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ABSTRACT

Sicilian Sulphur and Mafia: Resources, Working Conditions and the Practice of Violence*

This paper reconsiders the nexus between the abundance of resources and the origins of Sicilian mafia by exploiting a new set of historical data on the Sicilian sulphur industry in the late 19th century, obtained from official reports of the Royal Corps of Mining Engineers at the municipal level. We find that the impact of local production on mafia was smaller -or nil- in the areas richest in sulphur. We also find that mechanization in the extraction process was associated with lower incidence of mafia. Taken together, our findings suggest that larger lodes encouraged better and more orderly working conditions for the miners, possibly reducing physical and psychic strain and, consequently, inclination to violence.

JEL Classification: H75, J28, K42

Keywords: Mafia, sulphur, working conditions

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1 Introduction

Widespread consensus among historians sets the origins of the Mafia at the beginning of the 19th century: see, among others, Gambetta (1993), Lupo (2011) and Felice (2013). However, some recent contributions claim that the blossoming of organized crime in Sicily was stimulated by the natural resource booms - such as exports of citrus and suphur - over the second half of the 1800's. As argued by Dickie (2004, p.82), "like the lemon groves around Palermo, the sulphur mines were a breeding ground for criminal associations". Indeed, citrus and sulphur stand out as typical examples of the perverse combination between rich resources and weak State, in which public officers are eventually captured by gangs exerting violence and corruption.

The export of citrus towards Northern Europe and the United States boomed in the mid-nineteenth century. The control over its supply chain, thus, offered large rents to be reaped. Indeed, following suggestions by Lupo (2011) and Dickie (2004), the empirical analysis of Dimico et al. (2017) mainly attributes the development of modern Mafia to the rural areas of Western Sicily. The citrus business generated a "demand for violence". To protect themselves and their investment, local landowners (mostly noblemen) started to hire private guards, especially in the area around Palermo where citrus grew. These gunmen were meant to protect their landlords from kidnapping and, at the same time, to avoid that such a valuable cultivation could be damaged. The use of private force became an essential production factor, although – as we explain in what follows - the widespread use of private militias eventually eroded the power of the landed gentry who were, at the same time, users and victims of the gunmen they had hired.

The second half of the 19th century witnessed the rise of Sicily as the world leader in the production of sulphur, the focus of this paper. The importance of sulphur for the development of Mafia in the central parts of Sicily (in particular, the provinces of Caltanissetta and Agrigento) has been emphasized, again, by Lupo (2011) and Dickie (2004). More recently, Buonanno, Durante, Prarolo and Vanin (2015) exploited historical data on the number of mines at the municipal level and argued that there is a causal relation between the presence of sulphur and the development of local organized crime, explained by a combination of resource abundance, poor institutions and miserable working conditions. On the one side, the lack of effective law enforcement on behalf of the Italian state called for private "protection" supplied by local criminal gangs. As for citrus, sulphur boosted the demand for violence. On the other side, the Sicilian sulphur industry was generally characterized by the adoption of primitive technologies, disorganization, appalling working conditions, together with scarce cooperation among co-workers and, quite often, use of violence. In this perspective, sulphur mines most often constituted an environment which favoured the supply of violent individuals. The emphasis on the quality of working conditions directly questions those explanations that are restricted to the nexus between bad institutions and resource abundance.

Buonanno et al. (2015) consider, as a measure of local resource abundance, the number of mines located in Sicilian municipalities in 1886, and relate it to local organized crime, as reported in Cutrera's (1900) dossier on mafia activity in 1890. Their results confirm that the density of sulphur mines favoured organized crime. However, one can reasonably conjecture that the number of sulphur mines (567 in total, considering both the mines in activity as well as exhausted mines in 1886) is an imperfect proxy for local resource abundance, as most of the mines exhibited scarce levels of production.[1] In fact, there exist well established historical sources on the production of Sicilian sulphur in the 19th century (see Fenoaltea, 1988; Fenoaltea and Ciccarelli, 2006; Ciccarelli and Fenoaltea, 2014). The Rivista del Servizio Minerario provides a systematic account of the production of sulphur (thousand of tons) in the Sicilian provinces and, most important here, it occasionally reports data at the municipality level.

Building on measures of tons produced, we revisit the relation between sulphur and mafia. Although such a relation might be simply linear as Buonanno et al. (2015) suggest, there remain other possibilities. For example, the sulphur-mafia nexus might be increasing at an increasing rate, that is, when resources are very rich, they generate more and more criminality. When we go to the data, however, we find quite the opposite. The richer the sulphur production at the municipal

[1] As claimed by the Rivista del Servizio Minerario in 1899, the official report on the Italian mining industry issued by the Ministero di Agricoltura, Industria e Commercio (1900), "..in Sicily the number of mines has a very relative importance.. Indeed, the main 40 mines are sufficient to yield the 4/5 of the total production" (p.85).

level, the smaller the impact on local mafia activity.[2] To tackle this puzzle, we then inquire whether, besides poor institutions and resources, there is a third element -the quality of working conditions- at play.[3] Even in the contemporary mining industry, the importance of working conditions cannot be underrated. For instance, Neumann and Nelson (1982) emphasize the positive relation between establishment size and workplace safety in the post-WWII US coal industry, while Salas et al. (2015) investigate the link between working conditions and psychological distress in some Latin American mines.

Our presumption, grounded on the historical literature that will be surveyed in what follows, is that the varied quality of working conditions can be proxied by investments in the mechanization of the production process, especially in the presence of rich lodes. To this purpose, we exploit the Rivista del Servizio Minerario (1903, 97-103) to obtain data on the sulphur mines that, at the end of the 19th century, where carrying the ore to ground level by the "inclined shaft", powered either by steam or electrical engine. This advanced system replaced human transportation, mostly carried on the shoulders of the *carusi*, children and adolescents living in semi-slavery, after having been ceded by their families to the miners: see Franchetti and Sonnino (1876, p.333) and Cagni (1903, p.174-177).

By running OLS regressions, we find that the impact of sulphur on mafia's presence is largely attenuated in municipalities that: (i) were relatively richer in sulphur and, (ii) underwent more intensive mechanization. These results are confirmed when we instrument our measure of mechanization, so to tackle endogeneity issues. Our interpretation is that, when the local abundance of resources was sufficiently large to stimulate investment in organization and mechanization, the room for criminal attitudes reduced. In particular, the introduction of orderly production practices under the supervision of technically qualified personnel, the demand for state police patrol in larger mines, together with the improvements in both safety and working conditions due to new technologies, possibly decreased psychological distress and inclination to violence. In short, better working conditions lessened the local "supply

[2] As we show, this result does not depend entirely on the municipalities of Caltanissetta and Comitino, which accounted approximately for the 25% of the entire production of Sicilian sulphur.

[3] Indeed, Buonanno et al. (2015, p. F181, Note 12) find that citrus, the other valuable Sicilian export, did not have any impact on mafia. Clearly, the cultivation of citrus offered working conditions that were far from being as degraded as those of most of Sicilian mines.

of violence".

This paper contributes both to the literature on the curse of natural resources, such as Dell (2010), as well as on the literature on the economics of culture, as Grosjean (2014). Broadly speaking, the organization of labour matters. Dell (2010) analyzes the case of silver mines in the Potosì area at the end sixteenth century, and compares indigenous villages that were required to contribute with their male population to the production of silver with areas where large landowners sheltered their labourers from exploitation in mines, also providing some basic public goods as alphabetization and roads. The areas that were affected by the constriction still bear a gap in today's living standards. On the other hand, Grosjean (2014) suggests that aggressiveness and culture of honor were the adequate behaviour in a world, like the Scottish Highlands, where state law enforcement was absent and herds could be stolen.[4] Thus, to deter theft, it was necessary to build a solid reputation for toughness. Similarly, in most of Sicilian mines, miners could have their ore stolen by others, there was competition about the best veins of mineral, and there was no external law enforcement able to protect or punish. In other words, mines were an ideal training ground for learning how to hurt people.

The rest of this paper is organized as follows. Section 2 provides some background about the origin and development of Mafia and the Sicilian sulphur industry, while Section 3 presents the data. Section 4 reports and discusses the empirical findings. Section 5 concludes.

2 Some background on Sicilian Mafia and the Sicilian sulphur industry

2.1 Origins and development of Sicilian Mafia

Although "Mafia" becomes the name for Sicilian organized crime only after the birth of the Kingdom of Italy (1861), its actual origin dates back to the beginning

[4]See also Nunn (2014, p.381). The "code of honor" has several features which are common to the "code of the street", investigated by Anderson (1999) for the US, and Brookman et al (2001) for the UK. In environments where formal protection (police and justice system) is absent or unfeasible, the systematic use of violence against personal slights is a means to get "respect". Indeed, tough reputation deters against future attacks and builds self-reliance. Similar ideas are put forward by Gambetta (2009) in his work on prison inmates.

of the Nineteenth century (see Lupo, 2011; Felice, 2013). In the aftermath of the Napoleonic period, the Kingdom of the Two Sicilies abolished feudalism (1812-1838) and started a deep reorganization of the local administration (1819), focusing on new norms to introduce a modern judiciary system. Such provisions, however, were never to be implemented properly. As reported in Felice (2013), the refusal of the Bourbon King to raise taxation on land implied a scarcity of public funds for the creation of a functioning state police and magistrature. These unimplemented reforms led to a pervasive weakness of the Bourbon Kingdom in Sicily. Since the State was far from being able to enforce a "monopoly of violence" in the island, the void was readily filled by the birth of what observers of the time termed as "violence industry" (see Dickie, 2004). Indeed, the main explanations for the origins of mafia, including Acemoglu et al. (2020)[5], can be represented in terms of "demand for violence". To protect themselves and their cultivations, landowners hired private militias.[6] Unfortunately, these gunmen often ended up colluding with thieves and blackmailers themselves, so to cream off part of the rural rent. For instance, bargaining between gangsters and "middlemen" over stolen goods or herds was the norm for settling thefts. This process of "democratization of violence" (Lupo, 2011) created a new rural elite that was either directly or indirectly involved with criminals. Such an "aborted middle-class" progressively took control of cultivations and mines, mostly through local entrepreneurs (the "gabellotti") who rented the land from the gentry. The annexation of Sicily to the Italian Kingdom after 1861 recognized the Mafia as a public order problem, but it did not stop its expansion. The new state was prone to implement brutal and ineffective military repression and it introduced mandatory three-year draft, a very unpopular measure which put thousands of Sicilian young men on the run: see Felice (2013) and Marciante (2021). Also, the increasing political integration of Sicily to the rest of the Kingdom offered the chance of participating in

[5]Acemoglu et al. (2020) have recently argued that the widespread diffusion of mafia in Sicily at the end of the 19th century can be explained, in part, as a reaction of landowners to the rise of trade-unionism in the countryside. In particular, the local elites turned to the mafia gangs to intimidate and repress the growing demands of the peasants. In the words of these authors, "Mafia spread from its original surroundings in the most urban parts of Sicily and some of the mining areas to the more rural parts of the island" (p.541). Indeed, the baseline specification in Acemoglu et al. (2020) includes sulphur production among the determinants of Mafia. Even after accounting for such political motivations, the role played by sulphur maintains its relevance.

[6]See Gambetta (1993). Bandiera (2003) argues that the abolition of feudalism produced a dramatic increase in the number of landowners. In turn, land fragmentation promoted mafia activity by increasing the demand for private protection.

the electoral game to individuals connected with organized crime. The gangs of the Mafia became a systemic instrument of political struggle, often by eliminating rivals and - following the convenience of the moment - contributing to fuel or soothe local revolts against the State: see Lupo (2011). Both contemporaneous observers and historians seem to agree that the birthplace of Mafia was located in the Palermo's urban and rural areas (see, e.g., Lupo, 2011). The presence of the harbor favored both tobacco smuggling and control over the shipment of citrus, which was mainly produced in the rural areas around the town. However, Sicily offers another example of rich natural resources, that is sulphur. Differently from citrus, sulphur was located in the central part of the island, and its boom on international markets occurred from the 1860s onwards. Notwithstanding the geographic distance from Palermo, the sulphur area witnessed the development of forms of organized crime that had substantial similarities to the Mafia organization of the Palermo area. In most sulphur mines, the ability to exert violence was, if possible, even more relevant than in agriculture. The centerstage actor in the sulphur industry was the pickman ("picconatore"), a small entrepreneur who acquired the right to extract the ore with the support of few assistants: see Cagni (1903, p.173) and Dickie (2004). As argued by Lupo (2011), the pickman exerted violence in order to "regulate" the competition from other pickmen over the best lodes. As a matter of facts, such a consistent use of violence was associated with gangs' membership, like the Favara Brotherhood ("Fratellanza di Favara"). As reported by Dickie (2004), of the 107 men tried for the membership of the gang, 72 worked in the sulphur industry! The majority of sulphur mines were an ideal training ground for criminal practice, thus raising the "supply of violence".[7]

2.2 The sulphur industry

During the industrial development taking place over the nineteenth century, Sicily was the monopolistic producer of sulphur, supplied to an increasing world demand.[8] The mineral was often located a few meters below the surface. Thus, until 1850, the

[7]Recently, Marciante (2021) has proposed another mechanism for the supply of violence in 19th century's Sicily. He argues that the desire to escape the compulsory draft -which had been imposed by the newly-born Italian Kingdom- pushed a considerable fraction of male youth to become outlaws on the run.

[8]The Sicilian monopoly on sulphur ends with the introduction of the Frasch extraction method in Louisiana at the beginning of the twentieth century: see Fenoaltea and Ciccarelli (2006).

extraction technology was very rudimentary, and required little investment. Since 1860, the sulphur industry boomed, also due to increasing exports toward the USA. Progressive mechanization started quite late, after 1867, mostly implemented in a few large mines controlled by foreign investors, who also hired personnel with technical education: see Parodi[9] (1873, p.28) and Squarzina (1963). As a result, the Sicilian sulphur industry was characterized by remarkable heterogeneity. On the one side, there was a multitude of mines that were inefficiently small[10] while, on the other side, industrial groups emerged. As noted by Squarzina (1963, p.106; 116), such an heterogeneity implied deep differences not only in the degree of mechanization, but also in the organization of the extraction. The situation was pretty wretched in small mines, which in 1893 represented the 90% of all mines for a production that barely accounted for the 30% of the total (see Squarzina, 1963, p.116). The excavation procedures that characterized small mines were quite chaotic, suffering from the improvisation and disorder that arose from the advice of uneducated foremen. As reported by Ferrara (2016, p.114), "miners were allowed to dig wherever they found a sulphur vein without any geological study or preparatory plan and with no regard for the safety or the future of the mine." Lack of discipline and individualism were the norm, under the piece-rates system of remuneration. Mechanization was nil, and working conditions were miserable. Tunnels were not reinforced, floodings and fires were frequent, air circulation was scant and the material dug by the pickman (*picconatore*) was carried outside on the shoulders of children, the *carusi* (Ferrara, 2016, p.115).[11] Since mines were mostly located in the countryside, mineworkers did not have access to decent shelter over the working week. As a result, many Sicilian mines had barely tolerable living conditions, associated with insalubrity, analphabetism, and propensity to crime and violence (Squarzina, 1963, p.127-8;

[9]Lorenzo Parodi, member of the Royal Corps of Mining Engineers and director of the Solfara of Grottacalda, was appointed by the Italian government in 1872 to report on the conditions of the Sicilian sulphur industry and recommend possible amendments to extraction methods.

[10]According to the Repertorio delle Miniere (1875, p.418-419), the fragmentation of land into a large number of properties often favoured the proliferation of small mines managed by contractors (gabellotti) who had low incentives to make adequate investments both for the extraction of crude ore and for the dewatering of mines. Cagni (1903, p.165-168) indeed argues that underinvestment was induced both by liquidity constraints due to bank credit-rationing, and by the excessive shortness of the rental contracts that landowners were willing to grant.

[11]As reported by Malta (2012, p.96), the exposition of pre-pubertal youth to such wearying tasks often led to subsequent discharge from the military draft. Mostly due to short height and thoracic deformity, the rate of ineligibility among young sulphur workers was higher than 40 percent, while the corresponding figure among peasants was around 20 percent.

Franchetti and Sonnino, 1876, p.334). In short, many suphur mines were a sort of hellhole where homicide, revenge, theft, sexual abuse and male prostitution were common: see Strappa (1975).

By contrast, large mines were mainly organized along the lines of rationally planned industrial production, and were often patrolled by the sovereign police (*Carabinieri*), which enforced the rule of law: see Strappa (1975). Also, large and deep mines had a scale fit for investment in mechanization, which progressively led to the adoption of "more rational and modern transportation techniques": see Ferrara (2016, p.116). At the end of the 19th century, all the large mines had extraction equipment, thus replacing transportation on the shoulders of *carusi*: see Ferrara (2016, p.118). Here, we suggest that the introduction of rational and advanced production methods improved working conditions in large mines[12] and, at the same time, it eradicated juvenile's employment in tasks exposed to confrontation and violence. In our perspective, it is not only formal institutions that can affect the evolution of cultural traits (see Nunn, 2014). Other microeconomic factors are also crucial. For instance, the transition to organized and mechanized production methods can contribute to a safer and disciplined workplace, where employees are less exposed to fatigue and distress and children are excluded from jobs that require extreme strain. In such circumstances, the private interest of large producers who are ready to make substantial investments for their own profit may have positive social and economic spillovers, as in the case of Peru's big farmers investigated by Dell (2010), or as in the case of the United Fruit Company in Costa Rica analyzed by Méndez-Chacon and Van Patten (2021).

3 Data

We build on the cross sectional data by Buonanno et al. (2015), containing the number of mines and the local intensity of mafia for 282 Sicilian municipalities in late 19th century. Their dataset also includes information at the municipality level on terrain ruggedness, difference in elevation within a given area, suitability of local land for cereals, citrus and olives, access to the postal roads, and distance from

[12] The notion that both the size of the establishment and the intensity of mechanization are associated with safer workplaces is consistent with the evidence on the US coal mining industry over the post-WWII period reported in Neumann and Nelson (1982).

non-seasonal rivers and ports.

Here, we extend this dataset by including two measures of sulphur production. The first measure, thousands of tons produced in 1883 at the municipality level, was originally provided by the Rivista del Servizio Minerario in 1885, published by Ministero di Agricoltura, Industria e Commercio (1887), henceforth MAIC (1887), in a detailed historical map in Table A at page VII, where a colored square placed over each municipality represents the amount of sulphur produced.[13]

The second measure of production is recovered from the report drawn up for the Italian Parliament by Parodi (1873). The document reports the average amount of quintals of sulphur produced at the municipality level in the period 1868-1870.

Further, to consider the impact of mechanization on working conditions, we add a variable indicating the number of inclined shafts at the municipality level. This system replaced human transportation of ore with carriages on rail pulled by engine power and, at the same time, it imposed the implementation of safety devices for the prevention of accidents: see Cagni (1903, p.80-81). This variable is recorded at the municipality level and available from Rivista del Servizio Minerario (1903) in MAIC (1904) at pages 97-103. It refers to all mechanized inclined shafts installed or under completion between 1873 and 1903. As reported in MAIC (1904, p.97), at the end of the 19th century, inclined shaft transportation accounted for more than 40% of the entire production. Table 1 reports the descriptive statistics of these variables for the sample of 282 municipalities considered in the regressions.

To assess the robustness of our findings, we will also exploit the additional controls provided by the dataset in Acemoglu et al. (2020) for a smaller number of municipalities.[14]

[13]See Figure A1 in the Appendix. This map allows us to geolocalize the production of sulphur, since the corner of each square touches the corresponding municipality. Squarzina (1963, p.66) re-edited this map indicating, for each municipality, the production of sulphur with a number of little squares, each representing 250 tons of material. Each millimeter squared of the area corresponds to 250 tons of sulphur.

[14]The dataset we exploit allows us to observe more municipalities with positive production of sulphur than those used by Acemoglu et al. (2020). In Buonanno et al. (2015) there are 282 municipalities; 39 (35) of these have positive values of sulphur production using the MAIC (Parodi) measure. In Acemoglu et al. (2020) there are 245 municipalities; 33 (32) have positive values of sulphur production using the MAIC (Parodi) measure. In Acemoglu et al. (2020) two municipalities with positive sulphur production (Rammacca and Raddusa) but different number of inclined shaft are aggregated in a unique municipality.

Table 1: Descriptive Statistics

	mean	st dev.	min	max
Mafia intensity, Cutrera (1900)	1.43	1.14	0	3
N. mines	1.99	7.1	0	61
Sulphur prod. 1883, MAIC (1887)	1.05	4.59	0	49
Sulphur prod. 1868-70, Parodi (1873)	.597	2.33	0	21
Inclined shaft (1873-1903), MAIC (1904)	.135	.682	0	7
Citrus suitabilty	15.6	7.66	0	48
Cereal suitabilty	17.7	11.1	1.49	66.4
Olive suitabilty	30.9	12.1	3.48	69.3
Water scarcity	.702	.458	0	1
Ruggedness	219	105	31.9	578
Different elevation	797	519	48	3232
Postal roads	.55	.498	0	1
Distance to rivers	9.28	7.25	.993	42.1
Distance to port	37.9	19.4	.132	83.9
Urban	.124	.33	0	1
Population density	132	127	4.86	1178
N. obs.	282			

The descriptive statistics are computed for the sample of 282 municipalities used in the regressions. The variables that we have added to the dataset of Buonanno et al. (2015) are reported in italics.

4 Empirical Findings

When we investigate the nexus between resource abundance and criminality, should we necessarily expect a simple linear relation, as suggested by Buonanno et al. (2015)? Or, instead, can this relation exhibit substantial non-linearity? In principle, growing abundance of resources may be associated with elements which either exacerbate[15] or moderate outcomes such as crime. Motivated by this observation, we will test whether the impact of sulphur availability on organized crime is better described by a quadratic relation and, then, whether the mechanization of ore transportation by inclined shafts is related to the presence of mafia activity. In Sect.4.1, we run OLS regressions augmented by the quadratic production term and the number of inclined shafts. In Sect.4.2, we test our findings with a variety of robustness checks and we address the possible endogeneity of mechanization. Our results suggest that mechanization had a causal effect on mafia.

[15]For example, the vast amount of public spending that followed the 1980 earthquake in Campania (Italy) was a watershed that boosted the activity of the "Camorra", the Neapolitan organized crime: see, e.g., Saviano (2007).

4.1 Main Results

We run OLS regressions using the sample of municipalities exploited in Buonanno et al. (2015, Table 3). As in Buonanno et al. (2015) and Acemoglu et al. (2020), the dependent variable is the measure of mafia activity in 1890 reported by Cutrera (1900).

Table 2 reports our main results. Here, the main regressor of interest is the production of sulphur (in tons) in 1883, obtained from MAIC (1887). We include the full set of controls used in Buonanno et al. (2015), and control for department fixed effect in the even columns. Columns 1-4 report the estimates from a linear specification in sulphur production. The coefficient of sulphur production is always positive and significant.

Columns 3,4,7 and 8 include the number of inclined shafts, our measure of mechanization. The coefficient of this regressor has always a negative and significant impact of mafia activity. The last four columns report estimates from a quadratic specification in production. The square of production has negative impact and, with the exception of column 6, is significant.[16] The full specifications in columns 7 and 8, without and with department fixed effects respectively, show that the coefficients of the inclined shafts and of the quadratic terms are significantly different from zero and exhibit the expected negative sign. The last two specifications have also the highest values of the Adjusted R^2 measure, among similar specifications that include (or not) department fixed effects.

Figure 1 shows the marginal effect of sulphur production computed using the full specification in column 8 of Table 2. The impact of sulphur production on mafia activity is positive but decreases and becomes insignificant in municipalities at the highest levels of production.

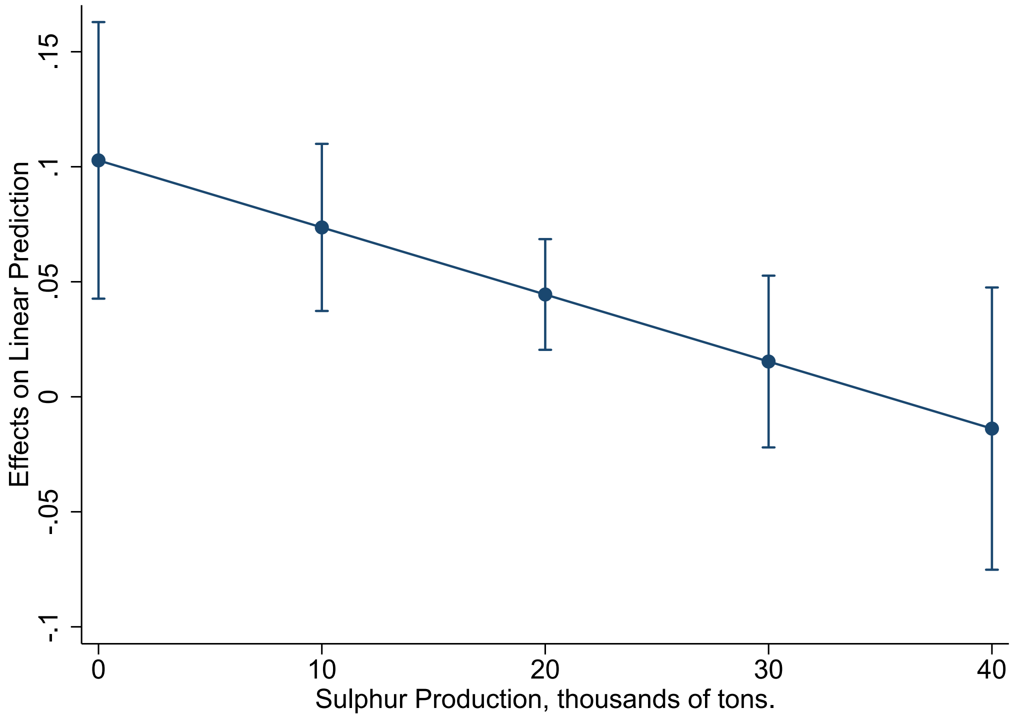
[16]The comparison of the adjusted R^2 of specifications in columns 2 and 6 supports the inclusion of squared production.

Table 2: Sulphur production in 1883 (MAIC, 1887) and incidence of Mafia.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sulphur Production	0.038***	0.034***	0.047***	0.049***	0.094***	0.071**	0.118***	0.103***
	(0.012)	(0.010)	(0.014)	(0.013)	(0.025)	(0.032)	(0.024)	(0.031)
Sulphur Prod. Squared					-0.002***	-0.001	-0.002***	-0.001**
					(0.001)	(0.001)	(0.001)	(0.001)
Inclined shaft			-0.107	-0.177*			-0.163**	-0.216**
			(0.071)	(0.093)			(0.070)	(0.092)
Citrus suitability	-0.025	-0.023	-0.024	-0.021	-0.026	-0.023	-0.024	-0.020
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Cereal suitability	0.034***	0.022**	0.033***	0.021*	0.036***	0.023**	0.034***	0.023**
	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)
Olive suitability	0.005	-0.001	0.005	-0.000	0.003	-0.003	0.003	-0.003
	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.013)
Water scarcity	1.156***	0.006	1.155***	-0.001	1.146***	0.005	1.143***	-0.004
	(0.153)	(0.193)	(0.153)	(0.193)	(0.154)	(0.194)	(0.154)	(0.194)
Ruggedness	0.003***	-0.001	0.003***	-0.001	0.003***	-0.001	0.003***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Different elevation	0.000***	0.001***	0.000***	0.001***	0.000***	0.001***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Postal roads	0.082	0.108	0.080	0.103	0.108	0.121	0.111	0.120
	(0.114)	(0.101)	(0.114)	(0.100)	(0.114)	(0.100)	(0.113)	(0.099)
Distance to rivers	-0.018**	0.004	-0.019**	0.003	-0.019**	0.004	-0.019**	0.002
	(0.008)	(0.009)	(0.008)	(0.010)	(0.008)	(0.009)	(0.008)	(0.009)
Distance to port	-0.002	-0.003	-0.002	-0.003	-0.002	-0.002	-0.001	-0.002
	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)
Urban	0.658***	0.198	0.671***	0.210	0.628***	0.207	0.642***	0.225
	(0.185)	(0.192)	(0.186)	(0.193)	(0.184)	(0.191)	(0.185)	(0.192)
Population density	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.778**	1.026**	-0.773**	1.044**	-0.784**	0.978*	-0.777**	0.982*
	(0.367)	(0.508)	(0.369)	(0.506)	(0.366)	(0.507)	(0.368)	(0.505)
Department FEs	no	yes	no	yes	no	yes	no	yes
Adj. R^2	0.382	0.563	0.383	0.568	0.390	0.565	0.393	0.573
N	282	282	282	282	282	282	282	282

The dependent variable is the measure of mafia intensity provided by Cutrera (1900). The production measure is thousands of tons of sulphur produced at the municipality level, recorded in MAIC (1887). Columns 2,4,6 and 8 include department fixed effects. Robust standard errors in parenthesis. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 1: Marginal effects of sulphur production in 1883 on Mafia intensity.



4.2 Robustness checks

We run a battery of tests to assess the robustness of our findings. All the results are reported in the Appendix. Table A1 explores the existence of a quadratic relation using as main regressor the number of mines, as in Buonanno et al. (2015). As confirmed in Figure A2 the marginal effect of the number of mines on mafia intensity is positive but decreasing.

When we use the alternative production measure provided in Parodi (1873), our main conclusions are generally confirmed, although the significance of the production squared term is slightly weaker (see Table A2 and Figure A3). Then, in Table A3, we re-estimate our basic OLS specification excluding the municipality of Caltanissetta, as it could be an outlier driving the quadratic relation between sulphur and mafia. Our results are still there. As a further robustness check, we replicate the analysis using a MS-estimator (Maronna and Yohai, 2000; Verardi and Croux, 2009). This procedure provides estimates that are robust to the presence of outliers.[17] As shown

[17] We use the command mmregress in STATA developed by Verardi and Croux (2009).

in Table A4 the main results are unchanged, thus confirming that the quadratic OLS specification is not driven by outliers.

We also run an ordered probit regression, instead of the standard OLS we presented (see Table A5). With the exception of the specification that uses production data from Parodi (1873) and includes department fixed effects, the squared production term is still negative and significant. Further, we explore the effect of sulphur production using the dataset by Acemoglu et al. (2020).[18] In particular, in Table A6, we present the estimates obtained with the instrumental variable and the controls exploited in Acemoglu et al. (2020), together with the measure of sulphur production provided by MAIC (1887). Considering the high number of regressors and the presence of collinearity problems, we also resort to a LASSO procedure to select the controls. We still obtain that the impact of the quadratic term of sulphur production is negative and significant.

Finally, when we investigate the relation between mechanization – as measured by the adoption of inclined shafts - and local criminal activity, one may legitimately ask in which direction causation is running. Although we suggest that more mechanization reduced local propensity to crime, there remains the possibility that causation runs the opposite way, i.e., that low levels of local criminal activity encouraged entrepreneurs to invest more. To tackle this issue, we instrument local mechanization by exploiting the altitude of the municipality. This choice is strongly supported by the observation that mountainous areas were particularly favorable to the adoption of the inclined shaft: see Cagni (1903, p.72). In Table A7 we report the result from instrumental variable regression. The main results hold and the coefficient of the instrument in the first stage regression is significant at 1% or 5% level.

To sum up, our evidence shows that the impact of sulphur on mafia's presence is largely attenuated in municipalities that (i) were relatively richer in sulphur, and (ii) underwent more intensive mechanization.

These results suggest that, when local resources were abundant enough to stimulate investment in organization and mechanization at the workplace, the thrust to criminal attitudes was weaker.

[18]The impact of sulphur production in the regression conducted by Acemoglu et al. (2020), although not reported in their tables, is positive and significantly different from zero.

5 Discussion and Conclusions

In this paper, we argued that the resource curse interpretation of the nexus between sulphur and Sicilian mafia needs to be, in part, revisited. For what concerns the sulphur industry, the availability of resources went together -in most cases- with miserable working conditions. Similarly to Buonanno et al. (2015), we find that Sicilian sulphur mines favoured the diffusion of mafia activities in municipalities that were on the small-medium scale of production. However, in municipalities that exhibited larger ore extraction, sulphur did not have a significant impact on mafia. Our explanation emphasizes the duality of the Sicilian mining industry in the second half of the nineteenth century. On the one side, there was a vast majority of small mines characterized by inadequate and chaotic cultivation techniques. Such mines were a sort of no-man's-land where disorder and confrontation were the norm, an ideal breeding environment for the supply of violent individuals. On the other side, the resource-richest locations offered room for the development of a few large mines, often controlled by foreign investors. Larger mines hired competent technical personnel, offered first-aid medical assistance and had a scale sufficient to implement mechanization, such as inclined shafts for transportation and updated devices for air-circulation and dewatering. Possibly, the organization of labour in such mines provided a novel set of implicit and explicit rules which disciplined the workforce and improved safety. At the same time, progressive mechanization alleviated working conditions by reducing fatigue, contributing to safer and healthier jobs and, finally, excluding children from ore transportation. In this perspective, it mainly was the varied quality of local working conditions in the sulphur industry that fueled or dampened the culture of violence. Differences in workplace conditions still seem to be crucial in the mining industry of developing countries. Recent research by Salas et al. (2015) has concentrated on the relation among miners' working conditions, workplace violence and psychological distress in some Latin American countries. The authors emphasize that psychological distress and exposure to violence are disproportionally large in the Bolivian and Chilean mines they consider. There, miners are exposed to precarious employment, "rare use of safety equipment" and "low life expectancy". By contrast, they find no evidence of abnormal distress and violence among Peruvian miners, “who were employed in a relatively large industrial mine offering formal contract” and “occupational health services” (p.472-473).

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Appendix

Figure A1 displays the map with the area and amount of sulphur production at the municipality level in MAIC (1887).

In Table A1 we add to the baseline specifications[19] of Buonanno et al. (2015) the squared number of sulphur mines in the municipality, controlling in the even columns for department fixed effects.[20] The significant and negative coefficients of the squared number of mines in columns 3, 4, 7 and 8 indicate that the effect of sulphur production is positive but concave. As shown in Figure A2, the marginal effect - based on the specification in column 8 of Table A1 - turns out to be insignificant in municipalities with more than 30 mines.

We then assess the robustness of our findings by: (i) using the measure of sulphur production provided in Parodi (1873); (ii) excluding the municipality of Caltanissetta as potential outlier driving the quadratic relation; (iii) using an MM-estimator robust to the presence of outliers; (iv) running ordered probit regressions, rather than OLS; (v) exploiting the dataset in Acemoglu et al. (2020) which provides, for a smaller number of municipalities, a larger set of controls; and (vi) instrumenting our measure of mechanization.

Parodi's (1873) production data. In Table A2 we report the OLS estimates using the production of sulphur from Parodi (1873) as the main regressor of interest. The OLS estimates show a pattern similar to the one displayed in Table 2. The number of inclined shafts has always a negative and significant impact on the level of mafia activity. The full specifications in columns 7 and 8, without and with department fixed effect respectively, exhibit the highest level of adjusted R^2 and report significant coefficients for both the quadratic terms of sulphur production. Figure A3 confirms that the positive impact of sulphur production declines and becomes insignificant in the municipalities where production is relatively high.

Excluding the municipality of Caltanissetta. In principle, the significance

[19] In the last specification of Table 3, column 7, Buonanno et al. (2015) use land fragmentation as an additional control. We do not include this regressor since the missing values in this variable would lead to the exclusion of the several municipalities with sizeable production of sulphur. Moreover, fragmentation of land does not correspond to fragmentation in the excavations. As emphasized by Parodi (1873), big land owners were often dividing an area barely sufficient for the installation of a good mine into 15 or 20 slots, to be rented to different *gabellotti*.

[20] Departments were the intermediate level of administrative division below provinces. Sicily was organized in 7 provinces and 24 departments.

of the quadratic production term could be driven by Caltanissetta alone, since it was the municipality with the highest production of sulphur. However, our results continue to hold even when we exclude this municipality from the sample, as shown by the estimates reported in Table A3.

MS-estimator. As a further robustness check, we replicate the analysis using a MS-estimator (Yohai, 1987; Verardi and Croux, 2009). This procedure provides estimates that are robust to the presence of outliers.[21] As shown in Table A4 the main results are unchanged.

Ordered Probit estimation. Given the discrete nature of Cutrera's (1900) index of mafia (although it is commonly used in the literature as a continuous measure of the intensity of mafia's activity), an obvious check is to perform an estimation by Ordered Probit, reported in Table A5. With the exception of column (4), based on Parodi's data and including department fixed effects, our main results still hold true. The marginal effects for each outcome are available upon request.

Determinants of Mafia: Acemoglu et al. (2020). In Table A6 we report estimates using the dataset provided in Acemoglu et al. (2020). The dependent variable is still the measure of mafia intensity by Cutrera (1900). The dataset includes a dummy for the local presence of peasants' Fasci (trade-unions), geographic controls, and additional controls for the determinants of Fasci and mafia. All estimates are obtained with instrumental variable regression to address the endogeneity of the variable measuring the presence of peasants' Fasci: the instrumental variable is relative rainfall over the spring of 1893, interpolated by using municipalities within 30 kilometers from weather stations. We use the measure of sulphur production -and its square - provided by MAIC (1887). As indicated by the Variance Inflation Factor (VIF) of the production measure, there is much multicollinearity among the regressors. To address this issue we also estimate an IV LASSO regression using the ivlasso command developed by Stata Corporation. We compute two way clustered standard errors using the procedure suggested by Cameron et al. (2011). Estimates in columns (1)-(2)-(3) in Table A6 indicate that the significance of the coefficient of squared production is somehow reduced by the wider set of controls adopted by Acemoglu et al. (2020). However, given the evidence about the presence of collinearity

[21] We use the command msregress in STATA developed by Verardi and Croux (2009)

among regressors, in column (4) we select the controls following a LASSO procedure. The squared production term is still negative and significant. The inclined shaft coefficient, though, is not significant. This result might be due to the reduced sample size, and to other differences between the datasets used in Buonanno et al. (2015) and Acemoglu et al. (2020), that are discussed in Footnote 14 of the main text.

Instrumental Variable regression. As mentioned in the main text, in order to tackle potential endogeneity in the adoption of inclined shafts, we exploit municipal altitude as an instrument. This choice is grounded on a simple motivation. According to the technical report of Cagni (1903) on sulphur extraction, the excavation technique largely depended on the features of local terrains. In particular, he argued that "in mountainous terrains, which include inclined strata, the implementation of horizontal galleries or inclined shafts is to be preferred" (p.72). As reported in Table A7, the F-statistics of the first-stage coefficient of the instrumental variable is pretty close to the conventional threshold of 10. However, as expected, the inclusion of department fixed effects captures most of the variability of the instrument, thus reducing the F-statistics.

Figure A1: Sulphur production at the municipality level in 1883, Ministero di Agricoltura, Industria e Commercio (1887)

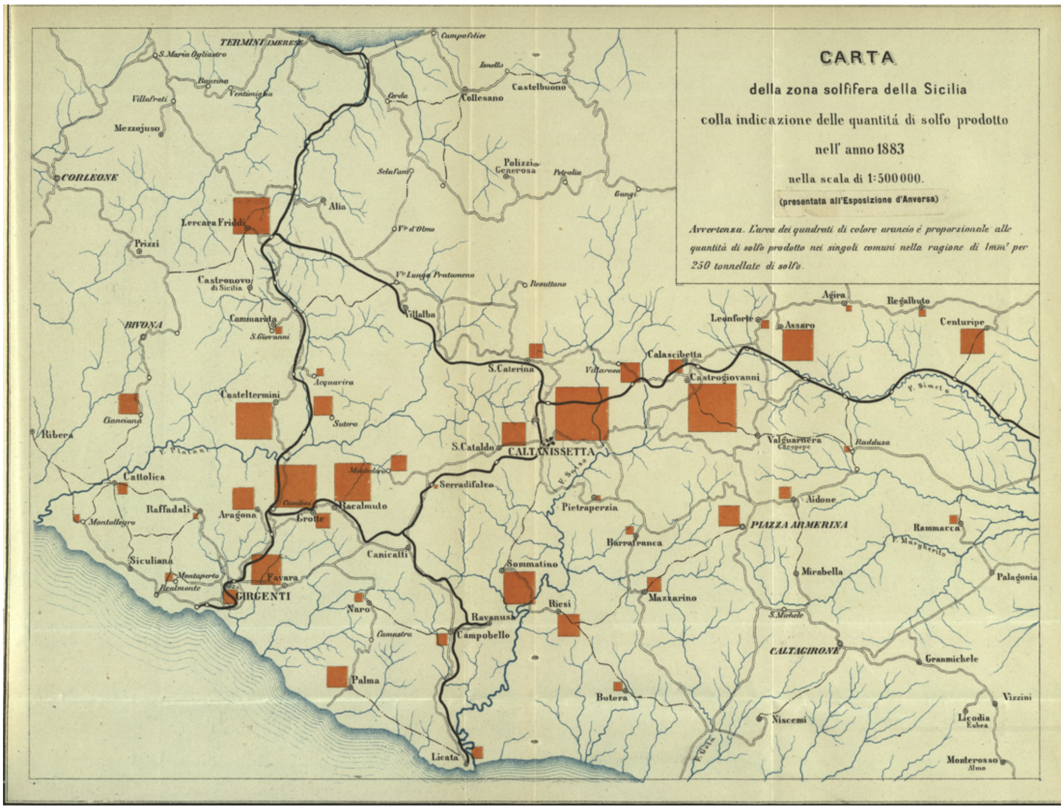

Table A1: Number of sulphur mines and incidence of Mafia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
N. of mines	0.033***	0.022***	0.065***	0.065***	0.026***	0.024***	0.079***	0.078***
	(0.011)	(0.008)	(0.021)	(0.021)	(0.009)	(0.009)	(0.018)	(0.022)
Squared n. of mines			-0.001**	-0.001**			-0.001***	-0.001**
			(0.000)	(0.000)			(0.000)	(0.000)
Citrus suitability					-0.025	-0.023	-0.027	-0.025
					(0.017)	(0.017)	(0.017)	(0.016)
Cereals suitability					0.035***	0.022**	0.039***	0.027**
					(0.010)	(0.011)	(0.010)	(0.011)
Olive suitability					0.004	-0.002	0.001	-0.005
					(0.009)	(0.013)	(0.009)	(0.013)
Water scarcity					1.150***	0.006	1.129***	-0.001
					(0.153)	(0.193)	(0.154)	(0.194)
Ruggedness					0.003***	-0.001	0.003***	-0.001
					(0.001)	(0.001)	(0.001)	(0.001)
Different elevation					0.000***	0.001***	0.000***	0.001***
					(0.000)	(0.000)	(0.000)	(0.000)
Postal roads					0.077	0.098	0.121	0.123
					(0.114)	(0.100)	(0.111)	(0.097)
Distance to rivers					-0.019**	0.005	-0.019**	0.006
					(0.008)	(0.009)	(0.008)	(0.009)
Distance to Port					-0.002	-0.003	-0.002	-0.002
					(0.004)	(0.007)	(0.004)	(0.007)
Urban					0.622***	0.186	0.564***	0.175
					(0.185)	(0.190)	(0.187)	(0.188)
Population density					0.001***	0.001***	0.002***	0.001***
					(0.000)	(0.000)	(0.000)	(0.000)
Constant	1.367***	1.388***	1.326***	1.355***	-0.776**	1.036**	-0.775**	0.979*
	(0.070)	(0.050)	(0.071)	(0.050)	(0.367)	(0.511)	(0.366)	(0.505)
Department FEs	No	Yes	No	Yes	No	Yes	No	Yes
Adj. R^2	0.039	0.526	0.062	0.534	0.385	0.564	0.400	0.576
N	282	282	282	282	282	282	282	282

The dependent variable is the measure of mafia intensity provided by Cutrera (1900). Columns 1,2 and 6 are the specifications shown in Buonanno et al. (2015) in Table 3, columns 1,2 and 6 respectively. Columns 2,4,6 and 8 include department fixed effects. Robust standard errors in parenthesis. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A2: Marginal effects of the number of mines on mafia intensity.

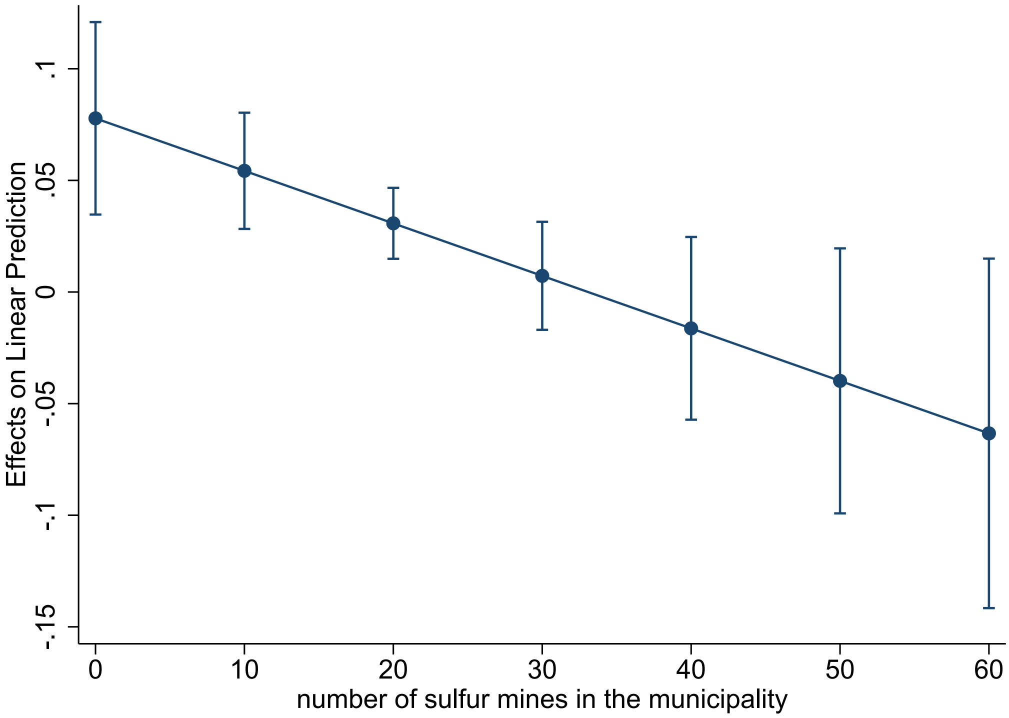

Table A2: Sulphur production and incidence of Mafia. Sulphur production from Parodi (1873), in 1868-70.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sulphur Prod.	0.088***	0.089***	0.115***	0.129***	0.173***	0.147**	0.251***	0.248***
	(0.022)	(0.026)	(0.032)	(0.038)	(0.057)	(0.063)	(0.066)	(0.067)
Sulphur Prod. Squared					-0.006*	-0.004	-0.009***	-0.008**
					(0.003)	(0.003)	(0.003)	(0.003)
Inclined shaft			-0.148**	-0.226***			-0.221***	-0.289***
			(0.073)	(0.082)			(0.071)	(0.074)
Citrus suitability	-0.027	-0.025	-0.025	-0.023	-0.026	-0.025	-0.024	-0.021
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)
Cereals suitability	0.036***	0.023**	0.035***	0.023**	0.037***	0.024**	0.036***	0.024**
	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)
Olive suitability	0.004	-0.002	0.004	-0.002	0.002	-0.003	0.001	-0.004
	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.013)
Water scarcity	1.149***	-0.001	1.148***	-0.014	1.148***	0.004	1.145***	-0.007
	(0.154)	(0.193)	(0.154)	(0.193)	(0.155)	(0.193)	(0.155)	(0.193)
Ruggedness	0.003***	-0.001	0.003***	-0.001	0.003***	-0.001	0.003***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Different elevation	0.000***	0.001***	0.000***	0.001***	0.000***	0.001***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Postal roads	0.108	0.131	0.112	0.135	0.114	0.132	0.124	0.137
	(0.114)	(0.100)	(0.113)	(0.099)	(0.113)	(0.100)	(0.113)	(0.099)
Distance to rivers	-0.019**	0.005	-0.019**	0.003	-0.019**	0.006	-0.019**	0.004
	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.010)	(0.008)	(0.009)
Distance to port	-0.002	-0.004	-0.002	-0.004	-0.002	-0.003	-0.002	-0.003
	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.007)
Urban	0.583***	0.120	0.581***	0.106	0.602***	0.148	0.609***	0.153
	(0.189)	(0.196)	(0.188)	(0.195)	(0.187)	(0.194)	(0.185)	(0.193)
Population density	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.766**	1.051**	-0.755**	1.094**	-0.782**	1.007**	-0.772**	1.024**
	(0.367)	(0.503)	(0.369)	(0.499)	(0.366)	(0.504)	(0.367)	(0.497)
Department FEs	no	yes	no	yes	no	yes	no	yes
Adj R^2	0.390	0.574	0.393	0.584	0.393	0.575	0.401	0.590
N	282	282	282	282	282	282	282	282

The dependent variable is the measure of mafia intensity provided by Cutrera (1900). The production measure represents thousands of tons of sulphur produced at the municipality level, recorded in Parodi (1873). Columns 2,4,6 and 8 include department fixed effects. Robust standard errors in parenthesis. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A3: Marginal effects of sulphur production from Parodi(1873), in 1868-70.

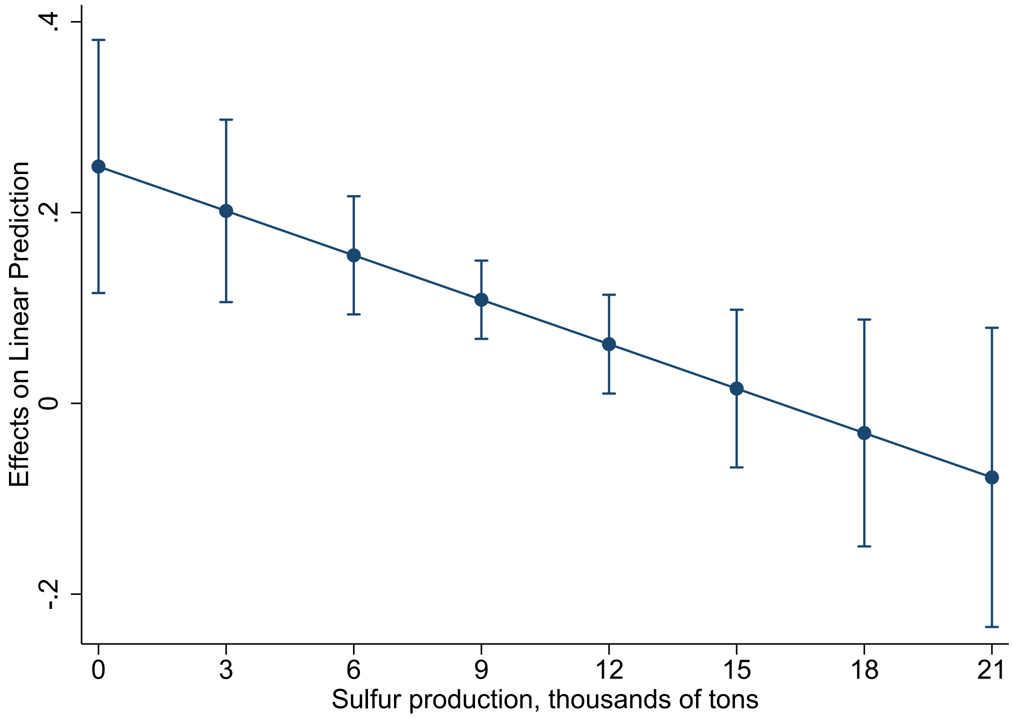

Table A3: Sulphur & Mafia: excluding Caltanissetta from the sample.

	Production MAIC, 1887		Production Parodi, 1873	
	(1)	(2)	(3)	(4)
Sulphur prod.	0.174***	0.191***	0.251***	0.252***
	(0.048)	(0.054)	(0.066)	(0.067)
Sulphur prod.squared	-0.004**	-0.005***	-0.009***	-0.008***
	(0.002)	(0.002)	(0.003)	(0.003)
Inclined shaft	-0.215***	-0.299***	-0.219***	-0.304***
	(0.073)	(0.094)	(0.073)	(0.075)
Citrus suitability	-0.024	-0.021	-0.024	-0.022
	(0.017)	(0.017)	(0.018)	(0.018)
Cereals suitability	0.035***	0.023**	0.036***	0.023**
	(0.010)	(0.011)	(0.010)	(0.011)
Olive suitability	0.002	-0.002	0.001	-0.003
	(0.010)	(0.013)	(0.010)	(0.013)
Water scarcity	1.141***	0.006	1.145***	-0.005
	(0.155)	(0.195)	(0.155)	(0.193)
Ruggedness	0.003***	-0.001	0.003***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
different elevation	0.000***	0.001***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
postal roads	0.109	0.108	0.125	0.130
	(0.113)	(0.100)	(0.114)	(0.099)
Distance to rivers	-0.019**	0.004	-0.020**	0.004
	(0.008)	(0.009)	(0.008)	(0.009)
Distance to port	-0.002	-0.001	-0.002	-0.004
	(0.004)	(0.007)	(0.004)	(0.007)
Urban	0.645***	0.244	0.608***	0.156
	(0.182)	(0.190)	(0.186)	(0.193)
Population density	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.779**	0.915*	-0.772**	1.024**
	(0.367)	(0.507)	(0.367)	(0.497)
Department FEs	No	Yes	No	Yes
Adj. R^2	0.396	0.580	0.400	0.590
N	281	281	281	281

All columns report estimates from and OLS. Columns 2 and 4 include department fixed effects. The municipality of Caltanissetta is excluded from the sample. The production measure in column 1 and 2 represents thousands of tons of sulphur produced at the municipality level, recorded in MAIC (1887). The production measure in columns 3 and 4 represents thousands of tons of sulphur produced at the municipality level, recorded in Parodi (1873). Robust standard errors in parenthesis. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Estimates robust to outliers: MS-estimator.

	Production MAIC, 1887				Production Parodi, 1873			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sulphur production	0.0497***	0.0482***	0.1509***	0.0964***	0.1149***	0.1543***	0.2173***	0.2039***
	(0.0175)	(0.0000)	(0.0241)	(0.0004)	(0.0279)	(0.0000)	(0.0000)	(0.0353)
Sulphur production squared			-0.0039***	-0.0018***			-0.0075***	-0.0074***
			(0.0007)	(0.0000)			(0.0000)	(0.0017)
Inclined shafts	-0.2097***	-0.2048***	-0.2923***	-0.2457***	-0.2657***	-0.2398***	-0.2587***	-0.2788***
	(0.0393)	(0.0000)	(0.0267)	(0.0003)	(0.0443)	(0.0000)	(0.0000)	(0.0375)
Citrus suitability	-0.0084	-0.0000***	-0.0062	-0.0000	-0.0131	0.0000***	-0.0000**	-0.0119
	(0.0232)	(0.0000)	(0.0139)	(0.0000)	(0.0119)	(0.0000)	(0.0000)	(0.0110)
Cereals suitability	0.0140	0.0000***	0.0096	0.0000	0.0068	-0.0000*	-0.0000**	0.0082
	(0.0241)	(0.0000)	(0.0125)	(0.0000)	(0.0106)	(0.0000)	(0.0000)	(0.0123)
Olive suitability	-0.0111	-0.0000	-0.0047	-0.0000	0.0064	-0.0000***	0.0000***	0.0025
	(0.0236)	(0.0000)	(0.0163)	(0.0001)	(0.0161)	(0.0000)	(0.0000)	(0.0151)
Ruggedness	-0.0011	0.0000	-0.0007	-0.0000	-0.0002	0.0000**	-0.0000	-0.0004
	(0.0011)	(0.0000)	(0.0009)	(0.0000)	(0.0009)	(0.0000)	(0.0000)	(0.0008)
Different elevations	0.0004***	0.0000*	0.0004***	-0.0000	0.0003***	-0.0000	-0.0000	0.0004***
	(0.0002)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
Distance to rivers	-0.0056	-0.0000	-0.0027	-0.0000	-0.0021	-0.0000	0.0000	-0.0007
	(0.0093)	(0.0000)	(0.0102)	(0.0000)	(0.0092)	(0.0000)	(0.0000)	(0.0113)
Distance to port	0.0030	-0.0000***	-0.0033	-0.0000	-0.0087	0.0000	-0.0000***	-0.0063
	(0.0174)	(0.0000)	(0.0085)	(0.0000)	(0.0090)	(0.0000)	(0.0000)	(0.0084)
Population density	0.0021***	0.0000	0.0021***	0.0000	0.0018***	0.0000	0.0000	0.0019***
	(0.0006)	(0.0000)	(0.0004)	(0.0000)	(0.0004)	(0.0000)	(0.0000)	(0.0004)
Water scarcity	2.0544***	0.0000*	1.8806***	-0.0000	1.8978***	-0.0000***	-0.0000	1.8840***
	(0.5034)	(0.0000)	(0.1990)	(0.0001)	(0.2772)	(0.0000)	(0.0000)	(0.2206)
Postal roads	0.0573	-0.0000	0.1382	0.0001	0.1506	0.0000	0.0000	0.1809
	(0.3465)	(0.0000)	(0.1637)	(0.0001)	(0.2323)	(0.0000)	(0.0000)	(0.1874)
Urban	0.6167	0.0000*	0.5411**	-0.0001	0.3185	-0.0000**	-0.0000***	0.3947
	(0.3860)	(0.0000)	(0.2554)	(0.0000)	(0.2746)	(0.0000)	(0.0000)	
Constant	-0.1575	3.0000***	-0.1796	0.9974***	-0.0932	1.0000***	1.0000***	-0.1548
	(0.2979)	(0.0000)	(0.2389)	(0.0026)	(0.2789)	(0.0000)	(0.0000)	(0.2778)
Department FEs	no	yes	no	yes	no	yes	no	yes
N	282	282	282	282	282	282	282	282

Estimates obtained from the MS-estimator implemented by the STATA command msregress (Verardi and Croux, 2009) Significance levels: * $p < 0.10$,

Table A5: Ordered Probit estimation: Sulphur production and incidence of Mafia.

	Production MAIC, 1887		Production Parodi, 1873	
	(1)	(2)	(3)	(4)
Sulphur prod.	0.194***	0.213***	0.357***	0.374**
	(0.052)	(0.071)	(0.130)	(0.171)
Sulphur prod. squared	-0.003***	-0.003**	-0.012*	-0.007
	(0.001)	(0.001)	(0.007)	(0.012)
Inclined shaft	-0.241***	-0.396***	-0.292**	-0.484***
	(0.094)	(0.143)	(0.114)	(0.131)
Citrus suitability	-0.033	-0.025	-0.033	-0.028
	(0.022)	(0.026)	(0.023)	(0.027)
Cereals suitability	0.045***	0.032*	0.046***	0.032*
	(0.013)	(0.017)	(0.014)	(0.017)
Olive suitability	0.003	-0.004	0.002	-0.002
	(0.011)	(0.019)	(0.011)	(0.020)
Waters scarcity	1.478***	0.009	1.487***	0.019
	(0.223)	(0.330)	(0.225)	(0.333)
Ruggedness	0.004***	-0.002	0.004***	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Different elevations	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Postal roads	0.205	0.271*	0.210	0.297*
	(0.144)	(0.158)	(0.144)	(0.162)
Distance to rivers	-0.029**	0.005	-0.029**	0.006
	(0.012)	(0.016)	(0.012)	(0.016)
Distance to port	-0.001	-0.002	-0.002	-0.007
	(0.004)	(0.011)	(0.005)	(0.011)
Urban	0.956***	0.447	0.920***	0.334
	(0.266)	(0.311)	(0.267)	(0.316)
Population Density	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
cut point	2.187***	1.548*	2.188***	1.421*
	(0.518)	(0.854)	(0.521)	(0.857)
cut point 2	3.068***	2.841***	3.071***	2.750***
	(0.525)	(0.862)	(0.528)	(0.868)
cut point 3	3.999***	3.951***	4.012***	3.886***
	(0.542)	(0.885)	(0.545)	(0.892)
Department FEs	No	Yes	No	Yes
N	282	282	282	282

All columns report estimates from and ordered probit. The production measure in column 1 and 2 represents thousands of tons of sulphur produced at the municipality level, recorded in MAIC (1887). The production measure in columns 3 and 4 represents thousands of tons of sulphur produced at the municipality level, recorded in Parodi (1873). Columns 2 and 4 include department fixed effects. Robust standard errors in parenthesis. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Determinants of Mafia: Data from Acemoglu et al. (2000) and sulphur production from MAIC (1887)

	(1) IV	(2) IV	(3) IV	(4) IV LASSO
Peasants Fasci	1.878***	1.567***	1.344***	1.199*
	(0.364)	(0.513)	(0.418)	(0.615)
Sulphur Production	0.100***	0.101**	0.108**	0.114***
	(0.039)	(0.043)	(0.043)	(0.031)
Sulphur Prod. Squared	-0.002**	-0.002	-0.002*	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Inclined shaft	0.005	0.010	-0.060	-0.046
	(0.051)	(0.102)	(0.116)	(0.045)
				Controls for IV LASSO selected from:
Determinants of Fasci	yes	yes	yes	yes
Determinants of Mafia	yes	yes	yes	yes
Geographic Controls		yes	yes	yes
province FE	no	no	yes	no
VIF sulphur production	10.178	11.745	12.961	10.207
Adj. R^2	0.163	0.326	0.389	0.387
N	245	245	245	245

All columns report estimates from IV regression using data from Acemoglu et al. (2020): the endogenous variable is the presence of peasants Fasci and the instrumental variable is the relative rainfall for the spring of 1893 interpolated using municipalities within 30 kilometers. Column 3 includes province fixed effects. The production measure used in all columns represents thousands of tons of sulphur produced at the municipality level, recorded in MAIC (1887). The set of controls used are the determinants of Fasci, of Mafia and geographic controls used in Acemoglu et al. (2020). Column 4 estimates an IV lasso selecting controls (except production which is included by default) from the full set of controls used by Acemoglu et al. (2020): the square of production and inclined shaft are selected from the LASSO algorithm. VIF reports the Variance Inflation Factor for the sulphur production. Two way clustered standard errors in parenthesis are computed using the method indicated by Cameron et al. (2011). Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7: Regression with instrumental variable.

	Production MAIC, 1887			
Sulphur Production	0.0629***	0.0578***	0.1347***	0.1096***
	(0.0144)	(0.0117)	(0.0259)	(0.0313)
Sulphur Production squared			-0.0022***	-0.0015**
			(0.0006)	(0.0007)
Inclined shafts	-0.2938**	-0.2804***	-0.2721***	-0.2622***
	(0.1243)	(0.0761)	(0.0607)	(0.0717)
Citrus suitability	-0.0218	-0.0198	-0.0224	-0.0196
	(0.0168)	(0.0159)	(0.0168)	(0.0160)
Cereals suitability	0.0314***	0.0204**	0.0336***	0.0225**
	(0.0094)	(0.0102)	(0.0093)	(0.0101)
Olive suitability	0.0057	-0.0002	0.0027	-0.0029
	(0.0095)	(0.0122)	(0.0094)	(0.0123)
Water scarcity	1.1540***	-0.0056	1.1408***	-0.0057
	(0.1490)	(0.1803)	(0.1499)	(0.1807)
Ruggedness	0.0028***	-0.0012	0.0028***	-0.0012
	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Different elevations	0.0004***	0.0006***	0.0004***	0.0006***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Postal roads	0.0770	0.1003	0.1122	0.1193
	(0.1128)	(0.0942)	(0.1103)	(0.0923)
Distance to rivers	-0.0195**	0.0017	-0.0199**	0.0017
	(0.0081)	(0.0087)	(0.0080)	(0.0085)
Distance to port	-0.0017	-0.0035	-0.0013	-0.0016
	(0.0035)	(0.0065)	(0.0035)	(0.0066)
Urban	0.6937***	0.2172	0.6520***	0.2289
	(0.1851)	(0.1818)	(0.1798)	(0.1794)
Population density	0.0013***	0.0012***	0.0014***	0.0013***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Constant	-0.7635**	-0.0917	-0.7729**	-0.1406
	(0.3618)	(0.4973)	(0.3589)	(0.4990)
Department FEs	no	yes	no	yes
	Coefficient of instrumental variable from first stage			
altitude	0.0081***	0.0062***	0.0052***	0.0062**
	(0.0017)	(0.0020)	(0.0017)	(0.0029)
First stage F-statistic	[23.9305]	[8.2771]	[9.4993]	[3.9490]
Adj. R^2	0.3744	0.5658	0.3905	0.5728
N	282	282	282	282

Estimates obtained using as instrumental variable the predicted number of inclined shaft computed from a first stage Poisson regression (Wooldridge, 2010). F statistic on instrumental variable coefficient in square brackets. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ** $p < 0.05$, *** $p < 0.01$.