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The extra-legal governance of corruption: Tracing the organization of corruption in public procurement

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Abstract

This article traces the organization of corruption in public procurement, by theoretically and empirically assessing the contribution of extra-legal governance organizations (EGO) to supporting it. Theoretically, we explore the governance role played by organized criminal groups in corruption networks, facilitating corrupt transactions by lowering search costs, bargaining costs, and enforcement cots. Empirically, the analysis exploits a rare empirical setup of proven cases of both EGO presence and absence in contract awards by Italian municipalities. We use traditional regression and supervised machine-learning methods for identifying and validating proxy indicators for EGO presence in public procurement such as single bidding or municipal spending concentration. Internal validity of our models is very high, 85% of unseen contracts are correctly classified. External validity is moderate, our predicted EGO presence score correlates with established indicators of organized criminality across the whole of Italy and Europe with a linear correlation coefficient of about 0.4.

1 | INTRODUCTION

Over the past decades, several far-reaching corruption scandals all over the world have involved policy makers at the highest reaches of government, staggering amounts of bribes, and money laundering of epic proportions (Transparency International, 2020). In the public procurement sector, for instance, the literature estimates the amount of bribes ranging from 8% to 25% of the value of procured goods, services, or works (Bosio et al., 2020). In the wake of scandals, awareness has grown about the contribution of extra-legal governance organizations (EGOs) in governing political corruption, that is, those organizations performing crucial functions as enablers, brokers, guarantors, and enforcers of corrupt deals (Della Porta & Vannucci, 2012). Mafia-like groups are a quintessential example of EGOs (Lessing, 2020; Lessing & Willis, 2019; Varese, 2010), given their ability to establish their extra-legal governance both within and outside their organization (Barnes, 2017; Catino, 2019; Lessing, 2020; Magaloni et al., 2020). More recently, the fast-growing interest in organized criminal groups mainly in developing countries, has shed light on the variety of forms of their governance, especially in those spaces that states perennially find difficult to govern (Lessing, 2020, p. 2), such as in prisons (Lessing & Willis, 2019; Skarbek, 2011), illicit sectors (Aziani et al., 2020; Kostelnik & Skarbek, 2013), urban periphery (Magaloni et al., 2020) and, more in general, in countries lacking state-capacity (Shortland & Varese, 2016).

Most studies contextualize extra-legal governance in competition/conflict with state-sponsored governance (Lupsha, 1996), scarcely investigating both collusive partnerships that can be fostered between criminal and institutional actors (Barnes, 2017; Lessing, 2020; Magaloni et al., 2020; Snyder & Durán-Martínez, 2009), and isomorphic processes (DiMaggio & Powell, 1983; Tilly, 1985), that is, the increasing convergence and conformity in organizational forms and practices between them. Likewise, as far as corruption studies are concerned, both principal-agent (Klitgaard, 1988; Lambsdorff, 2002) and collective action theories (Bauhr, 2017; Mungiu-Pippidi, 2015; Persson, Rothstein, & Teorell, 2013) have often overlooked the organizational context, behaviors, and processes that support corruption (Luo, 2005; Marquette & Peiffer, 2018). In fact, while "almost all corrupt transactions have organizational aspects, as the participants are typically organizational members or have organizational affiliations" (Jancsics & Jávor, 2016, p. 1), a few studies have scrutinized its internal workings (Della Porta & Vannucci, 1999; Jancsics, 2015; Jancsics & Jávor, 2012, 2016; Nielsen, 2003).

By combining the recent scholarship on extra-legal governance (Lessing, 2020; Varese, 2010) with the literature on organizational corruption (Della Porta & Vannucci, 1999; Jancsics, 2015; Nielsen, 2003; Yu et al., 2020), this article provides theoretical insights on the internal functioning of corrupt transactions and the role played by EGOs in reducing uncertainty about and incentives for opportunistic behavior. In particular, the article develops a theoretical framework that delimits organized criminal groups' governance of corrupt transactions, and its underlying logics. Empirically, our goal is to test the presence of proxies for EGO services (searching, bargaining, and enforcement) in line with our theory. Moreover, we also predict the provision of governance services by EGOs, including, as an extreme case, organized criminal groups infiltrating into public procurement contracts at municipal level.

The article draws on the case of Italy, a country experiencing both high levels of corruption (Della Porta & Vannucci, 1999, 2012)[1] and a rooted and heterogeneous presence of mafia-like groups. These groups operate in the South (Calderoni, 2011), their homeland and stronghold, but also in Central and Northern Italy, where these groups have transplanted new criminal branches since the 1960s, infiltrating the legitimate economy (Caneppele et al., 2009), such as the construction industry or public procurement (Caneppele & Martocchia, 2014; Catino & Moro, 2016; Dagnes et al., 2020; Sciarrone, 2012; Varese, 2011). In the past two decades, mafias' impact on Italy's economy

and policy-making has been widely scrutinized by a significant number of empirical studies, assessing their influence upon elections and local governance (Di Cataldo & Mastrorocco, 2020; Sberna & Vannucci, 2019), public spending (Acconcia et al., 2014; Barone & Narciso, 2015; Fenizia, 2018; Ravenda et al., 2020), legitimate economy (Montani, 2013). Our article relates to this literature, by empirically tracing organized criminal groups' extra-legal governance services in public procurement's corruption. To assess the impact of mafia-like groups' governance on public procurement, the empirical analysis relies on data from public procurement over the period 2008–2014 compiled by the Italian Anticorruption Authority (ANAC), and it exploits exogenous variation in law enforcement: the dissolution of local city councils under suspicion of being infiltrated by mafia-like groups (Minister of Interior data). Using a host of indicators such as the number of bidders, we compare traditional regression methods with tree-based machine learning algorithms (for a similar methodological approach see: Decarolis and Giorgiantonio (2020)).

The article contributes to both theoretical and empirical literature. Theoretically, we develop a model specific to EGOs in public procurement, focusing on the mechanisms and pathways through which EGOs—in particular mafia-like groups—can overcome problems of free-riding and opportunistic behavior in high-level, political corruption. Empirically, our article adds to the fast-growing literature on measuring corruption through risk indicators (Fazekas et al., 2018), showing how "red flags" can detect institutionalized forms of corruption, such as the ones involving mafia-like organizations on the local level. Methodologically, our article adds to the small methodological literature which uses supervised machine learning methods for identifying and validating proxy indicators for corruption (Decarolis & Giorgiantonio, 2020). Finally, from a policy perspective, while our results are specific to mafia-like infiltration in Italy, we offer pointers at how they can be applied more broadly, assessing mafia-like EGO presence in local public procurement across Europe.

The analysis proceeds in four steps. Section 2 introduces the theoretical model and briefly discusses the governance functions played by EGOs in political corruption, focusing on mafia-like organizations. Section 3 introduces data, indicators, and measurement. Section 4 presents results by comparing regression and machine learning models. Finally, Section 5 discusses the results in light of our theory and outlines limitations.

2 | THE GOVERNANCE OF CARTELS AND BRIBES: EGOS AS AN *ENABLER* OF CORRUPTION

2.1 | If political corruption's strength flows from its (organizational) force

Corruption studies have scarcely investigated the organizational context, behaviors, and processes that usually support corruption exchanges (Luo, 2005; Marquette & Peiffer, 2018). Principle-agent models have traditionally framed corruption as a simple relationship between an "agent" and a "client," "without reflecting the broader organizational and social context and the active or passive participation of other social network members" (Jancsics, 2015, p. 70). A growing body of studies, however, theorizes corruption as a networked phenomenon (Della Porta & Vannucci, 1999; Jancsics, 2015; Nielsen, 2003), with a multiplayer and multilevel structure (Jancsics & Jávor, 2012; Yu et al., 2018), whose internal workings explains the ability of actors involved to extract rents (Fazekas et al., 2016), becoming systemic and enduring (Jancsics & Jávor, 2012). Corruption in complex institutional settings and decision-making

processes, such as in public procurement, brings together a range of heterogeneous actors, who need to interrelate through deferred reciprocity, indirect mutuality, and disguise of payments. The Olsonian collective action problems do not only affect anti-corruption mobilization, but also its opposite: corrupt exchanges (Lambsdorff, 2002; Olson, 1965). These factors, in fact, exponentially increase uncertainty for parties (Husted, 1994). Negotiating each deal individually would be extremely dangerous and costly, due to secrecy and trust issues, and it would increase the difficulty to verify the fulfillment and to enforce illegal deals: by definition, corrupt exchanges are not legally binding—which in turn implies higher risks of cheating, seizure of assets, penal sanctions (Gambetta, 1993, p. 184). Therefore, a demand emerges for any governance mechanisms which would allow parties to trust in partners' willingness to preserve secrecy, respect formal rules, and contractual commitments. Spontaneous mechanisms of coordination and regulation have been investigated (Helmke & Levitsky, 2004; Lambsdorff, 2002), as well as the role played by middlemen, whose primary contribution is to provide information and brokerage services, "oiling the wheels" of the machinery of corruption (Bayar, 2005; Bussell, 2017).

As state-backed enforcement is not available in illegal markets (Gambetta, 1993; Varese, 2010), a variety of EGOs can emerge, that is, organizational actors capable and willing to provide extra-legal governance to illicit transactions, that is, *protection* of fragile property rights at stake against the risks of partners' cheating. In the case of corrupt transactions, EGOs both from the upper-world, such as political parties, bureaucratic structures or companies (Della Porta & Vannucci, 2012), and from the under-world, particularly organized criminal groups (Lessing, 2020), as informal "centers of authority" may reduce uncertainty of actors involved in corruption, capitalizing their enforcement power, whose essence "is in the enforcer's ability to punish (i.e., to impose costs)" (Barzel, 2001, p. 38). Mafia-like groups are a quintessential example of EGOs, since their reputation for potential—and occasionally also their actual—use of violence make them particularly effective enforcers (Gambetta, 1993). Varese (2010) claims, for instance, that mafia-like groups, as a subtype of organized crime, aspire to govern both illicit and licit transactions, rather than simply to trade in illegal markets. A growing literature is scrutinizing their governance functions (Lessing, 2020), shedding lights on a variety of organizations, operating both in illegal and legal markets of various countries, including Mexico (Morris, 2013), Brazil (Lessing & Willis, 2019; Magaloni et al., 2020), Honduras (Berg & Carranza, 2018), and even in established democracies, such as Japan (Hill, 2003) and Italy (Catino, 2019; Gambetta, 1993). More specifically, their presence in the legitimate economy and in the public sector can deeply affect corruption and cartels formation in public procurement (Caneppele et al., 2009; Gambetta & Reuter, 1995; Montani, 2013; Ravenda et al., 2020).

2.2 | The criminal governance of political corruption in public procurement: EGOs and transactions costs

Most scholars essentially consider mafia-like groups *as a cause* of corruption: bribes are paid to gain impunity from law-enforcement or to obtain anticipated control and preferential treatment in other public decisions, such as public contracts and funds (Godson, 2003; Gounev & Ruggiero, 2012; Lessing, 2020; Snyder & Durán-Martínez, 2009). Reciprocity mechanisms between mafia-like groups, as EGOs, and other actors involved in corruption may be more complex, however. In this article, we contend that extra-legal governance services provided by mafia-like groups may become an integral and functional component of corruption transactions in public procurement. From being merely an instrument to foster other illegal business, *bribes* can also become a *business in itself* for EGOs when they can provide *guarantees* to corrupt exchanges amongst parties, reducing their

transactions costs in three basic components: searching, bargaining, and enforcement activities (Lambsdorff, 2002; Sberna, 2014; Sberna & Vannucci, 2019).

2.2.1 | Searching costs

Regarding *searching* costs, that is, the costs of identification of reliable partners for corrupt transactions (Lambsdorff, 2002), in public procurement EGOs might facilitate the formation of collusive agreements, on one side, and, on the other side, they can establish connections between corrupting companies and cartels and those politicians and public officials willing to be part of the network. In other words, as gatekeepers they contribute to the setting of the "organizational field" of corruption (Sberna, 2014). They preserve it from outsiders and competitors, but, first, they act as a barrier to entry by managing who can or cannot become a trustworthy member of the cartel. In public procurement, an anticipated control over the number and identity of bidders and their offers is essential for a successful governance of hidden deals. Third-party actors, like EGOs, can in fact select companies, organize queues, control contract awarding, link entrepreneurs to corrupt public decision-makers. In other words, they are able to "organising cartel agreements for large number industries, as well as making cartels more stable," and through a "reputation for effective execution of threats of violence," may create "a reputational barrier to entry" (Gambetta & Reuter, 1995, p. 133).

2.2.2 | Bargaining costs

Regarding *bargaining* costs, that is, the costs in setting the "contractual terms" of corrupt transactions, EGOs can facilitate—or impose—the achievement of an agreement about the amount and the type of resources to be exchanged, such as the amount of bribes, the value of contracts, tendering procedures and timing, contract splitting, and so on. EGOs would facilitate the distortion of competitive procedures by a strategic tailoring of tender participation requirements and specifications and by fostering or forcing cooperation amongst political and bureaucratic actors involved in the various phases of the decision-making process, from resource allocation to post-award controls (Della Porta & Vannucci, 1999; Sberna, 2014). Thanks to extra-legal governance, corrupt transactions will become more profitable and less risky, since contractual conditions and rent-sharing criteria—sometimes automatically computed as a percentage of the value of the contract, divided among various participants in fixed quotas—can become institutionalized as a shared non-written rule. Because of it, all partners have a common incentive in maximizing the value of the contract, when this is possible, in order to get a bigger share as a bribe.

2.2.3 | Enforcement costs

Concerning *enforcement* costs, EGOs make corrupt deals less exposed to disloyalty and defection, given the sanctions they can menace or impose (Catino, 2019; Lessing, 2020; Varese, 2010). In the variety of arenas where corruption takes place, different EGOs can use dissimilar resources to enforce illegal deals: violence in the case of criminal groups, but also political sanctions, career impediments, exclusion from future deals and profitable opportunities when parties, bureaucratic structures, companies come into play as third-party guarantors (Barzel, 2001). EGO's supply of alternative forms of extra-legal governance makes cheating or

exit less profitable options for partners in corrupt exchanges, since opportunistic choices are deterred by the expected costs of sanctioning and retaliation (Gambetta & Reuter, 1995). Moreover, cheating is discouraged by the reputation of criminal groups to be capable of an effectively enforcement of corrupt deals, acquired with an investment in violent sanctioning at the outset of their activity, or when challenged by other illegal actors (Aziani et al., 2020). Once acquired, reputation is a durable capital that allows them to prevent rather than punish defections, saving on the "production costs" of protection (Gambetta, 1993, p. 44).

2.3 | Theorizing the presence of EGOs in public procurement

Based on these governance services, we expect corrupt exchanges to run more smoothly due to the regulatory role played by EGOs, such as mafia-like organizations. In a context where corrupt and collusive arrangements in public procurement follow informal rules enforced by an EGO, anomalies in the performance of public tendering may emerge as compared to clean contracts or "disorganized" corrupt deals. While the comparison group of clean tenders may vary themselves depending on, for example, the efficiency of a clean local government to organize procurement, some systematic expectations can still be formulated.

Considering searching costs, we expect the number of bidders to decrease, often to the point that there is no competition at all (i.e., single-bidding), given the barrier to entry enforced by the intimidating presence of an EGO, and the corrupt agreement among public decision-makers and entrepreneurs organized in queues, orderly waiting for the contract to win. Moreover, as open market coordination mechanisms are replaced by EGO-controlled contract award and "competition," we also expect a decrease in competitive tendering procedures (procedure type) which represents a stable and enduring distortion of the public procurement market.

Concerning bargaining cost, the enforcement of informal deals on the value of contracts and the amount of bribes to be paid tends to increase the expected rent to be collected, hence contract award prices should go up.

EGOs can further lower both bargaining and search costs by relying on a few dominant companies in the controlled municipality. This suggests that the share of a supplier in buyer's total procurement spending goes up.

Finally, concerning enforcement costs, EGOs can efficiently police and regulate otherwise hard-to-enforce informal deals with high technical complexity, long timeframes, and large sums of money. Hence, we expect signs of inadequate contract delivery to largely disappear, for example, low to no cost overruns on awarded contracts during the implementation phase.

3 | DATA, METHOD, AND OPERATIONALIZATION

3.1 | Data

In order to do it, we compiled administrative data on public tenders and dissolved municipalities to assemble our original dataset. Detailed information on each publicly available tendered government contract has been taken from a national dataset managed by the ANAC for the period 2008–2014. This dataset contains information about all the contracts with a reserve price higher than 150,000 euros. The dataset provides information on the auction ID, number of bidders, bidders' names, bids, contract awarding procedure, the reserve price of the contract, the

categories of work involved in the contract, and the final price paid by the contracting authority (Table 1 for full definitions).[2] For the analysis, we only consider contracts awarded by municipalities, at the first stage of the research, we look at mafia-infiltrated municipalities, then we expand to

TABLE 1 Overview of variables used in the analysis

Variable name	Variable description	Role
Contract-level features		
EGO presence	$y = 1$ if contract is awarded 0–36 months before dissolution $y = 0$ if contract is awarded 0–36 months after dissolution	Dependent variable
Number of bids	Number of bids submitted. Coded as four categories	Independent variable
Procedure type	Type of procurement procedure used in the tender (direct award, open procedure, negotiated, restricted, other/missing)	Independent variable
Relative price	Estimated price of the tender divided by the awarded contract value. Coded as five categories	Independent variable
Share of supplier in buyer's annual spending	Share of the winner's total annual contract value won from the buyer divided by the total annual contract value awarded by the buyer	Independent variable
Cost overrun	Final total contract value at the end of implementation divided with the total contract value at the contract award. Coded as four categories	Independent variable
Buyer size	Number of contracts awarded by the buyer in the year	Control variable
Log contract value	Logarithm of the awarded value. Coded as five categories	Control variable
CPV division[a]	First two digits of the main CPV code of the tender (XX000000-Y)	Control variable
Contract delivery in locality	Whether the location of contract implementation is the same as the buyer's location ($y = 1$), or not ($y = 0$)	Control variable
Consortium	Whether tender winner is a member of consortium ($y = 1$) or not ($y = 0$)	Control variable
Supply type	Whether procurement type is services, works, or supplies	Control variable
Administrative error	Share of missing key values (information about winner, buyer, contract value, number of bids, location, and assessment criteria) in the tender	Control variable
Month of contract award publication	Month of contract award publication	Control variable
Region-level features		
Log population	Logarithm of the population of the NUTS3[b] region of municipality	Control variable
Area, thousand sq km	Area of the NUTS3 region of municipality in sq km	Control variable
Coastal region ($y = 1$)	Whether the municipality is located in the coastal region ($y = 1$) or not ($y = 0$).	Control variable
Mountain region ($y = 1$)	Whether the municipality is located in the mountain region ($y = 1$) or not ($y = 0$)	Control variable

[a]For full details see: https://simap.ted.europa.eu/cpv.
[b]For full details on the region classification see: https://ec.europa.eu/eurostat/web/nuts/background/.

all municipal contracts in Italy, while finally we extrapolate using data on all European municipal contacts taking data from the EU's central register, Tenders Electronic Daily.

To directly measure mafia infiltration in Italian local government, we rely on a unique emergency measure imposed by the Italian national government in 1991. Following a period of intense mafia-related killings, the Italian government enacted a law aimed at preventing or breaking ties between mafia-like groups and (local) politicians (law No. 164/1991). The law states that the national government can impose the dissolution of any local government whenever direct or indirect links emerge between local elected politicians and criminal organizations, or when there are undue pressures, which influence or compromise the normal functioning of the local administration. Three "special" commissioners are assigned to manage the local government during the next 12–24 months. At the end of this period, new elections are hold, followed by the discharge of the commissioners. Since the introduction of the law in 1991, it has been invoked well over 250 times. As can be seen in Figure 1, where we display the number of local government dissolutions per year since the law's initiation, the number of dissolutions shows substantial variation over time even though there is some clustering when the measure first became available. Note also that the law was invoked also in 11 municipalities outside the four Southern Italian regions.

3.2 | Methods and causal identification

The goal of the empirical analysis is to identify the best explanatory model for mafia-like EGO presence within municipal public procurement contracts in line with our theory in Section 2.3. The dependent variable of the analysis is mafia-like EGO presence on the contract-level which results in the extra-legal provision of governance services in public procurement, including, as an extreme case, mafias in public procurement. The unique feature of the Italian anti-mafia policy of dissolutions is that it allows for marking those tenders which are most likely controlled by mafia-like groups, behaving as EGOs (pre-dissolution), and those that are most likely *not* governed by them (post-dissolution).[3] This empirical set-up uniquely gives us a set of proven positive and negative cases to train our models on. Our approach differs from previous studies that took proven cases of mafia infiltration and contrasted them with the rest of the sample assuming that there is no mafia infiltration in unknown cases (Ravenda et al., 2020). This is an assumption that we deliberately depart from and use a set of proven non-infiltrated cases instead.

The main parameters of interest are the hypothesized proxies for EGO governance such as lack of bidders, while also taking into account both structural features such as the market of purchase and behavioral factors such as contract value. The set of included predictors were selected so that the final model can be used for Europe-wide extrapolation on the Tenders Electronic Daily (TED)[4] data as compiled by the EU-funded research project, DIGIWHIST (i.e., all variables only available in the Italian public procurement dataset but not in TED were removed from the analysis). We estimate a range of regression and machine learning models, using a similar set-up. The baseline logit model is following:

$$\begin{aligned}\text{Logit}(\text{EGOpresence}=1)_i = \beta_0 + \beta_1 \text{EGOgovernance}_i + \beta_2 \text{ContractControls}_i \\ + \beta_3 \text{RegionControls}_i + \varepsilon_i\end{aligned} \quad (1)$$

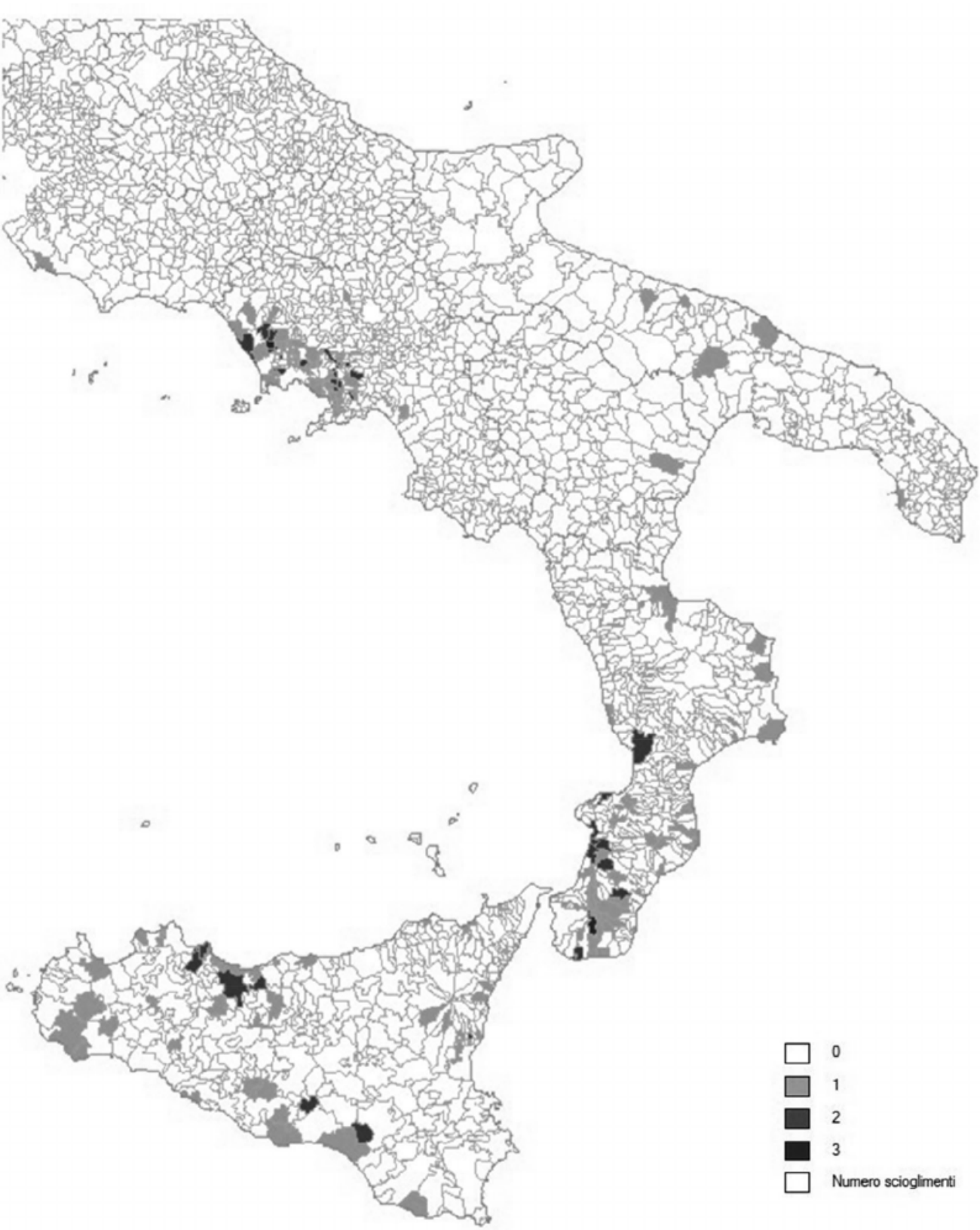

FIGURE 1 Municipalities dissolved due to mafia-like infiltration from 1991 to 2014 in South-Italy (Minister of Interior)

where $EGOpresence_i$ captures mafia-like EGO presence in the *i*th contract as a binary variable, with 1 = EGO presence and 0 = non-EGO presence. $EGOgovernance_i$ in the *i*th contract denotes one or all of the hypothesized proxies for EGO governance: number of bids (Table 3, Model 1), procedure type (Table 3, Model 2), relative price (Table 3, Model 3), share of supplier

in buyer's annual spending (Table 3, Model 4), and cost overrun (Table 3, Model 5; Table 3, Model 6 includes all five proxies). $ContractControls_i$ include all the contract-level controls corresponding to the *i*th contract listed in Table 1 such as buyer size. $RegionControls_i$ encompass all the region-level controls corresponding to the *i*th contract listed in Table 1 such as Mountainous terrain. Region-level controls follow from empirical studies of mafias which point at the importance of territorial facilitators of mafia establishment such as rugged terrain or sparse population (Barone & Narciso, 2015; Buonanno et al., 2015).

Alternative predictive models were estimated, and the best method was selected based on prediction accuracy as well as fit with existing organized crime proxies. The predictive models included both traditional regression analysis and machine learning: binary logistic regression, Random Forest, and Gradient Boosting Machines[5] (James et al., 2015). First, the best model was developed in each of the three modeling classes based on regression fit. Second, best models were compared based on the percent correctly classified contracts on the test dataset, with 70% of the sample used for training the models and 30% for testing accuracy. Third, to test external validity across all of Italy, we checked the correlation between our predicted score for all Italian municipal contracts and an established mafia measure: the province-level Transcrime Mafia Index for Italy (Calderoni, 2011). Fourth, to test external validity across all of Europe, we explored the correlation between our predicted score for all European municipal contracts and Europe-wide proxies for organized crime presence. Upon reviewing recent comprehensive studies of organized crime across Europe (Hulme et al., 2021; Savona & Riccardi, 2018), we selected those macro indicators which are most directly related to organized criminality in the legal economy, in particular public procurement (e.g., indicators of drug trafficking were excluded): (i) Tax Justice Network's Financial Secrecy Score, and (ii) Transcrime's share of shareholders from EU-blacklisted countries (for descriptive statistics on the external validity indicators see Table S2 in the Annex). For all these tests of convergent validity (Adcock & Collier, 2001), we expect a moderately strong positive correlation. This is because there is no existing EGO or organized crime measure for public procurement specifically, rather we can find proxies for organized criminality in the wider legal economy.

The main threat to our identification strategy is that not only EGO presence changes around dissolution, but also spending structure as for example the central government's special commissioners may avoid engaging in long term, high value construction projects. If such spending structure change is unaccounted for by the model, it could introduce bias into our parameter estimates. For example, if larger contracts are more likely to be awarded in competitive tenders our estimation of the independent effect of procedure type on EGO infiltration will be biased. While we cannot claim to account for the full range of such confounders, we are able to include contract value and main market of purchases as control variables. We will also explore to what degree spending structure changed in our dataset from before to after dissolution.

3.3 | Indicators of EGO presence and corruption risks

The dependent variable is the direct measure of mafia-like EGO presence in municipal public procurement as described in the data section above. This departs from other direct measures in the literature, such as the number of related crimes (Barone & Narciso, 2015; Daniele & Marani, 2011). We consider contracts awarded in the presence of EGOs when the award took place 0–36 months before dissolution and consider no EGO presence when the contract is awarded 0–36 months after dissolution (Table 1).

The independent variables of interest are the proxies for EGO governance services as outlined in Section 2.3 considering searching, bargaining, and enforcement costs. Each of these proxy indicators can be calculated on widely available public procurement data on the tendering, contract award, and implementation stages (Table 1). While there is relatively little academic literature on organized crime proxies in public procurement, there are many studies looking at high-level, political corruption risks (Fazekas et al., 2018). Given, that organized crime often makes use of corruption in its operations, we will also relate to this literature. The links to the much more widely applicable corruption literature also underpins our claims for applicability beyond Italy which we discuss at the end of the article.

First, the number of bids submitted, especially when there was only one bid submitted (single bidding) have been shown to be associated with corruption risks (Klašnja, 2015), while we also expect lack of competition signaling EGO presence (e.g., intimidation of potential market entrants). Second, the procedure type variable allows the model to capture the incidence of noncompetitive or non-open procedure types such as direct awards, also associated with corruption (Fazekas & Kocsis, 2020). These procedures allow to stifle competition and steer contracts to the bidders selected by EGOs. Third, relative prices calculated as the ratio between the contract award price and the initial price estimate offers a simple, comparable metric of how pricey contracts are (Coviello & Gagliarducci, 2017). EGO presence is likely to drive relative prices up. Fourth, the share of supplier in buyer's annual spending is calculated as the ratio between the total contract value of the winner won from the buyer in a given year and the total contract value awarded by the buyer in that year. Repeated supplier–buyer interactions and the corresponding high-spending concentration of individual procuring entities also signal corruption (Popa, 2019). Fifth, cost overrun is the ratio between the final total contract value at the end of contract implementation and the total contract value in the awarded contract. While higher cost overruns are expected in corruption tenders more widely (Fazekas et al., 2016), EGO presence is likely to drive down overruns. Bidder number, relative price, and cost overrun are formulated as categorical variables in order to explicitly include missing values (Table 1).

4 | RESULTS: THE EFFECT OF EGOS UPON PUBLIC PROCUREMENT

First, let's present stylized facts about the main confounding factor of spending structure change as discussed in Section 3.3 (Table 2). The mean contract value in the pre-dissolution period compared to the post-dissolution period is higher which is driven by very large contracts as the median is essentially the same in the two periods. The share of the largest economic sector by spending (CPV division = 45: construction works) are essentially the same in the two periods. Given the similarities in observed spending structure and our ability to control for main features of spending, we suggest that there is a limited risk of biased comparisons due to unobserved characteristics.

4.1 | Logistic regression results

As a starting point, traditional binary logistic regressions are estimated. To test our theoretical predictions, we include each of the five main predictors of interest separately; then, we enter them together. Each model includes the same set of controls (Table 3). Overall, the six different

TABLE 2 Stylized facts: Before–after dissolution samples

	Before	After
Number of obs.	1572	796
Mean contract value	2,588,385	824,273
Median contract value	263,165	275,823
Min. contract value	4.72	0
Max. contract value	1,286,562,951	25,041,824
Main market of spending (TOP-3 CPV[a] divisions by the share of awarded contracts)		
Construction work	51%	45.8%
Repair and maintenance services	7.7%	
Sewage-, refuse-, cleaning-, and environmental services	7.32%	13.1%
Medical equipment, pharmaceuticals, and personal care products		5.78%

[a]For full details see https://simap.ted.europa.eu/cpv.

models perform moderately well, they correctly classify 59%–63% of cases on the unseen test dataset (sum of true positive and negative cases over all cases). The best model is model 6 which includes all five proxies for EGO governance services. As expected, with the number of bidders increasing from only one bid submitted the probability of EGO presence drops. This effect is, however, only significant for 4–14 bidders. For procedure types, the least open procedure type, direct awards, is the highest risk, with all other types having a lower risk of EGO presence, albeit the effect is only significant for restricted procedures (restricted procedures are two-stage procedure types in which the first stage is fully open, but only those bidders are invited to submit a full bid who pass the minimum requirement criteria). The predicted impact of relative prices on EGO probability follows an interesting non-linear pattern. Compared to the standard, most typical 8%–24% discounts, both surprisingly large and small discounts appear to be of higher risk. In particular, unusually low prices (i.e., discounts of 24%–70%) are significant while the other categories are insignificant. The strongest predictor of EGO presence in the logistic regression models is the share of supplier in buyer's annual spending with the increasing spending concentration leading to much higher EGO risks. Finally, cost overruns have no statistically significant impact on EGO presence which may imply that EGOs are similarly effective in enforcing contracts as the central government administrators. However, this variable has a high missing rate, above 90%, so our estimation is unusually uncertain.

4.2 | Random forest classifiers

In order to improve prediction precision of mafia-like EGO presence in public procurement, we estimated a series of tree-based machine learning algorithms. The advantage of these methods over logistic regression is that they achieve higher explanatory power due to a more flexible parameterization. They can also incorporate a series of interactions and nonlinear relationships. Their disadvantage is that it is harder to interpret each predictor due to the nonlinear and interacted nature of effects. We provide a series of visual representations for impact functions to relate results to our hypotheses.

TABLE 3 Results of logistic regression for the mafia-like EGO presence prediction

	Dependent variable					
	EGO presence					
	(1)	(2)	(3)	(4)	(5)	(6)
2–3 Bidders	−0.481					−0.570
	(0.395)					(0.422)
4–14 Bidders	−0.679*					−0.936**
	(0.387)					(0.458)
15+ Bidders	0.299					−0.267
	(0.302)					(0.391)
Missing bidder number	−1.503**					−0.523
	(0.708)					(1.209)
Procedure type: Open procedure		−0.150				−0.212
		(0.230)				(0.243)
Procedure type: Negotiated		−0.378				−0.245
		(0.266)				(0.276)
Procedure type: Restricted		−1.138**				−0.995*
		(0.520)				(0.532)
Procedure type: Other/missing		−1.116				−1.038
		(0.880)				(0.910)
0.3 < Relative price < 0.77			1.332***			1.140***
			(0.314)			(0.348)
0.92 < Relative price < 1			0.584			0.259
			(0.387)			(0.426)
Relative price = 1			0.530			0.109
			(0.455)			(0.527)
1 < Relative price < 3			0.682			0.675
			(0.842)			(0.913)
Missing relative price			1.161			1.074
			(1.078)			(1.090)
Share of supplier in buyer's annual spending				1.479***		1.483***
				(0.198)		(0.201)
0.99 < Cost overrun < 1.01					0.101	0.503
					(1.005)	(1.059)
1.01 < Cost overrun < 1.15					0.403	0.504
					(0.906)	(0.948)
1.15 < Cost overrun < 4.98					0.983	0.680
					(0.932)	(0.952)

(Continues)

TABLE 3 (Continued)

	Dependent variable					
	EGO presence					
	(1)	(2)	(3)	(4)	(5)	(6)
Missing cost overrun					0.884	0.778
					(0.791)	(0.804)
Buyer size	−0.047***	−0.047***	−0.047***	−0.043***	−0.047***	−0.044***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Administrative error	0.710***	0.675***	0.779***	0.329	0.619***	0.293
	(0.192)	(0.187)	(0.194)	(0.200)	(0.193)	(0.217)
Log population	1.008***	1.013***	0.967***	0.927***	1.018***	0.844***
	(0.129)	(0.130)	(0.130)	(0.130)	(0.129)	(0.133)
Area, thousand sq km	−0.014	−0.007	−0.006	0.051	−0.008	0.041
	(0.059)	(0.059)	(0.059)	(0.060)	(0.059)	(0.061)
Coastal region ($y = 1$)	2.472***	2.448***	2.339***	2.551***	2.464***	2.376***
	(0.373)	(0.377)	(0.375)	(0.379)	(0.373)	(0.389)
Mountain region ($y = 1$)	0.475**	0.489**	0.394**	0.349*	0.490**	0.221
	(0.198)	(0.198)	(0.201)	(0.203)	(0.197)	(0.211)
Contract value	Yes	Yes	Yes	Yes	Yes	Yes
CPV division	Yes	Yes	Yes	Yes	Yes	Yes
Contract award month	Yes	Yes	Yes	Yes	Yes	Yes
Supply type	Yes	Yes	Yes	Yes	Yes	Yes
Local performance	Yes	Yes	Yes	Yes	Yes	Yes
Consortium	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1657	1657	1657	1657	1657	1657
Prediction accuracy on test set	60%	61%	59%	62%	60%	63%
Log Likelihood	−823.220	−824.297	−817.713	−799.428	−826.407	−783.209
Akaike Inf. Crit.	1788.439	1792.595	1781.426	1736.856	1796.813	1736.419

Note: The model is fitted on the train set to predict the probability of EGO infiltration. The table reports the measure of model performance—accuracy of predictions for the test set. Standard errors in parentheses.
***$p < .01$. **$p < .05$. *$p < .1$.

Advanced, ensemble-based methods are applied which combine the predictive power of a large number of decision trees: Random Forest[6] and Gradient Boosting Machine (GBM).[7] These models use the same set of predictors as the logistic regression. The first method achieves 80% prediction accuracy for EGO infiltration in the test set,[8] while the GBM model achieved 85% of accuracy, so the difference in the performance is small. The GBM algorithm which also preforms best on external validity tests (see Section 4.3) provides an opportunity to investigate the importance of different indicators for improving the accuracy of predictions (Figure 2) and to further explore the nonlinear effects discussed above (Figure 3 and Figure S1 in the Appendix).

Among the proxies of EGO presence, the share of the supplier in buyer's annual spending has by far the highest influence on prediction accuracy (Figure 2). Moreover, the number of

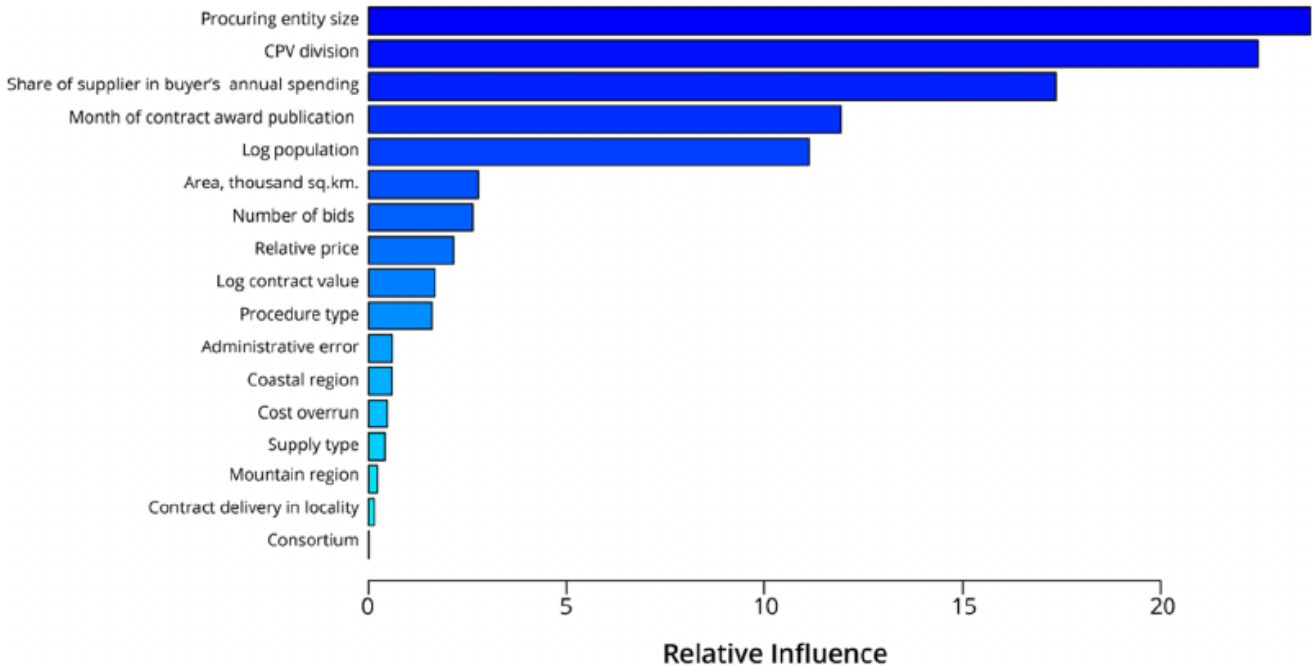

FIGURE 2 Relative influence of each predictor in the best Gradient Boosting Machine model

bids, relative price, and procedure type all have medium range relative importance. Cost overrun once again has very little influence on prediction accuracy.

The partial dependence plots in Figure 3 allow for a closer look at response functions. On these figures, the x-axis represents values of each predictor of interest, while *y*-axis depicts average predicted probability of mafia-like EGO presence across all trees, holding all other variables constant. First, as for the logistic regressions, with the number of bidders increasing, EGO probability goes down, while the effect is nonlinear (Figure 3a). The predicted probability of mafia-like EGO presence is high, about 15%, when only one bid is submitted, while the predicted probability drops just below 10% for tenders with 4–14 bidders. Second, direct awards have by far the highest EGO presence probability of about 18% while restricted and other types have close to 10% only (Panel B). This very much coincides with the results of the logistic regression. Third, large discounts of 24%–70% (i.e., very low prices) are predicted to have the highest EGO probability of 18%. While EGO risks are also high, about 14%–15%, for no (relative price = 1) to negative discounts (relative prices >1). Somewhat contrary to the logistic regression results, EGO risks drop to 11%–12% for typical discounts of 8%–24% and 0%–8% (Panel C). Fourth, the most impactful predictor, the share of supplier in buyer's annual spending displays a generally upward sloping trend (Panel E), however with a distinct nonlinear character, somewhat contrary to the logistic regression results. EGO presence probabilities remain at a low level of around 10% until the supplier's share is below 40%. However, as the supplier's spending share increases further, the predicted EGO probabilities jump to the range of 30%–40% with some erratic patterns at the upper end of the distribution which may be due to fewer observations in that range. Finally, just like for the logistic regression, predicted EGO probabilities by cost overrun display very little variation, they remain around 10% (Panel D).

4.3 | Not only mafia? Tentative extension to Italy and Europe

While our results are specific to mafia-like infiltration into Italian municipal public procurement, the traces of EGO governance identified are also connected to the literature on

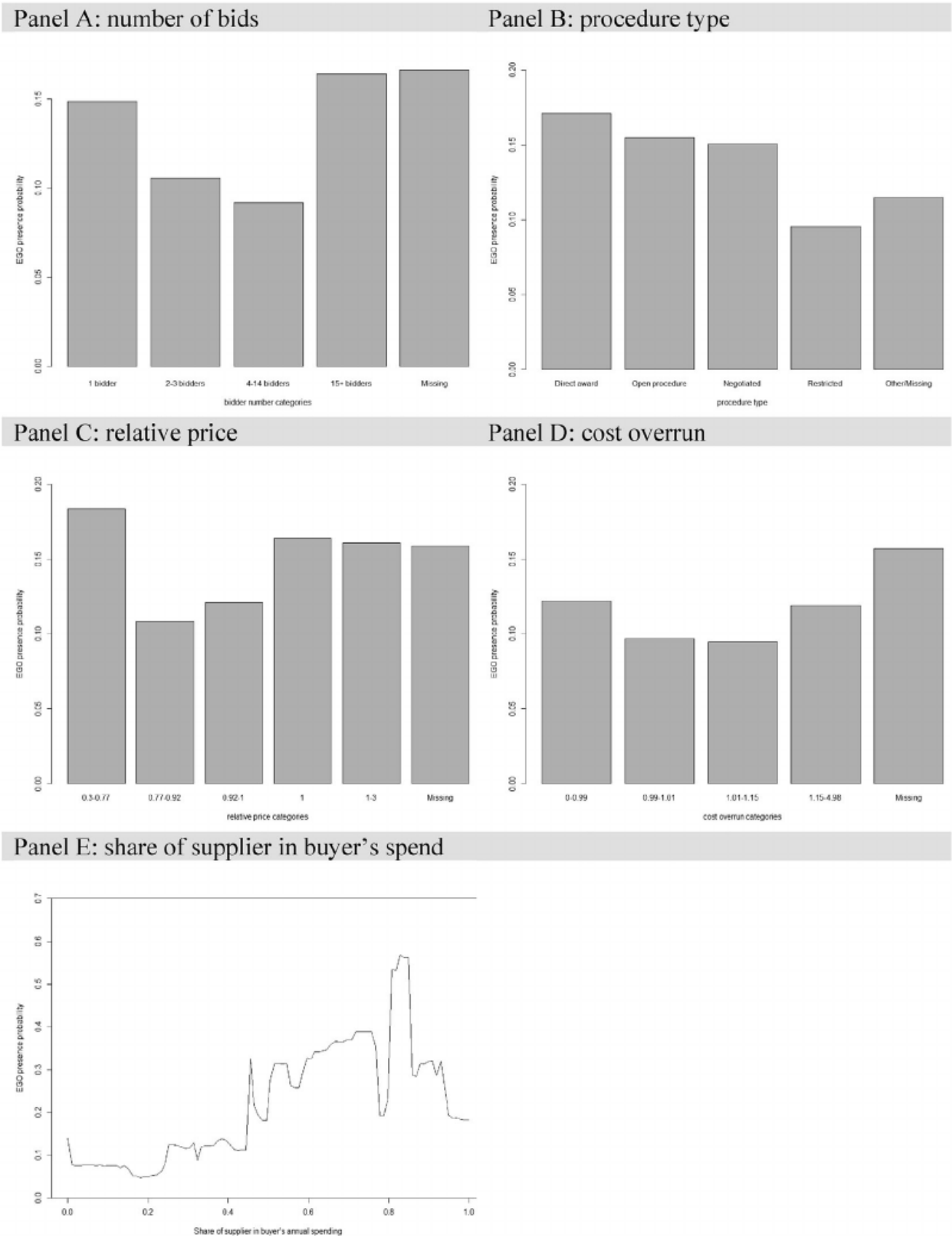

FIGURE 3 Partial dependence plots for the proxies of EGO presence in the best Gradient Boosting Machine model. (a) Number of bids. (b) Procedure type. (c) Relative price. (d) Cost overrun. (e) Share of supplier in buyer's spend

grand corruption in Italy and Europe (Fazekas & Kocsis, 2020). In as much as the identified factors signal corrupt and criminal phenomena which are used by non-mafia EGOs, our results may be more broadly applicable than the narrow Southern Italian training data. They might be

TABLE 4 Summary of model accuracy and validity

Test type/Model type	Logistic regression	Random Forest	Boosting	Number of observations
Accuracy				
Prediction accuracy on test set	64%	79%	85%	711 Contracts
False positive rate on test set	0.29	0.28	0.09	711 Contracts
False negative rate on test set	0.59	0.10	0.24	711 Contracts
Validity (Pearson correlations with EGO scores of municipal contracts)				
Italy: Transcrime mafia index	0.24*	0.30***	0.38***	103 Provinces
Europe: Financial secrecy index	−0.11	0.3	0.36*	33 Countries
Europe: Share of shareholders from EU blacklisted countries	0.12	0.53**	0.46*	27 Countries

*$p < 0.1$. **$p < 0.05$. ***$p < 0.01$.

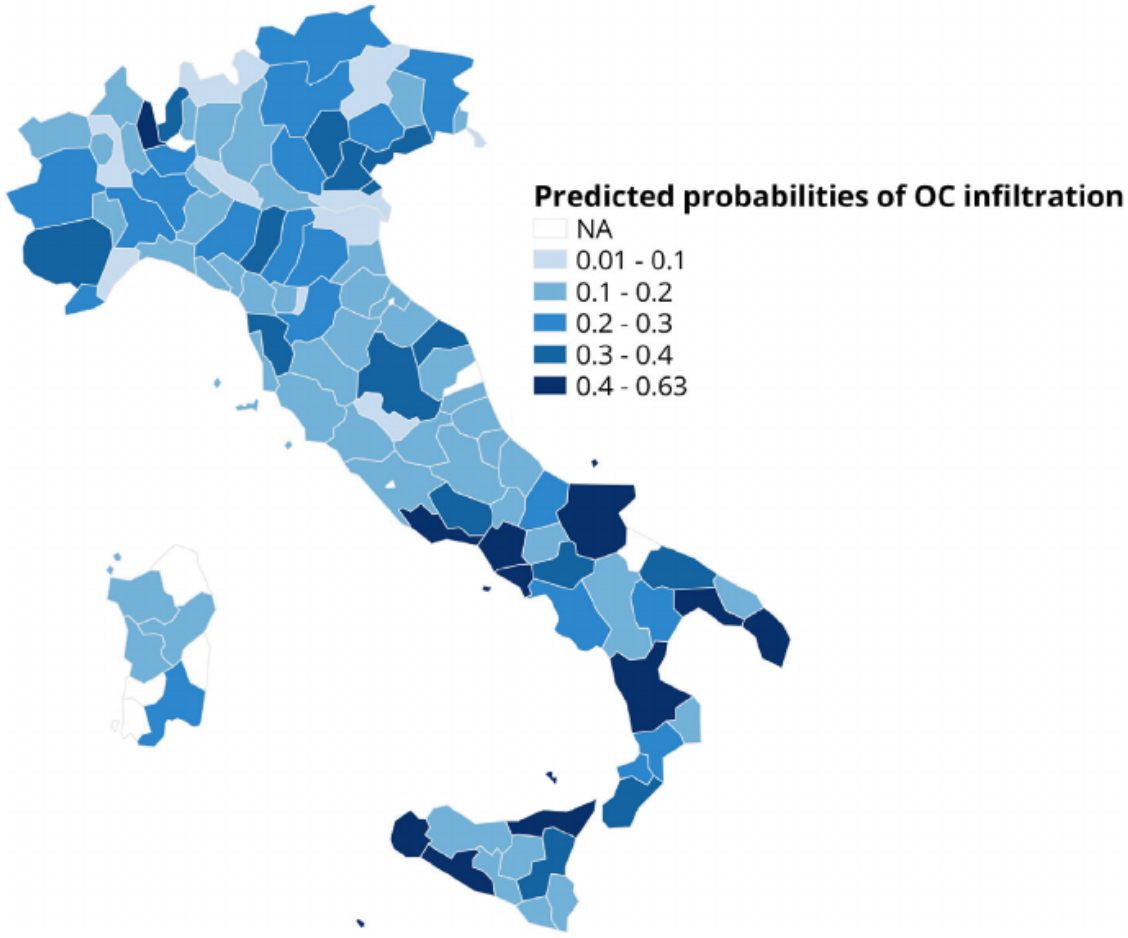

FIGURE 4 Mean value of predicted EGO influence probabilities for Italian regions based on contracts awarded by municipalities

interpreted and applied more broadly to detect the presence of other EGOs and institutionalized forms of political corruption in different contexts.

Following the model testing steps outlined in Section 3.2, we first identify the best model based on internal validity on the test dataset of proven cases. Second, we look at external

validity both regarding Italy and Europe (Table 4). Among the three models we developed, the Gradient Boosting Machine (GBM) delivers the highest prediction accuracy of 85% with very low false positive rate while somewhat higher false negative rate. This high performance is carried over to the external validity tests: GBM positively and significantly correlates with Transcrime's province-level mafia index and Europe-wide[9] organized crime indices. The relationships are of moderate strength 0.36–0.46 which is not surprising given the partial fit between EGO presence in procurement and other organized crime activities in the legal economy. The Random Forest model performs only slightly lower than GBM while logistic regression is considerably lower quality on all metrics.

The output of the best GBM model is demonstrated by the predicted probability of mafia-like EGO presence in municipal public procurement for Italian regions (Figure 4). This shows a partially familiar picture with southern regions at particularly high risk, but some center and northern regions also displaying surprisingly high EGO risks. These results are supported by abundant judicial evidence unveiling the migration of mafia-like groups from southern Italy to the rest of the country, and collusive exchanges between these groups and local corruption networks or cartels of companies. This is the case of some districts in Emilia-Romagna, Lombardy, Lazio, Liguria, and Veneto. For instance, in 2020 Emilia Romagna ranked third among Italian regions in Italy for the number of companies disqualified due to mafia infiltration by the anti-mafia investigation directorate, overtaking Sicily in the national ranking (DIA 2020). At the same time, several corruption scandals, such as in the health-care sector in Lombardy or the MOSE in Venice, showed the presence of enduring and systemic political corruption networks in crucial public sectors, where informal "centers of authority" used to regulate transactions (Della Porta, Sberna, & Vannucci, 2015).

5 | DISCUSSION AND CONCLUSIONS

The analysis sheds light on the extra-legal governance of corruption in public procurement, whose mechanisms and actors, despite their relevance, have been rarely investigated in the literature. We look at the governance role played by organized crime groups in political corruption networks as EGOs, being enablers, brokers, guarantors, and enforcers of corrupt deals. In this case, EGOs are not alternative to legitimate actors involved in corruption, rather, they establish reciprocal relationships with them. Tracing three key mechanisms of criminal governance lowering transaction costs for corrupt deals (searching, bargaining, and enforcement), we derive empirically testable hypotheses of EGO presence in public procurement: (i) number of bidders to decline often to only one bidder (searching costs); (ii) decreasing use of competitive tendering procedures (searching costs); (iii) prices to go up (bargaining costs); (iv) increasing the share of a supplier in buyer's total procurement spending (searching and bargaining costs); and (v) incidence of cost overruns to go down (enforcement costs).

The empirical analysis testing these expectations includes data on public procurement in Italian municipalities, exploiting the variation in the infiltration of mafia-like EGO groups at the municipal level. Drawing on traditional regression methods as well as tree-based machine learning algorithms, we developed high precision predictive models. Testing prediction accuracy (i.e., the share of correctly classified EGO-presence/absence contracts) on unseen data, our best model, Gradient Boosting Machine, achieves 85%. Looking at external validity, the model's predicted EGO score also significantly and moderately strongly correlates (Pearson correlation coef. = 0.36–0.46) with established indicators of organized criminality both within Italy and across Europe. Overall, these suggest that the EGO services-related proxy indicators and the

variety of control variables, such as data quality and contract value, together represent a reasonable approximation of EGO presence in municipal public procurement.

Looking at the results by EGO proxies and the corresponding hypotheses, we see a varied and sometimes surprising picture. A single bid submitted is clearly associated with very high EGO risks and increasing bidder number lowers this risk. However, quite intriguingly, very high number of bidders is also predicted to have a high EGO risk. This may be driven by elaborate corruption schemes which also involve cartels among bidding firms faking competition (see, e.g., the large number of companies involved in the 2015 Milan Expo 2015 organized crime and corruption case). Second, while our expectation that direct awards represent the highest risk of EGO presence is confirmed; interestingly, negotiated procedures, often associated with corruption in the literature, have turned out to be of modest risk on par with open tenders. This may signal that EGOs when holding firm control over the whole procurement process prefer to avoid complex, and visibly risky negotiated procedures. Third, we see that typical, modest discounts achieved on tenders (0%–24%) have the lowest EGO risk while both excessively high (24%–70%) and low discounts (negative discounts where the winning bid is above the reference price) display higher EGO risks. This may imply that EGO governance indeed pushes prices up from the typical baseline, while it also leaves marks typical of collusive markets. In the latter case, collusive bidders, supposedly linked to the corrupt clique, submit very low prices to deter potential market entrants not part of the clique. Fourth, the most impactful predictor of EGO presence, the share of supplier in buyer's annual spending, behaves as expected. As spending concentration increases EGO risks increase too. However, the relationship is far from linear, risks remain flat for roughly 0%–40% of supplier spending share, after which there is a steep uptick in risks. This underpins our interpretation that EGOs in public procurement establish stable, dominant relationships with selected companies and exclude outside bidders to lower search and bargaining costs. Fifth, contrary to our expectations cost overruns have little bearing on predicted EGO risks. While this may be due to low quality data (we had large share of records with missing overrun information), it may also suggest that EGOs are able to offer comparable levels of enforcement to formal government institutions.

While external validity results offer support for tentative applicability of our predictions to European countries outside Italy, we remain cautious. We relied on established corruption proxies and combined them so that they jointly signal EGO presence which typically goes beyond mere corruption. This approach should lend conceptual support to external validity. However, our initial training sample covered mafia-related infiltration of municipal governments in Southern Italy which clearly represent a special case of EGOs, warning us to over-extrapolate from the models.

The analysis was also limited by several factors. Missing values on a number of relevant variables such as cost overrun or contract value constrained modeling possibilities. Arguably, municipal administrations after dissolution (control sample) may behave in different ways than elected politicians linked to the mafia. While we tried to control for all major differences such as market of spending, there are certainly factors and process which remained unaccounted for, potentially biasing results.

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ENDNOTES

[1] Transparency International's, 2020 Corruption Perception Index ranks the country on 52nd place out of 180 countries (Transparency International, 2020).

[2] See Table S1 for descriptive statistics in the online Appendix.

[3] Note that there are several municipalities which have experienced multiple dissolutions in the 25-year period, implying that mafia-like organizations came back after dissolution. We claim to have clean tenders even in these municipalities immediately after dissolution because central government is running the local administration for up to 2 years, hence organized crime is only likely to return after local administration is returned to newly elected local officials. Crucially, even three dissolutions in a 25-year period means that the most likely mafia controlled periods are far spaced out form each other not causing mixed group membership (control/treatment) problem for our analysis.

[4] TED publishes all tenders regulated by EU procurement directives which also apply to some non-EU European countries such as members of the European Economic Area (e.g., Norway).

[5] We implemented data manipulations and modeling in R. For logistic models, we used stats library and glm function; for Random Forests we used the randomForest library and randomForest function; and for Gradient Boosting Machines we used the gbm library and gbm function.

[6] The Random Forest model was fitted using the following hyperparameters: number of trees = 1000, number of variables available for splitting at each tree node = 13. In order to improve the performance, the model relied on 50% of the most important features, selected by feature importance measure of Gini importance.

[7] The Gradient Boosting Machines model was fitted using the following parameters: learning rate (eta) = 0.2, maximum depth of a tree = 3, minimum loss reduction required to make a split (gamma) = 1.

[8] Test set contains 30% of randomly sampled observations from the sample of the dissolved municipalities.

[9] Please note that cost overrun was removed from the Europe-wide models because it was a marginally influential predictor in the training set models and also because this variable is almost always missing in the TED dataset.

DATA AVAILABILITY STATEMENT

The data underpinning the analysis in the paper and the R script used to produce the tables and figures are archived in Harvard Dataverse: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/JHIPZV

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