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Corruption as Organized Crime:
a game-theoretic approach

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Working paper. Corruption as organized crime: a game-theoretic approach

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Abstract

How does social structure affect corruption? I introduce a novel approach that views corruption as organized crime. Bureaucrats are embedded in a network; in order to form a criminal conspiracy, they play a strategic diffusion game: a bureaucrat finds an illegal opportunity to make money, and decides whether to recruit accomplices. Accomplices protect the bureaucrat, but non-corrupt neighbors denounce their corrupt ones. I show that for any network, although a conspiracy is less likely to appear as states become better at detecting corruption, when it does appear, the conspiracy becomes larger, because an increased risk of detection makes buying off accomplices more attractive. Stealthier portions of the network are more likely to be corrupt. Denser networks are less corrupt, because bureaucrats are more observable. Middlemen get a higher share of the bribe than nodes who do not recruit any accomplice.

Introduction

Corrupt bureaucrats seldom act alone. All over the world, corruption scandals almost always unfold vast conspiracies involving many bureaucrats. Corruption more often than not takes the form of a criminal network: a collective, organized activity that ties together individuals that are usually related to each other through preexisting

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“strong” ties (Granovetter 1973), be they ethnic, religious, or simply friendship ties. For instance, in December 2013, a corruption scandal shook the Erdogan government in Turkey. The charges included wrongful allocation of public works contracts, as well as money-laundering with Iran. The prosecution arrested 56 people, including dozens of AKP members, notably three ministers and their sons. The head of the conspiracy was, allegedly, the Azeri businessman Reza Zerrab (Perrier 2013).

When taking the form of criminal networks, corruption is collective, and often embedded in social life. Corruption may be collective in the sense that it may involve several bureaucrats, and several clients, acting together. Here, corruption is collective because those individuals seem to act in an organized manner, under the direction of some sort of kingpin. Corruption may be embedded in the sense that it may exploit pre-existing social ties. Here, members of the corruption network were also members of the same political party, and sometimes related by family ties.

The collective, and embedded dimensions of corruption suggest that the social structure of a bureaucracy, that is, the structure of the network of relationships in which bureaucrats are embedded, may be an important determinant of corruption. At the micro level, social structure is likely to shape the opportunities a bureaucrat has to engage in corrupt behavior, by varying the demand, and the probability of sanction she faces, as well as her possibilities to coordinate with colleagues. As a result, at the macro level, the total amount of corruption may vary in function of structure. This argument may have two important policy implications. First, as organizations shape agents’ social networks (Small 2009), they may have unintended consequences on the amount of corruption. Second, it may be that within a corruption network, some agents are structurally more vulnerable than others. Anti-corruption agencies may exploit these structural features to target those individuals first.

Surprisingly, the dominant theoretical approaches to corruption, either based on principal-agent, or market models, have little to say about how social structure affects the nature, and extent of corruption. Indeed, the principal-agent approach takes as given a very stark social environment, matching an “agent” with a set of “principals.” The market approach is able to account for collective forms of corruption, but it misses its embedded dimension. By contrast, existing work on covert networks highlights how criminal networks may exploit social structure in order to solve a tradeoff between
efficiency and secrecy. This line of work, however, often misses important issues of strategy, especially at the network formation stage.

This paper builds a formal model that sheds light on how social structure affects corruption. Corruption is modeled as the formation of a criminal network, where members face a tradeoff between secrecy and efficiency. Bureaucrats are embedded in a network of relationships, and play a strategic diffusion game: a bureaucrat finds an illegal opportunity to make money, and decides whether to spend some of it in order to recruit accomplices among her neighbors. Accomplices protect the bureaucrat, but non-corrupt neighbors denounce their corrupt ones.

For any bureaucracy, I show that when accomplices share the bribe equally, although corruption decreases as states become better at detecting it, the conspiracy that sustains the corrupt activity involves an increasingly large share of bureaucrats. Indeed, increasing the risk of detection makes buying off accomplices more attractive, which drives up the size of the conspiracy. Yet, recruiting more accomplices entails higher costs, which can only be sustained by the most profitable projects, which, in turn, reduces corruption. This might explain why less capable states are plagued by both petty, and grand corruption, while in more capable states, petty corruption is less prevalent, but grand corruption often persists. To sustain its growth, the conspiracy first recruits the stealthiest parts of the network; that is, sets of nodes that are jointly isolated from the rest of the network. Despite what state embeddedness arguments might suggest (Evans, 1995), increasing density on the bureaucratic network reduces corruption, because it makes bureaucrats more observable.

These results yield two important policy recommendations. At the individual level, the stealthiest portions of the network are most likely to be corrupt. When auditing a bureaucracy, anti-corruption forces should focus first on auditing those substructures; that is, isolated bureaucrats, or isolated divisions. At the organizational level, denser bureaucracies are less likely to be corrupt. As such, arrangements that increase the density of a bureaucracy, such as replacing individual offices by open-layout offices, should reduce corruption.

I also sketch out an extension to the model, where I allow accomplices to bargain over the division of the bribe, on a two-levels tree. I show that middlemen pocket a larger share of the bribe than nodes who do not recruit anyone. This is because bargaining
introduces a commitment problem: since middlemen cannot commit to recruit whoever the initial bureaucrat wants them to, he has to pay them a markup to ensure that they will follow his plan. Furthermore, bargaining introduces a nuance as to which nodes are the best accomplices. Although stealthiness still matters, recruiting middlemen that can bring in many accomplices also matters, because they provide more protection for the same price.

This paper contributes to existing research in several ways. First, it introduces a model of networked corruption that complements the principal-agent, and market approaches to corruption. Doing so, it borrows from the literature on covert networks, especially the concept of a tradeoff between security and efficiency. Second, it adds to the literature on covert networks by considering an exogenous social structure, and by introducing strategy in criminal network formation. Third, it adds to the literature on diffusion in networks by introducing strategy into diffusion processes.

To illustrate the corruption-prone bureaucratic behavior that is the focus of this analysis, I will rely on the example of the “Neyret case,” a case of drug trafficking in the police department of Lyon.

The remainder of this paper proceeds as follows. First, I review the theoretical literature on corruption (Section 1). Then, I introduce the model informally, taking the Neyret case as an example (Section 2). I present the model formally, characterize equilibrium, and derive comparative statics (Section 3). I then introduce an extension where I consider bargaining in a simple setting (Section 4). I finally discuss the assumptions and the findings in light of the literature (Section 5).

1 Literature review

Ethnographic studies of corruption consistently show that corruption is collective and embedded. One line of ethnographic research has focused on the functioning of solidarity networks, within which members engage in the reciprocal exchange of favors. The most detailed accounts cover blat in Russia, and guanxi in China. Blat is “the use of personal networks and informal contacts to obtain goods and services in short supply and to find a way around formal procedures” (Ledeneva 1998). Guanxi involves “relationships between or among individuals creating obligations for the continued exchange of favors” (Dunfee and Warren 2001, 192). These practices are rooted in ancient cultural frame-
works that precede the Communist period, and underwent substantial transformations both during the Communist period, and during liberalization. Blat and guanxi networks are often inherited, when they overlap with family, or kinship ties. They can also be the object of careful construction, when one chooses strategically who to include in his network.

Although not all the activity that takes place within a solidarity network is corrupt, some transactions clearly are. Solidarity networks provide firms with privileged access to a wide array of administrative resources, that are the basis for launching business and trading activities, such as export licenses, tax exemptions, permission to use state resources, and business information (Ledeneva, 2008). For instance, Ledeneva (2006, 105) mentions a “former party official who creates a company in which the shareholders are his former colleagues, still employed in the state apparatus. From them he obtains a license to export wood. This wood is then bought at low state prices by another former colleague and another shareholder who is the director of a local paper factory, and they become rich together.”

Since the 1990s, economists have been providing the major theoretical frameworks to our understanding of corruption. The first, and most widespread, centers on principal-agent models. The second, less developed, treats corruption as a market (Olken and Pande, 2011). Despite their many strengths, neither approach is suited to analyze the impact of social structure on corruption.

The principal-agent approach typically frames corruption as the interaction between three actors: a welfare-maximizing government monitors a potentially corrupt bureaucrat, who in turn may take bribes from a client. One need not assume that the government is welfare-maximizing, but only that while the bureaucrat maximizes her own welfare, the government cares about a broader constituency. As such, it wants to constrain the behavior of bureaucrats (Banerjee et al., 2013). Under this framework, corruption arises because of asymmetric information: the agent has some hidden knowledge—typically, whether she is of the honest, or corrupt type—or can take some hidden action, such as to embezzle or not. The principal therefore has to mitigate the problems of adverse selection and/or moral hazard.

Principal-agent models focus on an institutional analysis of corruption. Indeed, in this class of models, the principal optimizes the design of an institution on some dimen-
sion in order to maximize social welfare, taking into account the corruption that arises through the channels adverse selection or moral hazard. The dimensions considered include various policy instruments such as compensation schemes, as well as various strategies for enhancing monitoring and increasing punishment.\footnote{On wage incentives, see Besley and McLaren (1993) for theory; Di Tella and Schargrodsky (2003), Ferraz and Finan (2011) for micro-evidence. Becker and Stigler (1974) provide a classic theoretical framework for monitoring and punishment. See Björkman and Svensson (2009), Distelhorst (2012), Ferraz and Finan (2008), Olken (2007) for micro-evidence.}

Although valuable in its own right, the principal-agent approach is ill equipped when it comes to accounting for the existence of corruption networks. Indeed, the strength of the principal-agent approach is that it gives an institutional account of corruption. As such, these models aggregate bureaucrats into one or few types of “representative bureaucrats,” and clients into one or few types of “representative clients,” which are considered interchangeably. By design, the principal-agent approach sidesteps an analysis of the architecture of the web of relationships that characterize collective, embedded corruption.

The other major strand in the economics literature views corruption as a market, where several corrupt bureaucrats (the offer) control access to a government resource for which there is a demand. Bureaucrats charge a bribe to maximize their private benefit. The approach transfers to corruption concepts borrowed from industrial economics. For instance, in a seminal contribution, Shleifer and Vishny (1993) look at the amount of corruption when bureaucrats act as a single monopoly, as independent monopolies, and as competitors. They show that corruption should be high in the case of independent monopolies, intermediate in the case of a single monopoly, and low in the competitive case. Although they do not model explicitly bureaucrats’ incentives to collude, they argue that they should be at their highest when price-deviations are easy to detect and sanction.\footnote{See Burgess et al. (2012), Olken and Barron (2009) for both theoretical refinements and micro-evidence.}

The market approach does a better job than the principal-agent approach in explaining the collective nature of corruption. In the market approach, bureaucrats are a multitude. The extent to which they internalize each other’s behavior, and are able to enforce cartel agreements determines the global amount of corruption. For example,
Shleifer and Vishny (1993) argue that strong states, such as the USSR, are better able to monitor their bureaucracy, and therefore more able to enforce cartel arrangements. By contrast, weak states, such as Zaire, are less able to monitor their bureaucrats, and therefore more likely to have their bureaucracy acting as independent monopolies.

Yet, the market approach leaves many interesting questions unanswered. In particular, the comparative context taken by Shleifer and Vishny (1993) accounts for differences between countries, but not within them. Another shortcoming of the market approach is that it abstracts away from embeddedness. In other words, although they are many, bureaucrats and clients are interchangeable, while the complete information assumption built into these models neglects the fact that corruption is characterized by secrecy: in most settings, a corruption market is not one where bureaucrats and clients meet in an open marketplace, and jointly determine the equilibrium bribe. Although this assumption could be relaxed, doing so would still not account for embeddedness; that is, how social ties may facilitate, or hinder both the transaction between the bureaucrat and her client, and collusion between bureaucrats.

The network approach to corruption developed in this paper complements the principal-agent and market approaches. Its comparative advantage is in the study of how the web of social connections affects the nature of corruption. In doing so, the network approach frames corruption as organized crime, and borrows heavily from the literature on covert networks (Raab and Milward 2003) that orginated in criminology, and came to cover organized crime, terrorist networks, and peer effects in crime.

Since Erickson’s (1981) seminal contribution, this approach has explained the structure of covert networks as resulting from a tradeoff between secrecy and efficiency. The security imperative favors sparse and flat structures, while the efficiency imperative favors denser, more centralized structures. Given the difficulties of obtaining data on covert networks (Sparrow 1991), the theoretical effort has far surpassed the empirical work. The theoretical work has commonly framed the problem as one of “network defense” (Goyal and Vigier 2014): how would a social planner optimally design a criminal network in order to make it resilient to attacks carried out by law enforcement? This line of research shows that the optimal networks are sparse, and that their structure is

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See, for example, Baccara and Bar-Isaac (2008, 2009), Easton and Karaivanov (2009), Lindelauf et al. (2009).
very sensitive to the specifics of the detection policy. A new body of empirical evidence confirms that covert networks are sparser than their legal counterparts (Aven 2012), and highlights structural variation (Morselli et al. 2007).

The theoretical literature on covert networks usually makes, however, two assumptions that become problematic when transporting its insights to the study of corruption. First, it abstracts away from a pre-existing society. When forming their network, criminals are assumed to operate in a vacuum. This assumption seems reasonable for criminals, who can presumably find ways to hide from outside observers. Indeed, looking at the 9/11 network, Krebs (2002) finds that in order to maintain secrecy, terrorists were avoiding contact with the outside world. Nonetheless, the assumption seems unreasonable for corruption, since bureaucrats are assigned colleagues, from whom hiding seems difficult.

Second, this literature has often missed important issues of strategy, especially at the network formation stage. A strand of the literature, originating from economics, has introduced strategy. In a slightly different context, the literature on peer effects in crime (Ballester et al. 2010, Calvó-Armengol and Zenou 2004, Glaeser et al. 1996) has shown the existence of a “social multiplier;” that is, the fact that increases in network density translates into increases in aggregate crime. Baccara and Bar-Isaac (2008, 2009) consider how a strategic law enforcement interacts with strategic criminals, and allow for commitment problems between criminals. Nonetheless, they posit that criminals form the network that maximizes aggregate efficiency. This may be warranted for terrorist or criminal networks, in which ideology or coercion might induce an individual to accept a network position that is socially rational, in the sense that it protects the whole network, but individually irrational, in the sense that it makes her bear the greatest share of risk within the network. Regarding corruption however, the assumption seems less reasonable. Presumably, engaging into corrupt behavior is voluntary. Indeed, both the principal-agent, and the market approach assume that corruption has to be incentive-compatible. Baker and Faulkner (1993) also argue that agents are individually rational when engaging into corporate crime. From an efficiency point of view, they want to maximize centrality, because more central positions give them a better ability to control their peers. From a security point of view, however, they want to minimize centrality, in order to decrease their exposure.
The model contributes to the literature on covert networks by introducing an exogenous social structure, and strategy in the formation of the corruption network. Section 5 discusses these contributions in more details.

2 Modeling the Neyret case

In October 2011, Michel Neyret, deputy to the regional director of the criminal police in Lyon, France, was put in custody. He was charged with corruption, criminal conspiracy, influence peddling, and drug trafficking. Neyret was portrayed by the media as an “old-school super cop,” whose intimate knowledge of the underworld led him to solve many cases. He owed that knowledge to a carefully maintained network of informants. But maintaining that network had a cost, and Neyret would often pay his informants by embezzling drugs that had been seized by his services, taking his cut on the way. It seems that the few years preceding his arrest, Neyret got more greedy, and was leaving lavishly.

Neyret was not working alone. Four other policemen got charges pressed against: the head of the local branch of the criminal police in Grenoble and his deputy, the head of the anti-gang brigade, and the head of the anti-drugs brigade. The policemen were providing Neyret with the cannabis he would reward his informants with. In particular, the heads of the local branch in Grenoble are accused of having embezzled 25 kg of cannabis out of a seizure of 90 kg right before they would have been incinerated. The case is quite far-reaching, and several figures of the Lyon underworld were ensnared for influence peddling and corruption. For exposition however, we will only consider Neyret, and the four policemen.

Consider Neyret’s problem in a stylized way. He would like to reward his informants with drugs. To do so, he has to get access to these drugs. The seizure of drugs is heavily regulated, precisely to avoid those situations. Many people have to check the process, in order to make it secure. In particular, the heads of the anti-drugs and the anti-gang brigades coordinate the police operations that lead to the seizure themselves. The drugs incinerator is located in Grenoble, and is therefore under the supervision of the local branch of the criminal police.

Since Neyret is the boss, he has authority over his subordinates. What he is attempting is, however, clearly illegal, and they could easily denounce him. The option Neyret
chooses is to buy their silence by sharing the drugs with them. Because the employees are just as involved as Neyret, it is costly for them to denounce him. Nevertheless, because they are involved, they in turn attract the attention of other people. The head of the Grenoble branch, for instance, is under the constant scrutiny of his deputy. The head of the Grenoble branch now faces the same problem Neyret did, and solves it the same way, by including his deputy into the scheme.

The model attempts to answer the following question: would the same process play out differently in a different bureaucracy? Suppose the process occurs in a police force that has much more demanding regulations regarding the handling of drug seizures. In this case, Neyret might have not only needed to include four policemen, but ten. There may be so many people Neyret needs to bribe that it might not be worth it. Consider now a patronage-laden police force. Presumably, Neyret would know a few people working at the incinerators, say because he got them the job a few years ago. In this case, he might choose to include them in the scheme, instead of the heads of the Grenoble agency.

In order to model this process, I assume that bureaucrats are *embedded* in an ongoing network of social relations (Granovetter, 1985; Zukin and DiMaggio, 1990). In other words, bureaucrats are the nodes of an exogenous social network which structure reflects the social organization within the bureaucracy, and perhaps beyond. Nodes $i$ and $j$ are connected if they can observe each other. For the sake of exposition, assume that Neyret’s social network looks like the one in figure 1. Neyret (node $n$) is connected to the heads of the anti-gang, and anti-drugs brigades (nodes $p_1$ and $p_2$ respectively), his assistant (node $a$), and the head of the Grenoble branch (node $g_1$) whom is, in turn, connected to his deputy (node $g_2$).

![Figure 1: Stylized view of Neyret’s conspiracy](image-url)
The social network is the result of a wide array of social and institutional processes that may feed into the organization of a bureaucracy. Presumably, regulations within this bureaucracy determine who supervises whom. In this case, both the supervisor and the supervisee can observe each other. Those regulations also determine who shares an office with whom. The key relationship of interest is how the quantity of corruption varies with structural features of the network, such as size, density, clustering, etc.

On this network, I treat corruption as a strategic diffusion process. A node, Neyret in our story, discovers an illegal opportunity to make money, which we will refer to as the “bribe.” I call that node the seed. Neyret’s neighbors observe him. If they are not corrupt, I call them witnesses. Those are the grey nodes in figure 1. Witnesses increase the probability that the conspiracy gets detected because they hold incriminating evidence through the observation of corrupt nodes. Neyret can share his bribe with the neighbors of his choice. If they accept, they become accomplices. Those are the black nodes in figure 1. Recruiting accomplices makes the conspiracy harder to detect because for a fixed bribe, they have, per capita, less dirty money on their hands, and because, by actively covering for each other, they reduce the risk of whistle-blowing. In our story, it is either that (1) Neyret made an offer to all of his neighbors, and his assistant refused, or (2) he made an offer to only three of his neighbors (the division heads), and they accepted, but did not make an offer to his assistant.

Those newly recruited accomplices face the same problem: their neighbors are now witnesses. Suppose Neyret shares his bribe with node $g_1$, the head Grenoble branch. Node $g_2$, the Grenoble deputy, is now a dangerous witness. Node $g_1$ can do the same thing as Neyret, that is, sharing the bribe with node $g_2$. Suppose that the deputy accepts the bribe. He has one other neighbor, node 2, whom he can share the bribe with. The process would then continue, until either no accomplice wants to share the bribe, or the whole network has turned into accomplices.

The tradeoff is one between efficiency and security: once accomplices get recruited into the conspiracy, they may increase security by decreasing the probability of detection. Doing so, however, decreases efficiency, in the sense that it decreases their profit, per capita. The exact terms of the tradeoff depend on the structure of the network: some

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This assumption, as well as all other assumptions introduced in this section are discussed in more details in section 5.
nodes may have so many neighbors that recruiting them would make the conspiracy even more exposed. For instance, assume that Neyret’s assistant not only works for him, but for several other division heads. Then, it might be that Neyret did not recruit his assistant because now, only his assistant is observing him. Had he offered her the bribe, she would have been exposed to all the other division heads.

I make two extra assumptions. First, I assume that if they accept the bribe, players pay a sunk cost. The seed pays a sunk cost $\epsilon_S > 0$. Other players pay a smaller sunk cost $\epsilon_i$, with $0 \leq \epsilon_i \leq \epsilon_S$. This sunk cost represents some cost of corruption. This captures, first, the expected loss from getting caught, but it may also represent some other costs associated with corruption, such as a cost of effort, or a moral cost. The assumption that $\epsilon_i \leq \epsilon_S$ reflects the fact that while because the seed is the instigator, he might face a higher cost than his accomplices. As such, $\epsilon - \epsilon_i$ represents, for each accomplice $i$, the seed’s extra share of legal responsibility in the venture: in this scheme, Neyret was clearly the eminence grise, and will probably face a tougher penalty.

Second, the probability of detection depends on state capacity. State capacity here refers to the extent to which the state is capable of detecting and punishing corruption. This may reflect the probability that the criminal police in Lyon are subjected to a random audit. The probability that Neyret gets detected is a function of the amount of accomplices and witnesses, as well as of state capacity.

The situation in which the whole bureaucracy is corrupt seems special. In particular, if the whole agency is corrupt, it seems reasonable to assume that an external audit would not be able to detect corruption, because it would not find evidence. I consider that as a limit case, and assume that then, the probability of detection is 0 irrespective of state capacity.

Let $p$ denote the detection probability. Let $\hat{p} \in (0, 1)$ denote state capacity, $A$ and $W$ the number of accomplices and witnesses respectively. The detection probability satisfies:

$$ p = p(\hat{p}, A, W) = \hat{p} + \frac{W}{N-1}(1 - \hat{p}) - \frac{A}{N-1}\hat{p} $$

(1)

Under this specification, $p$ is a decreasing function of the number of accomplices, and an increasing function of the number of witnesses. It is also increasing in state capacity. We also have the limit case in which, when $A = N - 1$, the probability of detection is
zero, irrespective of state capacity (the seed is not tallied as an accomplice). Finally, we have the opposite case in which, when \( W = N - 1 \), the probability of detection is one. This captures panopticon-like situations in which the seed is observed by all other nodes in the network, but did not recruit any as accomplices.

3 The model

This section describes a formal model of the impact of network structure on corruption. I introduce the setting, and solve for equilibria. The next section discusses the behavioral assumptions and the results.

3.1 Setting

Criminal network formation is modeled as a dynamic game of complete information. Bureaucrats are represented as the nodes of an exogenous social network, the undirected graph \( g = (G, N) \), where \( N \) denotes the set of nodes, and \( G \) the set of ties. A node \( S \in N \), the seed, discovers an illegal opportunity of value 1. In what follows, we will refer to this opportunity as the “bribe.” The \( N - 1 \) remaining nodes are indexed by \( i \in \{1, \ldots, N - 1\} \). \( S \) can refuse the bribe, or she can accept it. If the seed accepts the bribe, he pays a sunk cost \( \epsilon_S \in (0, 1) \), and his neighbors turn into “witnesses.” He can then make offers to share that bribe with the witnesses he chooses.

Once the seed has made his offers, the nodes that have been made an offer are called “pending.” They play sequentially. Playing order is determined by lower indices playing first. Pending nodes face a similar action space. They can reject the offer, or accept it. If node \( i \) accepts the offer, she becomes an “accomplice.” Like the seed, she pays a sunk cost \( \epsilon_i \), with \( 0 \leq \epsilon_i \leq \epsilon_S \), and her non-pending, non-accomplice neighbors turn into “witnesses.” She can make offers to share the bribe with the witnesses she chooses. Once all the players whom \( S \) has made an offer have played, the players to whom this set of players has made offers (if any) can act. They face the same action space, and their moving order is determined the same way.

This process is repeated until no accomplice makes an offer, or until all the nodes in \( N \setminus S \) have become accomplices. Then, an enforcer detects the scheme with probability \( p \in [0, 1] \), where \( p \) is given in equation 1 above.

As an illustration of this process, consider figure 2. \( S \) is offered the bribe, he accepts
it. He pays the sunk cost $\epsilon_S$, and makes offers to nodes 1, and 2. Nodes 1, and 2 are now pending. Then, 1 plays. She accepts the offer, and pays the sunk cost $\epsilon_1$. She can only make an offer to node 4, because node 2 is pending. She makes an offer to node 4. Then, node 2 plays. Node 4 is pending. Node 2 rejects the offer. Then, node 4 plays. She accepts the offer, and pays the sunk cost $\epsilon_4$. She decides not to make any offers. The game is over. Its correspondig terminal history is depicted in figure 2.

As such, besides the seed, there are four types of players. Pending nodes at history $h$ have type $p$. They are all the nodes that have been made an offer prior to history $h$ and that will play at, or after $h$. Note that there is no pending node at the end of the game.

Accomplices at history $h$ have type $a$. They are all the nodes that have accepted an offer to share the bribe. Together, they form a criminal conspiracy, that we shall call the coalition. At the terminal history depicted in figure 2 the coalition is $c = \{1, 4\}$. Denote by $a_{c,g} = |c|$ the number of accomplices in coalition $c$ on graph $g$. A coalition is feasible if it is consistent with the rules of the game; more formally:

**Definition 1.** Let $\mathcal{C}$ be the set of feasible coalitions. A coalition $c \in \mathcal{C}$ is feasible if for any node $i \in c$, there is a path between $S$ and $i$ such that all nodes on that path are accomplices.

Witnesses have type $w$. They are all the nodes that are the neighbors of accomplices, and are non-pending. At the terminal history depicted in figure 2 the set of witnesses is $W_c = \{2, 3, 5\}$. Denote by $w_{c,g} = |W_c|$ the number of witnesses of coalition $c$ on graph $g$.

Finally, neutral nodes have type $n$. They are all the remaining nodes, and do not play any role. At the terminal history depicted in figure 2 the set of neutral players is $\{6\}$.

Once the coalition is formed, it is detected with probability $p \in [0, 1]$. Recall that
equation 1 tells us that $p$ is increasing in state capacity, $\tilde{p}$, decreasing in the number of accomplices, and increasing in the number of witnesses. In figure 2, we have $A = 2$, and $W = 3$.

Player $i$’s payoff is 0 if she refuses the bribe. If she takes the bribe, she pays the sunk cost $\epsilon_i$, and with probability $1 - p$, she gets her share of the bribe, while with probability $p$, she gets 0. For simplicity, we assume that the bribe is shared equally between accomplices and the seed. In figure 2, $S$, and nodes 1, and 4 each get $\frac{1}{3}$. We assume that players are risk-neutral. Conditional on accepting the bribe, and net of paying the sunk cost, the coalition $c$ on graph $g$ gives the expected utility $u(c, g) = \frac{1}{a_{c,g} + 1}(1 - p)$. Replacing $p$ by its expression given in equation 1 yields:

$$u(c, g) = \frac{N - 1 - w_{c,g} - [N - 1 - (w_{c,g} + a_{c,g})]\tilde{p}}{(N - 1)(a_{c,g} + 1)} \quad (2)$$

From Equations 1 and 2, expected utilities write:

$$u_i(c, g) = \begin{cases} 0, & \text{if } i \text{ rejects the bribe} \\ u(c, g) - \epsilon_i, & \text{otherwise} \end{cases} \quad (3)$$

Since coalitions affect payoffs through their associated number of accomplices, and of witnesses, we often use the following notation: $c(a_g, w_g)$ is the coalition that has $a_g$ accomplices, and $w_g$ witnesses on graph $g$.

### 3.2 Results

In this subsection, we characterize the subgame perfect equilibria, and provide comparative statics on state capacity and density. I first derive two interesting results.

**Lemma 1.** Let $c^* = \arg \max_{c \in \mathcal{C}} u_S(c)$. All equilibria have the same outcome that $S$ rejects the bribe if $u(c^*) < \epsilon_S$. Otherwise, he accepts it, and coalition $c^*$ is realized.

This result is straightforward. If $u(c^*) < \epsilon_S$, then $S$ rejects the bribe, since no coalition yields a higher payoff. Otherwise, recall that all players have the same utility function, up to their sunk cost $\epsilon_i \leq \epsilon_S$. Then $c^*$ also maximizes the utility of those who are accomplices in $c^*$. As such, they all accept the offer, and make the moves that realize that coalition.

Lemma 1 implies that to fully characterize equilibrium, we just need to find the coalitions that $S$ finds optimal. We show that within a set of coalitions, cheap stealthy
coalitions dominate. Coalition $\gamma_a$ is is the stealthy coalition of size $a$ if among all coalitions in $C$ that have $a$ accomplices, it has the least amount of witnesses. Coalition $\gamma_a$ is cheap if no convex combination of coalitions yields a lower amount of witnesses; that is, if there is no $j, k \in C$, and $\lambda \in [0, 1]$ such that $\lambda a_j + (1 - \lambda) a_k = a$, and $\lambda w_j + (1 - \lambda) w_k \leq w_{\gamma_a}$.

Note that for any graph, $\Gamma(C)$, the set of cheap stealthy coalitions associated to the set of feasible coalitions $C$ always has at least two elements, $\gamma_0 = \emptyset$, the empty coalition, and $\gamma_{N-1} = N \setminus S$, the complete coalition. It has at most $N$ elements.

In fact, cheap stealthy coalitions dominate, and if the seed accepts the bribe, then a cheap stealthy coalition is realized in equilibrium:

**Proposition 1.** In equilibrium, if $S$ accepts the bribe, then all the coalitions that can be sustained in equilibrium are cheap stealthy coalitions that all have the same size $j$. That is, $c^* = \gamma_j \in \Gamma(C)$, where $C$ is the set of feasible coalitions of graph $g$.

The intuition behind the above is fairly simple. To ground the discussion, consider figure 3. The proof mostly shows that cheap minimum coalitions dominate all coalitions; then, because $\Gamma^*$ is finite, and because $u_S(\gamma_j) = u_S(\gamma'_j)$ if and only if $j = j'$, there is a size that maximizes $S$’s payoff for a given $\tilde{p}$. In all equilibria, if $S$ accepts the bribe, this coalition is realized.
To get a sense as to why cheap minimum coalitions dominate all coalitions, recall that having more witnesses always hurts, since it only increases the probability of detection. As such, comparing two coalitions that only differ in the number of witnesses, the coalition that has the least amount of witnesses (the stealthy coalition) always yields a higher payoff, irrespective of the level of state capacity $\tilde{p}$. This is why the coalitions represented by black dots on figure 3b beat the one above them for any $\tilde{p}$.

Furthermore, one can think of the cost of a coalition as the amount of protection it provides relative to its cost in terms of accomplices; that is, the number of accomplices per witness, which I refer to as the unit cost of a coalition. A coalition is expensive if it has a larger unit cost than some combination of a smaller and a larger coalition. Indeed, when $\tilde{p}$ is low, protection is not much needed. The small coalition is then preferred, because it costs less accomplices. Conversely, when $\tilde{p}$ is high, protection is much needed. Then, the large coalition is preferred, because it provides more protection. For instance, coalition $\gamma_5$ is not cheap. It is beaten by the coalitions $\gamma_1$, which includes node $A$ only, and $\gamma_7$, the full coalition. The set of cheap stealthy coalitions comprises, then, all the black dots that are on the black line.

With lemma 1 and proposition 1, we can derive some comparative statics. First, we consider how the equilibrium varies with state capacity $\tilde{p}$ and the sunk cost $\epsilon_S$.

**Proposition 2** (State capacity). As $\tilde{p}$ increases, conditional on accepting the bribe, $S$ picks an increasingly large coalition: suppose that $\Gamma = \{\gamma_{a_1}, \ldots, \gamma_{a_h}\}$, with $0 = a_1 \leq \ldots \leq a_h = n$; there are $h$ thresholds $\Pi$, such that $0 < \Pi_{a_1} < \ldots < \Pi_{a_h} = 1$, and $S$ shares the bribe with coalition $\gamma_{a_j} \in \Gamma$, the coalition that satisfies $\pi \in (\Pi_{a_{j-1}}, \Pi_{a_j})$. As $\tilde{p}$ increases, $S$ is less likely to accept the bribe: let $\hat{\epsilon}(\tilde{p})$ be the maximum $\epsilon_S$ such that $S$ accepts the bribe; $\hat{\epsilon}$ is decreasing in $\tilde{p}$.

Figure 4 is a graphical representation of proposition 2 for the graph in figure 3a. Think of illegal opportunities to make money as projects, that are each characterized by a given cost $\epsilon$. The curve $\hat{\epsilon}$ separates the profitable projects from the non-profitable ones. If, for a given $\tilde{p}$, the project is above the curve, it is too costly to be undertaken, and the seed rejects the bribe. Note that $\hat{\epsilon}$ is decreasing. As state capacity increases, the range of criminal enterprises that can be sustained decreases. Increasing state capacity gradually weeds out the least profitable projects; that is, the ones that have a high cost relative to the benefit of size 1.
Furthermore, proposition 2 implies a change in the structure of the coalition. Below some threshold \( \Pi_3 \) of state capacity, \( S \) recruits coalition \( \gamma_3 = \emptyset \). That is, below this threshold, accomplices are superfluous, and corruption is an individual enterprise. As state capacity increases, corruption turns into an increasingly collective enterprise, because buying off accomplices becomes increasingly attractive. In the limit, that is, above \( \Pi_0 \), \( S \) recruits coalition \( \gamma_0 = N \setminus S \), all the nodes in the graph, and only the most profitable projects can be sustained.

Finally, taken together with proposition 1, proposition 2 also yields an interesting insight as to which nodes are most likely to be involved in corruption. Roughly, the idea is that isolated nodes, that is, nodes with few neighbors, are more likely to be corrupt. Indeed, they are least visible, and hence more beneficial to the coalition. Consider figure 3a. The first coalition to be recruited is \( \gamma_1 \), which has one isolated node. As \( \tilde{p} \) increases, \( S \) recruits nodes that are less and less isolated, in the sense that they have more and more children.

Proposition 1 gives a more nuanced account. The coalitions that are realized in equilibrium are stealthy. That is, they are a set of nodes that jointly minimizes exposure to witnesses. As such, although individual isolation is a sufficient condition for one being corrupt, it is not necessary. Indeed, a small clique in which members are densely connected to each other, but sparsely connected to outside members can also be stealthy. Because the clique is is small, it would be recruited for low values of \( \tilde{p} \). As \( \tilde{p} \) increases, the seed would add other accomplices to that clique.
Let’s now consider the impact of increasing density on the bureaucratic network $g$. Construct the graph $g' = (G', N)$ by adding ties to the graph $g = (G, N)$. All notations on $g'$ are the same as on $g$, with an extra apostrophe. Then:

**Proposition 3 (Density helps).** *Increasing density weakly decreases corruption. Comparing $g$, and $g'$, for any $\tilde{p}$, we have $\hat{\epsilon}'(\tilde{p}) \leq \hat{\epsilon}(\tilde{p})$.*

The intuition is simple. From proposition 2, we know that equilibrium behavior on $g$ and on $g'$ is similar. Nevertheless, adding ties to the bureaucratic network increases average visibility. As such, nodes on $g'$ have more neighbors than on $g$. Because nodes on $g'$ are more exposed than on $g$, $S$ is less willing to recruit them.

Furthermore, corruption is only weakly lower on $g'$ than on $g$ because some ties do not meaningfully change patterns of visibility. In figure 3a, this is the case, for instance, when adding a tie between nodes A and B. Suppose $S$ shares the bribe with node A, but not with node B. Both before, and after the addition, those nodes were observing $S$, and would have been tallied as witnesses if $S$ did not share the bribe with them. Adding this tie has no impact on B being tallied as a witness.

In line with the above discussion on what makes coalitions stealthy, what matters here is whether adding a tie makes a stealthy portion of the network more exposed. Consider the above example of a small clique that is sparsely connected to the rest of the network. Adding a tie between two members of the clique would not reduce corruption, since those members were already recruited jointly. To the contrary, adding a tie between a member of the clique and an outsider would reduce corruption, because it would make the clique more exposed.

**4 A simple extension with bargaining**

Although this is beyond the scope of this paper, we introduce in this extension a simple extension to the model, where we relax the assumption that the bribe is shared equally between members of the coalition. Instead, when the seed and accomplices propose other players to join the coalition, they make a take it or leave it offer whereby they set the amount of money they are willing to offer to the prospective member. The vector of offers made by an accomplice must satisfy her budget constraint. That is, assuming that accomplice $i$ has a budget $b_i \leq 1$, and makes offers $s_{ij}$ to players $j \in J$, it must be
that $\sum_{j \in J} s_{ij} \leq b_i$.

In this extension, we only consider a simple structure for the graph $g$. More specifically, we assume that $j$ is a two-level tree, where $S$ has two children, $A$ and $B$, who have, respectively, $0 < k_A \leq k_B$ children (see figure 5). We call $A$ and $B$ first-level nodes, and their children second-level nodes. We also assume that the sunk cost is constant across nodes: $\epsilon_i = \epsilon$ for all $i \in N$.

We solve this game by backward induction. First, note that second-level nodes accept any offer that gives them a positive payoff. As such, if in equilibrium, a second-level node is part of the coalition, it must be that her payoff is zero. This allows to pin down the equilibrium transfer a first-level node makes to a second-level node. Suppose that first level node $i$ made an offer to second-level node $j$. Let $c^*$ be the equilibrium coalition, with $p^*$ its associated probability of detection, and $s^*_{ij}$ the transfer $i$ made to $j$. We have $u_j(c^*) = s^*_{ij}p^* - \epsilon = 0$. Solving for $s^*_{ij}$, we get:

$$s^*_{ij} = \frac{\epsilon}{p^*} \quad (4)$$

Second, let’s pin down the equilibrium behavior of first-level nodes. We show the following proposition:

**Proposition 4.** In equilibrium, first-level node $i$ accepts the bribe whenever $b_i \geq \frac{\epsilon}{p^*}$. For $\frac{\epsilon}{p^*} \leq b_i < (N - 1)\epsilon$, $i$ does not make any transfers. For $b_i \geq (N - 1)\epsilon$, $i$ makes transfers to her $k_i$ children.

Proposition 4 reveals interesting patterns about the distribution of the spoils within the coalition. In particular, in any coalition, “brokers” (first-level nodes) get more of
the spoils than operatives (second-level nodes). This is quite counterintuitive, because second-level nodes are the ones that help most in reducing the probability of detection, since recruiting them as accomplices does not create new witnesses. This is due to the commitment problem introduced by bargaining. Indeed, with bargaining, first-level nodes cannot commit to not pocket what $S$ transfers them. As such, if $S$ wants to recruit second-level nodes, he has to give them a share of the bribe that is so high that they become indifferent between recruiting operatives or not.

Finally, let’s pin down $S$’s equilibrium behavior. First, note that proposition 4 implies that $S$’s options are limited. If he recruits a first-level node, he can either have her recruit all of her children, or none. Second, note that if he has one node recruiting all of her children, he would rather recruit the most connected one, $B$, since having more accomplices would further decrease the probability of detection, for the same price of $(N - 1)\epsilon$.

We compare $S$’s payoffs in every feasible coalition to pin down her equilibrium behavior for any $(\epsilon, \tilde{p})$. This is summarized in figure 6. The label $\emptyset$ denotes the empty coalition ($S$ recruits nobody); $B^+$ the coalition that includes $B$ and all of her children; $B^+ + A$ the coalition that includes $A$, $B$, and all of $B$’s children; $N - 1$ the coalition that includes every node.

Comparing this figure with the case of equal-sharing (figure 4), we see some similarities. First, as state capacity increases, corruption decreases, in the sense that $\hat{\epsilon}(\tilde{p})$ decreases. Second, conditional on $S$ accepting the bribe, as state capacity increases,
the size of the conspiracy increases. For an intermediate sunk cost $\epsilon$, we see that the equilibrium coalition moves from $\emptyset$ to $B^+$ to $B^+ + A$.

Finally, introducing bargaining introduces a nuance as to which nodes make up for the best accomplices. Although stealthiness still matters, recruiting middlemen that can bring in many accomplices also matters, because they provide more protection for the same price. As such, although $S$ still wants to minimize his exposure (that is why he does not recruit a coalition including only $A$ and $B$), he prefers to recruit the most exposed node, $B$, so that she brings in more protection by recruiting more accomplices.

5 Discussion

Assumptions. I look at the state from a sociological angle. I take bureaucrats as embedded in an ongoing network of social relations (Granovetter, 1985; Zukin and DiMaggio, 1990). In other words, bureaucrats are the nodes of the exogenous network $g$. Looking at the bureaucracy from a Weberian perspective, it does not seem too unreasonable to assume that $g$ is exogenous: bureaucrats are often recruited, assigned desks, and colleagues independently of their will.

That states are embedded in society has been much documented by political scientists (Carpenter, 2001; Evans, 1995; Van de Walle, 2001). The state embeddedness approach usually highlights a tension between social networks and formal institutions. Social networks have both positive effects—their capacity to enforce norms, facilitate communication, and consensus—, and negative ones, such as their ability to sustain corruption, and clientelist redistribution. When formal institutions are strong, networks act as grease in the wheels of the Weberian bureaucracy. This is what Evans (1995) argues, explains the Asian miracle. Conversely, when formal institutions are weak, the state becomes captured by those networks. The state embeddedness approach differs slightly from Granovetter’s original insight. While the latter only points to the existence of a social network, the former mostly consider networks of strong ties that connect bureaucrats to each other, or to the outside world.

The model follows the state embeddedness literature in that states vary in their capacity to detect corruption, and in that this capacity interacts with social structure. This is reflected in the way the probability of detection is operationalized (see equation [1]). The model contributes to this literature by explicitly considering how network
structure affects outcomes. The exogenous network \( g \) is assumed to result from all the forces, formal or informal, that shape the organization of a bureaucracy. Formal processes include regulations, hierarchies, as well as patterns of recruitment. For instance, Bourdieu (1989) shows how the structure of French higher education produces a tightly clustered elite linking politicians, high-ranking civil servants, and top businessmen. Informal forces include friendship formation, or patronage. Although not featured presently, the model can easily be extended to incorporate strong ties.

Considering network structure allows to account precisely for tensions between individual and collective social capital. Individual social capital is “the aggregate of the actual or potential resources which are linked to the possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition” (Bourdieu, 1980). Collective social capital is “those features of social organization, such as trust, norms and networks, that can improve the efficiency of society by facilitating coordinated actions” (Putnam, 1996, 167).

In many instances, collective social capital has been shown to have a “dark side.” There is, for instance, increasing evidence that civil society facilitated the rise of fascism (Riley, 2010, Satyanath et al., 2013). This dark side is in part due to the fact that individual social capital does not aggregate straightforwardly into collective social capital. As Portes (1998, 2000) points out, those concepts may sometimes be at odds, for instance when one uses contacts to be awarded a public contract. This is the case in this model: networks that are more favorable to the seed, in the sense that they yield a higher payoff, are less favorable to society, as they generate more corruption.

I take a legalistic view of corruption, and define it as “the breaking of a rule by a bureaucrat (or an elected official) for private gain” (Banerjee et al., 2013). Corruption is more typically defined as “the misuse of public office for private gain” (Svensson, 2005). The legalistic definition differs from the standard one in two ways. First, it captures a smaller set of phenomena. Indeed, it does not capture behavior that is morally questionable, but not illegal, such as political corruption. Relatedly, it avoids making subjective ethical judgments as to what is corrupt. The definition restricts corruption to those behaviors where breaking the rule exposes the offender to a credible threat of sanction. What defines Neyret’s behavior as corrupt in our story is not only that drug trafficking is illegal in France, but also that if detected, the offense of drug
trafficking will be punished.

Following this definition, the model can be given a cultural interpretation. First, by definition, the model only considers those instances where corruption is deemed unacceptable behavior. Second, the way the probability of detection is operationalized also lends itself to a cultural interpretation. As the number of accomplices increase, the relative contribution of a witness to the probability of detection vanishes: a culture of corruption is spreading in the bureaucracy, making the whistle-blowers less and less potent. In the limit, the probability of detection is zero because the culture of corruption has spread upon the whole bureaucracy: corruption gets “out in the open.”

Most importantly, the definition clarifies why corruption is characterized by secrecy. As Shleifer and Vishny (1993) argue, because corruption is illegal, it must be kept secret, which entails an extra cost to corrupt agents, and a dead weight loss to society.

As discussed above, the model shares with the literature on covert networks its key tradeoff: one between efficiency and secrecy. The tradeoff stems from the hypotheses that recruiting accomplices decreases the probability of detection, while being observed by witnesses increases this probability.

Two mechanisms may support why increasing the number of accomplices reduces the probability of detection. First, it makes evidence that would incriminate one specific member harder to collect. The intuition is that when Neyret shares the drugs with his accomplices, he makes the per capita quantity of drugs smaller, which in turn makes the scheme less detectable, because smaller quantities are less incriminating. In a highly detailed description of corruption in the canal irrigation administration in South India, Wade (1982, 297) shows how this works:

“The Assistant Engineer may tell the Supervisor to ask the farmers to pay the money directly to a named contractor, or the Supervisor may take the money and immediately pass it to the contractor. The only person with any money (evidence) on his hands is thus the contractor. If by chance he should be investigated by the police and large sums of money found in his possession he can say he has taken out loans for his works.”

Second, members of the coalition protect each other. As such, the larger the coalition, the more sources of protection each member can benefit from. Ledeneva (2006, 106) tells us how in Russia,
“a judge beat up a boy who scratched his car. In a lawful society the parents of the boy would have paid for the repairs of the car and the judge would have been sentenced to a maximum of two years in prison (according to Russia’s Criminal Code). Moreover, he would have lost his job for an offense like this. [However], the judge’s colleagues protected the ‘honor’ of the legal profession and covered the incident up as if nothing had happened. Similarly, militiamen routinely cover up for one another whenever a breach of legality takes place.”

However, having more accomplices has two disadvantages. First, it decreases one’s share of the bribe. Second, larger schemes may have more witnesses. The fact that the probability of detection increases with the number of witnesses captures the idea that the corrupt conspiracy has some visibility. Because witnesses are the neighbors of accomplices, they are direct eyewitnesses to their criminal activity. Similar to Baker and [1993], the model assumes that in court, witnesses would have evidence, and testify against criminals. As such, depending on \( g \)'s structure, increasing the number of accomplices might make the scheme too exposed.

Note that the model assumes away from enforcement problems within the conspiracy. This assumption incorporates in a reduced form what has been noted by many ethnographies: trust is maintained within organized crime networks by having members sharing with each other compromising information about themselves (Gambetta [1996], Yang [2002], Ledeneva [2006]). In China and Russia, businessmen and bureaucrats often partake in bonding rituals involving spending a long night in a sauna or nightclub, “sharing the pleasures of masculine heterosexuality and giving women’s sexual services as gifts [...] These can be video-recorded and kept for future reference” (Ledeneva [2008], 138). What seems crucial here is that because members of the coalitions are all involved in the same illegal scheme, they can potentially denounce any other member, and be denounced by any other member. As a result, they are incented not to denounce anyone, in order to keep the scheme working.

As argued in section [1], the model adds to the literature on covert networks by considering a pre-existing social structure, the exogenous network \( g \), and by introducing strategy in the formation of the corruption network. Contrarily to most network formation games, the equilibrium concept is not pairwise stability (Jackson and Wolinsky).
Instead, the model uses subgame perfection, and looks at network formation as a strategic diffusion game: a new agent becomes infected if and only if (1) infected agents choose to infect her, and (2) she accept to be infected. In this sense, the model also contributes to the theoretical literature on diffusion in networks, which has traditionally considered diffusion as a probabilistic process.

Although diffusion is strategic, in the model with equal-sharing, there is no tension between individual incentives and the seed’s welfare: the equilibrium network is also the network that is efficient to the seed (see lemma 1). This result hinges on (1) the assumption on the fact that agents face a cost of detection lower than the seed. It would break should some agent $i \neq S$ have a cost of detection $\epsilon_i > \epsilon_S$. In this case, situations might arise in which $S$ would be willing to make an offer to $i$, but $i$ would refuse the offer, thereby forcing $S$ to rely on a second-best conspiracy. It also hinges on (2) the assumption of equal-sharing of the bribe. As shown in the extension with bargaining, some agents –middlemen in particular– may be so expensive that the seed has to rely on second-best coalitions.

Also note that by treating corruption as organized crime, the model restricts its scope to corruption-prone bureaucratic behavior where maintaining secrecy is a cooperative endeavor. This condition would be broken, for instance, if Neyret could hide all traces of his conduct by himself. It holds precisely because Neyret needs the support of some of his colleagues.

Finally, the model does not explicitly rely on any notion of power which, at first sight, might seem surprising to most students of bureaucracy. Although this may be addressed in an extension, several reasons motivate this initial assumption. First, the principal-agent approach is much better equipped to address those situations, as it starts by positing an asymmetry of power between the principal and the agent. Second, it seems reasonable to assume that a witness’s capacity to denounce is somewhat independent of power: in the event of a trial, being a witness is independent of one’s hierarchical position. Third, power matters indirectly, in the sense that power is a major driver behind the construction of the social network $g$. Division heads are presumably observed by their employees, as well as by their superiors.

See Bailey (1975) for a seminal contribution, and Jackson and Rogers (2007) for a more recent application.

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Results. Proposition 2 yields a series of results. The first one is fairly standard: corruption decreases as state capacity increases. The occurrence of a qualitative change in corruption is less standard. As states become more capable, the corruption network becomes larger. In less capable states, witnesses are irrelevant, because state capacity is so low that their presence does not bother the seed. However, as the probability of detection increases, members become increasingly willing to sacrifice shares of the bribe in order to buy accomplices and therefore reduce the probability of getting caught.

Together, those two results yield a third one: as state capacity increases, corruption decreases by weeding out the least profitable corrupt ventures. In the limit, only the most profitable projects can be sustained (that is, the ones that have a cost smaller than $1/N$). This result hinges on the fact that increasing state capacity makes accomplices more necessary. Nevertheless, recruiting more accomplices entails higher costs, which can only be sustained by the most profitable projects. This may explain the casual observation that while less capable states feature both the pettiest forms of corruption—for instance, policemen soliciting bribes from drivers—, and the most egregious ones—for instance, bureaucrats pocketing large shares of state budget—, more capable states have managed to eliminate petty corruption, but are still sometimes shaken by high-fly corruption cases.

The model also yields an interesting result as to structural sources of social capital. Agents derive individual social capital from being isolated. By contrast, the source of collective social capital is connectedness. Note that the way individual social capital aggregates into collective social capital is not straightforward. Indeed, the key concept is stealthiness, which is implied by, but not equivalent to isolation. Put differently, although isolated agents have more individual social capital because they are more isolated, other non-isolated individuals may also have high levels of social capital, provided the group they are part of is stealthy; that is, small and isolated from the rest of the network.

The result that isolation is individually beneficial, and socially harmful is somewhat surprising in light of the literature on state embeddedness, and on peer effects in crime. Indeed, the definition of individual social capital suggests that more connections would make one more valuable. Similarly, Evans (1995) would suggest that very clustered bureaucracies should be overembedded, hence characterized by more corruption. The
literature on peer effects in crime, with its “social multiplier,” also predicts that increases in network density should increase corruption. In fact, Evans’ argument refers to a network that is dense in strong ties. The result in proposition 3 refers to increasing density with weak ties, which makes bureaucrats more observable, and hence reduces corruption. As such, the argument seems to conflate two different dimensions: on the one hand, more ties reduces corruption, because it increases observability; on the other, given a fixed amount of ties, more strong ties probably increases corruption.

The result is, however, consistent with other results in the literature. Larson’s (2012a, 2012b) model of ethnic cooperation features a similar tension between individual and collective social capital. In her setting, information flows through an exogenous network; agents play a communication game, or a cooperation game. Information is incomplete, and agents have opportunities to lie (in the communication game), or to cheat (in the cooperation game). The more isolated an agent, the higher her incentive to lie/cheat, because isolation makes her detection less likely, hence increasing the payoff from lying. As such, the social structures that are more conducive to honesty and cooperation are the denser ones. An extension to the current model that would integrate strong ties might help provide a better understanding of this isse.

Altogether, those results yield two important policy implications. At the individual level, the most isolated bureaucrats are most likely to be corrupt. When auditing a bureaucracy, anti-corruption forces should focus first on auditing those individuals. At the organizational level, denser bureaucracies are less likely to be corrupt. As such, arrangements that increase the density of a bureaucracy, such as replacing individual offices by open-layout offices, should reduce corruption.

6 Conclusion

This paper introduces a network approach to corruption. This approach complements the principal-agent, and market approaches to corruption in that it sheds light on how the web of social relations influences the nature of corruption. In doing so, the approach borrows from the literature on covert networks, and models corruption as organized crime. In this model, the bureaucracy is an exogenous social network. Corrupt agents face a tradeoff between secrecy and efficiency: they can decrease the probability of detection by sharing some of the bribe with their neighbors. Decreasing the probability of
detection increases secrecy, but reduces individual shares of the bribe, hence decreasing efficiency.

This paper contributes to existing research in several ways. First, it introduces a model of networked corruption that complements the principal-agent, and market approaches to corruption. Doing so, it borrows from the literature on covert networks, especially the concept of a tradeoff between security and efficiency. Second, it adds to the literature on covert networks by considering an exogenous social structure, and by introducing strategy in criminal network formation. Third, it adds to the literature on diffusion in networks by introducing strategy into diffusion processes.

For any bureaucracy, I show that when accomplices share the bribe equally, although corruption decreases as states become better at detecting it, the conspiracy that sustains the corrupt activity involves an increasingly large share of bureaucrats. Indeed, increasing the risk of detection makes buying off accomplices more attractive, which drives up the size of the conspiracy. Yet, recruiting more accomplices entails higher costs, which can only be sustained by the most profitable projects, which, in turn, reduces corruption. This might explain why less capable states are plagued by both petty, and grand corruption, while in more capable states, petty corruption is less prevalent, but grand corruption often persists. To sustain its growth, the conspiracy first recruits the stealthiest parts of the network; that is, sets of nodes that are jointly isolated from the rest of the network. Despite what state embeddedness arguments might suggest (Evans, 1995), increasing density on the bureaucratic network reduces corruption, because it makes bureaucrats more observable.

These results yield two important policy recommendations that could guide future empirical work, and, if supported empirically, could support some policy recommendations. At the individual level, the stealthiest portions of the network are most likely to be corrupt. When auditing a bureaucracy, anti-corruption forces should focus first on auditing those substructures; that is, isolated bureaucrats, or isolated divisions. At the organizational level, denser bureaucracies are less likely to be corrupt. As such, arrangements that increase the density of a bureaucracy, such as replacing individual offices by open-layout offices, should reduce corruption.

I also sketch out an extension to the model, where I allow accomplices to bargain over the division of the bribe, on a two-levels tree. I show that middlemen pocket a larger
share of the bribe than nodes who do not recruit anyone. This is because bargaining introduces a commitment problem: since middlemen cannot commit to recruit whoever the initial bureaucrat wants them to, he has to pay them a markup to ensure that they will follow his plan. Furthermore, bargaining introduces a nuance as to which nodes are the best accomplices. Although stealthiness still matters, recruiting middlemen that can bring in many accomplices also matters, because they provide more protection for the same price.
Appendices

A  Proof of lemma \[1\]

Proof. Suppose \( u(c^*) < \epsilon_S \). Then, no coalition gives \( S \) a positive payoff. He rejects the bribe. Suppose \( u(c^*) \geq \epsilon_S \). Since \( c^* \in \mathcal{C} \), there is at least one strategy profile that has \( c^* \) as an outcome. Since all utility functions are the same up to the constant \( \epsilon_i \), \( c^* \) maximizes the utility of any accomplice \( i \) in \( c^* \). Because \( \epsilon_i < \epsilon_S \), we have \( u_i(c^*) \geq 0 \). No accomplice has an incentive to deviate from the profile, since it yields their highest possible payoff. Because \( u_S(c^*) \geq 0 \), \( S \) accepts the bribe.

Showing that profiles that have different coalitions as outcomes cannot be sustained in equilibrium is straightforward. Consider a strategy profile that such a coalition as an outcome to one that has \( c^* \) as an outcome. At the first history where the two profiles diverge, the player that moves at this history has an incentive to deviate to the profile that has \( c^* \) as an outcome. \( \square \)

B  Proof of proposition \[1\]

We first prove the following two lemmas. Lemma \[2\] is only used to prove \[3\]

Lemma 2. Let \( i, j \in \mathcal{C} \) be two distinct coalitions such that \( a_i < a_j \); then, we have:

\[
\begin{cases}
  u(j) \geq u(i) \text{ for any } \tilde{p} & \text{if } \frac{1}{k} < -\frac{N-w_j}{a_i+1} \\
  u(j) \geq u(i) \iff \tilde{p} \geq \pi_{ij} & \text{if } \frac{1}{k} \geq -\frac{N-w_j}{a_i+1}
\end{cases}
\]

where \( a_j - a_i = k > 0 \), \( w_j - w_i = l \), and

\[
\pi_{ij} = 1 - \frac{k}{k(N-w_i) + l(a_i+1)}
\]

Lemma 3. Suppose \( c \in \mathcal{C} \) is not cheap. Then, \( i, j \in C \) satisfy \( u(i) \geq u(c) \) or \( u(j) \geq u(c) \) for any \( \tilde{p} \), with \( i, j \) and \( \lambda \in [0,1] \) such that \( a_i < a_c < a_j \), \( \lambda a_i + (1-\lambda)a_j = a_c \), and \( \lambda w_i + (1-\lambda)w_j \leq w_c \).

Proof of lemma \[2\]. Note that \( u(j) - u(i) \propto k - (1 - \tilde{p})[k(N-w_i) + l(a_i+1)] \).

If \( \frac{1}{k} < -\frac{N-w_i}{a_i+1} \), then \( k(N-w_i) + l(a_i+1) \leq 0 \). Since \( 1 - \tilde{p} \) and \( k > 0 \), we have that \( u(j) - u(i) \geq 0 \).

Conversely, if \( \frac{1}{k} \geq -\frac{N-w_i}{a_i+1} \), then \( k(N-w_i) + l(a_i+1) \geq 0 \). Solving for \( \tilde{p} \), we find that \( k - (1 - \tilde{p})[k(N-w_i) + l(a_i+1)] \geq 0 \iff \tilde{p} \geq \pi_{ij} \), which implies \( u(j) - u(i) \geq 0 \iff \tilde{p} \geq \pi_{ij} \) \( \square \)

Proof of lemma \[3\]. Because \( c \) is not cheap, then \( i, j \) exist. Let’s show that they satisfy \( u(i) \geq u(c) \) or \( u(j) \geq u(c) \) for any \( \tilde{p} \).

Rewrite \( a_c - a_i = k > 0 \), \( a_j - a_i = K \), \( w_c - w_i = l \), and \( w_j - w_i = L \).

Suppose \( l-1 \frac{1}{K-k} < -\frac{N-w_i}{a_i+1} \). Then, by lemma \[2\], we have \( u(j) \geq u(c) \) for any \( \tilde{p} \).
Suppose $\frac{L-l}{K-k} \geq -\frac{N-w_i}{a_i+1}$. First, note that:

$$\frac{L-l}{K-k} < \frac{l}{k}. \quad (5)$$

To see why, remember that we picked $i$ and $j$ such that $c$ would be above the $ij$ line segment. This implies that the $ic$ line segment has a steeper slope than the $cj$ line segment.

Second, let’s show that $\frac{L-l}{K-k} \geq -\frac{N-w_i}{a_i+1}$ implies $\frac{l}{k} \geq -\frac{N-w_i}{a_i+1}$. We have $\frac{L-l}{K-k} \geq -\frac{N-w_i}{a_i+1} \iff \frac{l(K-k) - k(L-l)}{(L-l)(a_i+1) + (K-k)(N-w_i)} \geq 0$. Equation (5) implies that $l(K-k) - k(L-l) > 0$. Then, if for this sum to be positive, it must be that $(L-l)(a_i+1) + (K-k)(N-w_i)$ is positive, which is equivalent to $\frac{L-l}{K-k} \geq -\frac{N-w_i}{a_i+1}$.

Then, we have that (1) $\frac{l}{k} \geq -\frac{N-w_i}{a_i+1}$, and (2) $\frac{L-l}{K-k} \geq -\frac{N-w_i}{a_i+1}$. By lemma 2, this implies that for $\tilde{p} \leq \pi_{ic}$, we have $u(i) \geq u(c)$, while for $\tilde{p} \geq \pi_{cj}$, we have $u(j) \geq u(c)$. Note that $\pi_{ic} - \pi_{cj} \propto (w_i+1)[(K-k)l - (L-l)k]$, which is positive by equation 5. That is, for any $\tilde{p}$, we have $u(i) \geq u(c)$ or $u(j) \geq u(c)$.

\textbf{Proof of proposition 2}\ First, let’s show that in a set of coalitions $C$, cheap stealthy coalitions dominate. That is, for any coalition $c \in C$, there is $\gamma_j \in \Gamma(C)$ such that $u(\gamma_j) \geq u(c)$.

If $c \in \Gamma(C)$, this is trivially true. Suppose that $c \notin \Gamma(C)$. If $c$ is not stealthy, then $\gamma_{a_c}$, the cheap stealthy coalition that has the same size as $c$ has as many accomplices but less witnesses. As such, $u(\gamma_{a_c}) > u(c)$. If $c$ is not cheap, then lemma 3 implies that there exists $i, j \in C$ such that $u(i) \geq u(c)$ or $u(j) \geq u(c)$ for any $\tilde{p}$. Since cheap stealthy coalitions are stealthy, we have $u(\gamma_{a_c}) \geq u(i)$, and $u(\gamma_{a_c}) \geq u(j)$ for any $\tilde{p}$. As such, for any $\tilde{p}$, $u(\gamma_{a_c}) \geq u(c)$ or $u(\gamma_{a_c}) \geq u(c)$.

Now, consider graph 9. By the above argument, it must be that for any $c \in \mathcal{C}$, there is $\gamma \in \Gamma(\mathcal{C})$ such that $u(\gamma) \geq u(c)$. Therefore, it must be that $c^* \in \Gamma(\mathcal{C})$. Since $j \neq j'$ implies $u(\gamma_j) \neq u(\gamma_{j'})$, $c^*$ is unique. That is, only one $\gamma_j$ maximizes $S$’s payoff. Lemma 4 implies that if $S$ accepts the bribe, then all equilibria have $\gamma_j$ as an outcome.

\textbf{C \ Proof of proposition 2}\n
\textbf{Proof}. Note that for any distinct $i, j \in \Gamma$, with $a_i < a_j$, there is a threshold $\pi_{ij}$ such that if $\tilde{p} < \pi_{ij}$, then $u(i) \geq u(j)$, and $u(i) \leq u(j)$ otherwise. To see why, note that because $i \in \Gamma, i$ is not cheap. As such, we have that the slope of the $i, j$ line segment is steeper than the slope of the $\gamma_0, i$ line segment. This writes $\frac{l}{k} \geq \frac{w_i-w_0}{a_i}$, with $k = a_j - a_i$, and $l = w_j - w_i$. Note that $\frac{w_i-w_0}{a_i} \geq -\frac{N-w_i}{a_i+1}$. Indeed, we have $\frac{w_i-w_0}{a_i} - \left( -\frac{N-w_i}{a_i+1} \right) \propto (N-w_i)(a_i-1) + (N-w_0) > 0$. As such, $\frac{l}{k} \geq \frac{N-w_i}{a_i+1}$, which implies, by lemma 2, that if $\tilde{p} < \pi_{ij}$, then $u(i) \geq u(j)$, and $u(i) \leq u(j)$ otherwise.

Define $\Pi_i = \pi_{a_j, a_{j+1}}$. Let’s show that if $\tilde{p} \in (\Pi_{a_{j-1}}, \Pi_{a_j})$, then $\gamma_{a_j} = c^*$. That is, we want to show that $u(\gamma_{a_j}) \geq u(\gamma_{a_{j'}})$ for any $a_{j'} \neq a_j$. Because $\tilde{p} \in (P_{a_{j-1}}, \Pi_{a_j})$, we have $u(\gamma_{a_j}) \geq
u(γ_{a_{j-1}}), and u(γ_a) ≥ u(γ_{a_{j+1}}). We can show easily that π_{a_{j'}a_j} ≤ π_{a_{j-1}a_j} if a_{j'} ≤ a_{j-1}. As such, if \( \tilde{p} > \Pi_{a_{j-1}} \), then \( \tilde{p} > \pi_{a_{j'}a_j} \), and u(γ_{a_j}) ≥ u(γ_{a_{j'}}) for a_{j'} < a_j. We can show similarly that \( \pi_{a_{j'}a_j} ≥ \pi_{a_{j+1}a_j} \) if a_{j'} ≤ a_{j+1}. Then, we get that if \( \tilde{p} < \Pi_{a_j}, \) u(γ_{a_j}) ≥ u(γ_{a_{j'}}) for a_{j'} > a_j.

From the definition of the \( \Pi_i \)'s, it is easy to show that they are increasing.

Finally, let’s show that \( \ell(\tilde{p}) \) is decreasing. This quantity is the highest \( \epsilon_S \) such that \( S \) accepts the bribe. That is, \( \ell(\tilde{p}) = u(c^*, \tilde{p}) \). Pick \( \tilde{p}_1 \leq \tilde{p}_2 \), and their associated equilibrium coalitions, \( γ_{a_1}, γ_{a_2} \). Coalition \( γ_{a_1} \) satisfies \( u(γ_{a_1}, \tilde{p}_1) ≥ u(γ_{a_2}, \tilde{p}_1) \). Since for a given coalition, \( u \) is decreasing in \( \tilde{p} \), we have \( u(γ_{a_2}, \tilde{p}_1) ≥ u(γ_{a_2}, \tilde{p}_2) \). This implies \( u(γ_{a_1}, \tilde{p}_1) ≥ u(γ_{a_2}, \tilde{p}_2) \), that is, \( \ell(\tilde{p}_1) ≥ \ell(\tilde{p}_2) \).

\[ \square \]

### D Proof of proposition 3

**Proof of proposition 3** We prove the proposition by induction. Consider \( g' \), the graph \( g \) on which we add one tie between nodes \( i \) and \( j \). Let \( \mathcal{C}' \) be the set of feasible graphs on \( g' \), and \( \mathcal{C} \) the set of feasible graphs on \( g \). Because any graph that is feasible on \( g \) is also feasible on \( g' \), we have that \( \mathcal{C} \subset \mathcal{C}' \). We first show that for any coalition \( c_{g'} \in \mathcal{C}' \) on the graph \( g' \), with \( w \) witnesses and \( a' \) accomplices, there is a coalition \( c_g \in \mathcal{C} \) on the graph \( g \) with \( w \) witnesses and \( a \) accomplices such that \( w ≤ w' \) and \( a ≥ a' \).

Note that any coalition on \( g' \) can be decomposed into a coalition that is feasible on \( g \) and a coalition that is not feasible on \( g \). That is, \( c_{g'} = c_f \cup c_{nf} \), where \( c_f \in \mathcal{C} \), and \( c_{nf} \notin \mathcal{C} \). If \( c_{nf} = \emptyset \), then \( c_{g'} \in \mathcal{C} \).

Consider first \( c_f \). By design, \( c_f \) has as many accomplices as \( c_f \), the same coalition on \( g \). However, \( c_f \) may have one more witness. Denoting \( a_{c_f} \) and \( a_{c_f} \), the number of accomplices on \( c_f \) and \( c_f \) respectively, and \( w_{c_f} \) and \( w_{c_f} \) their respective number of witnesses, we have:

\[
\begin{align*}
  a_{c_f} &= a_{c_f} \\
  w_{c_f} &= \begin{cases}
    w_{c_f} + 1, & \text{if } i \in c_f \text{ and } j \notin c_f \\
    w_{c_f}, & \text{otherwise}
  \end{cases}
\end{align*}
\]

Now, consider \( c_{nf} \). By definition, its amount of witnesses, \( w_{c_{nf}} \), and its number of accomplices, \( a_{c_{nf}} \) are non-negative.

Putting this together, we get that \( w' = w_{c_f} + w_{c_{nf}} ≥ w_{c_f} \), and \( a' = a_{c_f} + a_{c_{nf}} ≥ a_{c_f} \). The coalition \( c_f \) has both less witnesses and less accomplices than \( c_{g_f} \).

Since for any coalition on \( g' \), there is a coalition on \( g \) that has both less witnesses and less accomplices, coalitions on \( g' \) are dominated by coalitions in \( \Gamma(\mathcal{C}) \). As such, if for a given \( \tilde{p} \), \( c^* \) is the equilibrium coalition on \( g' \), then there is \( c \in \mathcal{C} \) such that \( u(c) ≥ u(c^*) \). Then, since \( c^* \), the equilibrium coalition on \( g \) satisfies \( u(c^*) ≥ u(c) \), it must be that \( \ell(\tilde{p}) ≥ \ell(\tilde{p}) \).

\[ \square \]
E Proof of proposition 4

Proof. Suppose that $S$ made an offer $b_i$ to only one first level node, $i \in \{A,B\}$. Suppose that $i$ accepted the offer. Her utility for making transfers to $0 \leq k \leq k_i$ second-level nodes writes $u_i(k) = (b_i - ks_i^*)p^*(k) - \epsilon$. Plugging in the equilibrium value of $s_i^*$ from equation 4 we get: $u_i(k) = b_i p^*(k) - (k + 1)\epsilon$, where $p^*(k)$ is the probability of detection associated with $i$ making $k$ transfers.

Note that since $u_i(k + 1) - u_i(k) = \frac{b_i}{N - 1} - \epsilon$, $u_i$ is increasing if and only if $b_i \geq (N - 1)\epsilon$. As a result, conditional on $i$ accepting $S$’s offer, if $b_i < (N - 1)\epsilon$, we have that $k^* = 0$; that is, $i$ makes no offer in equilibrium. Conversely, if $b_i \geq (N - 1)\epsilon$, $k^* = k_i$. That is, $i$ recruits all her children in equilibrium.

Node $i$ accepts the bribe whenever $u_i(k^*) \geq 0$. If $b_i = (N - 1)\epsilon$, then the coalition that is realized has one witness, and $k_i + 1$ accomplices. As such, $u_i(k^*) = u_i(k_i) = [N - 1 - (k_i + 2)](1 - \tilde{p})\epsilon > 0$. That is, $i$ always accepts the bribe. If $b_i < (N - 1)\epsilon$, $i$ accepts the bribe whenever $u_i(k^*) = u_i(0) = b_i p^*(0) - \epsilon \geq 0$. Solving for $b_i$, we get that $i$ accepts the bribe when $b_i \geq \frac{\epsilon}{p^*(0)} < (N - 1)\epsilon$.

Note that whether $S$ made offers to one, or two of his children does not change much of their behavior in equilibrium. Indeed, $(N - 1)\epsilon$, the threshold in $b_i$ above which $i$ makes transfers to all of her neighbors does not depend on the behavior of the other first-level node. \qed
References


