

Ties to trust: Factors influencing collaboration within and across organized criminal groups

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Collaboration is a fundamental feature of organized crime, yet research has rarely explored cooperation across groups. This study investigates collaboration within and across formal subgroups of a mafia organization. Drawing on data from three Italian law enforcement operations against the ‘Ndrangheta, we analyze the role of kinship and formal organizational structures using descriptive multiplexity measures and quasi-Poisson MRQAP models. Results show collaboration is associated with multiple complementary mechanisms: shared membership, kinship and leadership are all independently related to collaboration. Within subgroups, both kinship and leadership are positively associated with collaboration, alongside the effects of geographic proximity. Across subgroups, leadership homophily plays a key role, complemented by context-dependent effects of indirect kinship ties. The findings highlight how relational and organizational forces jointly sustain cooperation in mafia-type organizations.

Keywords organized crime, ‘Ndrangheta, criminal collaboration, kinship, formal structure, network analysis

Introduction

Since the first conceptualization of organized crime, researchers have investigated how individuals come to collaborate to commit crimes and pursue illicit objectives (Kleemans 2014). In illegal environments, criminals operate under significant constraints, including the risk of detection and the inability to seek state assistance for dispute resolution (Reuter 1983; Paoli 2002). These conditions make cooperation difficult, requiring a balance between secrecy

and trust, and the efficient pursuit of collective goals (von Lampe and Ole Johansen 2004; Morselli *et al.* 2007). Empirical research has shown that criminal groups manage these constraints through the adoption of a variety of strategies, including the embeddedness of activities within strong, trusted relationships (Kleemans and Van de Bunt 1999; von Lampe and Ole Johansen 2004; Van de Bunt *et al.* 2014; von Lampe 2016b).

Despite extensive research, most criminological studies focus on collaboration within single criminal groups, often overlooking how it extends beyond group boundaries. However, cross-group cooperation does occur (Coutinho *et al.* 2020), and it is particularly relevant in contexts where multiple groups coexist and must coordinate, such as clan-based criminal organizations.

The formal division into subgroups is a common feature of large criminal organizations, from mafias—typically divided into clans—to less structured entities like Latin gangs and Outlaw Motorcycle Gangs (OMGs) (Catino 2019; Fuentes 2019; von Lampe and Blokland 2020). Within clan-based organizations, collaboration enables coordination and resource acquisition, but it is challenged by intergroup distrust. Although such relationships are crucial for the existence of the overall organization, few studies have examined the mechanisms that foster trust and cooperation across groups (Calderoni *et al.* 2017; DellaPosta 2017; 2023; Coutinho *et al.* 2020; Battisti *et al.* 2022; Krajewski *et al.* 2022; Campana and Giovannetti 2025).

The present study contributes by examining the factors influencing collaboration among *locali*, the formal subgroups of the 'Ndrangheta, one of the most powerful mafia-type organizations originating from Italy. We focus on two major trust generators—kinship and formal organizational structure—whose relative relevance remains debated. Using data from three major law enforcement operations and applying network analysis, we disentangle their effects within and across *locali*. Our analysis shows that collaboration is shaped by multiple, complementary mechanisms. Across the overall network, shared locale membership, kinship and leadership homophily are all positively associated with collaboration. Within *locali*, kinship and leadership are almost equally relevant factors, with leadership with a less consistent role. Across *locali*, leadership homophily strongly associates with collaboration, with indirect kinship playing a smaller, context-dependent role.

The paper proceeds as follows: The Literature review section reviews the literature on bonding strategies in organized crime, focusing on kinship, affiliation, rules and rituals and introduces research on cross-group collaboration. The 'Current study' section presents the study's aims and research questions. The 'Methodology' section details the data and methods. The 'Results' section reports the results, while the 'Discussion and conclusion' section discusses the findings and highlights the limitations and contributions.

Literature review

Collaboration is an intrinsic feature of organized crime, as the notion of being *organized* implies the creation of social structures of cooperation that sustain collective illegal activities (Bouchard 2020: 426). Yet collaboration in criminal settings is not automatic: co-association does not necessarily entail cooperation, and individuals must actively decide to work together despite the high risks of betrayal and state intervention (van Koppen 2013; von Lampe 2016a; Wood 2016). Offenders operate 'against the state', under continuous threat surveillance and repression, and 'without the state', unable to rely on legal institutions to resolve disputes or enforce agreements (Reuter 1983; Paoli 2002). These conditions demand secrecy, reciprocity and above all, trust, which scholars have long recognized as the glue that holds organized criminals together (von Lampe and Ole Johansen 2004: 160).

Previous research shows that organized criminal groups reinforce trust through various strategies, including the embeddedness of their activities within the broader social context and by using rituals, symbols, rules and other associational structures that reinforce solidarity and reduce uncertainty (Gambetta 1992; Paoli 2003; von Lampe 2016b).

Bonding mechanisms: Kinship, rituals and rules

Crime and personal ties are more intertwined than other forms of relationships, as affectionate ties promote trust, reciprocity and a sense of obligation that facilitate criminal collaboration (von Lampe and Ole Johansen 2004; Kadushin 2012; Papachristos and Smith 2013; von Lampe 2016a). In the study of organized crime—particularly mafia-type organizations—kinship has been acknowledged as a central mechanism for trust and cooperation (Ianni and Reuss-Ianni 1972; Hess 1973; Blok 1974). Kinship provides a framework of obligations beyond personal sympathy (Giddens 1990) and generates both individualized trust, built through repeated interactions, and generalized trust, rooted in shared norms and values (von Lampe and Ole Johansen 2004). Scholars argue that kinship can also serve as a deterrent to defection by placing relatives at risk (Campana and Varese 2013). Empirical studies generally support its role: Berlusconi (2022) shows kinship sustains collaboration in drug networks even after arrests, reducing uncertainty and preserving ties. Mastrobuoni and Patacchini (2012) demonstrate that family ties in Cosa Nostra lower defection risk, with evidence of strategic intermarriage; Catino *et al.* (2022) similarly document cohesive clusters within the 'Ndrangheta linked by multiple marriages.

Along with these studies, contrasting perspectives on the role of kinship ties coexist in the literature (von Lampe and Ole Johansen 2004). Arlacchi (1986) observes that kinship can fuel rivalry and conflict, and Catino (2019) highlights its role in creating factions during criminal decision-making. Others argue that actual blood ties may be less important than symbolic kin-like bonds formed through rituals and initiation ceremonies (Paoli 2002; 2003; von Lampe 2016a).

Scholars have therefore emphasized the need to examine other mechanisms—such as rituals, affiliation practices, and organizational rules—that similarly generate trust and align members' behaviour. Mafias and other criminal organizations, including OMGs, rely heavily on rituals of affiliations, codes and rules as bonding strategies to strengthen cohesion and manage the inherent distrust of illegal environments (Skarbek and Wang 2015). Rituals play a crucial role in establishing common knowledge of a group's governance rules, ensuring that members not only know the rules but also know that everyone else does—a shared understanding that facilitates coordination and cooperation (Chwe 1998; Skarbek and Wang 2015). They also shape collective identity, aligning individual behaviour with group norms and enhancing commitment (Paoli 2003; Skarbek and Wang 2015).

Among these rituals, affiliation ceremonies are particularly symbolic: they create fictive kinship ties that bind members into cohesive clans, marking a 'new beginning' for initiates and defining the boundary between insiders and outsiders. Such rituals generate 'generalized reciprocity' and unconditional trust, reinforcing solidarity within the group (Paoli 2003; Skarbek and Wang 2015). Therefore, it is also through rituals that organizational membership acquires social meaning and becomes a source of trust, reciprocity and commitment among members. Complementing these symbolic mechanisms, criminal organizations enforce codes of conduct and behavioural rules designed to reduce conflict, protect secrecy and make member interactions predictable (Catino 2014; 2015; von Lampe 2016b). The enforcement of rules serves both to safeguard the organization's structure and leadership and to simplify the coordination of illicit activities (von Lampe 2016b). Overall,

membership, together with its deriving rituals and rules, create associational structures that produce trust based on generalization: members can anticipate one another's behaviour because they share—and are mutually aware of sharing—a common set of norms and obligations (von Lampe and Ole Johansen 2004; von Lampe 2016b; Catino 2019).

Clarifying the relative importance, and interplay, of blood kinship and ritualized affiliation is crucial for understanding how mafia-type organizations generate trust and cohesion. Because kinship ties and ritual bonds often reinforce one another, disentangling their respective contributions helps explain whether organizational stability depends primarily on pre-existing family relations, on formalized group membership, or on the interaction between the two. Yet, despite its prominence, this debate has rarely been addressed through empirical comparison. Moreover, research has largely focused on internal bonding mechanisms, paying less attention to how these same mechanisms might shape collaboration between groups. In criminal settings, the strong reliance on trust, and thus on established, close-knit ties, suggests that cooperation is more likely to occur within groups than across them. This makes intergroup collaboration a particularly high-risk and analytically interesting phenomenon, as it requires overcoming barriers of trust and coordination that exist between distinct subunits of the same organization.

Collaboration beyond the group

Subgroups are common features of large criminal organizations: Cosa Nostra is organized into *famiglie* and *mandamenti*, 'Ndrangheta into *'ndrine* and *locali*, the Yakuza into *ikka*, and the Triads into *societies* (Catino 2019; Baradel and Breuer 2024). Similar divisions also exist in less formal organizations, such as *chapters* in OMGs or *clicas* and *programas* in the Mara-Salvatrucha-13 (Fuentes 2019; von Lampe and Blokland 2020). These clan-based structures allow decentralization and flexibility, often considered optimal for illicit enterprises (Bouchard and Morselli 2014; Catino 2019). Clans within these organizations need to interact and coordinate; yet shared membership to the same criminal organization alone does not ensure collaboration, as interactions across subgroups often manifest as conflicts (Catino 2014; 2019; Calderoni et al. 2017).

Empirical research on cross-group collaboration has expanded only recently, largely due to the difficulty of collecting data on intergroup ties (Paquet-Clouston and Bouchard 2023). Despite methodological differences, several studies converge on key insights. First, formal structures and clear communication channels seem to promote cooperation: OMGs, with their chapter-based hierarchy, show greater intergroup collaboration compared to more loosely organized groups (Coutinho et al. 2020). Second, collaboration patterns depend on activity type. Violence and intimidation tend to remain within subgroups or chapters, whereas profit-driven crimes such as drug trafficking encourage cross-group alliances (Bright et al. 2024; Campana and Giovannetti 2025). Third, spatial and relational proximity matter. Groups closer in geography, age composition, or kinship ties are more likely to collaborate (Krajewski et al. 2022; Campana and Giovannetti 2025). Finally, kinship and marriage ties play a bridging role at higher organizational levels, linking syndicates and reinforcing broader organizational cohesion, often facilitated by women through inter-family marriages (Tumminello et al. 2021).

Overall, the literature suggests that collaboration between groups is shaped by a combination of structural factors (hierarchy, communication channels), situational factors (crime type, co-location) and social factors (kinship, identity, shared norms). These findings underscore the importance of looking beyond the group's boundaries to understand how large criminal organizations coordinate and maintain resilience across multiple subunits.

Current study

This study contributes to the literature on collaboration in clan-based criminal organizations by analysing the factors that influence cooperation between individual members of the 'Ndrangheta, focusing on how collaboration is shaped within and across its formal subgroups, the *locali*. The research addresses two research questions: *What factors are associated with collaboration in the 'Ndrangheta? Do these factors differ when collaboration occurs within a single locale versus between members of different locali?* By examining collaboration at the dyadic level, i.e. between pairs of individuals, this study sheds light on the different drivers of cooperation within and across distinct organizational units of a mafia-type organization, contributing to broader debates on the interplay between trust, kinship and formal structures—membership and hierarchy—in organized crime.

Overall, shared locale membership is expected to be associated with collaboration. Locali are organizational units with defined roles, hierarchies, rituals and obligations regulated by codified rules that foster predictability and trust. Shared membership strengthens collaboration both through formal obligations and through familiarity and shared identity (Paoli 2003; Ciconte 2014; Calderoni *et al.* 2016; Catino 2019). Beyond membership, kinship has long been recognized as a source of trust and reciprocity, providing both individualized and generalized trust that reduce defection risk and strengthens cooperative ties (Blok 1974; Paoli 2003; von Lampe and Ole Johansen 2004; Campana and Varese 2013; Sergi 2021; Catino *et al.* 2022). Leadership further contributes to collaboration by directing group action and coordinating operations, with leaders often acting as brokers between different parts of the organization (von Lampe 2016a; Calderoni *et al.* 2017; Calderoni and Superchi 2019; Catino 2019; Krajewski *et al.* 2022). Together, we expect these three factors to exert positive, independent, and complementary effects on collaboration across the overall network.

H1 (overall): Shared locale membership is positively associated with collaboration, net of kinship, leadership and socio-geographical factors.

H2 (overall): Kinship is positively associated with collaboration, net of shared membership, leadership and socio-geographical factors.

H3 (overall): Shared hierarchical status is positively associated with collaboration, net of shared membership, kinship and socio-geographical factors.

Within locali, collaboration is expected to be primarily driven by kinship ties, reflecting the blood-based nature of the 'ndrine—the core units of the 'Ndrangheta—which recruit mainly through family relations and consolidate influence through strategic marriages (Paoli 2003; Sciarrone 2014; Catino *et al.* 2022). Kinship fosters trust, reciprocity and a sense of obligation that are essential for coordinating collective action and maintaining secrecy in illicit environments (von Lampe and Ole Johansen 2004; Kadushin 2012; Campana and Varese 2013). By contrast, leadership homophily likely plays a weaker role: while leaders are central to governance and top-down coordination (Catino 2019), many daily activities are decentralized for security reasons (Calderoni 2012) and rely on collaboration across ranks rather than exclusively among leaders. Vertical differentiation thus facilitates implementation of directives but does not necessarily produce stronger collaboration between leaders themselves (von Lampe 2016a; Krajewski *et al.* 2022). Accordingly, kinship is expected to be

more strongly associated with collaboration than leadership ties within locali, and leaders are not hypothesized to collaborate significantly more than other pairs.

H4 (*within locali*): Kinship is positively associated with collaboration, net of leadership and socio-geographical factors.

H5 (*within locali*): Leadership homophily has a weaker or null association with collaboration once kinship and socio-geographical factors are accounted for.

Collaboration across locali is riskier and requires robust coordination mechanisms to overcome uncertainty and mistrust. It is reportedly facilitated by high-status bodies composed of senior members (Catino 2019), yet the extent to which collaboration follows these formal mechanisms remains unclear. Leaders are expected to act as brokers, balancing dense ties within their own locale with linking across groups, enabling information flow, dispute resolution and joint governance activities (Calderoni *et al.* 2017). Direct kinship ties across locali are expected to be relatively rare; however, indirect kinship ties, such as intermarriages or extended family relationships, are often used strategically to create alliances, reduce conflict and facilitate cross-group cooperation (Varese 2017; Catino *et al.* 2022). These symbolic connections can serve as bridges between otherwise separate subgroups, supporting coordination while maintaining each locale's autonomy. Based on this reasoning, we expect that both indirect kinship and leadership ties will facilitate cross-locale collaboration, with leadership playing a particularly central role in bridging organizational boundaries.

H6 (*across locali*): Indirect kinship is positively associated with collaboration between members of different locali, net of leadership and socio-geographical factors.

H7 (*across locali*): Leadership homophily is positively associated with collaboration between members of different locali, net of indirect kinship and socio-geographical factors.

Methodology

Data collection and processing

For the analysis, we draw on data from pre-trial court orders and judicial records from three major Italian operations against the 'Ndrangheta—*Crimine* (2010, Calabria), *Infinito* (2010, Lombardy) and *Minotauro* (2011, Piedmont)¹—as well as first-instance judgments² and other judicial sources (Carabinieri di Monza 2008; Tribunale di Reggio Calabria 2012). Together, these long-running operations, which lasted four to seven years and relied extensively on surveillance and wiretaps, produced high-quality data that allowed investigators to reconstruct the organization's structure, including the locali and their membership. The activities monitored were mainly governance-type (Campana and Varese 2018), including the resolution of internal conflicts, rank assignments, the management of criminal activity, and other strategic issues.

We systematically coded information on meetings, phone calls, kinship relationships (specifying their types), charges against the defendants and individual attributes, following and extending prior work (Calderoni 2014; Superchi 2018; Calderoni and Superchi 2019). Data on charges and kinship ties were newly collected for this study (Paternoster 2025).

¹ Source: Tribunale di Reggio Calabria (2010), Tribunale di Torino (2011), Tribunale di Milano (2023).

² The pre-trial court order, issued by the preliminary investigation judge, is a judicial document aimed at restricting the freedom of suspects prior to trial.

Table 1 Attributes information, by case study

	Infinito (N = 235)	Crimine (N = 283)	Minotauro (N = 208)
Age (years)			
(10–20)	0 (0%)	2 (0.7%)	0 (0%)
(20–30)	23 (9.8%)	33 (11.7%)	15 (7.2%)
(30–40)	40 (17.0%)	46 (16.3%)	33 (15.9%)
(40–50)	44 (18.7%)	74 (26.1%)	49 (23.6%)
(50–60)	38 (16.2%)	58 (20.5%)	38 (18.3%)
(60–70)	27 (11.5%)	35 (12.4%)	36 (17.3%)
(70–80)	8 (3.4%)	23 (8.1%)	12 (5.8%)
(80–90)	3 (1.3%)	6 (2.1%)	2 (1%)
Missing	52 (22.1%)	6 (2.1%)	23 (11.1%)
Residence (municipality)			
Lombardy	143 (60.8%)	–	–
Calabria	–	179 (63.3%)	–
Piedmont	–	–	121 (58.2%)
Others	32 (13.6%)	73 (25.8%)	42 (20.2%)
Missing	60 (25.5%)	31 (10.9%)	45 (21.6%)
Leadership	34 (14.5%)	38 (13.4%)	30 (14.4%)
Mafia association	132 (56.2%)	106 (37.5%)	136 (65.4%)
Total number of locali	18	47	16

For each individual, we recorded socio-demographics, locale affiliation, leadership roles, participation in events and the number of crimes prosecuted (Table 1). Leaders were classified following prior research (Calderoni 2014; Superchi 2018; Calderoni and Superchi 2019), composing the individuals holding the highest ranks: the boss of the locale (*capo locale* and *capo società*), the finance manager (*contabile*) and the spokesperson of the boss (*mastro di giornata*). We excluded individuals holding such ranks who were dead, imprisoned, or too distant to participate regularly during the investigation.

To test our hypotheses, we adopted a network approach: individuals are represented as nodes (vertices) in a network, while collaborative relationships between them as ties (edges). We used co-attendance at meetings and participation in phone calls as proxies for collaboration, which is intended, in line with Bouchard (2020) and Calderoni et al. (2026), as an umbrella concept encompassing actions including conspiracy, collusion, crime commission and non-criminal cooperation instrumental to the functioning of the ‘Ndrangheta.

We first constructed a *collaboration network*, linking individuals with known locale affiliation who attended meetings or participated in phone calls together. These networks captured collaborative relationships without specifying direction (undirected) and accounted for the frequency of interactions (weighted).³ This procedure resulted in three networks

³ For further details on network analysis methods, see Borgatti et al. (2022).

comprising 235 nodes for *Infinito*, 283 for *Crimine*, and 208 for *Minotauro* (Table 2). From this, we derived an *intra-locale collaboration network*, isolating ties occurring among individuals from the same locale, and an *across-locale collaboration network*, including only ties between members of different locali. Both intra- and across-locale networks were obtained by selectively removing ties from the original *collaboration network*—excluding across-locale ties for the intra-locale network and intra-locale ties for the across-locale network—and then removing any nodes (individuals) who no longer had any remaining connections.

For each collaboration network, we also constructed a set of additional networks (undirected, unweighted) representing different types of social and organizational relationships between individuals: *kinship* (any kinship ties), *direct family* (spouses, parent-child and siblings ties), *third-degree kinship* (any kinship minus direct family ties), *acquired kinship* (father/son/brother-in-law ties), *leadership* (ties between two leaders) and *co-charge network* (ties between co-defendants excluding Art. 416bis). For the overall *collaboration network* only, we also created the *same locale affiliation network*, while for the *across-locale collaboration network* we further included the *indirect kinship network*, linking two individuals from different locali when at least two members from their respective locali share a kinship tie. Table 2 provides details for the overall collaboration network and its dimensions, while descriptive statistics for the additional networks for the node set included in the intra- and across-locale collaboration networks are in Supplementary Appendix Table A2 and Table A3.

Analytical strategy

To investigate the factors associated with collaboration within and across locali, we first descriptively assessed the degree of overlap (multiplexity) between collaboration and the other relationships, computing the Jaccard Index [0,1] (Jaccard 1901), which measures the proportion of shared ties between two networks *A* and *B* relative to the total number of unique ties in either network:

To assess the association between collaboration and these relationships, we employed a series of quasi-Poisson multiple regression quadratic assignment procedure (MRQAP) models. Standard statistical linear models are inappropriate for network data due to the violation of the independence assumption, as networks are inherently dyadic in nature (Krackhardt 1988). Quadratic Assignment Procedure (QAP) regressions address this challenge by using permutation-based testing to account for such dependencies.⁴

QAP-based models (Mantel 1967) address dyadic dependence through permutation-based testing. Rows and columns of the dependent matrix are repeatedly permuted while preserving the dyadic structure of the network, and the observed coefficient is compared with the distribution of coefficients obtained from the permuted matrices (Borgatti et al. 2022). Because the dependent variable is a count and overdispersed, we employed a quasi-Poisson MRQAP specification using the Double-Dekker Semi-Partialing procedure (Dekker et al. 2007).⁵

$$J(A,B)=\frac{|A\cap B|}{|A\cup B|}$$

⁴ For further details of QAP regressions, see Borgatti et al. (2022).

⁵ Valued Exponential Random Graph Models (ERGMs) were explored as an alternative to MRQAP analyses. However, due to the high sparsity of the networks under study, ERGMs encountered high computational costs and convergence issues for some model specifications. Despite not being a statistical model, MRQAP remains a widely accepted and robust analytical approach for network data, allowing to account for the inherent dependencies through permutation-based testing and obviating the need to explicitly model structural configurations (Cranmer et al. 2017; Borgatti et al. 2022).

Table 2 Descriptive statistics of the networks, by case study

	Nodes	Edges	Density	Average degree	Average strength
Infinito					
Collaboration	235	2,036	0.074	17.33	36.54
Intra-locale collaboration	210	696	0.032	6.63	16.34
Across-locale collaboration	184	1,340	0.080	14.56	28.01
Co-charge	235	106	0.004	0.90	1.47
Kinship (whole)	235	166	0.01	1.41	–
Direct family	235	56	0.002	0.48	–
Third-degree kinship	235	110	0.004	1.82	–
Same locale affiliation	235	1,683	0.06	14.32	–
Leadership	235	561	0.02	4.77	–
Crimine					
Collaboration	283	1,769	0.044	12.50	18.94
Intra-locale collaboration	228	406	0.016	3.56	6.14
Across-locale collaboration	241	1,363	0.047	11.31	16.43
Co-charge	283	7	0.000	0.05	0.11
Kinship (whole)	283	126	0.003	0.89	–
Direct family	283	48	0.001	0.34	–
Third-degree kinship	283	78	0.002	0.55	–
Same locale affiliation	283	1,773	0.044	12.5	–
Leadership	283	703	0.018	4.97	–
Minotauro					
Collaboration	208	4,226	0.196	40.63	89.59
Intra-locale collaboration	172	1,084	0.074	12.60	36.07
Across-locale collaboration	189	3,142	0.177	33.25	65.78
Co-charge	208	48	0.002	0.46	0.63
Kinship (whole)	208	158	0.007	1.52	–
Direct family	208	69	0.003	0.66	–
Third-degree kinship	208	89	0.004	0.856	–
Same locale affiliation	208	2,112	0.098	20.31	–
Leadership	208	435	0.020	4.18	–

Note: Network dimensions are reported with respect to the whole network only. For more details on the intra- and across-local dimensions, see [Tables A2](#) and [A3](#) in the [Supplementary Appendix](#).

For each case study, we estimated three separate MRQAP models using the *collaboration network*, *intra-locale collaboration network* and *across-locale collaboration network* as dependent variables, respectively. The set of covariates comprises the dimensions explored in the

descriptive analysis. To examine kinship effects, the *direct family* and *third-degree kinship networks* were included in the models for the *collaboration* and *intra-locale collaboration networks*, while *indirect kinship* was used for the *across-locale collaboration networks*. To capture the formal organizational structure, the *leadership network* was included across all models, with *same locale affiliation network* added only to the model for the *collaboration network*.

Control variables accounted for age homophily, spatial proximity and potential prosecution biases. First, *same age network*, including a tie if two actors have less than 4 years of difference. The aim was to capture the tendency to rely on similar people, as cooperation is usually localized in social space (Charette and Papachristos 2017). Second, the *same residence network*, including a tie if two actors lived in the same municipality. Social relations are embedded in the physical space as well, and cooperation may be driven by the geographical distance between two people, especially in the case of physical collaboration such as meetings (Kleemans 2014; Charette and Papachristos 2017). Third, *mafia association network*, including a tie if two actors were charged for 416bis mafia association. Considering that the mafia association was the major charge for all three judicial cases, we included this variable to control for potential prosecution biases. The control variables were operationalized as one-mode, dichotomous, undirected matrices derived from the attribute dataset. The analyzes were conducted in R with packages *igraph* (Csárdi et al. 2024), *Multinet* (Magnani 2021) and *MrQAP* (Krause 2025).

Results

Descriptive analysis of multiplexity

Figure 1 shows that collaboration overlaps only modestly with other relational dimensions, confirming previous findings on limited multiplexity in organized crime (Smith and Papachristos 2016). The highest similarity is with same locale affiliation (13–23 per cent), suggesting that collaboration is largely embedded within locali, while also pointing to notable interactions across groups. Leadership ties overlap to a lesser but meaningful degree (5–12 per cent), indicating that leaders tend to collaborate with one another. Kinship shows weak overlap (2–6 per cent), mostly through third-degree ties, many of which are acquired through marriage (Table A1, Supplementary Appendix).

Co-charge ties show minimal similarity with collaboration (max 3.4 per cent in *Infinito*), mainly reflecting variability in the underlying data, with *Infinito* including 50 co-charge events, *Crimine* 12, and *Minotauro* 42. Co-charge also shows limited and variable similarity to kinship and same locale affiliation ($J = 0.3$ –4.8 per cent and $J = 1$ –7 per cent, respectively; Figure 1). Given the sparsity of the co-charge network, these results should be interpreted with caution.⁶ Indeed, a direct overlap analysis, as reported in Table A1 in the Supplementary Appendix, shows that most ties occurred within the same locale (62–86 per cent),⁷ indicating that co-offending is even more localized than collaboration. Direct overlap with kinship was inconsistent across cases (4–57 per cent), preventing firm conclusions about the role of family ties in co-offending.

⁶ Despite being the most used measure to investigate multiplexity, the Jaccard Index does not account for the size differences between networks. As a result, when one network is sparse and the other is much denser, it may yield a low value even if the ties in the sparse network are almost fully embedded within the denser one.

⁷ Percentages for *Crimine* should be interpreted with caution, as they rely on a small number of ties (see Table A1, Supplementary Appendix).

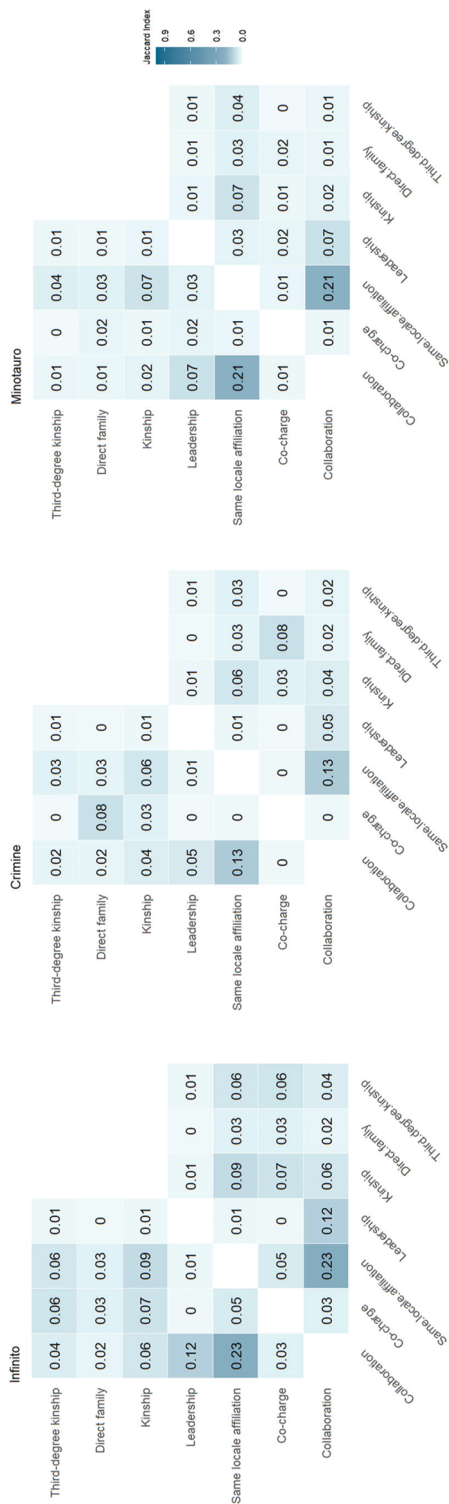


Fig. 1 Jaccard index heatmap of network dimensions based on the collaboration network, by case study

The analysis then focused on intra- and across-locali dynamics (Figure 2),⁸ revealing distinct patterns. Intra-locale collaboration overlaps strongly with kinship—16 per cent in *Infinito*, 14 per cent in *Crimine*, and 9 per cent in *Minotauro*—confirming the centrality of family ties within locali. Most overlaps in *Infinito* involve third-degree kinship (11 per cent), whereas direct family ties dominate in *Crimine* (7 per cent) and *Minotauro* (5 per cent). Many of these third-degree links result from marriage, highlighting the strategic use of marital alliances to consolidate trust and cohesion within locali (Table A2, Supplementary Appendix). Leadership overlap within locali is consistently low (3–4 per cent), mainly reflecting the limited number of leaders per locale.

Patterns differ when focusing on across-locali cooperation. Direct kinship overlap is rare (below 1 per cent in all cases), confirming that blood ties between members of different locali are exceptional and mostly third-degree. Indirect kinship—connections between locali through at least one kinship tie—shows a larger but variable similarity with across-locale collaboration (6 per cent in *Infinito*, 8 per cent in *Crimine*, 4 per cent in *Minotauro*), indicating that symbolic family linkages may play a role in bridging groups. Leadership overlap is much higher for across-locale collaboration (6–16 per cent), suggesting that leaders act as brokers of cross-locale cooperation and coordination.

Hypotheses testing

Table 3 presents three sets of quasi-Poisson MRQAP models, each corresponding to a different dependent network: the overall *collaboration network*, the *intra-locale collaboration network* and the *across-locale collaboration network*. For *collaboration* and *intra-locale collaboration*, we estimate two models each: Models I and III include a single kinship term, while Models II and IV separate kinship into direct family and third-degree ties. This modelling strategy allows us to first establish whether kinship is associated with collaboration and then determine which type of kinship ties (direct or third-degree) drive this association. Model V focuses on *across-locale collaboration* and includes leadership and indirect kinship between locali as the primary explanatory variables. Co-charge ties were excluded from all models, and direct/third-degree kinship were excluded from the *across-locale collaboration* models, where only indirect kinship at the locale level was included. These modelling choices were guided by the descriptive analysis, which revealed limited overlap for co-charge ties and very sparse kinship connections across locali. Table A4, Table A5 and Table A6 in the Supplementary Appendix report the single-covariate analyses.

Collaboration network

Kinship was positively associated with collaboration across all cases, with a particularly strong effect in *Crimine* (IRR $\approx$ 5.6). Disentangling kinship shows that in *Minotauro* only direct family ties were slightly positive and significant (IRR $\approx$ 1.6), whereas in *Crimine* third-degree kinship showed the stronger effect. Same-locale affiliation exhibited a larger effect, with collaboration rates between members of the same locale about $8\times$ higher in *Infinito*, $4\times$ higher in *Crimine* and $3\times$ higher in *Minotauro* than across locali. Leadership ties also showed strong homophily (IRR $\approx$ 4–9 across cases). Age and residence effects were smaller but significant in most models, suggesting a modest role for demographic and spatial homophily. Overall, the results confirm the strong association between formal structures and collaboration across all three case studies, with

⁸ Since co-charge ties mostly occurred within the same locale, their multiplexity with other dimensions is not discussed further.

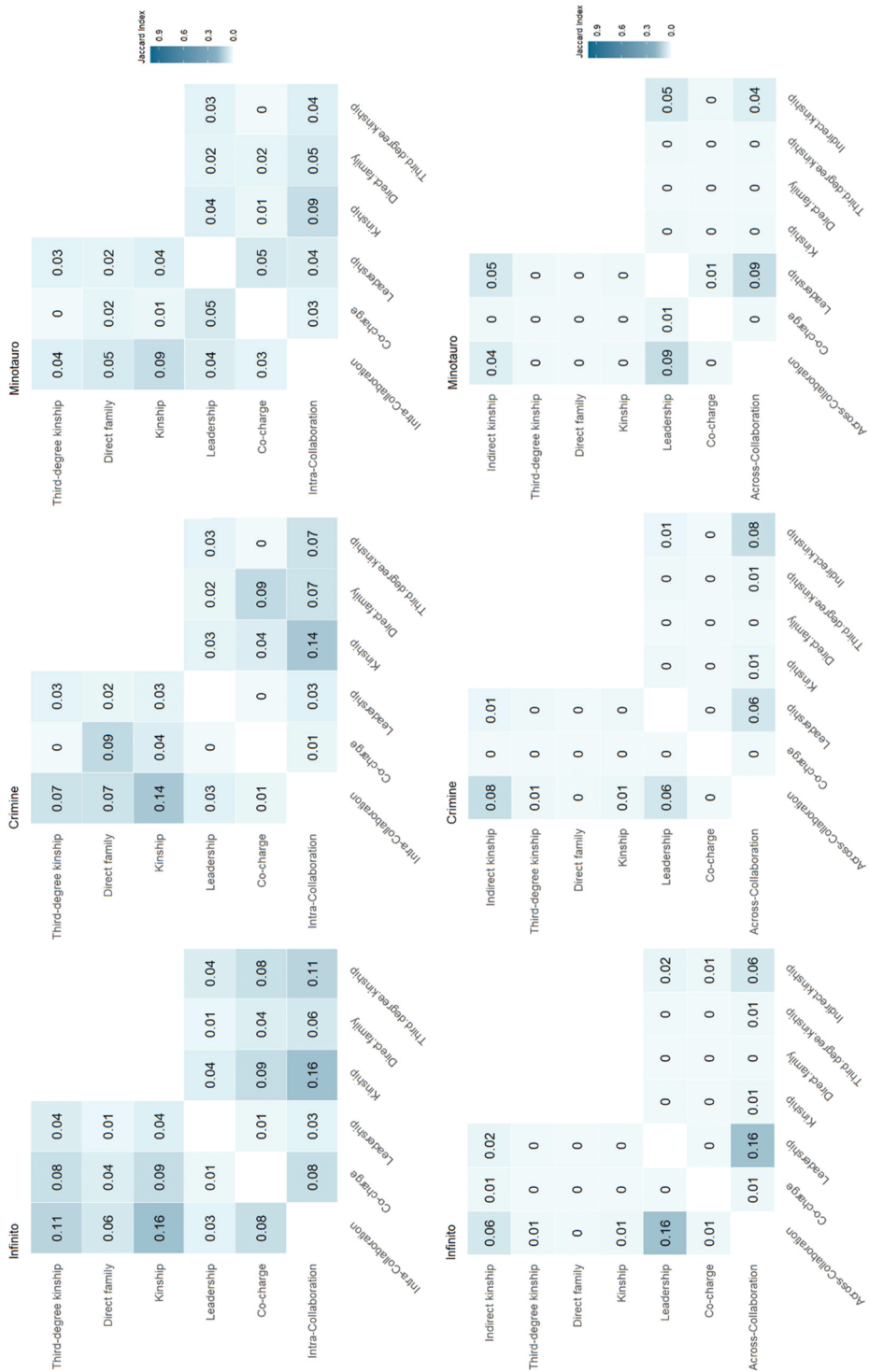


Fig. 2 Jaccard index heatmap of network dimensions based on the intra-locale (upper panel) and across-locale (lower panel) collaboration networks, by case study

Table 3 Results of the quasi-Poisson MRQAP for collaboration network, intra-locale collaboration network, and across-locale collaboration network, by case study (8,000 permutations, coefficients as IRR)

	Collaboration (whole)						Intra-locale collaboration						Across-locale collaboration					
	Crimine			Minotauro			Infinito			Crimine			Minotauro			Infinito		
	I	II	I	II	I	II	III	IV	IV	III	IV	IV	III	IV	IV	V	V	V
Kinship	1.67**	-	5.60***	-	1.28+	-	2.08***	-	-	6.05***	-	-	1.54+	-	-	-	-	-
Direct family	-	1.72*	-	5.05**	-	1.57*	-	2.49*	-	7.75**	-	1.82*	-	-	-	-	-	-
Third-degree kinship	-	1.65*	-	5.90**	-	1.03	-	1.95***	-	4.98**	-	1.27	-	-	-	-	-	-
Indirect kinship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.99**	3.86***	0.79
Leadership	9.50***	9.51***	4.14**	4.14**	6.68***	6.70***	3.64***	3.70***	3.70***	1.52	1.51	3.37***	3.39***	3.39***	9.48***	4.28**	8.61***	8.61***
Same locale affiliation	7.91***	7.91***	4.57***	4.57***	3.42***	3.42***	-	-	-	-	-	-	-	-	-	-	-	-
Same age	1.39*	1.3*	1.33*	1.33*	1.07	1.06	1.56*	1.56*	1.56*	2.32*	2.28*	1.10	1.09	1.48+	1.39+	1.39+	1.19+	1.19+
Same residence	2.13**	2.13**	1.36	1.36	1.38*	1.36*	1.73+	1.69+	1.69+	9.91***	9.68***	1.75*	1.72*	4.98*	3.21**	4.98*	1.49	1.49
Mafia association	3.41***	3.41***	2.56***	2.55***	2.88***	2.88***	59.55***	59.70***	59.70***	4.74***	4.98***	29.95***	30.04***	3.01***	2.82***	3.03*	3.03*	3.03*
(Intercept)	0.04	0.04	0.04	0.04	0.15	0.15	0.02	0.02	0.02	0.01	0.01	0.05	0.05	0.05	0.05	0.05	0.15	0.15
Observations	27,495	27,495	39,903	39,903	21,528	21,528	21,945	21,945	21,945	25,878	25,878	14,706	14,706	16,836	28,920	17,766	17,766	17,766
Null deviance	52,980	52,980	37,580	37,580	75,910	75,910	26,700	26,700	26,700	12,650	12,650	38,550	38,550	31,230	27,320	51,567	51,567	51,567
Residual deviance	32,890	32,890	31,340	31,330	54,360	54,330	11,790	11,790	11,800	8,215	8,229	19,210	19,190	22,650	23,970	39,791	39,791	39,791
Permutations	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.001$.
Note: Standard errors are omitted as they cannot be computed under the quadratic assignment procedure.

kinship also playing a role, albeit less pronounced compared to shared membership and formal hierarchy.

Intra-locale collaboration

Kinship emerged as a relevant factor associated with collaboration within locali, supporting H4. In *Infinito* and *Crimine*, kinship increased collaboration rates by approximately 2 and 6 times, respectively, with direct family kinship exhibiting the strongest effect. Contrary to H5, leadership also had a strong and positive association within locali, with leader dyads collaborating significantly more frequently than other pairs in *Infinito* and *Minotauro* ($IRR \approx 3$), while no significant effect emerged in *Crimine*. Geographic proximity had a strong effect, especially in *Crimine* ($IRR \approx 9$), confirming that internal collaboration is highly localized and reflecting the geographical-based nature of locali (Sciarrone 2014; Catino 2019). Although weaker than the effects of kinship, leadership and territorial proximity, age homophily emerged in *Infinito* and *Crimine*, suggesting that individuals were more prone to collaborate with others of a similar age. No such effect was observed in *Minotauro*.

Across-locales collaboration

Leadership remained the key factor associated with collaboration across locali, with leader dyads collaborating at rates ≈ 4 –9 higher than other pairs, confirming H7. Indirect kinship ties between locali were positively associated with across-locales collaboration in *Crimine* and *Infinito*, suggesting that family linkages between locali facilitate cross-group cooperation, though the effect was not statistically significant in *Minotauro*. Geographical proximity also confirmed its positive association with across-locales collaboration ($IRR \approx 5$ in *Infinito*, $IRR \approx 3$ in *Crimine*), yet results were not significant in *Minotauro*.

Overall, these findings indicate that both kinship and leadership contribute to structuring collaboration within locali. While kinship is positively associated with intra-locales collaboration, leadership emerges as consistently associated with higher collaboration rates both within (*Infinito* and *Minotauro*) and across locali, highlighting the importance of formal organizational structures in 'Ndrangheta coordination. Along with leadership, shared membership (same-locales affiliation) is the strongest factor associated with collaboration overall.

Discussion and conclusion

Collaboration in the 'Ndrangheta is shaped by both formal organizational structures and kinship, but their relevance varies by level of analysis. (Table 3, Models I and II). Across the overall network, shared locale membership, kinship and leadership homophily are all positively associated with collaboration. Within locali, kinship is a central driver, while leadership has a less consistent role. (Table 3, Models III and IV). Across locali, collaboration is primarily associated with leadership homophily, with indirect kinship providing a weaker and more context-dependent channel for bridging group boundaries. (Table 3, Model V).

Across the full network, the results provide strong support for H1–H3: shared locale membership, kinship and leadership homophily are all positively and significantly associated with collaboration, net of one another and socio-geographical factors. The strong association with shared locale membership highlights the role of locali as the primary arenas for coordination and resource allocation, an angle often overlooked compared to kinship or leadership. Membership entails formal obligations to participate in meetings and carry out collective criminal activities (Catino 2019), which may compel collaboration regardless of

personal willingness. As Paoli (2020: 178) notes, ‘subordinates in a regime of generalized reciprocity has no choice whether to execute superiors’ orders’. Beyond these obligations, generalized reciprocity and initiation rituals create a shared identity that fosters trust and solidarity (Paoli 2003; Skarbek and Wang 2015), while repeated interaction reinforces emotional bonds and predictability (von Lampe and Ole Johansen 2004; Catino 2019; Bright *et al.* 2024). These findings align with prior work highlighting the importance of kinship and formal hierarchy in sustaining cooperation (Paoli 2003; Calderoni *et al.* 2017; Catino 2019) but add a novel contribution by showing that shared group membership has an independent, non-redundant effect. By disentangling these three mechanisms with a multiplex network approach, this study demonstrates that structural, relational and institutional forces jointly shape collaboration and organizational cohesion in the ‘Ndrangheta.

When focusing on intra-locale dynamics, H4 receives partial support: kinship is a significant driver of collaboration in *Infinito* and *Crimine*, though weaker and limited to direct family ties in *Minotauro*. This difference may reflect, at least partially, variations in the structure and scope of the investigations themselves. Most recorded kinship ties in *Minotauro* were first-degree ties, potentially suggesting a more limited prosecutorial attention to extended family relations. In general terms, these findings highlight the blood-based nature of the ‘ndrine, where recruitment and influence are preserved through family ties and strategic marriages, especially in Calabria, which may help to explain *Crimine* results (Paoli 2003; Sciarrone 2014; Sergi 2021; Catino *et al.* 2022). Kinship fosters trust and reciprocity—both through repeated interactions and shared norms (von Lampe and Ole Johansen 2004)—providing the secrecy and cohesion needed to coordinate illicit activities (Kadushin 2012; Catino 2019). Many of these ties are acquired kinship, reflecting the strategic use of marriage to seal alliances, prevent conflicts and expand territorial control (Ciconte 1996; Paoli 2003; Varese 2017).

H5 does not receive full support: leadership homophily is statistically significant and positively associated in *Infinito* and *Minotauro* but not in *Crimine*. One possible explanation of this difference across case studies is that, in non-traditional territories, as Lombardy in *Infinito* and Piedmont in *Minotauro*, cooperation may be more centralized around high-ranking actors, who may play a coordination role in contexts where organizational structures are less consolidated. At the same time, the strong effect of leadership may also reflect investigative dynamics, as prosecutors may have devoted greater attention to monitoring interactions among apical members. This may also relate to the nature of the activities captured by the investigations, which mainly concerned governance-type activities requiring greater coordination and more direct involvement of leaders. The descriptive analysis, however, suggests that collaboration within locali is not exclusively leader-driven but also involves, although less frequently, rank-and-file members, consistent with the decentralization of many routine activities (Calderoni 2012; Catino 2019).

Results for across-locale collaboration provide partial support for H6 and strong support for H7. When managing governance-type activities, the leaders are the spokespersons (Chopin and Dupont 2024) coordinating locali activities and pursuing common objectives on behalf of the group. They are also elite members whose long and established criminal careers, reflected in their high-ranks, allow them to take part in the organization’s rituals of integration and aggregation (Catino 2019). Indirect kinship is positively associated with higher collaboration rates across locali in *Infinito* and *Crimine* but not in *Minotauro*, suggesting that kinship-based alliances may facilitate cooperation between locali in some contexts, although their role appears less consistent than that of hierarchy. The relevance of this type of connections is particularly visible in Calabria, where strategic marriages have historically been used to seal alliances, prevent conflict and expand the reach of powerful

families—especially in regions such as Aspromonte, known for a long tradition of such alliances (Sergi 2023). In general terms, these findings suggest that kinship bonds between locali act less as dense relational networks and more as symbolic connections (Paoli 2003): it is not a matter of quantity but quality of the family ties that create trust and reduce uncertainty, complementing the organization's formal structure.⁹

Our findings should be interpreted considering several limitations. First, the analysis relies on judicial documents, a well-established but imperfect source for studying criminal organizations (Baker and Faulkner 1993; Calderoni 2012; 2014; Campana and Varese 2013; Bright *et al.* 2015). Wiretaps and surveillance records provide rich information on actors, ties, and activities, and their probative purpose ensures relevance to criminal events. Yet, they are not collected for research and may reflect investigative priorities, producing non-random samples and potential bias (Berlusconi 2013; Bright *et al.* 2021). To mitigate these issues, we analyzed three distinct operations—*Crimine*, *Infinito*, *Minotauro*—conducted over several years in different regions but following similar investigative protocols and systematic approaches. This triangulation increases the robustness of our findings by showing that the observed patterns are not the product of a single investigation's focus but are replicated across different judicial inquiries. Missing data were nonetheless 'not at random' (Rubin 1976), since investigations did not cover all members of the monitored locali and reported kinship selectively, typically when relevant to specific events. Moreover, the documented activities were largely governance-related, limiting generalization to other types of collaboration (e.g. illicit markets).

Second, our method for distinguishing intra- and across-locale collaboration-derived networks by subtracting edges from the overall network, which does not isolate events occurring exclusively within or across locali. Directly constructing across-locale networks from multi-locale events was tested but failed to capture kinship effects accurately. Despite these trade-offs, the subtraction method best served our objective of isolating the dyadic effects of kinship and structure. In addition, by removing isolates, we excluded cases in which social and organizational relationships existed but no collaborative interactions were observed. While this choice may omit some potentially informative dyads, it ensured consistency with the construction of the overall collaboration network, which is defined only by individuals participating in at least one collaboration event.

Finally, MRQAP models identify associations but not causality, and do not provide standard errors to assess uncertainty around estimates. While our use of temporally prior independent variables (e.g. kinship) strengthens causal interpretation, results should still be interpreted cautiously. As a case study design, our findings have limited external validity; future research should replicate this analysis with other mafia-type and non-hierarchical criminal groups to test the generalizability of these mechanisms.

In sum, this study advances our understanding of collaboration in clan-based mafia-type organizations by disentangling the role of shared membership, kinship and leadership within a multiplex network framework. These findings contribute to theoretical debates on how trust, family bonds and formal structures sustain collective action in illicit settings. Future research should extend this approach to other mafia-type and non-mafia criminal

⁹ Operation *Crimine* provides an illustrative case where a symbolic marriage between two powerful families from Plati and San Luca sealed an alliance between factions (Tribunale di Reggio Calabria 2010). Such marriages are less about creating dense kinship networks than forging symbolic ties that strengthen reciprocity and may even shift local power balances (Paoli 2003), consistent with Catino *et al.* (2022), who report a median of one interfamily marriage per 'Ndrangheta family.

groups, explore collaboration in market-related activities and integrate longitudinal data to assess how these mechanisms evolve over time.

Supplementary material

Supplementary material is available at *British Journal of Criminology* online.

Funding

Caterina Paternoster was funded by the European Union [ERC, NEMESIS, project number: 101116718]. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union nor the granting authority can be held responsible for them.

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