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**The good connections: A Network Analysis of  
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# The good connections: A Network Analysis of organized crime, patronage, and local elites\*

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## Abstract

So far, the application of network analysis to crime has been limited to the relationships within criminal networks. We build a novel network dataset by encoding information coming from the archive of the Italian Anti-mafia Commission, describing relationships of collusion and exchange of favours between mafia members and the political, economic and social elites in Sicily, the homeland of the Sicilian mafia. We apply network analysis techniques to study the “topological” role of mafia bosses and show that they strategically position themselves in the social network as an interface between the criminal and the legitimate world.

*Keywords:* Network; Organized Crime; Boss; Institutions

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# 1 Introduction

Organized crime is the plague afflicting several countries nowadays given its power and the huge socio-economic costs it (im)poses on a society. The ability of criminal organizations to establish the right connections is at the heart of their ability to maintain control over the territory, through which they eventually become endemic and difficult to eradicate. In particular, the relationships with formal institutions allow them to infiltrate the legal economy, re-invest profits coming from illicit activities and survive prosecution. One of the most known and oldest criminal organizations is the Sicilian mafia, frequently referred to as *Cosa Nostra*, whose presence in Sicily dates back to the nineteenth century (Gambetta, 1993; Dickie, 2004; Lupo, 2004; Ciconte et al., 2012).

The study of organized crime has recently attracted the attention of scholars in various disciplines in the social sciences, including economics.<sup>1</sup> Moreover, the analysis of social networks has experienced a boom over the past few decades, thus spurring the study of criminal organizations from a network perspective, although the difficulty of obtaining suitable relational data about criminal and typically “hidden” connections is still a big obstacle for the application of Network Analysis to this type of phenomena.

This paper describes and applies Network Analysis to a novel dataset of connections between members of the Sicilian mafia and members of the Sicilian political, economic and social elites. We built this dataset by collecting information from a series of files made available by the Italian Anti-mafia Commission. The people and the related events described in the files refer mostly to the 1960s. To our knowledge, this is the first network dataset describing the connections both within the criminal organization and with the outside world. So far, the application of network analysis has indeed been limited to the relationships within criminal networks. In this paper we move a step further to analyse the interactions between mafia members and individuals belonging to the social, political and economic elites.

We analyse the topological role of mafia bosses in the network, relative both to the structure of links within members of criminal organizations and to the links with members of institutions. We find that mafia bosses, as compared

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<sup>1</sup>See for example Daniele and Geys (2015); Acemoglu et al. (2013); Dell (2015); Murphy and Rossi (2020); Buonanno et al. (2015); Pinotti (2015); Acemoglu et al. (2020); De Feo and De Luca (2017); Buonanno et al. (2016); Alesina et al. (2019); Barone and Narciso (2015).

to lower ranking mafia members, tend to be more connected with institutions and less connected with other criminal actors. We interpret our results as a suggestion that bosses act as an “interface” between the criminal world and the “official” world. Moreover, our results are also consistent with the view that bosses are the criminals more willing to minimise their criminal relationships in order to be less visible to law enforcement, while keeping good institutional connections.

The paper is organized as follows. In the next section, we discuss the related literature focusing on network analysis applied to criminal organizations. In section 3 we summarize the history of the Sicilian mafia, qualitative and quantitative evidence on the connections between mafia politics and the economy, and provide information on its internal structure. In section 4 we provide information on the source of data and its structure. In section 5 we present the network and describe its main characteristics. In section 6 we describe the empirical strategy and summarize the results, while section 7 concludes with the final remarks.

## 2 Related Literature

Over the past few decades, there has been a large increase in network research across several disciplines in the natural and social sciences (Borgatti et al., 2009). The application of social network analysis to the study of crime is relatively recent. Early contributions (Howlett, 1980; Davis, 1981; Sparrow, 1991) promoted social network analysis as a tool for criminal intelligence even though Sparrow (1991) also highlighted important limitations of criminal network data that, by their very nature, include incomplete information about nodes and links due to the covert nature of criminal activities. Coles (2001) promoted the application of social network tools to analyse criminal groups, and a growing number of network research applied to criminal activities has emerged in their footsteps. These studies analyse various criminal phenomena, ranging from juvenile delinquency (Sarnecki, 2001; Lee et al., 2021) and street gangs (McGloin, 2005) to terrorism (Sageman, 2004). Moreover, the analysis of criminal networks has paved the way to some research on peer effects in criminal behaviour (see Gavrilova and Puca, 2022, for a review of this literature).

The study of crime from a network perspective has also led to recent devel-

opments in the application of network analysis to organized crime and terrorist organizations (Calderoni, 2014b).<sup>2</sup> In this literature we find studies focusing on drug trafficking groups (Natarajan, 2006; Morselli, 2009; Bright et al., 2012), stolen-vehicle smuggling networks (Morselli and Roy, 2008) and, more related to our work, mafia-type organizations. Regarding the latter, Mastrobuoni and Patacchini (2012) examine the extent to which family and community ties, and various individual characteristics, predict the network centrality of mafia members. They analyse a dataset including individual and relational information on 800 members of American Cosa Nostra in the 1950s-1960s, and find that sharing the same surname and being married to someone sharing her maiden name with other mafia members are important correlates of various centrality measures. In addition to kinship ties, the strength of shared interactions with Southern Italy, the motherland of Italian mafias, is a relevant predictor of centrality.<sup>3</sup> Moreover, more central mobsters tend to be more involved in (legal and illegal) businesses. Using the same dataset, Mastrobuoni (2015) studies the impact of network centrality on the economic status of mafia members. With an Instrumental Variable approach, he shows that network centrality (especially closeness) of a mafia member has a significant effect on their wealth, approximated by the market value of the property where they reside.<sup>4</sup>

Morselli (2003) analyse promotions in the criminal career of a famous mafia boss, namely Sammy Gravano, in New York. Through various sources, he reconstructs the evolution of Gravano’s personal network from the 1960s to 1990s, and suggests that, as the criminal career progresses the mobster also becomes more involved in legitimate entrepreneurial activities. Calderoni (2014a) uses data on meetings of members of ‘Ndrangheta, one of the most powerful Italian criminal organizations, to explore if and how much various network centrality measures predict the ranking of mobsters in terms of criminal leadership. In a related study, Calderoni and Superchi (2019) use various network datasets built from different police operations against ‘Ndrangheta, and compare the effectiveness of centrality analysis in detecting mafia leaders comparing connections detected by wiretapped phone calls or meetings. They show

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<sup>2</sup>Although terrorism entails an underlying organization and needs money to pursue its goals, it is usually distinguished from organized crime since its main objective is political-ideological, whereas the main objective of organized crime is profit (Treverton et al., 2009).

<sup>3</sup>The authors call this variable “Interaction index”. It measures the probability of locally sharing the surname in Southern Italy with other mobsters.

<sup>4</sup>The author uses the “Interaction index” in (Mastrobuoni and Patacchini, 2012) as an instrument for network centrality.

that leaders tend to avoid phone calls and instead act as brokers in meeting networks. Catino et al. (2022) analyse the structure of interfamily marriage ties among ‘Ndrangheta families, and the extent to which different families use exogamic marriages as a strategic instrument to seal alliances and endogamic marriages to enhance their internal cohesion. Battisti et al. (2022) study the organizational structure of the Sicilian mafia by using a network dataset based on the documents of the 2008 anti-mafia police operation “Perseo” in Palermo (also analysed by Musotto, 2022). They show that the network behaves as a “small-world”<sup>5</sup>, and specifically features high clustering, which is consistent with the idea that the recruitment process of criminal organizations typically happens locally and new members are introduced by already existing members (Catino, 2019). Moreover, the network is disassortative, meaning that individuals with more connections tend to be linked to individuals with less connections. They also find that mafia bosses are not always the most connected actors in the network, but they are often connected to central relatives, and that the probability of link formation among mobsters is higher if they belong to the same local organizational unit, share similar functions and have a different rank in the hierarchy of the organization. The authors interpret these findings in light of the idea that mafia leaders try to balance a trade-off between the need to be efficient in communicating with other criminals and the need for secrecy to minimize the risk of being caught by law enforcement authorities (Morselli et al., 2007).

Although the available studies shed light on relevant aspects of organized crime from a network perspective, they only have information on relationships among members of the criminal underworld. An exception is Papachristos and Smith (2013), who analyse the set of wider connections among individuals linked to Al Capone’s criminal syndicate in Chicago in the early 1900s. They build a multidimensional network, i.e. a network composed by different (partially overlapping) types of links, in which individuals can be connected through relationships falling into the criminal, legitimate and/or personal spheres. By analysing the structural properties of this network, similarly to Battisti et al. (2022), they find evidence of the small-world property. Apart

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<sup>5</sup>A small-world is a network which features small cohesive groups connected in such a way that individuals can reach each other through a short sequence of connections. It exhibits higher clustering and lower average distance as compared to a random network (Watts and Strogatz, 1998). This behaviour has been observed in many real-world networks, including dark ones (Xu and Chen, 2008; Malm and Bichler, 2011).

from this finding, this work is conceptually close to ours as it highlights the importance of considering the connections between the criminal world and the wider society, especially legitimate institutions, when analysing organized crime.

### **3 The Sicilian Mafia**

The Sicilian mafia is one of the best known criminal organizations in the world. Originating in Sicily in the second half of the 19th century, it spread also in North America in the 1920s and was later popularized by movies and books describing their rituals, violence, and the organised structure of their activities.

Early historical work (Romano, 1966; Mack Smith, 1968; Brancato, 1976) linked the emergence of the Sicilian Mafia to the abolishment of the feudalism, the repartition of communal land and the submission of the workforce in the rural and most backward areas of the island. However, the more recent contribution agree that the origin of the Sicilian Mafia are to be found in the most developed and export oriented areas of the island during the tumultuous process of the Italian unification with the fall of the Bourbon Kingdom and the annexation of Sicily to the Italian Kingdom (see Gambetta, 1993; Dickie, 2004; Lupo, 2004; Benigno, 2015). In this revolutionary period, when patriotic insurgents organized themselves in secrets associations with a structure similar to the freemasonry, in a region where the central government was weak, faraway and incapable of enforcing the law, new organizations emerged challenging the state's monopoly of violence.

Historical work started in the 1980s (Lupo, 1984; Pezzino, 1985, 1987; Catanzaro, 1988) identifies the origins of the Mafia in the Sicilian capital Palermo and its neighbourhood. The demand for their protection services came in fact primarily from the small landholding, intensively cultivated with lemon and orange trees, with its complex chain of financial and commercial brokerage, in the most affluent areas around the former capital Palermo where also the best organized patriotic gangs developed. According to Dickie (2004, p38-9) "The mafia emerged in an area that is still its heartland; it was developed where Sicily's wealth was concentrated, in the dark green coastal strip, among modern capitalist export businesses based in the idyllic orange and lemon groves just outside Palermo." Most of the contemporary observers (Villari, 1875; Franchetti, 1876; Alongi, 1885; Cutrera, 1900) were also puzzled



that such an organization, which was immediately associated with ancient rituals from an archaic society, were instead to be found in the most developed areas of the region. But Gambetta (1993) provides a clear economic interpretation. The presence of small private properties makes easier to externalise the supply of protection to a specialised firm which ensures that the production process is not damaged and that the contracts between producers, middlemen, venture capitalists, shipping companies, wholesale firms are enforced. This was particularly relevant for the citrus cultivation which requires investments several years before the tree starts producing and it is very sensible to water interruptions and vandalism acts (Alfonso, 1875; Del Monte and Pennacchio, 2012).

This was also the case for the other affluent export-oriented area in Sicily, the region of the rich sulphur mines. The earliest trials against a Mafia association in Sicily was in fact held in Girgenti against the Favara brotherhood, composed mainly of sulphur miners, in 1885.

Such historical literature has also received empirical support in the recent years by several econometric works. Del Monte and Pennacchio (2012); Dimico et al. (2017); Buonanno et al. (2015), show in fact that the initial distribution of Sicilian Mafia is explained by the presence of citrus cultivation and sulphur mines. Acemoglu et al. (2020) analyse the expansion of the Sicilian Mafia in the rural areas and show that it occurs later as a result of the demand for protection of the local elites threatened by the 1893 peasant uprising led by the socialist Peasant *Fasci* organizations.

By the end of the 19th century the consolidation of the mafia presence in Sicily was evident. Police reports and inquiries highlighted a strong and well organized presence of Mafia organizations in most of the island well beyond the original setting (see for example Cutrera, 1900; Alongi, 1904).<sup>6</sup> Up to WWI the Sicilian Mafia was an integral part of the social and political power system in Sicily with a strong national influence.<sup>7</sup>

After the war, with the establishment of the fascist dictatorship the Mafia was subject to a tough repression started in 1925 by the prefect Mori, but it

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<sup>6</sup>See also Lupo (2010) which reprints the original report written in 1898 by Ermanno Sangiorgi, Chief of Police of Palermo, who describes in detail the well developed organization of the Mafia in the Palermo province.

<sup>7</sup>See Dickie (2004, pp. 87-130) for an interesting account of Palermo high society and its relationship with the mafia and Salvemini (1910) for a crude account of the relationship between the national political establishment and the mafia in the two decades from 1890 to 1910.

was not entirely eradicated.<sup>8</sup> During WW2 Sicily was an important strategic outpost in the Mediterranean sea. In 1943 the Anglo-American Army invaded the island which ended up separated by the rest of Italy for a long period. Many old mafiosi who had survived the fascist era found a novel social role in those turbulent months and some of them were even appointed by the Allies at the head of local administrations. In the late 40s and early 50s the Sicilian Mafia re-established its grip on the territory with a strong political connection with the Christian Democratic party, the Italian dominant party (De Feo and De Luca, 2017). In those years the Sicilian mafia, consolidate its structure following the example of *Cosa Nostra* in the US.<sup>9</sup> Tensions between and within different clans did not disappear, and eventually exploded for a drug-related dispute in the so-called First Mafia War in the 1962-63. The climax was reached with the so-called Ciaculli massacre when 7 policemen were killed by a car bomb explosion at the outskirt of Palermo. After this episode the mafia faced for the first time a crackdown by the authorities which led to the dissolution of the commission and the paralysis of most of the activities of the clans. However, the repression was short lived. The trials of the late 1960s ended up with the acquittal for most of the leaders; the mafia families recovered and found a common cause in the killing of Michele Cavataio, accused of being the main responsible of the first mafia war. Between 1973 and 1975 the mafia federal structure was rebuilt. However, the power struggle within the organization led to the Second Mafia War, which from 1981 to 1983 established the dominance of the Corleone family over the criminal organization. But a strong antimafia movement emerged in Sicily in the aftermath of the second war laying the ground for the *maxiprocesso* (maxi trial) which started in 1986 and ended in December 1987. The contribution of several important *mafiosi* turned justice witnesses (in particular Tommaso Buscetta, Salvatore Contorno, Antonino Corleone) was crucial for prosecutors' success: 342 alleged *mafiosi* were sentenced to a total of 2665 years in addition to 19 life sentences.<sup>10</sup>

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<sup>8</sup>A recent historical work (Coco and Patti, 2010) has further questioned the results of the fascist repression by describing the vigorous presence and intense activity of the Mafia in the Palermo province during the 1930s using recently discovered reports of the fascist police.

<sup>9</sup>The foundation of the federal structure was allegedly laid during a meeting in Palermo in 1957 attended by the New York boss Joe Bonanno (Lupo, 2004, 266-7).

<sup>10</sup>In January 1992 the Italian Supreme Court largely confirmed the verdict of the maxi trial and few months later two of the prosecutors, Judges G. Falcone and P. Borsellino, were murdered in two separate bomb attacks.

### 3.1 The connections between underworld and upper world in Sicily

The relationship between the Sicilian mafia and the political institutions is as old as the mafia itself. Benigno (2015) analyses the origins of the Sicilian Mafia in the light of covert strategies used by some governments to fight crime with criminals (in particular political “crime” by oppositions, the most dangerous crime for the authorities). Following the Napoleonic tradition, centralized state like the former Bourbons Kingdom and the newly formed Italian Kingdom used the underworld to fight against the political opposition. Benigno highlights the intimate links between the police apparatus and the first Mafia gangs in Palermo and in the neighbouring towns, and the practices of infiltration and manipulation of these gangs as a means of controlling the public and political order. Along the same lines, Dickie (2004) describes the mafia as a political tool used by the central government in Sicily, following the description given by the MP Tajani, a former chief prosecutor in Palermo, who in a parliamentary debate in 1875 explained that “The mafia in Sicily is not dangerous or invincible in itself. It is dangerous and invincible because it is an instrument of local government” (Dickie, 2004, p. 72).<sup>11</sup> In their 1876 inquiry into Sicily, the MPs Franchetti and Sonnino describe the pervasiveness of the mafia in the social and political life. “Let’s imagine a man, whose name and wealth allow reaching a high position among his citizens. [...] He’s got the chance to acquire authority and reputation through administrative, political or other elections. An individual with a known influence on the local population offers him his services; he knows that others exploit similar connections, and that the public opinions does not condemn this. He knows that the man committed some killings, [...] but those homicides only increased the respectability and reputation of its perpetrator. [...] Why not using the tool commonly used by others? So, he accepts the support offered.” (Franchetti, 1877, p.190)

But it was in 1899 that the relationship between mafia and politics in Italy became evident to the national public opinion. The trial of the MP Palazzolo, who was was accused of being the instigator of the murder of Marquis Notarbartolo, fully exposed the connections between mafia groups, politicians, the main Sicilian banks and some of the most renowned Sicilian entrepreneurs of

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<sup>11</sup>The complementary role of the criminal organizations in the local politics, in the struggle for power in the local council is well described in Mosca (1900) and Pezzino (1990).

the time. Notarbartolo was a former major of Palermo and former governor of the Bank of Sicily and in the trial the full scale of political and financial corruption involving the Sicilian elites and the mafia was on the front pages of the national (and often international) press for weeks.<sup>12</sup>

This qualitative evidence finds empirical support in Acemoglu et al. (2020), who show that the development of the mafia affects the political outcomes in the first decades of the 20<sup>th</sup> century by decreasing the level of competition for parliamentary elections.

During the fascist dictatorship, a tough repression started in 1925 by the prefect Mori weakened the criminal organization but did not eradicate it and already in the 1930s it managed to regain its social relevance and the connections with the establishment (Coco and Patti, 2010).

During WWII, Sicily was the first territory of the German-led alliance to be invaded by the allies in the summer of 1943. The allies established the Allied Military Government of Occupied Territories (AMGOT) and banned any political party activities for several months. In their quest for (non-left leaning) local leaders they appointed several known mafiosi as mayors and there was a documented resurgence of mafia organizations, especially in the western part of Sicily. Political freedom was restored in Sicily in 1944 and many mafia members briefly supported a Sicilian separatist movement, which did not succeed in the end. Meanwhile, the DC was becoming the major political force in the Italian National Unity government in opposition to the socialist and communist parties. Several mafia bosses decided to move their political preference towards that party. For instance, Calogero Vizzini and Giuseppe Genco Russo, mafia bosses previously appointed mayors of Villalba and Mussumeli by the AMGOT, became members of the DC in 1947 (Romano, 1966; Lupo, 2004).

There is clear qualitative evidence of the strong connections built in the post-WWII Sicily between the mafia and the Christian Democratic party. Two important Sicilian DC politicians with established mafia connections, Salvo Lima and Vito Ciancimino, built their political careers in the Palermo city council of Palermo between the end of the 1950s and the beginning of the 1960s, (CPM, 1976, pp. 230-4). This connections were not limited to Palermo. The final report of the special Parliamentary Commission investigating the mafia

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<sup>12</sup>See also Salvemini (1910) for a crude account of the relationship between the national political establishment and the mafia in the two decades from 1890 to 1910.

phenomenon, reported that “the city council of Trapani numbered 15 relatives of identified mafia members, while there were 16 in the Caltanissetta council and 20 in the Agrigento council” (CPM, 1976, p.217).

There is considerable judicial evidence that the mafia was supporting the DC in opposition to the left wing parties. For instance, “eleven members of Parliament were investigated as active members of criminal organizations; all of them had been elected in the Christian Democratic Party or in its allied parties” (Alesina et al., 2019). Furthermore, it has been established in several trials that Salvo Lima, Vito Ciancimino and Ignazio Salvo, some of the most relevant Sicilian DC politicians, were closely associated with or even members of the most important mafia families (Dickie, 2004, pp. 227, 253, 283). According to a court ruling, even the late MP Giulio Andreotti, seven times Italian Prime Minister, “made himself available to mafiosi in an authentic, stable and friendly way until the spring of 1980” (Dickie, 2004, pp. 322-3).

This qualitative evidence has been recently supported by quantitative analysis by De Feo and De Luca (2017); Alesina et al. (2019); Accardo et al. (2021). These contributions have shown the importance of mafia connections for the DC in Sicily, providing evidence of intimidation activities and electoral support provided by the Sicilian Mafia to the party as well as individual candidates.<sup>13</sup> De Feo and De Luca (2017) provide also suggestive evidence of the exchange of favours between mafia and politicians: in exchange for its support, the mafia received economic advantages for its activities in the construction industry, a sector in which the influence of public authorities and politicians is quite strong.

### 3.2 Structure of Cosa Nostra

The knowledge of the structure of *Cosa Nostra* was unveiled in the 1980s in the most important trial against the Sicilian mafia, the *maxiprocesso*.

Even though some information were known previously, they did not lead to a deeper understanding of the mafia. For example, the mafia member turned informant Leonardo Vitale, provided important information on mafia members and organization to the police but he was not taken seriously and, being considered mentally ill, was sent in an asylum where he spent several

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<sup>13</sup>See Buonanno et al. (2016) for an analysis of the political support provided by the Sicilian mafia to Berlusconi’s party from 1994 onwards.

years. Few months after his release in 1984 he was shot dead.

In the maxi-trial indictment against the *Cosa Nostra* members the structure of the organization, its leadership and their activities were fully disclosed. The prosecutors describe the affiliation of a new member with its oath of allegiance to the family based on the ritual of the legendary sect of the *Beati Paoli*.<sup>14</sup> Then they describe the structure of a family, which is summarized in Catino (2019, p. 154): “The families are organized according to a pyramidal model, a hierarchy with subdivision of power. The organizational structure of a *family* and the hierarchical chain of command work as follows: the base is formed by the *soldiers*, also known as ‘button men,’ or *picciotti*: they carry out the operational orders of the *family*. The *capodecina* (boss of ten) oversees a crew of soldiers, numbering from five to ten or twenty, with a maximum of thirty, according to the size of the family. The *representative* is the boss, he is elected *democratically* (one person–one vote) in a secret vote by the button men in specifically organized family meetings. For large-sized families, the heads of ten collect the votes from the men of honor, given the high risk of bringing together a large number of people in one place. The *vice-representative* (*underboss*) is nominated by the representative, and he can make decisions in his absence, but this is a situation that rarely arises. The *advisers* or counselors provide advice to the boss and also serve as liaison with the soldiers”. This structure is depicted in Figure 1.

Then, following the information provided by the informants – in particular Tommaso Buscetta – the prosecutor describe the structure that *Cosa Nostra* eventually developed from the 1950s and consolidated in the 1970s.

This organization was promoted by the American branch of *Cosa Nostra* that, while outsourcing the heroin trafficking to the Sicilian families, they also suggested to create a structure similar to the one that provided a conflict resolution mechanism to the New York families after the *Castellammarese* war in 1930. Joe Bonanno, the leader of the Brooklyn-based clan, held a series of meeting in Palermo in 1957 and put forward a proposal for a structure to coordinate the different families (Lupo, 2004, p. 266-7). “Each province in Sicily should have had its own commission. (It was not until 1975 that a Region or Inter-provincial commission would be created for the whole island). In the

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<sup>14</sup>This legendary sect was popularized by a novel by Natoli (2017 [1908-9]) who, drawing on Sicilian folk oral traditions, described this secret sect active in the early 18th century. See also Renda (1988).

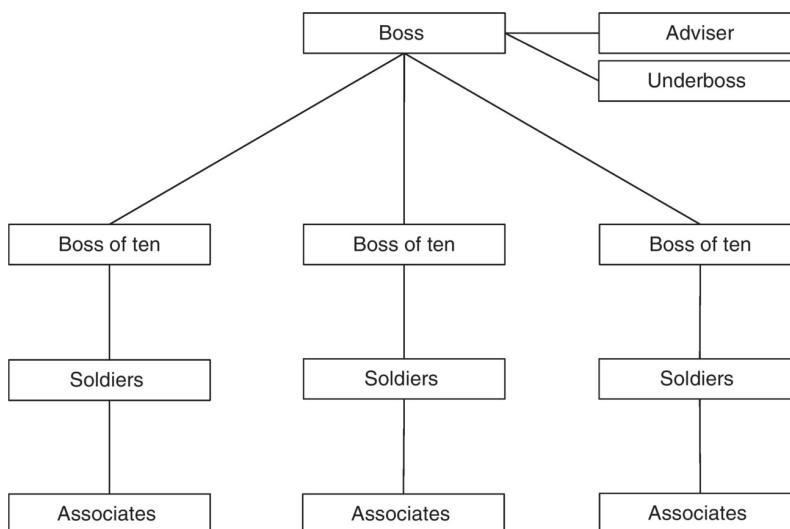


Figure 1: Structure of a mafia family according to the information provided by mafia members turned informant and summarized in the maxi-trial indictment. Source: Catino (2019, Figure 3.1).

province of Palermo, there were too many Families – around fifty – to make it feasible to have a consultative body in which all of them were represented. Thus there would be an intermediate level, the *mandamento* (district), combining three neighbouring families; together the three families would choose a single representative from their *mandamento* who would take a seat on the Commission. To avoid too much power being concentrated in the hands of a few people, it was forbidden for anyone to combine the role of capo of their Family and representative on the Commission. And the Commission’s crucial function would be to make rulings on the murders of men of honour” (Dickie, 2004, p. 236). But this structure was not a novel experience in the history of the Sicilian Mafia. From the notes and reports that the head of police in Palermo Sangiorgi wrote between 1898 and 1900 we know that the clans around Palermo already had some form of coordination and consultation (see Lupo, 2011). However, just a few years after being set up, the structure fell as a result of the so-called First Mafia War. After the war, once the state repression came to nothing with the mass acquittal of mafia bosses, the commission started working again and in 1975 a regional commission was set up. “Totò ‘shorty’ Riina would orchestrate an unparalleled slaughter of men of honour – a slaughter known as the second mafia war of 1981-3. Under Riina, the Corleonesi would establish a dictatorship over the organization and, in so doing, almost bring its history to an end” (Dickie, 2004, p. 259). The historical

evolution of the organizational structure of the Sicilian Mafia is summarized in Figure 2.

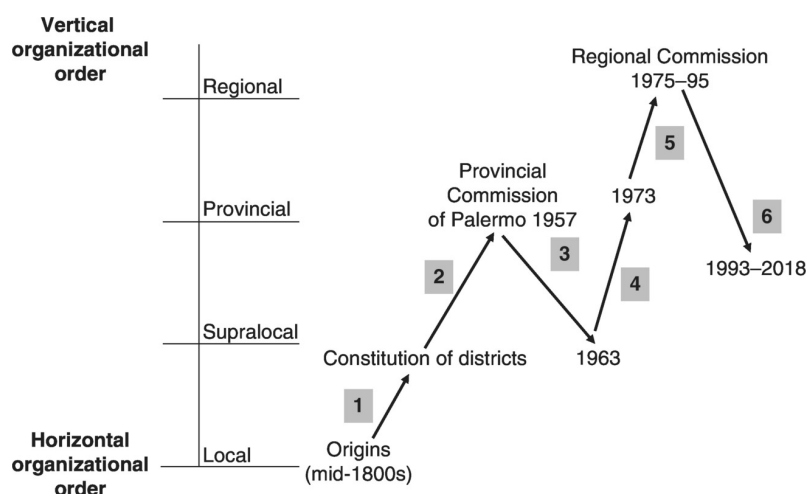


Figure 2: Historical evolution of the Sicilian mafia coordination structure. Source: Catino (2019, Figure 3.3).

## 4 Data

The data about the social network of mafia members and of their connections in the economic, social and political elite in Sicily have been codified from documents published by the special Parliamentary Commission investigating the mafia phenomenon (also known as the First Antimafia Commission). This committee was established at the beginning of the first Mafia war in 1962 but began its works only in July 1963, in the aftermath of the so-called Ciaculli massacre when 7 policemen were killed by a car bomb explosion at the outskirts of Palermo.

The First Antimafia Commission was established by the Law 1760/1962 in order to analyse the origins and the characteristics of the Sicilian mafia with the aim of “suggesting the measures to suppress its symptoms and eradicate its causes”. It was formed by 15 members of the Lower Chamber and 15 members of the Senate and its activity spanned three legislatures from 1963 to 1976. The Presidents were the Mp Rossi (1963), Senator Pafundi (1963-68), MP Cattanei (1968-72) and Senator Carraro (1972-76), who brought the work of the committee to an end. Senator Carraro submitted a final report to the Parliament in February 1976. Carraro’s report was approved by the majority



of the Antimafia Commission while two other reports were submitted by the minority components of the commission.

These reports were based on a large amount of document collected in the 13 years of activity of the commission, which were then published as annexes to the final reports and consisted of 42 volumes of more than 30,000 pages in total. The documents included: court papers and police reports on criminals, politicians and firms; local councils documents (i.e, building approvals, public procurement contracts, etc.); newspaper articles and investigations; bank documents on personal and business accounts, loans and deposits; documents produced by or submitted to the Antimafia committee such as reports of inspections, transcripts of hearings, statements and accusations submitted in several forms (including anonymous letters) to the same committee.

During the 1968-72 legislature, the committee decided to organise the information gathered so far from any source, as well as published since 1963 on newspapers or books, in personal files relative to “any individual who was somehow alleged to be connected and compromised with the mafia world”. The focus was initially “on the relationship between mafia and public institutions” but eventually the files included “any person that any source (including anonymous sources) hinted to be in any type of relationship with the mafia” (CPM, 1988, p.1). These files consisted of 3852 pages including information about 2405 people and 345 public and private organizations. The first Antimafia Commission decided not to include these files in the documents published as annexes to the final reports. However, in 1988 the third Antimafia Commission decided to publish this material, with the disclaimer that the new commission did not verify the information included in the files and in many cases there was no judicial sanctioning of such information.

So, the focus of these files were on relationships and connections between individuals, either allegedly belonging to the mafia, or connected with them. These connection were of business, political, or social nature as well as family connections. Examples of such relationships include the electoral support of mafia members to politicians, alleged protection against law enforcement offered by politicians or public officials to mafia members, irregular public procurement contracts or building licenses, provision of false passports, meetings, agreements to circumvent the law, collective acts of violence.

From the same files we also gathered personal information like place and date of birth, place of activity and their main (licit or illicit) occupation.

1974

NAME of the mafia member

**costruttore edile di Palermo-**

**capo mafia**

PONTE DI RILEVAMENTO	SINTESI DELL' ARGOMENTO CHE INTERESSA IL SOGGETTO
Doc.454 Rapp.Giud. del 20.7.1966	Si interessa a che il costruttore <small>Name of an entrepreneur</small> possa ottenere una variante al progetto di costruzione di un edificio in via A.Cirrinzione n.4. In seguito a questo interessamento chiede al <small>Name of an entrepreneur</small> la somma di lire 5 milioni da consegnare "agli amici" del Comune.
Doc. 590 - Sentenza di Catanzaro - pag. 318	idem
Doc. 236 (sentenza di rinvio a giudizio) pag. 69	Non si è chiarata la reale natura dei suoi rapporti con gli on.li <small>Two politicians</small> . Sembra comunque che egli abbia avuto aderenze nello ambito della amministrazione comunale di Palermo.
Doc. 412 (fasc. Questura di Palermo) (Foglio 1)	Per il rinnovo del suo passaporto si è interessato con lettera l'on. <small>Name of a politician</small>

Figure 3: First page of the individual file of a mafia boss.

When missing from the original files, we looked for additional sources for their personal information.

As examples, Figures 3 show part of the individual files contained in the Anti-mafia archive.

Figure 3 shows the first page of the (anonimized) individual file of a mafia member. In the top left corner there is the name of the individual the file is referred to. In the header he is identified as a building contractor (“costruttore edile”) mainly operating in “Palermo”, and his role in the mafia organization, if any; in this case he is identified as mafia boss (“capo mafia”). Then, in the left column of the file the source of the information is provided (“Fonte di rilevamento”). In this case the first three are court papers, while the last one is from police files. In the right column a summary of the information about the individual is provided. In the first one the information about its role of intermediary between the owner of a construction company and local council officials involving an alleged bribe of 5 million Lire is reported. In the last one

it is reported that an MP sent a recommendation letter to support his passport application. Figure 4 shows the second page of the file belonging to another mafia member, son of a mafia boss, who obtained a job as a public employee in exchange of electoral support to various national politicians. Finally, Figure 5 describes a public official who favoured an entrepreneur working in the road construction sector for the award of three public procurement contracts in one day.

2.

*MX*

Name of the mafia member (segue)

PONTE DI RILEVAMENTO	SINTESI DELL'ARGOMENTO CHE INTERESSA IL SOGGETTO
Doc. 758	Figlio di <small>Mafia member's father (another mafioso)</small> , capo mafia di Riesi. Nel 1961, dopo il decesso del padre, subentrò al medesimo nella carica di capo mafia.
D/762	Di pessima condotta, ritenuto elemento irascibile e violento, capace di commettere qualsiasi delitto. Sarebbe stato l'organizzatore della spedizione di VALLELUNGA, in cui trovarono la morte in conflitto a fuoco i noti mafiosi Cam-
D/764	<small>Name of other mafia members</small> , ma nel corso delle indagini non emersero elementi di prova a suo carico. E' stato sempre orientato verso la D.C. svolgendo attiva propaganda a favore dell'onorevole <small>Name of a politician</small> e dell'onorevole <small>Name of another politician</small> . Nel 1967, appena ultimata la pena del divieto di soggiorno in più province, fu assunto dalla SOCHIMISI in qualità di contabile di 2 <sup>a</sup> categoria presso la miniera Traba Tallarita di Somatino Riesi. Tale assunzione fu il frutto di un compromesso politico con il direttore generale della Società predetta, ora onorevole <small>Name of a third politician</small> della del P.R.I., in base al quale il <small>si</small> Cristina spiegò tutta la sua influenza di capo mafia, riuscendo a far convocare, in occasione delle elezioni, ben 380 voti in favore del Gunnella e del P.R.I., men-

Figure 4: Second page of the individual file of a mafia member.

Since the exact timing of the events is generally missing, the dataset does not have a time dimension and represents only a “snapshot” of the relationships existing in the period before 1972. We can generally assume that most of the connections are referred to the 1960s, but in a few cases information describe events occurring as far back as the 1940s.

Finally, the information collected by the Anti-mafia Commission comes from a variety of sources, and we assign to each node the kind of source(s)

2293

Name of a public official - Funzionario dell'Assessorato della Regione Siciliana

PONTE DI RILEVAMENTO	SINTESI DELL' ARGOMENTO CHE INTERESSA IL SOGGETTO
Prot. A/1064 del 18.11.1970	Nell'esposto anonimo si legge che il <small>Name of a public official</small> quale funzionario dell'Assessorato bilancio della Regione, ha favorito, nei concorsi di appalto di lavori stradali banditi dalla Provincia di Trapani, l'impresa appaltatrice di lavori stradali <small>Name of an entrepreneur</small> di Trapani, tanto che questa in un solo giorno ha ottenuto l'appalto di tre lavori per l'importo di lire 300.000.000.

Figure 5: File of a public official employer in the regional administration.

mentioning her/him, as an individual characteristic.

## 5 The good connections. The social network of mafia and local elites

For the reasons highlighted in the previous section, the information included in the individual files are used to build a static network which includes 2314 *nodes* and 5017 *links*. Due to the mutual nature of the relationships we define links to be *undirected* (i.e. bi-directional). Moreover, links are *unweighted* (i.e. they are either present or absent and all have the same unit intensity). We summarize individuals main occupation in 10 categories (mafia members being one of them) and the number of individuals in each node is reported in Table 1. For mafia members the number of mafia bosses is reported in parenthesis.

Figure 6 depicts a simplified version of the network where each node represents a category; nodes are sized by the number of individuals belonging to the category and links are sized by the number of connections between members of different categories. The most numerous category is represented by mafia members, 109 of which are mafia bosses.

The full network of connections between the 2314 nodes (individuals), with

Table 1: Number of individuals by occupation category.

<b>Category</b>	<b>Numerosity</b>
Mafia member (boss)	600 (109)
Politician	372
Entrepreneur	128
Public official	112
Police and law enforcement	90
Public employee	62
Priest	19
Doctor	15
Lawyer	11
Landowner and farmer	10
Missing	92

nodes sized by the number of their connections, and the *giant component* highlighted in orange are depicted in Figure 7.<sup>15</sup> For the rest of the paper we focus on the giant component, which includes most of the nodes (65%) and links (90%) of the network, since most of the other nodes are isolated individuals, pairs and triples. Table 2 shows the number of components by their size in terms of nodes (giant component in bold). So, for the rest of the paper when we talk about the network we will be referring to the giant component.

Table 3 shows the global characteristics of the network, which are compared to same characteristics of networks generated according to the *Erdős Rényi* model characterised by the same number of nodes and density of links of the observed network.<sup>16</sup> More precisely, we run 1,000 simulations and compute the average of each characteristic, which is shown in parentheses. As suggested by the low density of links, the network is quite sparse, which is not surprising given the “hidden” nature of criminal connections.<sup>17</sup> Both the overall and the average clustering coefficients, measuring the tendency of nodes to form “triangles”<sup>18</sup> are substantially higher than the average of the same coefficients

<sup>15</sup>A component is the maximal subset of nodes such that each pair is connected by some path. The giant component is the most numerous component in terms of nodes.

<sup>16</sup>The *Erdős Rényi* is a simple random graph model where every possible link between pairs of nodes forms independently and uniformly at random.

<sup>17</sup>The density is equal to the ratio between the total number of actual links and the total number of potential links.

<sup>18</sup>Overall clustering is computed as the ratio of the number of triangles (node A is linked to B, B is linked to C and A is linked to C) over the total number of potential triangles in the whole network, whereas average clustering is computed as the average of the individual clustering coefficients. The latter gives more weight to less connected nodes than the former.

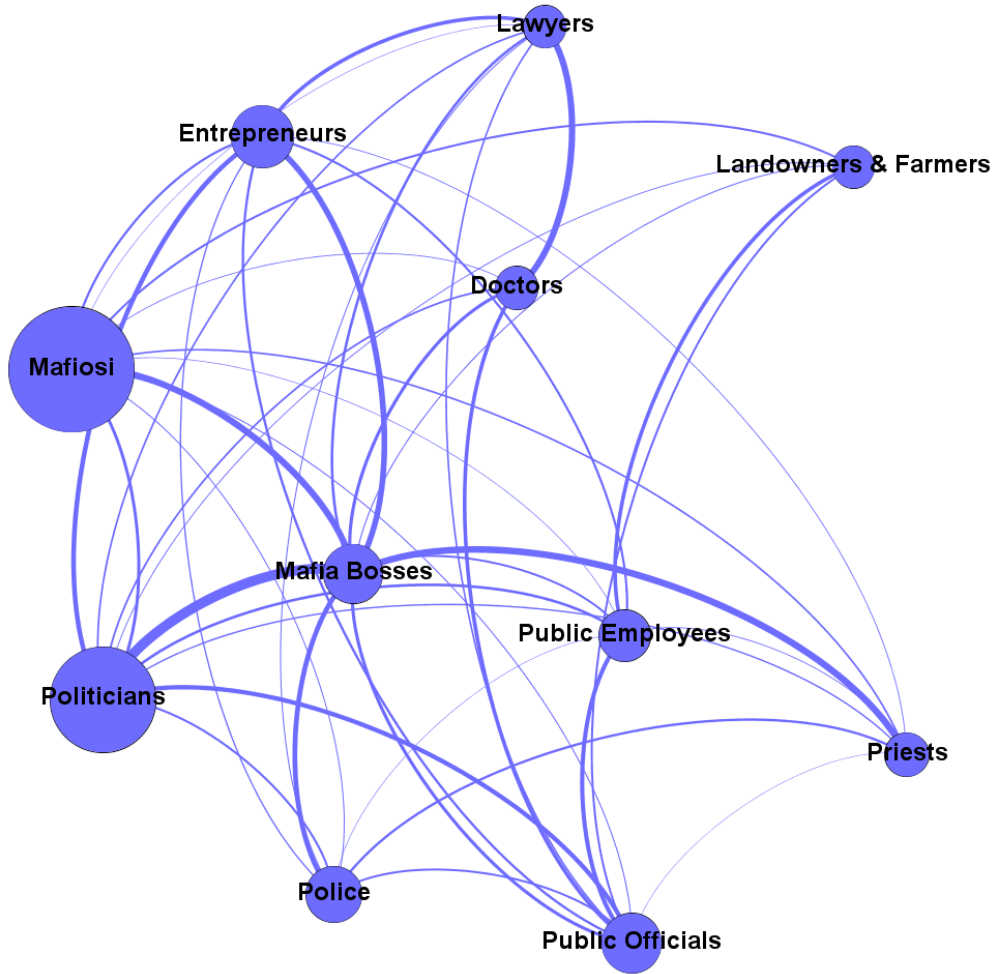


Figure 6: Simplified version of the network. Each node represents an occupation category, nodes are sized by the number of individuals belonging to the category and links are sized by the number of connections between members of different categories. Nodes for which information about occupation is missing are excluded.

obtained from the simulated networks.<sup>19</sup> The *average path length*, i.e. the average distance between any pair of nodes in the network<sup>20</sup>, is almost equal to the average value generated by the random networks. The combination of these two features (higher clustering and lower average distance as compared to a random network) is commonly referred to as the “small-world” property,

<sup>19</sup>As expected, the clustering coefficients are equal to the density of the network, since in the Erdős Rényi model links form independently of each other.

<sup>20</sup>The *distance* between two nodes is the length, in terms of number of nodes (or links) required to reach a given node starting from another one, of the shortest path between them. A *path* from node A to node B is the smallest number of links node A has to travel in order to reach node B. The *diameter* is the maximal shortest path.

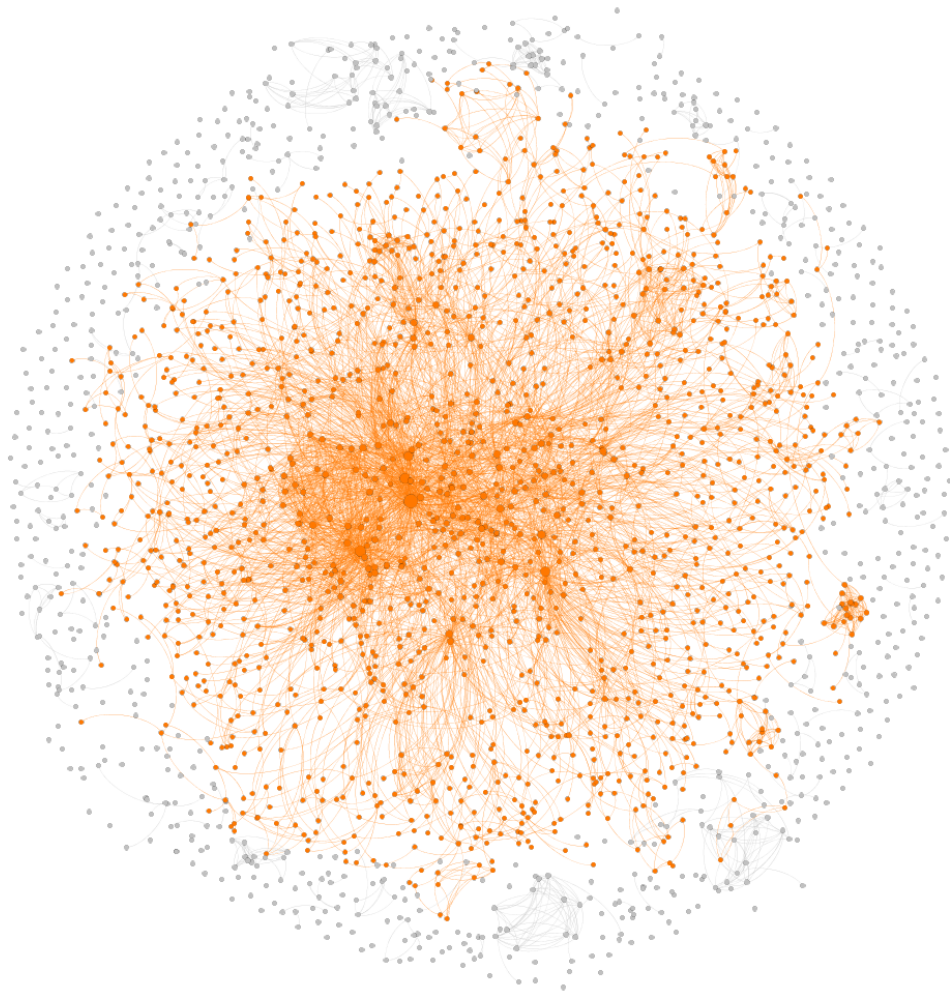


Figure 7: Whole network. The nodes and links in the giant component are in orange. Nodes are sized by the number of their connections.

which has been observed in many real-world networks (Watts and Strogatz, 1998).

Another feature commonly observed in social networks is the unequal distribution of nodes' degrees, as compared again to a random network (Jackson, 2008). We look at this in Figure 8, which compares the nodes' degree distributions of the observed network (in red) and a simulated random network (in blue), plotted on a log-log plot. The distribution of the observed network exhibits fatter tails than the random network, and displays the existence of some high-degree nodes and many low-degree nodes. Moreover, as reported in Table 3, the network is disassortative in degree, meaning that high-degree



Table 2: Census of network components

Components	Nodes per component
511	1
46	2
19	3
6	4
4	5
3	6
3	7
4	9
1	11
1	12
<b>1</b>	<b>1510</b>

The table shows the number of components for any given number of nodes belonging to each component, sorted in ascending order. For instance, there are 511 singleton components (i.e. isolated individuals) and 46 isolated pairs. The last row represents the (unique) giant component.

individuals tend to be connected to low-degree individuals.

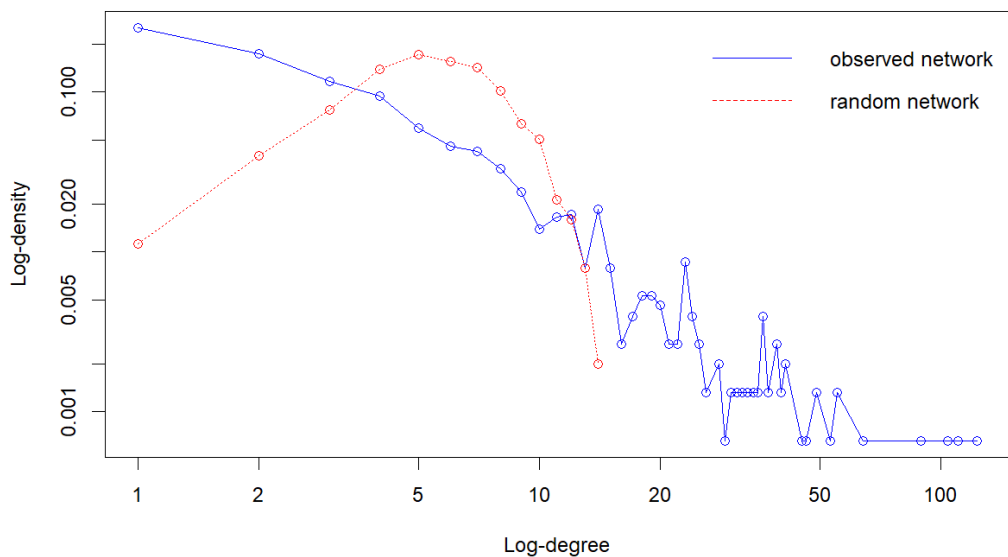


Figure 8: Degree distribution (log-log plot). The figure shows the distributions of nodes' degree on log-log scale for the observed network (blue) and a simulated random (Erdős Rényi) network with the same number of nodes and links of the observed network (red).



Table 3: Global characteristics of the giant component.

Characteristic	Value
N. of nodes	1510
N. of links	4557
Density	0.004
Average degree	6 (6)
Average path length	4.222 (4.276)
Diameter	12 (8)
Overall clustering	0.262 (0.004)
Average clustering	0.647 (0.004)
Degree assortativity	-0.052 (0.009)

The value of each characteristic is computed as the average of the values for that characteristic taken over 1,000 simulations of Erdős-Renyi random networks characterised by the same size (number of nodes) and connectivity (density) of the observed network.

## 6 Empirical analysis

Our aim is to empirically explore the relationship between the centrality in the network and the leadership role in the criminal organization of mafia bosses as identified in the files of the First Antimafia Commission.

We focus on the sample of mafia members, which includes 600 individuals (109 of which are mafia bosses), and for each of them we compute the following centrality measures:

- $Degree_i = \sum_j g_{ij}$ , where  $g_{ij}$  is a dummy equal to one if there is a link between node  $i$  and node  $j$ .<sup>21</sup> Therefore,  $Degree_i$  is simply the total number of connections individual  $i$  has.
- $Betweenness_i = \frac{\sum_{k \neq j \neq i} P_i(j,k)}{P(j,k)}$ , where the numerator is the number of times node  $i$  lies on the shortest path between node  $j$  and node  $k$ , and the denominator is the number of shortest paths linking  $j$  and  $k$ . This centrality index was first proposed by Freeman (1978), and it is meant to measure the bridging ability of a node in terms of how well it connects other nodes.
- $Closeness_i = 1 / \sum_{j \neq i} d(i, j)$ , i.e. the inverse of the average distance between node  $i$  and any other node  $j$  in the network. It measures how

<sup>21</sup>The network has no self-loops, i.e.  $g_{ii} = 0$  for any  $i$ .

easily a given node can reach any other node, and can be interpreted both in terms of “efficiency” in communication flows and “independence” from others (Freeman, 1978).

- *Eigenvector<sub>i</sub>*, which corresponds to the *i*th element of the (right-hand) eigenvector of the network adjacency matrix  $G$ , i.e.  $\lambda \text{Eigenvector}_i = G \text{Eigenvector}_i$ .<sup>22</sup> This measure was proposed by Bonacich (1972) and it also takes into account indirect connections, as it is based on the idea that the centrality of a node is proportional to the overall importance (in terms of connections) of its neighbors.

Formally, we estimate the following logit regression equation:

$$\Pr(\text{Boss}_i = 1) = \frac{1}{1 + e^{-(\alpha_p + \delta_s + \beta \text{Centrality}_i + \epsilon_p)}} \quad (1)$$

where  $\text{Boss}_i$  is a dummy equal to one if mafia member  $i$  is a boss,  $\alpha_p$  controls for place (of activity) fixed effects,  $\delta_s$  is a set of source dummies<sup>23</sup>,  $\text{Centrality}_i$  is one of the four centrality measures described above, and  $\epsilon_p$  is the error term clustered at place level. The coefficient of interest is  $\beta$ , which measures the correlation between a given centrality measure and the rank of mafia members (i.e. whether they are mafia bosses or not).

We also estimate a linear probability model which is represented by the following equation:

$$\text{Boss}_i = \alpha_p + \delta_s + \beta \text{Centrality}_i + \epsilon_p \quad (2)$$

## 6.1 Leadership position and centrality of mafia bosses in the whole network

Descriptive statistics of the centrality measures for the samples bosses and lower rank mobsters in the whole network are shown in Table 4, together with standard errors coming from t tests on the relative differences between

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<sup>22</sup>By the Perron-Frobenius theorem, there exists a unique non-negative eigenvector corresponding to the largest (positive) eigenvalue of  $G$  (Billingsley, 2008; Jackson, 2008).

<sup>23</sup>Note that these dummies are not mutually exclusive since individuals can be mentioned by more than one source.

means. The centrality measures are first standardized over the whole sample. This table suggests that, as compared to low rank mobsters, bosses have on average more connections, lie more times on the (shortest) paths between other individuals, are closer to others, and are more connected to other well-connected individuals.

Table 4: Descriptive statistics of (standardized) centrality measures for bosses vs lower rank mobsters in the whole network

Variable	Observations	Mean	Std. Dev.	Min	Max
<i>Panel A: Lower rank mobsters:</i>					
Degree (st.)	491	-0.123	0.712	-0.667	4.624
Betweenness (st.)	491	-0.15	0.383	-0.274	3.269
Closeness (st.)	491	-0.147	0.952	-2.583	1.839
Eigenvector (st.)	491	-0.095	0.818	-0.39	10.727
<i>Panel B: Bosses:</i>					
Degree (st.)	109	0.555*** (0.165)	1.692	-0.667	7.668
Betweenness (st.)	109	0.677*** (0.199)	2.076	-0.274	10.123
Closeness (st.)	109	0.665*** (0.099)	0.94	-2.193	2.599
Eigenvector (st.)	109	0.428*** (0.149)	1.51	-0.39	11.692

The panels B and A show the descriptive statistics of the centrality measures for the samples of mafia bosses and lower rank mobsters, respectively. All the centrality measures are first standardized over the whole sample. Standard errors on the difference between means of bosses and lower rank mobsters coming from two-sample t tests on the equality of means (with unequal variances) are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

The estimates of equations (1) and (2) are presented in Table 5, in panels A and B respectively. Since the number of clusters (places of activity) is not sufficiently high, in square brackets we also report the score-cluster bootstrap p-values of the estimated coefficients for the logit model (see Kline and Santos (2012) and Roodman et al. (2019)), and the wild-cluster bootstrap p-values for the linear probability model (Cameron et al., 2008). For the ease of comparability with linear model results, for the logit coefficients we also report the Average Marginal Effects, so that changes in the outcome associated with (standard deviation) increases in centrality can be interpreted on the probability (rather than the odds) scale (see Williams, 2012).<sup>24</sup> Overall, results suggest

<sup>24</sup>Standard errors in this case are obtained by the delta method.

that mafia bosses are more central in the network as compared to lower rank mobsters, in terms of numerosity of connections, brokerage ability and closeness to other individuals: depending on the model, a unit standard deviation increase in degree, betweenness and closeness is respectively associated with an increase in the probability of being a mafia boss by 4.2-6.2 %, 7-8.3 % and 8.5-10.8 %.

Table 5: Centrality analysis of mafia bosses

Dependent variable: Dummy for mafia boss				
	Degree	Betweenness	Closeness	Eigenvector
Panel A: Logit regression				
Centrality measure	0.329*** (0.052) [0.083]	0.555*** (0.081) [0.042]	0.874*** (0.142) [0.019]	0.100 (0.069) [0.281]
Centrality measure (Average Marginal Effect)	0.042*** (0.005)	0.07*** (0.009)	0.108*** (0.018)	0.013 (0.009)
Panel B: Linear probability model regression				
Centrality measure	0.062*** (0.009) [0.049]	0.083*** (0.011) [0.038]	0.085*** (0.013) [0.025]	0.023* (0.012) [0.313]
Place FEs	✓	✓	✓	✓
Source dummies	✓	✓	✓	✓
Observations	501	501	501	501
Number of clusters	9	9	9	9

Notes: Logit (Panel A) and OLS (Panel B) regression estimates of boss dummy on centrality measures. Coefficients are (x-)standardised. All regressions control for place (of activity) Fixed Effects and source dummies. Note that individuals may belong to more than one source group as they may be mentioned by more than one source. Standard errors clustered at place level in round brackets (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ). Score-cluster (for logit) or wild-cluster (OLS) bootstrap p-values with standard errors clustered at place level in square brackets.

## 6.2 Leadership position and centrality within the criminal underworld and in the wider upperworld

We separate the topological position of mafia bosses inside criminal organizations from that outside. More precisely, we “decompose” the centrality measures described above in two alternative ways, i.e. by taking into account either (i) only the links between mafia members, or (ii) only the links between mafia members and other actors in the network. We respectively name such centralities as “*intra*-(centrality measure)” and “*inter*-(centrality measure)”.<sup>25</sup>

<sup>25</sup>When removing links either between mafia members and institutional actors or between mafia members, the network becomes *disconnected*. The computation of the cen-

Estimates of logit and OLS regressions of the boss dummy on intra- and inter-centrality measures are reported in Table 6.

Table 6: Centrality analysis of mafia bosses inside and outside the criminal underworld

Dependent variable: Dummy for mafia boss				
	Degree	Betweenness	Closeness	Eigenvector
Panel A: Logit regression				
Intra-Centrality measure	-0.068 (0.201) [0.143]	-0.091 (0.216) [0.698]	-0.257 (0.209) [0.195]	0.273*** (0.073) [0.2]
Inter-Centrality measure	0.403** (0.157) [0.173]	0.648*** (0.242) [0.038]	0.901*** (0.348) [0.049]	0.123 (0.084) [0.162]
Intra-Centrality measure (Average Marginal Effect)	-0.008 (0.025)	-0.011 (0.027)	-0.031 (0.026)	0.035*** (0.008)
Inter-Centrality measure (Average Marginal Effect)	0.051** (0.021)	0.08*** (0.031)	0.111*** (0.043)	0.015 (0.011)
Panel B: Linear probability model regression				
Intra-Centrality measure	-0.004 (0.016) [0.814]	0 (0.033) [0.999]	-0.023 (0.022) [0.31]	0.03*** (0.008) [0.068]
Inter-Centrality measure	0.079*** (0.02) [0.153]	0.088** (0.03) [0.155]	0.071*** (0.016) [0.05]	0.028* (0.013) [0.331]
Place FEs	✓	✓	✓	✓
Source dummies	✓	✓	✓	✓
Observations	501	501	501	501
Number of clusters	9	9	9	9

Notes: Logit (Panel A) and OLS (Panel B) regression estimates of boss dummy on “Intra-” and “Inter-” centrality measures. Coefficients are (x-)standardised. All regressions control for place (of activity) Fixed Effects and source dummies. Note that individuals may belong to more than one source group as the may be mentioned by more than one source. Standard errors clustered at place level in round brackets (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ). Score-cluster (for logit) or wild-cluster (OLS) bootstrap p-values with standard errors clustered at place level in square brackets.

The estimated coefficients on *Inter-degree*, *Inter-betweenness* and *Inter-closeness* show that the centrality of mafia bosses mainly comes from their connections with legitimate institutions and local elites. Interestingly, contrary to other centrality measures, *Intra-eigenvector* is positively and significantly associated with the relative probability of being a mafia boss. These

centrality measures used in our analysis is the same as for connected networks, except from closeness, since for disconnected networks the denominator goes to infinity. To address this problem, for the computation of *inter-closeness* and *intra-closeness* we use the harmonic mean of distances between node  $i$  and any other node, as suggested by Rochat (2009), i.e.  $(\text{Inter} - / \text{Intra-})\text{closeness}_i = \sum_{j \neq i} 1/d(i, j)$

results suggest that bosses strategically position themselves in the network as an “interface” between the criminal and the legitimate worlds. At the same time, they might be willing to be less connected to other criminals in order to lower their exposure to the risk of being caught by law enforcement authorities. Moreover, as suggested by the positive coefficient on *Intra-eigenvector*, bosses are strategically connected to criminals who in turn have a high number of connections, thus trading-off between the needs of communicating with other criminals and being less visible to law enforcement.

### 6.3 Addressing the non-random selection issue

Although information about mafia members and their connections come from a variety of official and unofficial sources collected not only at national level but also locally, the network might still be affected by non-random selection, as more active and connected individuals are more likely to be noticed. To address this potential issue, we perform a series of *weighted* regressions, where weights attached to each individual represent the inverse of the probability that she/he is sampled. The procedure to compute the weights runs as follows. In the same vein of Mastrobuoni and Patacchini (2012), we model the sampling process as a *random walk* on the network, based on the idea that nodes are sampled through some kind of *link-tracing* procedures typically used when sampling from hidden populations (László et al., 1996; Salganik and Heckathorn, 2004). The process is simple: a seed node is selected at random, then one of her neighbours is selected at random, then again one neighbour of the latter is selected at random, and so on. Formally, let’s consider the (row-stochastic) network adjacency matrix  $G$  as the *transition matrix* of a *Markov chain* on the graph. Each element  $g_{ij}$  of  $G$  represents the probability of discovering node  $i$  when  $j$  is under observation. The stationary probability distribution  $\Pi$  of the chain is then computed as the left-hand unit eigenvector of  $G$ :<sup>26</sup>

$$\Pi = \Pi G$$

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<sup>26</sup>The Perron-Frobenius theorem ensures that, given that the Markov chain is irreducible (i.e. the graph is connected) and aperiodic (the graph is non-bipartite), such a vector exists and it is unique. Moreover, the stationary distribution is independent of the initial random seed.

Each element  $\pi_i$  can be interpreted as the “long-run” probability of sampling node  $i$ . It turns out that  $\pi_i = d_i/2m$ , where  $d_i$  is the degree of node  $i$ ,  $m$  is the total number of links in the network, and  $2m$  is the sum of individual degrees. Thus, the probability of sampling each node is proportional to her/his degree. The individual weight  $w_i$  in the regressions is simply equal to  $1/\pi_i$ , and therefore more connected individuals are “penalised” by the weighting scheme.

Table 7 reports descriptive statistics of centrality measures for bosses and non-bosses, with observations weighed according to the procedure described above.

Table 7: Descriptive statistics of (standardized) centrality measures for bosses vs lower rank mobsters in the whole network - Weighted observations

Variable	Observations	Mean	Std. Dev.	Min	Max
<i>Panel A: Lower rank mobsters:</i>					
Degree (st.)	491	-0.495	0.337	-0.667	4.624
Betweenness (st.)	491	-0.234	0.176	-0.274	3.269
Closeness (st.)	491	-0.299	0.901	-2.583	1.839
Eigenvector (st.)	491	-0.249	0.31	-0.39	10.727
<i>Panel B: Bosses:</i>					
Degree (st.)	109	-0.376* (0.623)	0.631	-0.066	7.668
Betweenness (st.)	109	-0.097** (0.014)	0.71	-0.274	10.123
Closeness (st.)	109	0.077*** (0.037)	0.983	-2.193	2.599
Eigenvector (st.)	109	-0.141* (0.054)	0.552	-0.39	11.692

The panels B and A show the descriptive statistics of the centrality measures for the samples of mafia bosses and lower rank mobsters, respectively. Weights are the reciprocals of the elements of the left-hand unit eigenvector of the row-normalised graph adjacency matrix. All the centrality measures are first standardized over the whole sample. Standard errors on the difference between weighted means of bosses and lower rank mobsters coming from two-sample t tests on the equality of weighted means (with unequal variances) are in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Even after weighting, bosses have on average higher values of centrality than lower rank mafia members. Estimates of weighted regressions are reported in Table 8 and Table 9.

Table 8: Centrality analysis of mafia bosses - Weighted regressions

Dependent variable: Dummy for mafia boss				
	Degree	Betweenness	Closeness	Eigenvector
Panel A: Logit regression				
Centrality measure	0.345* (0.204) [0.22]	0.669 (0.426) [0.28]	0.43*** (0.159) [0.08]	0.305 (0.248) [0.271]
Centrality measure (Average Marginal Effect)	0.038* (0.023)	0.074 (0.047)	0.047*** (0.017)	0.034 (0.028)
Panel B: Linear probability model regression				
Centrality measure	0.038 (0.028) [0.125]	0.105 (0.063) [0.185]	0.042** (0.017) [0.098]	0.044 (0.03) [0.197]
Place FEs	✓	✓	✓	✓
Source dummies	✓	✓	✓	✓
Observations	501	501	501	501
Number of clusters	9	9	9	9

Notes: Weighted logit (Panel A) and linear (Panel B) regression estimates of boss dummy on centrality measures. Weights are the reciprocals of the elements of the left-hand unit eigenvector of the row-normalised graph adjacency matrix. Coefficients are (x-)standardised. All regressions control for place (of activity) Fixed Effects and source dummies. Note that individuals may belong to more than one source group as they may be mentioned by more than one source. Standard errors clustered at place level in round brackets (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ). Score-cluster (for logit) or wild-cluster (linear model) bootstrap p-values with standard errors clustered at place level in square brackets.



Table 9: Centrality analysis of mafia bosses inside and outside the criminal underworld - Weighted regressions

Dependent variable: Dummy for mafia boss				
	Degree	Betweenness	Closeness	Eigenvector
Panel A: Logit regression				
Intra-Centrality measure	-0.217 (0.190) [0.333]	-0.146 (0.226) [0.236]	-0.197 (0.14) [0.297]	0.285*** (0.063) [0.049]
Inter-Centrality measure	0.676* (0.369) [0.224]	0.622* (0.35) [0.115]	0.394* (0.203) [0.043]	0.511 (0.425) [0.187]
Intra-Centrality measure (Average Marginal Effect)	-0.024 (0.021)	-0.016 (0.025)	-0.021 (0.015)	0.031*** (0.007)
Inter-Centrality measure (Average Marginal Effect)	0.075* (0.041)	0.069* (0.039)	0.043** (0.021)	0.057 (0.047)
Panel B: Linear probability model regression				
Intra-Centrality measure	-0.024 (0.016) [0.474]	-0.013 (0.037) [0.702]	-0.019 (0.012) [0.171]	0.024*** (0.006) [0.04]
Inter-Centrality measure	0.101* (0.047) [0.114]	0.09* (0.048) [0.072]	0.036* (0.016) [0.063]	0.066 (0.037) [0.275]
Place FEs	✓	✓	✓	✓
Source dummies	✓	✓	✓	✓
Observations	501	501	501	501
Number of clusters	9	9	9	9

Notes: Logit (Panel A) and OLS (Panel B) regression estimates of boss dummy on “Intra-” and “Inter-” centrality measures. Weights are the reciprocals of the elements of the left-hand unit eigenvector of the row-normalised graph adjacency matrix. Coefficients are (x-)standardised. All regressions control for place (of activity) Fixed Effects and source dummies. Note that individuals may belong to more than one source group as the may be mentioned by more than one source. Standard errors clustered at place level in round brackets (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ ). Score-cluster (for logit) or wild-cluster (OLS) bootstrap p-values with standard errors clustered at place level in square brackets.

*Closeness* and *Inter-closeness* are robust to the weighting scheme (although the coefficient on the latter loses some significance). As pointed out by Freeman (1978), individuals with high closeness centrality are more efficient in spreading “messages” throughout the network as they need less costs or time in order to reach other nodes, and are less dependent from other individuals as intermediaries when they need to send a message. The coefficient on *Intra-eigenvector* also keeps being positive and significant. This confirms the idea that, although bosses are relatively less connected to other mobsters, they are strategically connected to those criminals featuring a high number of links.

## 7 Conclusions

In this paper we present a novel network dataset of connections between members of criminal organizations and various actors belonging to formal institutions (e.g. politicians and public officials) and the legal economy (entrepreneurs). We apply Network Analysis to describe the main characteristics of the network, and we investigate what is the topological role of mafia bosses both “inside” and “outside” the criminal underworld. Overall, we find that mafia bosses have more relevant network positions as compared to lower rank mobsters, according to various centrality measures. Importantly, bosses tend to be more central with respect to connections with individuals belonging to formal institutions and the official economy, thus suggesting that mafia leaders mainly act as an interface between the criminal underworld and the wider upper world. Moreover, they might be willing to be less connected to other criminals in order to be less visible to law enforcement authorities. Among the centrality measures that we analyse, closeness appears to be the most important, which means that bosses are more efficient in communicating with members of the upper world, as they need less steps (and so less costs) to reach them and are less dependent from intermediaries.

Although our network dataset is limited by the absence of a time dimension and by the likely presence of sampling bias, which we try to address through probability weights, we believe it provides clearcut results on some important features of criminal organizations and on the characteristics of individuals in leadership position within the organization.

## References

- Accardo, Pasquale, Giuseppe De Feo, and Giacomo De Luca**, “With a Little Help from My Friends. Political Competition with Interest Groups.” Technical Report, SSRN Electronic Journal 2021.
- Acemoglu, Daron, Giuseppe De Feo, and Giacomo Davide De Luca**, “Weak States: Causes and Consequences of the Sicilian Mafia,” *The Review of Economic Studies*, 2020, *87* (2), 537–581.
- , **James A. Robinson, and Rafael J. Santos**, “The Monopoly of Violence: Evidence from Colombia,” *Journal of the European Economic Association*, 2013, *11* (s1), 5–44.
- Alesina, Alberto, Salvatore Piccolo, and Paolo Pinotti**, “Organized Crime, Violence, and Politics,” *The Review of Economic Studies*, 07 2019, *86* (2), 457–499.
- Alfonso, Ferdinando**, *Trattato sulla Coltivazione degli Agrumi*, Palermo: IT: Lauriel, 1875.
- Alongi, Giuseppe**, *La mafia. Fattori, Manifestazioni, Rimedi*, Milano: IT: Sandron Editore, 1904.
- Barone, Guglielmo and Gaia Narciso**, “Organized crime and business subsidies: Where does the money go?,” *Journal of Urban Economics*, 2015, *86*, 98 – 110.
- Battisti, Michele, Andrea Mario Lavezzi, and Roberto Musotto**, “Organizing Crime: an Empirical Analysis of the Sicilian Mafia,” 2022.
- Benigno, Francesco**, *La Mala Setta. Alle origini di mafia e camorra. 1859-1878*, Torino, IT: Einaudi, 2015.
- Billingsley, Patrick**, *Probability and measure*, John Wiley & Sons, 2008.
- Bonacich, Phillip**, “Factoring and weighting approaches to status scores and clique identification,” *The Journal of Mathematical Sociology*, 1972, *2* (1), 113–120.
- Borgatti, Stephen P, Ajay Mehra, Daniel J Brass, and Giuseppe Labianca**, “Network analysis in the social sciences,” *science*, 2009, *323* (5916), 892–895.
- Brancato, F. in Commissione Parlamentare d’Inchiesta sul Fenomeno della Mafia in Sicilia**, “Relazione Conclusiva,” 1976.
- Brancato, Francesco**, “Genesi e Caratteristiche della Mafia,” in “Relazione Conclusiva della Commissione Parlamentare d’Inchiesta sul Fenomeno della Mafia in Sicilia,” Senato della Repubblica, 1976.

- Bright, David A, Caitlin E Hughes, and Jenny Chalmers**, “Illuminating dark networks: A social network analysis of an Australian drug trafficking syndicate,” *Crime, law and social change*, 2012, 57 (2), 151–176.
- Buonanno, Paolo, Giovanni Prarolo, and Paolo Vanin**, “Organized crime and electoral outcomes. Evidence from Sicily at the turn of the XXI century,” *European Journal of Political Economy*, 1 2016, 41, 61–74.
- , **Ruben Durante, Giovanni Prarolo, and Paolo Vanin**, “Poor Institutions, Rich Mines: Resource Curse in the Origins of the Sicilian Mafia,” *The Economic Journal*, 2015, 125 (586), F175–F202.
- Calderoni, Francesco**, “Identifying mafia bosses from meeting attendance,” in “Networks and network analysis for defence and security,” Springer, 2014, pp. 27–48.
- , “Social network analysis of organized criminal groups,” in Gerben Bruinsma and David Weisburd, eds., *Encyclopedia of Criminology and Criminal Justice*, New York, NY: Springer New York, 2014, pp. 4972–4981.
- **and Elisa Superchi**, “The nature of organized crime leadership: Criminal leaders in meeting and wiretap networks,” *Crime, Law and Social Change*, 2019, 72 (4), 419–444.
- Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller**, “Bootstrap-Based Improvements for Inference with Clustered Errors,” *The Review of Economics and Statistics*, 08 2008, 90 (3), 414–427.
- Catanzaro, Raimondo**, *Il delitto come impresa: Storia Sociale della Mafia*, Padova, IT: Liviana, 1988.
- Catino, Maurizio**, *Mafia Organizations: The Visible Hand of Criminal Enterprise*, Cambridge University Press, 2019.
- , **Sara Rocchi, and Giuseppe Vittucci Marzetti**, “The network of interfamily marriages in ’Ndrangheta,” *Social Networks*, 2022, 68, 318–329.
- Ciconte, Enzo, Francesco Forgione, and Isaia Sales**, *Atlante delle mafie (Vol. I)*, Rubettino, 2012.
- Coco, Vittorio and Manuela Patti**, *Relazioni mafiose. La mafia ai tempi del fascismo*, Roma, IT: XL edizioni, 2010.
- Coles, Nigel**, “It’s not what you know—it’s who you know that counts. Analysing serious crime groups as social networks,” *British Journal of Criminology*, 2001, 41 (4), 580–594.
- Cutrera, Antonino**, *La mafia e i mafiosi*, Palermo, IT: Reber, 1900.

- Daniele, Gianmarco and Benny Geys**, “Organised Crime, Institutions and Political Quality: Empirical Evidence from Italian Municipalities,” *The Economic Journal*, 2015, 125 (586), F233–F255.
- Davis, Roger H**, “Social network analysis: An aid in conspiracy investigations,” *FBI L. Enforcement Bull.*, 1981, 50, 11.
- Dell, Melissa**, “Trafficking Networks and the Mexican Drug War,” *American Economic Review*, 2015, 105 (6), 1738–1779. &nbsp;.
- Dickie, John**, *Cosa Nostra: A history of the Sicilian mafia*, Hodder & Stoughton, 2004.
- Dimico, Arcangelo, Alessia Isopi, and Ola Olsson**, “Origins of the Sicilian Mafia: The Market for Lemons,” *The Journal of Economic History*, 2017, 77 (4), 1083–1115.
- Feo, Giuseppe De and Giacomo Davide De Luca**, “Mafia in the Ballot Box,” *American Economic Journal: Economic Policy*, 2017, 9 (3), 134–167.
- Franchetti, Leopoldo**, “Condizioni Politiche e Amministrative della Sicilia,” in “La Sicilia nel 1876,” Vol. primo, Firenze, IT: Barbera, 1877.
- Freeman, Linton C.**, “Centrality in social networks conceptual clarification,” *Social Networks*, 1978, 1 (3), 215–239.
- Gambetta, Diego**, *The Sicilian Mafia. The Business of Private Protection*, Harvard University Press, 1993.
- Gavrilova, Evelina and Marcello Puca**, “Peer effects in crime,” in “A Modern Guide to the Economics of Crime,” Edward Elgar Publishing, 2022, pp. 227–242.
- Howlett, J**, “Analytical investigative techniques: Tools for complex criminal investigations,” *Police Chief*, 1980, 47 (12), 42–45.
- Jackson, Matthew O.**, *Social and Economic Networks*, Princeton University Press, 2008.
- Kline, Patrick and Andres Santos**, “A Score Based Approach to Wild Bootstrap Inference,” *Journal of Econometric Methods*, 2012, 1 (1), 23–41.
- László, Lovász, L. Lov, and Of Erdos**, “Random Walks on Graphs: A Survey,” *Combinatorica*, 01 1996, pp. 1–46.
- Lee, Lung-Fei, Xiaodong Liu, Eleonora Patacchini, and Yves Zenou**, “Who is the Key Player? A Network Analysis of Juvenile Delinquency,” *Journal of Business & Economic Statistics*, 2021, 39 (3), 849–857.

- Lupo, S.**, *Il tenebroso sodalizio: il primo rapporto di polizia sulla mafia siciliana* Cose nostre, XL, 2011.
- Lupo, Salvatore**, “Agricoltura ricca e sottosviluppo: Storia e mito della Sicilia agrumaria (1060-1950),” *Archivio Storico per la Sicilia Orientale*, 1984, I, 7–158.
- , *Storia della mafia. Dalle origini ai giorni nostri*, Donzelli, 2004.
- Malm, Aili and Gisela Bichler**, “Networks of collaborating criminals: Assessing the structural vulnerability of drug markets,” *Journal of research in crime and Delinquency*, 2011, 48 (2), 271–297.
- Mastrobuoni, Giovanni**, “The Value of Connections: Evidence from the Italian-American Mafia,” *The Economic Journal*, 2015, 125 (586), F256–F288.
- **and Eleonora Patacchini**, “Organized Crime Networks: an Application of Network Analysis Techniques to the American Mafia,” *Review of Network Economics*, 2012, 11 (3), 1–43.
- McGloin, Jean Marie**, “Policy and intervention considerations of a network analysis of street gangs,” *Criminology & Public Policy*, 2005, 4 (3), 607–635.
- Monte, Alfredo Del and Luca Pennacchio**, “Agricultural Productivity, Banditry and Criminal Organisations in Post-Unification Italy,” *Rivista Italiana degli Economisti*, December 2012, 17 (3), 347–378.
- Morselli, Carlo**, “Career opportunities and network-based privileges in the Cosa Nostra,” *Crime, Law and Social Change*, 2003, 39 (4), 383–418.
- , *Inside criminal networks*, Vol. 8, Springer, 2009.
- **and Julie Roy**, “Brokerage qualifications in ringing operations,” *Criminology*, 2008, 46 (1), 71–98.
- , **Cynthia Giguère, and Katia Petit**, “The efficiency/security trade-off in criminal networks,” *Social Networks*, 2007, 29 (1), 143–153.
- Mosca, Gaetano**, “Che Cosa è la Mafia,” *Giornale degli Economisti*, 1900, 20, 236–262.
- Murphy, Tommy E. and Martín A. Rossi**, “Following the poppy trail: Origins and consequences of Mexican drug cartels,” *Journal of Development Economics*, 2020, 143, 102433.
- Musotto, Roberto**, *Understanding Mafia Networks*, Taylor & Francis, 2022.

- Natarajan, Mangai**, “Understanding the structure of a large heroin distribution network: A quantitative analysis of qualitative data,” *Journal of Quantitative Criminology*, 2006, 22 (2), 171–192.
- Natoli, Luigi**, *I beati Paoli* Universale economica, Feltrinelli, 2017.
- Papachristos, Andrew V and Chris M Smith**, “The embedded and multiplex nature of Al Capone,” in “Crime and networks,” Routledge, 2013, pp. 109–127.
- Pezzino, Paolo**, “Alle origine del potere mafioso: Stato e società in Sicilia nella seconda metà dell’Ottocento,” *Passato e Presente*, 1985, 8, 33–69.
- , “Stato violenza società: Nascita e sviluppo del paradigma mafioso,” in “La Sicilia,” Torino, IT: Einaudi, 1987.
- , *Una certa reciprocità di favori. Mafia e modernizzazione violenta nella Sicilia post-unitaria*, Milano: IT: Angeli, 1990.
- Pinotti, Paolo**, “The Economic Costs of Organised Crime: Evidence from Southern Italy,” *The Economic Journal*, 2015, 125 (586), F203–F232.
- Renda, F.**, *I Beati Paoli: storia, letteratura e leggenda* Biblioteca siciliana di storia e letteratura: Quaderni, Sellerio, 1988.
- Rochat, Yannick**, “Closeness centrality extended to unconnected graphs: The harmonic centrality index,” Technical Report 2009.
- Romano, Salvatore F.**, *Storia della Mafia*, Milano: IT: Mondadori, 1966.
- Roodman, David, Morten Ørregaard Nielsen, James G. MacKinnon, and Matthew D. Webb**, “Fast and wild: Bootstrap inference in Stata using boottest,” *The Stata Journal*, 2019, 19 (1), 4–60.
- Sageman, Marc**, *Understanding terror networks*, University of Pennsylvania press, 2004.
- Salganik, Matthew J. and Douglas D. Heckathorn**, “5. Sampling and Estimation in Hidden Populations Using Respondent-Driven Sampling,” *Sociological Methodology*, 2004, 34 (1), 193–240.
- Salvemini, Gaetano**, *Il ministro della malavita: notizie e documenti sulle elezioni giolittiane nell’Italia meridionale*, Firenze, IT: Edizioni della Voce, 1910.
- Sarnecki, Jerzy**, *Delinquent networks: Youth co-offending in Stockholm*, Cambridge University Press, 2001.
- Smith, Denis Mack**, *A History of Sicily: Modern Sicily*, London, UK: Chatto and Windus, 1968.

- Sparrow, Malcolm K.**, “The application of network analysis to criminal intelligence: An assessment of the prospects,” *Social Networks*, 1991, *13* (3), 251–274.
- Treverton, Gregory F., Carl Matthies, Karla J. Cunningham, Jeremiah Goulka, Greg Ridgeway, and Anny Wong**, “Organized Crime and Terrorism,” in “Film Piracy, Organized Crime, and Terrorism,” RAND Corporation, 2009, pp. 11–26.
- Watts, Duncan J. and Steven H. Strogatz**, “Collective dynamics of ‘small-world’ networks,” *Nature*, 1998, *393* (6684), 440–442.
- Williams, R.**, “Using the margins command to estimate and interpret adjusted predictions and marginal effects,” *Stata Journal*, 2012, *12* (2), 308–331(24).
- Xu, Jennifer and Hsinchun Chen**, “The topology of dark networks,” *Communications of the ACM*, 2008, *51* (10), 58–65.