

IS THE MAFIA RESPONSIBLE FOR TECHNOLOGICAL BACKWARDNESS IN SICILY? AN ANALYSIS
FROM THE UNIFICATION OF THE KINGDOM OF ITALY (1861) TO 1913

by

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Abstract. In this paper we study how the presence of Mafia may have affected technological progress in Sicily. In particular we investigate if the presence of this criminal organisation may explain the technological backwardness recorded in Sicily, and among the Sicilian municipalities, from the unification of the Italian Kingdom (1861) up to 1913. We found empirical evidence that the strengthening of the mafia begun in 1894, date of the dissolution of the socialist Peasant Fasci organizations. Moreover this criminal association flourish in the illiteracy, that constitutes a constraint of technological progress. In conclusion, the Mafia in Sicily has hampered the process of technological development since 1894.

JEL classification: N93, O31.

Keywords: Economic Growth; Instrumental variable approach; Patents history; Sicilian Mafia; Technological Development.

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1. INTRODUCTION.

This paper investigates how ~~the role played by~~ the criminal organization named Sicilian Mafia¹ (here in after Mafia, for shortness), ~~to demonstrate~~ may contribute to explain the technological under-development of ~~the region of South of Italy~~ Sicily, from the unification of the Italian Kingdom (1861) up to 1913. In particular, this research wants to explain how the non uniform ~~different~~ intensity of Mafia presence, may contribute to explain the different levels of technological progress observed among the Sicilian municipalities since 1864 to 1913. ~~These different levels were measured through the creation of a new database on patents for Sicily at the municipal level for the period of analysis based on archival work.~~

The aims of this paper is to contribute to the stream of literature that investigate the relationship among crime, technological progress and growth, from an historical point of view. While the strong connection between the crime and growth has been extensively studied (Detotto and Otranto, 2010, Goulas and Zervoyianni. 2015, Raj and Kalluru, 2023), the impact of crime on technological progress has not been investigated in depth, with some notable exceptions (Caglayan *et al.*, 2021, Dimico *et al.*, 2017, Mirenda *et al.*, 2022, 2019).

The implementation of technological progress, by means of knowledge, is generally considered as one of the main determinants of economic growth and development (Gerschenkron, 1962, Landes, 1969, Rosenberg, 1982, Romer, 1990, Galor and Tsiddon, 1997, International Monetary Fund, 2018, Hornung *et al.* 2022). Nevertheless, in the economic literature little attention has been given to exploring the possible impact of the ~~Sicilian~~ Mafia on the technological backwardness of Sicily, with respect to other Italian regions.²

¹ Sicilian Mafia (commonly called *Cosa Nostra*) is a mafia-terrorist criminal organization present in Italy, especially in Sicily, and in several parts of the world. For the history of Sicilian Mafia see Lupo, 1993.

² See Acemoglu *et al.* (2020) for an updated and detailed survey on the causes of the economic underdevelopment of Sicily.

Recently Caglayan *et al.* (2021), using contemporary data, provided empirical evidence that criminal organisations (like the ~~Sicilian~~ Mafia) are harmful to technological progress.³ The presence of such criminal organisations distorts incentives by promoting rent seeking behaviour, and reduces the resources that can be allotted to finance R&D and innovation implementation (Dimico *et al.*, 2017, Mirenda *et al.*, 2022, 2019).

From a historical point of view Nuvolari and Vasta (2017, 2015b), in their research on the Italian provinces in the period 1861-1913, found evidence that the southern Italian regions are less developed from a technological point of view, in comparison with regions located in other areas of Italy.

There are no previous studies directly investigating the role of criminal organisation in explaining the technological backwardness of southern Italian regions. This issue has been studied indirectly by some scholars, who found evidence that in the south of Italy the productivity of firms is lower than in the rest of the country (Daniele and Malanima, 2007, Nuvolari and Vasta 2015b, 2017, Caglayan *et al.* 2021).

The problem is that the presence of the Mafia is a hidden phenomenon, not directly observable and difficult to measure (Le Moglie and Sorrenti, 2022).⁴ These difficulties in quantitatively measuring the influence of the Mafia were greater in the 1860s, when data were not systematically collected, especially those relating to crime rates. In the previous historical analyses of the roots and strength of the Mafia in Sicily (Buonanno *et al.* 2015, Daniele and Geys, 2015, Dimico *et al.* 2017, Acemoglu *et al.* 2020, Ferrante *et al.* 2021), two indicators were employed for the period immediately following the unification of the Italian Kingdom (1861). The first indicator is due to Damiani (1885) and is based on the 1880–85 parliamentary enquiry into the agricultural sector in Italy. The information regarding Mafia presence was

³ Le Moglie and Sorrenti in a recent paper states: “... mafia does not heavily invest in the professional, scientific, and technical sector (R&D), as it is highly professionalized and involves a very high level of competition and know-how ...” (Le Moglie and Sorrenti, 2022).

⁴ In recent times the presence of Mafia at municipal level has been estimated using the data of *city council dismissals (CCDs)* (Fenizia and Saggio 2024).

based on the answers of local state officials in each of the 162 Sicilian judicial districts and is useful to account for Mafia presence, in 1885, among the Sicilian municipalities. The second indicator of Mafia presence was elaborated by Cutrera (1900), a police official, and it ranked Mafia presence in 1900. It is based on the personal opinion and experience of this policeman, who assumed that the Mafia did not always behave in a criminal manner, and that not all the crimes committed by the members of this criminal organisation could be classified as mafia crimes.

Some scholars have stated that the Mafia grew as an answer of landowners against the Peasant Fasci movement, which demanded better living conditions (Acemoglu *et al.* 2020, Lupo 2023). The Sicilian Fasci Movement was an association of peasants claiming higher salaries and better living conditions, active from 1889 up to January 4th, 1894, when it was first declared illegal, and subsequently dissolved with a decree bearing the date of 17 January 1894, signed by the Extraordinary Commissioner for the Sicily regent of the Royal Prefecture of Palermo. With the same decree, the Fasci of the surrounding municipalities were also dissolved (Colajanni, 1895, Seton-Watson, 1967). As a direct consequence of this in previous literature it was claimed that in the Sicilian municipalities the Mafia grew stronger after the dissolution of Sicilian Fasci, as it became the reference point of landowners to defend their economic interests against the social and economic vindications of peasants (Bandiera, 2003), and to maintain and reinforce the rent position.

This is the first research that addresses the economic impact of Mafia on the technological development in Sicily for 50 years, from 1864 to 1913⁴. Another novelty of the paper is that the econometric analysis was performed using first-hand data on patents for Sicily, collected through archival work at municipal level:

. Moreover, there are no previous analyses to explain the different levels of technological progress among Sicilian municipalities as a result of Mafia presence. Finally, our research is in the wake of specific literature that consider the dissolution of Socialist Peasant

Fasci movement (1894) as one of the main reasons of the strengthening of ~~Sicilian~~ Mafia, after this data. Based on our econometric analysis it is possible to state that the ~~Sicilian~~ Mafia has represented a constraint to technological progress throughout the Sicilian cities in the period immediately after the unification of the Italian Kingdom. The main results are reinforced by the comparison of the effect of the Mafia presence before and after the dissolution of Fasci Movement.

The paper is structured as follows. After this introduction, Section 2 is devoted to a survey of literature on the origin and economic effects of Mafia. Section 3 investigates the relationship between the Mafia and technological progress in Sicily in an historical perspective. Section 4 describes the database used in the analysis. Section 5 focuses on the econometric strategy and results. Final remarks conclude the paper.

2. SURVEY OF THE LITERATURE.

Many scholars have investigated the origin and the economic impact of the Sicilian Mafia, as stated by Acemoglu *et al.* (2020), who wrote an updated survey of literature. For the aims of this research, ~~refer to the most important recent analyses on this topic~~ we illustrate the main analyses on the impact of Mafia on economic growth and technological progress ~~impact of Mafia from an historical point of view.~~

Bandiera (2003) affirms that the ~~Sicilian~~ Mafia have flourished on the island to protect land from theft by predatory bands since 1885, when public order and safety was insufficiently provided by the central State, and banditry in the countryside was widespread. Bandiera (2003) assumes that Mafia protection switched the robbers' attention to the landowners who did not pay for protection (i.e., *pizzò*). Bandiera (2003) using data reported in the 1880–85 parliamentary enquiry on Italian agriculture (Damiani, 1885), found evidence that at the end of the 19th century the rural mafia was in fact more likely to be active in municipalities ~~provinces~~ and areas where land was fragmented.

Buonanno *et al.* (2015) demonstrated that sulphur production is strongly and positively correlated with Mafia presence as measured by the Cutrera indicator in 1900 (Cutrera, 1900). Sulphur prices were rising from 1870 onwards, thus the Sicilian mine owners of sulphur this natural resource, earned high profits exporting their product worldwide. Their main argument is that a positive shock on the demand for sulphur, combined with weak institutions and law enforcement, created fertile ground for emerging criminal organisations like the Sicilian Mafia, who supplied private protection services to mine owners.

Dimico *et al.* (2017) found that Lind's scientific discovery, that scurvy may be cured by the citrus fruit, which is extensively cultivated in Sicily, may alone explain the origin of the Mafia in towns where citrus grove lands are located. The high revenues of citrus grove owners allowed them to pay the private insurance of the Sicilian Mafia to protect citrus production from theft. The Mafia also acted as intermediaries between producers and exporters, taking advantage of the institutional weakness. Dimico *et al.* (2017) employed the information reported in the 1880–85 parliamentary enquiry on Italian agriculture (Damiani, 1885), to show that Mafia presence is strongly related to the production of citrus fruit. These scholars also found evidence that the Mafia is mainly located in wealthy towns.

Acemoglu *et al.* (2020) emphasise the role played by the rise of the Socialist Peasant Fasci movement (i.e. *Fasci dei Lavoratori*), to explain the origin of the Sicilian Mafia at the end of the 19th century. In the presence of the weak rule of law, the *mafiosi* had an easy task of introducing themselves as a supplier of private insurance for landowners, estate managers, and local politicians to fight the claims of peasants demanding better living conditions. These scholars have shown that the location of the Peasant Fasci was significantly explained by a severe drought which affected Sicily in 1893. By using information on rainfall, they estimate the impact of the Peasant Fasci on the location of the Mafia in 1900. Acemoglu *et al.* (2020) found a negative and statistically significant correlation between Mafia, literacy and various public goods. Finally, these scholars provide empirical evidence that the results of political

elections were influenced by the Mafia, which could be one of the channels through which this criminal organisation affected local economic outcomes.

From an institutional point of view, Candela (2020) emphasise how the failure of Italy's unification process to secure the rule of law in Sicily at the end of the 19th century, may explain the reinforcement of the Mafia territorial diffusion ~~presence~~ and strength. Candela (2020) stated that institutional uncertainty due to the unification of the Italian Kingdom, which caused weak protection of property rights over land, raised the transaction costs of competing for resources through productive specialisation. In turn, it reduced the relative costs of competition for land ownership and the use of enforcement through other means, such as rent-seeking or organized crime.⁵

Nuvolari and Vasta (2017, 2015b) by using a dataset covering the period immediately after the unification of the Italian Kingdom, from 1861 to 1913 (the so-called “Liberal Age”), found a strong correlation between literacy and the number of “basic” registered patents (their intensity and duration), and between secondary technical education, scientific and engineering studies and “high quality” patents. The results of the empirical analysis of Nuvolari and Vasta (2017, 2015b) highlight that the role of patents seems to be more relevant than that of the availability of water-power and of the level of real wages. Nuvolari and Vasta (2015b, 2017) concluded their research emphasizing the prominent role played by patents to explain why Northern provinces were characterized by more effective innovation systems. This research presents an image of the Sicilian Mafia as an instrument in the hands of the upper class to maintain high income inequalities and restrict the growth and development of Sicily. These arguments are of help in explaining the duality of economic performance between the North and the South of Italy during the ‘Liberal age’ (Felice, 2019).

⁵ Daniele and Geys (2015) investigate how the legal institutions affect the influence of politically active criminal organisations on the human capital of elected politicians using data from over 1,500 Southern Italian municipalities in the period 1985–2011.

There is some research that using contemporary data investigates the impact of organized crime associations, such as the ~~Sicilian~~ Mafia, on the productivity of firms. For example, Albanese and Marinelli (2013) found a negative effect of organised crime on the ~~productivity~~ efficiency of Italian firms. Ganau and Rodríguez-Pose (2018) highlighted the relationship between the context in which Italian firms operate and their productivity, to conclude that organised crime has a negative impact on productivity, because it reduces the positive spill-over effects due to the creation of industrial districts. Caglayan *et al.* (2021) were the first to investigate how the ~~Sicilian~~ Mafia and similar kinds of criminal associations hinder technological progress, which is the most important condition for increasing productivity.⁶ Caglayan *et al.* (2021), using a first-hand dataset covering 46 provinces from northern Italy spanning the period between 2005 and 2012, supplied empirical evidence, in terms of the balanced-growth path in relation to the Solow model, highlighting that for a province with median mafia presence, a 10% increase in the mafia presence leads to a fall in output per-capita growth of 1.6%.

Slutzky and Zeume (2018), using data regarding Italian municipalities, covering the period 1995-2015, found that the policies against the Mafia, have increased the competition among firms, the innovation activity, and promote efficiency of public procurement auctions. They proved ~~have showed~~, that reducing the strength of organised criminal associations, Sicilian Mafia included, raises the efficiency of production process ~~level of competition and innovative capacity of firms~~, especially in the non-tradable output sector of economy.

Forgione and Migliardo (2023), using data coming from a survey conducted by the Bank of Italy, since 2009 to 2020, to measure the perceived fear of Mafia, found that the mafia's playing a relevant role in preventing backward regions from catching up with the rest of Italy in terms of productivity and R&D investment. This way confirming that in presence

⁶ Regarding the (negative) impact of the Mafia on the economic growth of Italian regions, see Pinotti (2013) and Barone and Narciso (2013). About the process of spreading of Mafia presence among regions see Buonanno and Pazzona (2014), Pinotti (2015), and Scognamiglio (2018).

of high crime rates the investment levels is lower, and the credit costs rises, as well as, corruption and bribery in the public procurement system. Finally, the expenses in technological progress seems to be negatively correlated with all the Mafia perception indicators (Forgione and Migliardo 2023, Pinotti, 2015).

The common trend of these research is that Mafia constitutes an obstacle for the economy as a whole, because obstructs the efficient allocation of input and output. The presence of such criminal association distort resources that could be used to promote technological progress and accrual knowledge to maintain rent seeking behaviour (Caglayan et al., 2016, Mocetti and Rizzica, 2021).

3. MAFIA AND TECHNOLOGICAL DEVELOPMENT IN SICILY: A HISTORICAL OVERVIEW.

To investigate the forces underlying the technological progress in Sicily, since the unification of the Italian Kingdom (1861),⁷ it is necessary to ask whether in this region there was the availability of the necessary resources and the social conditions to support the accumulation of technology and the implementation of innovation. Growth and development factors, such as the availability of large amounts of capital, a high level of education, infrastructure, natural resources and a strong rule of law. Input that in Sicily, were probably insufficient and inefficiently allocated, due to Mafia presence,⁸ and the weakness of the Sicilian ruling class.

Lupo (1993)⁹ stated the years after Italian unification (1861) highlighted the complexity of the origins and diffusion of the Mafia within and outside Sicilian borders.¹⁰ The senior leaders in the public service of the Kingdom of the Two Sicilies¹¹ were the first to

⁷ The Kingdom of Italy was established in 1861 and was ruled by the Savoia, one of the oldest dynasties in Europe, until 1946.

⁸ On measuring the presence of organized crime across Italian provinces see Bernardo et al. (2021).

⁹ Three fundamental works on the history of the Mafia are those of Lupo (1993), Dickie (2004), and Benigno (2015).

¹⁰ To put a name to the Mafia phenomenon was the popular comedy *I mafiusi di la Vicaria*, composed and staged in 1863 by Giuseppe Rizzotto and Gaspare Mosca.

¹¹ This name denotes the State formed in December 1816 with the unification of the Kingdoms of Naples and Sicily.

highlight the presence of conditions that the Mafia would exploit for social rent extract.¹² For example, the abolition of the feudal system approved in Sicily in 1812, and the reform of public administration completed in 1819, were implemented with such serious flaws that the new liberal regime of the Savoy (period 1861-1925, see Cammarano, 2005) was grafted *de facto* onto a feudal structure (Brancato, 1986).¹³

The Kingdom of the Two Sicilies, having scarce resources (Bastasin *et al.*, 2019), did not invest in infrastructures (Ciccarelli and Fenoaltea, 2008), nor in education (Cappelli, 2019, Martinez 2023), nor in justice system (Capussela, 2018). Three kinds of public expenditure they could have played a crucial role in promoting economic growth development, and the respect of rule of law. The Savoy (McIntosh, 2005) brought a centralized State, but not at the end of a gradual process. Reason why the less well-off social classes felt it as an imposition from above. Moreover, the State created in 1861 was not efficient. The expected economic and social reforms were never approved, because the aristocracy remained without political representation. The landowners were not sufficiently protected by the State, the peasant and working class were exasperated by the violent repression carried out by the authorities (Brancato, 1986). The Mafia, therefore, succeeded in capitalizing on the shortcomings of the new unitary State. This criminal organization exploited the opportunities ~~occasion~~ with exceptional timing and efficiency, because it had already existed, in an embryonic stage, for several decades (Felice, 2014).

Since the unification of the Italian Kingdom the mafia presence in Sicily, after its birth, became more and more strong ~~evident~~, especially in western Sicily, where the middle class was missing, with the lack of social actors who acted as intermediary between the

¹² In 1838 the Attorney General of the King, Pietro Calà Ulloa, considered Sicily “an anachronism in the European civilization” highlighting the lack of a middle class, thin population, absence of roads, trade, and industry, the arrogance of the aristocracy, and insolence of the people (Pontieri, 1965). In the same year of 1838, another Attorney General of the King, Giuseppe Ferrigni, noted how the reasons for the under-development of Sicily were the limitations of the middle class, extremely dependent on the aristocracy, the lack of public and private education, and the absence of a strong and independent judiciary (Nisco, 1908).

¹³ For the history of the Italian Royal House of Savoy see (McIntosh, 2005).

landowning aristocracy and peasants (Brancato, 1986). In the western part of the island, sulphur and citrus fruit were produced, stimulating the spread of the Mafia in Sicily (Buonanno *et al.* 2015, Dimico *et al.* 2017).¹⁴ Moreover, the socialist Peasant Fasci organizations were widespread in western Sicily and it played a crucial role in the Mafia strengthening at the end of the 19th century.

The Peasant Fasci organizations were active from 1889 to 1894 and were formed by workers, craftsmen, miners, and peasants calling for better working and living conditions, linked to the rising Socialist Party.¹⁵ After months of serious violence, in which Mafia action was significant, the ~~struggle~~ rebellion was bloodily suppressed and the leaders of the *Fasci* were arrested. On 4 January 1894 the head of the government, Francesco Crispi, a Sicilian himself, declared a state of emergency ~~siege~~ on the island: the *Fasci* were declared illegal, and subsequently dissolved. But the calm was only apparent, as latent and deep-rooted reasons for conflict persisted. Moreover, as pointed out by the politician Napoleone Colajanni, this did nothing more than create the most suitable conditions to make the Mafia organization even stronger (Colajanni, 1900), which, with the reaction against the socialist uprisings of the *Fasci*, acquired greater power and ~~new prestige~~ social consideration (Brancato, 1986).

A consequence of the new careful consideration of the Mafia that began to take place after the uprisings of the Peasant Fasci of 1893-94 was certainly the 1900 book by police officer Antonino Cutrera. Cutrera's book was prompted by the trial that followed the assassination (1 February 1893) of Emanuele Notarbartolo, former mayor of Palermo from 1873 to 1876, and then general manager of Bank of Sicily (*Banco di Sicilia*) from 1876 to 1890.¹⁶ Cutrera argued that “[...] we can't fight the Mafia with a simple measure, but with a series of laws and penal and administrative provisions, applied with serenity and rigor, for a long period [...]” (Cutrera, 1900). The thesis was not original, but the importance of Cutrera's

¹⁴ However, a rethinking of the link between the abundance of resources and the origins of the Sicilian mafia can be found in Ciccarelli *et al.* (2023).

¹⁵ On the *Fasci* see Romano (1959) and Renda (1977).

¹⁶ On the Notarbartolo crime see Lupo (1989-90).

work lies elsewhere, namely the preparation of a map showing the density of the Mafia in Sicily, which is very useful for our analysis in which the presence of the mafia has been investigated in connection with technological progress.

~~In this regard, it should first be~~ Cutrera (1900) states that Mafia behave as extortionists and criminal rent seekers, preventing the accumulation of savings (capital) that could be used in R&D activity (Lall, 1982, World Bank, 2008, Balletta and Lavezzi, 2023). Moreover, in developing and rural areas as a consequence of the poverty of the households, the Mafia may employ adolescents as peasants for a very low salary (see, among others, Franchetti and Sonnino 1876, Ciccarelli *et al.* 2023). This means that the children cannot attend school, to accumulate human capital, which is an essential condition for technological progress (Romer, 1990). When a criminal organisation behaves as a private insurer it takes an significant share of the rent created by the economic activities and obstructs an income distribution reflecting the productivity of input (Galor and Tsiddon, 1997). The Mafia was used by Sicilian landed nobility to keep peasant salaries low (sometimes, at a subsistence level), and to reduce competition within the economy (Gambetta, 1993, Wang, 2017). Moreover, this criminal association discourages direct foreign investment, which is unanimously recognized as a channel to spread technological progress¹⁷ (Daniele and Marani, 2011).

In Sicily, the Mafia experienced an increase in its strength and influence immediately after 1894 (Acemoglu *et al.* 2020, Lupo, 2023) as an answer of landowners to the Peasant Fasci movement, which advocated better living conditions for peasants. In an interesting novel set in the late nineteenth century in Caltagirone, a town close to Catania, is stated that: “... the notables and landowners of Caltagirone applauded the repression and dissolution of the Peasant Fasci movement, with the recommendation to go to the root of social unrest by

¹⁷ The diffusion within the provinces of the Sicilian Mafia reduces economic competitiveness and constitutes an obstacle to direct foreign investment that represents a channel for the spread of technological knowledge (World Bank, 2008).

abolishing primary education, so that farmers and miners could not, by reading, learn new ideas ... ” (Attanasio, 2018).

In the Italian pre-unitary states patent and intellectual property rights legislation was not a major concern. There was a very limited patenting activity: in the two major political units of pre-unitary Italy, that is the Kingdom of Sardinia and the Kingdom of the Two Sicilies, for instance, there was less than one patent per million inhabitants per year. In addition, the patent systems of the pre-unitary states were not particularly attractive for foreign inventors, due to the limited market prospects open to inventors, and the small size of the pre-unitary states of Italy (Nuvolari and Vasta 2019).¹⁸

Regarding the Kingdom of the Two Sicilies the characteristics of the internal market were one of the main reasons to explain the success or failure of the implementation of innovative technologies. Other decisive circumstances were the possibility of leveraging natural vocations, the relative lack of availability of technical expertise and capital, and the weakness of the institutions. The central State seemed to behave prudently to avoid product shortages or economic difficulties, due to the introduction of some innovation, that could change the economic and social equilibrium of the Sicily. The government of the Italian Kingdom tended to preserve the *status quo*, following a slower and more controlled, but also less dangerous, policy of technological change, which in its opinion was more appropriate for southern Italy (Lupo, 2017).

When using patents to measure the innovative capacity of the Sicilian provinces, the scenario is quite negative, and this confirms the backwardness even from the point of view of technological progress of southern Italy, concerning the regions located in the Centre and the North of the peninsula. Nuvolari and Vasta (2017) pointed out that the geographical distribution of the patenting activity in the ‘Liberal Age’ was characterized by a rather sharp geographical division indicating a triple division of Italy into North, Centre, and South. As

¹⁸ On the Italian patent system during the 19th century see Nuvolari and Vasta (2020).

early as 1864-65, Naples represented the only southern province with between 10 and 30 patents per million population (i.e., the same level as Milan, Genoa, and Florence, while only the provinces of Turin and Livorno performed better, with 100 to 300 patents per million inhabitants respectively). They were followed at a clear distance in the South by Bari, Lecce, Reggio Calabria, Palermo, and Messina, with between 0.1 and 5 patents per million inhabitants. The rest of the southern provinces all fell in an even lower range, that is, in the range of 0 to 0.10 patents per million inhabitants.

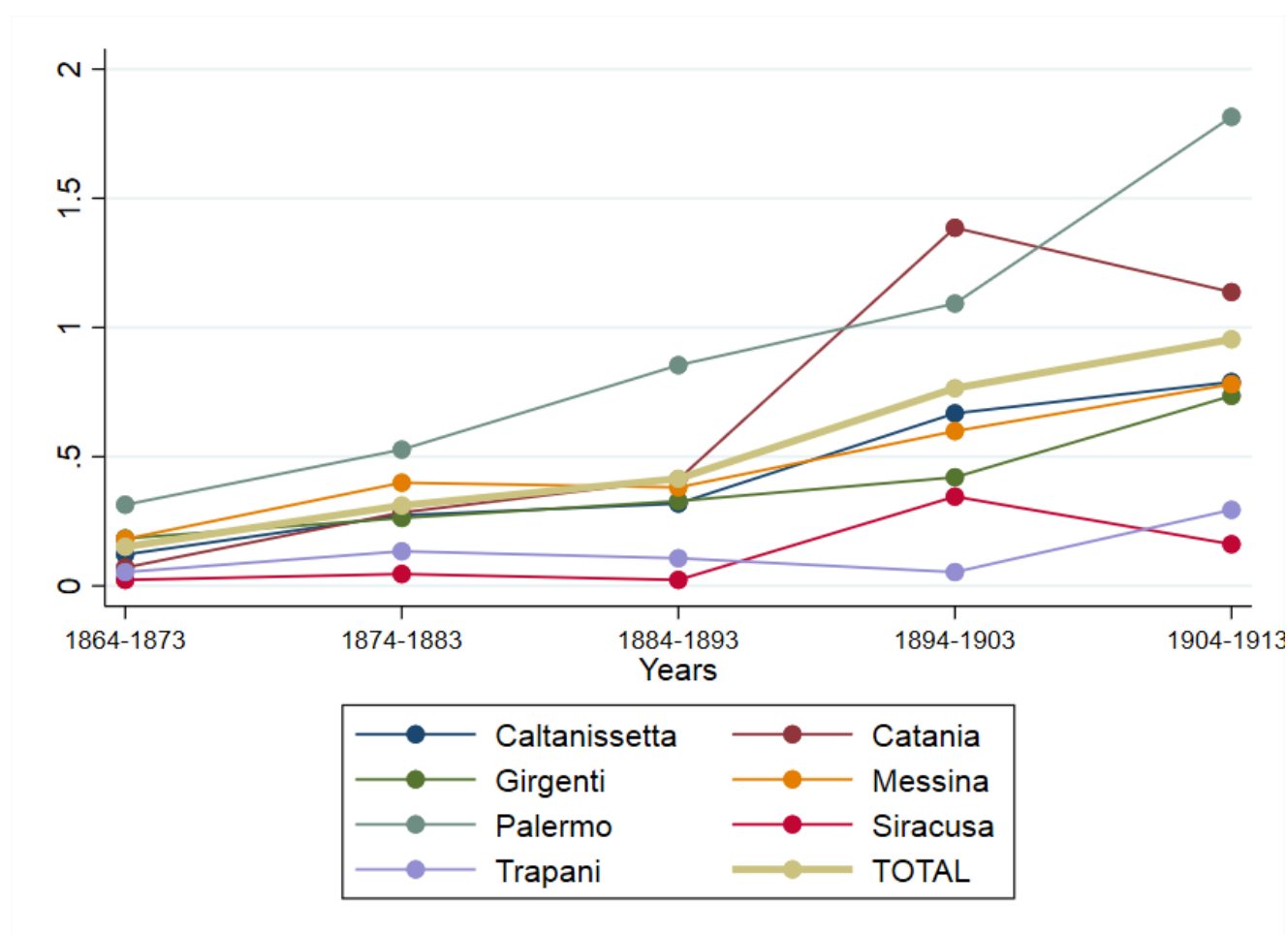
The gap between Central and Northern Italy is relevant. If we consider the distribution of patents according to pre-unitary state borders, in 1881 we find that the data relative to the Sicilian provinces, 3.78 patents per million inhabitants, is completely in line only with that of the Kingdom of the Two Sicilies (3.7), to which, moreover, they belonged. For the rest, it is lower both in comparison to the central area (the Grand Duchy of Tuscany issued 8.8 patents per million population, while the Papal State issued 13.7) and compared to the North of the new unitary State (the Kingdom of Sardinia issued 21.2 patents per million inhabitants, the Kingdom of Lombardy-Venetia 19.7). The territorial divergence in terms of patents persist even after 1881, as shown in provincial data for the years 1891, 1901, and 1911 (available in Nuvolari and Vasta, 2017), will remain evident for the following decades. With specific reference to Sicily, we have collected and analyzed the annual data at the municipal level, obtained by consulting the *Gazzetta Ufficiale del Regno d'Italia* (the official journal of record of the Italian Kingdom). The *Gazzetta* published lists of certificates of industrial property rights divided into quarters, in which there was valuable information such as the applicant's details and the duration in years of the right and extension.¹⁹

Through these data we can grasp in more detail the innovative performance of the Sicilian area, demonstrating the evolution in the number of patents and their scheduled

¹⁹ In case an inventor wanted to extend the term of a patent initially taken for a shorter period, he or she had to apply for an extension certificate (*attestato di prolungamento*). See Nuvolari and Vasta (2015).

duration on the island.²⁰ By aggregating the available municipal data by province, we can, for example, construct a picture that allows us to compare the number of patents per 10,000 inhabitants issued in the province in each decade. We can then do the same with the data on the duration of patents, again weighted by population.²¹ We then divided the fifty years considered here (1864-1913) into five subperiods of ten years each and constructed ten-year pictures, reported below

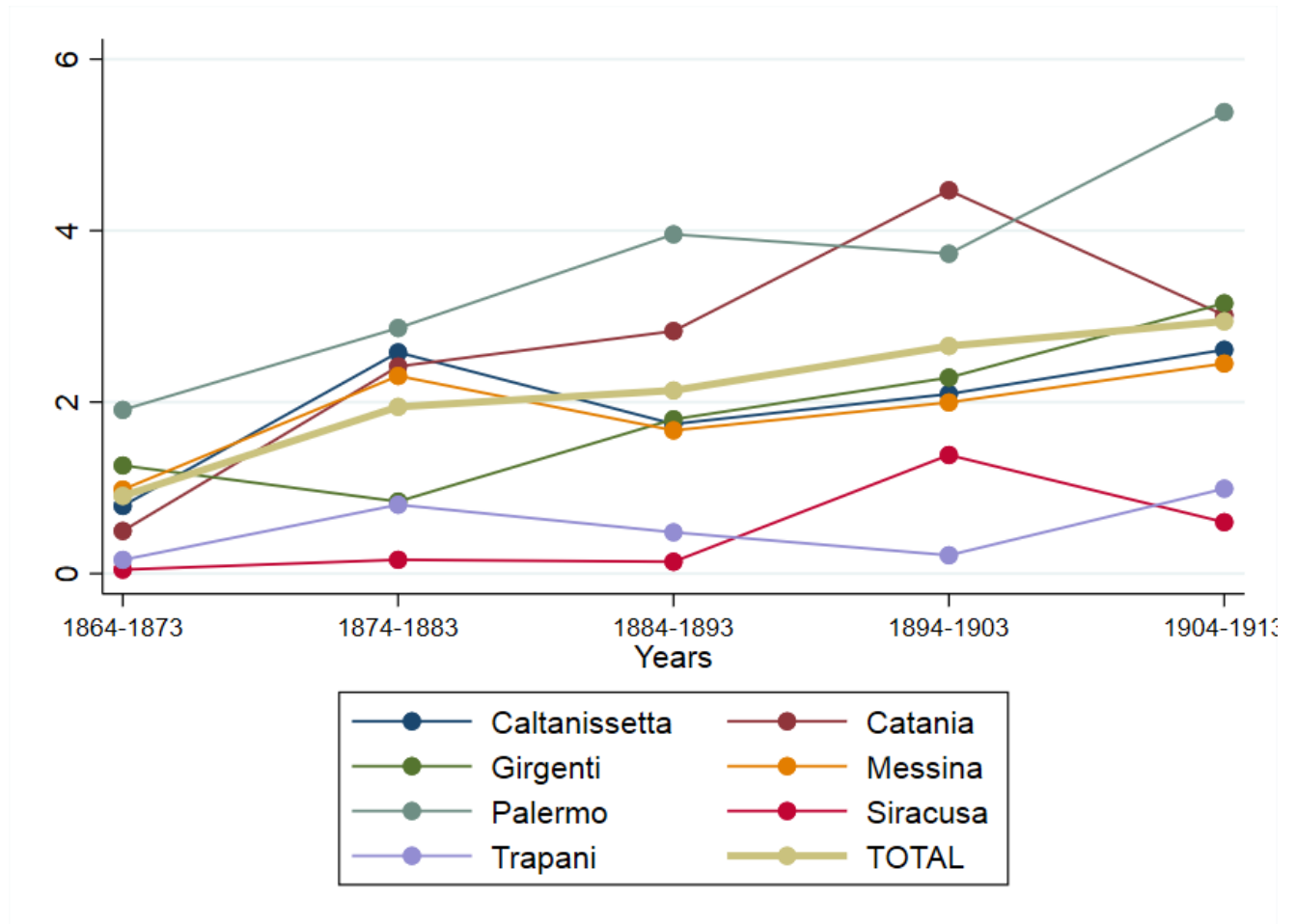
PICTURE 1. NUMBER OF PATENTS PER 10000 INHABITANTS AT PROVINCIAL LEVEL
(SOURCE: OUR OWN ELABORATION).



PICTURE. 2. SCHEDULED DURATION OF PATENTS IN YEARS PER 10000 INHABITANTS
AT PROVINCIAL LEVEL

²⁰ With reference to the scheduled duration, we have combined the years of duration of the main patent with those of the possible extension.

²¹ See also Section 4.1. for more details.



A great difference emerges among the Sicilian provinces: Trapani and Syracuse always have achieved the worst results; Messina, Caltanissetta, and Girgenti fit into an intermediate range; the first province is Palermo, although Catania reveals a steady growth that will lead it, in the decade 1894-1903, to have the most significant figure. Later, however, Palermo came back first, and by a wide margin.

4. DATA AND VARIABLES.

4.1. DEPENDENT VARIABLES

In this research a novel dataset on Sicilian municipalities which covers the period from 1864 to 1913 is employed.²²

To investigate the economic impact of the Sicilian Mafia on technological progress we use as a dependent variable the number of patents over 10,000 inhabitants (variable *patents*) despite we are aware that it is a proxy of technological progress. The patents are considered in the existing literature the best indicator of technological progress (see, among others, Caglayan *et al.* 2021, and Nuvolari and Vasta 2017, 2015a).²³ The data regarding the period immediately after the Unification of the Italian Kingdom, 1864-1913, was found after archival work by aggregating micro-data at a municipal level year by year. Each registered patent has been attributed to its inventor's place of residence. In the case of different places of residence, the attribution of patents was split among the municipalities. We also use an additional index of the intensity of technological progress (variable *patents_duration*), as measured by duration in years of the right of the patents granted or extended over 10,000 inhabitants.

We choose to group our data in decades since in many municipalities, especially smaller ones, only few patents were registered during our period of analysis. Making a patent can take up a lot of time, thus adopting a longer time span rather than a single year can better represent the technological development of territories. Again, decades fit well with our data which comprehend a period of 50 years and allow us to split, without overlapping, the period before and after the dissolution of Sicilian Fasci which falls after the third decade.²⁴

²² See also Section 3 for more details.

²³ It is worthwhile noting that the economic impact of the Sicilian Mafia on technological development is an undesired by-product of a criminal organization that may at least directly control wages and schooling, but not technological progress. The presence of this criminal association on innovation and patenting represents one more negative externality imposed on growth and welfare.

²⁴ Anyway, our results are robust to the use of different time spans.

4.2. INDICATORS OF MAFIA PRESENCE.

The Mafia is a hidden phenomenon that is difficult to detect and to assess quantitatively. In our analysis, we choose to use the indicator of the Mafia presence created by Antonino Cutrera (1900), a police officer. Cutrera drew a map showing the density of the Mafia in Sicily in 1900, and this indicator of Mafia presence is time invariant. In his book, he stated that his ranking of Mafia presence in 1900, within Sicilian municipalities, is not based only on the number of crimes or any other criminal statistics, but “ ... because I am convinced that the Mafia density cannot be represented with numbers [of crimes]. We have already seen that the Mafia does not always commit crimes, and that the crimes perpetrated by them are not exclusive of the Mafia. [...] For this reason we drew this map using our personal appraisal of the different densities of the Mafia from town to town” (Cutrera, 1900, pp. 114–115).”

Thanks to this work we know that, out of a total of 357 municipalities, 84 municipalities did not have any presence of the Mafia, 66 municipalities had a little presence, 70 a medium presence and 69 a high Mafia presence (68 municipalities were unclassified). Following the classification of Cutrera (1900), we use a continuous variable *mafia* which measures the intensity of the Mafia presence ($0=no_mafia_reported$; $1=low_mafia$; $2=medium_mafia$; $3=high_mafia$). To give more robustness to our results, we also build the dummy variable *mafia_strong* equal to 1 in each municipality with at least a medium level of Mafia presence and, in a third specification, we use separately the dummy variables for each level of the Mafia reported.²⁵

²⁵ In the historical analysis of the Sicilian Mafia the indicator of Mafia presence from Abele Damiani is often employed (Damiani, 1885). Damiani reported the conditions of agriculture in Sicily using the answers to specific questions that the pretori were asked (lower court judges), and local state officials in each of the 162 judicial districts of Sicily that were concerned with the Mafia phenomenon too. However, from Damiani (1885) it is possible to extract only a list of a few districts affected by the Mafia without any information about the intensity of the Mafia infiltration. Anyway, our results hold also using this alternative Mafia indicator.

It is also worth underline that, although the index was published in 1900, it refers to the Mafia presence in the overall post-unification period.²⁶ The assumption that Mafia levels remained unchanged for several decades seems to be plausible, considering that this criminal association is strongly rooted in the territory, reflecting social customs. Notwithstanding, Buonanno *et al.* (2015), Acemoglu *et al.* (2020) and Lupo (2023), point out that after the dissolution of the Peasant Fasci Movement, the power of the Mafia among the seven Sicilian Provinces significantly increased as an answer to private insurance demand coming from landowners, against the social and economic claims of the Fasci movement.²⁷ In line with them, we expect a negative sign of the Mafia's presence in the differences in patenting before and after the dissolution of Peasant Fasci.

4.3. OTHER EXPLANATORY VARIABLES.

We include some additional controls which can explain the differences in technology development among municipalities. To take into account the levels of human capital during the post-unification period, we collect data regarding the share of illiterate people for each municipality (variable *illiteracy*), as reported in the official yearbooks.²⁸ We expect lower rates of illiteracy associated with a lower level of patenting. We also control for the number of inhabitants (expressed in natural log – *population*) to take account of the scale effects and knowledge externalities in living in larger communities. The dummy variable *land*, equal to 1 in municipalities where large lands were prevalent, takes into account the level of

²⁶ Such a qualitative measure of the Mafia presence is time-invariant since it is defined at a single point of time. However, it can be considered a good proxy for the Mafia presence in the Sicilian provinces after the Italian unification.

²⁷ The Sicilian provinces remained seven until 1927, when they became nine.

²⁸ We use data from the 1911 Italian national census since no data at the municipal level were reported in the previous ones (ISTAT, 2014). In further specifications, we control for the university presence by adding a dummy variable equal to one for the provinces with a university (in the period from 1864 to 1913 the universities were present in Sicily in just three provinces: Catania, Messina, Palermo). Results do not substantially change.

concentration of the land distribution.²⁹ Another dummy *Urban* is equal to 1 for municipalities closer less than 10 kilometers from the 5 Sicilian main cities. Variables *cereals*, *citrus*, and *olives* tells us the average land suitable for each cultivation, while *rugged* the average terrain ruggedness in the municipality. Finally, we add two further variables on the availability of resources (a dummy variable for the presence of a sulfur mine, *mines*, as reported by Squarzina, 1963, on mines operating in 1886, and a variable equal to the distance from the closest river in kilometers, *river_dist*) as a proxy for the economic opportunity could push the dynamic of the innovation process.³⁰

Table 1 reports the summary statistics for all our variables.

[TABLE 1 ABOUT HERE]

5. EMPIRICAL ANALYSIS.

5.1. METHODOLOGY.

We estimate the following regression:

$$Tech_{i,d} = \alpha_0 + \beta MAFIA_i + \bar{\theta}_i + \gamma_d + \varepsilon_{i,d} \quad (1)$$

where *Tech* is the level of technology over time represented alternatively by the number of patents over 10,000 inhabitants or their duration (variables *patents* and *patents_duration*), in municipality *i* at the decades *d*. *MAFLA* is our interest variable, while $\bar{\theta}$ is a vector of control variables as specified respectively in Section 4.2 and 4.3. We also add time fixed effects that control for the common trend in all municipalities and we use standard errors robust to the heteroskedasticity in all specifications.

It is worth noting that the identification of the relationship between the Mafia location and technological progress suffers from the endogeneity problem represented by the

²⁹ Data are taken by “Statistiche agrarie”, vol. XIII, book II-5, which reported the predominant status of the land property among municipalities.

³⁰ Last variables and that ones on cultivations and terrains are taken by Buonanno et al., 2015.

fact that the Mafia can be located in the wealthiest areas (Dimico *et al.*, 2017). To address such an issue, we exploit the exogenous shock represented by the dissolution of the Peasant Fasci movement in early 1894 to identify how the Mafia affected the technological progress in Sicilian municipalities. Since the removal of Peasant Fasci suddenly extended the power of the Mafia over territories, in a second regression we split our data in two sub-samples (years 1864-1893 and years 1894-1913) to compare the coefficients of Mafia presence before and after the year 1894. Lastly, we exploit the panel nature of our data using as dependent variable the first difference between all the patents registered (or their total duration) after and before the dissolution of Sicilian Fasci, as follows:

$$\Delta \text{Tech}_{i,\text{after1894}-\text{before1894}} = \alpha_0 + \beta \text{MAFIA}_i + \bar{\theta}_i + \varepsilon_i, \quad (2)$$

In such a way, we account for all time invariant idiosyncratic characteristics of municipalities and different proneness of territories and populations to patenting. So, we can evaluate how municipalities affected by the Mafia deviates from the previous level of patenting when the Mafia increase its influence due to the dissolution of the Sicilian Peasant Fasci.

5.2. RESULTS

The results of regression (1) are reported in Table 2. The coefficients of both the continuous and the dummy index of the Mafia presence are negative and statistically significant at the 5% level (columns 1 and 2). In magnitude, an additional level of the Mafia index reduces the patenting process by about 35% of its average value. Being a municipality with at least a medium level of Mafia leads to a decrease of 0.127 patents per 10,000 inhabitants compared to municipalities not affected by the Mafia (column 2), a value close to the 80% of the medium level of patenting. In general, the results seem to be driven by municipalities with a high presence of the Mafia (column 3), while low levels of the Mafia do not appear to affect the patents' rate. Among other covariates, as expected, the illiteracy rate

is negatively associated with the patenting dynamic. On the other hand, bigger populations, being close to a big city and the presence of a sulfur mine seem to foster the patenting process (all the coefficients are positive and statistically significant in all specifications).

When we use the measure of the intensity of technological development as dependent variable (variable *patents_duration*), the coefficients of Mafia are negative but not statistically significant at any conventional level, while similar considerations to the previous ones on the impact of other covariates apply.

[TABLE 2 ABOUT HERE]

In Table 3 and 4 we split our sample taking into account respectively the period 1864-1893 and 1894-1913. In the first sub-sample the impact of the Mafia on our dependent variables is not statistically significant even when we evaluate the relationship between the Mafia and the number of patents (columns 1-3). However, when we consider the period after the 1894 (Table 4), the coefficients of Mafia variables become again statistically significant at at least the 5% level, and they more than double in magnitude compared to the full sample results. In addition, the Mafia appears now to be also strongly associated with a reduction of the intensity of technology (columns 4-5), and it seems to be especially true in the presence of high levels of Mafia (column 6).

[TABLES 3-4 ABOUT HERE]

In Table 5 we report the results of eq.(2) where the dependent variables are expressed in first differences. As expected, the changes in the level of patenting before and after the dissolution of Peasant Fasci appear to be negatively affected by the Mafia. The average increase of about 0.37 between the two periods is completely overtaken in the municipalities

with at least a medium level of Mafia. Again, the coefficient of *high_mafia* (column 3) is much higher than the previous value, showing a decline of patenting due to the strengthening of the Mafia after the dissolution of the Sicilian Fasci movement. The same applies when we take into account the duration of patents, where the coefficients of Mafia are negative and statistically significant although at the 10% level (columns 4-6). We acknowledge that our estimations cannot exclude the Mafia affected the technological progress even before the dismissal of Sicilian Peasant Fasci, as well as it could impact the human capital accumulation process. In those case, the effect of the Mafia would be at least underestimated, strongly supporting the responsibility of the Mafia for the technological backwardness.³¹

[TABLE 5 ABOUT HERE]

6. FINAL REMARKS.

The analysis carried out in the paper supports the main hypothesis that the Mafia presence in Sicily during the “Liberal age” (i.e. 1861 to 1913), represented a constraint on the technological progress and economic development of this region of Italy. Our results obtained by using municipal data confirm the conclusion of previous literature that the dissolution in 1894 of Fasci movement strengthened the power and diffusion of Mafia (Acemoglu *et al.*, 2020, Nuvolari and Vasta 2020), and represent a constraint to technological progress in Sicily.

The intensity of the Mafia’s presence allows us to justify the observed differences of technological progress among Sicilian municipalities. Using the Cutrera’s (1900) indicator of Mafia intensity we found that high levels of criminal association hamper the research activity,

³¹ Two main channels can explain why the Mafia could have restricted the technological progress in the long term. The first one is by hindering the accumulation of knowledge. Following the endogenous growth theory (Romer, 1990), it is simple to state that if the Sicilian Mafia was the source of the insufficient (sub-optimal) accrual of knowledge, this may alone explain the persistence of the technological backwardness of Sicily and of Sicilian municipalities where the Mafia was powerful and deeply rooted. The second channel through which the Mafia could have permanently switched cities on to a different trajectory of technological progress is related to the socio-economic consequences of the Mafia presence, which can persist long into the future.

while the low level of mafia presence intensity is not statistically significant and is positively correlated with patents and their duration. This is the first empirical research that investigates the impact of Mafia on technological progress among municipalities and provinces in Sicily.

The dissolution of the Peasant Fasci Movement in 1894 is an exogenous event with respect to the process of technological development. In this manner our research could be considered as a “natural experiment” of the relationship between Mafia and technological progress first and after the dissolution of Peasant Fasci Movement. After 1894 the Sicilian landlord aristocracy used the Mafia as a type of private insurance to continue to extract social rent, exploiting its privilege position (Bandiera, 2003), and the Mafia became more and more stronger and diffused in the island, filling the power void, caused by the weak presence of the central and local institutions. The scarce resources available in Sicily were not used to reduce illiteracy or improve the standard of living of poor class, but to maintain unaltered the social equilibrium and avoid any form of income redistribution and social mobility. Moreover, Cutrera’s (1900) indicator of Mafia presence reliability was confirmed by using several specifications of the econometric model. In municipalities with high levels of Mafia lower levels of patents and their duration were found and their duration, while the variable low mafia (intensity), despite not being statistically significant, denote a positive algebraic sign. The literacy level of population is the only covariate that is statistically significant and possesses always a negative algebraic sign. This result confirms that technological backwardness of Sicily has its roots in illiteracy.

There is room for more in-depth analysis to investigate whether there is any relationship between the issue of patents and the industries protected by the Sicilian mafia. In a nutshell, if the mafia pushed technological progress in the industries under its control, crowding out sectors of the economy outside its control.

Further research are necessary to evaluate the long-term impact of the observed difference of Mafia presence among the Sicilian municipalities and provinces.

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Table 1. Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>patents</i>	1,300	.162	.647	0	6.257
<i>patents_duration</i>	1,300	.691	3.108	0	42.508
Δ <i>patents</i>	260	.367	1.429	-6.959	8.044
Δ <i>patents_duration</i>	260	.502	7.163	-74.229	33.623
<i>mafia</i>	260	1.45	1.14	0	3
<i>mafia_strong</i>	260	.496	.501	0	1
<i>low_mafia</i>	260	.219	.415	0	1
<i>medium_mafia</i>	260	.258	.438	0	1
<i>high_mafia</i>	260	.238	.427	0	1
<i>illiteracy</i>	260	62.488	10.114	27	85
<i>population</i>	260	8.882	.907	6.441	12.63
<i>land</i>	260	.204	.404	0	1
<i>urban</i>	260	.127	.334	0	1
<i>cereals</i>	260	17.902	11.268	1.49	66.38
<i>citrus</i>	260	15.678	7.771	0	48
<i>olives</i>	260	30.892	12.138	3.478	69.273
<i>rugged</i>	260	219.518	107.002	31.866	578.288
<i>mines</i>	260	.162	.369	0	1
<i>rivers_dist</i>	260	9.474	7.33	.993	42.075

Table 2. Estimation results. Full sample 1864-1913.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	<i>patents</i>	<i>patents</i>	<i>patents</i>	<i>patents_duration</i>	<i>patents_duration</i>	<i>patents_duration</i>
<i>mafia</i>	-0.0576*** (0.0191)			-0.1226 (0.1032)		
<i>mafia_strong</i>		-0.1274*** (0.0442)			-0.2707 (0.2042)	
<i>low_mafia</i>			0.0052 (0.0467)			0.0290 (0.1973)
<i>medium_mafia</i>			-0.0995** (0.0458)			-0.1933 (0.1978)
<i>high_mafia</i>			-0.1592*** (0.0557)			-0.3405 (0.3235)
<i>illiteracy</i>	-0.0092*** (0.0021)	-0.0088*** (0.0020)	-0.0090*** (0.0021)	-0.0307*** (0.0084)	-0.0299*** (0.0086)	-0.0304*** (0.0082)
<i>population</i>	0.1534*** (0.0290)	0.1532*** (0.0287)	0.1554*** (0.0293)	0.5581*** (0.1327)	0.5576*** (0.1284)	0.5631*** (0.1344)
<i>land</i>	-0.0321 (0.0365)	-0.0358 (0.0368)	-0.0389 (0.0374)	0.1065 (0.2482)	0.0987 (0.2504)	0.0897 (0.2564)
<i>urban</i>	0.1435** (0.0701)	0.1259* (0.0685)	0.1358** (0.0676)	0.5934* (0.3164)	0.5557* (0.3040)	0.5775* (0.3084)
<i>cereals</i>	-0.0004 (0.0032)	-0.0003 (0.0033)	-0.0002 (0.0033)	-0.0151 (0.0136)	-0.0149 (0.0140)	-0.0147 (0.0139)
<i>citrus</i>	0.0076* (0.0040)	0.0075* (0.0040)	0.0070* (0.0040)	0.0391** (0.0183)	0.0390** (0.0186)	0.0379** (0.0190)
<i>olives</i>	-0.0034** (0.0017)	-0.0034** (0.0017)	-0.0036** (0.0017)	-0.0159** (0.0079)	-0.0160** (0.0079)	-0.0164** (0.0074)
<i>rugged</i>	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)	-0.0004 (0.0013)	-0.0004 (0.0013)	-0.0004 (0.0013)
<i>mines</i>	0.2048*** (0.0566)	0.2028*** (0.0560)	0.2093*** (0.0567)	1.1056*** (0.3263)	1.1011*** (0.3315)	1.1171*** (0.3227)
<i>rivers_dist</i>	0.0024 (0.0031)	0.0028 (0.0031)	0.0027 (0.0031)	0.0201 (0.0175)	0.0208 (0.0164)	0.0206 (0.0170)
Constant	-0.8075*** (0.2817)	-0.8461*** (0.2837)	-0.8440*** (0.2841)	-2.8255* (1.4817)	-2.9072** (1.4807)	-2.9083** (1.4638)
Time dummies	YES	YES	YES	YES	YES	YES
Observations	1,300	1,300	1,300	1,300	1,300	1,300
R-squared	0.1199	0.1201	0.1211	0.0772	0.0772	0.0775

Notes: ***, **, and * denote significance at 1%, 5% and 10%. Robust standard errors in parentheses.

Source: Our elaboration.

Table 3. Estimation results. Period 1864-1893 - before the dissolution of Socialist Peasant Fasci.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	<i>patents</i>	<i>patents</i>	<i>patents</i>	<i>patents_duration</i>	<i>patents_duration</i>	<i>patents_duration</i>
<i>mafia</i>	-0.0024 (0.0133)			0.0875 (0.1453)		
<i>mafia_strong</i>		-0.0114 (0.0268)			0.0987 (0.2609)	
<i>low_mafia</i>			0.0068 (0.0249)			0.0465 (0.1884)
<i>medium_mafia</i>			-0.0123 (0.0270)			-0.0219 (0.2160)
<i>high_mafia</i>			-0.0017 (0.0418)			0.3211 (0.4650)
<i>illiteracy</i>	-0.0032*** (0.0012)	-0.0032** (0.0013)	-0.0032** (0.0012)	-0.0191** (0.0089)	-0.0200** (0.0095)	-0.0184** (0.0088)
<i>population</i>	0.0834*** (0.0216)	0.0841*** (0.0212)	0.0837*** (0.0219)	0.3638** (0.1643)	0.3747** (0.1589)	0.3617** (0.1696)
<i>land</i>	0.0557 (0.0348)	0.0550 (0.0351)	0.0549 (0.0356)	0.4537 (0.3501)	0.4503 (0.3528)	0.4621 (0.3610)
<i>urban</i>	0.0346 (0.0339)	0.0346 (0.0321)	0.0316 (0.0344)	0.0886 (0.2741)	0.1276 (0.2435)	0.0580 (0.2827)
<i>cereals</i>	-0.0016 (0.0019)	-0.0015 (0.0019)	-0.0015 (0.0019)	-0.0155 (0.0137)	-0.0138 (0.0136)	-0.0145 (0.0138)
<i>citrus</i>	0.0038* (0.0023)	0.0036 (0.0023)	0.0037 (0.0023)	0.0317* (0.0182)	0.0294* (0.0174)	0.0318* (0.0186)
<i>olive</i>	-0.0010 (0.0011)	-0.0009 (0.0011)	-0.0009 (0.0010)	-0.0140 (0.0088)	-0.0130 (0.0087)	-0.0126 (0.0080)
<i>rugged</i>	0.0001 (0.0002)	0.0001 (0.0002)	0.0001 (0.0002)	-0.0007 (0.0016)	-0.0006 (0.0016)	-0.0006 (0.0016)
<i>mines</i>	0.1214*** (0.0446)	0.1228*** (0.0455)	0.1216*** (0.0445)	1.0835** (0.4360)	1.1101** (0.4552)	1.0725** (0.4258)
<i>rivers_dist</i>	0.0036* (0.0021)	0.0035* (0.0020)	0.0036* (0.0021)	0.0347 (0.0231)	0.0328 (0.0213)	0.0341 (0.0223)
Constant	-0.5903*** (0.1881)	-0.5960*** (0.1898)	-0.5994*** (0.1908)	-2.1266 (1.5279)	-2.1327 (1.5557)	-2.1743 (1.5635)
Time dummies	YES	YES	YES	YES	YES	YES
Observations	780	780	780	780	780	780
R-squared	0.1019	0.1021	0.1022	0.0604	0.0598	0.0615

Notes: ***, **, and * denote significance at 1%, 5% and 10%. Robust standard errors in parentheses.

Source: Our elaboration.

Table 4. Estimation results. Period 1894-1913 - after the dissolution of Sociali Fasci.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	<i>patents</i>	<i>patents</i>	<i>patents</i>	<i>patents_duration</i>	<i>patents_duration</i>	<i>patents_duration</i>
<i>mafia</i>	-0.1403*** (0.0410)			-0.4379*** (0.1278)		
<i>mafia_strong</i>		-0.3016*** (0.0966)			-0.8248*** (0.3121)	
<i>low_mafia</i>			0.0028 (0.1086)			0.0028 (0.3999)
<i>medium_mafia</i>			-0.2302** (0.1054)			-0.4504 (0.3721)
<i>high_mafia</i>			-0.3956*** (0.1179)			-1.3329*** (0.3767)
<i>illiteracy</i>	-0.0180*** (0.0046)	-0.0171*** (0.0045)	-0.0178*** (0.0046)	-0.0481*** (0.0159)	-0.0446*** (0.0157)	-0.0484*** (0.0155)
<i>population</i>	0.2583*** (0.0572)	0.2568*** (0.0566)	0.2630*** (0.0576)	0.8495*** (0.2130)	0.8319*** (0.2062)	0.8652*** (0.2098)
<i>land</i>	-0.1637** (0.0733)	-0.1719** (0.0740)	-0.1796** (0.0744)	-0.4143 (0.3188)	-0.4287 (0.3261)	-0.4688 (0.3270)
<i>urban</i>	0.3069* (0.1574)	0.2628* (0.1543)	0.2921* (0.1509)	1.3505** (0.6554)	1.1979* (0.6484)	1.3567** (0.6244)
<i>cereals</i>	0.0014 (0.0074)	0.0015 (0.0077)	0.0018 (0.0076)	-0.0144 (0.0273)	-0.0165 (0.0287)	-0.0149 (0.0283)
<i>citrus</i>	0.0132 (0.0093)	0.0132 (0.0094)	0.0121 (0.0095)	0.0503 (0.0372)	0.0533 (0.0389)	0.0470 (0.0388)
<i>olives</i>	-0.0070* (0.0039)	-0.0072* (0.0039)	-0.0075** (0.0038)	-0.0188 (0.0148)	-0.0204 (0.0147)	-0.0221 (0.0142)
<i>rugged</i>	0.0006 (0.0006)	0.0006 (0.0006)	0.0006 (0.0006)	0.0002 (0.0023)	-0.0001 (0.0023)	0.0000 (0.0024)
<i>mines</i>	0.3298*** (0.1237)	0.3227*** (0.1219)	0.3408*** (0.1246)	1.1387** (0.4791)	1.0877** (0.4625)	1.1840** (0.4838)
<i>rivers_dist</i>	0.0007 (0.0070)	0.0017 (0.0070)	0.0012 (0.0069)	-0.0019 (0.0260)	0.0029 (0.0255)	0.0005 (0.0258)
Constant	-0.9096 (0.6273)	-0.9975 (0.6304)	-0.9872 (0.6295)	-3.1301 (2.8705)	-3.3251 (2.8293)	-3.2656 (2.7555)
Time dummies	YES	YES	YES	YES	YES	YES
Observations	520	520	520	520	520	520
R-squared	0.1492	0.1486	0.1522	0.1212	0.1175	0.1250

Notes: ***, **, and * denote significance at 1%, 5% and 10%. Robust standard errors in parentheses.

Source: Our elaboration.

Table 5. Estimation results. First difference pre- and post- 1894 (dissolution of Sicilian Fasci).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta patents$	$\Delta patents$	$\Delta patents$	$\Delta patents_duration$	$\Delta patents_duration$	$\Delta patents_duration$
<i>mafia</i>	-0.2735*** (0.1023)			-1.1383* (0.6488)		
<i>mafia_strong</i>		-0.5690** (0.2234)			-1.9459* (1.1845)	
<i>low_mafia</i>			-0.0147 (0.2366)			-0.1338 (0.9555)
<i>medium_mafia</i>			-0.4234** (0.2145)			-0.8350 (0.9420)
<i>high_mafia</i>			-0.7862** (0.3049)			-3.6293* (2.0580)
<i>illiteracy</i>	-0.0263*** (0.0099)	-0.0244** (0.0099)	-0.0260*** (0.0099)	-0.0391 (0.0382)	-0.0291 (0.0411)	-0.0417 (0.0375)
<i>population</i>	0.2662** (0.1166)	0.2612** (0.1150)	0.2749** (0.1190)	0.6078 (0.6513)	0.5398 (0.6196)	0.6454 (0.6652)
<i>land</i>	-0.4946** (0.1933)	-0.5087** (0.1962)	-0.5240*** (0.1987)	-2.1896 (1.4856)	-2.2082 (1.5105)	-2.3239 (1.5433)
<i>urban</i>	0.5101 (0.3439)	0.4217 (0.3319)	0.4896 (0.3305)	2.4352 (1.6020)	2.0130 (1.5013)	2.5393 (1.5793)
<i>cereals</i>	0.0076 (0.0149)	0.0074 (0.0150)	0.0081 (0.0151)	0.0177 (0.0636)	0.0086 (0.0625)	0.0137 (0.0631)
<i>citrus</i>	0.0150 (0.0192)	0.0155 (0.0192)	0.0130 (0.0196)	0.0055 (0.0965)	0.0183 (0.0951)	-0.0014 (0.1011)
<i>olives</i>	-0.0111 (0.0091)	-0.0116 (0.0091)	-0.0122 (0.0087)	0.0044 (0.0436)	-0.0016 (0.0430)	-0.0063 (0.0398)
<i>rugged</i>	0.0008 (0.0013)	0.0007 (0.0013)	0.0008 (0.0013)	0.0026 (0.0070)	0.0015 (0.0068)	0.0019 (0.0068)
<i>mines</i>	0.2956 (0.3007)	0.2771 (0.3072)	0.3168 (0.2980)	-0.9732 (1.8674)	-1.1548 (1.9676)	-0.8494 (1.8058)
<i>rivers_dist</i>	-0.0094 (0.0172)	-0.0072 (0.0170)	-0.0083 (0.0168)	-0.1079 (0.1132)	-0.0925 (0.1067)	-0.1013 (0.1095)
Constant	-0.0857 (1.3814)	-0.2443 (1.4037)	-0.2137 (1.4142)	-0.5891 (7.6224)	-0.9609 (7.6994)	-0.7172 (7.5660)
Observations	260	260	260	260	260	260
R-squared	0.1255	0.1225	0.1299	0.0595	0.0508	0.0681

Notes: ***, **, and * denote significance at 1%, 5% and 10%. Robust standard errors in parentheses.

Source: Our elaboration.