998) provides some tentative estimates of the overall costs and benefits of the Italian colonial expansion in Africa and of its effect on aggregate growth. He concludes that, for Italy, the economic benefits from colonialism were negligible. Podestá's book "Il mito dell'impero: economia, politica e lavoro nelle colonie Italiane dell'Africa Orientale, 1898-1941" (Podestà, 2004) looks with some level of detail at the economic activities implemented by the Italian administration and provides useful background. It gives particular attention to farming activities in Eritrea and Somalia, and it describes the economic organization of Oriental Italian Africa after 1936. A second remarkable work that looks at the economic history of the Horn of Africa during 1936 and 1941 is the book by Larebo (1994), which reconstructs the Italian land policies implemented during the period of the occupation of Ethiopia. Larebo employs a variety of sources to describe the different types of Italian agricultural activity in Ethiopia. The study of the interplay between

large capitalistic plantations for the production of coffee and cotton and the creation of small farms focused on the production of grains, along with the labor policies implemented by the government is of particular interest.

With respect to Libya, Maugini's work on the Italian agricultural activities in the colonies (Maugini, 1969), remains a vital source to document Italian agricultural policies in the colonies, despite the cultural bias described above. Maugini, in fact, was the director of the "Istituto Agricolo d'Oltremare" (a governmental body in charge of setting the guidelines for the agricultural policies in the colonies) and provides first-hand data on the colonization process of the "Fourth Shore" but also gives insights into the Italian agricultural development plans in Libya. These are of particular interest given the fact that Maugini was one of the key masterminds involved in the technical planning and execution of these projects. Segré (1974) describes, for the first time with a more scientific historiographical approach, the process of Italian agricultural settlement in Libya. More recently, his contribution was updated by Cresti (2011), who analyses the interplay between Italian agricultural settlement and the resistance of the local population in Cyrenaica. Biasutti (2004) studies the economic and social policies implemented by the colonial governments for the indigenous population. Fowler (1973) and Ballinger (2016) look at the process of decolonization of Libya after World War II and at the political history of the expulsion of Italian farmers. Allan, McLachlan, and Penrose (1973) offer a throughout analysis of agricultural dynamics in post-colonial Libya, as well as a brief historical overview of the country's agricultural development.

Apart from Libya, the only other part of the former Italian colonial empire to receive significant attention was Eritrea. A first important contribution to the subject was Rainero's research on the first attempts of agricultural colonization between 1890 and 1895 (Rainero, 1960). Taddia (1986) performs a very detailed analysis of the agricultural activity implemented before the Fascist period, whereas Negash (1987) and Mesghenna (1988) look specifically at the education policies implemented under the various governors. Strangio's research on enterprises in Eritrea offers a more business-oriented history of Italian colonialism in the area and updates Podestá's work on the subject (Strangio, 2010). The same author also provides the only significant contribution that attempts to relate Italian colonialism and economic failure in Somalia (Strangio, 2012). Tuccimei (1999) provides a comprehensive study of the activity of the Bank of Italy in the colonies and, also, the most significant contribution in terms of Italian colonial monetary history.

This literature review would not be complete without mentioning the work by Richard Pankhurst. His publications provide an alternative view to the otherwise overwhelmingly Italo-centric perspective that dominates the literature. For instance, the articles that assess the impact of the Italian occupation on the Ethiopian economy in general (Pankhurst, 1971b), its commercial development (Pankhurst, 1971a) and its educational policies (Pankhurst, 1972) are extremely important to put my own research into a more comparative context.

2.6 A note on the archival sources

While also exploiting the secondary literature and the available primary printed sources when available, both my second and third substantive papers rely on primary archival sources to reconstruct the Italian farming activities in Libya during the colonial era and, to a lesser extent, the development of Libyan agriculture in the post-colonial period. The materials relevant to this thesis are preserved in three main archives in Italy. Two of them, the "Archivio Centrale dello Stato" (ACS - "Central National Archive") and the Archive of the Food and Agricultural Organization (FAO), are located in Rome. The third one is the "Archivio Storico dell'Agenzia Italiana per la Cooperazione allo Sviluppo" (ASAIC - Former "Istituto Agronomico d'Oltremare"), and it is located in Florence.

The "Archivio Centrale dello Stato" (Central National Archive, ACS) has absorbed a large part of the documents produced by the "Ministero dell'Africa Italiana (MAI)" (the name of the Ministry of Colonies after 1937), which are contained in the homonymous section (MAI). The archive of the MAI had an adventurous history, as it was partially destroyed due to bombing during an attempt to ship it by train, along with other archival funds, from Italy to Germany at the end of World War II. Partially due to this fact, the fund is lacunary, fragmentary, and poorly cataloged.

The key source retrieved from this set of archival documents is the village-level Agricultural Survey of Libya of 1939 (Ministero dell'Africa Italiana, 1939a), which is contained in folder 685. As no accompanying document that describes the source sits with the original survey sheets, it is difficult to tell the extent to which the source suffers from missing data. At any rate, considering the geographical distribution of the reported villages as well as the small discrepancies between the individual sheets and the reported totals, systematic reporting bias does not seem to be a particularly worrisome issue. The collection of statistical data and also

the reliability of the men in the field (typically colonial administrators and officers) was not always of the highest level. Several robustness tests are employed in the second substantive chapter to deal with these potential problems.

The ASAIC archive ("Archivio Storico dell'Agenzia Italiana per la Cooperazione e lo Sviluppo", archive of the former "Istituto Agricolo d'Oltremare") in Florence contains a large collection of unpublished documents related to both private and state-managed Italian agricultural activities in the colonies between 1912 and 1941. The institute provided technical advice to the government on all matters regarding colonial agricultural policies and, today, boasts a remarkable collection of unpublished papers, surveys, and reports. Some of these documents date back to the early post-WWII period when the institute was involved in facilitating the transition from the colonial administration to the new, independent governments. The archive also preserves the original (and, to the best of my knowledge, possibly only copy) of the 1937 agricultural census of Italian farms in Libya in a specific box (Ministero dell'Africa Italiana, 1937a). This source reports size, employed workers, available machinery, and dwellings for all operational Italian farms in Libya up to April 1937.

The FAO archive in Rome is accessible at the Debin Lubin Memorial Library. It contains an array of documents and technical reports from both the Food and Agricultural Organization from after World War II and its pre-war ancestor, the International Institute of Agriculture. For my research, I benefited particularly from accessing the reports of the Expanded Technical Assistance Program, which was implemented after the war. These precious and unique materials allow a detailed study of the agricultural history of Libya after the war through the analyses that were carried out by the agricultural experts of the FAO in support of the Libyan government. Due to the technical nature of their scope and the preparation of the experts, I consider the provided information highly reliable.

A fourth archive that contains valuable materials on African colonialism is the Archive of the foreign ministry (Archivio Storico del Ministero degli Affari Esteri, ASMAE) which is also in Rome. This institution played a central role in the history of Italian colonialism especially from the beginning until the creation of the "Ministero delle Colonie" ("Ministry of the Colonies"), in 1912. Moreover, parts of other colonial archives have been moved to the ASMAE after WWII. For this reason, the vast majority of the documents that belonged by the "Ministero delle Colonie", in particular, those produced between 1912 and 1936, are contained in this archive. Finally, the archive of the local colonial government of Eritrea, the

only one that the Italian authorities had managed to ship back to Italy before the British expelled them from the Horn of Africa, is also preserved at the AMSAE. This fund is now the "Archivio Eritrea". Although data from this last archive have not been employed in this thesis, this deserves a mention given its importance for Italian colonial studies.

Chapter 3

The long-term impact of Italian colonial roads in the Horn of Africa, 1935-2000.

3.1 Introduction

Roads are central to development strategies in poor countries. By reducing transport costs, they facilitate market integration between cities (Storeygard, 2016), foster agglomeration (Faber, 2014) and improve living standards (Stifel, Minten, and Koru, 2016). Compared to railroads, they are cheaper to build (Chaves, Engerman, and Robinson, 2014; Marchitto, 1940) and, most importantly, they are easier to maintain. Maintenance costs per mile are lower, on average, and roads can still be used if parts of the surface are damaged[2]. For these reasons, some colonial roads are still operational today, while construction of new roads absorbs significant portions of public spending across Africa (Burgess et al., 2015). Yet, unlike railroads which have received growing attention (Donaldson, 2018; Jedwab, Kerby, and Moradi, 2017), little empirical evidence exists on the effect of roads on the distribution of economic activity in developing countries, especially in the long run and with a focus on their effect on agglomeration in non-nodal locations.

This paper addresses this gap. It studies whether a first-mover advantage in transportation provided by roads can permanently alter the distribution of economic activity. It also examines

[2]http://www.transport-watch.co.uk/facts-sheet-8-rail-versus-road-track-maintenance-costs, last accessed 10th March 2019

the mechanisms that allow for the persistence of the economic advantage after the first-mover advantage in transportation disappears.

To examine these issues, the paper analyses the repercussions of the construction of the road network built by the Italians in the Horn of Africa, between 1935 and 1940. Italian East Africa presents some unique features that make it both akin to a natural experiment and particularly suited for the purpose of this study. All major Italian roads were built by paving the military tracks that had been laid out roughly in a straight line to connect important cities to facilitate the conquest of the country, in the context of the Second Italo-Ethiopian War of 1935-7. The Italian occupation of Ethiopia lasted for just five years, which allows to effectively isolate the role of infrastructure from other confounding factors, such as human capital formation and changes to the land tenure system, that could be associated with a prolonged colonial rule.

Obtaining a reliable measure of economic activity to trace changes across space and over time is a critical empirical challenge for the paper, especially due to lack of micro-level statistics for the selected countries. I address this issue in three steps: firstly, I collect information on population density from different sources for the period between 1920 and 2000 to proxy for economic activity (Henderson et al., 2017, pp. 370–1), and to measure its distribution. Density is a good proxy for economic activity, as it has been shown to reflect differences in productivity more accurately than population (Ciccone and Hall, 1996; Duranton, 2015). Secondly, to capture changes in urbanization, I collect information on the location of cities and small towns between 1925 and 2000 for Ethiopia only. Thirdly, as population density and urbanization are both imperfect proxies for productivity differentials and development, especially in poor countries,[3] I include data on night-time light density, which is increasingly used as a proxy for economic development in the literature (Henderson, Storeygard, and Weil, 2012; Michalopoulos and Papaioannou, 2013); I also use information on income and occupational structure from the Demographic and Health Survey (DHS) of Ethiopia.

I perform regression analysis to test, first, whether proximity to colonial roads correlates with significantly higher levels of economic activity today, and, then, whether this translates in higher living standards. The estimates show that cells located within 10km of Italian roads are significantly more populous, more luminous, and more urbanized today. I corroborate the grid-level analysis with individual-level data from the 2011 Demographic and Health Survey of

[3]For a discussion on the reliability of population density data, see Section 3.4

Ethiopia (DHS), and find that people living in treated locations are markedly more prosperous, whether a wealth index or employment structure is introduced as a dependent variable. The employed dataset is a grid, containing 15,288 non-nodal cells, each measuring roughly 11x11km (0.1x0.1 decimal degrees) and covering Eritrea, Ethiopia, and Italian Somalia. Distances to colonial roads and facilities are calculated from each cell's centroid.

To address potential endogeneity in the placement of Italian roads, I rely on two main robustness checks. First, I instrument colonial roads by least cost paths (based on ruggedness and land cover) connecting the network's poles. Instrumented coefficients are positive, significant, and roughly 10% larger compared to the ordinary least squares (OLS) estimates. These results underscore a causal link between road construction and contemporary levels of economic activity and a moderate downward bias in the OLS results. Second, I use as a placebo test that compares the effect of being located next to Italian paved roads with proximity from unfinished roads - those that the Italians planned to pave, but did not complete due to the outbreak of World War II. Placebo cells - which are otherwise statistically indistinguishable from the treatment group based on observable characteristics before 1936 - show no statistical association with population density (or any other indicator) in 2000.

The first-mover advantage evaporated soon after the end of the Italian occupation. New roads were built between 1950 and 1960, and the colonial network deteriorated, despite some refurbishments. Therefore, how could the effect of Italian roads persist? This is an important question. If the roads led to the creation of a permanent higher-density equilibrium that altered the distribution of the economic activity, a strong case could be made for policy intervention. In that case, local economic benefits from infrastructural development, in fact, would go beyond market integration and urban growth in cities directly targeted by the network. By contrast, if the area is slowly returning to the pre-colonial economic geography, the scope for investments in transport infrastructure to change location fundamentals would be diminished.

The results show that the effect of colonial roads on population density emerged by 1940, reached its peak in 1960, moderately declined and ultimately stabilized afterward. A higher concentration of cities next to Italian roads only emerged in the 1960s, and this concentration grew exponentially thereafter. The inclusion of the controls for colonial investments explains a declining share of the effect over time. This finding suggests that persistence is not explained by non-fully depreciated sunk investments, but rather by a higher density equilibrium. Urban-

ization emerges as a critical factor in explaining persistence. Though population distribution in 1960 largely captures the effect of colonial roads on population in 2000, the location of cities in the past does not explain higher urban density next to colonial infrastructure today. Furthermore, introducing controls for urban density between 1968 and 2000 captures an increasingly larger share of the effect of roads on population in 2000.

By pinpointing the central role of increasing urbanization in maintaining the higher density equilibrium, these findings contrast with those of related studies that examine the effects of railroads (Jedwab and Moradi, 2016; Jedwab, Kerby, and Moradi, 2017). These studies - which find higher urban density but no faster growth of urban density for regions near railroads after the railroad networks' demise - support the "path dependency explains persistence" view. By contrast, my findings show that a functioning road network can lead to uninterrupted urban growth even after the first-mover advantage has been lost.

Finally, to test the role of urbanization more formally, I look at the relationship between a concentration of factors, productivity differentials, and urbanization. The findings are consistent with a model featuring increasing returns to scale (Krugman, 1991) linked to urbanization and revolutions in transportation (Jedwab and Moradi, 2016); that is, the location of cities in 2000 explains the treated locations' higher concentration of factors (hospitals and schools) today, the superior living standards of their populations, and differences in employment, which, taken together, give a rough proxy for productivity differentials. I take this as evidence of the role of urbanization both in solving the problem of the coordination of factors, demonstrating that factors followed the cities; and in leading to higher productivity through economies of scale and specialization. Urbanization, therefore, allowed the persistence of the higher-density equilibrium, after the first-mover advantage was lost, by counteracting centrifugal forces linked to congestion through productivity gains from specialization and economies of scale (Duranton, 2015; Venables, 2011; Krugman, 1991).

The paper adds to the literature that has looked at the effect of transport revolutions on economic development and agglomeration in Africa and, more generally, in developing countries. The empirical work has looked at the effect of railroads (Donaldson, 2018; Berger and Enflo, 2017; Herranz-Loncán and Fourie, 2017), which involve more considerable building costs and that, in the African continent, collapsed after the end of colonialism (Jedwab and Moradi, 2016; Jedwab, Kerby, and Moradi, 2017). My work looks at the effect of roads - a cheaper and more widespread type of transport infrastructure after independence - and studies

the agglomeration effects linked to a first-mover advantage in transportation facilities that outlasted the institutional framework in which they were created. In this sense, my work bears more obvious policy implications: the results show that if transportation facilities continue to operate for extended periods, these can be conducive to stronger and longer-lasting effects on urbanization.

By offering results from a quasi-natural experiment, and by taking a longer historical perspective, I also contribute to those studies that have focused on the market-integration effect of roads between termini (Storeygard, 2016), or have examined the effect of roads on patterns of consumption (Stifel, Minten, and Koru, 2016), firms' location (Shiferaw et al., 2015) or agglomeration (mostly in China) (Banerjee, Duflo, and Qian, 2012; Faber, 2014). By showing different effects between paved and unpaved roads (unfinished placebo roads), my study also underlines how infrastructural quality should be carefully considered in the early phase of construction in developing countries, as this can have substantially different long-term consequences, in line with Fourie (2008).

Thirdly, my article adds to the debate on the role played by colonialism in shaping contemporary development and inequality. Scholars have emphasized the role of institutions (Acemoglu, Johnson, and Robinson, 2001; Bruhn and Gallego, 2012), taxation (Gardner, 2012; Huillery, 2014), human capital (Glaeser et al., 2004; Huillery, 2009; Cogneau and Moradi, 2014), and physical transportation infrastructure (Andrabi and Kuehlwein, 2010; Burgess and Donaldson, 2010). Little has been said, however, about the role of colonial roads, despite their paramount importance for transportation in poor countries.

Finally, with a narrower focus, this paper also relates to the Italian colonialism-focused literature, which has often dismissed the importance of Italian colonial investments in general and, specifically, for the post-colonial history of the Horn of Africa (Del Boca, 1986a; Labanca, 2002; Podestà, 2004).

The remainder of the paper is structured as follows. Section 3.2 provides a brief description of the historical framework. Sections 3.3 and 3.4 illustrate the empirical strategy and the data, respectively. The main results and robustness checks are presented in Sections 3.5 and 3.6. Section 3.7 studies the mechanism. Section 3.8 concludes.

3.2 Historical framework: Italian road construction in the Horn of Africa

Prior to Italian Prime Minister Benito Mussolini's decision to annex the Ethiopian Empire to Eritrea and Somalia in 1934, the Horn of Africa had seen little investment in transportation. The Italian colonies were too poor to justify extensive road (or railroad) building. The Ethiopian monarchs had only managed to construct a few gravel roads concentrated around Addis Ababa (Emmenegger, 2012), so that virtually no modern roads apt for wheeled transportation existed in Ethiopia before the Italian invasion (Cobolli-Gigli, 1938, pp. 39-41).

The Italo-Ethiopian war completely changed the transportation dynamics in the area: between 1934 and 1935, the Italian military engineers started building new road tracks (mostly gravel) that connected the core of Eritrea and Somalia with the Ethiopian border to allow troops and supplies to reach the front and, subsequently, the main Ethiopian cities (Badoglio, 1937; Graziani, 1938). When Addis Ababa was occupied on May 5, 1936, just a small portion of the Ethiopian territory was actually under Italian control. The Italian garrisons patrolled major cities such as Addis Ababa, Jimma, Gondar, Dessié, Harar, and only a few minor centers. With the rainy season approaching (the first heavy rains were due between November and December), it would have been impossible for the Italian army to preserve the main strongholds without improvements to the road network, due to the intense guerrilla warfare carried out by Ethiopian patriots (Dominioni, 2008a).

In this difficult situation, the Italian government ordered the construction of a large road network to connect the main cities with asphalt roads and prevent them from being isolated and exposed to guerrilla warfare, while cut-off from supplies (Cobolli-Gigli, 1937, p. 1480). This plan largely involved improvement and pavement of the military tracks. Before the start of the rainy season, construction was completed on the main sections of the Asmara-Gondar, Asmara-Dessié-Addis Ababa, Addis Ababa-Jimma, Addis Ababa-Lechemti, and Addis Ababa-Harar-Mogadishu roads. In the following years (1937-1939), the Addis Ababa-Debra Tabor and Assab-Dessié roads were built.[4] Other secondary arteries were started but left unfinished (left unpaved, that is) because of the drastic cut in the budget due to the World War II preparations, and, ultimately the outbreak of the war (Del Boca, 1986a). By 1940, these major roads, together with those previously built in Eritrea and Somalia and an array of

[4] Angelo Piccioli (eds.) (1937–1943). *Gli Annali dell'Africa Italiana*

secondary unpaved tracks formed an extensive network, which extended for around 6,000 km. Of this, of 3,500 km were paved and 2,500 km were unpaved (Leul, Petros, and Kebede, 2008). In the empirical analysis, I focus on the paved roads.

The Italian rule did not last for long. In 1941, the last Italian strongholds surrendered to the combined British and Ethiopian forces. During the war, parts of the network's surface, major bridges, and tunnels were destroyed (Del Boca, 1986a). Nevertheless, the bulk of the colonial road network survived. No comprehensive maintenance was undertaken until 1951, due to a lack of capital and economic stagnation. From the 1950s, several infrastructure-improvement plans were implemented: initially (during the 1950s), parts of the Italian roads were refurbished, while from the late 1950s new construction plans were laid out and implemented. Eventually, the substantial monopoly in transportation that Italian roads had enjoyed during the colonial era and throughout the 1950s waned with the construction of new roads, poor maintenance of Italian routes, and the deterioration of parts of the road network primarily due to the dismemberment of the former territory of Oriental Italian Africa[5] (Emmenegger, 2012).

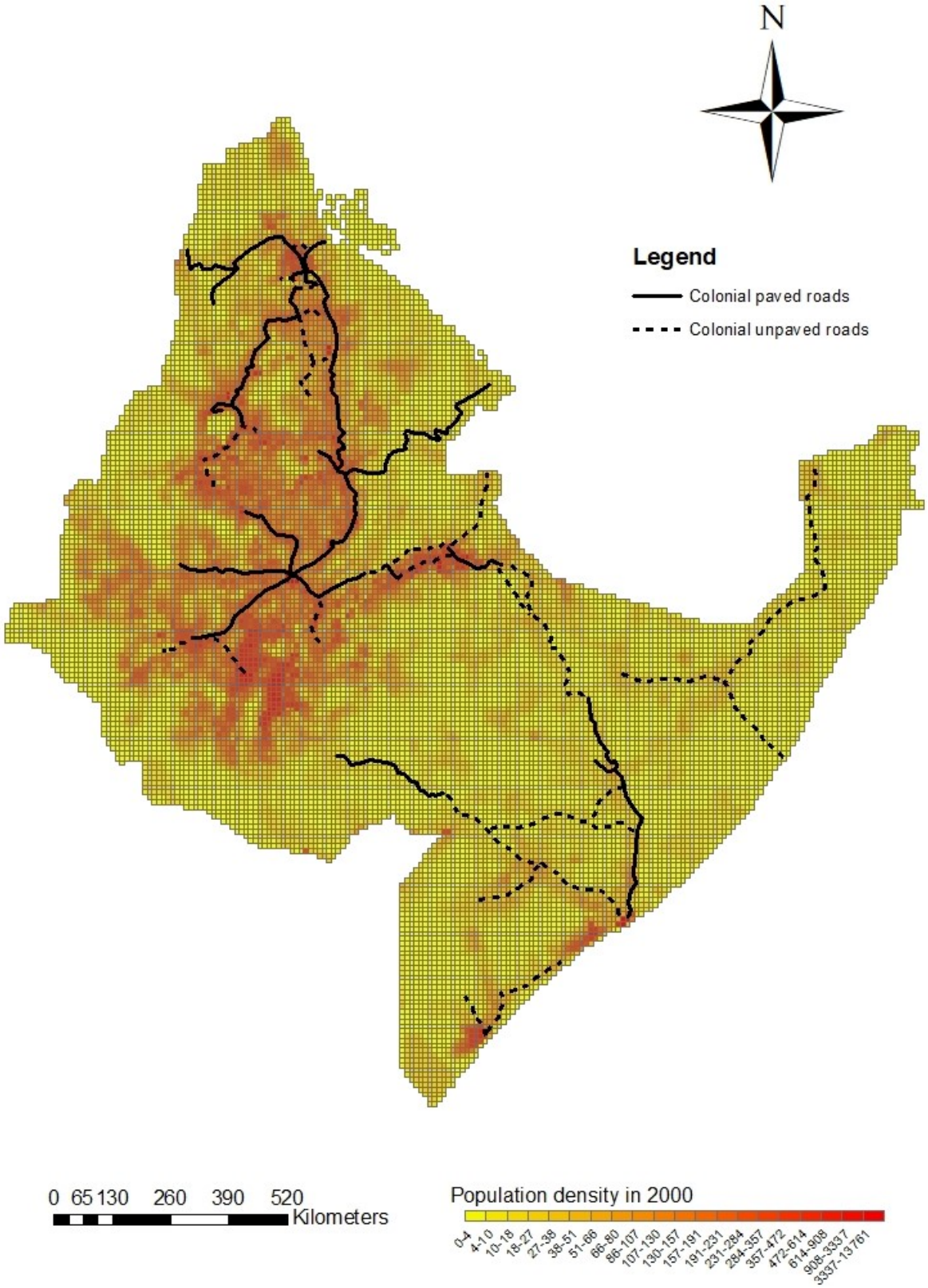
From this brief historical framework, two key elements emerge: on the one hand, Italian roads were designed to serve contingent strategic military needs, and, therefore, their placement was unrelated to the pre-1930s infrastructure or patterns of settlement. On the other hand, as opposed to the case of railroads in Kenya or Ghana, Italian roads were re-built and kept operational in the post-colonial period, but they lost their first-mover advantage by 1960. These characteristics make the Horn of Africa an ideal scenario in which to study the effect of a first-mover advantage in transportation on the economic activity distribution over the long run.

3.3 Empirical strategy

The first research question that this paper considers is whether the Italian road network had a long-term impact on the concentration of economic activity of Eritrea, Somalia, and Ethiopia. To address this issue, I employ regression analysis on a spatially explicit gridded dataset, composed of 15,288 non-nodal cells, each measuring 0.1x0.1 degrees (roughly 11x11 km). The grid includes the entire territories of the aforementioned countries but excludes

[5]Somalia and Eritrea became independent countries and this inevitably damaged the network that had been created to connect them

Figure 3.1: Population density in 2000 and colonial roads



British Somalia, all lakes, and all cells located within 20km of the network's termini. For each observation, I calculate the average values of population density in 2000 and luminosity in 2010, together with the Euclidean distance of each cell's centroid from the closest Italian road. I also add various pre-colonial, colonial, environmental, and geographical controls.

I start by checking whether a robust correlation between proximity to colonial roads and contemporary levels of development is in place by estimating equation 1 through OLS:

$$\begin{aligned} y_{i,e} = \alpha + \beta_1 DColonialRoad_{0-10km,i,e} \\ + \beta_2 DColonialRoad_{10-20km,i,e} \\ + x'_{i,e}\gamma + \delta_e + \epsilon_{i,e} \end{aligned} \tag{3.1}$$

$y_{i,e}$ represents the two main dependent variables, population density in 2000 (normalized by standard deviations) and luminosity in 2010 (in logarithm), both measured in cell i and ethnic group e. I use population density as the main dependent variable because this is the only proxy available for the entire period. However, as distinguishing between rural and urban agglomeration is vital for the empirical question of this paper, I also provide results from an estimation similar to equation 1, but using a binary variable for the location of cities with more than 10,000 inhabitants as dependent variable.

$DColonialRoad_{0-10km,i,e}$ and $DColonialRoad_{10-20km,i,e}$ are the explanatory variables of interest, two dummies that equal one if cell i in ethnic group e is located within a 10km radius of colonial paved roads, and within a radius of between 10 and 20km of paved roads, respectively. If the colonial infrastructure has affected economic concentration and income distribution persistently, I expect colonial roads to show a positive and statistically significant effect on my dependent variables. (β_1, $\beta_2 > 0$).

$x'_{i,c}$ is a vector representing the full set of controls. These can be divided into three groups, namely pre-colonial, colonial, geographical, and environmental controls. Pre-colonial controls include dummies for centroids being located within 10 km of, or between 10 and 20 km away from 1935 tracks, and population densities in 1920 and 1930. As better access to telecommunications could improve total factor productivity (TFP) and growth potential (Wong, 2004), I include a dummy for being located within 10 km of telephonic and telegraphic lines that existed prior to the outbreak of the war. Controls for colonial investments include zero-to-10km distance cut-offs from important colonial facilities: railroads, primary and secondary hospitals, schools for Africans, colonial provincial capitals, Italian unpaved tracks, and provincial

administrative capitals. I also include a dummy for being in an area of mining interest during the colonial era. Additionally, I introduce a standard set of geographical controls for the following: latitude, longitude, altitude, annual average rainfall, FAO land suitability, being located within 10km of perennial rivers, and being located less than 30km from the coast. Finally, I include malaria rates, ruggedness, and temperature. Table 3.A.1 reports the main descriptive statistics for all the variables included in specification 1.

δ_e is the baseline set of fixed effects, the 53 ethnic groups in which Oriental Italian Africa was divided, according to Murdock (1967). A cell is assigned to a specific ethnic group if its centroid falls within its boundaries. Ethnic boundaries do not overlap in Murdock, so each cell can only belong to one group. These account for unobservable characteristics at the tribe level. The error term is $\epsilon_{i,e}$. In all the specifications, in order to make my estimates robust to spatial correlation, I cluster the standard errors by 202 colonial provinces, called "Residenze", the smallest administrative units in the colonial period. Conley errors, robust to spatial correlation, are also calculated with different cut-offs[6][7]. In Appendix 3.B, I provide a more detailed description of variables and calculations.

3.4 Data

The described analysis required a novel dataset containing information on a vast array of dependent, historical, geographical, and environmental variables. In this section, I focus the main dependent and explanatory variables: population density, agglomeration data and Italian colonial investments only, my main dependent and explanatory variables (a detailed description of each variable and data source can be found in Appendix 3.B).

The main dependent variable, employed for the baseline estimation, is decennial population density for the 1920-2000 period. For the years 1960, 1970, 1980, 1990 and 2000 (last available), this is obtainable through the United Nations Environment Programme / Global Resource Information Database (UNEP/GRID)-Sioux Falls dataset in raster format. I calculate the average value of the raster's centroids that fall into a grid-cell i. This source distributes

[6]The one reported in Table 3.1 use a 1 decimal degree cut-off

[7]In a recent paper, Kelly (2019) pointed out the risk for long-term studies of displaying inflated t-statistics due to spatial autocorrelation. He also argues that standard Conley error calculations might not address the problem in full. This issue, however, is not worrisome for my results from both a technical and a conceptual perspective. First, I observe the outcome variable both before and after treatment, so that I am able to trace change over time (see Section 3.7.1). Second, in this exercise and with the outlined empirical framework, I aim to capture precisely the spatial autocorrelation of economic activity, namely how the construction of Italian roads led to the concentration of economic activity in nearby locations

district-level population across a raster surface by looking at the variation of an "accessibility index" that incorporates data on agglomeration and cost distances between cells. As the variation primarily comes from micro-level statistics, this methodology offers fairly reliable information on population distribution. However, as assumptions are needed to project the available population statistics at the raster cell's level (and transport infrastructure is incorporated in the cost-distance analysis), it is of paramount importance to check the robustness of the estimates with alternative measures of economic activity, such as light density, urbanization, and living standards. As all grid cells have the same size, after the population density data are aggregated at the grid level, differences in density closely approximate differences in the population count. The unit of measurement is people per square km.

Conversely, for the years 1920, 1930, 1940 and 1950, micro-level surveys of population density do not exist. As a first step to solve this issue, I employ reconstructed population densities from the History Database of Global Environment (HYDE), which combines historical population statistics with cropland and pasture information to reconstruct population distribution in raster format (Klein Goldewijk et al., 2011). This source gives an approximation of varying quality on the population distribution across the area before 1960. Relatively precise reconstruction is possible for specific areas, such as Eritrea and Somalia, for which more historical statistics are available. By contrast, the central part of Ethiopia is problematic; the reconstructed data are marred by artificially high levels of spatial correlation due to very limited availability of population statistics in the pre-colonial and colonial period.

To distinguish between agglomerations of different size and density, and also to address the limited reliability of the information from HYDE, I back up the available population density information with the location of villages, towns, and cities. Patterns of agglomeration and population concentration largely correlate, although they technically measure two distinct features. A series of maps edited by Achille Dardano, the director of the Cartographic Office of the Ministry of the Colonies between 1922 and 1938, allowed me to obtain information on the location of all villages, towns, and cities in Eritrea, Somalia, and Ethiopia for the years 1925, 1935, 1938[8], and 1939. Additionally, for Ethiopia only, I was able extend this

[8]Consociazione Turistica Italiana-Ufficio Cartografico (1938?). *Africa Orientale Italiana (6 maps)*

to the years 1968[9], 1981[10], 1988[11] and 2000[12] for small towns with a population of more than 4,000 inhabitants and cities with more than 10,000 inhabitants. All colonial maps are from the same source. Though the set of cartographic materials for the 1960-2000 period is less homogeneous, it is appropriate for the purpose of locating large agglomerations. In fact, in addition to providing information on the size of the population of each village and city, these sources, in combination with the described population density data, allow me to trace the distribution of the population in the early periods of the study as well as the formation of towns and cities over time more precisely. For villages, with fewer than 4,000 inhabitants between 1925 and 1939, I have binary variables for whether a cell contained a village. Conversely, I take distance from each cell's centroid and the closest small town (more than 4,000 inhabitants) and city (more than 10,000 inhabitants) and then created dummy variables for being located within a 10 and 20 km cut-off, respectively.

The principal sources for colonial investments are taken from "Gli Annali dell'Africa Italiana", a review, edited by the Italian Ministry of the Colonies, that describes the public investments implemented by the Italian Government in Oriental Italian Africa. I rely on the third and fourth issues of the 1939 edition, and the first and second issues of the 1940 edition. The location of colonial paved and unpaved roads in 1939 comes from a map contained in the fourth issue of the 1939 edition. This source details which road sections had been completed by 1939, and which sections remained under construction. It also describes the road surface as paved or unpaved. (this information is employed as both a control and a placebo test.) From the first issue of the 1940 edition, I collected data on the location of colonial schools for Africans. I obtained information on locations of Italian hospitals and clinics by geo-referencing a series of maps from the same volume. I collected a variety of other features from the colonial period from diverse sources, including the location of colonial railroads, colonial administrative capitals and boundaries, and areas of mining potential (see Appendix 3.B for a detailed description of the sources). Finally, pre-colonial tracks come from Dardano's 1935 map, which is, to the best of my knowledge, the most accurate map ever drawn for pre-1936 Ethiopia. I calculate linear distances between each cell's centroid and the closest colonial facilities; I then calculate cut-off distances based on this calculation. Finally, historical ethnic boundaries are

[9] USSR (1968). *Ethiopia (Map 1:2,500,000).* Cartography Department - URSS Ministry Committee

[10] Ethiopian Mapping Agency (1981). *National Atlas of Ethiopia (preliminary version).* Ethiopian Mapping Agency

[11] Ethiopian Mapping Authority (1988). *National Atlas of Ethiopia.* Ethiopian Mapping Authority

[12] Ajhethiopia (2000?). *Ethiopian Towns.* GIS online

obtained from Murdock's atlas (Murdock, 1967): each cell is assigned to the ethnic boundary that fully contains its centroid; each cell can belong to one ethnic group only. I followed a similar procedure for colonial administrative boundaries and zones of mining interest.

3.5 Main results

Are historically better-connected cells richer today? In order to answer the core question of the paper, I begin by estimating equation 1 through OLS. Table 3.1 reports the estimates from the main specification: standardized population density (*z-scores*) in 2000 is employed as dependent variable in columns 1 to 4, whereas the results for log light density at night are displayed in columns 5 and 6. Finally, column 7 reports the marginal effects from a probabilistic estimation with a binary variable for being located within 20km of an Ethiopian city with more than 10,000 inhabitants in 2000. For all specifications, ethnic fixed effects are included; standard errors are clustered by the 202 colonial provinces; and network' poles are excluded.[13] The estimation in column 1 has no controls; column 2 includes pre-colonial factors; columns 4 and 5 report colonial and geographical controls, respectively. Column 5 displays the restricted model with light density as dependent variable, which is conditioned on population density in 2000, in column 6. Column 7 displays the estimates with the full set of controls and fixed effects from the probabilistic model.

As column 4 shows, cells located within 10km of colonial paved roads are, on average, 0.193 standard deviations more densely populated, once the full set of controls has been included. This effect is economically very large, as it implies a statistically significant deviation from the mean of about 20% of the standard deviation, or 15 points. This result implies that treated locations have an average population density of about 55 inhabitants per square kilometer, compared to the average, for the whole area, of roughly 40 inhabitants per square kilometer (see Table 3.A.1). The estimates are quite robust to the introduction of the different sets of controls. As underlined above, population density is a good approximation if one wants to estimate the concentration of economic activity, but leaves room for uncertainty when it comes to disentangling the economic activity from productivity and living standards. However, the replication of the previous exercise with light density at night and location of urban centers relaxes these constraints, and makes it possible to say more about actual levels of development.

[13] Columns 2 and 3 of Table 3.A.4 report the same estimation with the full sample and without the baseline set of fixed effects

Table 3.1: The long-term effect of colonial roads on economic concentration

Dependent variables:	Pop density 2000, z scores				ln luminosity 2010		City 2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Road 1939, 0-10km	0.409***	0.243***	0.209***	0.193***	0.345***	0.292***	0.080***
	(0.061)	(0.055)	(0.056)	(0.052)	(0.087)	(0.084)	(0.019)
	|0.063|	|0.058|	|0.060|	|0.058|	|0.088|	|0.084|	.
Road 1939, 10-20km	0.194***	0.080**	0.082**	0.059*	-0.042	-0.058	0.052***
	(0.040)	(0.036)	(0.036)	(0.032)	(0.043)	(0.042)	(0.014)
Pop density 2000 z scores						0.272***	
						(0.051)	
Track 1935, 0-10km		0.133***	0.103***	0.102***	0.030	0.002	0.058***
		(0.029)	(0.028)	(0.026)	(0.022)	(0.020)	(0.012)
Track 1935, 10-20km		0.076***	0.063***	0.059***	-0.016	-0.032**	0.037***
		(0.018)	(0.018)	(0.016)	(0.013)	(0.013)	(0.010)
Pop density 1920 z scores		0.243***	0.239***	0.162**	0.078	0.034	0.018
		(0.071)	(0.072)	(0.063)	(0.072)	(0.065)	(0.021)
Pop density 1930 z scores		0.241***	0.226***	0.131*	0.054	0.018	0.013
		(0.076)	(0.078)	(0.068)	(0.080)	(0.076)	(0.022)
Telegraph 1934 CMI, 0-10km		0.083**	0.056	0.030	0.039	0.031	0.016*
		(0.034)	(0.035)	(0.032)	(0.037)	(0.035)	(0.009)
Rail 1940, 0-10km			-0.060	0.044	0.184	0.172	0.070**
			(0.094)	(0.086)	(0.234)	(0.225)	(0.030)
Track 1940, 0-10km			0.178***	0.146**	0.044	0.004	0.028
			(0.067)	(0.060)	(0.039)	(0.035)	(0.017)
District capital 1940, 0-10km			0.132**	0.100*	0.448***	0.420***	0.032**
			(0.058)	(0.055)	(0.103)	(0.101)	(0.014)
Secondary hospital 1940, 0-10km			0.142**	0.129**	0.125	0.090	0.030*
			(0.064)	(0.060)	(0.081)	(0.077)	(0.016)
Main hospital 1940, 0-10km			-0.029	0.038	-0.656**	-0.666**	-0.065
			(0.182)	(0.169)	(0.315)	(0.292)	(0.060)
School 1940, 0-10km			0.193**	0.130*	0.759***	0.723***	0.050**
			(0.077)	(0.077)	(0.189)	(0.185)	(0.024)
Observations	15,288	15,288	15,288	15,288	15,288	15,288	10,088
R-squared	0.46	0.50	0.52	0.56	0.10	0.12	x
Ethnic FE	YES	YES	YES	YES	YES	YES	YES
Precolonial controls	NO	YES	YES	YES	YES	YES	YES
Colonial controls	NO	NO	YES	YES	YES	YES	YES
Geographical controls	NO	NO	NO	YES	YES	YES	YES

OLS regression estimates in columns 1 to 6 from the grid dataset (11x11 km). Column 7 reports marginal effects from a probit model with the same regressors as in model (1) but restricted to Ethiopia. All columns exclude the network's poles (cells within a 20km radius from targets). Dependent variables: population density (*z-scores*) in 2000 (columns 1 to 4), the logarithm of light density at night in 2010 (columns 5 and 6) and a dummy for being located within 20km from a city with more than 10,000 inhabitants (column 7). Robust standard errors, clustered by 202 provincial colonial districts, in parentheses. Vertical brackets report Conley standard errors robust to spatial correlation (row 3), estimated with 1 decimal degree cut-off. All columns include fixed effects for 53 ethnic groups from Murdock's map (Nunn, 2008). Column 1 has no controls. Columns 4, 5, 6, and 7 display results with the full set of controls. Pre-colonial and colonial controls' coefficients are displayed throughout the table. Geographical controls include altitude, longitude, latitude, average annual rainfall, malaria index, area of mining interest, average annual temperature, crop suitability for low input rain-fed cereals (FAO), ruggedness and dummies for being within 10km of a perennial river and the coast, respectively. *** p<0.01, ** p<0.05, * p<0.1

Column 5 shows how, conditional on the full set of controls, cells located within 10km of Italian motorways are, on average, about 34% more luminous than the control group. As visible in column 6, once contemporary population density is added to the equation, the coefficient remains positive and significant at the 1% level, albeit a bit smaller with a magnitude of roughly 29%. Finally, column 7 gives convincing evidence that historically better-connected cells in Ethiopia are also more urbanized today: treated locations, in fact, are roughly 8% more likely to be located within 20km of a city. In other words, Table 3.1 suggests that proximity to Italian paved roads is not only associated with higher levels of population density, but also with higher luminosity (and, therefore, income, according to a recent strand in the development economics literature (Michalopoulos and Papaioannou, 2013) and higher urbanization rates.

3.5.1 Living standards

Population density, luminosity, and urbanization are good proxies for economic concentration and productivity. Nevertheless, one might still worry that the estimates could reflect overpopulation and not higher levels of income, following the idea that urbanization in developing countries does not necessarily lead to higher industrialization and higher productivity (Gollin, Jedwab, and Vollrath, 2016). Therefore, I test my working hypothesis on the 2011 male individual Demographic and Health Survey of Ethiopia. In Table 3.A.2, I employ the individual-level dataset to re-estimate equation 1, this time with 10,091 Ethiopian males as units of observation (once clusters of individuals located within 20 km from the road network's termini have been excluded).

Consistent with the main results, the data show that people who are at present living in historically better-connected areas are significantly richer. Ethiopian males located less than 10km away from Italian roads have an average wealth score index that is about 0.6 points larger than the comparison group and significant at the 1% level (column 4). Similarly, Table 3.A.11 from, Appendix 3.A, shows that treated individuals have better chances of being employed in highly remunerated jobs in the tertiary sector. For instance, they are more likely to be professionals (doctors, technicians or teachers), to be employed in services, and to be skilled workers (columns 1, 2 and 4, respectively). Most importantly, they are also 13% less likely to be employed in agriculture.

In conclusion, Tables 3.1 and 3.A.2 provide evidence that historically better-connected cells

are not only more populous but also significantly more affluent and with higher productivity levels.

3.6 Causality

Despite the consistency of the estimates across different development indicators, endogeneity could bias my results; unobservables could be driving a spurious correlation between proximity to colonial roads and higher levels of development. To address this issue, I focus on population density, my main dependent variable, and implement an IV and a placebo test, which are reported in Table 3.2. All columns include the full set of controls from equation 1, ethnic fixed effects, and they exclude the network's poles.

3.6.1 *IV estimation: Least Cost Path (LCP)*

I implement an instrumental variable estimation that takes advantage of the peculiar characteristics of my case study. To conquer Ethiopia quickly, and to secure steady supplies for the urban centers of the newly conquered territory, Italians sought to connect major cities while minimizing construction costs. This approach often relied on paving tracks that had previously been laid out by the army. In this respect, the Italian case differs from the vast majority of road construction plans that tend to pass through areas with higher economic potential. I instrument distance from colonial roads with distance from a least-cost-path network connecting the road network's termini.

I generate least cost paths between targeted cities based on ruggedness and terrain cover, together with information on cost differentials for building paved roads across different terrains as depicted by contemporary construction manuals for sub-contractors. By using data provided by coeval primary sources, I adjust these differences to the specific building cost differentials that the Italians faced in the Horn of Africa during the 1930s. Ruggedness and land cover account for a great deal in the cost variation for building new arteries, especially in territories mostly lacking pre-existing facilities. I expect my instrument to be a strong predictor of road location. Channels other than proximity to Italian paved roads (conditional on the full set of controls) should not affect long-term economic concentration. See Appendix 3.B and Figure 3.A.2 for more details on the creation of the least-cost path network.

Table 3.2: Robustness checks: colonial roads on populations density in 2000

Dependent variables:	Pop density 2000, z scores			
Specification:	Baseline	First	IV LCP 0-10km	Placebo
	(1)	(2)	(3)	(4)
Road 1939, 0-10km	0.193***		0.213**	
	(0.052)		(0.089)	
Road 1939, 10-20km	0.059*	-0.235***	0.063*	
	(0.032)	(0.016)	(0.036)	
0-10km, IV LPC 1940		0.447***		
		(0.054)		
Proj road 1937 unpav, 0-10km				-0.031
				(0.079)
Proj road 1937 unpav, 10-20km				0.083
				(0.064)
Observations	15,288	15,288	15,288	15,288
R-squared	0.56	0.39	0.22	0.56
Cragg-Donald Wald F-Stat	.	.	3538	.
Kleibergen-Paap F-Stat	.	.	68.50	.
Ethnic FE	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES

All columns include fixed effects for 53 ethnic groups from Murdock's map (Nunn, 2008). Robust standard errors, clustered by 202 provincial colonial districts, are shown in parentheses. The full set of controls (see Table 3.1) is included in all columns. Column 2 shows the first stage regression, whereas column 3 reports the second stage. A dummy for being between 0 and 10 km from least cost paths connecting the road network's targets is employed as the instrumental variable (columns 2 and 3). Column 4 reports the placebo exercise with projected paved roads that were under construction but were not completed due to the outbreak of WWII. *** p<0.01, ** p<0.05, * p<0.1

Column 2 from Table 3.2 reports the first stage of the 2SLS estimation and shows that the selected instrument is, consistently with the historical narrative, a good predictor for proximity to colonial paved roads. The second stage (column 3) shows a positive and statistically significant coefficient of roughly the same magnitude. The Kleibergen-Paap F statistic is extremely large and well above the 10-point customary threshold, which in turn indicates that the instrument is very strong. These results, on the one hand, pinpoint a causal link between the construction of colonial roads in the 1930s and present-day concentration of the

economic activity. On the other hand, they suggest that the OLS approach might suffer from attenuation bias; in fact, the IV coefficient is about 10% larger than the OLS, which, in turn, suggests a moderately larger effect of Italian roads on agglomeration compared to the OLS estimates.

3.6.2 *Placebo: unfinished roads*

Additionally, as a placebo test, I exploit incomplete roads that were in the process of being paved, but could not be finished due to the outbreak of WWII. This approach is a more convincing falsification exercise than examining both projected paved roads or unpaved tracks alone. That is, projected roads that had not been started by 1939 could simply show lower agglomeration in 2000 due to lower initial potential, which might have been a motivating factor in the delayed start of the works. Similarly, lorry tracks might deliberately have been left unpaved, due to the lower economic potential of the regions they crossed. By contrast, the selected placebo is an excellent counterfactual. These unfinished roads arguably have similar characteristics to completed roads. These unfinished lines were part of the originally planned network and were left incomplete only due to exogenous reasons, namely the diversion of funds from civil engineering to war preparation. As one can see from Map 3.A.2 in Appendix 3.A, the only reason why the construction of these parts of the network began later has to do with distance from the ports of Massawa and Mogadishu, where the construction (and military operations) started.

Table 3.A.7 in (Appendix 3.A) shows the results of t-tests on differences between unconditional averages for placebo and treated cells, for a selection of salient observable characteristics. These two groups were statistically indistinguishable before the construction of Italian paved roads, which in turn suggests that this is an appropriate placebo. If anything, placebo cells had both higher land suitability and concentration of towns with more than 10,000 inhabitants. Column 4 from Table 3.2 shows that placebo cells are not significantly more populous today: both coefficients, in fact, are very small and statistically indistinguishable from zero.

3.6.3 *Additional robustness checks*

Several additional robustness checks are reported in Appendix 3.A. One test is of particular importance for the paper. Access to transport infrastructure is a component of the algorithm employed by UNEP to create raster files from population statistics; thus, in column 5 of Table

3.A.4, I show that the main results hold if only locations within a 10km-radius of roads in 2000 are selected. The estimates are also robust to an array of additional specifications with varying sets of fixed effects and restrictions to the comparison group (see Tables 3.A.4, 3.A.5 and 3.A.6 in Appendix 3.A).

3.7 Mechanisms

The results presented so far show that the construction of Italian roads changed the economic geography of the area persistently. But this finding raises more questions about the mechanisms: how did treated areas maintain higher levels of agglomeration and living standards after the first-mover advantage was lost?

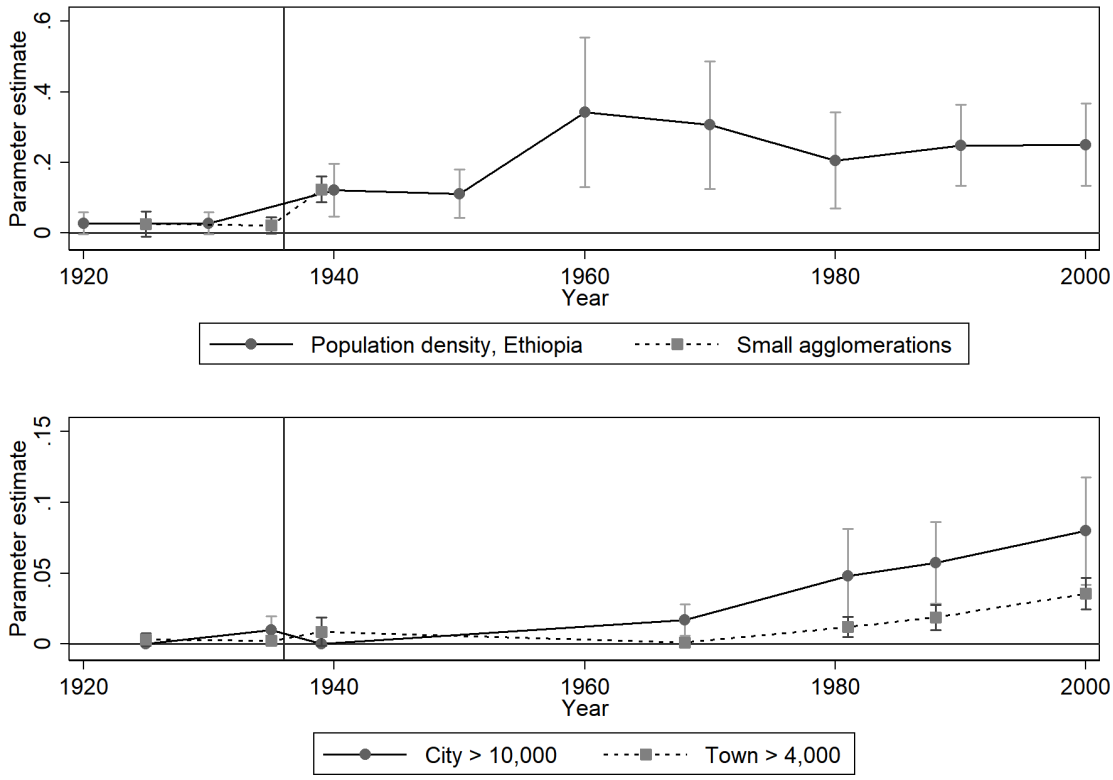
To answer this question, I restrict this part of my analysis to Ethiopia, for which I have complete information on the evolution of both urban and road networks for the post-colonial period. I start by studying patterns of agglomeration next to Italian roads over time. Secondly, I focus on explaining the emergence of the effect in the colonial period. Finally, I borrow the theoretical framework proposed by Bleakley and Lin (2012) to understand whether colonial transport infrastructure led to a temporary shock, or rather to a persistent higher-density equilibrium.

3.7.1 The effect over time

How did the effect of Italian roads change over time? In the top panel of Figure 3.2, I plot the coefficients from equation 1 with decadal population density as dependent variable and 95% confidence bands. Prior to the Italian occupation, proximity to colonial roads showed no effect on population density. By contrast, in the wake of the occupation, the effect begins to emerge rapidly and is already evident in 1940. This rapid concentration of the economic activity is consistent with the available qualitative evidence, which portrays rapid agglomeration alongside main roads. This dynamic is already evident during the phase of construction (e.g., creation of barracks for the workers, grocery stores, gas stations) (Cobolli-Gigli, 1938; Benti, 2016) and immediately after completion. As the quality of reconstructed population density data from HYDE is poor, I use newly collected data on agglomeration in 1925, 1935 and 1939 to verify that the jump in the coefficient between 1930 and 1940 is not driven by data back-projection. The reported marginal effects for villages show a consistent story, and

emphasize the immediate reorganization of economic activity following the construction of Italian roads.

Figure 3.2: The effect of Italian roads over time



Coefficients for dummy 0-10km from colonial paved roads (see equation 1) are reported with 95% confidence intervals. Dependent variables are reported in the legends. All estimations include the full set of controls (see Table 3.1 for details) and the employed sample includes all non-nodal cells located in contemporary Ethiopia. Vertical lines correspond to 1936. *Top panel*: Reported coefficients for population density are OLS elasticities. Results for agglomerations are marginal effects from a Probit model (same as equation 1) with binary variables for the presence of villages in cell i in 1925, 1935 and 1939. *Bottom panel*: Marginal effects from a Probit model. Dependent variables are dummies for being located within 20km from a city with more than 10,000 inhabitants and within 10km from a small town of 4,000 or more. For probabilistic estimations, the model is the same as for equation 1, but the set of fixed effects is different and now corresponds to the four regions in which the Italian government divided Ethiopia in 1936.[a]

[a]For the early period there is not enough variation in the dependent variable to keep ethnic fixed effects in the model as these occasionally fully predict failure

The effect remains stable between 1940 and 1950, during a decade of financial hardship for the independent Ethiopian government, which was unable to implement any relevant infrastructural development program (Bekele, 1995) and it increases significantly between 1950 and 1960. This rise in economic concentration coincided with the first period of moderate

growth (averaging 3% per annum) for the regional economy (Bekele, 1995) and with the "First Highway Plan". Launched by the Imperial Ethiopian government between 1951 and 1957, the plan refurbished the existing Italian network (Emmenegger, 2012), possibly reinforcing the first-mover advantage. The effect moderately declined after 1960 and, by 1980, it stabilizes, remaining at around the same level through 2000. Relevant construction plans of both major and rural roads were undertaken between 1961 and 1974 through five distinct Highway Plans (Emmenegger, 2012). As a result, by 1970, colonial roads had lost their monopoly in transportation. In the 1980s and 1990s, during a period of major conflicts (the Eritrean War of Independence and the Ethiopian Civil War) and economic setback (Henze, 2000), the effect remained stable.

Interestingly, as shown in the bottom panel of Figure 3.2, a different story emerges from the marginal effects for Ethiopian cities (those with more than 10,000 residents) and towns (with more than 4,000 residents). Cities and towns only start showing a significantly higher concentration next to Italian roads from the late 1960s, roughly 20 years after the end of the colonial occupation. The size of the coefficients grows exponentially thereafter, reaching a peak of roughly a 10% higher probability of finding a city in treated locations in 2000.

3.7.2 Relocation, or population growth?

From a general equilibrium perspective, it is important to understand whether the initial increase in population came at a cost for neighbouring locations or whether settlement of foreign people (and firms) played a central role. Three possibilities exist: relocation from neighbouring cells, relocation from remote locations and immigration of foreigners from abroad (Italians and workers from neighbouring countries). By using information on location and relative size of villages for 1938 and 1939, I test which one of these mechanisms is stronger.[14] Following Berger and Enflo (2017), I introduce controls in equation 1 for separate distance cut-offs (20-30km, 30-40km, 40-50km and 50-60km) and one stacked cut-off (20-60km). The intuition behind this exercise is that, if sizeable relocation from neighboring cells takes place, one would expect to observe negative and significant coefficients.

[14] As pinpointed before, these sources are more reliable for granular-level analysis of the early post-construction period than reconstructed population densities from HYDE, which are instead marred by spatial correlation.

Table 3.3: Population relocation vs population growth in 1939

Dependent variables:	Villages 1939, 0-10km			Villages 1938, 0-10km			Fascist branch 0-10km	Fuel station 0-10km
Specification: Probit								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Road 1939, 0-10km	0.123***	0.116***	0.117***	0.084***	0.071***	0.076***	0.094***	0.102***
	(0.019)	(0.021)	(0.021)	(0.023)	(0.026)	(0.026)	(0.015)	(0.013)
Road 1939, 10-20km	0.014	0.007	0.008	-0.007	-0.020	-0.015	0.071***	0.079***
	(0.019)	(0.024)	(0.023)	(0.024)	(0.026)	(0.026)	(0.013)	(0.010)
Road 1940, 20-30km		-0.013			-0.043			
		(0.023)			(0.026)			
Road 1940, 30-40km		-0.013			-0.029			
		(0.020)			(0.019)			
Road 1940, 40-50km		-0.015			-0.004			
		(0.021)			(0.023)			
Road 1940, 50-60km		-0.002			0.013			
		(0.017)			(0.021)			
Road 1940, 20-60km			-0.010			-0.014		
			(0.015)			(0.016)		
Observations	10,088	10,088	10,088	10,088	10,088	10,088	8,006	10,083
Ethnic FE	YES	YES	YES	YES	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES	YES	YES

Marginal effects from a probabilistic model based on equation 1, with 11x11 grid-cells. The dependent variables are a dummy for village presence in 1939 (columns 1 to 3), a dummy for village presence in 1938 (columns 4 to 6) and dummies for being located within 20km from a branch of the fascist party and an Italian fuel station in column 7 and 8, respectively. Robust standard errors, clustered by 202 provincial colonial districts, in parentheses. Columns 1 to 6 include fixed effects for 53 ethnic groups from Murdock's map (Nunn, 2008). Columns 7 and 8 include fixed effects for the four regions in which Ethiopia was divided under colonial rule. The full set of controls is employed in all columns (see Table 3.1). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

As one can see from columns 2 and 3 of Table 3.3, relocation from nearby cells does not seem to be the primary driving force behind early agglomeration. Both the separate cut-off bins (column 2) and the stacked one (column 3) show insignificant coefficients. These results are mirrored by the estimates from the 1938 cross-section (columns 5 and 6) which also shows little re-location. To be precise, some cut-offs have negative signs, but their magnitude is always around a 1% probability of seeing a reduction in the settlement in neighboring locations. Moreover, both stacked bins' coefficients are much smaller than the coefficient of interest, which ranges, instead, from 7% to 11%. As the estimates based on binary outcomes for agglomeration could be imprecise or even fail to capture variation due to reduction in village size (rather than full disappearance of villages), I replicate the estimations in Table 3.3 as follows: I rank settlement by relative size, and run an ordinal probabilistic regression (Panel A, Table 3.A.8), this time also including 1935 settlement as a control (Panel B, Table 3.A.8). This additional exercise yields very similar results, which suggests that the jump in density observed in Figure 3.2, is chiefly - albeit not exclusively - related to the settlement of foreign migrants and relocation from more remote areas. This hypothesis is consistent with the secondary evidence (Del Boca, 1986a; Benti, 2016), and with the case of Kenya, where foreign migrants constituted a large share of the population next to railroads (Jedwab, Kerby, and Moradi, 2017).

The available data do not allow to test this hypothesis thoroughly, but some proxies on the location of Italian communities between 1936 and 1941 do exist in the form of fuel stations and offices of the Fascist Party. I test the relationship between colonial roads and proximity to these facilities in columns 7 and 8 of Table 3.3. Consistent with the hypothesis of immigration explaining part of the increase in population density in treated locations after 1936, I find a positive and significant association between proximity to colonial roads and the presence of Italian communities (roughly 10% higher likelihood for both) as proxied by location of Fascist Party facilities and gas stations.

Altogether, these results suggest that although migration of indigenous people from neighboring villages was probably in place on a small scale, initial agglomeration can be chiefly explained by the immigration of foreigners and relocation from distant cells.

3.7.3 Persistence

The monopoly in transportation and the increase in market access provided by transport infrastructure explain why people located next to Italian roads during the colonial period and up until 1960. By contrast, accounting for the persistent effect of colonial roads until today is less straightforward. In a diminishing or constant returns-to-scale scenario, people (and firms) should relocate when the first-mover advantage is lost due to congestion costs.

By 1973, roughly 17% of cells from the control group had already gained access to paved roads. This implies a total of roughly 1,600 new locations in addition to the 605 cells that had already been connected in 1940. Moreover, the original Italian network deteriorated significantly during the post-colonial era, due both to a lack of resources for maintenance, and to dramatic changes in the strategic commercial preferences after decolonization[15]. As a consequence, at its lowest point after the communist coup of 1974, only 48% of the network still had a paved surface[16]. Finally, Italian migrants, who arguably accounted for a significant share of the newly established population, overwhelmingly left after 1941. This phenomenon arguably created a negative shock in population and human capital (Del Boca, 1986a).

In this context, a first explanation for the persistence of the effect is a scenario in which decreasing returns to scale and non-fully depreciated sunk investments were disproportionally concentrated in treated areas when the first-mover advantage was still in place (Bleakley and Lin, 2012). If this were the case, the region would be gradually returning to the pre-colonial spatial equilibrium determined by location fundamentals (Davis and Weinstein, 2002; Miguel and Roland, 2011). An alternative explanation is that agglomeration effects linked to increasing returns to scale have consolidated the initial higher density this way leading to a persistent higher density equilibrium (Krugman, 1991; Krugman, 1993; Rosés, 2003).

To discern between these two possibilities, I first address the issue of sunk investment depreciation by looking at the change over time in the difference between the magnitude of the coefficients of the restricted and unrestricted model with respect to colonial investments. Second, I look at the role of path dependency in density and urbanization. Finally, I study the role of urbanization in explaining persistence and the dynamics that led to faster urbanization next to Italian roads during the post-colonial period.

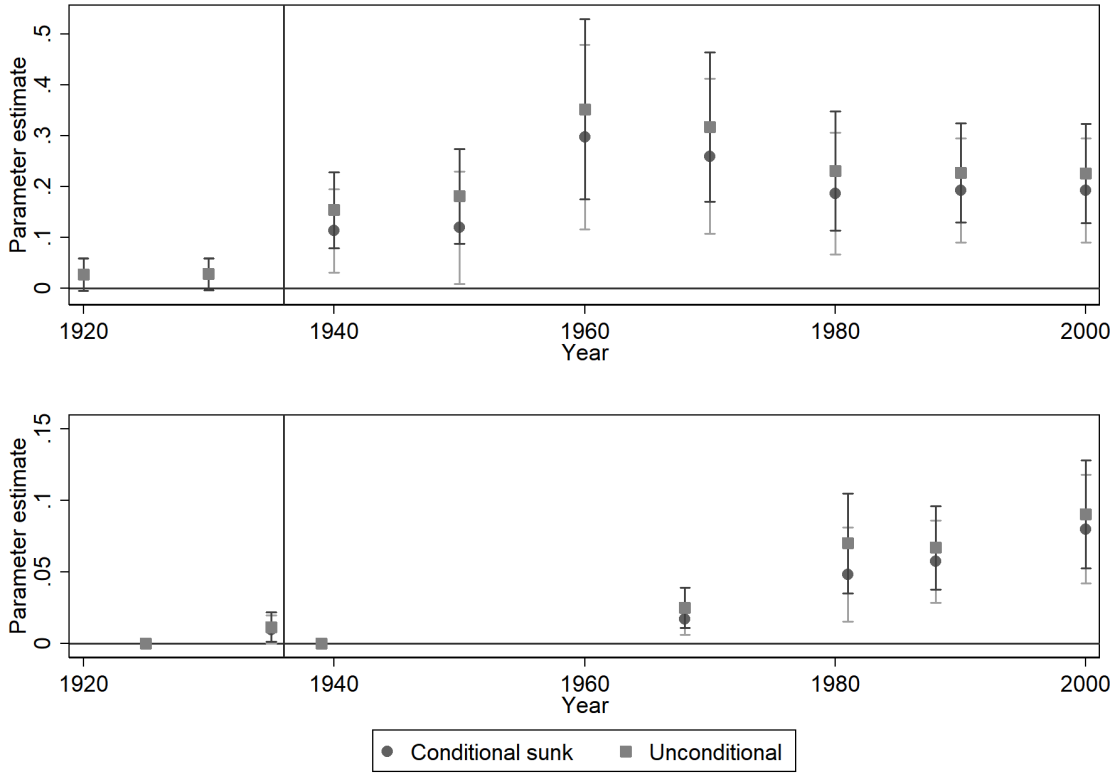
[15] After Somalia and, eventually, Eritrea became independent countries, connections with their capitals and ports were no longer a priority for the Ethiopian government. Linkages with the ports of Djibouti and Assab were preferred instead

[16] Figures from Table 3.A.9

Together, the results point to an explanation based on early increases in population density functioning as a coordination factor for the creation of cities. Faster urbanization in the post-colonial period led to the persistence of the higher density equilibrium thanks to gains in productivity and the coordination of factors.

3.7.3.1 Sunk investments depreciation

Figure 3.3: The effect of sunk investments over time



Top panel: population density. Bottom panel: cities (>10,000 inhabitants) Coefficients of the main explanatory variable of interest (equation 1) are reported with a 95% confidence interval for both the restricted and unrestricted model with respect to proximity to other colonial investments (unpaved tracks, railways, schools, hospitals and administrative capitals). Both panels reports estimates for the sub-sample of cells located in contemporary Ethiopia only. *Top panel*: OLS estimates (equation 1) with population density over time as dependent variable. *Bottom panel*: marginal effects from a probabilistic model (similar to equation 1) with cities (more than 10,000 inhabitants) as dependent variable. In the top panel, fixed effects for 53 ethnic groups from Murdock's map (Nunn, 2008), while the bottom panel - similarly to Figure 3.2 - only includes dummies for 4 regional administrative areas in which Italy split Ethiopia after occupation.

If sunk investment depreciation is in place, one would expect two trends: The effect of roads on population density and urban concentration should decrease over time. And, the

share of the effect explained by controls for colonial sunk investments (schools, hospitals, governmental buildings, unpaved tracks, and railways) should increase over time. The top panel of Figure 3.3 plots the coefficients of roads over time for both the unrestricted and restricted model (equation 3.1) with respect to sunk investments. The bottom panel reports estimates from the similarly specified probit model with a binary indicator for presence of cities with more than 10,000 inhabitants as the dependent variable.

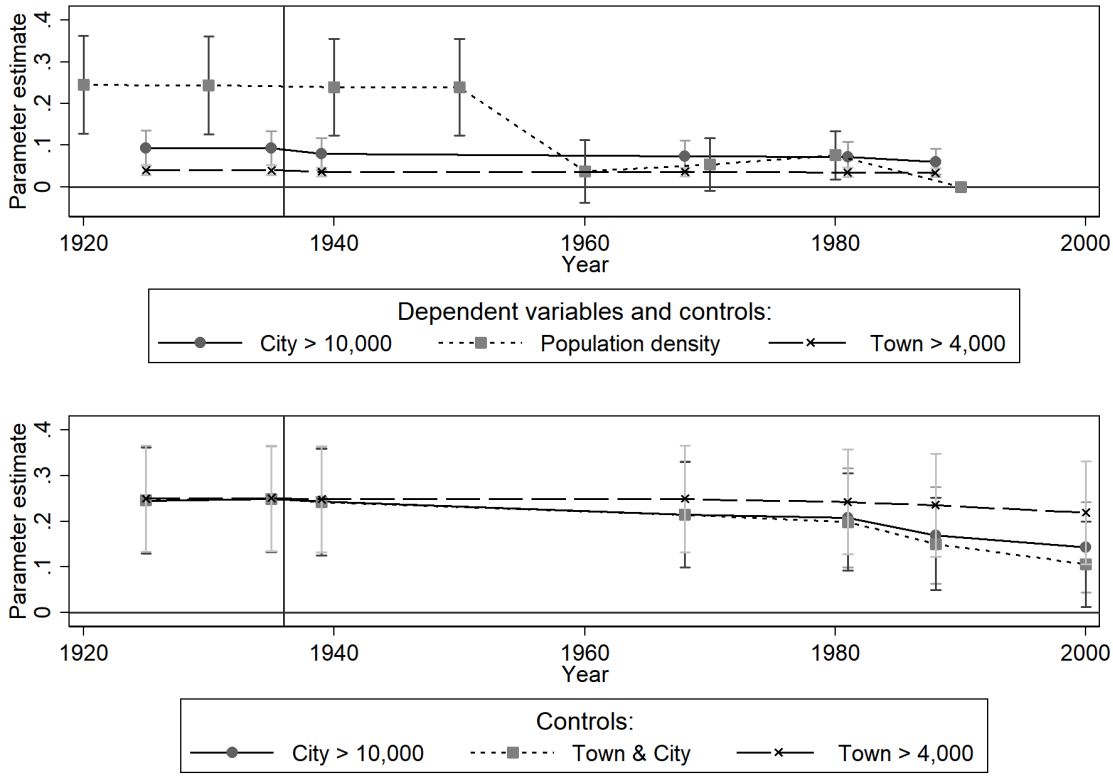
The effect of roads on population density stabilizes at around 0.2 standard deviations from 1980 onward. The effect of sunk investments reduces simultaneously, and, in 2000, it captures roughly 10% of the unrestricted coefficient, down from 25% in 1950. This finding suggests that the effect in 2000 not the result of a slow depreciation of other colonial facilities, but rather the outgrowth of a new stable equilibrium that was reached in 1980, and that provided a steady advantage to the treated locations. Interestingly, if one looks at the coefficients for cities in the bottom panel, the elasticity is increasing over time and takes off between 1960 and 1980, in parallel with the convergence towards an equilibrium in population density. The relative share of the effect explained by sunk investments reduces in coincidence with the urban take-off, which reinforces the validity of an explanation based on a new higher density equilibrium.

3.7.3.2 Persistence and urbanization

The literature on railroads has emphasized the role of increasing returns in explaining persistently higher levels of agglomeration, but the Ethiopian case presents a salient difference: while the related contributions find a substantial urban persistence in historically better-connected areas, higher urban density cannot be observed along Italian roads at the end of the colonial era (Figure 3.2). It follows that persistence cannot be explained by path dependence linked to the coordination effect of the existent urban network. This feature raises more questions on the interaction between the concentration of economic activity and urbanization. To what extent do population and urban network distribution at the end of the colonial period explain the effect of Italian roads in 2000?

In the top panel of Figure 3.4, I report the coefficient of paved roads from equation 1 with population density (OLS) and location of cities and towns (probit) in 2000 as dependent variables. For each estimation, I introduce lags of the dependent variable as reported by the x axis to test for path dependence. While population density in 1960 fully explains

Figure 3.4: Density and Urbanization



Coefficients for the main explanatory variable of interest (0-10km from Italian paved roads) with 95% confidence intervals from equation 1 are reported in both panels. Regressors as in model (1), see Table 3.1 for details. The analysis is limited to Ethiopia and to non-nodal locations *Top panel*: Dependent variables in 2000 as reported in the legend. Lagged controls of the same variable are included as indicated by the x axis. For estimates with cities and towns as dependent variables, marginal effects from a probit model are reported. *Bottom panel*: OLS estimates with population density in 2000 as dependent variable. Controls for the variables reported in the legend are introduced in chronological order as indicated by the x axis

the distribution of economic activity in 2000, the location of cities (and towns) in previous decades does not explain contemporary urban density. New cities formed next to colonial roads throughout the entire post-colonial period. Higher urban density does not merely reflect the existing urban network that was created at the end of the colonial period.

The next question I ask is whether the growing urban network absorbs an increasingly larger share of the elasticity of proximity to roads with respect to population density. I test this hypothesis in the bottom panel of Figure 3.4, where I run my baseline model with population density in 2000 as the dependent variable while adding controls for proximity to cities and towns over time as reported by the x axis. This exercise shows how the Ethiopian

urban network captures an increasingly larger share of population density in treated locations. Proximity to cities and towns explains roughly 50% of the concentration economic activity next to Italian roads in Ethiopia in 2000. The comparable figure for 1968 is roughly 10%. Treated locations are, therefore, less densely populated in relative terms than in the past, but more intensively urbanized.

In sum, the localized effect of railroads persisted in Kenya and Ghana thanks to increasing returns to scale and coordination of factors triggered by the urban equilibrium that formed during the colonial period; in the Ethiopian case, urban growth in treated areas continued at a faster pace than the comparison group (i.e., no path dependency in urban location).

3.7.3.3 Urbanization and increasing returns to scale

The increasing concentration of cities next to colonial roads is a suggestive hypothesis to explain the persistence of the effect of colonial roads on the distribution of the economic activity in Ethiopia. In fact, although a lively debate exists on the productivity effects of cities in developing countries (Gollin, Jedwab, and Vollrath, 2016)), there is widespread consensus on the association of cities with higher productivity through specialization and increasing returns to scale (Duranton, 2015; Venables, 2011), which could counteract centrifugal forces of congestion. If urbanization explains the persistence of the new higher density equilibrium, we should observe a concentration of factors and higher productivity next to Italian roads (Jedwab and Moradi, 2016)), while cities' location should capture the effect (Berger and Enflo, 2017). I test this hypothesis in Table 3.4, where I focus on hospitals, schools and individual wealth from the Demographic & Health Survey (DHS) (a proxy for income that gives an (imperfect) idea of productivity differentials across Ethiopia). Consistently with the working hypothesis, columns 1, 4 and 7 from Table 3.4 show that proximity to colonial roads indeed increases the likelihood of being located within 10km from a school or a hospital in 2000, and the average wealth of the population in 2011. The findings are consistent with the central role played by delayed urbanization in allowing the persistence of the higher density equilibrium. When population density alone is introduced as a control (columns 2, 5 and 8), the coefficients remain large and significant; by contrast, the effect disappears when controls for urbanization are introduced in the regression (columns 3, 6 and 9), which in turn suggests a causal link between urbanization, the concentration of factors and higher productivity.[17]

[17]The same applies if I perform the same exercise with employment structure (not shown)

Table 3.4: Colonial roads, coordination and path dependence

Dependent variables:	School 2000, 0-10km			Hospital 2000, 0-10km			DHS Wealth Index 2011		
Specification:	Probit						OLS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Road 1939, 0-10km	0.022***	0.016***	0.007**	0.062***	0.029*	-0.000	0.623**	0.593**	0.380
	(0.006)	(0.005)	(0.003)	(0.017)	(0.016)	(0.017)	(0.255)	(0.256)	(0.264)
Road 1939, 10-20km	-0.000	-0.001	-0.003	-0.011	-0.022*	-0.020*	-0.175	-0.170	-0.191
	(0.005)	(0.004)	(0.004)	(0.012)	(0.012)	(0.011)	(0.216)	(0.213)	(0.202)
Pop density 2000 z scores		0.015***	0.009***		0.103***	0.085***		2.587***	1.637***
		(0.003)	(0.002)		(0.010)	(0.010)		(0.619)	(0.546)
City 2000, 1-0			0.018***			0.033***			0.347**
			(0.004)			(0.011)			(0.141)
Town 2000, 1-0			0.017***			0.170***			0.296*
			(0.004)			(0.016)			(0.157)
Observations	8,011	8,011	8,011	10,088	10,088	10,088	10,091	10,091	10,091
R-squared	.	.	.	.	.	.	0.19	0.20	0.21
Ethnic FE	NO	NO	NO	NO	NO	NO	YES	YES	YES
State FE	YES	YES	YES	YES	YES	YES	NO	NO	NO
Precolonial Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Colonial Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Geographical Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES

Columns 1 to 6: Probit estimates with dummies for being located between 0 and 10 km from different types of post-colonial facilities from the 11x11km grid dataset. Columns 7 to 9: OLS estimates with wealth index as dependent variable from individual DHS dataset from Ethiopia (see Table 3.A.2). Robust standard errors, clustered by 202 provincial colonial districts, are reported in parentheses. The full set of controls is included in columns 1 to 9 (see Table 3.1). The dependent variables employed in columns 1 to 6 were only available for Ethiopia and Eritrea, which reduces the sample size to 11,382 cells. For columns 8 and 9 data were available for Ethiopia only, which further reduces the sample size to 10,260 units. See Appendix 3.B for details on the sources. *** p<0.01, ** p<0.05, * p<0.1

Transport costs in treated locations relative to the control group remained, at best, stable over time, and most likely increased due to the deterioration of the Italian network in the post-colonial era. As a result, the rising levels of urbanization observable after the 1960s are likely to be determined by the initial increase in market access linked to the redistribution of the population that took place between 1936 and 1960. A detailed analysis of the urbanization dynamics within treated areas that would allow greater understanding of the combination of location fundamentals and changes in market access (Ploeckl, 2012) that determined urbanization in certain cells but not in others is beyond the scope of this paper and the available data.

However, it is important to show more formally whether higher density in 1960 (at the end of the first-mover advantage) is associated with higher urban density in later periods. I do so in Table 3.A.10 in Appendix 3.A. I run a simple probabilistic regression that looks at the association between Market Potential *à la Harris* (Harris, 1954) (see Appendix 3.B for details on the calculation) and location of cities over time. The results show (after conditioning on the location of cities in $t-1$) a strong and positive association between market potential in 1960 and the location of cities in 1968, 1981 and 1988. This pattern, in turn, confirms that the fastest urbanization observed in treated locations is related to the spatial equilibrium that was achieved before the first-mover advantage was lost.

3.8 Conclusion

In this paper, I exploit the quasi-natural experiment provided by Italian road building in the Horn of Africa, to study the effect of colonial roads on economic development. To do so, I create an 11x11-km-grid dataset, covering Eritrea, Ethiopia, and Italian Somalia, and containing spatially explicit information on Italian investments. These are contemporary proxies for economic development.

Regression analysis shows that cells within a 10km radius of Italian paved roads are more developed today, both in terms of economic concentration and income. These cells have a higher concentration of cities compared to the control group. A 2SLS estimation based on the least costly paths connecting the network's termini, and a falsification exercise that exploited roads that had been started but could not be paved due to the outbreak of World War II

confirm the results: Italian roads caused these regions to become more agglomerated and richer.

The analysis of the mechanisms pinpoints how Italian roads fostered an increasing concentration of economic activity (proxied by population density and location of villages) immediately after construction (between 1936 and 1940) and until 1960. After 1960, although population concentration stabilized, treated locations maintained their advantage, despite the construction of new roads, and the deterioration of large parts of the Italian network. I explain this persistence through faster urban growth in treated locations. The initial increase in population provided an advantage in access to markets. The productivity gains achieved through urbanization counteracted centrifugal forces and determined the persistence of a higher density equilibrium.

This article focuses on the relationship between transportation infrastructure and agglomeration. The issues of social savings and market integration in the Italian colonies remain unexplored topics. Furthermore, this paper finds a localized positive association between colonial infrastructure and agglomeration; however, it does not address the question of whether transport facilities were allocated optimally, or whether they created inefficiencies and congestion in the distribution of the economic activity. Such matters remain open and particularly essential issues in the colonial context. Future research should focus on these aspects.

Appendices

3.A Additional estimations and figures chapter 3

Table 3.A.1: Summary Statistics

	(1) mean	(2) sd	(3) min	(4) max	(5) N
Population density, 2000	40.99	77.81	0	1,623	15,288
ln luminosity 2010	-4.521	0.676	-4.605	2.834	15,288
Road 1939, 0-10km	0.0440	0.205	0	1	15,288
Road 1939, 10-20km	0.0451	0.208	0	1	15,288
Track 1935, 0-10km	0.216	0.412	0	1	15,288
Track 1935, 10-20km	0.166	0.372	0	1	15,288
Population density, 1920	9.354	9.517	0	227.1	15,288
Population density, 1930	10.18	10.23	0	137.7	15,288
Telegraph 1934 CMI, 0-10km	0.0829	0.276	0	1	15,288
Rail 1940, 0-10km	0.00863	0.0925	0	1	15,288
Track 1940, 0-10km	0.0544	0.227	0	1	15,288
District capital 1940, 0-10km	0.0288	0.167	0	1	15,288
Secondary hospital 1940, 0-10km	0.0309	0.173	0	1	15,288
Main hospital 1940, 0-10km	0.00124	0.0352	0	1	15,288
School 1940, 0-10km	0.00922	0.0956	0	1	15,288
Dummy mining 1940	0.142	0.349	0	1	15,288
River, 0-10km	0.318	0.466	0	1	15,288
Coast, 0-10km	0.0117	0.108	0	1	15,288
Rainfall	11.26	11.56	0	95.17	15,288
Malaria index	6.527	5.044	0	31.17	15,288
Altitude	947.5	738.7	-119.5	4,140	15,288
Latitude	8.023	3.821	-0.367	16.67	15,288
Longitude	41.23	4.016	34.53	51.27	15,288
Ruggedness	1,499	1,183	0	6,593	15,288
Temperature	24.45	4.547	0	33.74	15,288
Land Suitability	5.804	1.472	0	9	15,288

Summary statistics of dependent, explanatory and control variables from equation 1. See Appendix 3.B for details on individual variables. Similarly to the baseline estimation in Table 3.1, the sample is restricted to non-nodal locations.

Figure 3.A.1: The Italian colonies of the Horn of Africa

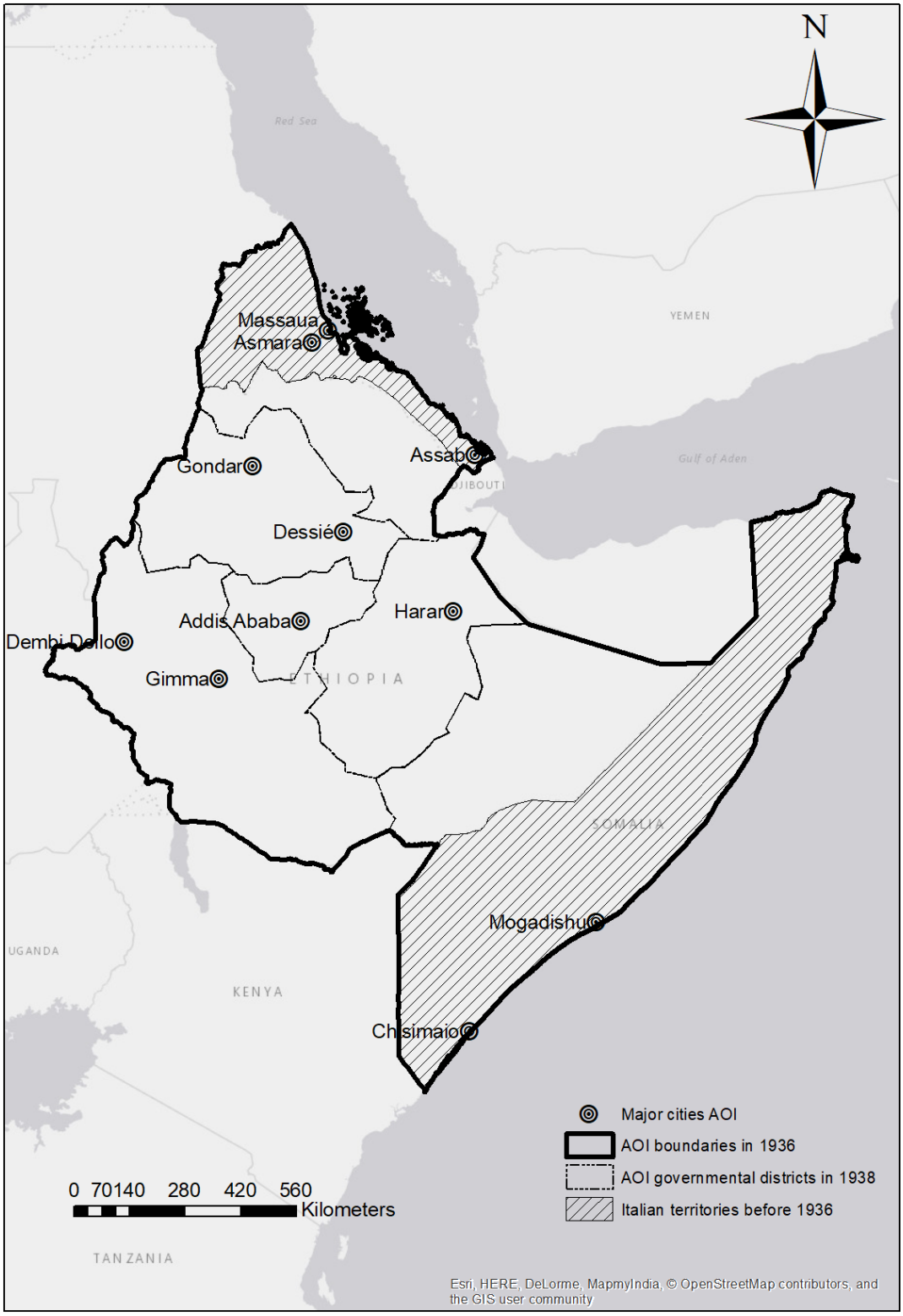


Table 3.A.2: Italian roads and contemporary standards of living

Dependent variables:	DHS Wealth Index			
	(1)	(2)	(3)	(4)
Road 1939, 0-10km	0.843***	0.737***	0.642**	0.623**
	(0.218)	(0.244)	(0.260)	(0.255)
Road 1939, 10-20km	-0.129	-0.187	-0.143	-0.175
	(0.195)	(0.211)	(0.217)	(0.216)
Observations	10,091	10,091	10,091	10,091
R-squared	0.12	0.13	0.17	0.19
Ethnic FE	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES

OLS regression estimates (see equation 3.1) employing data from the 2011 male DHS dataset, in columns 1 to 4; household's wealth index is employed as dependent variable. All columns include fixed effects for 53 ethnic groups from Murdock's map (Nunn, 2008). The same set of controls of the baseline estimation (see Table 3.1 for details) is employed and all columns exclude clusters located within 20km from the network's termini. Robust standard errors, clustered by 202 provincial colonial districts, are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

Figure 3.A.2: Robustness checks

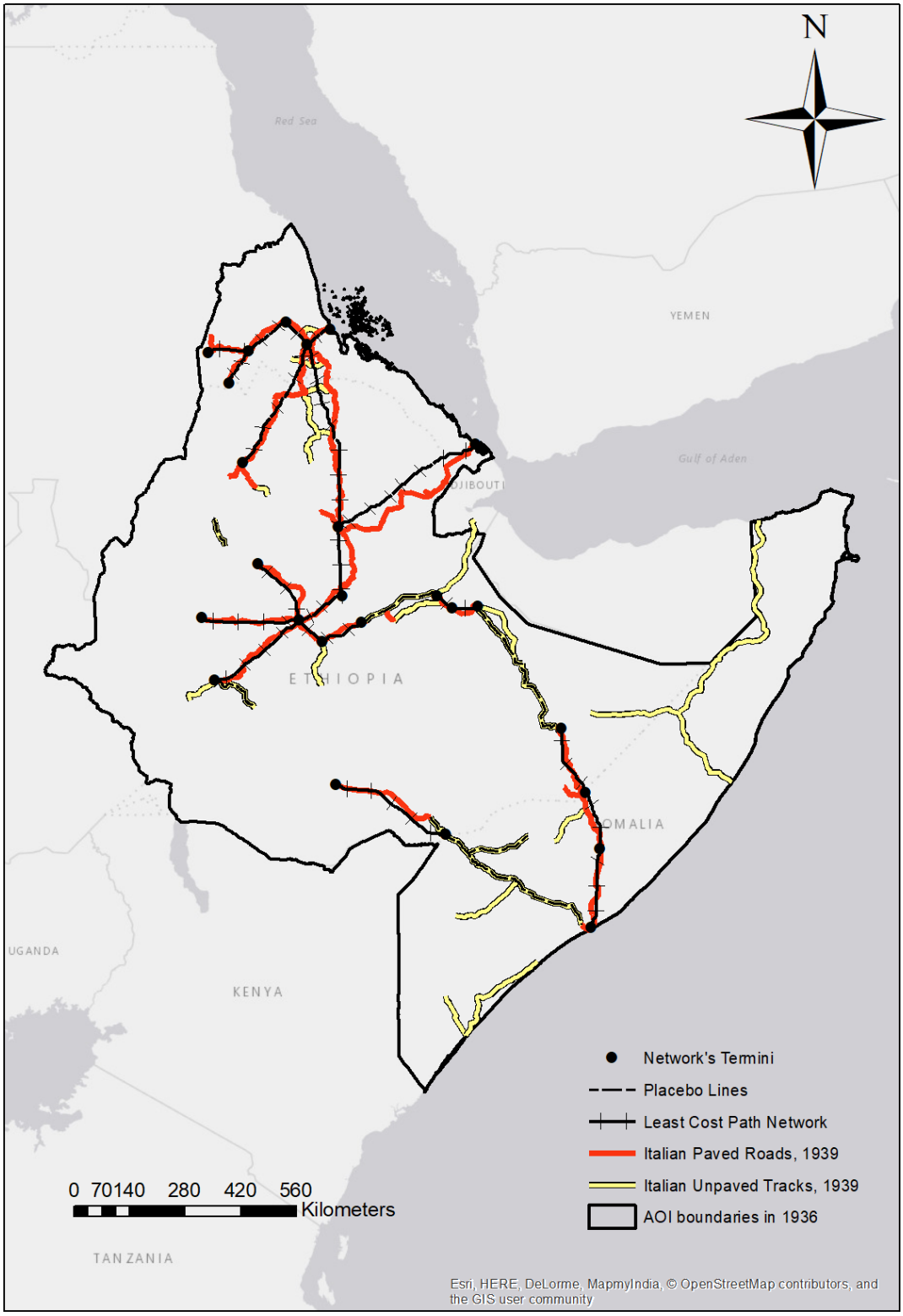


Table 3.A.3: Descriptive statistics, individual men dataset

	(1) mean	(2) sd	(3) min	(4) max	(5) N
wealth index	2.787	1.417	1	5	10,091
Professional/technical/managerial, 1-0	0.0393	0.194	0	1	10,091
Agriculture - employee, 1-0	0.757	0.429	0	1	10,091
Services, 1-0	0.00842	0.0914	0	1	10,091
Skilled manual, 1-0	0.0388	0.193	0	1	10,091
Road 1939, 0-10km	0.0983	0.298	0	1	10,091
Road 1939, 10-20km	0.0830	0.276	0	1	10,091
Track 1935, 0-10km	0.222	0.415	0	1	10,091
Track 1935, 10-20km	0.149	0.357	0	1	10,091
Telegraph 1934 CMI, 0-10km	0.161	0.368	0	1	10,091
Population density, 1920	18.02	10.60	0	66	10,091
Population density, 1930	19.50	11.34	0	69	10,091
Rail 1940, 0-10km	0.00634	0.0794	0	1	10,091
Track 1940, 0-10km	0.0610	0.239	0	1	10,091
District capital 1940, 0-10km	0.0827	0.276	0	1	10,091
Secondary hospital 1940, 0-10km	0.0845	0.278	0	1	10,091
Main hospital 1940, 0-10km	0.00287	0.0535	0	1	10,091
School 1940, 0-10km	0.0386	0.193	0	1	10,091
Dummy mining 1940	0.252	0.434	0	1	10,091
River, 0-10km	0.574	0.494	0	1	10,091
Rainfall	12.43	11.54	0	72	10,091
Malaria index	3.465	4.953	0	21	10,091
Ruggedness	2,136	1,071	1	5,151	10,091
Temperature	20.12	4.192	9.900	32	10,091
Land Suitability	4.957	1.325	1	9	10,091
Latitude	9.795	2.512	3.536	14.55	10,091
Longitude	38.08	2.084	33.28	43.79	10,091
Altitude	1,670	663.9	0	3,322	10,091

Descriptive statistics for the variables of equation 1, individual DHS dataset (Table 3.A.2).

Table 3.A.4: Additional robustness tests for Table 3.1: 1

Dependent variables:	Pop density 2000, z scores					
Specification:	Baseline	No FE	Full sample	No targets 30km	< 10km Roads 2000	Dist targets
	(1)	(2)	(3)	(4)	(5)	(6)
Road 1939, 0-10km	0.193***	0.166***	0.231***	0.189***	0.155***	0.184***
	(0.052)	(0.059)	(0.068)	(0.053)	(0.053)	(0.051)
Road 1939, 10-20km	0.059*	0.040	0.042	0.047	0.062*	0.050
	(0.032)	(0.038)	(0.062)	(0.032)	(0.037)	(0.032)
Log dist targets, km						-0.025
						(0.018)
Observations	15,288	15,288	15,550	14,965	8,594	15,288
R-squared	0.56	0.41	0.27	0.56	0.63	0.56
Ethnic FE	YES	NO	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES

The full set of controls and fixed effects are included in columns 1 to 6 (see Table 3.1 for a description). Column 1 reports the baseline estimation from column 4 of Table 3.1. Columns 2 and 3 drop fixed effects and include nodal locations, respectively. Column 4 drops cells located within 30km from targets. Column 5 limits the sample to cells located within 10km from contemporary roads. Column 6 controls for logarithmic distance from targets. *** p<0.01, ** p<0.05, * p<0.1

Table 3.A.5: Additional robustness tests for Table 3.1: 2

Specification:	Baseline	No low-lands	< 200km	<100km	<50km	Province FE	Regional FE	State FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Road 1939, 0-10km	0.193***	0.322***	0.191***	0.203***	0.219***	0.224***	0.189***	0.160**
	(0.052)	(0.079)	(0.052)	(0.051)	(0.046)	(0.054)	(0.054)	(0.062)
Road 1939, 10-20km	0.059*	0.118**	0.058*	0.061*	0.071**	0.083**	0.069**	0.037
	(0.032)	(0.047)	(0.032)	(0.032)	(0.028)	(0.033)	(0.033)	(0.040)
Track 1935, 0-10km	0.102***	0.092***	0.107***	0.093***	0.119***	0.100***	0.107***	0.102***
	(0.026)	(0.034)	(0.026)	(0.031)	(0.032)	(0.028)	(0.029)	(0.031)
Track 1935, 10-20km	0.059***	0.045*	0.069***	0.036	0.038	0.059***	0.068***	0.063**
	(0.016)	(0.026)	(0.019)	(0.022)	(0.024)	(0.018)	(0.020)	(0.024)
Pop density 1920 z scores	0.162**	0.076	0.177***	0.139**	0.143***	0.185***	0.191***	0.199***
	(0.063)	(0.081)	(0.062)	(0.057)	(0.049)	(0.069)	(0.067)	(0.075)
Pop density 1930 z scores	0.131*	0.209**	0.107	0.060	0.072	0.120	0.176*	0.240**
	(0.068)	(0.088)	(0.070)	(0.075)	(0.075)	(0.078)	(0.100)	(0.114)
Telegraph 1934 CMI, 0-10km	0.030	-0.020	0.020	0.065*	0.031	0.037	0.039	0.050
	(0.032)	(0.041)	(0.034)	(0.033)	(0.033)	(0.033)	(0.032)	(0.033)
Rail 1940, 0-10km	0.044	0.027	0.049	0.014	-0.017	0.017	-0.006	0.099
	(0.086)	(0.089)	(0.090)	(0.107)	(0.128)	(0.060)	(0.064)	(0.067)
Track 1940, 0-10km	0.146**	0.225*	0.192**	0.266***	0.215**	0.105*	0.109*	0.158**
	(0.060)	(0.131)	(0.090)	(0.099)	(0.097)	(0.055)	(0.056)	(0.065)
District capital 1940, 0-10km	0.100*	0.062	0.118*	0.061	0.044	0.117**	0.123**	0.106*
	(0.055)	(0.077)	(0.063)	(0.069)	(0.078)	(0.049)	(0.050)	(0.058)
Secondary hospital 1940, 0-10km	0.129**	0.086	0.168**	0.102	0.013	0.127**	0.141**	0.176**
	(0.060)	(0.122)	(0.068)	(0.085)	(0.061)	(0.051)	(0.055)	(0.074)
Main hospital 1940, 0-10km	0.038	-0.099	0.002	0.160	0.249	0.126	0.128	0.038
	(0.169)	(0.245)	(0.193)	(0.242)	(0.241)	(0.194)	(0.197)	(0.190)
School 1940, 0-10km	0.130*	0.193	0.089	0.094	0.153*	0.089	0.077	0.046
	(0.077)	(0.117)	(0.086)	(0.090)	(0.085)	(0.072)	(0.075)	(0.094)
Observations	15,288	5,713	11,143	6,553	3,486	15,288	14,955	15,288
R-squared	0.56	0.54	0.56	0.55	0.57	0.59	0.52	0.42
Ethnic FE	YES	YES	YES	YES	YES	NO	NO	NO
Precolonial controls	YES	YES	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES	YES	YES
State FE	NO	NO	NO	NO	NO	NO	NO	YES
Regional FE	NO	NO	NO	NO	NO	NO	YES	NO
Provincial FE	NO	NO	NO	NO	NO	YES	NO	NO

The full set of controls included in columns 1 to 8 (see Table 3.1 for a description). Robust standard errors, clustered by 202 colonial provincial districts, in parentheses. Column 1 reports the baseline estimation from column 4 of Table 3.1. In columns 2 to 5, the comparison group is restricted: column 2 restricts the sample to those cells that had an average altitude between 800 and 2,000 meters above sea level. Columns 3, 4, and 5 restrict the sample to cells located within 200, 100, and 50km from Italian paved roads, respectively. In columns 6 to 8, I employ different sets of fixed effects, using different administrative colonial units: in column 6, 202 provincial boundaries ("residenze"); in column 7, 73 regional boundaries ("commissariati"); in column 8, six state boundaries ("governi"). *** p<0.01, ** p<0.05, * p<0.1

Table 3.A.6: Light density robustness and different cells size

Dependent variables:	ln luminosity 2010					Pop density 2000
Specification:	10x10km Baseline	10x10km IV first	10x10km IV LCP 0-10km	10x10km Placebo	30x30km Baseline	30x30km Baseline
	(1)	(2)	(3)	(4)	(5)	(6)
Road 1939, 0-10km	0.345***		0.314*		0.305***	0.459***
	(0.087)		(0.168)		(0.111)	(0.174)
Road 1939, 10-20km	-0.042	-0.235***	-0.048		0.196	0.401***
	(0.043)	(0.016)	(0.049)		(0.131)	(0.124)
0-10km, IV LPC 1940		0.447***				
		(0.054)				
Proj road 1937 unpav, 0-10km				-0.115*		
				(0.059)		
Proj road 1937 unpav, 10-20km				-0.035		
				(0.032)		
Observations	15,288	15,288	15,288	15,288	1,719	1,719
R-squared	0.10	0.39	0.07	0.09	0.19	0.44
cdf	.	.	3538	.	.	
rkf	.	.	68.50	.	.	.
Ethnic FE	YES	YES	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES

The full set of controls and fixed effects are included in columns 1 to 7 (see Table 3.1, main text, for a description). Robust standard errors, clustered by 202 colonial provincial districts, in parentheses. Column 1 reports the baseline estimation (column 5, Table 3.1). Columns 1 to 5 employ the 11x11km grid dataset, columns 6 and 7 replicate baseline estimations for Light density and population density (columns 4 and 5, Table 3.1, main text) with a 33x33km (0.3x0.3 decimal degrees) grid dataset. In columns 2, 3, 4, and 5, I replicate the main robustness checks (Table 3.2) with the logarithm of light density at night in 2010 as dependent variable. In columns 2, roads projected but not completed are employed. In column 3, unpaved colonial roads are used. Columns 4 and 5 report IV estimates for straight lines connecting major cities and telegraphic & telephonic lines before 1936, respectively.

Table 3.A.7: Differences in observables' means between placebo and treated observations

	Mean	t-stat
	(1)	(2)
Rainfall	-0.360	(-0.53)
Land Suitability	0.367***	(4.50)
Temperature	3.209***	(8.96)
Agglomeration 1935, 1-0	-0.0281	(-0.99)
City 1935, 1-0	0.0750**	(2.95)
Town 1935, 1-0	-0.0259	(-1.22)
Track 1935, 0-10km	0.0135	(0.37)
Telegraph 1934 CMI, 0-10km	-0.00858	(-0.25)
Observations	918	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.A.8: Alternative estimates for re-location

Panel A						
Dependent variables:	Village Rank, 1939			Village Rank, 1938		
	(1)	(2)	(3)	(4)	(5)	(6)
Road 1939, 0-10km	0.498***	0.473***	0.473***	0.405***	0.382***	0.421***
	(0.065)	(0.077)	(0.076)	(0.086)	(0.098)	(0.101)
Road 1939, 10-20km	0.075	0.051	0.051	0.025	0.001	0.121
	(0.068)	(0.085)	(0.084)	(0.080)	(0.093)	(0.093)
Road 1940, 20-30km		-0.041			-0.099	
		(0.086)			(0.092)	
Road 1940, 30-40km		-0.031			-0.066	
		(0.075)			(0.068)	
Road 1940, 40-50km		-0.066			-0.016	
		(0.076)			(0.076)	
Road 1940, 50-60km		-0.030			0.068	
		(0.064)			(0.072)	
Road 1940, 20-60km			-0.042			0.006
			(0.055)			(0.053)
Panel B						
Dependent variables:	Villages 1939, 0-10km			Villages 1938, 0-10km		
	(1)	(2)	(3)	(4)	(5)	(6)
Road 1939, 0-10km	0.122***	0.117***	0.117***	0.081***	0.070***	0.074***
	(0.017)	(0.020)	(0.020)	(0.024)	(0.026)	(0.026)
Road 1939, 10-20km	0.014	0.009	0.009	-0.007	-0.018	-0.013
	(0.018)	(0.023)	(0.022)	(0.023)	(0.025)	(0.025)
Road 1940, 20-30km		-0.009			-0.040	
		(0.021)			(0.025)	
Road 1940, 30-40km		-0.010			-0.027	
		(0.019)			(0.019)	
Road 1940, 40-50km		-0.012			0.000	
		(0.020)			(0.022)	
Road 1940, 50-60km		-0.003			0.014	
		(0.017)			(0.020)	
Road 1940, 20-60km			-0.008			-0.011
			(0.014)			(0.015)
Agglomeration 1935, 1-0	0.227***	0.227***	0.227***	0.179***	0.179***	0.179***
	(0.014)	(0.014)	(0.014)	(0.018)	(0.018)	(0.018)
Observations	10,088	10,088	10,088	10,088	10,088	10,088
Ethnic FE	YES	YES	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES

Panel A: marginal effects from an ordinal probabilistic regression, which exploits the ranking of cities from colonial maps (Dardano, 1939; Cartografico, 1938?). Panel B: marginal effects similar to Table 3.3 (see main text), but controlling for settlement in 1925. Both panels include the standard set of controls and fixed effects. Robust standard errors, clustered by 202 provincial colonial districts, in parentheses. Columns 1 to 6 include fixed effects for 53 ethnic groups from Murdock's map (Nunn, 2008). Columns 7 and 8 include fixed effects for the four regions in which Ethiopia was divided under colonial rule. The full set of controls is employed in all columns (see Table 3.1). *** p<0.01, ** p<0.05, * p<0.1

Table 3.A.9: Transformation of the road network in Ethiopia, 1955-2011

	(1)	(2)
Deterioration, %	mean	N
1955	0.172	605
1962	0.283	605
1973	0.174	605
1981	0.526	605
1988	0.486	605
2011	0.0926	605
Expansion, %		
1955	0.0997	9,655
1962	0.0669	9,655
1973	0.167	9,655
1981	0.0643	9,655
1988	0.0732	9,655
2011	0.169	9,655

The table refers to contemporary Ethiopia only. "Deterioration" is a dummy that equals one if a cell's centroid was located within 10km from an Italian paved road, but has lost accessibility (not within a 10km radius from a paved road) in one of the following years. "Expansion" equals one if a cell of the control group in 1940 (farther than 10km away from a paved road) gains accessibility to an asphalted road in the post-colonial period.

Table 3.A.10: Market potential and urbanization

Dependent variables:	City 1925 1-0	City 1935 1-0	City 1939 1-0	City 1968 1-0	City 1981 1-0	City 1988 1-0	City 2000 1-0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
External MP, 1960	0.000	-0.021	-0.000	0.026**	0.169***	0.092***	0.006
	(0.000)	(0.015)	(0.000)	(0.012)	(0.057)	(0.024)	(0.043)
Internal MP, 1960	0.000	0.000	0.000	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
City 1925, 1-0		0.052***					
		(0.015)					
City 1935, 1-0			0.000				
			(0.000)				
City 1939, 1-0				0.020**			
				(0.008)			
City 1968, 1-0					0.085***		
					(0.019)		
City 1981, 1-0						0.056***	
						(0.010)	
City 1988, 1-0							0.141***
							(0.015)
Observations	4,331	9,996	7,919	8,011	8,006	8,011	10,088
State FE	YES	YES	YES	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES	YES	YES	YES

Marginal effects from a probabilistic model in columns 1 to 7 from the grid dataset (11x11 km) but restricted to Ethiopia. All columns include fixed effects for the 6 state administrative boundaries created by the Italian colonial administration. All columns include the full set of controls (see Table 3.1) and the error term is clustered at the provincial level *** p<0.01, ** p<0.05, * p<0.1

Table 3.A.11: Colonial roads and employment structure: DHS individual data

Professions	professional	agricultural worker	services	skilled manual
Probit	(1)	(2)	(3)	(4)
Road 1939, 0-10km	0.0228***	-0.133**	0.00652**	0.0123
	(0.00836)	(0.0586)	(0.00271)	(0.0110)
Road 1939, 10-20km	-0.00763	0.0195	-0.00168	-0.00407
	(0.0117)	(0.0575)	(0.00315)	(0.0167)
Observations	10,062	10,091	10,062	10,062
Ethnic FE	NO	NO	NO	NO
Precolonial controls	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES
Geographical controls	YES	YES	YES	YES

Probit estimates from the 2011 individual men DHS dataset, in columns 1 to 4. Binary variables with types of employment are employed as dependent variables. Marginal effects are reported. *Professional* includes managers, teachers, and engineers (column 1). *Agricultural workers* defines workers in the primary sector (column 2). *Services* includes all workers in insurance services, banking, and, more generally, the tertiary sector, excluding column 1 and sales (column 3). Columns 4 reports estimates for *skilled manuals*. The same set of controls of the baseline estimation (see Table 3.1 for details) is employed and all columns exclude clusters located within 20km from the network's termini. Robust standard errors, clustered by 202 provincial colonial districts, are reported in brackets. *** p<0.01, ** p<0.05, * p<0.1

3.B Data appendix chapter 3

3.B.1 Dependent variables

1. **Population density 1960-2000**: from the Unep/Grid Sioux Falls database[18], raster format (0.04 x 0.04 decimal degrees). It is combined with the grid dataset by averaging all raster's cell, whose centroid falls within a grid's cells. The raster dataset is constructed from district-level population statistics, which are distributed on the raster surface through an accessibility index that incorporates agglomerations and cost-distances. Population densities are calculated by dividing population count per cell by the actual area of the cell (different latitudes can cause severe distortions in the grid). This source covers the period between 1960 and 2000.

2. **Population density 1900-1950**: reconstructed population density from the History Database of Global Environment (HYDE)[19], it is based upon available historical statistical and back-projected cropland and pasture statistics, available in raster format (0.08x0.08 decimal degrees). The reconstruction is accurate for Eritrea and Somalia, whereas the Ethiopian territory shows a significant spatial correlation.

3. **Villages 1925-1939**: data on location and relative size of small human agglomerations have been digitized from different sources: data on villages' locations for Ethiopia, Eritrea and Italian Somalia come from a set of Maps by the Cartographic office of the Ministry of the colonies for the years 1925, 1935 and 1939 (Dardano, 1925; Dardano, 1935; Dardano, 1939). An additional year could be added by using a tourist map of the Consociazione Turistica Italiana from 1938 (Cartografico, 1938?).

4. **Cities and Towns 1925-2000**: data on towns larger than 4,000 inhabitants and cities with more than 10,000 inhabitants come from various cartographic sources and only cover Ethiopia consistently over time. For the years 1925, 1935 and 1939 these are retrieved from Achille Dardano's series of maps. Settlement ranked in position three are taken as towns, while 4 and above as cities. For 1968 data come from a Russian intelligence map and cover Ethiopia and Eritrea only (USSR, 1968). Cities and towns

[18] Available at http://na.unep.net/siouxfalls/datasets/datalist.php, last accessed on 20th of April 2016

[19] Available at http://themasites.pbl.nl/tridion/en/themasites/hyde/download/index-2.html, last accessed on 20th of April 2016

for 1981 and 1988 come the official atlases of Ethiopia. (Agency, 1981; Authority, 1988). Finally, Ethiopian cities in 2000 can be downloaded from GIS online (Ajhethiopia, 2000?)[20]. Cells are attributed to a town if their centroid falls within 10km from a town's location. By contrast, cells are coded as being part of a city if their centroid falls within a 20km radius.

5. **Satellite Light Density 2010**: the employed data are accessible from the National Geophysical Data Center (NOAA) in a raster format (0.008x0.008 decimal degrees)[21]. I converted pixels to points, and, for each cell, I calculated the average value of the contained points. This raster depicts the measured average nightly luminosity produced by humans, and it is corrected for potential natural lights and atmospheric phenomena.

6. **Individual living standards 2011**: the individual dataset has been downloaded from the USAID website[22] and was collected in the context of the Ethiopian "Demographic and Health Survey" from 2011. For each individual, this source provides categorical information about profession, frequency in accessing media (television, radio, and newspapers) and preferred types of payment, together with a wealth index that combines all goods and assets owned by the individual's household. The database contains 14,110 men, but due to a village having the wrong coordinates, I was unable to use the full sample, which left me a total of 13,528 observations. Each individual is linked to one of the 649 geo-coded Ethiopian villages available; their location has been modified for anonymity purposes within a 5km radius. When residents living within 20km of the Italian road network's targets are excluded, the sample shrinks to 10,091 individuals.

3.B.2 Historical data

1. **Colonial road network**: paved and unpaved colonial roads completed and under construction in 1939 were digitized from the map *Carta progressiva delle costruzioni stradali* contained in the 4th issue of 1939 (outside text). Only distance from finished roads, categorized as "completed" in this map, was considered. The map was digitized, and the Euclidean distance of each cell's centroid from paved and unpaved roads was calculated.

[20] Last accessed on 21st November 2017

[21] Available at http://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html, last accessed on 20th April 2016

[22] Available at http://www.dhsprogram.com/Data/, last accessed on 20th of April 2016

2. **Colonial railroads**: with respect to the location of colonial railroads, for Eritrea and Ethiopia the data come from DIVA GIS[23] (functioning railroads have not changed since 1941) whereas, for Somalia, where colonial trunks were dismissed, I have geo-referenced the map *Carta dei commissariati, delle residenze, delle vie di comunicazione e delle popolazioni* (outside text) in Guido Corni's 1937 book *Somalia Italiana*.

3. **Colonial facilities in 1940**: colonial primary and secondary hospitals and colonial schools for indigenous people can be found in a series of maps (one per government per type of investment) in issue 1 of 1940 of "Annali dell'Africa Italiana".

4. **Administrative units in 1940**: colonial district capitals, along with provincial (Residenze), regional (Commissariati) and governmental (Governi) boundaries come from the map "Circoscrizioni amministrative dell'Arica Orientale Italiana", contained in the 1939's 3rd issue of *Annali dell'Africa Italiana* (outside text).

5. **Areas of mining interest in 1940**: information on whether a cell's centroid falls within a zone of mining interest come from the map *Carta mineraria dell'AOI* from issue 2 of 1940 (outside text) of *Annali dell'Africa Italiana*. All cell's centroids falling within these areas are considered suitable for mining exploitation.

6. **Pre-1936 transmission lines**: telegraph and telephone lines were digitized from the map "Impero etiopico - Rete delle trasmissioni" (CMI, 1935).

7. **Pre-colonial tracks**: the location of pre-colonial tracks employed in the baseline were digitized from Dardano's map from 1925 (Dardano, 1925).

8. **Post-colonial transportation network**: post-colonial data on the road network come from various maps and atlases published by the Ethiopian government, which I have geo-coded and digitized. These only cover the territories of Ethiopia and Eritrea. The road network in 1955, 1962 and 1973 has been reconstructed from a series of maps produced by the Ethiopian Imperial Highway Authority (Authority, 1955; Authority, 1962; Authority, 1973), while maps from the "National Atlases of Ethiopia" were employed to reconstruct the transportation network in 1981 and 1988 (Agency, 1981; Authority, 1988). Contemporary roads can be downloaded from DIVA-GIS, and they are open source.

[23] Available at http://www.diva-gis.org/, last accessed on 20th of April 2016

9. **Post-colonial hospitals and schools**: Data on the location of contemporary (2000?) schools and hospitals were accessed from online sources: locations of contemporary hospitals in Ethiopia come from the map "Ethiopia health facilities", available online on the GIS online platform. For contemporary schools, instead, due to the unavailability of similar sources, I had to rely on a list of Ethiopian schools taken from an Ethiopian social network, used by former students to keep in contact after graduation[24].

10. **Placebo lines**: roads that were projected in 1936-7, but never completed under Italian occupation due to WWII, are reported in the map "Strade in AOI" (outside text) (Sillani, 1937). For unpaved colonial roads, see point 1.

3.B.3 Geographical and environmental controls

1. **Altitude**: altitude in meters was downloaded, in raster format (0.008x0.008 decimal degrees), from DIVA-GIS.[25]

2. **Rainfall**: annual rainfall average (centimetres/year) from the "Worldclimate" project, available in raster format (0.04x0.04 decimal degrees) on DIVA GIS.[26]

3. **Malaria**: malaria transmission index is available, in raster format (0.5x0.5 decimal degrees), from Kiszewski's dataset (Kiszewski et al., 2004). This source informs on the rapidity and likelihood of malaria transmission in each cell.

4. **Land suitability**: agricultural suitability for rain-fed low input cereals for each cell was calculated from the GAEZ-FAO land fertility database[27], available in raster format (0.5x0.5 decimal degrees). This index ranges from 0 to 9 (0 highest, 9 lowest) and factors in temperature, soil moisture, and rainfall patterns.

5. **Ruggedness**: terrain ruggedness in thousands of percentage points comes, in raster format (0.08x0.08 decimal degrees) from Nunn and Puga (2012).[28]

6. **Temperature**: monthly (September) average temperature data between 1960 and 1990 come - in raster format (0.008x0.008 decimal degrees)- from the "Worldclimate"

[24] Available on the website graduates.com, http://www.graduates.com/Schools/Ethiopia, last accessed on 21st of April 2016
[25] Available at http://www.diva-gis.org/, last accessed on 20th of April 2016
[26] Available at http://www.diva-gis.org/, last accessed on 20th of April 2016
[27] Available at http://www.fao.org/nr/gaez/about-data-portal/en/, last accessed on 21st of April 2016
[28] Available at http://diegopuga.org/data/rugged/, last accessed on 3rd of October 2017

project.[29]

7. **Perennial rivers**: perennial waterways can be downloaded by country as a shapefile from DIVA GIS.[30]

3.B.4 Market potential

8. **Internal market potential**: internal market potential in 1960 is calculated as by multiplying each cell's i population by 2: $2 * Population_{i,1960}$ (Martinelli, 2014)

9. **External market potential**: external potential for each cell i in 1960 is calculated as the sum of the population of each cell j weighted by the euclidean distance between the two centroids $\sum_{j \neq i} \frac{Population_j,1960}{Distance_i j}$ (Harris, 1954; Martinelli, 2014)

3.B.5 Least Cost Path Network (LCP)

10. **Procedure**: the LCP network was created starting from the target locations reported in Figure 3.A.2. Paths were only calculated between pairs that had an actual road built in between by the end of the Italian occupation. The outcome of the calculation is plotted in Figure 3.A.2.

    The calculation of building costs is based on the main geographical variables that, from historical and contemporary sources, influence the costs of road-building most significantly (Cobolli-Gigli, 1938). These are land cover (created by merging land use raster with rivers, both major and seasonal) and terrain gradient (calculated in % from elevation data).

    After creating a weighted cost raster, based on the cost differential calculations and the weighting procedures described below (points 11 and 12), I use this to calculate a cost distance raster and the least cost paths between targets using the "Cost path" tool in Arcgis.

11. **Cost differentials**

    Cost differentials between raster cells with different characteristics are determined by combining the land cover and the gradient data through a weighting matrix. The cost

[29] Available at http://www.worldclim.org/version1, last accessed 3rd October 2017
[30] Available at http://www.diva-gis.org/, last accessed on 20th of April 2016

differentials for building on different terrains are retrieved from the available construction manuals (Anas, 2018; USDA, 2017) and are reported in Table 3.B.1. For instance, building on an empty cell with a gradient between 1 and 4% would be 10% more expensive than the base cost for building on a flat and empty cell.

Table 3.B.1: Cost matrix from contemporary sources

Slope	0-1%	1-4%	4-8%	8-12%	>12%
Land Cover					
Empty	100	110	115	120	125
Forest	110	120	125	130	135
S Rivers	115	125	130	135	140
L Rivers	120	130	135	140	145
Lakes	125	135	140	145	150

As these gaps reflect the costs of building a paved road on the described surface at current prices and with the technology available today, these are unlikely to reflect the actual constraints faced by Italian builders in the Horn of Africa. The technology was obsolete and materials costly as they had to be largely imported from Italy or transported at high costs from coastal areas (Cobolli-Gigli, 1938). Therefore, I multiply cost differential from Table 3.B.1 by 4, following the suggested ratio between cost per kilometer in Italy in 1936 and cost per kilometer in Italian East Africa (Cecini, 2007, pp. 134-5), as reported in Table 3.B.2.

Table 3.B.2: Cost matrix adjusted by 1936 costs

Slope	0-1%	1-4%	4-8%	8-12%	>12%
Land Cover					
Empty	100	140	160	180	200
Forest	140	180	200	220	240
S Rivers	160	200	220	240	260
L Rivers	180	220	240	260	280
Lakes	200	240	260	280	300

In the final cost matrix, therefore, the cost of building a paved road in a certain cell, ranges from the basic unitary cost of 100 (for a flat and empty cell) to 300 (for a hypothetical cell which has a gradient of more than 12% and it is covered by a lake.)

12. **Weighting procedure**:

I use cost matrix B2 to weight the land cover and the gradient rasters (previously re-classified in the categories reported in Tables 3.B.1 and 3.B.2) using the "weighted overlay" tool in ArcMap. For the final version, I assign 40% of the overall weight to the land cover layer and 60% to the gradient one. In fact, from the available historical sources, slope seemed to be a more important variable for the builders, given the strong gradients in the area due to significant ruggedness (Cobolli-Gigli, 1938).

As the assigned weights are, to a certain extent, arbitrary, I run several robustness checks, both by changing the weight assigned to each raster (40-60%, 50-50% and 60-40%) and by replicating all calculations by using the unadjusted cost differentials (Table 3.B.1) and different adjustments for local costs (x2, x8 and x12). Small changes to the LCP network do materialize when this is implemented, but they do no change the IV calculations significantly. Consistently with the secondary evidence, the selected weighting procedure has the best fit.

3.C History of road construction in the Horn of Africa

3.C.1 Italian colonialism in the Horn of Africa

The Italian colonial occupation of the Horn of Africa started with the establishment of private commercial bases in Eritrea and Somalia. Initially, in fact, the Italian government was not willing to intervene directly and only supported private enterprises. Eritrea (first Italian private settlement in 1869) received colonial legal status in 1882, whereas Somalia (first private settlements in the early 1890s) became a colony in 1905. Between 1880 and 1920, few Italian settlers and businesses moved to the horn, due both to the limited resources that Eritrea and Somalia had to offer and the modest commitment of the liberal governments towards the economic development of these regions.

After Mussolini seized power in 1922, the colonies received more attention and resources. The renewed emphasis that the dictator placed on colonial expansion was due, on the one hand, to the fact that the colonies could provide the regime with military successes and the mirage of unlimited land for the Italian people, both extremely important elements of the internal propaganda (Labanca, 2002, pp.237-53). On the other hand, especially after the autarchic shift of the early 1930s, Mussolini was convinced that a large colonial empire could furnish raw material for manufacturing and protected export markets for Italian goods (Dore,

2013, p.62). Consequently, the government implemented a more aggressive colonial policy, that culminated in the invasion of Ethiopia in 1936. After this episode, which arguably has no precedent in colonial history both for the magnitude of the deployed army and violence against any form of organized resistance, Mussolini declared the foundation of the "empire" on May 9th, 1936 (Del Boca, 1986a, pp. 710-1).

The annexation of Ethiopia to Eritrea and Somalia substantially enlarged the Italian territories in the area, which were re-organized in the "Africa Orientale Italiana" (AOI). It was within the context of the Italo-Ethiopian war and immediately after the annexation that road-building started to be implemented on a large scale, predominantly for military purposes.

3.C.2 Road construction before 1936

The first organic intervention on the Ethiopian road network dates back to the second half of the nineteenth century and followed the formation and consolidation of the Amhara Empire. Emperor Tewodros (1855-68) was responsible for the creation of a centralized embryonic network that gravitated around the Amhara region in the northern part of the country. This network featured simple gravel tracks, appropriate for more rapid deployment of infantry troops (Emmenegger, 2012, p.15). A net improvement, both in terms of quality and extension of the existing network, was achieved under the emperors Menelik II (1889-1913) and Hailé Selaissé (1920-1936), who considered a modern transportation network fundamental to achieve military and political control over the heterogeneous Ethiopian empire. The road network was then centered on Addis Ababa, which was elevated to the rank of capital of the empire by Menelik in 1889. Hailé Selaissé instituted the Ministry of Public Transport and promoted more structured road-building plans, starting in the late 1920s. This project, which aimed to connect the major centers of the empire with Addis Ababa, was not completed due to the outbreak of the war as well as the lack of financial resources, materials, and know-how (Emmenegger, 2012, p.16). As a result, at the outset of the Italian-Ethiopian war, few roads were completed, and none had a modern asphalt surface. Only two unpaved tracks for lorries existed in 1935, the Jimma-Addis Ababa and the Addis Ababa-Dessié.[31]

The situation in Eritrea and Somalia before 1935 did not greatly differ: these colonies were neither particularly densely populated nor endowed with valuable natural resources that

[31] Istituto Agricolo Coloniale (1946d). *Main features of Italy's action in Ethiopia.* Roma: Tipografia del Senato, plate 1

could justify significant investments in infrastructure. In Somalia, only 4 major lorry tracks existed in 1925, and none of them was paved: these connected Mogadishu with Brava, Lugh Ferrandi, Oddur and Fer Fer.[32] In the same year in Eritrea, only the region of Asmara had an extensive network: paved roads with rudimentary asphalt surface connected Asmara with the port of Massawa and with the towns of Cheren, Adi Qualá and Adi Caieh.[33]

Between 1934 and 1935, several interventions were carried out to provide logistic support during the Ethiopian military campaign. In Eritrea, the artery connecting Massawa to Asmara was re-furbished. Military engineers rapidly built the road Nefasit-Decameré *ex nihilo*, which aimed to direct the traffic coming from Massawa directly to Adigrat without passing through Asmara (Del Boca, 1979, p.297). After the occupation of Macallé, in 1935, the road Adigrat-Macallé was quickly built in order to support military penetration (Badoglio, 1937, pp.34-7). At the battle of the Ascianghi Lake (Mai Ceu, end of March 1936), the last part of the Ethiopian army was destroyed and General Badoglio, the Italian commander in chief, started planning the march on Addis Ababa: all available men were employed to refurbish the track Macallé-Quoram-Dessié-Addis Ababa (Badoglio, 1937, pp.197-8).

Similarly, in Somalia, General Graziani employed remarkable means for the construction of strategic roads aimed to support the Italian troops. In 1935, the paved road Mogadishu-Fer Fer-Mustahil was built; this satisfied the double need of connecting the outposts with the capital of the colony and of facilitating the march towards Harar and Dire Dawa in the planned offensive of 1936. During the two main operations on the Southern front, the one leading to the occupation of Neghelli in January 1936 and the one aiming at the occupation of Gorrahei, Dagabur, and Harar in the following April, Graziani ordered the construction of new tracks in these directions. Mogadishu was therefore connected with Neghelli and Fer Fer with Harar (Graziani, 1938, pp.284-5).

3.C.3 Italian road construction 1936-1941

With the conquest of Addis Ababa on the 5th of May 1936, the war was officially concluded. Mussolini immediately stated that the priority in the newly founded empire was to build an extensive highway network as quickly as possible. Several reasons motivated him: firstly,

[32] Istituto Agricolo Coloniale (1945b). *Some data on Italian activity in the colonies*. Roma: Tipografia del Senato, plate 69

[33] Istituto Agricolo Coloniale (1945b). *Some data on Italian activity in the colonies*. Roma: Tipografia del Senato, plate 66

the peripheral regions such as those of Jimma and Gore were completely out of control, due to the impossibility of moving troops efficiently. Secondly, some of the major cities of the empire, such as Gondar, Harar, Dire Dawa, and even Addis Ababa, were at risk of remaining isolated during the rainy season (between June and September). Thirdly, the army and the civilian personnel in the main centers needed a constant flow of supplies from Italy. Roads were cheaper to build than railroads, faster to realize and, moreover, it was clear that for at least the next 20 years the trade volumes would not have justified the construction of railroads (Marchitto, 1940, pp.78-81). Mussolini personally laid out the infrastructural plan, that was officially communicated on the 19th of May 1936. Five main arteries had to be realized immediately. These were the Om Ager-Gondar-Debra Tabor-Dessié (650 km), the Debra Tabor-Debra Marcos-Addis Ababa (500 km), the Adigrat-Dessié-Addis Ababa (850 km), the Assab-Dessié (500 km) and the Addis Ababa-Jimma (350 km). The Addis Ababa-Allata-Neghelli-Dolo (1,100 km) had to be constructed in a second phase.[34] Some of these projects were started but not completed due to the outbreak of WWII.[35]

The simple list of the projected roads gives an idea of the magnitude of the investments undertaken. The vast majority of the works were managed by the AASS (Azienda Autonoma Statale della Strada), a public company created by the Minister of the public works (Sillani, 1937, p.242). The AASS obtained an incredibly large budget from Rome: not only the six-year development plan allocated more than 7.7bn Italian Lire (out of the total 12bn) for road construction (Sillani, 1937, p.233), but the AASS even received additional 3.1bn Lire, for the financial year 1936-7 (Sillani, 1937, p. 243).[36] In 1939, the newly built colonial transportation network totalled roughly 4,625 km paved roads and 4,877 km unpaved tracks.[37]

The construction of this vast road network did not prevent Italians from being expelled from the Horn of Africa in November 1941. During the military events of 1940-1, the Italian troops were progressively forced to abandon all the territories of the AOI. In order to slow down the British offensive, the army destroyed several bridges, tunnels and large parts of the asphalt surface. Some of the major threats to network's integrity were the disruption of Mussolini Bridge between Agordat and Cheren, of the ramp that gave access to Cheren from

[34] Angelo Piccioli (eds.) (1937–1943). *Gli Annali dell'Africa Italiana*, year 2, issue 4, pp. 321-2

[35] This original plan was marginally modified after the approval of the six-year plan on the 21st June 1937, but the fundamental arteries remained the same

[36] The plan, which was passed in 1936, was modified into a 12-year plan in 1937. Therefore, the total public capital invested in road construction amounted to roughly 7bn Italian Lire: 1bn for the four financial years 1936/7-1939/40, plus the 3bn allocated in 1936.

[37] Angelo Piccioli (eds.) (1937–1943). *Gli Annali dell'Africa Italiana*, year 2, issue 4, p.365

the North-West (Del Boca, 1986a, p.411), the dismantlement of the surface of the Mogadishu-Harar (Del Boca, 1986a, p.451), of the Addis Ababa-Dessié (Del Boca, 1986a, p.486) and of all the arteries that gave access to Gondar (Del Boca, 1986a, p.507).

3.C.4 Post-colonial road construction (1941-2000)

Emperor Hailé Selaissé regained control over Ethiopia and Eritrea by the end of 1941. The economic stagnation that hit the area in the 1940s along with the lack of available international capitals prevented the independent government from undertaking any maintenance of the existing network. This effect cumulated with the disruption caused by the war and yielded a substantial deterioration of the road network that shrank from about 6,000 km in 1940 to about 1,000 km in 1951 (Leul, Petros, and Kebede, 2008, p.9). Between 1951 and 1974, when the Communist coup, led by Mengistu, overthrew the imperial regime, four highway plans were implemented. The first one (1951-7) focused on reconstructing the Italian road network and restored about 4,200 km of paved roads, whereas the next three started building new sections, often paving colonial and pre-colonial tracks. The road network was expanded from 6,400 km, in 1951, to 9,260 km, in 1974 (Emmenegger, 2012, p.17).

As opposed to the imperial government, which had given precedence to the creation of a large highway network, the communist regime (1974-1991) placed more emphasis on rural roads. These were considered fundamental to improve market access for farmers and constituted a valuable propaganda tool in the countryside. Consequently, the Highway programs were progressively replaced by Sector Programmes (First Sector Programme 1977-1982), which extended the road network from 9,260 km to 19,020 km in 1991 (Emmenegger, 2012, p.17). During the 1990s, the last decade considered in this study, the liberal EPRDF government (Ethiopian People's Revolutionary Democratic Front) launched the First Road Sector Development Programme (1997-2007), which to some extent continued the investments in rural roads, recognizing the absence of a suitable transportation network in the countryside as a major limit to Ethiopia's development.

3.D List of Abbreviations Chapter 3

- ACS = “Archivio Centrale dello Stato” (Central State Archive)
- AOI = “Africa Orientale Italiana” (Oriental Italian Africa)
- ASAIC = “Archivio Storico dell’Agenzia Italiana per la Cooperazione e lo Sviluppo” (Archive of the former “Oversea Agricultural Development”)
- ASMAE = “Archivio Storico del Ministero degli Affari Esteri” (Historical Archive of the Ministry of Foreign Affairs)
- CMI = “Comando Militare Italiano”
- DHS = “Demographic and Health Survey”
- EMA = “Ethiopian Mapping Agency”

Chapter 4

Cultivating the "Fourth Shore": The effect of Italian farming in colonial Libya, 1920-1942

4.1 Introduction

Settler farming is arguably one of the most extractive forms of European colonialism in Africa: affected regions developed dual economies and unprecedented levels of economic and social inequality. In Kenya, Southern Rhodesia, South Africa, and Algeria, for instance, white farming elites seized large shares of fertile land and set up political systems intended to keep African peasants in a subordinated position, while importing advanced technologies, capital, and skills to boost their own productivity. Despite the importance of this phenomenon in shaping long-term patterns of inequality and growth, little empirical evidence exists on the effect of white farming on the indigenous agricultural sector in Africa and, more specifically, on how to reconcile the positive and negative effects that the literature theorizes.

On the one hand, migrations of skilled workers, especially if coupled with substantial inflows of capital, are thought to be beneficial for the receiving regions. High-skilled laborers raise productivity by adopting more efficient technologies and through interpersonal skills transfers (Hornung, 2014; Fourie and Von Fintel, 2014; Peri, 2012; Bharadwaj and Ali Mirza, 2019). Furthermore, the literature posits positive agricultural technological spillovers among neighbours (Parman, 2012; Conley and Udry, 2010; Foster and Rosenzweig, 1995). On the

other hand, settler economies in Africa were extractive in nature: in Kenya, Southern Rhodesia and South Africa, for instance, Europeans seized the most fertile lands, thus pushing most African producers below subsistence level and in turn hampering African productivity (Arrighi and Saul, 1973; Feinstein, 2005). To the best of my knowledge, only a few contributions have studied the relative importance of these counteracting forces, and none has convincingly identified causal links. Furthermore, we know little about the mechanisms through which European settlement could affect the well-being of African farmers, other than land expropriation.

By looking at the case study of Italian agricultural settlement in colonial Libya, which took place between 1913 and 1940, this paper aims to take a first step towards solving this puzzle. At the same time, it wants to add empirical evidence on the dynamics that affect patterns of agricultural production in a dual economy and contribute to the history of Libya and Italian colonialism. Roughly 40,000 Italian farmers settled in what was called the "Fourth shore", starting in 1913, but mostly during the 1930s. These colonists, who relied mostly on private capital until roughly 1934, and increasingly on state-financed projects thereafter, formed a small European farming elite, capable of deploying substantially larger amounts of capital and newer technologies, compared to indigenous farmers. However, they were only allowed to settle on land that was not under permanent cultivation before their arrival, which cut them out of the most fertile coastal and pre-desert oases. In practice, this meant they were only able to farm around pre-existing areas of permanent agriculture. Italians were then expelled from the eastern region of Cyrenaica as early as 1942, after the definitive British occupation, and subsequently from Tripolitania in 1970.

This series of events constitutes an ideal case study to explore the impact of European agricultural settlement on the traditional Libyan agriculture: the peculiar historical process of land selection, in fact, makes the issue of the endogenous location of European and indigenous farmers less problematic. I start by asking the question of what impact white settlement had on productivity and nominal agricultural output in 1939, at the end of the colonial period, in both Italian villages and neighboring Libyan ones. Secondly, I explore the mechanisms that drive this effect.

I create a spatially-explicit, village-level dataset, by geo-referencing the locations contained in the 1938-9 unpublished governmental Agricultural Survey (Ministero dell'Africa Italiana, 1939a) for cereal production. This source provides information on cultivated land and total

output for barley and wheat - the two main crops at the time - for both Libyan and Italian farmers (182 villages). I match these data with the unpublished firm-level agricultural census of Italian farms from 1937, which provides comprehensive information on factors of production, such as size and composition of the workforce, types of cultivation, irrigation facilities, machinery, and livestock, for the 839 Italian farms operating in Libya in 1937. Thirdly, I collect village-level data from the 1936 population census of Libya.

Firstly, I run an OLS regression analysis to test the effect of proximity to Italian villages in 1938 (dummy 0-50 km from a location affected by white farming) on Libyan productivity and nominal output in 1939 (measured as yields and produced value per hectare) and the correlation between Italian presence and land productivity. I find a strong and negative effect of Italian presence on Libyan productivity in the surrounding villages, which show roughly 68% lower average cereal yields compared to more distant Libyan villages. By contrast and maybe less surprisingly, the estimates show a positive and statistically significant effect of Italian presence on land productivity and nominal output at the village level, relative to nearby Libyan clusters (86% more productive). The correlations are robust to a variety of geographical, pre-colonial, and colonial controls, to different sets of fixed effects and restrictions of the sample size.

Secondly and contrary to the literature, my estimates show that the observed negative effect is not driven by expropriation of the best lands and relocation of indigenous farmers to marginal areas with limited market access, but was instead due to a diversion of the available local workforce towards waged labor for Italian landowners. This migration forced the indigenous population in neighboring villages to adopt land-extensive cultivation strategies as captured by the land-to-population ratio. Although the data do not allow the exploration of this mechanism in full, additional estimates provide evidence that the labor drain took place in combination with the depletion of the available stock of camels, which constituted the primary source of animal power for the locals. This relocation of factors of production might have pushed the Libyans into wage work due to the impossibility to farm intensively. While Libyan labor productivity in districts affected by Italian settlement did not increase relative to the control group, thus confirming the negative impact of Italian farming on Libyan agricultural productivity, the availability of cereals per capita also remained stable, which possibly questions whether Libyan living standards actually suffered due to lower yields. A comparison between yields in 1913 with estimates from 1939 for a selected group of villages,

however, reveals how the Italian farming practices possibly triggered a complete reversal of fortune across Libya. Libyan villages affected by Italian settlement in their surroundings, in fact, witnessed a dramatic drop in yields between 70 and 95% over the period, which was not compensated by a proportional increase in acreage. In turn, this suggests a severe negative impact on Libyan living standards.

In terms of land productivity, Italians did not outperform Libyan producers located in more remote areas, and who employed more labor-intensive cultivation techniques. However, they did consistently overtake their indigenous neighbors within 50 km and experienced significantly higher levels of labor productivity. This positive localized association between Italian presence and higher yields is also largely explained by higher intensity of factors of production, which in combination with proximity to transport infrastructure, such as paved roads, provided a small productive advantage to white settlers. In other words, the empirical evidence suggests that, in a dual economy characterized by resource extraction, labor scarcity, and relative land-abundance (although not very fertile), the short-run equilibrium leads to a decrease in land productivity in villages surrounding centers of European farming. White farmers did achieve relatively high yields and labor productivity, but only at the cost of reducing indigenous productivity and through draining local resources.

The main concern about the validity of these results relates to potential omitted variable bias: Italians might have simply chosen locations that were already more productive in the pre-colonial period and that were historically draining resources from the surrounding areas. Despite the historical narrative not supporting this view, in fact, Italians might have been able to select areas that were initially better due to unobservables. To tackle this problem, I start by running a falsification exercise that compares the estimated effects with those generated by locations affected by Italian agricultural settlement only after 1938 (placebo villages). Secondly, I instrument proximity to Italian farms with a 0-40 km cut-off distance from the centroids of the first Italian coastal strongholds, that were in firm control of the colonial army before military operations on a larger scale started in 1922. The intuition is that, due to an element of randomness in military events with respect to land productivity, proximity to areas that were historically under stronger Italian control can only affect agricultural productivity through the settlement of Italian cultivators, who preferred these locations due to more security. Finally, I implement a Nearest Neighbour Matching test, which compares villages with similar scores in terms of population, market potential, and land suitability. All these

exercises provide evidence of the causal link existing between Italian farming and agricultural productivity.

This paper contributes to the literature that has looked at the effect of migrations, skill transfer, and technological adoption on receiving countries' productivity. By testing the effect of white agricultural settlement in Africa through the lenses of the Libyan case study, I add to the works of Hornung (2014), Fourie and Von Fintel (2014) and Peri (2012), who have instead focused on the short and long-term spillovers in industry and services, along the same lines of a small but growing literature that has looked at agricultural migrations in developing countries (Bharadwaj and Ali Mirza, 2019; Dell and Olken, 2017). As my results show, settler farming was a special case as it negatively impacted the local agricultural sector despite the migration of more skilled and wealthier farmers, whose settlement led to a misallocation of resources in agriculture and thus reduced indigenous productivity and, arguably, living standards. Furthermore, this article sheds new light on the mechanisms of skills transfer and technological diffusion in agriculture (Parman, 2012; Conley and Udry, 2010; Foster and Rosenzweig, 1995) by showing how, in a dual extractive economy, the potential positive technological spillovers are offset, at least initially, by the unequal distribution of the factors of production, that can undermine indigenous productivity in the short run. I show that in an unequal agricultural economy, the settlement of capital-endowed and technologically more advanced farming elites imposes initial negative externalities on the primary sector thorough a drain on resources, which can have negative spatial spillovers in terms of land productivity.

With respect to the literature that deals explicitly with the impact of settler farming and land policies on the African agricultural sector (Sartre, 1964; Mosley, 1982; Feinstein, 2005), I contribute by employing micro-level data that allow for an empirical quantitative analysis of the direct impact and the spatial spillovers of white farming. Although the estimates also pinpoint a temporary negative effect on indigenous agriculture, consistent with the seminal works of Arrighi (1967), Bundy (1979) and Palmer and Parsons (eds.) (1977), this effect is explained by the extraction of mobile resources (camels and workers), as opposed to seizure of land of better quality, and shows an active adaptation of local farmers through extensive farming techniques.

By measuring the local effect of Italian farming in Libya, my findings also supplement the literature which has looked at the economic and social changes triggered by Italian agricultural policies in Africa (Larebo, 1994; Segré, 1974). The observed localized drop in Libyan

productivity is in line with the "exploitation" theory proposed by Cresti (2011). Finally, this paper also relates more generally to the debate on the impact of colonialism on erstwhile colonies (Bruhn and Gallego, 2012; Lowes and Montero, 2018a): my estimates emphasize that it is crucial to consider the micro-level impact of colonial activities and underline the importance of agricultural and land policies for the primary sector in colonial territories.

The remainder of the paper is organized as follows. Section 4.2 outlines the historical context and the most salient facts regarding Italian farming in Libya. Section 4.3 presents the database. Sections 4.4 and 4.5 explain the identification strategy and the main results, respectively. Section 4.6 reports the main robustness checks. Section 4.7 explores the mechanisms. Section 4.8 discusses the implications for Libyan living standards and Section 4.9 concludes.

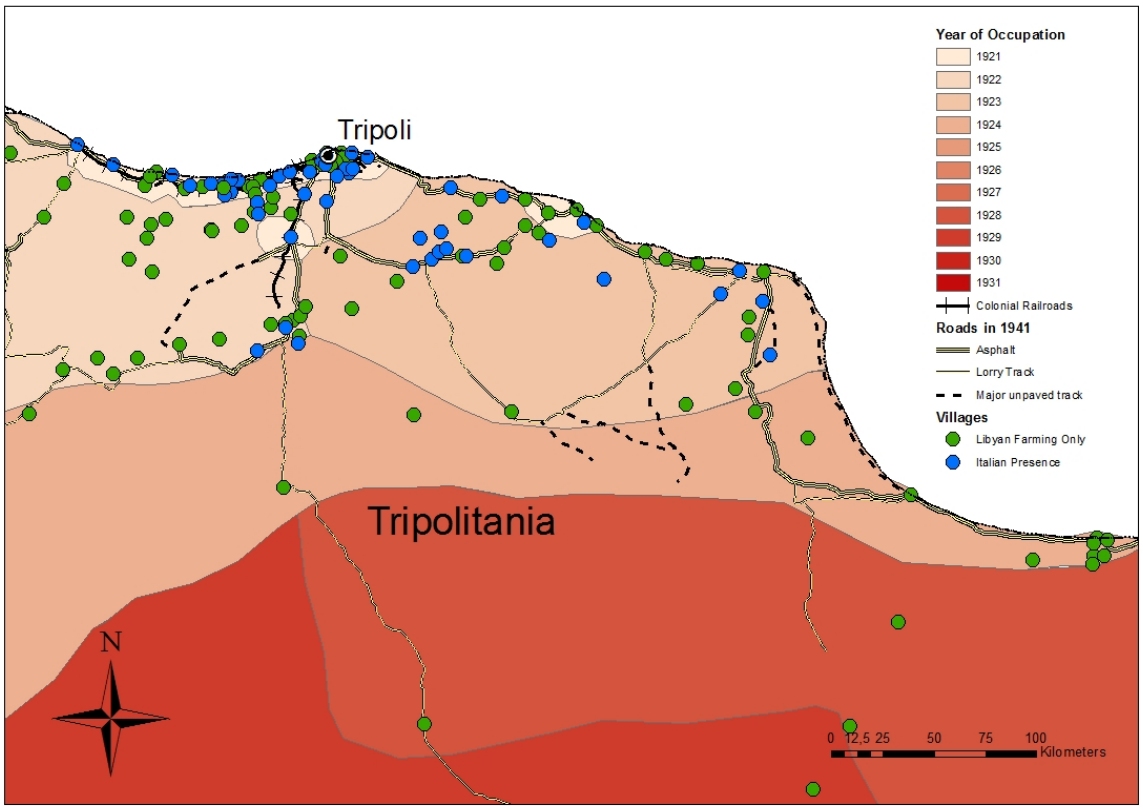
4.2 Historical context

4.2.1 The occupation of Libya, 1911-1931

The Italian occupation of Libya dates back to the Italian-Turkish war of 1911-12. Local resistance, combined with the sudden outbreak of WWI (Italy joined the Allies in 1915) and the consequential allocation of resources to the Austrian front, hampered the attempt of imposing an effective territorial control over the colony. By 1922, the year of Mussolini's rise to power, only coastal cities, and a few strongholds were under stable Italian control. The Eastern region of Cyrenaica was ruled indirectly, through the services of the Emir Idris As-Senussi (who became, in 1951, the first king of the United Kingdom of Libya under the name of Idris I), supported by a council of notables. Virtually no Italian farmer moved to Libya before 1922, with only a few pioneering attempts in the area surrounding Tripoli (Cresti, 2011).

Fascisms changed the rules of the game. Under Governor Volpi (1921-5), the army undertook the complete conquest of Tripolitania, which was followed by the rapid subjugation of the Southern region of Fezzan and the occupation of Cyrenaica, which was only achieved in 1931 despite the largesse of the employed means. The fierce local resistance was orchestrated by the religious Senussyya movement which did not recognize the Italian authority.

Figure 4.1: Tripolitania: Italian occupation and settlement in 1939



Note: Libyan villages and Italian agricultural settlement in Tripolitania. The map also shows the tendency of Italian farmers to settle in villages that had been under permanent Italian control for longer.
Source: villages are from the 1939 Agricultural Survey of Libya (Ministero dell'Africa Italiana, 1939a). Roads, Railroads and territorial changes from Piccioli (1934)

4.2.2 Main features of the Italian agricultural settlement

Linked to the military conquest of the region was an ambitious plan to divert part of Italian economic emigration to Libya: traditionally, Italy had been a net supplier of low skilled workers to a variety of countries, including Argentina, Belgium, and the US. Mussolini's Fascist government aimed at reducing this outflow. Fostering agricultural settlement in what started to be called "Quarta sponda" (Fourth shore) was seen as the ideal economic integration between the labor-rich Italy and the supposedly land-abundant colony.

An innovative yet highly controversial, land reform was implemented in 1923: according to this decree, all land that was not cultivated or that had not been farmed in the previous three years was considered public and available for allotment, rent, and purchase for Italian farmers. By 1937, roughly 840,000 hectares were made available thanks to this system, 240,000

of which in Tripolitania and 600,000 in Cyrenaica (Ballico, 1939). Although the impact of this radical decision on the traditional Libyan subsistence sector has not been adequately quantified, anecdotal evidence suggests it was crucial. Most of the land that fell into the category of "unused" was part of an antiquated, but complex tribal customary system based upon shifting cultivations and migrant herding, both activities that were severely affected by the decree (Cresti, 2011). Yet the land that was intensively farmed by Libyans was left virtually untouched.[38]

This peculiar compromise on the allocation of land that aimed to strike a balance between the colonial government's ambitious settlement plan and the traditional farming patterns of the local population led to a unique situation. As shown in Figure 4.3, Italians were, in fact, only allowed to farm marginal lands outside of Libyan oases. Land pertaining to oases tended to be more fertile and had easier access to water compared to the land available to Italian settlers outside the main Libyan farming clusters. This characteristic is essential for the empirical analysis as it makes endogeneity less problematic: as white farmers were not able to secure the best land, I expect the OLS estimates to be downward-biased when estimating the localized effect of Italian farming and upward-biased when measuring the spatial spillovers in the surrounding area.

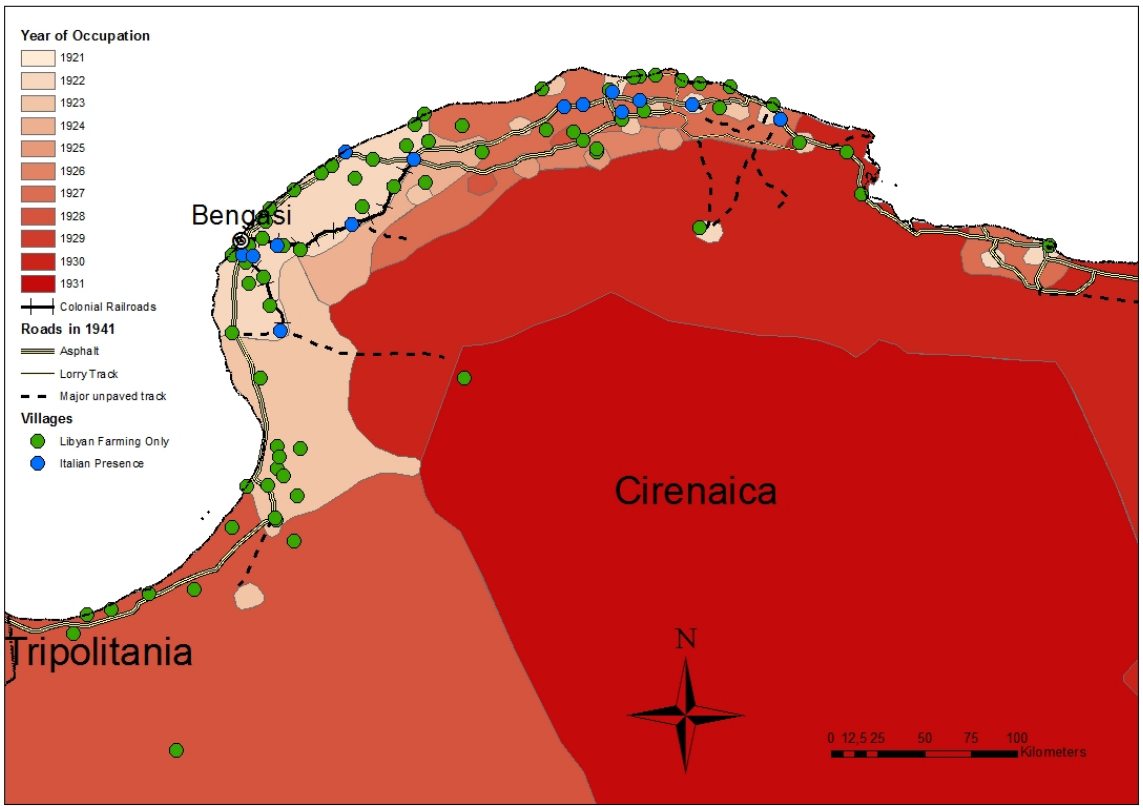
Also for these reasons, Italian farmers started receiving financial support from a specially designed agricultural bank, the *Cassa di Risparmio di Tripoli* (founded in 1923), which provided credit at subsidized interest rates. The combination of more accessible credit and technical assistance from governmental agricultural institutes facilitated white settlement. However, despite an exponential increase over the period, the total number of Italian holdings only reached the modest number of 839 farms by the end of the decade.[39]

Even though these incentives facilitated settlement, the establishment of white farms in the colony was far from unconstrained. Not only Italian cultivators had to face severe climatic challenges, such as scarce precipitations, high temperatures and strong dry wind from

[38] A partial exception to this general pattern was the land allocation process in Cyrenaica. Here, due to the large-scale deportation implemented before 1932 by Marshal Graziani to fight the Cyrenaican Senussiya during the phase of guerrilla war, vast extensions of land were expropriated by the colonial government and later distributed among Italian farmers (Del Boca, 1986b, pp. 267-9). These included the monasteries ("Zavie") that were the direct property of the Senussi. The phenomenon mainly affected the Gebel area in the hinterland and not the coastal areas that were more firmly under Italian control in the late 1920s and that form the majority of the sample. Arguably, this fact only partially affects this analysis, as most of the expropriated land had previously been used for grazing rather than intensive agriculture and these parts of the Gebel were occupied only during the intensive demographic settlement scheme after 1938. Nevertheless, this potential weakness of the study is formally addressed in Section 4.6.

[39] Those reported in the 1937 census

Figure 4.2: Cyrenaica: Italian occupation and settlement in 1939



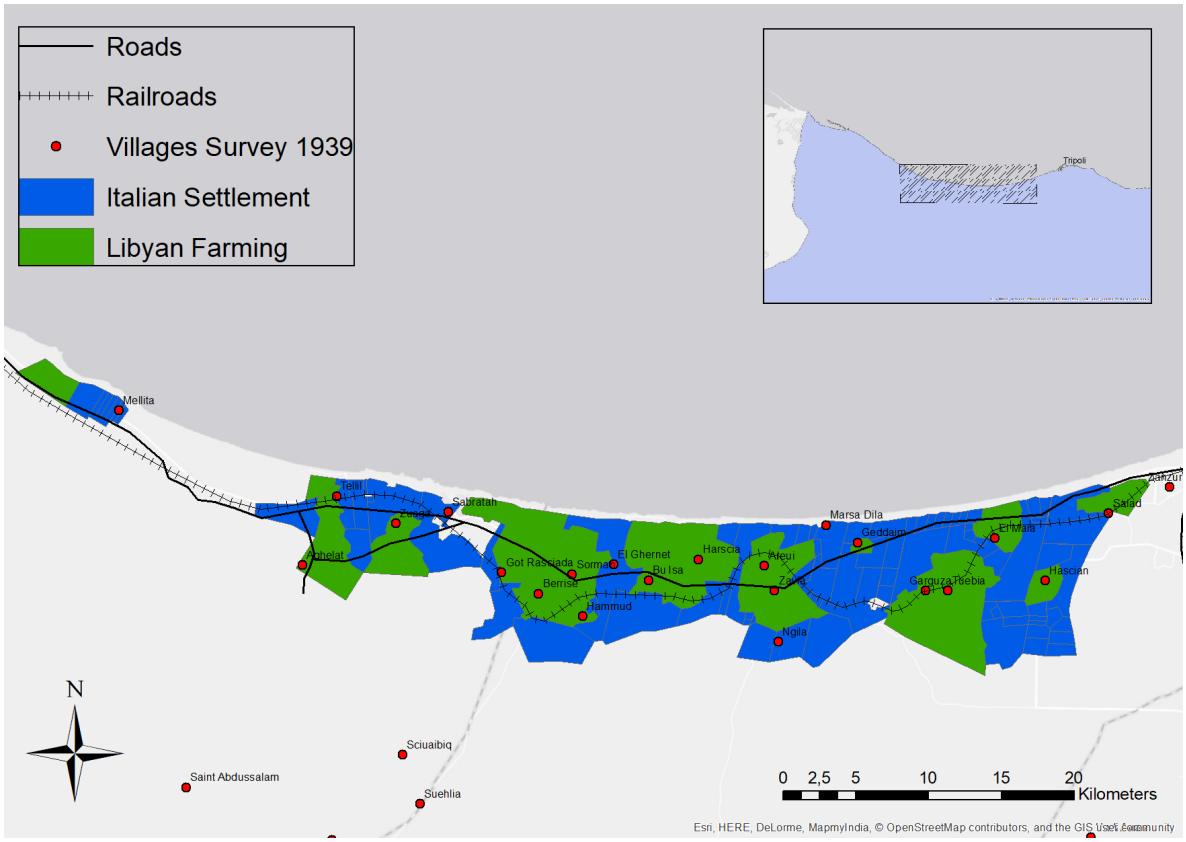
Note: Libyan villages and Italian agricultural settlement in Cyrenaica. The map also shows the tendency of Italian farmers to settle in villages that had been under permanent Italian control for longer.
Source: villages are from the 1939 Agricultural Survey of Libya (Ministero dell'Africa Italiana, 1939a). Roads, Railroads and territorial changes from Piccioli (1934)

the desert (*Ghibli*): as outlined above, the complete control over the region was not fully accomplished until 1931 and, although governor Badoglio declared the colony "pacified" in 1932, peripheral zones remained out of the Italian control until the end of the 1930s. This insecurity forced Italian farmers to select, especially between 1922 and 1937, more "civilised" locations: this initially meant settling close to Tripoli and Benghazi and, subsequently, to spread out progressively, following the expansion of the governmental control over the peripheral regions. This process can be observed in Figures 4.1 and 4.2, which highlight the clustering of Italian settlements in locations that had been under government control for longer. These political constraints, together with the impossibility of expropriating the land that was under permanent Libyan cultivation, translated into a pattern of settlement that was only marginally influenced by the suitability of the soil. In other words, Italian farmers were only capable of

selecting the best land within a limited sub-sample, composed by those areas that were under stable control of the Italian government and that were not already under Libyan cultivation. This particular pattern makes the identification of the effect of Italian settlement easier, as endogeneity problems are less likely to arise.

The period between 1922 and 1932 is defined by the sources as "capitalistic settlement", as opposed to the "intensive demographic settlement" implemented from 1932 onwards (Piccioli, 1934). These expressions define two different approaches taken by the Fascist government, the former relying on the use of private capital and minor public subsidies, and the latter one characterized by direct state-led initiatives, aimed at creating widespread smallholding farming in Libya.

Figure 4.3: Example of agricultural settlement in the area of Zavia



Note: example of Italian settlement pattern around Libyan intensive farming in the traditional oases from the area of Zavia.
Source: patterns of agricultural settlement are digitized from the map "Zona Occidentale", from the incomplete and unpublished cadastral survey of Tripolitania retrieved at the historical archive of the Istituto Agricolo d'Oltremare (ASAIC). Villages are from the Agricultural Survey of Libya 1938-9, ACS (Ministero dell'Africa Italiana, 1939a). Roads and Railroads Piccioli (1934)

Through the direct intervention of the public pensions and insurances fund (INFPS) and the creation of a specific state corporation (Ente Colonizzazione Libia, ECL) 24 agricultural villages were built between 1932 and 1940 in Tripolitania and Cyrenaica. The event received ample coverage by both Italian and foreign media, especially as it coincided with the most famous mass migration waves of the period, with 20,000 farmers shipped to Libya in 1938 ("I Ventimila"), followed by an additional 11,000 in 1939. My analysis mostly focuses on the first capitalistic wave, as the sources only capture the early attempts of state-led settlement. Villages of the second phase are only used as counterfactual locations in a falsification exercise.

4.3 A new database on colonial Libya

To address the described questions, I assembled a novel village level database, with information on cereal production for both Italians and Libyans at the end of the colonial period. Table 4.A.6 summarises the main sources and their coverage, while Table 4.A.1 presents the descriptive statistics for the variables employed in the empirical estimations.

The coordinates of each village have been identified by geo-localizing the names reported in the Agricultural Survey of 1938-9. This source informs on the extension of barley and wheat cultivations (cultivated land) for both Libyan and Italian farmers, as well as the harvested quantities for each crop. The survey is unpublished at the village level. For each surveyed location, four different sheets exist: two for Italians and two for Libyans farmers, one for sowing and one for harvesting. A total of 256 villages are reported, however, excluding those for which matching harvest and sowing was not possible, only 182 villages remain. Nevertheless, this sub-sample is evenly distributed across Libya and reports all important centers of agricultural production. The distribution of the villages primarily reflects the distribution of the population at the time which, similarly to the present, was concentrated along the coast (see Map 4.A.3 in Appendix 4.A).

The crucial second source for this paper is the 1937 Agricultural Census of Italian farms in Libya, which reports detailed information on the 839 white farms that existed in Tripolitania and Cyrenaica at the time. This source informs, among other things, about the number of Italian and Libyan workers, the size of the buildings, the irrigation facilities and the machinery & animal stocks on each holding. I aggregate farms at the Agricultural Survey's village level, which yields a total of 60 villages with complete data on grain productivity and factors of

production for Italian farmers.

Thirdly, in order to obtain reliable data on population size and gender ratios, the Population Census from 1936 has also been digitized. This source informs about the total number of Libyan and Italian residents in each center by sex. Due to the sometimes different administrative levels of data collection, only 129 of the 182 villages employed in the empirical analysis could be matched successfully. These data were therefore interpolated with the reconstructed population estimates from the HYDE project, which brings the number of data points for which population size is available up to 182. Fourthly, the location of colonial paved roads, lorry & unpaved track, railroads, administrative districts, and wells were digitized from different maps from Piccioli (1934). Finally, land suitability for barley and wheat was added from the FAO-GAEZ database (FAO-GAEZ, 2000).

The archival nature of the bulk of my data presents both advantages and disadvantages: the 1939 agricultural survey is often handwritten and patchy. It is sometimes difficult to determine whether missing sheets and reported zeros were due to negligible agricultural production in those locations, imprecise data collection in the field or lousy preservation of the materials. Furthermore, this is subject to errors of the Italian civil servants in charge, who often had other main jobs, limited knowledge of the territory, and Libyan farming strategies. Yet, despite these caveats, the level of detail is impressive for the region and the period, which makes is the best (and only) source to investigate agricultural dynamics in colonial Libya at such a disaggregated level. The fact that this has remained unpublished and for ministerial use only gives me confidence that, at least, no systematic attempt was made by the authorities to alter the reported figures, unlike in the case of other publications that were used for propagandistic purposes.

4.4 Identification

I start by running regression analysis on this newly assembled village-level dataset to identify the impact that the settlement of Italian farmers had on the Libyan agricultural sector. In order to estimate the direct effect of the Italian presence on agricultural productivity and, at the same time, to capture potential spatial spillovers in the surrounding villages, I estimate equation 4.1 through OLS:

$$
\begin{aligned}
lny_{i,1939} = \alpha + \beta_1 DITfarm_{0-50km,i,1938} \\
+\beta_2 DITfarm_{i,1938} \\
+x_i'\gamma + \delta_p + \epsilon_{i,t}
\end{aligned}
\tag{4.1}
$$

The left-hand side variable $y_{i,t}$ measures agricultural productivity in village i. Both land productivity (hundredweights/hectare) and nominal output per hectare ($) in 1939 are employed. I apply a logarithmic transformation to smooth the right-skewed distribution of my dependent variables (see Figure 4.A.2 in Appendix 4.A). It should be noted that land productivity is not necessarily the best measure for levels of efficiency in agriculture, as it depends on the employed inputs and can show relatively high levels in backward countries (Federico, 2005, p. 69). Unfortunately, for colonial Libya, this is the only measure that is available at a level of disaggregation sufficient to capture local spatial spillovers.[40] $DITfarm_{0-50km,i,1938}$ is the main explanatory variable of interest and equals 1 if a village is positioned within a 50km cut-off from a location where Italian farming took place in 1938 (I consider sowing to calculate proximity as crop failure would potentially alter treatment). I expect β_1, whose variable is designed to capture spatial spillover effects of white farming, to be positive ($\beta_1 > 0$) if Italian presence increased land productivity in surrounding areas; conversely, it will be smaller than 0 ($\beta_1 < 0$) if negative spatial externalities are in place. The former hypothesis would be consistent with the idea of Parman (2012) and Conley and Udry (2010), who postulate positive spillovers from more advanced farming centers. In the latter case, the result would point towards a process of resource drain more in line with the literature on European farming in settler economies (Arrighi and Saul, 1973; Bruhn and Gallego, 2012). While a binary variable for a 50km cut-off remains my favorite specification because it allows a more intuitive interpretation of the results, I also replicate the same estimation with the logarithmic distance from Italian villages. The cut-off, in fact, is chosen in a somewhat arbitrary fashion in the attempt to capture those villages that were located at a distance suitable for seasonal migration (Segré, 1974), but checking the robustness of the results to the inclusion of continuous distance is very important.

$DITfarm_{i,1938}$, the second explanatory variable of interest, is a dummy that equals one if the 1938-9 Agricultural Survey reports any amount of land being under Italian cultivation.

[40] Village-level TFP for Italian farmers could be calculated, but information on labor and capital concentration for Libyans is, to the best of my knowledge, unavailable

I expect this coefficient to be larger than 0 ($\beta_2 > 0$) if the Italian presence is positively correlated with land productivity, negative otherwise. In practice, this is a sub-category of the main explanatory variable of interest as this dummy equals one if a village is located within the 50km cut-off and was directly affected by Italian farming. Thus, its coefficient will capture the average productivity in Italian villages for Libyan agricultural centers within the 50km radius.

x_i' is a vector of time-invariant geographical, pre-colonial, and colonial controls. All specifications include those variables that the literature has depicted as important in determining the performance of Libyan agriculture: latitude, longitude, land suitability (intermediate inputs irrigated barley), distance to the coast, altitude, average annual temperature, monthly precipitations and distance from waterways. Pre-colonial data are scarce, but in all specifications, I also control for the logarithm of the reconstructed population in 1900, distance from 19th-century caravan tracks and pre-1930 land-use, in the attempt to capture the effect of potentially relevant characteristics from the pre-Italian era. Finally, in order to control for other colonial factors, I also add a set of variables that includes the distance from Tripoli and Benghazi (the two main cities and markets in the colonial period), distance from 1941 wells and the logarithm of the population in 1936.

All specifications include a set of provincial fixed effects (δ_p) (the 5 Italian provinces in which Libya was partitioned in the 1930s) to capture unobservables at the provincial level. Finally, as I am also concerned that, due to the archival nature of the 1939 survey, the data might show systematic measurement error at the municipal level (the level of data collection), I cluster my error term ($\epsilon_{i,t}$) for the 27 municipalities in which Italian Libya was divided under colonial rule. This approach also adequately accounts for potential spatial correlation.

Due to data limitations and, in particular, to the unavailability of comprehensive productivity estimates at the village level before the settlement of the Italian farmers, the problem of spurious correlations driven by an omitted variable bias is likely to occur. In order to estimate the causal effect of Italian agricultural settlement on Libyan grain productivity, I run a series of robustness checks, focusing on $DITfarm_{0-50km,i,1938}$ my main explanatory variable of interest.

Firstly, I implement a falsification exercise based on the period of arrival of Italian settlers: several additional projects of state-led intensive (or "demographic") colonization were launched between 1938 and 1939 and became operational only in 1939 and 1940, after my

period of observation. I use these as placebo locations to test causality in a counterfactual framework: if the measured effect is mirroring pre-colonial patterns of production (the settlement of Italian farmers was endogenous), a similar correlation should be observed between post-1938 settlement and land productivity. Although one might argue that later agricultural villages were not comparable to earlier capitalistic settlements, the time difference is so limited that, once the full set of baseline controls is introduced, the falsification exercise will give sufficient evidence of the causal link between Italian presence and changes in yields per hectare.

Secondly, I run an instrumental variable exercise that exploits the political constraints to white agricultural settlement. The strategy relies on the idea that the location of Italian farms was exogenous to pre-colonial farming patterns and, instead, somewhat dependent on the unique political conditions created by the progressive occupation of Libya during the 1920s and 1930s. As discussed in Section 4.2, Italian farmers were unable to settle in the best available land, due to the scattered control that the state had on the Libyan hinterland and, by contrast, had to select areas under stable governmental control to mitigate risk. Hence, I instrument proximity to Italian villages with a binary variable that equals one if a village is located within a 40km cut-off from the centroid of those areas that were permanently under Italian control before the beginning of the process of re-conquest started by Mussolini in the 1920s. These include areas under Italian control in 1921 and 1922 in Tripolitania and Cyrenaica, respectively.

Figure 4.A.1 in Appendix 4.A shows the spatial correlation between Italian farming and early territorial occupation, which emerges as very strong. For the exclusion restrictions to hold, my instrument has to be a good predictor of Italian agricultural settlement while, at the same time, proximity to the first occupied areas should affect productivity patterns through Italian farming only. As permanently occupied areas generally (but not always) coincided with the main coastal towns, market access could be an obvious violation (Martinelli, 2014). To address this issue, I make my estimates conditional on market potential (in logarithm), which I calculate as the size of the closest market (measured by total population), weighted by the linear distance from each observation.

Finally, I run a Nearest Neighbour Matching test. The average treatment effect is estimated by comparing pairs of treated and untreated observations having similar scores for market potential, land use before 1930 (Piccioli, 1934) and population density, which are three

key variables in determining productivity differentials in agriculture (Kopsidis and Wolf, 2012; Mosley, 1982; Cresti, 2011).

4.5 Main Results

Table 4.1 reports the main set of results for 1939. In columns 1 to 4, the dependent variable is the natural logarithm of total land productivity, which is measured as the quantity of harvested cereal crops (Cwt) divided by cultivated land (Ha) and includes both Italian and Libyan productions. Column 5 shows the results for the logarithmic nominal value ($) of harvested cereals per hectare.

The estimates highlight a counteracting effect of Italian farming. On the one hand, villages located within a 50km radius from Italian farms in 1939 were significantly less productive. On the other, Italian locations show a significant productivity advantage compared to nearby Libyan ones. The unrestricted model in column 1, for instance, shows a sizeable gap between the two groups. The simple elasticity of the logarithm does not tell much about the effect of Italian presence and, given the size of the coefficient, the standard approximation in percentage points would be severely biased: however, having applied the appropriate conversion[41], it is possible to see how proximity to Italian farms resulted in a 62% reduction compared to Libyan villages located farther away from white clusters. At the same time, European villages were, on average, roughly 113% more productive compared to their Libyan neighbors. In other words, it appears that Italian settlers were relatively successful locally while they hampered the output per hectare for Libyan farmers in surrounding locations. Figure 4.A.4 shows the productivity patterns visually on a map.

These results are not only robust to the introduction of the full set of geographical controls in column 2. The restricted model even performs more efficiently, as the increase in the magnitude of the main coefficient of interest pinpoints, which in turn suggests an attenuation bias in column 1. This arguably mirrors the fact that the surroundings of Italian clusters were the areas with the highest land suitability for barley and hence, given their agricultural potential, the reduction in productivity triggered by Italian settlement was even stronger than the unconditional estimates would suggest (see Map 4.3 and Section 4.2).

[41] $100 * [exp\beta - 1]$

Table 4.1: The effect of Italian farming in 1939

Dependent variable:	Log Productivity 1939				Log Cer $/Ha
	(1)	(2)	(3)	(4)	(5)
Dist IT Village, 0-50km	-0.988***	-1.320***	-1.447***	-1.471***	-1.500***
	(0.236)	(0.253)	(0.253)	(0.229)	(0.245)
IT Dummy 1938	0.760***	0.681**	0.653**	0.676**	0.817***
	(0.230)	(0.251)	(0.240)	(0.278)	(0.270)
Barley suit		-0.000	-0.000	-0.000	-0.000
		(0.001)	(0.001)	(0.001)	(0.001)
Dist coast, km		-0.001	-0.002	-0.001	-0.002
		(0.002)	(0.002)	(0.003)	(0.003)
Dist waterways, km		0.003*	0.005***	0.008***	0.009***
		(0.002)	(0.001)	(0.003)	(0.002)
Altitude		0.001	0.001*	0.001	0.001
		(0.001)	(0.001)	(0.001)	(0.001)
Temperature av 1950-2000		0.066	0.138	0.102	0.036
		(0.138)	(0.120)	(0.146)	(0.150)
Rainfall av 1950-2000		0.037**	0.025	0.006	0.011
		(0.017)	(0.017)	(0.019)	(0.019)
Longitude		-0.079	-0.081	-0.062	-0.089
		(0.069)	(0.070)	(0.145)	(0.142)
Latitude		0.025	0.032	0.023	0.037
		(0.038)	(0.038)	(0.078)	(0.077)
Land use, pre-1930			0.022	0.033	0.028
			(0.033)	(0.033)	(0.036)
Log Population, 1900			0.094***	0.092**	0.091**
			(0.028)	(0.037)	(0.039)
Dist 1884 tracks			-0.004	-0.000	-0.000
			(0.004)	(0.005)	(0.005)
Dist Tripoli, km				-0.002	-0.001
				(0.002)	(0.002)
Dist Benghazi, km				-0.002	-0.002
				(0.001)	(0.001)
Dist wells, km				0.003**	0.004**
				(0.001)	(0.002)
Log population, 1936				0.027	0.026
				(0.055)	(0.059)
Observations	182	182	182	182	182
R-squared	0.33	0.40	0.43	0.44	0.46
Provincial FE	YES	YES	YES	YES	YES
Geographical Controls	NO	YES	YES	YES	YES
Precolonial Controls	NO	NO	YES	YES	YES
Colonial Controls	NO	NO	NO	YES	YES

OLS regressions in columns 1 to 5 with logarithmic output in hundredweights per hectare as the dependent variable. Robust standard errors clustered for 27 municipalities in brackets. Provincial fixed effects for the 5 provinces in which Italian Libya was divided are added in each specification. Geographical controls include longitude, latitude and altitude, average annual temperature, average rainfall, intermediate input barley suitability, distance from the coast, and distance from the closest river. Pre-colonial controls include: land use before 1930 (Piccioli, 1934), logarithmic reconstructed population from 1900 (HYDE) and distance from 1884 tracks. Colonial controls include: distances from Tripoli and Benghazi, distance from reported wells in 1941 and logarithmic population in 1936 (population census and HYDE) *** p<0.01, ** p<0.05, * p<0.1

The coefficients remain large and significant when pre-colonial and colonial controls are introduced in columns 3 and 4, respectively. The fully specified model, in column 4, still pinpoints an 86% local gap between Italian and Libyan cultivators, together with a 68% lower average productivity of treated Libyan villages relative to more remote indigenous farming. The local productive gap is consistent with the information provided by Italian and British sources which, during the period of British military administration (1942-1951), reported 1.5 and 5 points difference between Libyan and Italian farming in barley and wheat productivity in the early post-war period, respectively.[42] By contrast, the qualitative sources seem to miss the productivity gulf between areas of white farming and the rest of the country, which practically implies a lower average output of about 3.2 Cwt per hectare (See Table 4.A.3 in Appendix 4.A for summary statistics by group). In column 5 from Table 4.A.2, I run equation 4.1 employing the logarithmic distance from Italian village instead of the 50km cut-off to show that this does not matter for the results.

A similar picture emerges if one looks at the effect of Italian farming on logarithmic nominal value of harvested grains per hectare (column 5): the same pattern can be observed when looking at the 0-50 km dummy, which shows that Libyan villages surrounding Italian ones not only experienced lower yields but also that this productive gap was not compensated through the cultivation of more valuable crops. On average, Libyans cultivators in the proximity of Italian settlements were able to produce roughly 70% less nominal output per hectare compared to their more remote counterparts. By contrast, Italian locations maintained a statistically significant and sizeable local advantage in the nominal value of harvested crops per hectare, with a 112% higher produced value.

These negative spillovers contradict various models of positive externalities from more productive agricultural centers towards surrounding areas (Conley and Udry, 2010; Parman, 2012). Although this could be consistent with extraction mechanisms highlighted for other settler economies (Arrighi, 1967; Feinstein, 2005), the Italian case study presents some characteristics that make it unique: as opposed to other colonies - where the reduction in productivity observed on indigenous lands is often explained with restricted access to high-quality lands or with the designation of peripheral areas far from modern infrastructure to indigenous farming - in Italian Libya, local cultivators were allowed to keep their holdings, provided that

[42] Military Administration British (1945). *Survey of Land Resources in Tripolitania*, Pp. 129-30

those had been continuously farmed before 1923. This fact suggests that the explanation for the observed effect lies elsewhere.

Moreover, even if one might think the absolute reduction in land access as detrimental to the Libyan primary sector (for instance due to the necessity to concentrate grazing and farming on scarcer land), the theory suggests that Boserupian dynamics linked to reduced land per capita ratios should increase yields per hectare rather than reduce them (Mosley, 1982). This peculiar spatial equilibrium, therefore, calls for further analysis.

It is also important to stress how - in contrast to $DITfarm_{0-50km,i,1938}$, the main coefficient of interest that should be considered in comparison with Libyan villages located farther than 50km away from Italian farms - the Italian dummy is a sub-category of the binary variable for proximity to Italian farms and should therefore be compared to the average productivity of treated Libyan villages. This is a key point, as it implies that Italian farmers were only able to out-compete their immediate neighbors, but the average productivity of their villages remained well below (at least in the years immediately following their settlement) the output per hectare in Libyan areas located further away from Italian farming.

To sum up, these findings suggest the following: the areas of land farmed by Italian settlers enjoyed higher land productivity and nominal output in 1939 compared with adjacent areas cultivated by Libyan farmers. Lower average productivity for Libyan farmers, instead, was associated with proximity to Italian farms: compared to the average Libyan cluster located more than 50km away from Italian settlements, this group of villages shows 68% lower productivity.

4.6 Robustness

Despite the robustness of the observed correlation to the introduction of relevant controls and provincial fixed effects, there are potential critical threats to the identification of the causal effect of proximity to Italian villages. The main challenge lies in the potential endogenous placement of Italian farms: productivity patterns in place before 1922 might have shaped the modes, and the location of colonial farming and differences in productivity levels might be due to unobservable characteristics that pre-dated Italian settlement. If this was the case, my estimates would merely reflect the persistence of pre-colonial agriculture. In order to tackle endogeneity, which is particularly problematic in this context due to the impossibility

of controlling for pre-1939 productivity, I rely on three main strategies.

As a first step, I re-run the baseline regression, this time employing distance from placebo locations that only received Italian settlers between 1939 and 1940, after my period of observation. The intuition behind this exercise is that if Italian settlement causally determined the described reduction in Libyan productivity in the surrounding areas, we would expect to observe no effect of later settlement clusters. The estimates from this exercise are reported in column 2 of Table 4.2 and are reassuring: Libyan villages located within a 50km radius from placebo locations that received Italian migrants after 1938 are not different from the control group in terms of productivity. Placebo locations themselves even show a small and negative (although statistically insignificant) gap compared to their surroundings. These results strongly suggest that Italian settlement led to the observed differences in yields across Libya.

Secondly, I run an IV estimation, which exploits the peculiar pattern of Italian military occupation of Libya: settlement possibilities for farmers were limited by the extent to which the government was effectively in control of the different parts of the territory. Italian farming presence, therefore, was inversely related to distance from the strongholds controlled in 1921 and 1922 by the Italian army before more comprehensive military operations were launched to regain control over Tripolitania and Cyrenaica. Arguably, even after the full occupation of the hinterland, the original areas of settlement and their immediate surroundings remained safer. Although the strategic decisions made by the Italian army about which strongholds to defend up to 1922 depended on specific local economic factors and were by no means random, pre-colonial agricultural productivity was arguably irrelevant for strategic military choices that were instead influenced by the relative importance of urban centres and strategic geographic features (such as mounds and ports)

I implement this strategy by instrumenting proximity to Italian villages with a dummy variable that equals 1 if a village was located inside the territory of the oldest Italian military strongholds (those that were under Italian control in 1922) or within a 40km radius from the polygons' centroids[43]. The correlation between the instrumented variable and the selected instrument is shown in Figure 4.A.1 from Appendix 4.A. The instrumented coefficient in column 3 (Table 4.2) is large, negative and statistically significant at the 1% level. Its size is very similar to the OLS baseline, but moderately larger which suggests an attenuation bias

[43]The 40km radius was selected so that in combination with the distance between the stronghold's centroid and its border this would total about 50km, in line with explanatory variable of interest

in the OLS estimates, in line with the described historical pattern of land distribution, which led Italian farmers to take unused land around centers of traditionally intense farming.

Table 4.2: Robustness checks

Estimation:	Baseline	Placebo	IV military occupation			Nmatch
	(1)	(2)	(3)	(4)	(5)	(6)
Dist IT Village, 0-50km	-1.471***		-1.779***	-1.768***	-1.653***	
	(0.229)		(0.340)	(0.343)	(0.442)	
IT Dummy 1938	0.676**		0.692***	0.702***	0.677***	
	(0.278)		(0.260)	(0.267)	(0.263)	
Dummy 0-50 km, after 1939		0.097				
		(0.288)				
IT Dummy 1940		-0.789				
		(1.126)				
Log Market Potential				-0.035		
				(0.092)		
Battle dummy, 0-50km					0.174	
					(0.210)	
SATT						-0.738***
						(0.210)
Observations	182	182	182	182	182	182
R-squared	0.44	0.30	0.44	0.44	0.44	.
Cragg-Donald Wald F stat	.	.	89.94	88.85	64.95	.
Kleibergen-Paap F stat	.	.	12.58	12.45	7.680	.
Provincial FE	YES	YES	YES	YES	YES	.
Geographical Controls	YES	YES	YES	YES	YES	.
Precolonial controls	YES	YES	YES	YES	YES	.

Robustness checks for the baseline equation (column 1) are reported in columns 2 to 5. All specifications in columns 1 to 4 include the same controls as for the baseline. In column 2 estimates from placebo villages that received Italian migrants only after 1938 are reported. Columns 3 and 4 report the estimates from a 2SLS exercise which instruments proximity to Italian enclaves with a dummy for being located within 40km from a military stronghold before 1922. In columns 4 and 5, the logarithm of market potential and an indicator for the location of battles are included as controls, respectively. Column 6 shows the estimate from a Nearest Neighbour Score Matching exercise based on the logarithm of market potential, population, and pre-1930 land use. Robust standard errors clustered for 27 municipalities in brackets. Provincial fixed effects for the 5 provinces in which Italian Libya was divided are added in each specification. Geographical controls include: longitude, latitude and altitude, average annual temperature, average rainfall, intermediate input barley suitability, distance from the coast, and distance from the closest river. Pre-colonial controls include: land use before 1930 (Piccioli, 1934), logarithmic reconstructed population from 1900 (HYDE) and distance from 1884 tracks. Colonial controls include: distances from Tripoli and Benghazi, distance from reported wells in 1941 and logarithmic population in 1936 (population census and HYDE) *** p<0.01, ** p<0.05, * p<0.1

In column 4, the IV model is made conditional upon the logarithm of market potential ($MP_i = (2 * Population_i + \frac{Population_j}{Distance_j})$): access to markets, in fact, could be a possible violation of the exclusion restrictions, as coastal areas were also located next to the most prominent agricultural markets.[44] Both estimations yield reassuring first-stage F-statistics, which are well above the Stock and Yogo test's threshold. A second possible violation of the exclusion restriction is the fighting itself. If to conquer areas located in the surroundings of early Italian strongholds, the Italian army created havoc and disrupted production in the agricultural villages, this could potentially explain the effect and thus violate the exclusion restrictions. As data on war damage inflicted on local farmers are not available, in column 5, I introduce a control for being within 50km from major battles or counter-guerrilla events, by using the reconstruction provided by Piccioli (1934, pp. 20-250) (see Appendix 5.B for details). The instrumented coefficients are robust to this additional control, which is consistent with the available narratives that depict the most intense warfare events as typically located far from Italian territories, with the rebels taking shelter in the pre-desert belt and the Gebel hills in Cyrenaica (Del Boca, 1986b).

Finally, I implement a Nearest Neighbour Matching estimation which compares pairs of treated (located nearby villages that experienced Italian farming) and untreated villages with similar scores in terms of the logarithm of market potential, population size, and pre-1934 land use. Column 6 displays the results: these show that similar villages only differing in proximity to Italian farms have a statistically significant gap in land productivity.

Columns 1 to 4 in Table 4.A.2 from Appendix 4.A report additional tests that verify that the results are not driven by different institutional settings at the tribal level or by systematic differences in yield differentials in Saharan and pre-desert oases. In column 1, I introduce a set of ethnic fixed effects from Murdock's map (Murdock, 1967): although the available qualitative sources underline how enforcement of property rights and risk management at the tribal level did make a significant difference in agricultural productivity, ethnic fixed effects do not alter the magnitude and significance of the two coefficients of interest. In column 2, the Saharan province (Hun) is excluded from the sample, while in columns 3 and 4, the analysis is limited to villages located within 100km and 50km from the coast, respectively. Despite these restrictions of the sample size, the coefficients of interest remain significant, which in

[44] The location of the main markets is identified through the list reported in (Ministero dell'Africa Italiana, 1939b, p. 17), while population levels are from the 1936 population census (Regno d'Italia, 1939). The total population in the closest municipal market is employed.

turn provides further evidence that the estimates are not merely mirroring a persistence of pre-colonial patterns of production in colonial dynamics, but rather a negative spatial effect triggered by the settlement of Italian farmers. Column 5 shows that the results are robust to the use of the logarithmic distance from Italian villages instead of the 50km cut-off. As Cyrenaica experienced a more violent process of land expropriation (Del Boca, 1986b, pp. 267-9), it is essential to show that the results are not solely driven by a drop in land productivity in this region. Column 6 shows that Cyrenaica alone is not driving the results, as these survive the exclusion of this region from the sample, which corresponds to a loss of more than 30% of the observations.

Finally, columns 3 and 4 from Table 4.A.5 provide district-level evidence that Libyans did not increase their labor productivity significantly in areas affected by Italian farming. This is reassuring as a different result would make us question the extent to which the drop in yields could be interpreted as an actual reduction in productivity and not, for instance, as reflecting the adoption of different (and possibly more capital-intensive) farming techniques, which would instead be compatible with a process of structural transformation.

Altogether, these findings provide strong evidence of the causal link between proximity to Italian farms and lower Libyan productivity, the main effect of Italian agricultural settlement. Far from being conclusive, these estimates raise two key and interlinked questions: *Why did productivity decline in Libyan villages neighboring Italian ones?* and, related to this question, *What made Italian villages more productive locally?* The remainder of the paper discusses the mechanisms.

4.7 Mechanisms

4.7.1 Explaining the negative spillovers

The literature posits positive spillovers from centers experiencing innovative market-oriented farming to more backward neighbors (Parman, 2012; Conley and Udry, 2010; Foster and Rosenzweig, 1996). Therefore, Libyan cultivators in the proximity of Italian farms should have been, for instance, more inclined to adopt wheat as the main crop, mechanized farming techniques, and better irrigation facilities. Indeed, a collapse in grain yields is entirely incompatible with this model.

Furthermore, the peculiar spatial pattern of agricultural productivity in the Libyan con-

text represents a novelty also with respect to the body of literature on settler economies, which explains the reduction in productive capacity as a function of political choices that either pushed the indigenous farmers into less fertile lands, or marginal ones where the necessary market incentives were absent (markets and transport infrastructure) (Feinstein, 2005; Arrighi, 1967). As described above, neither of these two conditions materialized in the Italian case in Libya due to the initial settlement of white colonizers in peripheral plots located around Libyan clusters with the highest agricultural potential in terms of land suitability and access to markets. A small but recent literature has underlined the success of indigenous farming elites who responded to market access incentives through increasing productivity in proximity to areas of white settlers, for instance in colonial Southern Rhodesia (Shutt, 2002; Frankema, Green, and Hillbom, 2016), a model which is also incompatible with the described empirical results.

For all these reasons, it is particularly important to understand the mechanisms behind the collapse in yields for Libyan farmers that were more exposed to European agricultural activity in the Libyan context. As the sources do not provide micro-level information on Libyan factors of production, I will be able to explore the mechanisms behind this effect only indirectly by either testing relationships between demography and productivity gaps, or by comparing the characteristics of Italian farming in the closest white village with output per hectare in the surrounding area. I will focus on the sub-sample of Libyan villages that did not receive Italian settlers, which leaves me with 122 observations with complete information on population and productivity.

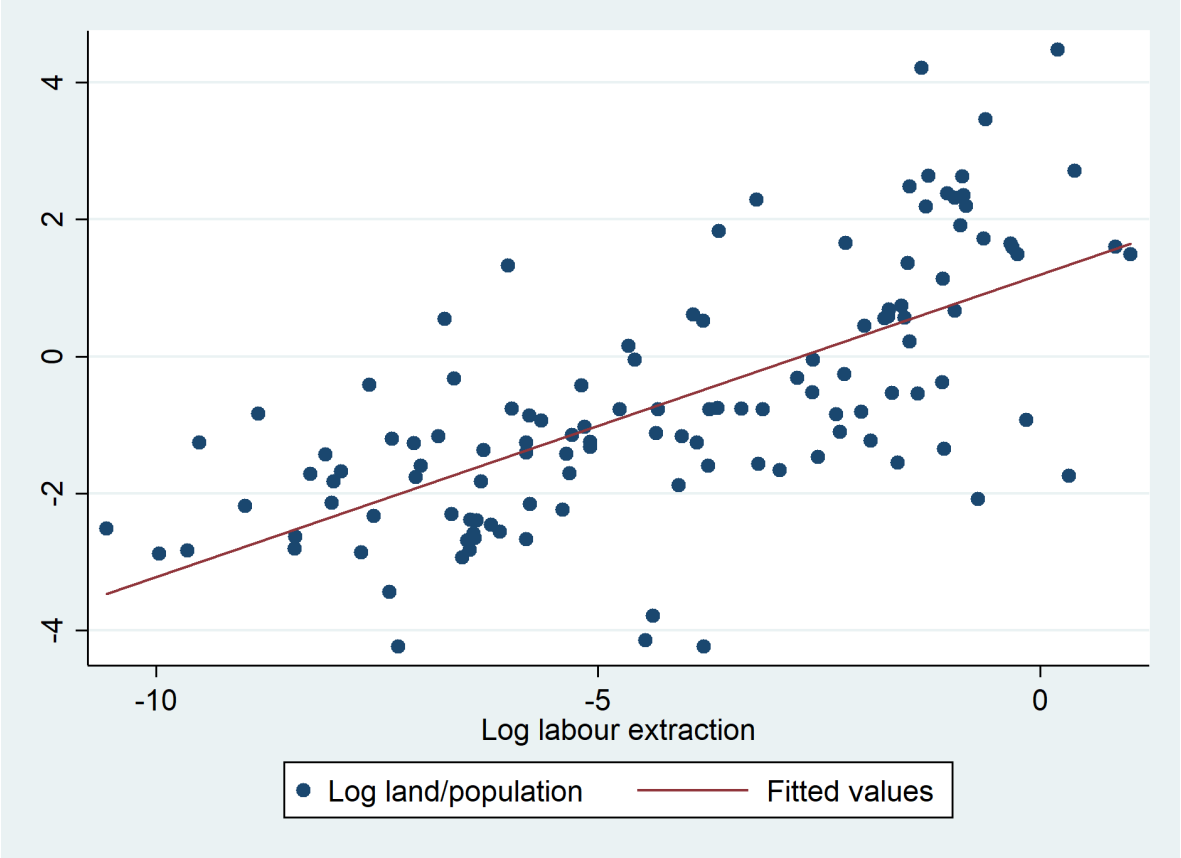
As a first step, I explore the relationship between levels of Libyan productivity and (cultivated) land to population ratio, which provides an indication of farming intensity in indigenous villages. Especially in the African context, the selection of intensive versus extensive farming played a vital role within the survival strategies of different ethnic groups and often depended on local factor endowments, such as labor scarcity and land abundance (Austin, 2008a). Could the observed collapse in output per hectare be linked to extensive farming? In Figure 4.4, I plot the logarithms of land productivity (y axis) against the land to population ratio (x axis), which I use as a proxy for farming intensity. This exercise shows a clear negative relationship between productivity and farming intensity.

In Table 4.3, I test this channel more formally by introducing cultivated land per capita as a control in the baseline equation (limiting the sample to those villages that did not experience

Figure 4.4: Libyan productivity and cultivated land per capita

Italian settlement). Column 2 shows that the land to population ratio fully captures the negative effect of proximity to Italian clusters: the coefficient of interest, in fact, halves in size and loses significance. Thus, these estimates indicate that land-extensive cultivation determined a drop in land productivity. This dynamic, which has been identified in different African contexts as a form of risk mitigation and profit maximisation in situations of relative labour scarcity and land abundance (Austin, 2014; Shutt, 2002; Austin, 2008a; Fenske, 2012) calls for further analysis: on the one hand, as opposed to other African countries, highly fertile farmland is limited in Libya, especially in absence of sophisticated and comprehensive irrigation facilities that were mostly unavailable to Libyan farmers during the colonial period. This lack of water made intensive cultivation that exploited the scarce water resources more rational, especially in the coastal areas where the Italians settled more intensively. On the other hand, only cultivators who were farming close to white settlers adopted land extensive techniques systematically, which emphatically suggests that this phenomenon was linked to white farming activities.

Figure 4.5: Cultivated land per capita and labor extraction



In other words, the question of why proximity to Italian farms triggered a transition towards land-extensive cultivation and lower yields remains. What did the Italians do to push the Libyans to shift from intensive to extensive cultivation? The available data are not ideal to answer this question, as the sources do not report factors of production on Libyan farms. Nevertheless, I can exploit the variation in Libyan productivity together with heterogeneity in Italian farming practices to explore the possible mechanisms. Do farming strategies adopted differently across the country on European farms significantly correlate with the heterogeneous land to population ratios? In order to address this issue, I create an index of labor extraction that - for each Libyan village - incorporates the number of indigenous laborers employed in the closest Italian village, the distance between the two villages (as a weight) and a proxy of the available workforce, for which I employ 1936 population levels:

$$100/\left(\frac{Pop_{i,1936}}{L_{jLib}/Km_{ij}}\right) \tag{4.2}$$

Where $Pop_{i,1936}$ is the total (male and female population) in village i, L_{jLib} is the number of Libyan workers employed in the closest Italian village j and Km_{ij} is the linear distance in Kilometres between village i and j. The computed index is then transformed in logarithms to make estimations consistent across specifications and easy to interpret. The index intuitively provides an approximation of the amount of labor employed in the closest cluster of white farms, relative to the potentially available stock. Critical simplifying assumptions lie behind this index, such as the fact that labor migration only took place between each Libyan village and the closest Italian one and that linear distance is the only factor that mattered in this choice. Nevertheless, given the described data constraints, this strategy allows shedding some light on the relationship between proximity to white farming and the adoption of land-extensive farming strategies.

Figure 4.5 plots the logarithms of land to population ratio against the index of labor extraction. As one can see, the two measures strongly and positively correlate, which suggests that the labor extraction channel could be essential to explain the observed drop in land productivity. At the same time, the qualitative evidence suggests that Italian farming activity could affect Libyan agriculture through channels other than labor. Increasing competition for other local resources, such as livestock (camels were the primary source of animal power, but horses and cows were also important for the indigenous primary sector) (Wheatley, 1951, p. 33) and water (which was employed for irrigation on Italian farms) could also play a role in diminishing yields per hectare by pushing Libyans to adopt land-extensive practices. Therefore, following the same procedure as in equation 4.2, I calculate the same index of resource extraction for these variables.

To measure the effect of resource extraction on the land to population ratio, I estimate equation 4.1 with cultivated land per capita as the dependent variable. In columns 3 to 7 of Table 4.3, I introduce the different measures of resource extraction. To correctly identify the effect of the extraction and differentiate between the latter and other weights incorporated in the index, I introduce the logarithmic distance from the closest Italian village as a control. The model will, therefore, hold distance from the closest village and population constant.

From this exercise, it is clear how - *ceteris paribus* - a higher land-to-population ratio was associated with the extraction of specific resources, such as Libyan workers and camels. The estimates advocate that increased pressure on strategic resources in areas of white farming is a key channel to explain the different levels of farming intensity and, in turn, land productivity.

Column 3, for instance, suggests that a 1% increase in labor extraction corresponds to a 0.2% growth in the land to population ratio. Similarly, if one looks at column 4, an increase of 1% in camel extraction is linked to a 0.3 jump in the left-hand side term. By contrast, other measures of resource extraction, such as those for horses, cows, and water (in columns 5 to 7) do not show any statistically significant association with farming intensity and have smaller and even negative coefficients.

Table 4.3: Explaining spillovers on Libyan productivity in 1939

	Log Productivity 1939		Log land/population				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dist IT Village, 0-50km	-1.509***	-0.843					
	(0.309)	(0.526)					
Log land/population		-0.301**					
		(0.143)					
Log labour extraction			0.214**				
			(0.094)				
Log camels extraction				0.309***			
				(0.093)			
Log cows extraction					-0.067		
					(0.078)		
Log horses extraction						0.152	
						(0.136)	
Log water extraction							-0.118
							(0.171)
Log population, 1936	0.026	-0.174	-0.483***	-0.422***	-0.728***	-0.530***	-0.767***
	(0.070)	(0.116)	(0.085)	(0.097)	(0.143)	(0.129)	(0.181)
Log dist IT village,km			-0.456**	-0.336	-0.714***	-0.489**	-0.775**
			(0.191)	(0.206)	(0.240)	(0.230)	(0.297)
Observations	122	122	122	122	122	122	122
R-squared	0.50	0.55	0.71	0.72	0.70	0.71	0.70
Provincial FE	YES	YES	YES	YES	YES	YES	YES
Geographical Controls	YES	YES	YES	YES	YES	YES	YES
Precolonial Controls	YES	YES	YES	YES	YES	YES	YES
Colonial Controls	YES	YES	YES	YES	YES	YES	YES

OLS regression analysis estimates for the sub-sample of 122 Libyan villages reported in columns 1 to 7. Robust standard errors clustered for 27 municipalities in brackets. Provincial fixed effects for the 5 provinces in which Italian Libya was divided are added in each specification. Geographical controls include: longitude, latitude and altitude, average annual temperature, average rainfall, intermediate input barley suitability, distance from the coast, and distance from the closest river. Pre-colonial controls include: land use before 1930 (Piccioli, 1934), logarithmic reconstructed population from 1900 (HYDE) and distance from 1884 tracks. Colonial controls include: distances from Tripoli and Benghazi, distance from reported wells in 1941 and logarithmic population in 1936 (population census and HYDE) *** p<0.01, ** p<0.05, * p<0.1

As reverse causality is not an issue - i.e., my robustness checks showed that Italian settlement influenced Libyan farming and not vice-versa - we can interpret these findings as

strong evidence that Italian cultivators using more substantial amounts of indigenous labor and camels for local farming pushed their Libyan neighbors to adopt land-extensive cultivation to maximize food availability and minimize labor and capital inputs. These findings are consistent with the analytical narrative proposed by Segré (1974, pp. 154-7), who emphasizes how the attraction of salaries paid by Italian farmers and in the coastal cities of Libya triggered an exodus from the countryside where mostly old and young farmers were left behind. By contrast, little narrative evidence exists on the role played by camels, that instead seem to play a pivotal role in explaining the described effect. Unfortunately, also due to the collinearity between the variables (concentration of workers and camels), it is at this stage impossible to explore the link between labor and camel extraction further. Yet, the hypothesis that the two processes could be interlinked is not difficult to imagine. On the one hand, considering that the supply of camels was relatively inelastic and that these beasts were the main source of animal power for the Libyans (Wheatley, 1951), it is possible that in areas where Italian bought a high number of them, Libyan cultivators would have struggled to implement intensive farming (whether that meant pulling the plow or operating water pumps). On the other hand, higher camel concentration on Italian farms could be a simple side effect or even a consequence of more laborers moving into waged labor for European employers: if lower labor availability on Libyan lands prevented intensive cultivation in any case, camels might have become cheaper and therefore could have been purchased in more significant numbers by Italian entrepreneurs, who probably employed Libyan labor and camels as complements.

These results provide compelling evidence to reject the mainstream hypothesis according to which the adverse effects of white farming came about through land expropriation and, instead, advocate a different explanation, associating them with the drain caused on the available factors of production. Camels and workers arguably played an important role in determining this peculiar geographical pattern with markedly lower levels of land productivity in the proximity of Italian farms.

4.7.2 Accounting for Italian productivity in 1939

If land-extensive cultivation linked to resource extraction explains the gap in productivity between Libyan villages in treated and untreated areas (areas that were affected by Italian settlement and more remote locations), does the same explanation hold for the gap between Italian enclaves and nearby indigenous ones? In other words, what are the drivers of the differ-

ence between white and Libyan villages within the 50km cut-off? Despite substantially lower productivity levels compared to remote indigenous farmers, Italian settlers managed to keep higher outputs per hectare than their Libyan neighbors, which calls for further explanations. As mentioned above, due to data constraints, I cannot compare Libyan and Italian production strategies systematically, but I can approach this question from two distinct angles. Firstly, I will compare land to population ratios (my proxy for farming intensity) to verify whether these explain the productivity gap within the sub-sample of 117 villages located within the 50km radius. Secondly, I can explore the mechanisms further by testing what production strategies significantly correlate with higher yields for the sub-sample of 60 Italian villages for which I have more detailed information, to check whether results from this sub-sample confirm the broader findings on farming intensity.

Although it might seem intuitive that the import of capital and modern agricultural techniques should guarantee a substantial productive advantage to white farmers, this has proved wrong in other African contexts. A simple look at the unsuccessful attempts of the "groundnut scheme" in Tanzania (Havinden and Meredith, 1993), or at the relative performances of white settlers and black peasants in various countries (Frankema, Green, and Hillbom, 2016; Shutt, 2002) demonstrates how difficult it was, for white farmers, to select and adopt the best farming practices. The Libyan case is a very particular one, as European farmers managed to outperform local producers within a certain radius around their settlements, but lagged behind - at least during the first years after settlement and with respect to land productivity only - when compared to more distant areas.

Different reports from both the colonial and early post-colonial period generally acknowledge the localized higher productivity of Italian farmers,[45] but fail to provide a clear explanation of what factors account for this advantage. Italian publications, typically politically biased towards Fascism, generally emphasize the "enlightened action" of the government, as well as the heroic activity of the settlers, often pictured as modern Roman soldiers bravely fighting for the glory of the motherland against the hardship of the North African weather (Pace, 1935; Ballico, 1939). Fascist authors, when attempting to take a more scientific approach, tend to list the many "virtuous" characteristics of Italian farming, from the employment of modern tractors to the construction of sophisticated wells, from the rotation of the

[45] Military Administration British (1945). *Survey of Land Resources in Tripolitania*; Military Administration British (1947). *Handbook on Tripolitania*

crops to the selection of better plants (Piccioli, 1926; Piccioli, 1934). These types of contributions, although very informative for the purpose of this analysis, do not provide an explicit explanation of which factors mattered the most.

Table 4.4: Explaining differences in Italian productivity

Dependent variable:	Log Productivity 1939									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
IT Dummy 1938	0.588	0.330								
	(0.340)	(0.253)								
Log IT and LB land PC		-0.213***								
		(0.066)								
Log population, 1936	0.025	-0.114	0.021	0.031	0.032	0.045	0.057	0.048	0.053	0.037
	(0.074)	(0.069)	(0.060)	(0.057)	(0.057)	(0.058)	(0.056)	(0.068)	(0.059)	(0.063)
Month from IT occupation			0.011							
			(0.011)							
Average farm size (Ha)				-0.000						
				(0.000)						
No IT managers/IT cult land (Ha)					-0.111					
					(0.360)					
Tot workers/Ha						0.182*				
						(0.100)				
No IT workers/IT cult land (Ha)							0.604			
							(0.382)			
No LB workers/IT cult land (Ha)							-0.048			
							(0.156)			
No new machines/IT cult land (Ha)								-0.507		
								(1.084)		
No old machines/IT cult land (Ha)								0.093		
								(0.295)		
No Wells/IT cult land (Ha)									0.230	
									(0.289)	
Irr+sem area/IT cult land (Ha)									-0.095**	
									(0.039)	
D Rail 1934, 0-10km										-0.443
										(0.574)
D Road 1934, 0-10km										0.820***
										(0.154)
D Lorry 1934, 0-10km										0.254
										(0.277)
D Track 1934, 0-10km										0.059
										(0.322)
Observations	117	117	60	60	60	60	60	60	60	60
R-squared	0.35	0.46	0.50	0.49	0.49	0.51	0.54	0.49	0.40	0.48
Provincial FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Geographical Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Precolonial Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Colonial Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

OLS regression analysis estimates for the sub-sample of 117 Italian and Libyan villages within the 50km cut-off in columns 1 and 2. Columns 3 to 10 report OLS estimates for the sub-sample of 60 villages affected by Italian agricultural settlement. Robust standard errors clustered for 27 municipalities in brackets. Provincial fixed effects for the 5 provinces in which Italian Libya was divided are added in each specification. Geographical controls include: longitude, latitude and altitude, average annual temperature, average rainfall, intermediate input barley suitability, distance from the coast, and distance from the closest river. Pre-colonial controls include: land use before 1930 (Piccioli, 1934), logarithmic reconstructed population from 1900 (HYDE) and distance from 1884 tracks. Colonial controls include: distances from Tripoli and Benghazi, distance from reported wells in 1941 and logarithmic population in 1936 (population census and HYDE) *** p<0.01, ** p<0.05, * p<0.1

In Table 4.4, I tackle these questions empirically. Firstly, in column 1, I re-run equation

4.1 for the sub-sample of 117 Libyan and Italian villages located within the 50km radius from white agricultural settlements. In order to test the different levels of land productivity between the two groups, I drop the 0-50km binary variable and only keep the dummy for Italian presence. Similarly to Table 4.1, this shows a positive a significant (just below the 10% threshold) association with land productivity. Also, in this case, the level of farming intensity seems to be the critical driver of different agricultural productivity levels: when the logarithm of the land to population ratio is introduced in column 2, in fact, the coefficient of interest halves in size.

As discussed above, land to population ratio is a very imperfect measure of farming intensity as it does not distinguish between employment structure across observations: this is undoubtedly problematic for Libyan rural villages, where a significant number of locals could be employed in pastoralism (which would artificially reduce my proxy for farming intensity) and for larger Italian villages and towns, where more employment in services and trade would bias my estimates upward. Luckily, the extensive data provided by the 1937 agricultural census of Italian farms, allows for testing this hypothesis more convincingly within the sub-sample of 60 Italian villages. This source, in fact, provides precise information on the number of Italian and Libyan agricultural workers employed on each farm. A positive association between labor intensity and land productivity for this sub-group would add strong evidence to the suggested labor channel in explaining productivity differences across the country. By contrast, if other channels seemed to matter more, this would question my working hypothesis, at least for areas of white settlement.

In columns 3 to 10, I run regression analysis with the same controls as in equation 4.1 for the sub-sample of 60 Italian villages. In each column, I add variables capturing the different factors that might explain productivity levels, following the potential explanations suggested by the qualitative sources (Piccioli, 1934). A first element is the progressive adaptation of Italian farming techniques to local conditions: villages with higher productivity levels might be those where Italians had settled earlier and where settlers had been able to refine their cultivation strategies to cope with local constraints (Frankema, Green, and Hillbom, 2016). As adaptation to local conditions requires time, a measure that proxies the duration of agricultural settlement would pin this effect down: the 1937 census does not provide information about when each farm was created, but I can proxy length of settlement by months of Italian occupation, as the two dynamics were strongly interlinked (as my IV strategy suggests). This

variable does not significantly correlate with productivity (column 3).

A second hypothesis is that economies of scale might have been important, especially for dry farming techniques, which are particularly relevant for grain cultivation in frontier regions (Libecap and Hansen, 2002a; Hansen and Libecap, 2004). In order to capture this potential mechanism, I introduce the average farm size as a control in column 4, which does not show any meaningful correlation with output per hectare.

In order to explore skill, labor, capital, and transport infrastructure channels, instead, I focus on five possible mechanisms. Firstly, agricultural skills imported by Italians, proxied by the number of Italian farm managers per hectare, might account for higher local productivity. Secondly, labor intensity could play a role in driving productivity. Thirdly, the availability of more machinery could have been of pivotal importance for increasing land productivity, either through a higher concentration of traditional machinery (for instance animal plows) or due to modern machinery equipment (mechanic plows and tractors). Fourthly, the observed advantage might derive from better irrigation facilities: cheaper and more abundant water might have allowed higher yields, especially in a region characterized by extremely low precipitations. Finally, proximity to transport infrastructure might have also played a role through market access and cheaper input goods, which might have in turn influenced cultivation techniques and concentration of factors of production (Jedwab and Moradi, 2016).[46]

I test these different channels in columns 5 to 10. Most variables are insignificant and have small coefficients: for instance, Italian managers per hectare do not seem to drive differences in productivity at the village level (column 5), similarly to machinery stock (column 8) and water availability per hectare (column 9).

By contrast and consistently with my labor intensity hypothesis, column 6 shows a positive and significant association between workers per hectare and land productivity, which further emphasizes how labor intensity was vital to achieving high yields in the Libyan context. When I decompose the coefficient between Italian and Libyan laborers (column 7), the effect seems to be driven by the concentration of white workers. Furthermore, column 10 provides evidence of the importance of proximity to transport infrastructure for agricultural productivity: the binary variable for being located within 10km from a paved road shows a large, positive and statistically significant coefficient.

[46] Use of inorganic fertilizer might have also played a role, but the data do not allow to test this explicitly. This said, farms endowed with high capital stocks are also more likely to use this technique, so this should be - at least partially - captured by machinery stock and presence of white managers.

The small number of observations and the high degree of collinearity between the variables certainly make the analysis of the causal links problematic. Nevertheless, Table 4.4 provides convincing additional evidence on the importance of labor intensity in running highly productive farms in Libya during the colonial period. Proximity to transport infrastructure and market access also seem to have played a role in this context, possibly through the labor channel (i.e., cultivators strategically located next to better infrastructure had the incentive to implemented labor-intensive farming as transport costs were cheaper). Causation could run in both directions, with most profit-driven farmers purchasing more expensive land next to pre-existing infrastructure and hiring more workers or, vice-versa, with the government building more and (possibly) better roads in locations with a more intensive settlement and thus giving the incentives to boost output per hectare by hiring more labor. Probably, both dynamics are in place, with private and public investments interacting with each other differently across the country.

4.8 Discussion: Implications for indigenous living standards

One important caveat is in order at this point. The analysis performed so far only allows capturing two specific elements of the transformations brought about by the settlement of Italian farmers, namely the effect on average yields and its proximate causes (extraction of resources). It has not been possible to study the dynamics behind this resource drain empirically, whether, for instance, these happened through wage and price differentials between Italian and Libyan farming sectors or political decisions aimed at extracting factors more easily to the benefit of the white population. Similarly, we do not know how this shift towards land extensive techniques due to Italian settlement affected the well-being of the Libyans.

The latter is an important question which, given the paucity of disaggregated data on Libyan salaries and cattle (another key source of income for the Libyan population), is difficult to answer in full. A study in this direction is further complicated by the fact that the resource extraction dynamics pinpointed in Section 4.7.1 would affect the Libyan population heterogeneously, as young workers could take advantage of the new wage labor opportunities, while elder people, women, and children would be left behind in the countryside to cope with a lack of factors of production and falling yields (Segré, 1974, pp. 155-6). The extent to which remittances could compensate for this drop in yields is even more challenging to quantify.

In the remainder of this section, I gather the available evidence to offer a tentative answer to the question of the magnitude of the identified effect on Libyan welfare. I provide three pieces of evidence. First, I look at differences in labor productivity across Libya, to verify that growing labor productivity did not counteract the drop in yields. Second, I verify the extent to which the land-extensive response was successful by comparing grain availability per capita between treated and untreated locations. Finally, I compare the available estimates of Libyan yields in affected locations before and after the Italian settlement to quantify the severity of the decline in land productivity in treated locations. The results show a certain degree of success of the land-extensive response that allowed to maintain similar levels of grain availability per capita relative to the control group, but also a significant worsening of living conditions if 1913 and 1939 are compared.

4.8.1 Labor productivity

As a first step to address this issue, I construct district-level measures of labor productivity, which is important for the robustness and interpretation of the results. In fact, one possibility that would lead to diametrically opposite conclusions from the ones outlined is that a capital-driven increase in labor productivity could have mirrored the drop in yields in villages affected by Italian resource extraction. As I do not observe capital stock at the village level (and neither the agricultural labor force), the results presented so far do not rule out this possibility, although the secondary literature does not provide evidence on growing labor productivity in the proximity of Italian farms (Cresti, 2011; Segré, 1974).

To do so, I employ nominal output from cereals, calculated from the Agricultural Survey of 1939 (Ministero dell'Africa Italiana, 1939a) and data on occupational structure at the district-level from the 1936 population census (Regno d'Italia, 1939) to calculate the number of Libyans working in agriculture in each district.[47] I then use these data to run a simple OLS regression with regional fixed effects that compares districts affected by Italian settlement with those located farther away from them. Regional fixed effects are particularly relevant here as they allow us to compare labor productivity within areas of relatively homogeneous

[47]The number of Libyan workers employed on Italian farms and reported in the 1937 agricultural census (Ministero dell'Africa Italiana, 1937a) are subtracted from the total. The number of Italian workers in each district is instead taken directly from the 1937 census (Ministero dell'Africa Italiana, 1937a) as this was more accurate than the one reported by the 1936 census. This procedure provides reliable estimates of Italian and Libyan workers per district, with the only exception of seasonal workers that would not be reported in either census.

traditional cultivation techniques and regional colonial policies. Table 4.A.5 shows the results of this exercise for both Tripolitania and Cyrenaica. As one can see, while both quantity and value of produced cereals per worker is higher in Tripolitanian districts affected by Italian farming when output from Italian farms is included in the computation (columns 1 and 2), the same is not valid for Libyan output. In fact, when Libyan labor productivity in Italian areas is compared with untreated districts in columns 3 and 4, this does not show a significantly higher level (although the coefficients are positive[48]). Thus, although the level of disaggregation is not ideal for this kind of analysis, we can conclude that the drop in yields was not driven by a shift, for instance, to mechanized farming which would be more clearly reflected in labor productivity estimates. However, the higher levels measured for some Italian districts in Tripolitania suggest that the more widespread level of mechanization possibly provided Italian farmers with a comparative edge over Libyan cultivators, which is not reflected by land productivity statistics.

4.8.2 Produced cereals per capita

Another way to tentatively evaluate the effect of the resource drain on Libyan welfare is to look at grain output per capita (entire population) in proximity to Italian clusters, a rough proxy for caloric availability per capita. As previously mentioned, this measure is highly imperfect as it does not incorporate other sources of food, such as livestock, but nevertheless gives an idea of whether Italian farming reduced food availability dramatically or whether Libyans managed to somehow cope with this situation through land-extensive cultivation. As one can see in column 3 from Table 4.A.4 in Appendix 4.A, proximity to Italian farms is associated with a statistically insignificant but positive coefficient. This coefficient becomes larger and significant when productivity is included as a control in the equation in column 5, which suggests that, assuming that the entire cereal production was available for local consumption, land extensive farmers (in proximity of Italian farms) were actually better off than their counterparts employing intensive farming methods when holding land productivity constant. Hence a, at least partially successful, adaptation of indigenous farmers seems to have taken place in coincidence with the changes in factor endowments linked to the migration of Italian settlers.

[48]These are driven by a few outliers, especially the are of Barce in Cyrenaica which had very high levels of productivity, but this was an exception

Table 4.5: Libyan barley yields (Cwt/Ha) and cultivated land in 1913 and 1939

Source for 1913:	*Bertolini (1913)*			*Franchetti (1914)*		
Village:	Misurata	Zliten	Homs	Msellata	Garian	Tarhuna
	(1)	(2)	(3)	(4)	(5)	(6)
Barley yields (Cwt/Ha)						
1913	7.5	16.3	9.2	18.3	4.2	8
1939	0.35	3.6	0.35	1.1	0.5	1.4
Cultivated land (Ha)						
1913	2,000	15,000	.	.	.	.
1939	2,810	3,600	.	.	.	.

In the top panel, the table compares barley yields in Cwt per hectare for the same area in 1913 and 1939. The bottom panel reports total cultivated land for the few villages for which information is available for both years. The 1939 data is from the 1939 Agricultural Survey (Ministero dell'Africa Italiana, 1939a) (see Section 4.3 for details) and locations correspond to those reported in the table, apart from Homs, Garian and Tarhuna which are district capitals and only feature Libyan cultivation in smaller nearby villages in 1939. In these cases, Libyan barley productivity of the closest Libyan village for which the information was reported is used instead. These are Suk el Kemis (Homs), Beni Daud (Garian) and Abiar Miggi (Tarhuna). The 1913 data come from two surveys collected by Italian technical experts after the occupation of Libya; the data points are collected from the text and correspond to lower bound estimates of barley yield (Bertolini, 1913; Franchetti, 1914). All six villages are located within 50km from an Italian village in 1939 and, therefore, belong to the treatment group in the analysis

4.8.3 How significant was the drop?

Finally, it is also important to add a more historical perspective to the analysis in order to outline a better counterfactual scenario. Libyan villages located next to Italian ones were undoubtedly the least productive in 1939 with average cereal yields of about 1.4 Cwt/Ha versus the 4.8 Ctw/Ha average measured in those located at a greater distance from Italian clusters (see Table 4.A.3 and in the OLS results in Table 4.1). However, what levels of productivity could Libyans achieve in the absence of Italian settler agriculture? Had affected locations always been characterized by relatively land extensive production strategies that had only been accentuated further by the arrival of Italian farmers, or did the situation change completely?

Table 4.5 reports productivity and acreage estimates for six Tripolitanian villages for both 1913 and 1939 and offers a preliminary answer to these questions. The available quantitative

evidence on barley yields for six major agricultural centers of Tripolitania (top panel) suggests that the Italian agricultural settlement brought about a striking reversal of fortunes. Before Italian farming started on a significant scale, in fact, all recorded villages were between 5 and 20 times more productive than in 1939, at levels that we could consider fairly high by international standards (Federico, 2005, pp. 70-1), although arguably based on labor-intensive and semi-irrigated farming (Franchetti, 1914, pp. 295-7). If these figures are reliable and representative, in the absence of Italian settlement affected districts would have arguably been, in 1939, significantly more productive than the control group (average productivity of roughly 5 Cwt/Ha for the control group compared to roughly 10 Cwt/Ha for the treatment one, see Table 4.A.3). While we have too few data points to draw sound and definitive conclusions from this table, if the patterns were accurate for the rest of Libya as well, this drop in yields would have certainly significantly affected local living standards, at least relative to the levels preceding the Italian occupation. Although granular data to calculate this more precisely it is not, to the best of my knowledge, available, it seems unlikely that the combined relief offered to farmers by land extensive cultivation techniques and, possibly, remittances, could have compensated for such a dramatic drop in land productivity. In fact, in the only two villages for which we observe total cultivated land for both periods, namely Misurata and Zliten, the increase in the acreage would not have been sufficient to maintain the same level of output. The village of Zliten even seems to experience a severe contraction in cultivated land which, together with the collapse in yields, would have led to a complete drop of the agricultural output and, consequently, the living standards of the local population.

To sum up, regression analysis has shown how Italian settlers made neighboring villages less productive by diverting significant parts of the available labor and animal stocks away from Libyan rural centers, which in turn responded through land-extensive cultivation strategies. The extent to which land-extensive farming was successful (and driven by market forces) is debatable. First, district-level data suggests that the drop in yields was not compensated by an increase in labor productivity in areas of Italian settlement, which maintained statistically indistinguishable levels of output per worker compared to the control group. Second, village-level evidence suggests that Libyan farmers might have been partially successful, through land-extensive cultivation, in maintaining a cereal per capita output not dissimilar from the control group. Finally, a comparison between Libyan barley yields in 1913 and 1939, for those few Tripolitanian villages for which the data are available, however, portray a very negative

picture for the living standards of the Libyan population (at least those that did not join the waged labor force). In those areas that were the most-productive in pre-Italian Libya, yields fell between 95% and 70% in less than 30 years, and there is little evidence that the extension of the cultivated area managed to compensate for this fall.

Although the evidence on the negative effect of Italian settlement on the Libyan agricultural sector is novel and extremely interesting, it should be further stressed how, mostly due to data limitations, some critical aspects of the Libyan economy are not included in the analysis. For instance, the role of grazing, the change in marketing strategies, and the impact of remittances have not been formally considered. Therefore, a more comprehensive assessment of Italian land policies on Libyan living standards remains a challenge for future research. This paper, instead, provides compelling evidence on the impact that Italian settlement had on Libyan agriculture and on the channels through which this happened, while it only tentatively gathers some evidence in the attempt to preliminary quantify how much these changes affected Libyan living standards. This exercise seems to pinpoint a potentially substantial effect.

4.9 Conclusion

In this paper, I have studied the settlement of Italian farmers in colonial Libya to shed light on the effect of white agricultural farming on indigenous agriculture in a dual economy.

The results have highlighted how, during the colonial period, white settlement triggered a substantial drop in land productivity and nominal output in neighboring villages due to a drain on labor and livestock. This relocation of resources forced indigenous farmers to adopt land-extensive cultivation. Locations that were affected by Italian farming in the 1930s managed to maintain higher productivity and nominal output compared to their Libyan neighbors. In 1939, superior yields per hectare on Italian farms were associated with proximity to transport infrastructure and higher concentrations of labor per hectare.

These results add to the related literature in two main ways. First, contrary to the traditional understanding of the economic dynamics shaping agricultural production in African settler colonies (Arrighi and Saul, 1973; Mosley, 1983; Feinstein, 2005), the Libyan case study shows that land grabbing by the white elite played little role in reducing indigenous productivity, which was instead hindered by a drain on labor and livestock caused by Italian settlers.

Moreover, as opposed to the model of technological diffusion presented by the literature (Parman, 2012; Conley and Udry, 2010; Foster and Rosenzweig, 1995), in the short run, I could not find evidence of positive spatial effects in villages surrounding centers that employed more advanced techniques.

More research is needed to understand the aggregate effect of resource drain on the living standards of Libyan farmers, as this could go in two opposite directions: Libyans could be negatively affected by the drop in yields due to lower food availability, but could also benefit from remittances. Suggestive evidence from output per capita calculations does not show a lower availability of food per head in proximity to Italian settlements, which would point to the former hypothesis. A more in-depth look at the change in barley yields between 1913 and 1939 for a selected group of Tripolitanian villages in areas affected by Italian farming, however, shows a dramatic drop in yields. These fell between 70 and 95% across the sub-sample, and the adopted land extensive strategies hardly compensated this drop.

Additionally, it would be interesting to understand the mechanisms behind rural labor migration, whether this could be explained by wage-pull effects or a particular form of labor coercion. Finally, it would also be essential to study how Libyan agriculture interacted with white settlements in the medium and long-run or, in other words, whether Italian farming in the colonial period persistently changed patterns of production, or only caused a temporary shock. These questions, however, fall beyond the scope of this paper.

Appendices

4.A Additional estimations and figures chapter 4

Table 4.A.1: Summary statistics

Statistics:	mean	sd	min	max	N
	(1)	(2)	(3)	(4)	(5)
Productivity, 1939	3.076	2.860	0.0667	15.49	182
Cer $/Ha, 1939	13.28	12.66	0.233	79.94	182
Dist IT Village, 0-50km	0.643	0.480	0	1	182
IT Dummy 1938	0.330	0.471	0	1	182
Land use, pre-1930	5.341	1.582	0	7	182
Population, 1900	3,781	10,647	10	66,498	182
Dist 1884 tracks	10.71	19.10	0	156.4	182
Dist Tripoli, km	372.9	335.8	0.100	1,382	182
Dist Benghazi, km	470.9	252.0	4.686	1,249	182
Dist wells, km	16.75	60.70	0.217	627.2	182
Interpolated population, 1936	3,661	9,301	10	99,884	182
Barley suit	4,533	217.1	4,125	5,218	182
Dist coast, km	52.20	118.3	0	896.9	182
Dist waterways, km	33.97	48.61	0.0191	474.5	182
Altitude	185.1	237.6	-6	821	182
Temperature av 1950-2000	19.62	1.552	14.23	24.84	182
Rainfall av 1950-2000	18.33	8.795	0	49.25	182
Longitude	15.81	4.685	0	25.09	182
Latitude	30.91	5.399	0	32.93	182
IV dummy first occupation, 0-50km	0.610	0.489	0	1	182
Dummy 0-40 km, after 1939	0.440	0.498	0	1	182
Market Potential	41,224	127,566	71.41	1.325e+06	182
Tripoli	0.374	0.485	0	1	182
Benghazi	0.209	0.408	0	1	182
Misurata	0.258	0.439	0	1	182
Darna	0.126	0.333	0	1	182
Hun	0.0330	0.179	0	1	182

Table 4.A.2: Additional robustness checks

Estimation:	Ethnic FE	Coastal provinces	< 100km coast	< 50km coast	Distance km	No Cyreanica
	(1)	(2)	(3)	(4)	(5)	(6)
Dist IT Village, 0-50km	-1.519***	-1.522***	-1.835***	-2.492***		-0.730*
	(0.202)	(0.256)	(0.282)	(0.356)		(0.369)
IT Dummy 1938	0.901***	0.683**	0.699**	0.734**	2.420***	0.719*
	(0.257)	(0.285)	(0.287)	(0.303)	(0.467)	(0.400)
Barley suit	-0.000	-0.000	0.000	0.000	-0.000	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dist coast, km	-0.001	-0.003	-0.004	0.019**	-0.004	0.004
	(0.002)	(0.003)	(0.004)	(0.009)	(0.004)	(0.005)
Dist waterways, km	0.008***	0.008***	0.007**	0.004	0.009***	0.008***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Altitude	0.002***	0.001	0.002	-0.004*	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Temperature av 1950-2000	0.238*	0.119	0.177	-0.386	0.104	-0.431*
	(0.124)	(0.160)	(0.153)	(0.268)	(0.164)	(0.221)
Rainfall av 1950-2000	-0.007	-0.001	0.002	0.019	-0.008	-0.007
	(0.016)	(0.020)	(0.024)	(0.026)	(0.018)	(0.039)
Longitude	-0.076	-0.054	-0.213	-0.240	-0.077	-0.219*
	(0.122)	(0.147)	(0.147)	(0.186)	(0.137)	(0.107)
Latitude	0.031	0.018	0.107	0.126	0.027	0.110*
	(0.066)	(0.079)	(0.080)	(0.101)	(0.076)	(0.059)
Land use, pre-1930	0.009	0.027	0.044	0.047	0.035	0.010
	(0.038)	(0.036)	(0.044)	(0.051)	(0.030)	(0.041)
Log Population, 1900	0.072**	0.090**	0.081*	0.075	0.110**	0.162***
	(0.032)	(0.041)	(0.042)	(0.051)	(0.041)	(0.040)
Dist 1884 tracks	0.000	-0.002	-0.003	0.001	0.000	0.013
	(0.006)	(0.005)	(0.006)	(0.008)	(0.006)	(0.013)
Dist Tripoli, km	-0.001	-0.002	-0.001	-0.004*	-0.001	-0.000
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Dist Benghazi, km	-0.003**	-0.002	-0.002	-0.002	-0.002	-0.007***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Dist wells, km	0.003*	-0.002	0.003	0.003	0.004***	0.003**
	(0.002)	(0.005)	(0.010)	(0.012)	(0.001)	(0.001)
Log population, 1936	0.042	0.036	0.047	0.064	0.028	0.020
	(0.055)	(0.059)	(0.062)	(0.062)	(0.060)	(0.077)
Log dist IT village, km					0.394***	
					(0.078)	
Observations	182	176	161	144	182	125
R-squared	0.47	0.41	0.43	0.45	0.39	0.42
Provincial FE	NO	YES	YES	YES	YES	YES
Ethnic FE	YES	NO	NO	NO	NO	NO
Geographical controls	YES	YES	YES	YES	YES	YES
Precolonial controls	YES	YES	YES	YES	YES	YES
Colonial controls	YES	YES	YES	YES	YES	YES

OLS regression analysis in columns 1 to 4. Robust standard errors clustered for 27 municipalities in brackets. Provincial fixed effects for the 5 provinces in which Italian Libya was divided are included in columns 2 to 5. Column 1, instead, includes ethnic fixed effects (Murdock, 1967). Column 2 drops the hinterland region of Fezzan. Columns 3 and 4 restrict the sample to villages located within 100km and 50km from the coast, respectively. Column 5 shows the robustness of the results to the substitution of the 50km cut-off with the logarithmic distance from Italian villages. Column 6 excludes Cyrenaica from the analysis. See Section 4.3, 4.4 and Table 4.1 for details on the included controls *** p<0.01, ** p<0.05, * p<0.1

Table 4.A.3: Summary statistics by treatment groups

	Obs	Mean	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)
0-50km					
Productivity, 1939	57	1.432293	1.293159	.071826	5.084091
LB land/population	52	6.370342	19.12823	.0143979	88.35934
Italian Dummy					
Productivity, 1939	60	2.722317	1.901592	.2818352	8.5
LB land/population	59	.582434	1.817106	0	9.346939
> 50km					
Productivity, 1939	65	4.842619	3.555317	.0666667	15.49394
LB land/population	52	.2892378	.5255242	.0143979	3.781437

The table shows descriptive statistics by treatment group for total land productivity and the ratio between land cultivated by Libyans and the total Libyan population in each village. The three panels correspond to the two treated groups (Libyan villages next to Italian ones and villages affected by Italian settlement), and the control group (those villages located more than 50km away from Italian farms). See Section 4.3 for details on the data sources

Table 4.A.4: Living standards

Dependent variable:	Log Productivity 1939		Log LB grain/population		
	(1)	(2)	(3)	(4)	(5)
Log dist IT village, km	0.386***	0.150			
	(0.097)	(0.139)			
Log land/population		-0.372***			
		(0.120)			
Dist IT Village, 0-50km			0.700		1.674***
			(0.436)		(0.358)
Log Productivity, 1939				0.448***	0.645***
				(0.090)	(0.076)
Observations	122	122	122	122	122
R-squared	0.43	0.53	0.68	0.72	0.77
Provincial FE	YES	YES	YES	YES	YES
Geographical Controls	YES	YES	YES	YES	YES
Precolonial Controls	YES	YES	YES	YES	YES
Colonial Controls	YES	YES	YES	YES	YES

OLS regression analysis in columns 1 to 5 for the sub-sample of 122 Libyan villages. Robust standard errors clustered for 27 municipalities in brackets. Provincial fixed effects for the 5 provinces in which Italian Libya was divided are added in each specification. Columns 1 and 2 display results with the natural logarithm of land productivity as a dependent variable, while columns 3 to 5 employ the cereal output (Cwt) to population ratio as the dependent variable. See Section 4.4 and Table 4.1 for a description of the employed controls, *** p<0.01, ** p<0.05, * p<0.1

Figure 4.A.1: IV, distance from pre-1922 territories

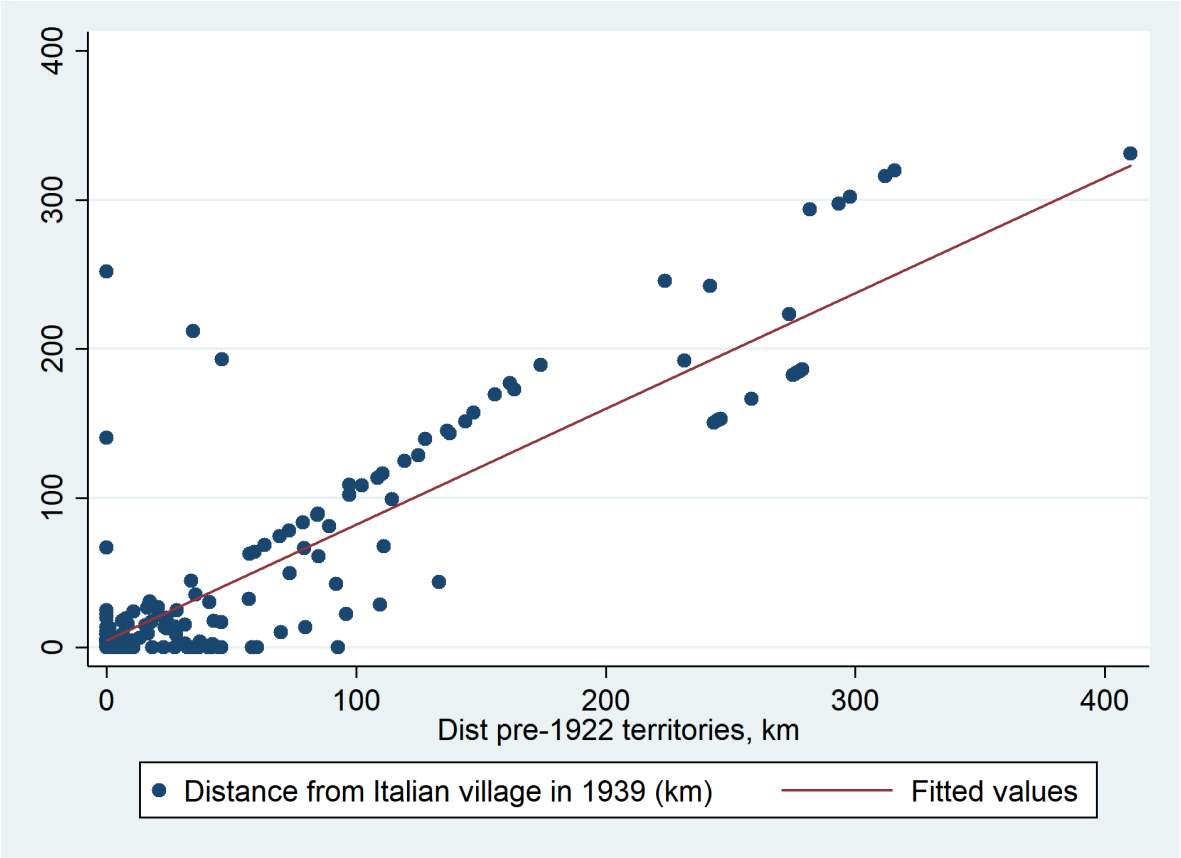


Figure 4.A.2: Kernel density distribution of total land productivity

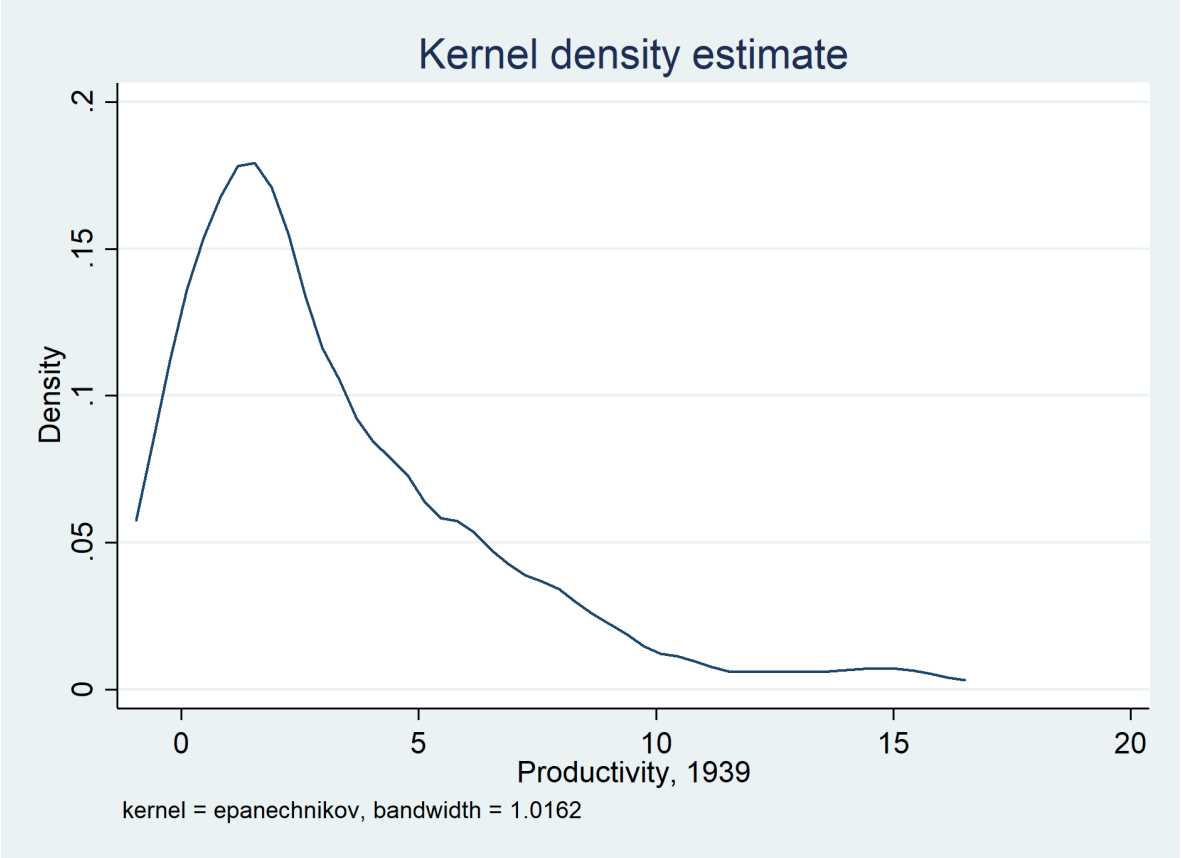
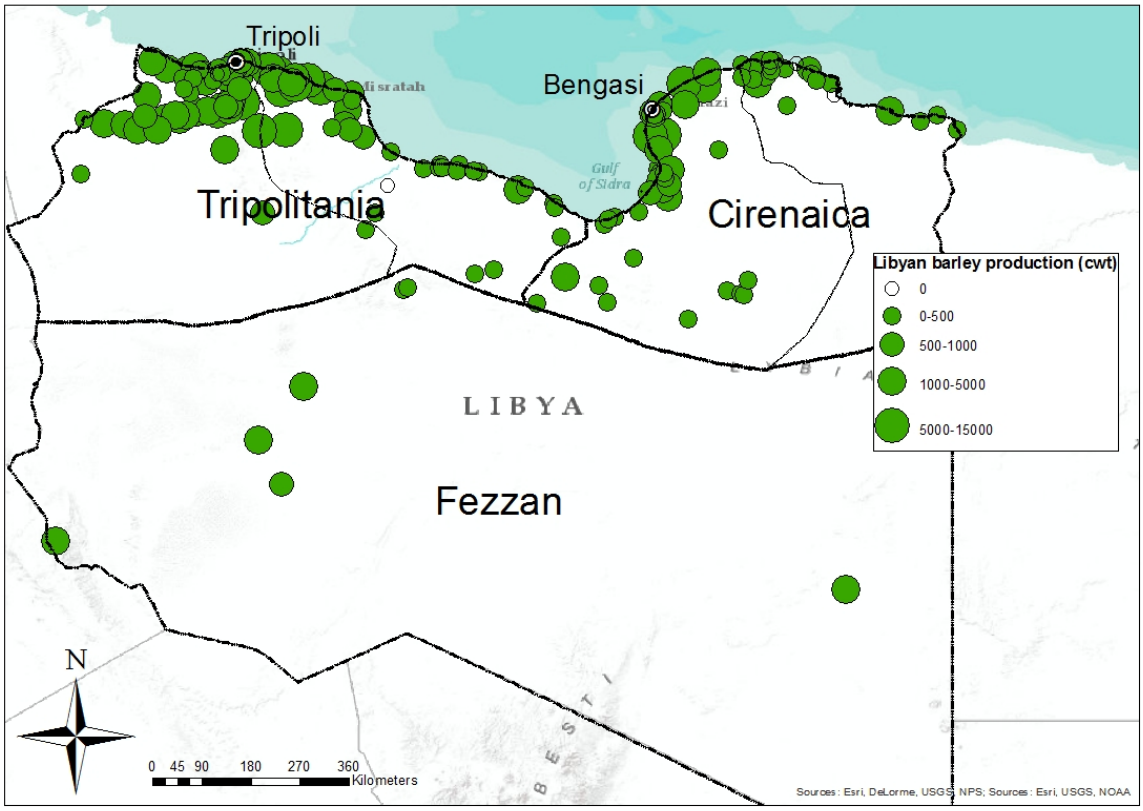
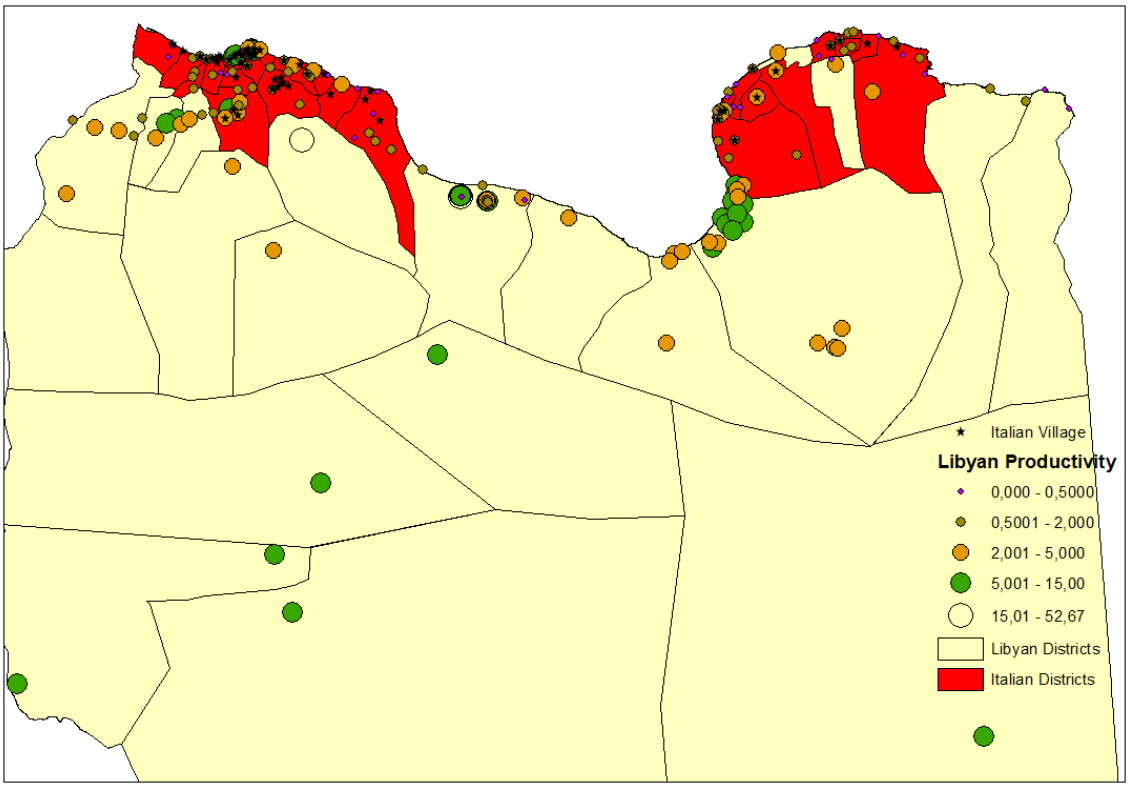


Figure 4.A.3: Libyan barley production in 1939



Note: villages are from the Agricultural Survey of Libya 1938-9. The scale is in hundredweights (100kg). Boundaries represent the 5 provinces in which the country was divided during the colonial period and that are employed as fixed effects in the regression analysis.
Source: author's calculations, see Section 4.3 for details

Figure 4.A.4: Libyan cereal yields and Italian presence in 1939



Note: total Libyan cereal productivity (Cwt/Ha) and Italian presence. Reported districts are from the 1936 population census (Regno d'Italia, 1939). *Source*: author's calculations, see Section 4.3 for details

Table 4.A.5: Labour productivity

Dependent variable:	Total output per worker		Libyan output per worker	
	Ctw	$	Ctw	$
	(1)	(2)	(3)	(4)
Italian*Tripolitania	0.819*	2.375**	0.637	1.517
	(0.409)	(1.059)	(0.455)	(1.127)
Italian*Cyrenaica	10.72	41.58	6.009	18.49
	(10.21)	(36.34)	(5.935)	(17.22)
Observations	46	46	46	46
R-squared	0.181	0.175	0.291	0.292
Provincial FE	YES	YES	YES	YES
Geographical Controls	NO	NO	NO	NO
Precolonial controls	NO	NO	NO	NO

OLS regression analysis on the 46 districts in which Libya was divided after independence (Socialist People's Libyan Arab Jamahiriya, 1978). All columns include fixed effects for the three regions of Tripolitania, Cyrenaica, and Fezzan. Columns 1 and 2 calculate the total output per worker by combining Italian and Libyan cereal output, both quantity and value (for barley, wheat, and oats), and dividing by the total number of Italian and Libyan agricultural workers. In columns 3 and 4, only Libyan output and independent farmers (subtracting the number of workers employed by the Italians in each district) are used for the calculation. See Section 4.3 for more details on the data. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4.A.6: Main data sources and their coverage

Data Source	**Year**	**Information**	**Coverage**	**Location**	**Material type**
Agricultural Survey of Libya	1938-1939	Cultivated land (Ha) and produced cereals (Cwt) for both Libyan and Italian farmers by village	Total of 256 villages. Land productivity could be calculated for 182 with matching inputs and outputs	Archivio centrale dello stato (ACS) Rome.	Archival
Agricultural Census of Libya	1937, (Up to April 1937)	Labour (number of employees and managers), capital (buildings, irrigation facilities, animals, machinery) endowments and cultivation techniques by farm	Total of 839 Farms (All Italian farms in Libya), distributed across 89 villages	Archivio Storico dell'Istituto Agricolo d'Oltremare (IAO) Florence	Archival
Population Census of Libya	1936	Number of Libyans, Italians and foreigners living in each village by gender and agricultural workforce over total population by district	Total of 337 villages and towns, of which 170 were matched with the agricultural survey's observations (129 for the land productivity sub-sample). 48 districts with occupational structure data	Istat online archive	Archival
Piccioli (1934)	1934	Year of occupation of each village by the Italian army, historical land suitability, transport infrastructure (cartographic material)	All villages	na	Published
FAO-GAEZ	2000	Land suitability for barley and wheat	Suitability is available for the entire sample.	na	Online

Chapter 5

Leaving the "Fourth Shore": The effect of Italian farmers' expulsions from post-colonial Libya, 1930-2005

5.1 Introduction

This paper uses a triple difference approach to study the effect of the expulsion of Italian farmers from post-colonial Libya on the performance of the agricultural sector. Namely, it looks at how this shock impacted the productivity and capacity of the farmers to adopt new, commercial crops. This issue is relevant for two main reasons.

On the one hand, little is known, despite the relevance of the phenomenon for African economic history, on the effect that the removal of white farming elites had on the agricultural sectors of erstwhile colonies. The Libyan case study allows shedding first light on this issue. On the other hand, while the link between agricultural productivity (Bustos, Caprettini, and Ponticelli, 2016), diversification of production (Fiszbein, 2017) and structural transformation is well established in the literature, less is know about the drivers of innovation in agriculture and, specifically, about the role of human capital in developing countries. By exploiting the "quasi natural experiment" provided by the two-step expulsion of Italian farmers from the country, the Libyan case study allows identifying the role of human capital and skills in agriculture. In fact, despite the existing evidence on the importance of human capital in driving agricultural productivity (Parman, 2012), suitable settings to identify its effects are rare due

to reverse causality (i.e., the best-educated farmers tend to be wealthier and vice-versa). This question is essential for developing countries, where governments and international donors are often faced with the dilemma of whether to allocate the limited resources to the education and training of the farmers, to farm equipment or infrastructural development.

Despite being relatively unsuitable for agricultural development, Libya was affected by a substantial wave of Italian in-migration during the dictatorship of Benito Mussolini (1922-1943), who incentivized white farming with subsidies and *ad hoc* state settlement schemes (Cresti, 2011) that affected the coastal regions of the country (see Figure 5.1). Governmental intervention facilitated a consistent settlement across the country but did not allow expropriation of land that was already under permanent Libyan cultivation. Italian colonists could only settle in parts of the country that were not under permanent cultivation before 1923, which practically excluded them from the most fertile areas (see Chapter 4, Section 4.2). This fact is particularly important as it makes the issue of endogenous selection of the best land by farming elites less problematic than in otherwise comparable settings such as Algeria or Zimbabwe.

Most importantly, Italian farmers were expelled from Libya in two steps. First, the British army chased the Italo-German troops out of the eastern part of Libya in 1942. In anticipation of the defeat, all Italian colonists from Cyrenaica were repatriated, and their fields were left available for distribution to local cultivators. By contrast, Italians in the Western part of Libya (Tripolitania) were allowed to stay and to maintain full ownership of their fields until 1970, when Gaddafi unilaterally decided to expel them and seize their properties (Fowler, 1973). The two expulsions were similar in the sense that they caused a comparable negative shock in human capital and labor force. Importantly, however, one key difference existed between the two events: the 1942 expulsion took place in a period of complete economic uncertainty (the war), followed by stagnation. The 1970 expulsion, instead, took place after the beginning of the oil boom in a period of fast GDP growth and high prices. This peculiar set of events thus offers the opportunity to study the effect of similarly negative shocks in human capital and labor force in periods with different macro-economic conditions and market incentives.

The historical setting naturally suggests the adoption of a triple difference approach. This strategy allows comparing the performance of areas that were affected by Italian agricultural settlement (first difference), within a region affected by an expulsion (second difference), before and after the expulsion (third difference). I can thus study the performance of those

areas from which Italian farmers were removed relative to two relevant control groups, namely those areas that were affected by Italian settlement but not by the same expulsion and those within the same region that were not affected by the expulsion because no Italian settlement had been established during the colonial era.

The outlined strategy requires the construction of a novel panel dataset, which is also a major original contribution of this paper, especially given the lack of quantitative information and empirical work on Libya. I collect spatially explicit data for four years (1939, 1960, 1974 and 2005) from published censuses and archival agricultural surveys. As I had to rely on different data sources for each year and these come with varying levels of disaggregation, I collapsed all data at the 1974 district-level. Libya was then organized in 46 districts, which constitute my units of observation (see Figure 5.1). First, I gathered information on the location and intensity of Italian agricultural settlement at the end of the colonial period. Second, I assembled data on the quantity of produced ground-crops, namely grains (barley, wheat, maize), industrial crops (tobacco, groundnut, castor beans) and other crops (tomato, watermelon, melon, vegetables, and potato). Third, also I collected prices by crop to calculate the nominal output. Finally, I completed the database with information on the agricultural labor force active in each district, the availability of agricultural machinery and, where possible, employment of irrigation in each location.

The analysis proceeds in three steps. First, I employ the triple difference design to identify the effect of the expulsion of Italian farmers on agricultural productivity and commercialization. I do so by constructing proxies for agricultural productivity (cereal yields, nominal output per worker and per district), and level of commercialization. The latter is defined as the share of the nominal output from commercial ground-crops over the total ground-crop output in each district. In the baseline estimation, a district is categorized as commercialized if at least 80% of the nominal output comes from commercial crops. I use a simple working definition for "commercial" and "subsistence" crops, and later check its robustness: if a crop is both imperishable (can be preserved for at least one year) and edible, this makes it a subsistence crop, a definition that applies to grains and potatoes (flour). By contrast, if a product is either inedible (tobacco, castor beans), absent from the local diet (groundnut) or perishable (tomatoes, melons, and vegetables), this is categorized as commercial. The idea behind this distinction is that commercial crops require farmers to take additional risk because of the difficulties in feeding theirs household in the case of a fall in prices or partial crop failure of

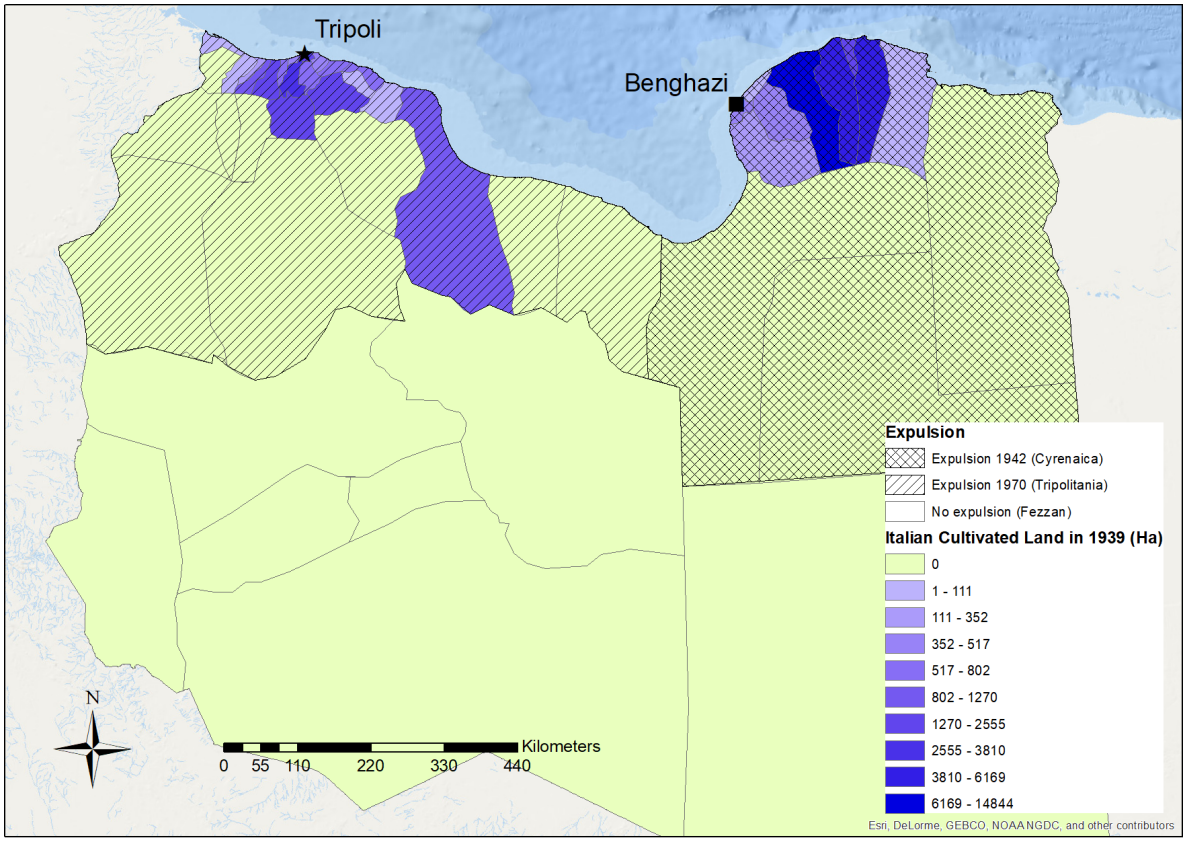
commercial crops.

As a second step, I isolate the effect of human capital from labor and physical capital by adding these variables as controls. The sources point out that Italian farmers were more educated than their Libyan counterparts, but it is not possible to test this notion statistically due to the lack of individual (or group-level) information on literacy and scholastic background at a suitable level of disaggregation. The available data on education, however, suggest a gap of about four years of schooling between Italian and Libyans in the same district, or an average literacy of roughly 90% and 48% for Italians and Libyans, respectively (Theodorou, 1954, p. 91). Higher literacy is vital in agriculture as, by making access to information easier, it allows to make better informed and timely decisions on the selection of crops and cultivation techniques (Parman, 2012).

Two main results emerge from the analysis. On the one hand, both expulsions show a significant drop in the level of market orientation of affected districts. The likelihood of treated districts to be highly commercialized relative to the control groups drops significantly after the shock. While I cannot completely rule out the possibility that unobservables linked to Italian presence in the West of Libya after 1942 (such as informal trade networks) could explain part of the measured effect, the evidence points to a pivotal role of human capital in explaining the results. In fact, the negative effect on commercialization is robust to the introduction of controls for labor and capital endowment and to a variety of additional robustness checks. On the other hand, the results also portray a substantially different response of indigenous cultivators to the expulsions depending on market incentives. While after the 1942 expulsion Libyan farmers in treated districts did not increase cereal yields significantly, indigenous cultivators responded to the 1970 expulsion (when the economy was booming, and prices were higher) with a significant, labor-intensive boost in subsistence crops' yields. These witnessed an average increase of almost eight Ctw/ha, which indicates different adaptation strategies of local farmers based on price levels.

As a third step, I explore the persistence of the shocks and the country-specific mechanisms; in other words, what cultivation techniques were put into practice by Italian farmers to allow the adoption of new crops. Long term estimates show a steady persistence of the shocks on market orientation. Italian districts before the expulsions showed the highest commercial to subsistence crops ratio across Libya. After the shocks, their average share of commercial crops slowly declined, down to the lowest country average in 2005. In other words, the expulsions

Figure 5.1: Treatments. Italian Farming in 1939 and expulsions by region



Note: Libyan districts in 1974 (units of observation) and intensity of Italian farming in 1939, measured as hectares cultivated by Italian farmers in each district. In the baseline estimation, an Italian district (treatment) is defined as a district with any amount of land (>0) cultivated by Italian farmers. In the robustness checks, several alternative definitions are tested based on more refined measures of farming intensity (more than 5% of all land cultivated by Italians and more than 5% of the labor force is Italian). These alternative definitions would enlarge the control group and reduce the number of treated districts in each region by getting rid of the light blue ones (Table 5.A.3). While the baseline estimates always include the southern region of Fezzan, I also replicate the main results after having dropped the Southern districts belonging to the latter (Table 5.A.5). *Source*: 1978 administrative districts from the Libyan atlas of 1978 (Socialist People's Libyan Arab Jamahiriya, 1978) and extension of land cultivated by Italian farmers as reported by the 1939 Agricultural Survey (Ministero dell'Africa Italiana, 1939a)

led to a complete reversal of fortunes between Italian and Libyan districts, which suggests a permanent effect of negative shocks in human capital on agricultural business practices. By contrast, the increased cereal yields generated by the 1970 expulsion was only temporary and faded away rapidly after 1974. Finally, additional tests shed some light on the country-specific agricultural practices that allowed Italians to diversify production. After the war and through the adoption of systematic irrigation, Italian farmers in Tripolitania increased the production of commercial crops, such as groundnut and tomato. These technical innovations and production strategies had very limited spillovers in neighboring Libyan villages. This

lack of spatial spillovers, in turn, suggests that the diffusion of agricultural practices among neighbors pinpointed, for instance by Conley and Udry (2010), might be limited by profound cultural and linguistic edges, as in the case of settler economies.

Besides adding to our knowledge of the economic history and legacy of Italian agricultural development in Libya (Segré, 1974; Cresti, 2011), this article also contributes more generally to the literature on African economic history. European farmers settled in several countries such as South Africa, Kenya, and Algeria, and created *de facto* dual economies characterized by centers of highly capitalized and productive white farms, alternating with more backward enclaves of indigenous holdings. Understanding the effect that the expulsion of these farmers had on the agricultural sector of former colonies is of broader interest for African economic history. In this sense, the paper adds to the debate concerning the effect of white settlement in Africa and its interaction with indigenous cultivation (Mosley, 1982; Feinstein, 2005; Shutt, 2002). My study emphasizes the strong and negative effect of the expulsions on commercialization, but also shows a substantial persistence of productivity levels, which in turn suggests a quick adaptation of indigenous farmers to the shocks. To the best of my knowledge, this article is a primer in the attempt to study the consequences of expulsions of European farmers from erstwhile colonies.

By studying the effect of the expulsion of Italian farmers from Libya on the performance of its agricultural sector, this paper also contributes to the literature that has examined the role of skills and human capital in agriculture. In line with Bharadwaj and Ali Mirza (2019) and Parman (2012), this study finds that human capital plays an essential role in boosting the performance of the primary sector, but it adds to their results by focusing more narrowly on identifying the causal effect of shocks in human capital on agricultural performance. It also innovates their work by showing that while the immigration of more educated farmers can boost yields, their removal does not necessarily result in their decline. Instead, only the capacity to adopt new commercial crops is severely and persistently affected by the expulsions, a finding that adds to the literature that has looked at the importance of innovation and diversification in agriculture and their determinants (Fiszbein, 2017; Bustos, Caprettini, and Ponticelli, 2016). The paper also adds more broadly to the literature that has looked at the determinants of success and failure of technological adoption in agriculture (Conley and Udry, 2010; Parman, 2012) (see also Feder (1985) for a survey). It complements these works by studying the effect of a negative shock in human capital and by drawing a comparison between

periods of low and robust market incentives in agriculture. Finally, this paper contributes to the literature on the effect of the expulsions of productive minorities (Waldinger, 2010; Acemoglu, Hassan, and Robinson, 2011; Chaney and Hornbeck, 2016; Hornbeck and Naidu, 2012). By looking at the impact of the removal of Italian farmers from Libya, this article contributes to this body of the literature by showing how the expulsion of farming elites might affect the agricultural sector of developing countries.

The remainder of the paper is structured as follows: Section 5.2 describes the historical setting, Sections 5.3 and 5.4 outline the empirical strategy and the data, respectively. Sections 5.5 presents the main results. Section 5.6 presents the robustness checks, Section 5.7 discusses the mechanisms and Section 5.8 concludes.

5.2 The Libyan agricultural sector between 1939 and 2005

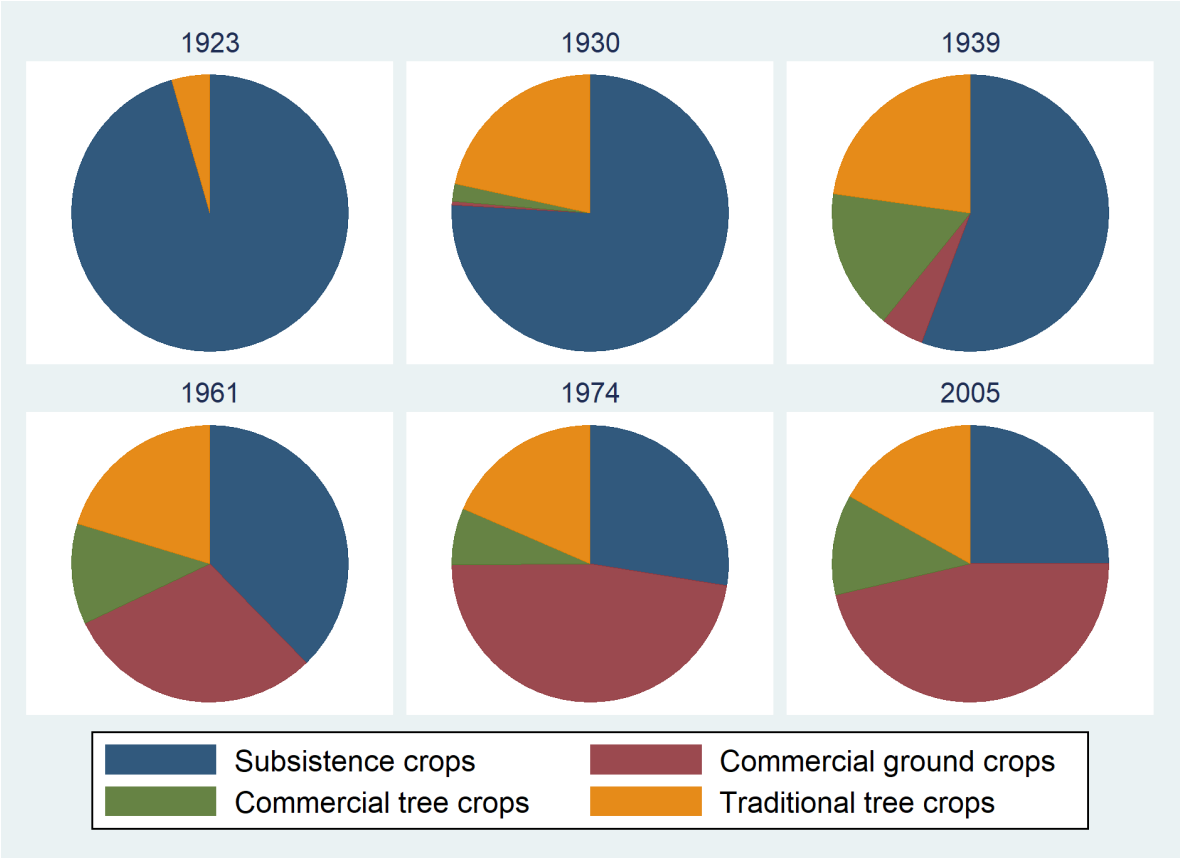
The Libyan economy and, more specifically, its agricultural sector underwent deep transformations over the period covered by this study.

5.2.1 Farming dynamics in the colonial period

During the 1930s, the Italian government heavily subsidized the settlement of Italian migrants along the Libyan shores in the attempt to secure tighter control over the colony, increase local agricultural production and divert parts of the exuberant labor force (Cresti, 2011). As a result, by 1940, roughly 40,000 Italian farmers operated in Libya, for a total cultivated land of roughly 374,000 hectares (Del Boca, 1986b, p. 266). Of these, roughly 30,000 moved to Libya between 1938 and 1940, within the framework of state-managed intensive agricultural colonization. By contrast, roughly 12,000 farmers had already settled by 1937, before the peak in state-managed migration (Ministero dell'Africa Italiana, 1937a). In this paper, I will focus on Italian cultivated land in 1939 from data reported by the 1939 agricultural survey of Libya (Ministero dell'Africa Italiana, 1939a). This source excludes most of the new agricultural settlements of 1938 and 1939 which were inevitably at an early stage of development. The effect of late agricultural projects was arguably small, as they were allowed to operate for only 1-3 years and were then expelled from Libya irrespective of the region where they had settled (Cresti, 2011; Del Boca, 1986b). As the location of late settlement schemes tended to affect the same districts that were colonized during the first wave of migration, and the baseline

estimation considers as "treated" all districts where Italians cultivated any amount of land in 1939, the fact that a few new agricultural villages are not included in the 1939 data should not affect the baseline estimates.

Figure 5.2: Production Shares by Product Category and Year



Note: production shares by agricultural product category between 1923 and 2005.
Source: for the years 1923 and 1930 I use aggregate production statistics for Tripolitania and Cyrenaica from the Yearbook of the International Institute of Agriculture (Institute International d'Agriculture, 1925; International Institute of Agriculture, 1939). For 1939 the data are from the Italian Yearbook of Agriculture (Istituto Centrale di Statistica, 1948). For 1961, 1974 and 2005 the data were downloaded from FAOSTAT (Food and Agriculture Organization of the United Nations, 2012).

The Italian government could not expropriate land that had been under permanent indigenous cultivation before the initial phase of agricultural settlement (before 1923), so Italian farmers tended to select the best land within a subset of less desirable locations that had not been previously intensively cultivated by Libyan farmers (see Chapter 4, Section 4.2). This peculiarity in the pattern of settlement is particularly important for this study as it allows us to isolate the effect of Italian presence more effectively, without having to worry about the potential systematic selection of the best land. Although selection bias could still be in

place due to unobservables unrelated to land quality, in fact, the characteristics of Italian land appropriation and the employed cultivation techniques were similar in Tripolitania and Cyrenaica (Piccioli, 1934). The only significant difference between the two areas relates to the timing of the settlement, which started slightly earlier for Tripolitania (the late 1920s) and only in the early 1930s in Cyrenaica, due to the delayed pacification of the area (Allan, McLachlan, and Penrose, 1973, pp. 49-50). As one can see from the pie charts in Figure 5.2 and 5.A.5, during the colonial period the Libyan agricultural sector transitioned from a production overwhelmingly based on barley to a more diversified one by 1939. Most notably, the "Italian colonial effect" in agriculture can be seen in the increase in the relative shares of olives, tobacco, and grapes between 1923 and 1939. The "battle for grain", launched by the fascist regime in the late 1920s, can be seen in the substitution of potato production with wheat, which became the staple grain crop for Italian settlers (and was largely adopted by Libyan farmers as well).

While production progressively diversified during the colonial period, the total agricultural output of the colony stagnated as it is visible in Figure 5.3. This dynamic, which can partially be explained by the local unfavorable climatic conditions (Piccioli, 1934), was also linked to the inefficient allocation of resources caused by the settlement of Italian farmers. These diverted the available Libyan labor away from traditional areas of production towards Italian farms placed in less suitable areas and needing more onerous investments which, in the short-term, reduced grain yields and led to stagnant agricultural output, as shown in Chapter 4.

5.2.2 Libyan agriculture after 1942

The Italian colonial occupation of Libya ended abruptly. In 1942, the Italo-German forces surrendered Libya to the British army and retreated to Tunisia. In coincidence with the final British offensive from the East, the Italian government implemented the evacuation of all Italian colonists from Cyrenaica (the Eastern region), who either relocated to Tripolitania (to the West) or went back to Italy (Allan, McLachlan, and Penrose, 1973, pp. 51-2). As a result, no Italian farmer was left in the eastern region after 1942. By contrast, Italian citizens in Tripolitania were allowed to remain on their farms under the protection of the British Military Administration and, after a long series of negotiations following the end of World War II, they were granted permission to stay indefinitely in the newly-born United Kingdom of Libya (Fowler, 1973). Things changed when colonel Muammar Gaddafi seized power in

1969 and unilaterally expelled all Italians, including the remaining farmers from Tripolitania, in 1970.

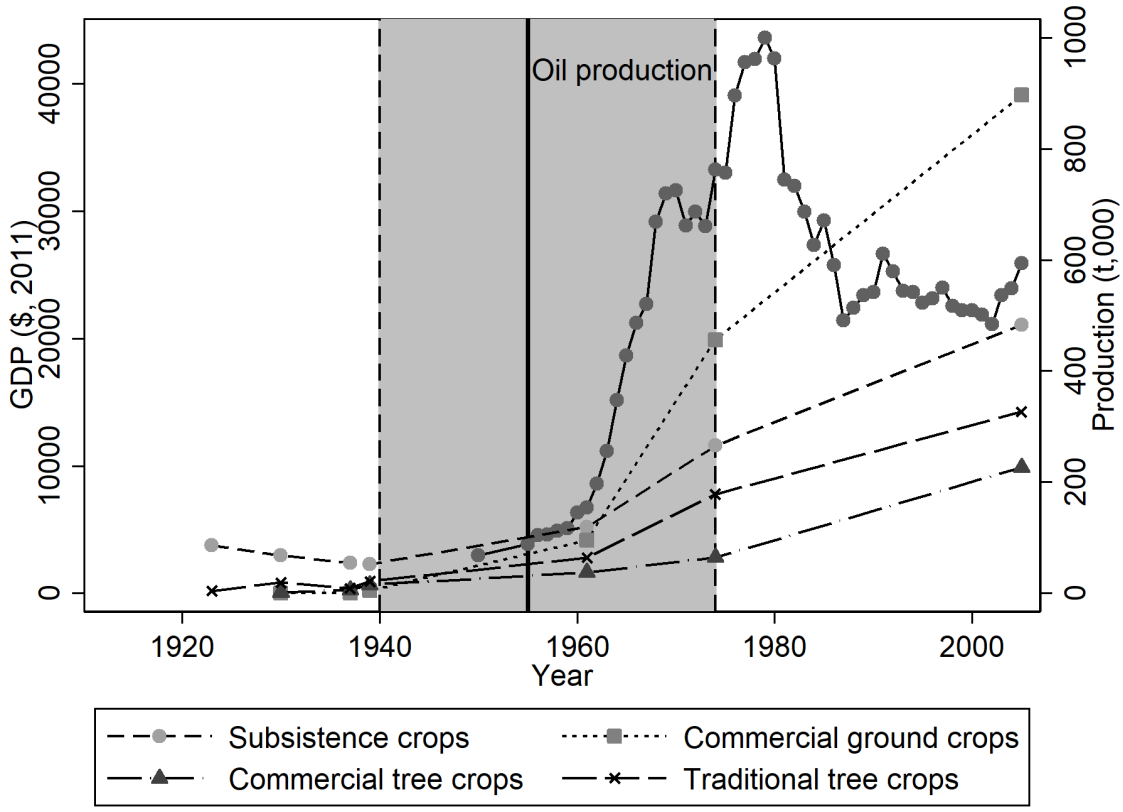
Interestingly, the two expulsions took place in different macroeconomic settings, which offers the possibility to study the response to the same type of human capital shock when different economic incentives are in place. As one can see from Figure 5.2, in fact, the Libyan agricultural sector transitioned, between 1923 and 2005, from being heavily reliant on subsistence crops (cereals and potatoes) to a more widespread adoption "commercial crops" (either ground cash crops, such as tobacco and groundnut, or perishable fruits, such as tomatoes and melons). These could yield higher profits, but represented a deviation from the traditional Libyan pattern of production and constituted a higher risk for the farmer as these could not sustain a family for a whole year. Tree crops also constituted a sizeable share of the total production, but their relative importance remained stable throughout the period, at around 30% of the total, with the significant shift taking place in the earlier phase of the colonial occupation, between 1923 and 1939.

As one can see from Figure 5.2, the most significant shift away from traditional subsistence crops towards commercial ground crops, which jumped from about 5% to just below 50% of total agricultural output, took place between 1939 and 1974. This time span contains both expulsions of Italian farmers and, interestingly, it can be split into two sub-periods, one before and one after the take-off of the Libyan oil industry. While the first concession for oil extraction was granted in 1955 (Allan, McLachlan, and Penrose, 1973, p. 10), GDP per head took off only after 1960, in coincidence with the jump in oil exports (see Figures 5.3 and 5.A.1). In practice, this peculiar coincidence of events offers two comparable quasi-natural experiments (the expulsions of Italian farmers) in two distinct periods of growth. The 1942 one was followed by economic stagnation, while the 1970 one took place during a period of strong economic growth for the Libyan economy, which translated into the enhancement of domestic demand for more and more diverse agricultural products.

As one can see from Table 5.A.4, which reports wholesale prices for the main agricultural products between 1939 and 2005 in constant 1982 US dollars, all major crops witnessed a striking increase in prices in coincidence with the oil boom. For instance, in 1960, barley and wheat could be purchased for $2.4 and $5.4 per hundredweight, respectively. Fourteen years later, the same amount of grains would sell at about 1.5 times more, namely $6.3 for a hundredweight of barley and $12.1 for one of wheat. Interestingly, while all crop prices

underwent an average increase, commercial ones grew faster: the price of tobacco and tomato more than doubled. The picture for fruit trees crops is more mixed, also due to significant changes in supply due to the long lag between planting and production (about 20 years for olive trees for instance), which made supply vary significantly and independently from overall patterns of growth. However, most fruit crops also saw a manifold increase in prices, with dates and citrus fruits being the best examples with an increase of 5 and 20 times, respectively.

Figure 5.3: GDP growth and agricultural production



Note: real GDP growth in 2011 USD (left axis) relative to sectoral agricultural production (right axis). The shaded area highlights the early post-colonial period, when the commercial transition took place. The vertical, solid line marks the first grant for oil extraction given to a foreign company in 1955, the beginning of the oil boom.
Source: GDP per head is from the Maddison project (Bolt et al., 2018). Agricultural production statistics come from multiple sources. For the years 1923, 1930 and 1937 I use aggregate production statistics for Tripolitania and Cyrenaica from the International Institute of Agriculture (Institute International d'Agriculture, 1925; International Institute of Agriculture, 1939). For 1939 the data are from the Italian Yearbook of Agriculture (Istituto Centrale di Statistica, 1948). For 1961, 1974 and 2005 the data were downloaded from FAOSTAT (Food and Agriculture Organization of the United Nations, 2012).

This brief analysis of changes in agricultural prices suggests that incentives to increase agricultural output were significantly stronger in the early 1970s than they were between

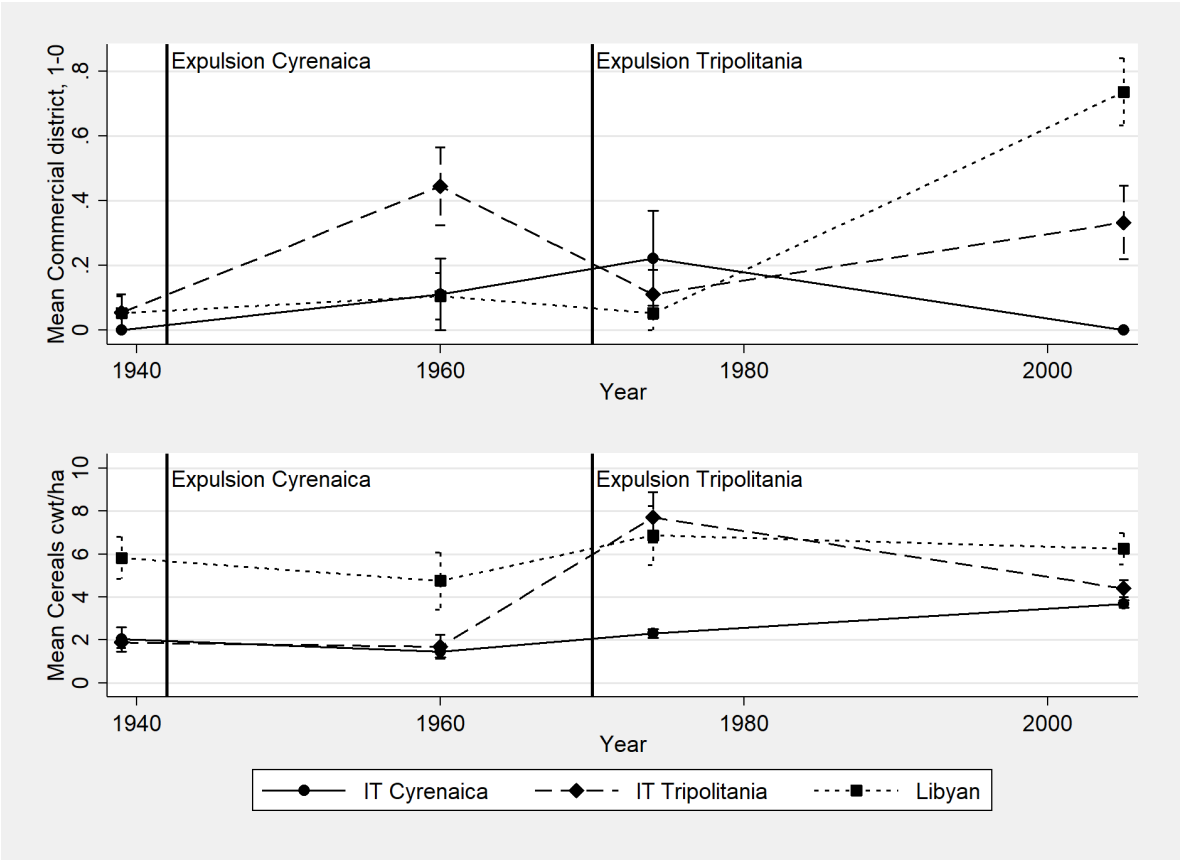
1939 and 1960. While high prices gave incentives to increase the production of virtually every crop, the incentives were stronger for commercial crops and weaker for subsistence ones. Interestingly, it was precisely between 1960 and 1974 that commercial ground crop production boomed, amounting to the largest share of Libyan agricultural production (see Figure 5.3). Altogether, these changes offer meaningful discontinuities that allow for the identification of the effect of the expulsion of Italian farmers on patterns of agricultural production. More broadly, they offer an ideal case study to look at the role of human capital in fostering the adoption of new crops in periods characterized by different levels of market opportunities.

5.3 Empirical strategy

Given the described historical setting, a natural way of answering the research question is the adoption of a triple difference estimation to identify the causal effect of the expulsions. This approach exploits the heterogeneous patterns of Italian settlement across Libya (first difference) in combination with the separate regional expulsions of the colonists (second difference), before and after the shocks (third difference) to identify the causal effect of each individual expulsion on the performance of the agricultural sector. This strategy has two major advantages. First, as it is safe to maintain that Italian settlers selected farmland with the same criteria and bounded by similar constraints across the country (see Chapter 4), possible threats to identification linked to unobservables and the endogenous selection of farming areas by Italian settlers are accounted for. Secondly, the case study and the approach also make the issue of pre-trends - particularly relevant in this setting due to unavailability of pre-1939 data at a sufficient level of disaggregation - less worrisome: identification stems from the relative performance of treated and untreated Italian districts across the country between 1939 and 1974. As Italian settlement only took place within the decade preceding the first period of observation, pre-trends are not a concern as long as we believe that Italian settlement was not systematically correlated with determinants of agricultural innovation that preceded colonization.

Finally, as explained in Section 5.2, the two expulsions were orthogonal to the performance of the agricultural sector and, in particular, of Italian farmers. This fact, which is largely supported by the narrative accounts on the subject, is also confirmed by a series of balancedness tests reported in Table 5.A.7 that show no correlation between the expulsions and the lag of

Figure 5.4: The effect of the expulsions



Note: top panel. Share of commercial districts (80% of nominal output from commercial crops) out of total Libyan districts and Italian districts in Cyrenaica and Tripolitania, with standard error bars. Districts are grouped as reported in Figure 5.1. Bottom panel. Average cereal yields (wheat, barley and maize) for Libyan districts and Italian districts in Cyrenaica and Tripolitania, with standard error bars. Libyan districts correspond to districts that were not affected by Italian settlement while Italian districts in the two regions correspond to those districts that had some Italian farmers in 1939 (see Figure 5.1). Figure 5.A.4 breaks Libyan districts down by region. As indicated, vertical lines indicate the two expulsions. The Cyrenaican one
Source: author's own calculations, see Section 5.4 for details.

the main dependent and control variables employed in the paper.

For the purpose of this analysis, I select two sets of indicators to study the performance of the primary sector. On the one hand, I am interested in looking at changes in productivity following the expulsions. Due to data limitations (cultivated land by major crops and district is not available consistently in the sources for 1939, 1960 and 1974), I focus on the following measures of agricultural productivity: nominal output (in constant 1982 USD) per district and worker, and cereal yields (Ctw/Ha). On the other hand, I am also interested in exploring changes in market-orientation and production strategies that might be affected by shocks in human capital. In order to capture this second potential effect of the expulsions, I rely on the

computation of the share of nominal agricultural output coming from the main "commercial crops", relative to the total nominal output in each district. The latter is defined as the sum of commercial and traditional field crops that could provide food to farming families throughout the entire year. I use a working definition of subsistence crops based on edible and imperishable characteristics. In the Libyan case, these are barley, wheat, millet, sorghum, maize, and potato (which could be turned into flour). Conversely, commercial ground crops are defined as all those crops that were either inedible (tobacco, castor beans, sugar cane), absent from the local diet (groundnut) or that were edible, but perishable (watermelon, tomato, melon).

Although thus defined commercial crops also tended to have higher market values and, especially after the oil boom, to be exported in greater quantities (see Figure 5.A.2 and Table 5.A.4), for this study, I cannot rely on a definition based on variables that are in turn determined by agricultural productivity and have to select an *a priori* definition instead. The share of commercial ground-crops has a marked bimodal distribution throughout the period of analysis (see Figure 5.A.3). Therefore, to distinguish between "highly commercialized" and "traditional" districts, I rely on a binary indicator that equals one if a district was producing more than 80% of its nominal (ground)-output through commercial ground-crops. Albeit imperfect, this measure allows us to identify with some precision willingness to take risk and to divert from traditional patterns of production. As both the definition of commercial crops and the 80% cut-off are somewhat arbitrary, I run a variety of robustness checks to verify definitions do not drive the results. I start to estimate the combined average effect of the Italian expulsions over the entire panel through a triple difference estimation, as in equation 5.1.

$$\begin{aligned} Y_{i,t} = \delta_1 IT * Expulsion * Post + \delta_2 Expulsion * Post + \delta_3 IT * Post \\ + X_{i,t} + x_{i,1939} * \alpha_t + \alpha_i + \alpha_t + \epsilon_{i,t} \end{aligned} \tag{5.1}$$

$Y_{i,t}$ is either agricultural productivity in district i and time t, or a dummy for a district being "highly commercialized" (producing more than 80% of the nominal output with commercial ground crops). δ_1 is the coefficient of interest that captures the average effect of Italian expulsions. In equation 5.1, $IT * Expulsion * Post$ takes the value of 1 if Italians cultivated any amount of land in a certain district in 1939 (Italian cultivated land > 0, see Figure 5.1), and the district is either in Cyrenaica in 1960 (after the first expulsion of 1942), or Tripolita-

nia in 1974 (after the second expulsion of 1970). More formally, $IT * Expulsion * Post = 1$ if $IT * Expulsion_{Cyr,Trip} * Post_{1960,1974} = 1$, where IT is a dummy for whether a district was affected by Italian agricultural settlement, $Expulsion_{Cyr,Trip}$ equals 1 if the district was affected by a regional expulsion and $Post_{1960,1974}$ equals one for the period following the expulsion, so either 1960 for Cyrenaica or 1974 for Tripolitania. $X_{i,t}$ is a matrix of controls that includes population in the baseline specification and, in the robustness checks, capital (tractors per workers) and labor (agricultural workers) endowments. $x_{i,1939} * \alpha_t$ represents time-invariant controls interacted with year fixed effects. In the baseline specification, interacted fruit tree production (Cwt) in 1939 is also included. α_t represents year fixed effects and α_i district-level fixed effects. $\epsilon_{i,t}$ is the error term, which is clustered at the district level.

While equation 5.1 will provide an estimation of the average effect of the two expulsions on the aforementioned measures of productivity and commercialization (Goodman-Bacon, 2018), I will also study the effect of each expulsion separately in order to compare similar shocks in periods of different market incentives. I will identify the effect of each expulsion through equation 5.2. This model is similar to equation 5.1, but introduces the triple difference interaction separately for each shock.

$$\begin{aligned} Y_{i,t} = \delta_1 IT * Expulsion_{Cyr,Trip} * Post_{1960,1974} + \\ \delta_2 Expulsion_{Cyr,Trip} * Post_{1960,1974} + \delta_3 IT * Post_{1960,1974} \\ + X_{i,t} + x_{i,1939} * \alpha_t + \alpha_i + \alpha_t + \epsilon_{i,t} \end{aligned} \tag{5.2}$$

In this specification, the effect of each expulsion is given by δ_1, which is the interaction between the dummy for Italian presence in 1939, the region where the expulsion took place and a dummy equalling 1 for the first year after the expulsion. Besides the relevant interactions of the triple difference setting, the equation features, similarly to equation 5.1, a matrix of controls $X_{i,t}$, time-invariant controls interacted with time fixed effects $x_{i,1939} * \alpha_t$. The standard errors are also clustered at the district level. Sub-setting by expulsion is an interesting exercise as it allows us to study experiments with different characteristics. Namely, the adaptation of the agricultural sector to a similar expulsion taking place in a period of substantial economic stagnation and low prices (1942) and during the fastest period of Libyan economic growth (1970) (see Figure 5.3).

5.4 Data

5.4.1 Sources

The main challenge in carrying out the outlined analysis is the creation of a panel dataset that allows examining changes in agricultural production over time and across space. Due to the series of institutional changes described in the previous section, it was not possible to obtain all the necessary information from one comprehensive source. While a schematic but detailed description is provided in Table 5.A.8, in this section, I only describe the main sources for agricultural production at a disaggregated level, the process of construction of the panel dataset and the main data limitations. Table 5.A.6 provides summary statistics for the full panel.

The dataset is based on the administrative division on which the 1974 agricultural census was organized (Socialist People's Libyan Arab Jamahiriya, 1979). As the census does not provide a map with the 46 administrative districts in which the country was divided, these were digitized from the 1978 Atlas of Libya (Socialist People's Libyan Arab Jamahiriya, 1978). Data on agricultural production for the year 1939 mostly come from the 1938-9 Agricultural Survey of Libya (Ministero dell'Africa Italiana, 1939a). This source provides information, at the village level and for a total of 256 locations, on cereal yields for both Libyan and Italian cultivators (Ministero dell'Africa Italiana, 1939a). Factors of production for Italians farms were digitized from the 1937 agricultural census (Ministero dell'Africa Italiana, 1937a), also at the village level. Finally, district-level information on the production of crops, different from field ones, were retrieved from the statistical yearbook of the Italian central statistical agency (Istituto Centrale di Statistica, 1948). The 1960 agricultural census of the Kingdom of Libya provides information on the agricultural sector for the early post-colonial period at the county level (145 "Mudirias") (United Kingdom of Libya, 1962a). Finally, the Spatial Allocation Model Database (SPAM) made information on yields available at a granular level for a variety of products. This paper uses the 2005 version.[49]

The more disaggregated data from 1939, 1960 and 2005 were simply collapsed at the 1974 district-level to generate the panel dataset. The data for 1939, 1960 and 1974 provide consistent information on total agricultural production (by product for all districts), total

[49] International Food Policy Research Institute (IFPRI) and International Institute for Applied Systems Analysis (IIASA), 2016.

workforce employed in agriculture, and the number of tractors in each district. The data for 2005[50] only inform about production so the baseline estimates will focus on the first three years of the panel. Furthermore, fruit-tree production is not consistently recorded in the different censuses. This shortcoming, which could potentially be problematic for the proposed analysis, is mitigated by two elements: on the one hand, as it is visible from Figures 5.2 and 5.A.5, the share of fruit tree over total production has remained stable between 1939 and 2005, which suggests how substitution was prevalent among ground-crops. On the other hand and related to the latter point, fruit-tree production is a long term investment (trees, such as olives take up to 20 years to bear fruits). Thus, for the purpose of this analysis, this is not particularly interesting data as it is less capable of capturing short-term adaptation to sudden shocks in human capital and market incentives.

In order to calculate nominal output, wholesale prices in constant 1982 dollars were collected from a variety of sources. Details on the sources are in the footnote of Table 5.A.4 and in Appendix 5.B.

It is also important to note how, due to the daunting task of collecting district level production for multiple crops over different years, a full sampling of agricultural production for all years was not possible. The selection of the most relevant ground-crops was made based on the aggregate production Figures at the country-level, as reported in Figure 5.A.5 (see footnote for sources). I, therefore, collect district-level data for all subsistence crops which, following the adopted working definition of imperishable and edible crops, amounted to barley, wheat, maize, millet, sorghum (other cereals in Figure 5.A.5) and potatoes. As mentioned above, data on fruit tree production were excluded: this made me drop grape, olive, almonds, apricots, and citrus fruits and dates. Lastly, the collected commercial ground-crops (defined as being perishable or inedible) were tobacco, groundnut, tomatoes, and melons (including watermelons). This procedure, which is not perfect, still allows us to capture the most significant variations in produced quantities for all the main ground-crops cultivated throughout the period relative to subsistence ones but should be taken as an approximation in the measurement of change rather than a precise estimate.

The described approach has two main weaknesses. First, it fails to capture variations in the production of vegetables at the district level. As is visible from Figure 5.A.5, this category represents an important share in the overall increase of commercial crop production,

[50]The 2000 Agricultural census only provides data at a higher level of disaggregation

especially between 1974 and 2005. Second, while FAOSTAT provides detail on each type of vegetable at a country level, SPAM only provides granular information on a general category "vegetables", which is employed in the construction of the commercial crop variable for 2005. This approximation should not introduce significant discrepancies across groups in 2005, but might severely impact the measurement of changes between 1974 and 2005. In general, therefore, while data for 1939, 1960 and 1974 are consistent and allow for reliable inferences, the 2005 source presents some weaknesses, and the gathered evidence should be considered more as suggestive rather than final.

5.4.2 Main variables

The described data were employed to calculate the main variables for the empirical analysis.

Italian Presence: Italian presence is defined as a binary variable signaling presence of Italian farmers in 1939. In the baseline specification, a district is assigned a one if more than 0 hectares of land were under Italian cultivation in 1939, as reported by the agricultural survey of 1939 (Ministero dell'Africa Italiana, 1939a). In Section 5.6, alternative definitions of Italian presence are tested.

Commercialization: for simplicity, commercialization is also given a binary definition (dummy yes/no). A district is considered highly commercialized if more than 80% of the ground-crop nominal output comes from commercial crops. I use a working definition to define commercial and subsistence crops, based on edibility and perishability. Subsistence crops are barley, wheat, millet, sorghum, maize and potato (which could be turned into flour), which are imperishable (over one year) and edible. Conversely, commercial ground crops are defined as all those crops that were either inedible (tobacco, castor beans, sugar cane), absent from the local diet (groundnut) or that were edible, but perishable (watermelon, tomato, melon). In Section 5.6, alternative cut-offs are tested for robustness.

Nominal Output: the nominal value of all ground-crops output in each district, expressed in constant 1982 USD.

Labour Productivity: calculated as nominal output from ground-crops per agricultural worker.

Cereal Yields: output in hundredweights (Cwt) per hectare for all grain crops.

5.5 Results

5.5.1 The aggregate effect of the expulsions

Before presenting the results from equation 5.1, it is useful, as a descriptive exercise, to look at simple difference in difference estimates that compare the region affected by the shock in a given year with the control group, without introducing the distinction between Italian and Libyan districts within the same region. Table 5.A.1 displays the results of this exercise and shows an average negative association between the Italian expulsions, level of market orientation (column 1) and nominal output per worker (column 2) in the regions affected by the shock. By contrast, Italian expulsions positively correlate with labor shares in agriculture (column 3) and cereal yields (column 4). Consistently with the related literature, these estimates provide suggestive evidence that the Italian expulsions had a sizeable influence on the performance of the agricultural sector. However, they do not allow causal inference as they do not deal with potential selection bias and pre-trends because they only rely on the comparison between regions that potentially experienced different trends independently of Italian presence. By focusing on both within-region trends and between-region differences for Italian districts only, the triple difference estimation in the following section will allow for causal inference.

5.5.2 Triple difference approach

Before formally estimating equation 5.1, it is worth looking at long-term patterns in Figure 5.4. This chart reports averages by group and over time for two key variables, namely the binary variable for commercialization (equalling one if a district produces more than 80% of its output from commercial ground-crops) and cereal yields. The top chart shows a decline in the level of commercialization in former Italian districts after both shocks when changes are considered relative to both Italian districts in a different region and Libyan ones.[51] By contrast, the bottom panel shows a strong increase in cereal yields in those districts that were affected by the 1970 expulsion from Tripolitania.

Table 5.1 reports the estimates from equation 5.1 and thus carries out the analysis more formally through the fully specified model. Column 1 shows the results for the level of

[51] The merging of all Libyan districts in one category in Figure 5.4 is done for graphic purposes, but the same chart by ethnic group in each region is reported in Figure 5.A.4

commercialization and points to an average negative effect of the expulsion of Italian farmers from Libya. For a district affected by the expulsions, it suggests a 50% percentage points probability reduction of being highly commercialized. Treated districts, in other words, suffer a significant reduction in the probability of producing more than 80% of their ground-crop output from non-subsistence crops. The coefficient of the triple interaction is significantly larger than the difference in difference point estimate from Table 5.A.1, which suggests that the measured average effect is largely driven by Italian districts within the region, and shows a statistically significant coefficient at the 1% level.

Table 5.1: Expulsions and agricultural performance, a triple difference approach

	Commercial district	Log USD/worker	Log output USD	Cereals Cwt/Ha
	(1)	(2)	(3)	(4)
IT*Exp*Post, stacked	-0.499***	0.671	0.540	4.745***
	(0.157)	(0.691)	(0.810)	(1.494)
IT*Post, stacked	0.823***	-0.175	0.003	-1.298
	(0.138)	(0.494)	(0.620)	(1.138)
Exp*Post, stacked	0.129	-0.766	-0.151	-0.656
	(0.112)	(0.617)	(0.782)	(1.059)
Observations	184	138	184	180
R-squared	0.39	0.47	0.39	0.31
Number of FID	46	46	46	46
Baseline Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
District FE	YES	YES	YES	YES

Triple difference estimates from equation 5.1. The interaction term equals 1 if $\gamma_2 IT * \gamma_3 Expulsion * \gamma_1 YearPost = 1$ and gives the causal average effect of both expulsions. Controls include population and time-interacted fruit tree production in 1939. The dependent variable in column 1 is a binary indicator that equals one if a district produced more than 80% of its ground-crop nominal output from commercial crops. In column 2, the dependent variable is the natural logarithm of the nominal output in 1982 dollars per agricultural worker. In column 3 and 4, the dependent variables are the natural logarithm of the nominal output from ground-crops and output of cereals per hectare (yields) in hundredweights, respectively. Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

Interestingly, no significant average effect can be measured for labor productivity (the nominal output per worker in constant 1982 dollars) in column 2, nor on nominal output per district (column 3). If anything, these coefficients show a positive response in productivity, albeit imprecisely estimated. By contrast, the average effect of the expulsions on cereal yields (column 4) is positive, large, and statistically significant at the 1% level. This coefficient suggests that the described shift away from more market-oriented crops in treated districts

resulted in the intensification of the production of traditional subsistence crops, namely cereals. However interesting, these results mirror the average effect of both shocks. By estimating the impact of each expulsion separately, it will be possible to study how different levels of market incentives (different prices) interact with the expulsions.

5.5.3 By-period analysis

If economic incentives matter for production choices, we would expect indigenous farmers in treated districts to respond differently to different market incentives. In a setting characterized by low internal market opportunities due to stagnating GDP growth and prices (see Table 5.A.4), the removal of the most innovative farmers might well cause a relative decline in the production of commercial ground crops, but this should not necessarily lead to an intensification of subsistence crop production due to lack of markets incentives. By contrast, if the same expulsion had to take place in a period of rapid economic expansion and high prices, we would expect indigenous farmers to use the available land intensively to take advantage of these opportunities.

Intuitively, by looking at the two expulsions separately, I implement a quadruple difference estimation where I consider the effect of expulsions before and after the oil boom (first-difference), for the affected region (second difference), comparing Libyan and Italian districts within the same region (third difference), before and after the expulsion (fourth difference). However, including an additional interaction in equation 5.1 to explicitly account for the effect of the take-off of GDP growth after the first oil discoveries in a fully specified quadruple difference model would make the estimation very demanding for the relatively small number of observations. Therefore, I prefer to simply run the two triple differences separately and compared the estimates with a more narrative approach.

Table 5.2 reports the triple difference estimates separately for each expulsion. Panel A focuses on the 1942 expulsion, while panel B reports the estimates for the 1970 one. As one can see in column 1, both expulsions led to a significant reduction in the level of market orientation of affected districts. After the shocks, the likelihood for former Italian districts to be highly commercialized (in other words to derive more than 80% of the nominal output from commercial ground-crops) declined significantly relative to the control groups.

Table 5.2: The separate effect of the Italian expulsions before and after the oil boom

	Commercial district	Log USD/worker	Log output USD	Cereals Cwt/Ha
Panel A: 1942 expulsion	(1)	(2)	(3)	(4)
Cyrenaica*Italian*1960	-0.943**	-0.622	-2.275**	3.099
	(0.426)	(1.195)	(1.124)	(2.327)
Cyrenaica*1960	0.319	-0.029	2.589**	0.247
	(0.388)	(1.057)	(1.055)	(2.223)
Italian*1960	0.919***	-0.763	-0.429	-2.649
	(0.191)	(0.609)	(0.594)	(1.615)
Observations	184	138	184	180
R-squared	0.34	0.50	0.41	0.24
Panel B: 1970 expulsion	(1)	(2)	(3)	(4)
Tripolitania*Italian*1974	-0.350**	1.279	1.918	7.802***
	(0.169)	(0.812)	(1.187)	(2.815)
Tripolitania*1974	-0.030	-0.801	-1.131	-0.129
	(0.086)	(0.692)	(1.167)	(2.348)
Italian*1974	0.415***	0.539	0.045	-1.517
	(0.142)	(0.582)	(0.723)	(2.307)
Observations	184	138	184	180
R-squared	0.23	0.51	0.40	0.35
Number of FID	46	46	46	46
Baseline Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
District FE	YES	YES	YES	YES

Triple difference estimates from equation 5.2. Panel A reports the estimates from the 1942 expulsion (1960 is the first year in the panel after the expulsion), while panel B shows the estimates from the 1970 expulsion. The interaction term equals 1 if $\gamma_2 IT * \gamma_3 Expulsion * \gamma_1 YearPost = 1$ and gives the causal average effect of both expulsions. Controls include population and time-interacted fruit tree production in 1939. The dependent variable in column 1 is a binary indicator that equals 1 if a district produced more than 80% of its ground-crop nominal output from commercial crops. In column 2, the dependent variable is the natural logarithm of the nominal output in 1982 dollars per agricultural worker. In column 3 and 4, the dependent variables are the natural logarithm of the nominal output from ground-crops and output of cereals per hectare (yields) in hundredweights, respectively. Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

The estimates show, for districts affected by the 1942 expulsion (column 1, panel A), an average 94 percentage point reduction in the probability of this district to be highly commercialized in 1960. For locations affected by the 1970 shock, the estimates still give a negative and significant coefficient, suggesting a negative and significant effect of roughly 35 percentage points (column 1, panel B).

The comparison of the magnitude of the two coefficients, however, can only be done

tentatively. In fact, while I can employ two previously unaffected control groups to study the effect of the 1942 expulsion, the Italian districts that were affected by the 1942 expulsion are used as a control group for the 1970 shock. This feature is undoubtedly likely to introduce bias in the estimation, but it can only affect the precision in the estimation of the coefficients' magnitude through attenuation bias. In other words, the estimated effect of the 1970 shock provides a lower bound estimate of the effect (Goodman-Bacon, 2018).

Columns 2, 3 and 4 pinpoint how the 1942 expulsion did not lead to a significant increase in output of cereals per hectare in Cyrenaica, which ultimately resulted in an average reduction in nominal output per districts (column 3) and a negative effect on labor productivity which is visible in column 2 (although imprecisely estimated). Districts affected by the 1970 expulsion, instead, increased cereal yields dramatically by 1974, as clearly visible in column 4 of panel B and Figure 5.4. This intensification in the production of traditional crops arguably allowed to maintain (or even to increase) the total nominal output and the nominal output per worker in each district, as displayed in columns 3 and 2, respectively.

A suggestive hypothesis for the effects identified after the 1970 shock is the Libyan economy experiencing Dutch disease. The boom in oil exports, in fact, led to an appreciation of the Libyan Dinar against the Dollar, as it is visible in Figure 5.A.1. By making the import of durable crops such as grains cheaper, this currency appreciation provided the incentives to specialize in perishable crops that could not be imported from abroad at a low price. This explanation would be consistent with the differentially larger increase in prices for perishable commercial crops, such as tomatoes and fruits visible in Table 5.A.4. In other words, the transition of the Libyan agricultural sector from subsistence to commercial crops depicted above (Figure 5.3) might have been partially driven by new market incentives created by the oil boom through currency appreciation. Despite being the most commercialized in the 1960s, those districts affected by the expulsions failed to keep up with the transition to perishable market crops, instead often switching back to traditional crops with thinner market opportunities and thus losing ground relative to the control groups. This is an interesting finding for developing countries that often experience natural resource booms, but whose effect on the agricultural sector is not well understood (Ross, 2012b).

To sum up, the estimates shown so far suggest, on the one hand, that the expulsion of Italian farmers from Libya led, on both occasions, to a significant decline in the level of commercialization of the affected areas. On the other hand, they suggest that macro-economic

conditions mattered in determining the response of indigenous farmers to these shocks.

5.5.4 Explaining the effect

While Tables 5.1 and 5.2 provide convincing evidence about the causal nature of the effect of Italian expulsions on agricultural performance, the mechanisms require further explanation.

5.5.4.1 Human capital

A first issue with interpreting the measured effect as being linked to a drop in human capital relates to the difficulty in isolating the effect of the latter from other confounding factors that tend to be highly correlated with human capital itself, namely physical capital and labor. As Italians had received financial support from the state and had, in general, easier access to credit compared to the Libyan average farmer, it is possible that their departure also correlated with a significant reduction in available capital in affected districts. Italians might have just used existing machinery to exhaustion due to uncertainty on their future or might have even destroyed parts of the capital stock as a reaction to the expulsion. If this was the case, the drop in available production tools might simply explain the move away from certain crops (such as groundnut and tomato) if these required more extensive use of machinery compared to traditional subsistence crops. Furthermore, and perhaps more obviously, the removal of Italian farmers also led to a reduction in the available labor force in affected districts, which might have in turn led to a move away from more labor-intensive commercial crops.

Luckily, the data allow to control for both these possibility by introducing controls for number of tractors per agricultural worker (tractors are a good proxy for capital availability) and number of agricultural workers per district (weighted by total population), as I do in columns 1 and 2 of Table 5.3, for my two main dependent variables. The estimates do not change when these controls are introduced, thus strongly suggesting that the drop in human capital is the proximate cause for the drop in commercialization in affected districts.

Table 5.3: Human capital and indigenous adaptation

Expulsions:	Combined		Cyrenaica, 1942		Tripolitania, 1970	
Dependent variable:	Commercial district	Cereals Cwt/Ha	Log agricultural share	Log tractors/worker	Log agricultural share	Log tractors/worker
	(1)	(2)	(3)	(4)	(5)	(6)
IT*Exp*Post	-0.460***	4.473***	-0.095	-0.004	0.910**	-0.022*
	(0.160)	(1.663)	(0.392)	(0.012)	(0.366)	(0.012)
IT*Post	0.480***	-1.051	0.178	0.006	-0.601***	0.026**
	(0.133)	(1.516)	(0.309)	(0.009)	(0.198)	(0.012)
Exp*Post	0.088	0.451	0.949**	-0.022*	-0.464*	-0.002
	(0.122)	(1.278)	(0.392)	(0.012)	(0.253)	(0.010)
Log agricultural share	0.040	0.267				
	(0.054)	(0.827)				
Log tractors/worker	1.031	52.044				
	(2.296)	(48.887)				
Observations	138	135	138	138	138	138
R-squared	0.31	0.39	0.45	0.46	0.34	0.47
Number of FID	46	46	46	46	46	46
Factors of Production	YES	YES	NO	NO	NO	NO
Baseline Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES

The table reports estimates from equation 5.1 in columns 1 and 2 and from equation 5.2 in columns 3 to 6. Columns 1 and 2 have a binary indicator that equals 1 if a district produced more than 80% of its ground-crop nominal output from commercial crops and cereal yields per hectare as dependent variables, respectively (see Table 5.1), but include controls for share of workers in agriculture and number of tractors per worker as controls. Columns 3 to 6, instead, show estimates with the share of workers in agriculture and the number of tractors per worker as dependent variables, but estimate the coefficients for the two expulsions separately. Errors hare clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

This finding would be consistent with the technical reports from the time that emphasize superior cultivation practices being applied on Italian farms, in combination with commercial crops (Theodorou, 1954, pp. 45-6). Some caveats apply to this interpretation. If it is true that unobservables, such as informal networks and preferential access to Italian markets might also be important, this is unlikely to explain the effect in full. First, while Libya did maintain preferential access to Italian markets through a compensation trade scheme after the war, there is no evidence that trade policies were explicitly targeted to Italian producers in the post-colonial period as these would have automatically applied to Libyan producers as well (Wheatley, 1951, pp. 159-60). Informal networks that allowed Italian farmers to have preferential access to markets could partially explain the effect for the 1942 expulsion and form a complementary explanation to the human capital story, a possibility that I fully acknowledge but cannot test empirically.

However, the same effect is identified for both expulsions, which is reassuring in this sense. In fact, while the negative effect in commercialization following the 1942 expulsion could indeed be explained by preferential access (Or any other unobserved policy) targeted to remaining Italian farmers, this cannot be true for the effect measured after the 1970 expulsion. The 1970s, in fact, were the period of maximum expansion in commercial crop production for the Libyan agricultural sector (Figure 5.5) and the effect is driven by the strong performance of the control groups (column 1, panel B, Table 5.2). If any specific policies were implemented in this period by the Libyan government, these would have been targeted to locations affected by the shock, certainly not to the control groups. As, by exclusion, a human capital shock is the only common feature of the two experiments, the described results provide sound evidence of the role of human capital in capturing market opportunities in the Libyan context.

5.5.4.2 Indigenous response

A second important question regarding the mechanisms is the nature of the indigenous adaptation to the expulsions. Columns 3 and 4 from Table 5.3 report estimates for the 1942 expulsion (as in panel B of Table 5.2), but this time using the share of agricultural workers over the total district population and number of tractors per worker as dependent variables, respectively. The expulsion of Italians from Cyrenaica, which did not lead to any significant intensification in subsistence crop production as shown in column 4 of Panel A (Table 5.2),

did not trigger any changes in factors of production. The share of agricultural workers over the total population and the number of tractors per workers did not change, consistently with the limited scope for intensification of the production during a period of insecurity and economic stagnation. By contrast, the 1970 expulsion did foster a substantial adjustment in the concentration of factors. The number of agricultural workers relative to the total population increased significantly after the expulsion (column 5) while the number of tractors per worker did not keep up with the pace of the adjustment, resulting in a sizeable reduction in machinery per worker (column 6). These two results suggest that the measured increase in yields after 1970 was mainly due to a labor-intensive response (more workers moving into agriculture) rather than productivity gains linked to a capital intensive production.

Altogether these results provide convincing evidence of the profound transformations brought about in the Libyan agricultural sector by the expulsion of the Italian settlers. The removal of the most market-oriented farming community at the time caused a reduction in the level of commercialization of the affected districts, whose likelihood to derive more than 80% of total output from commercial ground crops declined markedly in both periods. However, the response of the indigenous farmers to the shocks depended heavily on the macro-economic conditions of the Libyan economy. After 1970, when economic growth was faster, the void left by the Italians led to an intensification in the production of traditional subsistence crops that allowed to maintain similar levels of nominal output. By contrast, after the first expulsion in 1942, cereal yields were not boosted sufficiently to compensate for the relative decline in nominal output.

This picture, which is largely consistent with the available qualitative sources from the period (see Section 5.7), emphasizes how macro-economic conditions can attenuate the effect of a human capital shock in agriculture significantly by allowing to compensate, at least in the short-run, the decline in nominal output through a labor-intensive increase in yields. Independently of market incentives, however, districts that were hit by the removal of the Italian settlers experienced in both experiments a decline in the level of diversification and commercialization of the production. The different effect of human capital shocks that interacted with market incentives and the overall state of the economy is reminiscent of Foster and Rosenzweig (1996) findings on the different returns to schooling, which in their study depended on the rate of technological advances in post-colonial India. My findings emphasize how human capital shocks might influence the agricultural sector differently depending on

macro-economic conditions.

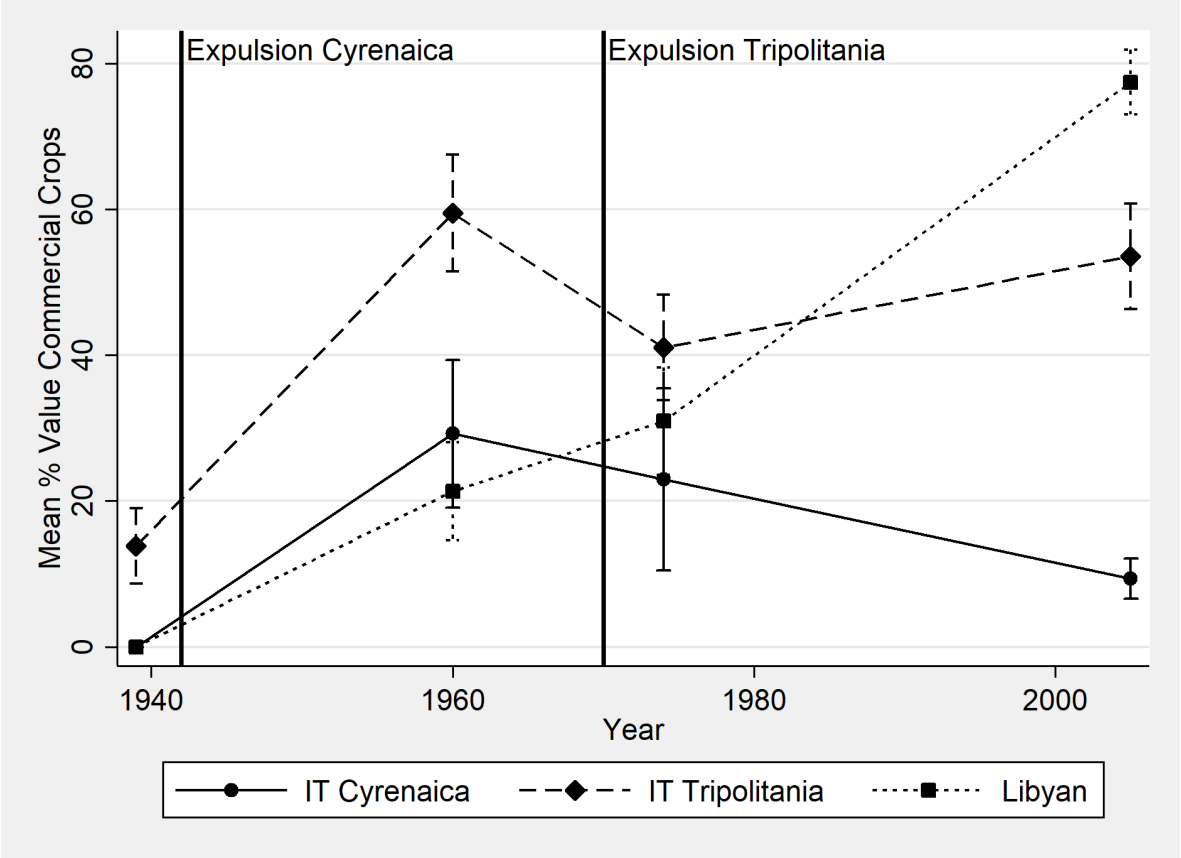
5.5.5 The persistent effect of the expulsions

An important issue related to the effect of adverse human capital shocks in agriculture is their persistence. Was the described shift away from more market-oriented practices towards intensification in the cultivation of traditional subsistence crops temporary, or did this affect the Libyan economy permanently? Figure 5.5 provides a first answer to this question. It shows the ratio between nominal commercial ground-crop output over total ground-crop output between 1939 and 2005. The sample is split between Italian districts in Tripolitania and Cyrenaica (that were affected by the expulsions of Italian farmers in 1942 and 1970, respectively) and all other Libyan districts. As one can see, the trends depict a complete "reversal of fortunes" among groups. Italian districts in Tripolitania pulled ahead in terms of agricultural commercialization between 1939 and 1960, widening the pre-existing gap with both Italian districts in Cyrenaica and Libyan ones while reaching an average 60% value of output from ground crops over the total. This figure drops significantly, both in absolute and relative terms, after the 1970 expulsion, when Italian Tripolitanian districts become indistinguishable from Libyan ones which, instead, underwent a continuous phase of commercialization and diversification.

Both groups of Italian districts fell, in relative terms and with respect to Libyan ones, after 1974. The latter became the most commercialized, with an average of 80% commercial output, in 2005. Italian Tripolitanian districts bounced back to a level slightly below the 1974 one but never gained primacy again, while Cyrenaican ones underwent an uninterrupted decline that brought the commercial share down to 10% by 2005. This heterogeneous effect for districts affected by early and late removal of skilled farmers suggests that the length of the exposure of local indigenous farmers to more advanced farming practices makes a difference in the long-term trend, following their expulsion.

This trend is also clear from panel estimates in Table 5.A.9. These include time and district-level fixed effects as in equation 5.1, but instead of introducing difference-in-difference interactions, they include sub-group time-interacted dummies that allow comparisons around the mean. All coefficients should be considered in relation to the 1939 baseline, which is the excluded category in each specification. This exercise, therefore, allows comparing the relative performance of Italian districts in both regions over the entire period of the study. While,

Figure 5.5: Commercialization by group, 1939-2005



Note: average share of commercial ground-crops relative to total nominal output from ground-crops by group, with standard error bars. Districts are grouped as in Figure 5.1.
Source: author's own calculations, see section 5.4 for details.

in 1960, Italian districts in Tripolitania were by far the most commercialized and Cyrenaican ones were not different from the average, both groups are significantly below the mean Libyan level of commercialization in 2005 (columns 1 and 2). The same exercise with average cereal yields as dependent variables in columns 3 to 6, instead does not show a long term effect of the expulsions on the outcome of interest. The increase in land productivity, observed in Tripolitanian Italian districts after the expulsions, is visible in column 5 and, mechanically, the negative coefficient for Cyrenaica in column 6. Yet, the adjustment in cereal yields only appears to be temporary and falls back after 1974 (see Figure 5.4)

Altogether, these results emphasize the significant and persistent effect of Italian expulsions on commercialization. On the one hand, the Libyan case study shows the importance of human capital in agriculture in fostering commercialization and diversification. The negative consequences of an exogenous shock are strong and long-lasting, although not directly affect-

ing productivity. On the other hand, these experiments show how the intensive response to the expulsion, achieved through higher yields for traditional subsistence crops, is only temporary and materializes in periods of strong economic growth offering market incentives. While total nominal output per hectare cannot be measured consistently throughout the panel (cultivated land by crop is not available at the same level of disaggregation for all cross-sections), an analysis of the effect of the expulsions on this measure of productivity would probably show a long-term decline similar to the one highlighted by this study in terms of commercialization, as more commercial crops tend to yield higher nominal output per hectare.

5.6 Robustness

Although the employed identification strategy largely addresses most of the main problems related to omitted variable bias, some robustness tests are necessary. A first potential problem is that unobserved changes either at the ethnic group or at the regional level, such as targeted policies, might affect the commercialization pattern or the land productivity one differentially. In columns 2 to 4 from Table 5.A.2, I introduce group-time fixed effects (Italian districts vs Libyan ones) and region-time fixed effects, in combination with controls for capital and labour, for both my indicator for highly commercialized districts (columns 1 and 2) and cereal yields (columns 3 and 4). These absorb location and group-specific time-invariant factors that could affect the primary outcomes differentially (Alsan and Wanamaker, 2017).

A second issue relates to the choice of the dependent variable. On the one hand, the separation of commercial and subsistence crops attributes potatoes to the latter category, when these were not part of the traditional Libyan diet and required different cultivation techniques compared to grains. In column 5 of Table 5.A.2, I drop potatoes from the calculation of commercial shares (and therefore from the definition of the binary indicator for highly commercialized districts), thus using only grains as subsistence crops. The results are robust to the additional check. On the other hand, as the continuous variable (the share of nominal output from commercial ground-crops over total nominal output) cannot be employed due to its bimodal distribution (see Figure 5.A.3), the use of dummy variables is the obvious solution, but the procedure of selecting an 80% cut-off is arbitrary. Columns 2 and 3 from Table 5.A.3 show that the reduction in commercialization in treated locations also holds if we define highly commercialized districts as generating more than 70% and 90% output

from commercial crops, respectively. Furthermore, in column 4, I restrict the sample to those districts that, over the entire panel, always generated at least more than 20% of the output from commercial crops. The test is particularly demanding, as in 1939 only very few districts produced ground-crops different from grains. All these tests confirm the robustness of the estimates.

A third issue concerns the definition of the treatment. While the one employed in the baseline estimation is the most conservative option (every district where Italian farmers cultivated any amount of land is considered treated), this does incorporate settlement intensity and is a somewhat crude measure for Italian presence. The effect should survive the restriction of the treatment to those locations where the Italian settlement was somewhat sizeable. As what "sizeable" means in this context is difficult to define, I take two alternative and conservative measures. I start by calculating the share of Italian cultivated land in 1939 over the total and assign treatment only to those locations that had more than 5% of the agricultural land cultivated by Italians. Similarly, I create an alternative treatment that only considers those districts where Italian workers constituted at least 5% of the labor force in 1939. Columns 5 to 8, in Table 5.A.3, show the results for the triple difference analysis using the described alternative treatments for the two main dependent variables (commercialization and cereal yields). The results are largely consistent with the main estimates.

Fourthly, it is also essential to address the fact that, while the two expulsions were similar and both orthogonal, for different reasons, to the transformations that were taking place in the Libyan agricultural sector, the time-lapse between treatment and observed outcome variables differs markedly for the two experiments. In fact, we observe the situation after 18 years from the 1942 expulsion and only four years after the 1970 one. Unfortunately, due to data limitations, it is not possible to fill these gaps in the time series. Empirically, the estimations are not affected by this discrepancy, but the comparison between the shocks in relation to changes in market incentives could be affected by this different lag. As discussed in Section 5.5.5, the negative effect of expulsions on commercialization is quite persistent over time, so for this outcome, it should not matter if the cross-sectional variation is observed 4 or 18 years after treatment (other than possible adjustments in the size of the effect). Conversely, there is no evidence of the persistence of the effect on cereal yields after 30 years from the expulsion of Italian farmers from Tripolitania (see Table 5.A.9). As the increase in yields was arguably a temporary shock in reaction to the expulsion, it is possible to hypothesize that a similar

increase occurred in Cyrenaica after 1942 but that we are not able to observe it in 1960 as this had already dissipated.

Although I cannot address this issue empirically, convincing qualitative evidence exists on the average yields in former Italian districts in Cyrenaica in the period between 1942 and 1960, and this provides little evidence of a temporary increase in yields following the 1942 expulsion. A technical report by the Food and Agriculture Organization (FAO) from 1951 reports average yields in Cyrenaica between 1942 and 1950 as ranging between 2.4 and 5 Ctw per acre, so roughly 5,7 and 12 Cwt per hectare in the highly mechanized areas managed under the farming schemes of the British Military Administration (Wheatley, 1951, p. 55). Therefore, the average for the entire region must have been well below both these figures and the average for Libyan districts in 1960 shown in Figure 5.4. Specifically, with respect to former Italian districts, the situation did not appear significantly better: "In Cyrenaica, many of the farms built by the Italians (who were evacuated during the war and have not returned) are now operated by the Cyrenaicans under minimal guidance by the British authorities. The progress of the Arabs in Cyrenaica in adopting the careful, tidy procedures of the Italians appears to have been extremely slow. Production is also small compared to the level reached by the Italian farmers" (Wheatley, 1951, p. 34). Probably, therefore, the actual land productivity for Italian districts in Cyrenaica immediately after the expulsion would not have been far from the average yields for those same districts in 1960, somewhat around two Cwt per hectare. In any case, this is far from the jump in cereal yields observed in Tripolitania after the 1970 expulsion, which reassures about the causal link between labor-intensive response and market opportunities linked to faster economic growth.

5.7 Channels and discussion

The empirical estimates have revealed two main consequences of the expulsions of Italian farmers from Libya. On the one hand, the analysis has pointed out a significant drop in commercialization and diversification of ground-crop production following the expulsions, which suggests a role of human capital in adopting riskier agricultural practices and in taking advantage of market incentives. On the other hand, the results emphasize the resilience of cereal yields - the largely predominant Libyan subsistence crop - to the expulsions. Cereal yields even show robust increases following the expulsion as a form of adaptation to human capital losses

in periods of strong market incentives. The triple difference estimations also suggest that it was a labor-intensive adaptation (rather than a capital-intensive one), which therefore was not reflected in measures of labor productivity. What the previous analysis has not tackled are the context-specific mechanisms behind these effects, in other words, what cultivation techniques had to be adopted for a more market-oriented approach and diversification of the production to take place. As a first step, it is important to shed some light on the characteristics of the Italian production strategies. How did Italian farmers raise the level of commercialization in Tripolitania after the World War, and how does this help to explain the measured effect of the expulsions? The triple difference estimates provided some convincing evidence that a collapse in the available capital (proxied by tractors per agricultural worker) did not explain the decline in commercialization following the expulsions. However, it is important to shed light on what production techniques were associated with the increased diversification and commercialization of production. Secondly, it is also essential to better understand how Italian enclaves interacted with the surrounding villages, to study whether knowledge spillovers were in place between Italian villages and Libyan neighbors within each district. The literature has shown that knowledge spillover among neighbors can help to spread innovative agricultural practices and to raise output (Parman, 2012; Conley and Udry, 2010). We would, therefore, expect positive spillovers to mitigate the effects of the expulsions, while lack of thereof to make those more severe. It is particularly interesting to look at knowledge spillovers in a dual economy characterized by substantial cultural barriers between groups.

The data available to address these questions is, however, far from exhaustive and requires the combination of the scant sub-district level quantitative sources with qualitative evidence. This section aims to achieve a better understanding of the mechanisms that contributed to the peculiar development of the Libyan agricultural sector, rather than to establish robust causal links. Furthermore, as the employed agricultural techniques were necessarily country and region-specific, the following analysis can hardly be generalized to other contexts. The 1960 agricultural census provides a first glimpse into these patterns. This source gives information on the territories of roughly 145 villages and towns (Mudirias) with a high level of detail on the different aspects of cultivation techniques and the property structure of each village. This census is the only source that allows studying sub-district dynamics for the post-colonial period. It thus provides a snapshot of the Libyan agricultural sector a few years after independence when Italian farmers from the Eastern region of Cyrenaica had already been

expelled, while the ones in Tripolitania were still allowed to operate. A sub-district analysis is necessary to achieve a better understanding of how Italian areas differed from the rest of the country. Table 5.4 shows the results from equation 5.3, a simple OLS model designed to capture differences in production strategies between Italian villages, Libyan ones located in their proximity (within a 20km radius) and other Libyan clusters farther away.

$$y_{i,1960} = \alpha + \beta_2 DITfarm_{i,1939} + \beta_1 DITfarm_{0-20km,i,1939} + x_i'\gamma + \delta_p + \epsilon_{i,t} \tag{5.3}$$

In equation 5.3, Italian presence is captured by the term $DITfarm_{i,1939}$, a binary variable that takes the value of 1 if a certain amount of land (> 0) was cultivated by Italian farmers in 1939 (as in equation 5.1). The dummy $DITfarm_{0-20km,i,1939}$, instead captures proximity to Italian farmers and equals one if a village was not affected by Italian settlement, but was located less than 20km away from an Italian village. This variable gives an approximation of the agricultural dynamics within districts that were affected by Italian agricultural settlement and allows capturing spatial spillovers. The dependent variable, $y_{i,1960}$, represents a set of indicators that allow studying the different cultivation techniques (labor intensity, machinery, irrigation, and land tenure system). x_i' is a vector of controls that makes the estimates conditional on a standard set of geographical variables (distance from the coast, from waterways, altitude, land suitability, average rainfall, average temperature, latitude and longitude) and confounding pre-1939 characteristics (land use in the 1920s, population in 1900 and distance from caravan routes). δ_p is a set of provincial fixed effects.[52]

As one can see, from a statistical viewpoint, Italian locations differed from the mean only for a few elements. First, if we look at employed labor per hectare (column 1), one can see how no significant differences existed in terms of concentration of agricultural workers between Italian villages (whether already abandoned by the settlers or not) and the rest of the country. This simple statistic does leave an open question regarding the quality of the employed labor but does not show any differences in terms of labor intensity. Second, column 2 shows a positive association between Italian presence in Tripolitania and the adoption of tractors. Comparable districts in Cyrenaica, instead, do not show higher levels of mechanization after the 1942 expulsion. Interestingly, in both Tripolitania and Cyrenaica, Libyan villages located in the proximity of Italian ones show a significantly higher likelihood of employing tractors.

[52]The model follows the one employed in Chapter 4

Table 5.4: Proximity to Italian villages and factors of production in 1960

Dependent variable:	MF workers/Ha 1960	Tractors employed 1/0	N. Tractors/ Worker	Share holdings irrigation	Share holdings generator	Share farms fertilizer	Tribal tenure share Ha
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Italian village Trip, 0/1	1.640	0.276**	0.000	0.444***	0.076**	-0.086	-0.150
	(1.973)	(0.131)	(0.011)	(0.096)	(0.032)	(0.070)	(0.104)
Italian village Cyr, 0/1	0.627	-0.152	0.005	0.160***	0.080		0.065
	(0.697)	(0.148)	(0.004)	(0.053)	(0.060)		(0.086)
< 20km IT Village Trip, 1/0	1.281	0.380**	0.021	0.048	0.031	0.175**	-0.359***
	(1.366)	(0.176)	(0.013)	(0.117)	(0.030)	(0.076)	(0.106)
< 20km IT Village Cyr, 1/0	-0.201	0.615***	0.006*	0.114**	0.060**		-0.357***
	(0.883)	(0.118)	(0.003)	(0.052)	(0.027)		(0.075)
Observations	144	145	145	145	145	57	145
R-squared	0.23	0.44	0.10	0.38	0.18	0.41	0.30
Fixed Effects	YES	YES	YES	YES	YES	YES	YES
Pre-colonial Controls	YES	YES	YES	YES	YES	YES	YES
Geographical Controls	YES	YES	YES	YES	YES	YES	YES

OLS regression estimates from equation 5.3, employing township level data from the 1960 agricultural census of Libya (United Kingdom of Libya, 1962a). Dependent variables are the following. Column 1, total agricultural workers per hectare. Column 2, at least 1 tractor is employed in town. Column 3, Number of tractors per agricultural worker. Column 4, share of holdings employing irrigation relative to the total number of holdings. Column 5, share of holdings employing an electric generator relative to the total number of holdings. Column 6, share of holdings reporting the use of artificial fertilizer (data only available for Tripolitania). Column 7, share of cultivated land under tribal tenure in each town. The fixed effects are the 5 provinces in which colonial Libya was administered. Pre-colonial controls include land use before 1930, reconstructed population in 1900 and distance from caravan routes in the 19th century. Geographical controls include distances from coast, distance from waterways, rain-fed barley suitability, average temperature, average precipitations, altitude, longitude and latitude (see Section 5.B for details on the employed data). Errors are clustered at the 1936 census district level in all specifications (Regno d'Italia, 1939). *** p<0.01, ** p<0.05, * p<0.1

This result, on the one hand, suggests that machinery was indeed employed more systematically in Italian districts but, on the other, that this was not a peculiarity associated with Italian farmers only, who were not more likely to employ tractors in their village relative to their neighbors. The fact that the number of tractors per worker (column 3) does not show any significant association with Italian presence further downplays the importance of machinery for Italian cultivation techniques. Similarly, Italian villages did not employ fertilizer more systematically than their neighbors (column 6), a problem often stressed by British officers when surveying the Libyan agricultural sector while looking for potential for improvement (Wheatley, 1951). Furthermore, in villages affected by Italian settlement, the share of land under tribal tenure was not below the country's average, an institutional channel that therefore appears not to be directly related to Italian presence (column 7).

By contrast, what emerges as a critical difference between Italian and Libyan methods of cultivation in 1960 is the employment of irrigation (column 4). Villages that experienced Italian farming in the colonial period reported, in Tripolitania, an average 44 percentage points larger share of farms employing irrigation. Italian clusters in Cyrenaica, after the expulsion of the settlers, also had more widespread use of irrigation, with roughly 16% more farms reporting the use of irrigation relative to the control group. The average effect is economically large although significantly smaller than in Tripolitania, where Italian farmers were still active. An essential difference between the two regions is the availability of generators, which were key to operate electric pumps for water lifting. In fact, a seven percentage points higher share of holdings in Italian villages in Tripolitania reported the use of this type of equipment (column 5). The importance of water for Italian farming in Tripolitania is confirmed by the FAO reports and was undoubtedly a critical factor in allowing local farmers to flexibly adapt their productive strategies to market incentives: "As timely irrigation is the most important factor for successful farming in the area, all Italian farms acquired motor pumps. There were 98 motor pumps on the Italian farms, of which 62 were operated with electric power and 36 with crude oil." (Theodorou, 1954, p. 57). This passage suggests that the more diversified production strategy employed by the Italians after WWII was primarily based on irrigation.

As the coefficient for Cyrenaica in column 4 suggests, after the expulsions the irrigation system did not collapse but was arguably employed by Libyans for other crops, most likely subsistence ones. The more systematic use of irrigation practices during the colonial period, in fact, largely survived the war and was still widespread in the 1950s and 1960s: "By 1940,

the land use pattern of Libya had been altered radically by Italian colonising efforts. [...] The application of modern methods of water-lifting had made possible intensive use of land for irrigated arable crops in a broad belt of the province lying in the steppe to the south of the Arab oases from Zuwarah and Misuratah. Developments in Eastern Libya, although less impressive, [...] had succeeded in raising the level of land use from grazing and shifting cultivation to organized orcharding and relatively sophisticated mechanized cereal cultivation." (Allan, McLachlan, and Penrose, 1973, p. 51). Widespread irrigation allowed significant changes in production in Tripolitania: "Apart from the rapid increase in olive oil output, changes were wrought in crop production by the groundnut boom of the the mid-1950s and the increasing acreage under tomato crops, average production of these two crops rising by some 600% and 400% respectively, between 1945 and 1950 (Allan, McLachlan, and Penrose, 1973, p. 53)."

An FAO report from 1951 on Italian and Indigenous farming in the Zavia area (an important agricultural area to the West of Tripoli) that looked at a sample of 140 farms (50% Libyan and %50 Italian) shows how diversification and commercialization ultimately made Italian farmers significantly better-off in the 1950s. In fact, they were not only able to generate more revenues per hectare (an average of L£ 1,025, against L£ 178) but they were also selling a larger share of the produce (L£ 968, against L£ 99) (Theodorou, 1954, pp. 65–6). The gap in revenues is explained mainly by the crops selected for cultivation, with Italians investing more on groundnut and olives while Libyan on barley and traditional crops, products with significantly different prices in the 1950s (see Table 5.A.4): "Barley was the most important crop in Libyan farms in 1952. Second in importance was dates and third olive oil production. On the Italian farms, groundnut production amounted to over 40% of total value of crop production and olive oil was second in importance." (Theodorou, 1954, p. 67) As a result of this more pronounced diversification in production: "Gross income, which includes cash receipts from sales of farm products, income from other sources and net increase in inventory, but excluding farm privileges consumed by the household averaged L£ 165 per Libyan farm in 1952, as compared with L£ 1,409 per Italian farm. Even on a per hectare basis, gross income on Italian farms was about three times that of Libyan farms" (Theodorou, 1954, p. 71).

By contrast, the sources depict an entirely different situation in former Italian areas affected by the 1942 expulsion. An FAO survey from 1966 does give additional evidence on the capacity of Libyan farmers to adapt to the new situation and to maintain use Italian

some Italian innovations, such machinery, but these were only employed for the production of traditional crops: "Mechanised farming, ploughing by tractors and threshing by combines has very recently been introduced to the area and is carried out both by the Governmental tractor station in Marj (Barce) and by private tractors owners. [Describing the ex-Ente villages of Beida (Beda Littoria), Messa (Razza) and Omar Mukhtar (Mameli)]" (Meliczek, 1966, p. 18) and continues: "There is one Ente tenant in Messa (Razza) who does not cultivate field crops. All the others grow wheat and almost all of them had also a piece of land under barley" (Meliczek, 1966, p. 19). Technological adoption allowed to maintain higher yields compared to the rest of the region: "[Describing the situation in Messa (Razza)] In 1964/65 wheat yields amounted to 358 kg/Ha or 7 times the amount of seed sown, which is relatively high for the Jebel el Akhdar. Barley also gave a good yield amounting to 259 kg/Ha. [...] Beida (Beda Littoria), like Messa is one of the better areas for agricultural production in the Jebel Akhdar. 1964/65 yields of wheat and barley were even higher than in Messa." (Meliczek, 1966, pp. 19–20)

To sum up, Italian farmers that were allowed to remain in Libya after the war started a process of diversification and commercialization of the agricultural production aimed at seizing market opportunities, which triggered a divergence with former Italian districts in Cyrenaica, that witnessed instead a relative decline in commercialization and the continuing production of more traditional field crops (grains), probably using Italian agricultural investments in machinery and irrigation to that end. This reduced commercialization, but allowed to maintain the same levels of grain yields and, when prices were high (as after the 1970 expulsion) even to increase cereal yields significantly. Italian diversification was made possible by the more widespread use of irrigation, which allowed for the production of more vegetables and cash crops (mainly tomato and peanuts). Knowledge spillovers in terms of farming practices were quite limited, with the possible exception of agricultural machinery which was employed more systematically in the proximity of Italian farms after the war.

5.8 Conclusion

This paper has studied the effect of the expulsion of Italian farmers from Libya on the performance of its agricultural sector. It has exploited the "quasi-natural experiment" provided by the expulsion of Italian farmers from Libya in two, separate steps to employ a triple-difference

design to infer causality. In fact, by comparing Italian districts affected by an expulsion with both other Italian areas not affected by the same shock and Libyan districts in the same region, this methodology allows to identify the causal effect of the expulsions. I have used a novel district-level dataset with information on the production of ground crops, cereal yields, machinery and agricultural labor force for 1939, 1960, 1974 and 2005 from a variety of untapped primary sources.

The results have pointed out two main effects. On the one hand, the expulsion of the most educated farmers has led to a decline in the level of commercialization of affected districts, as measured by the likelihood of a district to be "highly commercialized". Districts obtaining more than 80% of its total nominal output from commercial ground-crops, such as tomato, groundnut, and vegetables, are defined as commercial. While the relatively high level of commercialization achieved by Italian farmers after the war can be chiefly explained by the use of systematic irrigation that was conducive to the introduction of these new ground-crops, the estimates are also robust to controls for for capital and labour endowment, which suggests that it is the knowledge of the farmers and their willingness to take risk that determines their capacity to introduce new crops on a large scale.

On the other hand, the negative shocks in commercialization were not mirrored by a significant drop in productivity. The estimates not only show that the indigenous cultivators maintained the same levels of cereal and labor productivity after the expulsions. In periods of high prices and fast GDP growth that provided strong market incentives (as in the case of the 1970 expulsion that coincided with the oil-boom), they even responded with a substantial increase in the output of traditional crops (for instance wheat and barley). This response was mostly labor-intensive, as pinpointed by the increase in workers per hectare in locations treated by the 1970 expulsion.

The results thus indirectly indicate a pivotal role of human capital in agriculture in achieving diversification and commercialization. This is only true, however, in the sense of diversifying production by means of introducing new crops, but it does not apply to traditional crops produced with well-established techniques. In fact, no negative effect of the expulsions emerges with respect to labor productivity or cereal yields. Rather, indigenous farmers showed significant adaptability in traditional crop production in the face of negative human capital shocks and arguably used this to compensate for the loss in output. This response is evident from the fact that the nominal output per worker did not decline in coincidence with

any of the two expulsions.

By analyzing the heterogeneous effects of the expulsion of Italian farmers from Libya, this article makes two main contributions to the literature. Firstly, by looking at the effect of the expulsions of European colonists from African erstwhile settler colonies, it provides a first empirical investigation of the effect of this phenomenon on the local economy. This study is important as, even though several similar expulsions of European farmers took place in comparable settings (such as Zimbabwe and Algeria), this paper is, to the best of my knowledge, a primer in shedding light on their consequences for the economic development of former colonies. Secondly, by studying the effect of a negative shock in human capital on agricultural performance, this article also contributes to the growing literature that looks at the determinants of agricultural productivity and transformation (Bharadwaj and Ali Mirza, 2019; Parman, 2012; Conley and Udry, 2010).

Future research should focus on studying the effect of similar shocks in different contexts and on the trickle-down effects that these phenomena had beyond the immediate ones in the agricultural sector. For instance, given the critical role of agricultural productivity in fostering growth that the literature has emphasized (Bustos, Caprettini, and Ponticelli, 2016; Fiszbein, 2017), it would be essential to study whether and how this type of shocks impacted the processes of urbanization and structural transformation.

Appendices

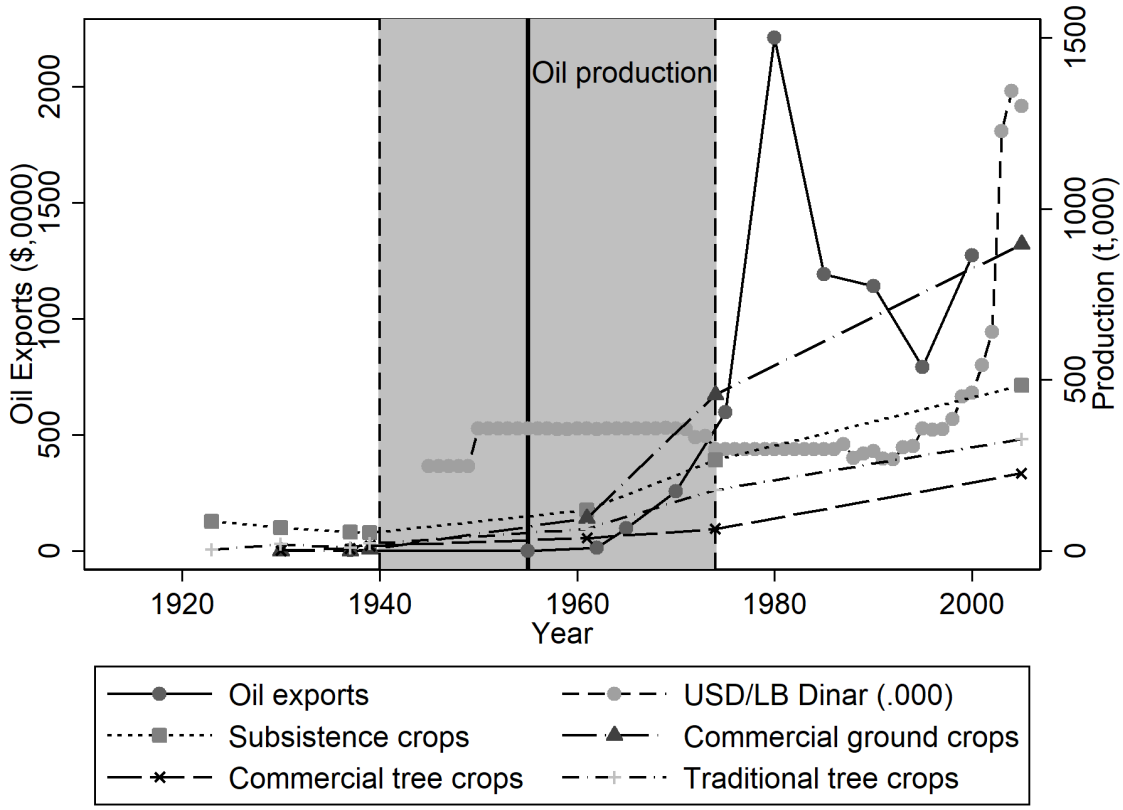
5.A Additional estimations and figures chapter 5

Table 5.A.1: Expulsions and agricultural performance, a DD approach

	Commercial district	Log USD/worker	Log agricultural share	Cereals Cwt/Ha
	(1)	(2)	(3)	(4)
Exp*Post	-0.161**	-0.363	0.331**	2.511***
	(0.0793)	(0.305)	(0.131)	(0.668)
Observations	138	138	138	135
R-squared	0.163	0.464	0.344	0.311
Number of FID	46	46	46	46
Baseline Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
District FE	YES	YES	YES	YES

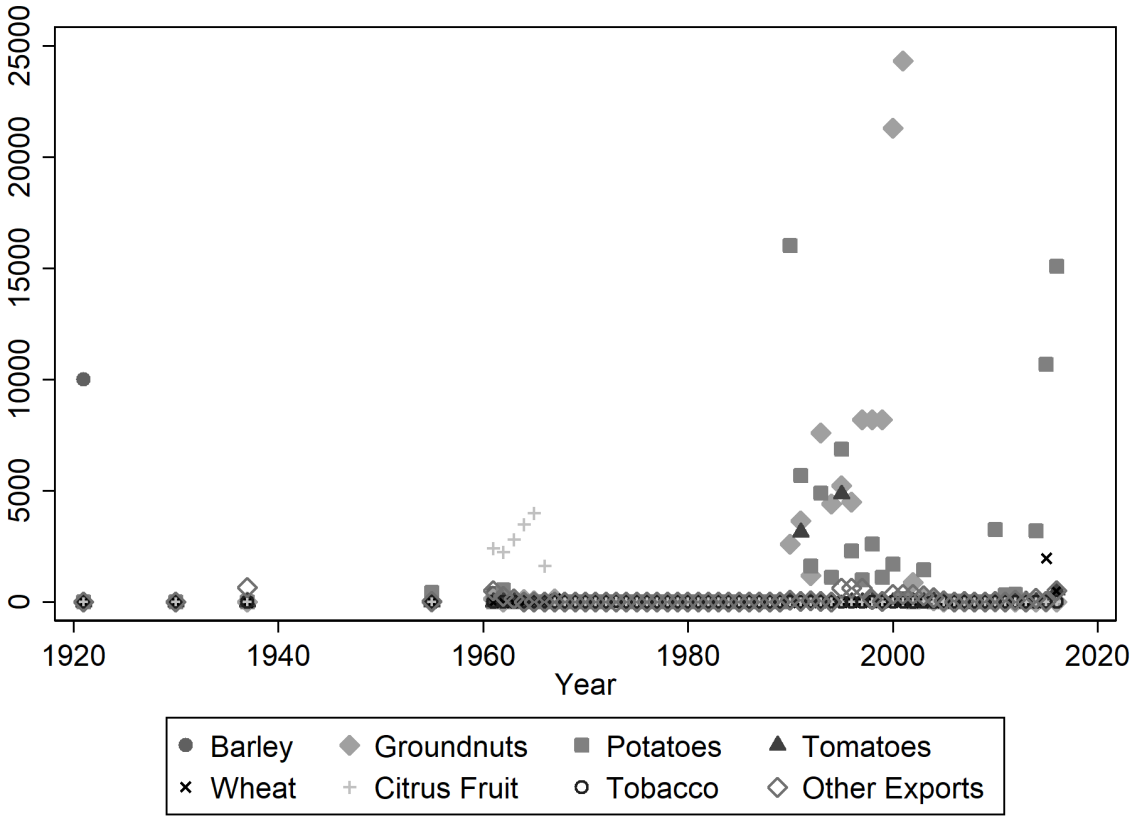
Difference-in-Difference estimates showing the coefficient of the interaction between a binary indicator for the region affected by the expulsion and the year following the shock. The two expulsions are stacked together, so the coefficients show the average correlation between the expulsions and the dependent variables. Other than changing the interaction terms, the model is the same as in equation (1). The dependent variable in column 1 is a binary indicator that equals one if a district produced more than 80% of its ground-crop nominal output from commercial crops. In column 2, instead, the natural logarithm of nominal output in 1982 dollars per agricultural worker is employed as dependent variable. In columns 3 and 4, the dependent variables are the natural logarithm of the share of agricultural workers over the total population and output of cereals in hundredweights per hectare, respectively. Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

Figure 5.A.1: Oil boom and agricultural production



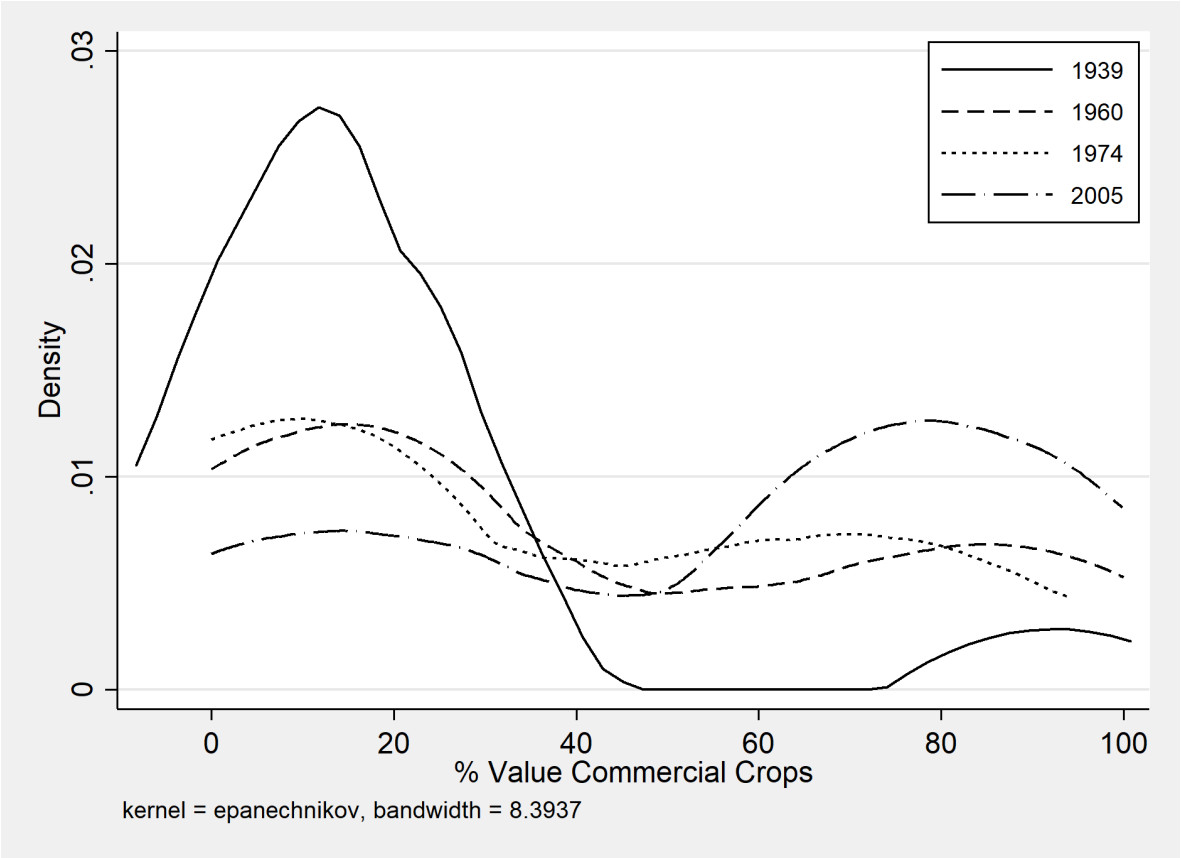
Note: value of Libyan oil exports in US Dollars (,000) and US Dollar to Libyan Dinar exchange rate (.000) on the left axis, relative to sectoral agricultural production in metric tonnes (right axis). The shaded area highlights the early post-colonial period, when the commercial transition took place. The vertical, solid line marks the first grant for oil extraction given to a foreign company in 1955, the beginning of the oil boom.
Source: Value of oil exports between 1962 and 2000 is from Feenstra et al. (2005), for 1955 is from United Kingdom of Libya (1956), while the 1937 one is from Ministero dell'Africa Italiana (1937b) (the key is "Bitumi"). Dollar/Dinar exchange rates were retrieved from the Global Financial Data Database (lastly accessed on 10/06/2019) and come from multiple sources. Agricultural production statistics come from multiple sources. For the years 1923, 1930 and 1937 I use aggregate production statistics for Tripolitania and Cyrenaica from the International Institute of Agriculture (Institute International d'Agriculture, 1925; International Institute of Agriculture, 1939). For 1939 the data are from the Italian Yearbook of Agriculture (Istituto Centrale di Statistica, 1948). For 1961, 1974 and 2005 the data were downloaded from FAOSTAT (Food and Agriculture Organization of the United Nations, 2012).

Figure 5.A.2: Exports (Tonnes) over time by crop



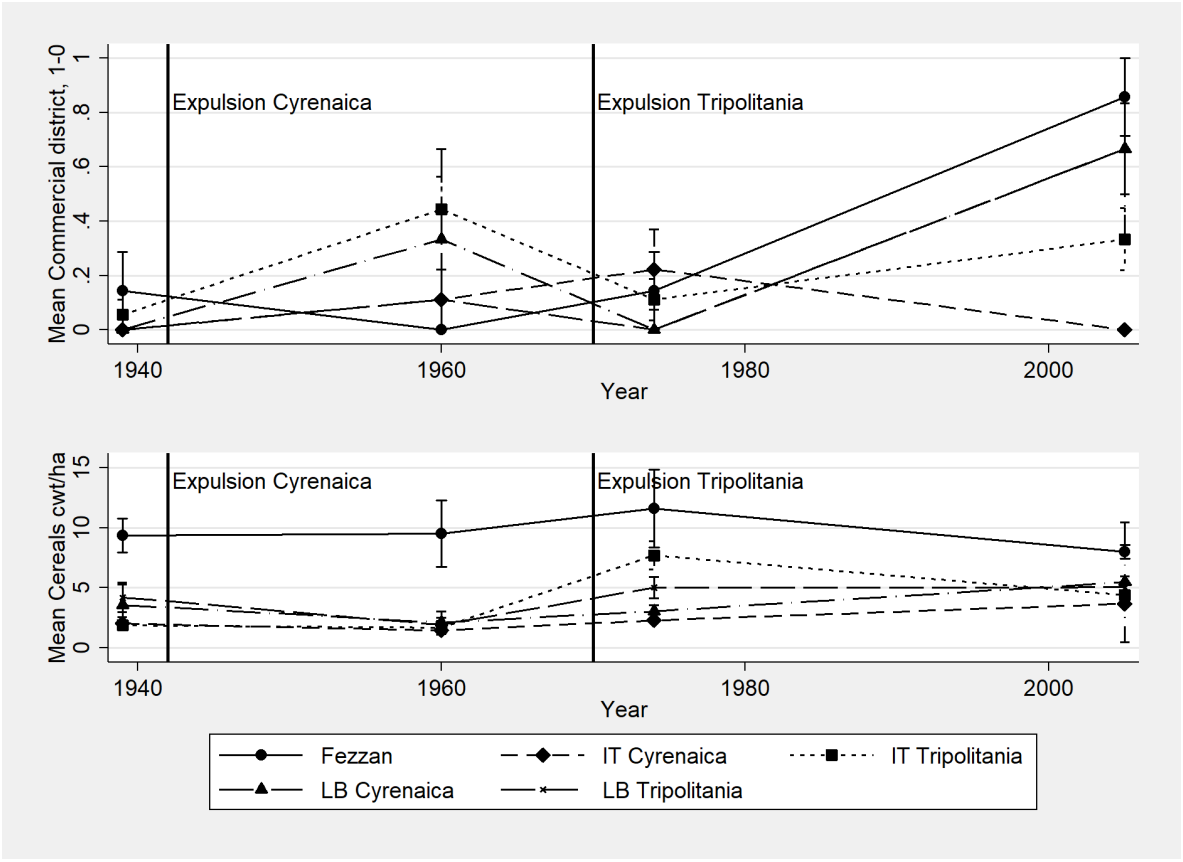
Note: exports of main agricultural products in metric tonnes.
Source: Data for 1921, 1930 and 1937 come from the Yearbooks of the International Institute of Agriculture (Institute International d'Agriculture, 1925; International Institute of Agriculture, 1939), the 1955 data come from (United Kingdom of Libya, 1956), while, after 1961, the data were downloaded from FAOSTAT (Food and Agriculture Organization of the United Nations, 2012).

Figure 5.A.3: Kernel distribution of value shares of commercial crops by year



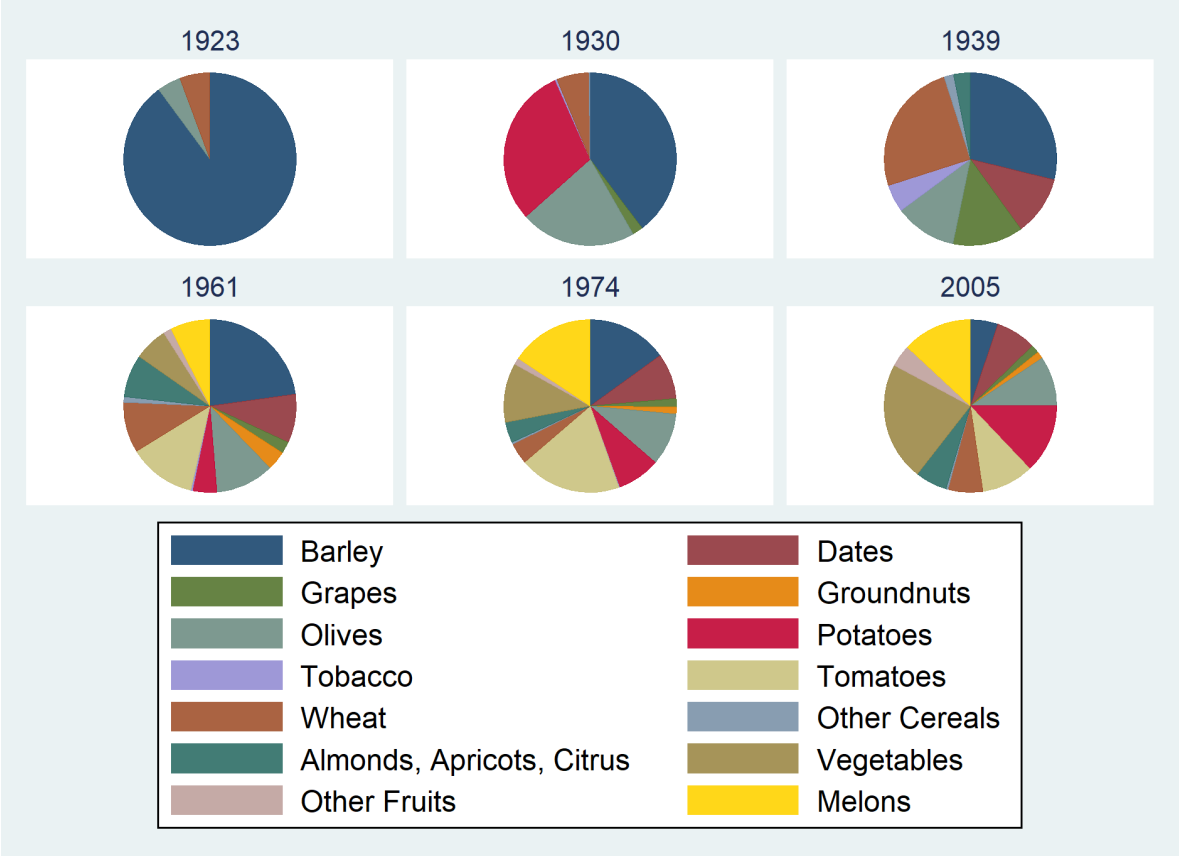
Note: the chart shows bimodal Kernel density distributions by year
Source: author's calculations, see Section 5.4 for details

Figure 5.A.4: Commercial shares by ethnic group and region



Note: top panel. Share of commercial districts (80% of nominal output from commercial crops) by ethnic group and region, with standard error bars. Districts are grouped as in Figure 5.1 and broken down both between Libyan and Italian and by region. Bottom panel. Average cereal yields (wheat, barley and maize) by group and region, with standard error bars. Districts are grouped as in Figure 5.1 and broken down both between Libyan and Italian and by region.
Source: author's own calculations, see Section 5.4 for details.

Figure 5.A.5: Production shares by product over time



Note: production shares by product type between 1923 and 2005.
Sources: for the years 1923 and 1930 I combine aggregate production statistics for Tripolitania and Cyrenaica from the International Institute of Agriculture (Institute International d'Agriculture, 1925; International Institute of Agriculture, 1939). For 1939 the data come from the Italian Yearbook of Agriculture (Istituto Centrale di Statistica, 1948). For 1961, 1974 and 2005 the data were downloaded from FAOSTAT (Food and Agriculture Organization of the United Nations, 2012).

Table 5.A.2: Robustness 1

Dependent variable:	Commercial district		Cereals Cwt/Ha		No Potato
	(1)	(2)	(3)	(4)	(5)
IT*Exp*Post	-0.415**	-0.468***	3.931**	3.738**	-0.290*
	(0.160)	(0.169)	(1.512)	(1.685)	(0.163)
IT*Post	0.366***	0.474***	0.405	0.580	0.343**
	(0.132)	(0.150)	(1.910)	(1.266)	(0.137)
Exp*Post	0.0493	0.0286	0.976	-0.500	0.0675
	(0.138)	(0.0597)	(1.371)	(3.361)	(0.124)
Log agricultural share	0.0289	-0.00321	0.363	0.914	0.00699
	(0.0513)	(0.0679)	(0.831)	(0.913)	(0.0606)
Log tractors/worker	1.351	2.680	48.05	63.95	3.347
	(2.193)	(2.290)	(45.96)	(43.70)	(2.264)
Observations	138	138	135	135	138
R-squared	0.329	0.385	0.409	0.429	0.754
Number of FID	46	46	46	46	46
Factors of Production	YES	YES	YES	YES	YES
Group*Year Trends	YES	NO	YES	NO	NO
Region*Year Trends	NO	YES	NO	YES	NO

Robustness tests based on equation 5.1. All columns include controls for factors of production. Column 1 includes group*time trends (Italian vs. Libyan districts); column 2 includes Region*time trends (Tripolitania, Cyrenaica, and Fezzan). Columns 3 and 4 replicate the estimates in columns 1 and 2, but with cereal yields as dependent variable. In column 5, potatoes are dropped from the sample, to check that the effect survives if the value of produced potatoes does not affect the distinction between subsistence and commercial ground-crops. Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

Table 5.A.3: Robustness 2

	Commercial district			Share of commercial output (USD)	Commercial district		Cereals Cwt/Ha	Cereals Cwt/Ha
	80%, baseline	70%	90%	districts > 20%	80%	80%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IT*Exp*Post	-0.499***	-0.334*	-0.230	-40.572**				
	(0.157)	(0.168)	(0.152)	(19.913)				
IT*Post	0.823***	0.813***	0.235**	73.412***				
	(0.138)	(0.157)	(0.114)	(8.456)				
Exp*Post	0.129	0.142	0.036	17.291	-0.036	-0.003	0.615	0.718
	(0.112)	(0.134)	(0.113)	(17.965)	(0.107)	(0.085)	(0.738)	(0.819)
IT*Exp*Post, land (>5%)					-0.180		3.515**	
					(0.152)		(1.347)	
IT*Post, land (>5%)					0.351**		0.279	
					(0.167)		(1.008)	
IT*Exp*Post, work (>5%)						-0.349**		4.178***
						(0.151)		(1.352)
IT*Post, work (>5%)						0.509***		-1.245
						(0.161)		(0.858)
Observations	184	184	184	86	184	184	180	180
R-squared	0.39	0.38	0.12	0.60	0.23	0.26	0.31	0.30
Number of FID	46	46	46	41	46	46	46	46
Baseline Controls	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES	YES	YES

Robustness tests based on equation 5.1. Columns 1 to 4 report estimates from a model identical to equation 5.1 1, but with alternative dependent variables. Column 1 is the baseline (see Table 5.1). Columns 2 and 3 employ 70 and 90% of nominal output's share from commercial crops to define a commercial district, as opposed to the 80% employed in the baseline. Column 4 has value share from commercial crops as a continuous dependent variable but restricts the analysis to those districts that produced at least 20% of the ground-crop nominal output from commercial crops throughout the panel. Columns 5 to 8 report estimates similar to equation 5.1 and with the same dependent variables of Table 5.1, but using different definitions of Italian districts. In columns 5 and 6 a district is considered "Italian" and, therefore, treated if Italian owners farmed at least 5% of the cultivated land. In column 7 and 8, I define as treated those districts whose labor force had a share of Italian workers of at least 5%. Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

Table 5.A.4: Prices of Main Agricultural Products

	1939	1960	1974	2005
Subsistence Crops				
Barley	2,28	2,38	6,38	9,15
Wheat	3,94	5,45	12,12	15,57
Oats	3,10	1,88	3,27	
Maize		3,37	6,38	11,93
Potatoes		3,69	2,61	14,18
Commercial Ground Crops				
Tobacco	7,50	11,75	25,31	70,71
Tomatoes		7,07	18,24	86,81
Peanuts		10,23		27,83
Melons		3,69	4,00	13,25
Vegetables		4,14	4,49	13,19
Fruit Crops				
Dates	1,89	0,34	11,73	6,76
Olives	3,26	20,68	6,69	26,51
Citrus Fruit	3,65	4,96	17,47	23,72
Apricots	7,99	4,14	4,24	21,47
Grapes	2,12	2,11	3,76	20,54
Almonds (No shell)	9,88	18,99	16,90	153,08

Wholesale prices per hundredweight of product in Tripoli, expressed in 1982 dollars. Prices in Tripoli are not available for all products and years. Some interpolations were necessary, see Appendix 5.B for the various sources employed. Prices in local currencies are exchanged to dollars with real exchange rates provided by Global Financial Database (various sources, lastly accessed on 10/06/2019) and then deflated using the Producer Price Index reconstructed and published by the Federal Reserve of St. Louis.

Table 5.A.5: Robustness 3

	Commercial district	Log USD/worker	Log output USD	Cereals Cwt/Ha
	(1)	(2)	(3)	(4)
IT*Exp*Post	-0.499***	0.797	1.249	3.864**
	(0.168)	(0.773)	(0.788)	(1.473)
IT*Post	0.778***	-0.375	-1.090	0.168
	(0.169)	(0.632)	(0.873)	(1.051)
Exp*Post	0.119	-0.887	-0.895	0.288
	(0.125)	(0.710)	(0.754)	(0.990)
Observations	156	117	156	154
R-squared	0.37	0.45	0.37	0.48
Number of FID	39	39	39	39
Baseline Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
District FE	YES	YES	YES	YES

Robustness tests based on equation 5.1. Columns 1 to 4 report the exact same estimates from Table 5.1, but exclude the southern region of Fezzan from the analysis (see Figure 5.1). Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

Table 5.A.6: Overall summary statistics

	mean	sd	min	max	N
	(1)	(2)	(3)	(4)	(5)
Commercial district, 1-0	0.207	0.406	0	1	184
USD/Worker	46.12	86.35	0	568.6	138
USD Ground Crops	797,236	2.143e+06	0	1.648e+07	184
Cereals Cwt/Ha	4.428	4.141	0.0129	26.81	180
IT*Exp*Post	0.147	0.355	0	1	184
Cyrenaica*Italian*1960	0.0489	0.216	0	1	184
Tripolitania*Italian*1974	0.0978	0.298	0	1	184
# Tractors/Worker	0.0121	0.0186	0	0.0983	138
% Labor in Agriculture	33.18	20.39	3.454	117.3	138
Population	43,268	62,190	2,098	479,472	184
Number of FID	46	46	46	46	46

Selected overall summary statistics for the main dependent variables and treatment

Table 5.A.7: Balancedness tests

Dependent variable:	IT*Exp*Post						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cereals Cwt/Ha = L,	-0.00422						
	(0.00739)						
Commercial district, 1-0 = L,		0.256					
		(0.171)					
Log USD/worker = L,			0.0200				
			(0.0421)				
Log output USD = L,				-0.0169			
				(0.0235)			
Population = L,					-4.36e-07		
					(1.55e-06)		
Log agricultural share = L,						-0.0802	
						(0.0723)	
Log tractors/worker = L,							3.617
							(2.559)
Observations	135	138	138	138	138	138	138
R-squared	0.190	0.226	0.198	0.198	0.196	0.207	0.211
Number of FID	46	46	46	46	46	46	46
Year FE	YES	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES	YES

Balancedness test with lags of the main outcome and control variables and combined treatment (locations treated in both expulsions) as dependent variables. The same fixed effects as in equation 5.1 are included in all regressions.

Table 5.A.8: Main panel data sources and their coverage

Data Source	Year	Cross-section	Information	Coverage	Location	Material type
Agricultural Survey of Libya (Ministero dell'Africa Italiana, 1939a)	1938-1939	1939	Cultivated land (Ha) and produced cereals (Cwt) for both Libyan and Italian farmers by village	Total of 256 villages. Some are reported but have no cereal production. Land productivity could be calculated for 182 only (matching inputs and outputs)	Archivio centrale dello stato (ACS) Rome.	Archival
Agricultural Census of Libya (Ministero dell'Africa Italiana, 1937a)	1937	1939	Labour (number of employees and managers), capital (buildings, irrigation facilities, animals, machinery) endowments and cultivation techniques by farm	Total of 839 Farms (all Italian farms in Libya), distributed across 89 villages	Archivio Storico dell'Istituto Agricolo d'Oltremare (IAO) Florence	Archival
General Population Census (Regno d'Italia, 1939)	1936	1939	Number of Libyans, Italians and foreigners living in each village by gender. Number of workers in agriculture over the total active population by district	Total of 337 villages and towns and 48 census districts	Istat online archive	Archival
Annuario Statistico dell'Agricoltura Italiana 1939-42 (Istituto Centrale di Statistica, 1948)	1939	1939	District-level output of tobacco, grapes, dates, almonds, apricots, citrus fruit and olives	19 districts with production different from 0	na	Published
Agricultural Census of Libya (United Kingdom of Libya, 1962a)	1960	1960	Ground-crops (grains, vegetables, fruit) and tree-crops output, cultivated land, machinery, use of irrigation, employed agricultural labor-force, land tenure system	150 districts, ("Mudirias")	na	Published
General population census of Libya 1954 (United Kingdom of Libya, 1959)	1954	1960	Population by gender	150 districts, ("Mudirias")	na	Online
Libyan Agricultural Census 1973-4 (Socialist People's Libyan Arab Jamahiriya, 1979)	1974	1974	District-level output of ground-crops (grains, vegetables, fruit), employed machinery and employed agricultural labor force	46 districts ("Baladiya")	David Lubin Memorial Library, FAO, Rome	Published
UNEP (United Nations Environment Program)	1970	1974	Population (total)	Entire sample	na	Online
SPAM (Spatial Production Allocation Model)	2005	2005	Yields and cultivated area for barley, wheat, maize, fruit and vegetable	Entire sample	na	Online
UNEP (United Nations Environment Program)	2000	2005	Population (total)	Entire sample	na	Online

Table 5.A.9: Italian presence and long-term trends

Dependent variable:	Commercial district		Cereals Cwt/Ha	
Region:	Tripolitania	Cyrenaica	Tripolitania	Cyrenaica
	(1)	(2)	(3)	(4)
Italian*Region*2005	-0.345**	-0.520***	1.454	0.580
	(0.163)	(0.0989)	(0.875)	(1.027)
Italian*Region*1974	0.0126	0.191	7.233***	-3.128**
	(0.110)	(0.149)	(1.859)	(1.263)
Italian*Region*1960	0.677***	-0.148	-0.0309	0.641
	(0.181)	(0.148)	(1.140)	(1.116)
Observations	184	184	180	180
R-squared	0.344	0.270	0.349	0.255
Number of FID	46	46	46	46
Baseline Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
District FE	YES	YES	YES	YES

Fixed effect model estimating the coefficients of the interaction between Italian presence (as in Figure 5.1) with regional dummies fro Tripolitania (1970 expulsion) and Cyrenaica (1942 expulsion) and year fixed effects. The year 1939 is the excluded reference group. Controls and fixed effects as in equation 5.1. Columns 1 and 2 have a binary indicator that equals one if a district produced more than 80% of its ground-crop nominal output from commercial crops, while columns 3 and 4 employ cereal yields per hectare as dependent variables (see Table 5.1). Errors are clustered at the district level in all specifications. *** p<0.01, ** p<0.05, * p<0.1

5.B Data appendix chapters 4 and 5 by year and source

1. *Pre-1939*

   Piccioli (1934). This source provides maps with the timing of the occupation of the Libyan hinterland for Tripolitania (p. 27) and Cyrenaica (p. 133), as well as information on the location of the major battles fought during the re-conquest of Libya between 1925 and 1932 (pp. 20-250). Major locations in in-text maps are digitized and linear distance from those is calculated for each village. It also provides information on land use and soil suitability before Italian occupation for Tripolitania (pp. 392-3) and Cyrenaica (pp. 536-7). All these maps are digitized in GIS and then combined with the village-level dataset.

   Camperio (1883). This source provides the location of pre-Italian tracks across Libya in 1883. These were digitized in GIS, and linear distances in kilometers are calculated.

   Klein Goldewijk et al. (2011). Reconstructed HYDE population in 1900 is employed to proxy for the pre-colonial population at the village level. The data come in a raster format (0.08x0.08 decimal degree cells). Population values are assigned to the village that falls within.

   Institute International d'Agriculture (1925). The source provides aggregate agricultural production for Tripolitania and Cyrenaica in 1923.

   International Institute of Agriculture (1939). The source provides aggregate agricultural production for Tripolitania and Cyrenaica in 1930 and 1937.

2. *1939*

   Agricultural Survey of Libya 1938-9 (Ministero dell'Africa Italiana, 1939a). Cultivated land in hectares (Ha) and produced cereals (barley, wheat, and oats) in hundredweights (Cwt) for both Libyan and Italian farmers by village. A total of 256 villages was reported, but due to missing data inputs and outputs could be matched for 182 villages only. Location: Archivio Centrale dello Stato (ACS), Rome. Folder MAI/685.

   In theory, for each village or group of villages, four distinct sheets exist. The survey, in fact, was conducted in a fashion that would yield four distinct sheets for each village (or group of villages), two for cultivated land for both Libyans and Italians (from fall/winter

of 1938) and two others with harvested quantities of cereals for both Italian and Libyans (from spring/summer 1939). The sheets should show a 0 if no production of a certain ethnic group was being carried out in a certain village, but in a few cases, some of the sheets are missing. In this case, a 0 is reported. Only villages with both input and output for the same ethnic group (Italian and Libyan) in a certain village are used for the analysis. If data for a certain village exist but the location could be found neither through coeval maps (Piccioli, 1934) nor through gazetteers, the village is dropped from the sample.

The archival documents required two additional judgment calls. Whenever information is reported at different levels of disaggregation (both a sheet reporting village-level production and a municipal-level one exist), the most disaggregated one is selected. The alternative version is only used as a sanity check for total production. Secondly, there are typically two copies for each sheet (some were either not delivered, or lost), with partial data at different points in time during the agricultural year, which probably reflects heterogeneous timings in harvesting operations across Libya. The sheet with the latest date (which is typically also the one with the larger figure for production, unless corrections were made) is used.

Production is normally reported in hundredweights. When Libyan production is reported in local units of measurement, the equivalences provided on the survey sheets were employed to convert figures into hundredweights. Table 5.B.1 reports the employed equivalences.

Table 5.B.1: Weight equivalences (Ministero dell'Africa Italiana, 1939a)

Unit Name	Barley (kg) (1)	Wheat (kg) (2)
SAA	60	90
Keila (Northen Libya)	60	100
Keila (Fezzan)	9	9
Marta	12	16
Kantar	56.5	56.5

Agricultural Census of Libya 1937 (Ministero dell'Africa Italiana, 1937a). Firm-level data (total of 839 farms) covering all Italian farms in Libya up to April 1937. This

reports information on the location, total extension, the type of cultivation (dry, irrigated and semi-irrigated), the employed labor (split by Italian managers, Italian workers and Libyan workers), the type, size and number of buildings, number of fruit-trees (grapes, almond, olive and "other" trees) the water-lifting equipment (types of pumps), the machinery (by type) and the livestock (by type) for each farm. The firm-level data were aggregated at the village level by matching the location name with the villages in the agricultural survey (Ministero dell'Africa Italiana, 1939a). Location: Archivio Storico dell'Agenzia Italiana per la Cooperazione e lo Sviluppo (ASAIC), Florence.

Annuario Statistico dell'Agricoltura 1939-42 (Istituto Centrale di Statistica, 1948, p. 506). This source provides, for 1939, total tobacco, grapes and fruit-tree (apricots, almonds, olives, citrus fruits, and dates) productions at a district (municipal) level for both Libyan and Italian producers. A total of 19 districts are reported. I use the same source to calculate total Libyan agricultural production by crop and crop type in 1939. Data for the southern region of Fezzan are missing, so a value of 0 is given to all districts in the area. Whenever possible, if data for 1939 are missing, I interpolate production with the 1938 data from (Istituto Centrale di Statistica, 1940, pp. 510-1).

As some municipalities in Cyrenaica and Tripolitania are not reported, but aggregate production at the provincial level is provided, I split the residual production at the provincial level evenly between missing municipalities. The latter are identified (and geo-located) by matching the ones reported by the source with the maps contained in the Population Census of 1936 (Regno d'Italia, 1939, pp. 16-17)

These are Mizda and Nalut for the Tripoli province, Beni Ulid, and Sirte for the Misurata province, Apollonia, Tobruch and Porto Bardia for the Derna province.

Finally, to match 1938-9 data with the post-colonial districts employed in the triple difference analysis, I split production equally between districts when multiple 1974 districts (Socialist People's Libyan Arab Jamahiriya, 1978) fall into the territory of a former Italian municipality (32 districts in 1939 vs. 46 in 1974).

General Population Census 1936 (Regno d'Italia, 1939). This source provides total population by gender, separately for Libyans and Italians, for a total of 337 locations across Libya (all permanent settlements). Moreover, the census also provides information at the census-district-level (total of 48 districts) on the occupational structure of

the active population in each district.

1936 census districts and 1974 administrative ones mostly overlap. On two occasions, I merge two 1936 districts into one.

Capresi (2007). This unpublished thesis provides consistent quantitative information on the population and the cultivated area of the settlements developed during the intensive demographic colonization phase, namely between 1938 and 1940. This source complements the information from the other sources that only cover settlement until 1937. The information provided is cross-checked and interpolated when necessary with (Cresti, 2011).

Bollettino Statistico dell'Africa Italiana (Ministero dell'Africa Italiana, 1939b, p. 17). The source provides wholesale prices for the main agricultural products in the Tripoli market. The average price is taken. Missing prices are interpolated with the information contained in (Istituto Centrale di Statistica, 1948) for 1939 for selected southern Italian markets. The prices of oats, olives, and tobacco are approximated with those for Foggia, Salerno, and Benevento, respectively. These are used to calculate nominal output in 1939.

3. *1960*

Agricultural Census of Libya 1960 (United Kingdom of Libya, 1962a). The source provides rich granular data for a plethora of variables. Only selected ones were collected. These are:

1) Cultivated land and output by field crop (barley, wheat, maize, millet, and sorghum), irrigation technique (dry farming and irrigated) and land tenure system (tribal communal system and private property). 150 districts are reported (townships "Mudiria").

2) Cultivated acreage and output for the following non-grain crops: groundnut, castor beans, tobacco, tomato, potatoes, melons, and watermelons, which constitute the bulk of agricultural production.

3) Number of tractors (both wheel and track-laying ones), number of holdings reporting the use of inorganic fertilizer (for Tripolitania only) and number of electric generators.

4) Number of workers in agriculture by gender.

The data are geolocated by matching each district with its capital and then collapsed at the 1974 district-level.

Population Census 1954 (United Kingdom of Libya, 1959). The source provides population by gender for all the 150 districts reported in the 1960 agricultural census.

Statistical abstract of Libya 1958-1962 (United Kingdom of Libya, 1962b). The source provides average wholesale prices for agricultural products in Tripoli in 1962 (p. 90). These are used to calculate nominal output in 1960.

FAOSTAT (Food and Agriculture Organization of the United Nations, 2012). The source provides aggregate agricultural production for Libya in 1961 (earliest year available). Prices for the same source are not available for Libya in the 1960s. Therefore, producer prices for Tunisia in 1966 are employed instead, for those commodities that were not reported in (United Kingdom of Libya, 1962b), namely for melons, vegetables, tobacco, and oats. These are used to calculate nominal output in 1960.

4. *1974*

Agricultual Census of Libya 1974 (Socialist People's Libyan Arab Jamahiriya, 1979). The source provides information for 46 districts ("Baladiya"). A map with the corresponding districts is reported in the 1978 Atlas of Libya (Socialist People's Libyan Arab Jamahiriya, 1978). The following information is collected.

1) Cultivated land and output in hundredweights by field crop (barley, wheat, maize, millet, and sorghum) by irrigation type (dry vs. irrigated).

2) Total production in hundredweights of sugar cane, tobacco, groundnut, melon, watermelon, and potato.

3) Number of tractors (one type only) and number of employed workers in agriculture by gender.

UNEP 1970[53]. The source provides the total population in raster format (cells 0.04 x 0.04 decimal degrees). Raster cells' values are collapsed at the 1974 district-level.

Statistical abstract of Libya 1972 (Libyan Arab Republic, 1974). The source provides average wholesale prices for Tripoli in 1972. These are used to calculate nominal output in 1974.

[53] Available at http://na.unep.net/siouxfalls/datasets/datalist.php, last accessed on the 20th of April 2019

FAOSTAT (Food and Agriculture Organization of the United Nations, 2012). The source provides information on aggregate agricultural production by product in 1974. From the same source, I download prices for selected agricultural products not contained in (Libyan Arab Republic, 1974). As FAOSTAT does not report prices for Libya in the 1970s, I use average 1974 producer prices in Tunisia for the following products: potatoes, melons, vegetables, tobacco, and oats.

5. *2005.*

SPAM 2005 (International Food Policy Research Institute (IFPRI) and International Institute for Applied Systems Analysis (IIASA), 2016). The source provides data on cultivated area and yields for barley, wheat, maize, other cereals, groundnut, vegetables, and fruit and can be downloaded in raster format from the SPAM Project website with raster cells measuring 0.08x0.08 decimal degrees.

UNEP 2000[54]. Total population in raster format (cells 0.04 x 0.04 decimal degrees). Population values are collapsed at the 1974 district-level.

FAOSTAT (Food and Agriculture Organization of the United Nations, 2012). The source provides information on aggregate agricultural production by product in 2005. From the same source, I download prices for all agricultural products in the dataset (Libyan Arab Republic, 1974). As FAOSTAT does not report prices for Libya in 2005, I use average 2005 producer prices in Tunisia for all products.

[54] Available at http://na.unep.net/siouxfalls/datasets/datalist.php, last accessed on 20th of April 2019

Chapter 6

Conclusion

This thesis has explored the micro-level effect of two flagship policies implemented by the fascist government of Benito Mussolini in Libya and the Horn of Africa during the 1930s. Namely, it has studied the effect of road building in Eritrea, Ethiopia and Somalia on the distribution of the economic activity across the region, the effect of Italian agricultural settlement on the Libyan farming sector and, finally, the changes that the expulsion of Italian farmers, after the end of the colonial era, triggered in the primary sector. A novel dataset, constructed with comprehensive, newly collected data from both primary printed and archival sources, has allowed analyzing the within-country effect of the aforementioned policies, with a degree of disaggregation that has unveiled localized patterns of change. The analysis has focused on both the short and long-term effects of Italian colonial investments.

Three main sets of results have emerged from this study. Chapter 3 has shown how locations that were connected to the paved road network constructed by the Italians, after the occupation of Ethiopia in the late 1930s, are, still today, the most populated and wealthy. The higher density equilibrium created during the colonial period, in fact, remained stable throughout the post-colonial period despite the construction of a plethora of new roads. The resilience of this new spatial equilibrium was possible through faster urban growth in the proximity of Italian road infrastructure, which allowed to take advantage of increasing returns to scale, thus counteracting dispersion forces, linked to the loss in the comparative advantage in transportation.

Second, the settlement of Italian farmers in Libya during the 1930s, the focus of Chapter 4, led to a substantial reduction in Libyan cereal yields in indigenous villages surrounding Italian clusters. The results suggest that this effect was driven by a drain on mobile resources,

namely workers and camels, caused by Italian settlers. The reduction in the availability of factors of production forced the remaining Libyan peasants to adopt land-extensive cultivation. Evidence on the extent to which this negatively affected Libyan living standards is scarce, due to a lack of disaggregated data. A tentative analysis of the available quantitative information, however, suggests that the drop in yields before and after Italian settlement was substantial and that land-extensive cultivation might have only mitigated an inevitable drop in living standards.

Third, the analysis of the effect of the two separate expulsions of Italian farmers from the "Fourth shore", performed in Chapter 5, sheds light on the effect of the removal of European farming elites from erstwhile colonies. The results pinpoint a twofold effect. On the one hand, the level of commercialization, namely the share of agricultural output from commercial crops, markedly declined in districts affected by the expulsions. On the other hand, cereal yields increased significantly, in particular, when high prices linked to the oil-boom-led growth stimulated production. The results point at a pivotal role of human capital in explaining the described effects, which in turn suggests a central role of literacy and skills in inducing commercialization in the agricultural sector.

6.1 Implications

In this section, I will not repeat the specific conclusions and contributions outlined separately in each of the substantive papers. Instead, I will draw some more general implications that emerge from the combined pieces of evidence included in this thesis.

A first general implication of the outlined results is that Italian colonial policies generally altered the economic landscape across the territories of Libya and the Horn of Africa, both by the force of their immediate impact as well as through the permanent nature of the changes they caused. As such, the described findings add further evidence hinting at the importance of considering colonial investments and policies to make sense of post-colonial development in Africa. Furthermore, they call for a re-assessment of the importance of the Italian colonial experience for both the comparative history of colonialism and for the economic history of former Italian colonies. The legacy of Italian policies, in fact, is still alive in erstwhile Italian colonies today. Locations in the Horn of Africa that were given access to the road network in the 1930s are still the most developed, while Libyan districts affected by Italian farming in the

colonial era and later hit by their expulsions are the least commercialized today. Similarly, Italian farming brought about significant changes in traditional cereal production only a few years after the start of the Italian settlement during the colonial era, likely undermining Libyan living standards in the countryside. While an overall evaluation of whether colonial policies were positive or negative for colonized countries is neither in the interest of the author nor feasible given the lack of suitable counterfactual scenarios, the fact that Italian investments led to significant localized effects is a well-established fact from the gathered evidence.

A second general implication of this study is the importance of looking at types of colonial investments different from the ones generally considered by the empirical literature in the field, which typically focuses on railways, missionary activities, and welfare provision, to fully understand the effect of colonialism on former colonies. This thesis has shown how both road building and agricultural settlement altered the economic dynamics in former Italian colonies. Although these two types of investments had been particularly central to Italian colonial development plans, they were by no means exclusively implemented in Italian territories but were rather widespread across Africa (and around the globe). Furthermore, several other African countries were affected by targeted expulsions of European farmers during the post-colonial era. On the one hand, these findings call for a renewed consideration of the effect of investments in road construction and agricultural development similar to the Italian ones in comparable settings elsewhere in Africa. On the other hand and more generally, these results also stress the importance of not limiting the ongoing research to the more mainstream and measurable types of colonial investments (such as railroads and missions), for which extensive empirical evidence already exists. Colonialism was a more multi-faceted phenomenon than sometimes suggested and the various channels through which this affected colonized societies should be explored in depth. Data collection is challenging, but the implications for the economic history of colonialism are far-reaching.

Third, from a methodological perspective, this thesis emphasizes how the use of historical settings (and in particular colonial ones) as quasi-natural experiments to identify causal links between variables and events can be a fruitful exercise in social science. This type of analysis, in fact, can have implications that go beyond context-specific case studies. This research has shown how the Italian colonial setting is suitable to address relevant development issues, such as the effect of roads on agglomeration in developing countries in both the medium and long run, the impact of the settlement of farming elites in settings with an inelastic supply of labor

and, finally, the effect of the removal of the most educated and skilled farmers from developing countries. While each of these sets of results has specific implications and limitations to the generalization of the findings, as discussed in each substantive chapter, the general lesson from this exercise is that careful historical research can provide valuable lessons for policy-making in the present.

Fourth, this thesis has also stressed the importance of a micro-level approach to the study of colonial investments, in line with the recent cliometrics literature in African economic history and comparative development. All the findings of this thesis, in fact, stem from the analysis of within-country heterogeneity, which was only possible thanks to the collection of new granular data. The outlined spatial patterns would have been difficult to identify even with a regional analysis approach, common in the historical economic geography literature (Rosés and Wolf (eds.), 2019). At the same time, macroeconomic events should not be overlooked when dealing with the micro-economic impacts of policies. The third substantive paper of the thesis, for instance, offers an example of how through a difference-in-difference design that incorporates the oil boom into the analysis, the two components can be considered together, thus providing a more comprehensive view of the patterns of change and their determinants.

6.2 Limitations and future research

This thesis has strived to gather existing evidence serving three primary purposes. First, to provide convincing causal estimates for the effect of the described colonial policies. Second, to plausibly identify the mechanisms that explain the causal effects. Third, to describe change over time and, thus, avoid a "compression of history" (Austin, 2008b). The performed analysis confidently addresses these three objectives for each of the three substantive papers, thanks to the combined use of micro-level data and appropriate econometric techniques. However, this work has significant limitations, and these should be considered both when reading this thesis and when thinking about potential avenues for future research, which I briefly sketch in this section. I organize the discussion of these limitations around three core problems that I have encountered throughout my work, namely data limitations, the importance of a comparative perspective and the challenges posed by the lack of counterfactual scenarios.

First, data limitations always impose constraints on economic history research, either

because these are unavailable or because they are costly to collect. This problem is particularly daunting, however, when dealing with African economic history, for which pre-colonial data on development and living standards are often non-existent, while colonial and post-colonial ones are patchy and not necessarily reliable (Jerven, 2013). In my research, data constraints chiefly limited the accuracy in the analysis of the mechanisms through which investments affected the economic landscape of erstwhile Italian colonies. In the first substantive paper, for instance, information on the distribution of agricultural and manufacturing firms across the territories of the Horn of Africa and over time would have allowed studying the effect of colonial roads more precisely. What type of agglomeration economy did transport infrastructures create? Were the areas of higher density equilibrium characterized by structural transformation, or was this a case of "urbanization without industrialization" (Gollin, Jedwab, and Vollrath, 2016). In the second substantive paper, the lack of information on factors of production in Libyan villages and of granular level data on fruit tree cultivation prevented a precise calculation of agricultural productivity (for instance Total Factor Productivity) that would have allowed a more accurate description of the difference in production efficiency across Libya, thus incorporating systematic differences in labor and capital intensity (Federico, 2005, pp. 74-5). Moreover, the analysis of the implications of the Italian settlement for Libyan welfare was limited by the scarce information on cereal yields and acreage for pre-Italian Libya, as well as, by the virtually non-existent data on the magnitude of migrants' cash remittances. The conclusions on the implications of Italian settlement on Libyan living standards should only be considered as tentative. Finally, in the third paper, the analysis did not address the extent to which Italian expulsions and the induced changes in agricultural production affected structural transformation and urbanization across Libya. This part of the story is particularity relevant for the Libyan case study, due to the coincidence of the expulsions[55] with the oil boom. Additional research in this direction is both possible and promising but will require the collection of additional data from multiple sources (such as population and industrial censuses) and, as such, was beyond the scope of this thesis that aimed to focus specifically on the agricultural sector instead.

A second more conceptual limitation of the described analysis relates to the fact that the thesis is composed of a collection of case studies that lack a systematic comparative approach with regard to other colonial settings. In other words, it would have been fruitful to examine

[55]Specifically the 1970 expulsion from Tripolitania that was implemented by Gaddafi

and compare the effect of policies similar to the Italian ones in different countries. In fact, while to a certain extent the identified causal effects, as well as the mechanisms, have external validity (provided that comparable conditions are in place), a more comparative approach would have provided sounder empirical evidence for a generalization of the results and, possibly, some interesting additional insights on the heterogeneous effects of the selected colonial policies. In this respect, my work has been limited by the lack of existing empirical work and datasets on former Italian colonies, which required context-specific studies before proceeding with relevant comparisons. This issue is particularly relevant for the part of my thesis that looks at the effect of Italian agricultural settlement and the expulsion of European farmers in Libya. Two main avenues of research exist in this direction. First, it would be interesting to compare the dynamics triggered by the Italian agricultural settlement in Libya with other countries that experienced European farming across Africa. Two apparent comparisons would be Tunisia and Algeria, which experienced comparable patterns of settlement in similar environmental conditions. Extending the validity of the Libyan results to these countries would be a fruitful exercise in the attempt to better understand how settler economies affected indigenous farming across North Africa. Furthermore, although land grabbing dynamics in sub-Saharan Africa are very different, it would also be essential to explore the micro-level effect of European settler farming on indigenous productivity, for instance, in Zimbabwe, Kenya, and South Africa. The existing research is outdated and typically relies on aggregate data. Second, the expulsion of Italian farmers was not an isolated case in African history, and Kenya, Algeria, and Zimbabwe come to mind as some of the most relevant parallels. Regrettably, there is a lack of quantitative research on the subject, despite the importance of the phenomenon for African economic history. It would, therefore, be important to study the effect of the expulsions of farming minorities on agricultural productivity and regional patterns of growth for other African regions, to be able to draw comparisons with the Libyan case study.

Finally, a third significant limitation of this research is that it does not fully incorporate a counterfactual history of Italian colonial policies in Africa. This issue, which has been most coherently outlined by Heldring and Robinson (2012), refers to the difficulty, intrinsic to the study of the effect of colonialism, in identifying causal effects linked to colonial policies in the absence of relevant comparisons and counterfactual scenarios. In other words, one empirical challenge relates to the understanding of what would have happened to colonized

countries had colonialism never taken place. This problem is challenging, as the history of Africa does not feature countries that were completely unaffected by colonialism, with the only partial exception of Ethiopia and Liberia. Although the within-country approach of this study allows the use of locations unaffected by colonial policies as a suitable counterfactual (control group), more research in this direction would constitute a natural improvement of this work. This exercise should focus on the question of what policies would have been implemented in the absence of colonial occupation and whether these would have targeted the needs of the indigenous population more effectively. In other words, it should try to understand what the within-country developmental trajectory would have been in the absence of colonial policies. One promising starting point in this sense is the counterfactual exercise, attempted in the second substantive paper, regarding the welfare effect that Italian farming had on Libyan living standards, by means of comparing pre and post-Italian settlement yields. A more comprehensive data collection for the period preceding Italian settlement (perhaps using Turkish sources) would allow a sounder measurement of the phenomenon as well as the identification of heterogeneous effects across the country. By contrast, in the case of Ethiopia, a question regarding the optimality of the roads' allocation applies. Would the independent Ethiopian government have been able to develop transport infrastructure in the absence of Italian occupation? If so, would have the allocation of the investments been more effective in providing infrastructure more tailored to the needs of the Ethiopian economy, instead of serving the strategic purposes of the colonial government? Future research should address these questions.

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