# CORRUPTION IN HIERARCHIES

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**Abstract**

We gain access into and experiment with a traffic police agency battalion to analyze the economics of corruption in a hierarchy. The organizational and incentive structure of the battalion resembles that of a gang. Commanders offer their protection to street-level agents. Protection enables the agents to collect stable revenue through a bribing system institutionalized as toll fees. In exchange, the agents must detain a pre-agreed number of drivers every day, which they escort to the police station for the commanders to take bribes (the quota system). This finances respectively 94% and 79% of commanders' and police agents' income, respectively ten times and 64 times the city minimum wage. Guided by a simple contract theory model, we present three findings. First, quota levels across locations are consistent with maximization of corrupt revenue. Second, we disincentivize bribe-taking effort by doubling the daily income of street-level police agents. This decreases harassment of drivers, attendance and quality of traffic flow worsen—demonstrating the link between decentralized corrutpion and public service. Third, commanders are able to "tax" 29% of this extra income, and their taxation halves the effect of extra income. Furthermore, experimentally lowering quotas decreases traffic congestion and harassment of drivers. Our results suggest that rent-seeking and contracting frictions alone can explain the individual and collective behaviors that we observe in this battalion.**JEL Codes:** D23, O1, K42, L33, D73

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# 1 Introduction

Economists generally view the state officials' practice of selling public assets for private gain as an individual incentive problem, potentially at the expense of the public good. However, state officials work in the organization of the state, and the state is the quintessential form of hierarchy. Thus, individuals in the hierarchy are likely to benefit from it and influence the officials' incentives for private gain. A fundamental challenge to study the organization of private gains in a hierarchy is that the agreements that govern these transactions, and the transactions themselves, are likely to take place outside of the public eye because they are often illegal or taboo. As a result, there is no systematic empirical evidence to date on corruption in hierarchies.

In this paper we are able to directly analyze for the first time a range of economic questions related to corruption organized in a hierarchy. We do so by creating a unique data set containing detailed information of payments, transactions, tasks, and informal contracts over a one month period of an entire battalion of the traffic police agency known to be corrupt in a country within Sub-Saharan Africa. These data were obtained through multiple operations that we conducted under cover to gain access inside the battalion, leveraging trust relations within the hierarchy built over multiple years of ethnographic work. Observers of the study operate inside police stations, at street intersections, inside minibuses. Most are hired by the traffic police or other state institutions (such as the Fine Collection Agency or the Transport Agency) or are associated with the national association of drivers. The rest are civilians.[1]

Updated daily, the data include the universe of interactions between street-level police agents and drivers (contracts, payments, properties of the interaction and drivers), daily contracts between street-level police agents and their commanders in police stations, daily payments and transactions between levels of the hierarchy, of the universe of interactions and payments between drivers and police station staff, the distribution of informal profits at different levels in the hierarchy. These data are supplemented with directly observed properties of public service in different locations of the battalion (such as occurrence of traffic jams, accidents, and absenteeism of street-level police agents), as well as ethnographic interviews with commanders, agents, and drivers, and real-time observational analysis of the battalion recorded by observers in open-ended questions for each movement and interaction with drivers. While the data suffer from important limitations

[1]For the security of the teams that were involved involved in this research (to protect them against any possible retaliation), we anonymize the location and traffic police agency.

and a number of potential biases, which we discuss below, they nonetheless represent a substantial improvement on previously available data.

Using these data, we examine the conditions under which the individual and collective actions of the battalion members can be rationalized as economic maximization of corrupt revenue and resemble that of a gang. We consider three questions. First, we provide, for the first time, stylized facts of corruption organized in a hierarchy and quantify contracts, profits and their allocation. The higher the profits, the more likely it is that the economic forces are a driver of observed behavior and de facto organizational structure. Second, we propose a model that rationalizes the observed behavior and contracts as the result of economic maximization and strategic interaction among the different agents in the hierarchy. The model provides a lens through which we examine the data to test for rational economic motives in the design of the informal organization of corruption. The model also guides the design of two experiments. In a first experiment, designed to elicit the link between bribe effort and socially productive corruption and to measure the interaction with the de facto hierarchy, we inject large income shocks to street-level police agents in randomly selected days. In a second experiment, designed to measure the social costs of vertically organized corruption, we reduce the pressure from commanders (by altering their contracts with street-level police agents, the quotas of drivers) in randomly selected days. Third, we use the model and the experiments to examine how decentralized corruption compares to corruption with a supervisor in this context, and provide a measure of the social cost of vertically organized corruption.

A number of insights emerge from the paper. The traffic police agency we study operates in a fashion consistent with rational rent-seeking and its organization and incentives resembles that of a gang. Street-level police agents have incentives to regulate traffic that emanate from the revenues they derive at the intersection. The hierarchy, in contrast, provides street-level police agents with incentives to detain drivers in violation of regulation. Their main source of revenue is a system of tolls, paid by drivers who frequently drive through their intersection, and which whom they have built a relationship. They also derive revenues from payment known as "voluntary contributions" and from "harassment bribes," which are obtained through a time consuming and often violent bargaining with drivers with whom they have no relationship. Commanders use the threat of withholding their "protection" to their street-level police agents (that enables street-level police agents to collect payments from drivers at profitable intersections without being detained) in order to generate revenue for themselves. Such revenue seldom originates from payments from

their agents. Instead, to maintain their commander's "protection," street-level police agents have to escort a pre-negotiated number of cars (a daily quota) for their commander. The commander then collects bribes himself from the drivers that are escorted to the police station (using two Judicial Police Officers working for him at the police station as his interface with drivers). This system, which became entrenched as police stations multiplied in 2014 and the opportunity cost to the battalion of escorting drivers dramatically reduced, is named the "quota system." Drivers who are escorted to the police station make payments to liberate their car. Of all payments escorted drivers make at the police stations, 26% are fines for traffic violations through the formal system to the Fine Collection Agency, but 74% are made to the police (illegally).[2] To maintain their position at police stations that generate such private revenue, commanders themselves must also pay regular "protection fees" to individuals higher in the hierarchy. We do not have reliable data for that level in the hierarchy, but our data suggests that commanders can be asked to pay up to 550 USD every month in the period leading to our study. Our ethnographic work, however, suggests that most commanders are protected through kin and multi-facetted relationships that entail other services to their protectors besides money. Accounting for all sources of revenue and costs, this organization generates private income to street-level police agents which amounts to 79% of their total income, 94% for commanders. Their total income is equal respectively to 1 and 4.3 times the income of a school teacher, that is 10 and 64 times the city minimum wage. Given the weak monitoring capacity of the central government, and the institutionalized system of toll fees, the low formal wages can be rationalized in a weak state as the result of informational advantage of civilians over the government to incentivize state officials ("informal taxation" as described in Prud'homme (1992))—street-level police agents made 70 USD per month in formal wages, twice the minimum wage at the time, against 100 USD for commanders.

We then propose a contracting model that achieves the following goals. First, we explain why such particular contracts (quota system and higher-level protection payments) emerge in equilibrium in this context, and why they may take different forms elsewhere. Second, we provide conditions under which the quota system is second best and reflects contracting frictions in the hierarchy—namely informational asymmetry between commander and his agents, and agents' limited liability. Third, the model provides testable implications, which will guide our empirical exercise. In particular, the model provides conditions under which allowing corruption to be

[2]Of the 26% paid as fines, an unknown number is further converted into bribes or Fine Collection Agency actors in the Fine Collection Agency hierarchy.

hierarchically organized adds costs for society in comparison to its counterpart of decentralized corruption without vertical corruption contracts. Our derivations lead us to experimentally reduce the quota in order to measure the social costs of vertical corruption.

The determination of hierarchical corruption contracts in "equilibrium" is consistent with the maximization of corruption revenues for the supervisors, but inconsistent with fining the worst traffic offenses, as seen through the amount issued in fines. Indeed, higher quotas are observed in locations where drivers pay relatively more to the supervisors at the police station compared to what they pay at the intersection. In contrast, higher quotas are not observed in locations where drivers pay higher formal fines.

Street-level police agents provide socially productive effort because they derive bribe revenue from such effort. In days in which we double their informal income, we observe more absenteeism than in days in which we do not, and a significant decrease in "harassment bribes" (the only ones not governed by relationships and thus exposed to transitory shocks to incentives). Our experiment is not designed to examine efficiency wage effects, which would arise with permanent income changes. However, we leverage the fact that savings technology, so that transitory income shocks will induce disincentives effort that produces monetary gain.

Our design also allows us to quantify the dampening effect of the informal hierarchy on street-level police agents' incentives. On average, 29% of the extra income is passed to their commanders in the police stations by the end of the day, which we are able to track. This percentage captures the bargaining power of the commander. We find that, if there was no hierarchy to tax the extra income, the effect of extra income on behavior would be at least twice as large for equal cost.

Finally, while decentralized street level corruption weakly finances the provision of socially productive public service, the instruments used for vertically organized corruption are socially costly. Using our experimental variation in the quotas, we find that lower quotas lead to lower occurrences of street-level police agents harassment of drivers, as well as lower rates of traffic congestion. We analyze this reduced form result through the lens of our model, which suggests that vertically organized corruption generates a cost for society that is absent in decentralized corruption.

Based on these findings, we conclude that in this battalion, the decision making of agents can be reconciled with that of optimizing economic agents motivated exclusively by the generation of rents from a system of extortion, protection, and profitable service agreements with drivers with specific contracting frictions. The contracts and behavior we observe can be rationalized under of

the presence of contracting frictions (informational asymmetries and wealth constraints governing street-level police agents), and complementarity between the two extortion instruments (quotas increase street-level agents ability to extract bribes). These contracts can also be rationalized on purely technological grounds (bribes at police stations generate more revenue) as long as drivers have liquidity constraints in the short-run. Ethnographic and experimental evidence provide support for the existence of such frictions. The career paths and contract forms resemble that of a gang (Levitt and Venkatesh, 2000). Certainly, non-rent-seeking considerations may also play some role in the decisions of members and the activities of the battalion members, although we do not find evidence, quantitative or ethnographic, for such motives. These conclusions are based on the analysis of a single battalion, in one peculiar city of Sub-Saharan Africa, in a specific snapshot of its history. The degree to which these results are broadly generalizable remains an open question.

This study is the first to systematically document corruption within a hierarchy. Rich anecdotal evidence suggests that corruption can typically not be explained by incentives of individuals alone, in isolation from their organization (Rose-Ackerman, 2008). Numerous theoretical arguments have been developed about the possibility of collusion in hierarchies (Dixit, 2012, Tirole, 1986). However, both the theoretical (Banerjee, 1997, Shleifer and Vishny, 1993) and empirical study of corruption (Bertrand, Djankov, Hanna, and Mullainathan, 2008, Olken and Barron, 2009) have been limited by the availability of data of corruption within hierarchies. As a result, the literature has usually focused on corruption by individual state officials. For instance, Bertrand, Djankov, Hanna, and Mullainathan (2008) take as given the industrial organization of corruption to study mis-allocation of driving licenses. As they note, documenting, explaining, or experimenting with such organization is beyond the focus of their study: "[T]wo main points for future research in the corruption literature. First, greater efforts to collect micro data are needed to penetrate the black box of corruption. Second, this industrial organization of corruption (e.g., around the agent system) is intriguing and has been largely ignored by the theoretical literature."

Section 2 presents the context. Section 3 presents the data and stylized facts of the organization. Section 4 presents the economic returns of the traffic police "gang." Section 5 presents the model and Section 6 presents a test of whether the organizational structure is consistent with economic maximization. Section 7 presents the experimental design and results.

# 2 The battalion

The traffic police battalion for which we have data covers multiple neighborhoods of a large, Sub-Saharan city, which, in the period of our study, was composed of 11 Million inhabitants. The area it covers is populated by approximately of 5 Million individuals, ethnically mixed and poor.[3]

The formal organizational structure of the city traffic police agency in the period of the study is shown in Figure 1. This organizational structure has existed since its creation, except for the 2010-2014 period, when it took a different form. In this structure, the top of the organization is the Major General, also General of the national police, and is often directly linked to the president of the country. The Major General active in the period of our study was dismissed after our study. Directly under him, there is a Provincial Commissary, in charge of the traffic police in the city-province. The city traffic police is then divided in two battalions, each led by one Colonel of the traffic police. Between the two battalions, there were, in the period of our study, 29 police stations, or sections of the traffic police of the city—one battalion has 14, the other 15. In each police station, there is a police station commander. Some of these police stations occupy a higher role in the hierarchy, and have command over lower-level sections (police stations). Police stations above are named Squadrons, in which case the commander is also a Captain. In each police station, a police commander disposes of a number of street-level police agents (on average, 10), who he deploys to the intersections of his choice.

According to the law, this formal hierarchy functions as follows. Commanders deploy street-level police agents to manage traffic flows and monitor drivers respect for the traffic regulation. When a street level traffic police agent identifies a driver in potential breach of the traffic law at the intersection, the agent is expected to escort the driver to the police station. In the police station, the Judicial Police Officers (henceforth, JPO), assess the traffic violation based on the street-level police agent's testimony and determine the level of the fine to be paid. The JPO's work for the Office of Public Prosecution. They are the "eyes and ears of the prosecution office."[4] The JPO's then issue a formal citation. Fined drivers must then take the citation to the agents of the Fine Collection Agency, who also sit inside the police station (henceforth FCA). FCA agents

[3]Throughout the paper we omit details of the battalion's location, identity of individuals, and the exact time period examined in order to protect the anonymity of the 160 individuals who collaborated with us to obtain this data. The data were obtained in the course of research for a multi-city study of the traffic police initiated by Titeca in 2010.

[4]Drunk driving is fined between 50$ and 100$, to be negotiated between the JPO's and the driver.

issue a collection note that enables the driver to pay the fine at the bank, so he/she can recover the car. The police station commander supervises street-level police agents and JPO's.

In reality, however, the de facto organizational structure of the city agency during our study is similar to the organization of a gang (Levitt and Venkatesh, 2000), a middle-sized corporation motivated by the generation of profit for the agents in the hierarchy. Upstream, street-level police agents ransom drivers for bribes at the intersections. The income from such bribes is core to their survival. One agent of ours study recounts:

> "Eating is day by day: you leave the morning to find to eat that same day. The day after you go out again to find to eat. A bag of rice costs 40-50 USD. We cannot make a provisions we have to go ransom drivers to have kids eat."

This practice is costly for drivers and entails substantial physical and financial risk. The process of extracting an extortionary bribe from a driver is violent (henceforth harassment bribe). Many street-level police agents of this study explained that they often drink beer to the point of being drunk because of the dangers of this process as well as the "moral cost" that they incur when fighting with drivers to extract payments and as a result are often drunk and aggressive. The officers systematically engage in scare tactics, such as threats of violence (and actual violence in equilibrium), threats of arrest, and torture. During bargaining over a harassment bribe, the police agents usually operate in teams and frequently enter the car, confiscate the key, the driving license, the radio, and the negotiation is usually violent.[5] A commander illustrates it:

> "Some of these street-level police agents are real thieves. When they enter a car to arrest it, they can steal things from inside."

As a result, drivers seek insurance against this risk by personalizing relations. Many drivers build relations with actors higher in the hierarchy of the security agencies (police or army), which is able to reduce or cancel their fine. During an exchanged aimed to determine the amount of a bribe, the driver often calls his informal "protector," and the protector reveals his/her identity to the officer negotiating. Drivers (particularly taxi drivers) actively try to create these personal linkages, for example by regularly sending money or phone credit to security officers. The following recounting of an observer of our study illustrates the the nature of the threats:

[5] An example of strategy is recounted by one of our study observers: "they have a constraining method: they do everything to extract the car battery. They keep the battery at a small bar on the side of the road. With 5-6 USD, they may return the battery."

> "The police stopped a motorbike yesterday. The street-level police agent and a soldier who owned a motorbike quarreled over the motorbike. The soldier said 'tomorrow you'll see what I do, I will come back!' The soldier came today with a jeep, heavily armed. They arrested the street-level police agent in front of everyone. They threw him in the jeep in front of everyone! The other street-level police agent wanted to intervene. The soldiers said: if you intervene, we will shoot; they were almost going to shoot! The street-level police agent fled. The soldiers left with the street-level police agent, and they are going to beat him up. After the incident, the street-level police agents were very aggressive: they harassed and attacked people. They were taking the motorbikes out of the hands of the drivers, and going away with it."

For poorer drivers who frequently pass through the same intersections, relational contracts that govern the behavior of street-level police agents and drivers had emerged, which reduce violence and time waste. A system of toll fees was in application for frequent drivers, who, through repeated interaction, developed a system of "protection." This system of low-level protection based on relationships with street-level police agents was commonly known as the "salute of the cola nut," referring to the secretive manner in which the payment is made, with a hand shake (the cola nut is often used for embarrassing medicinal purposes). Drivers that transport people would pay 50 cents per intersection. Drivers that transported goods regularly would pay 1 USD per intersection. Street kids gangs also benefited from the protection of street-level police agents. In exchange for a daily fee, they were allowed to remain at intersections and harass drivers. The following quote from a minibus driver illustrates the value of protection:

> "If we have to be honest, we have to acknowledge that our vehicles are generally in bad shape, and that we also lack transport documents. And even when we have these, it are fake documents. You therefore need a relationship of trust between us and the police agents. It is a question of understanding."

As a result, almost every car could be arrested for breach of the law.[6] Ability to pay is mostly

[6] An driver of our study recounts "Every police agent knows his driver. The right of ownership is on the drivers and not on the intersections. How do we get these rights? Family relationship (my cousin, for instance). For instance consider the fact that the driver was arrested one day and the street-level police agents intervened for him. It becomes a form of friendship. He buys. The conditions that push him to collaborate are for instance that, with that, he can also get more. Why some police agents more than other? It depends on the social condition of the police agents. Police agents are responsible for what they win. Where they work, they are obliged to build this

determined by the coercive power of the protector, rather than by traffic law violations.[7]

This process, however, is also risky for street-level police agents. In 2014, the state created the police of the police, an agency which, despite being used for extracting purposes, exposed street-level police agents to risk of being detected. At the time of the study, the agency had one jeep and four police officers, but was a major threat to many street-level police agents' ability to extract. Commander protection ensured that they can collect bribes without being detained—they may otherwise be left exposed or even reported by their commander.[8] In exchange for this protection, street-level police agent had to detain, every day, a pre-agreed number of drivers (ranging from 4 to 16 per team of 4 street-level police agents) and escort each of them to the police station. Once at the police station, to determine the bribe that the driver has to pay, JPO's use the threat of the formal fine to be paid to FCA, as well as the time wasted by the car held in the car pound, which they can arbitrarily detain. Payments from bribes were then distributed among JPO's and commanders. Drivers detained to be escorted at the police station were typically "unprotected" drivers, as driver's protection main benefit is the shield from harassment and detainment. This system is commonly known as the "quota system." The proceeds from bribes taken by the JPO are distributed among commanders and JPO's in the office.[9] However, monetary payments from street-level police agents to their commanders were rare, except when commanders had knowledge of unusual revenues. As one study observer recounted:

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relationship to supplement their condition of life. Consider a driver passing by this busy intersection. The driver will tell you that on this line, has has already 'bought the land.' It means that between him and the police on all the intersections it is difficult for him to be stopped because he is known to them. He is flexible, he speaks well, he is known. Here, in contrast, I am new. It's easy to get arrested here because I'm new."

[7]At the time of the study, very few drivers carried even driving licence and insurance documents, and many had technical failures, including outdated licensing.

[8]Indeed, powerful commanders, by sharing some of their revenue, colluded with the police of the police to prevent their agents from being caught. In practice, the police of the police would warn the commanders that they would travel through a particular intersection, and the commanders would call their staff in advance to avoid arrests. An observer of the study recounts how the police of the police systematically engages also in predatory behavior: "Today there are many thunderstorms [police of the police]. For 3-4 days, the thunderstorms [police of the police] continuously arrested cars, motorbikes, minibuses. They did not bother private drivers. But many thunderstorms [police of the police] arrests! They use a machine with pins which blocks the tires of drivers, causing accidents!" Despite the fact that the police of the police is not supposed to arrest drivers.

[9]The FCA agents, whose main duty is to collect formal revenue are generally sidelined: very few drivers are actually escorted to the FCA agents to get a collection note to pay at the bank. The FCA agents have less leverage than the JPO's, as the FCA is relatively weak. Based on our own fieldwork, this is because the higher level networks of the FCA are much weaker, whereas JPO's can activate powerful networks of the Ministry of Justice and of the Interior if they are unhappy with a given allocation. However, commanders have an interest in maintaining a minimal flow of formal fines through the FCA agents. In practice, FCA agents have an arrangement with the police station determining how much formal revenue they are allowed to collect. These arrangements are often determined in kind, and specify that the FCA agents are allowed to collect one car per day or every two days.

> "the 'retrocession' is a form of quota: when a commander learns that a street-level police agent has received money, he imposes a 'retrocession' of that money to the commander [...] Also, when you are unable to fulfill the quota because the traffic did not help, you have to let the commander know. In that case you can say 'chief, I got nothing as big today, but I can still buy you 500 or 1000 phone credit units [...] You may hear 'My commander, today there were not many arrests in the field, but there were many voluntary contributions, and on that I took something for you, a beer, phone credit, or I can buy your wife a wine' that way so he gets positioned with the commander and to keep the contact. Non quota payments are not common otherwise"

When a police agent fails to meet his quota, the commander usually withholds the agent's traffic police jacket— the police agent's is then unable to make revenue from bribes.[10] The following quote from a commander in our study illustrates this explicitly:

> "If a street-level police agents is unable to bring his quota, I hunt him. That means I keep him at the office the next day as punishment."

Stopping and escorting drivers to the police station involves a significant loss of time.[11] Detaining a car often requires blocking the car, accessing the key, removing the radio, or removing the battery in an attempt to kidnap the driver. Furthermore, escorting a driver to the police station also takes time. Given the high bribe expected at the police station and the time waste involved in the process, one may wonder why drivers can't instead pay directly to police agents in expectation of the time loss and higher bribes at the police station. Our ethnographic work indicates that drivers and street-level police agents' liquidity constraints prevent them from making a large payment, either to the agent, or to the commander. A second justification is that the existence of the quota increases the equilibrium bribes that street-level police agents can extract from drivers. Last, the quota system allows to shield street-level police agents: they provide a

[10] One street-level police agent recounts: "The colonel does not have the power to discharge a street-level police agent, as this is the general police station, in collaboration with the Ministry of the interior, which does so. But the commander can punish a street-level police agent momentary. A police agent which is at 8 o'clock on the pavement and which is removed the vest during 3 or 4 hours will complain strongly. For a street-level police agent whose vest has been removed, his team leader asked me to plead at the level of the commander to let him work. The commander explained that this gentleman did not bring sufficient vehicles for a while. He didn't meet his quota, and he learned that he had been punished."

[11] Reflecting the concern for time loss, a commander that we interviewed after the study shared a common saying among the street-level police agent: "arrest the shy ones and leave the non-shy."

facade of formality that hides the process of extraction in police stations, and adds a form of theatricality that gives the appearance of legality.

In response to this system, street-level police agents differ widely in their strategies. Some specialize in traffic management and are accustomed to receive tips. Others focus on the toll fee. The following quote from supervisors of the project recount the functioning of this system:

> "So I spoke with the observer there, and who recorded this. So he told me there's a palm tree [street-level police agent] there who is very powerful. He is called BARABAS. He's much, much worse than Tarzan; he extracts so much! When he is there with Tarzan, they are a team that bits a lot = Barabas + Tarzan."

In contrast to intersections, the structure of the police station is similar to that of a franchised company. Police station commanders pay a protection fee to the hierarchical protectors, but are the residual claimants on the profits made at the police station through bribe taking. Their contracts are a simple monthly fee, reflecting that escorting cars to a central location is prohibitively costly, and the fact that commanders, unlike street-level police agents, face little liquidity constraints. Payments were typically low (we heard one commander self-reporting to pay 550 USD monthly prior to our study, but during our study, in the battalion we study, the highest payment was 250 USD monthly). Rather than making large monetary payments, commanders had protection through ethnic and kin connections and provided non-monetary services (such as prioritizing traffic flows and protecting them from officers' harassment). Consistent with this, commanders in our data that have connections to a protector make the smallest payments. One commander told us "I invest in relationships with my superiors to better exploit my agents" and another:

> "In order to earn money easily, you need an 'umbrella,' an officer in a higher places to which you give an envelope in such a way that he protects you in case you are accused."

Police stations and intersections have a known price tag. One of the actors of the agency recounted:

> "The Colonel gave me a particular intersection, for which he asked me to pay his brother in law, who is a colonel, 500 USD per week, as this would guarantee me an easy life. The problem was that I was based on a sterile intersection: no cars were passing by! So I could no longer pay this amount, and I lost my position."

The organization of the city traffic police underwent two drastic changes in 2010 and 2014, which show its importance for the generation of private revenue. Prior to 2014, there were only 2 police stations in the city, and street-level police agents were mostly making financial payments to their superiors. In 2010, a new body emerged, the so-called "coordination." This body, led by the cousin of the National Commander, and of the same ethnic network as the Interior Minister, was designed to circumvent lower levels of the agency and concentrate revenues in the hands of a powerful elite of the agency, largely based along ethnic lines. During the "coordination," commanders begun to make systematic weekly payments directly to the coordination. The coordination received a substantial share of the revenue generated informally by police commanders, and directly deployed agents to the most profitable intersections in order to complement the revenue generated by commanders. The coordination used the power to demote those who under-performed. Their power stemmed from their connections at the highest level of the country politics. Commanders described the system as 'slavery' or being a 'blood donor:'

> "There is too much pressure on us from certain commanders, which are too demanding. They write bad evaluations to the hierarchy if you do not give them enough and you will be transferred to a bad intersection"

In 2014, a new General, closely tied to the president, was named for the city police agency. His informal mandate was to improve the popularity of the president. He immediately abolished the coordination system, and introduced "community policying," increasing the number of police stations from 2 to 29. Community policying's stated goal was to approach the state services to its citizens and improve safety. In practice, it reduced the costs of escorting drivers to the JPO's. This allowed the development of the "quota system." Furthermore, motivated with improving the president's popular support, the General engaged in counter-corruption campaigns against harassment bribes in the street. In the face of risky bribe-taking, the quota system provided a safe legal cover for systematic corruption that followed the formal process, and escaped the public eye. Rather than curbing corruption, these changes led to the mutation of the organization of corruption, crystallizing the quota system and empowering commanders. It is possible that both reforms were designed with the aim of maintaining/increasing the stream of corruption revenue, while providing a cover. One project observer recounts the sensitivity of the quota:

> "The question of quotas is so sensitive. Everyone does as if there is no quota because

the police general of the city forbid it. Street-level police agents find it difficult to talk about it. They have an instruction not to talk about it. We have this unique chance to be with the commanders. Street-level police agents are otherwise afraid"

The typical monthly wage of street-level police agents in the period of the study was 70 USD, twice the national minimum wage (100 USD for a police commander). The ethnic composition of the agency was relatively homogeneous at the key positions, and ethnic networks was the central mode by which actors were protected to access profitable positions. The traffic police is among the best paid officers of the police. According to one of our study informants: "to arrive there you need [...] either the commander or a high level police officer."

The battalion for which we have data battalion was overseen, during the period of our study, by a Colonel, and covered the 20 most populated intersections of their half of the city. The number of police stations covered by this battalion was 14 over the period examined, with 14 commanders, 44 JPO's, 79 street-level police agents, and hundreds of protected drivers. During the period of our study, we observed no rotation of street-level police agents across police stations. The area in which the battalion operates is demarcated in Figure 2.

Table I presents descriptive statistics of police officers from exit surveys we conducted on police officers after the study. The data covered 79 street-level police agents, the commanders of 7 police stations and 44 JPO's. The typical street-level police agents is 41 years of age, is married and has 5 children—3 less than the average commander. Of street-level police agents, 24% are female, as opposed to 14% for commanders, and 63% have finished secondary education. Street-level police agents are ethnically diverse and have long tenure but commanders are mostly from eastern ethnic networks and are reallocated when higher levels of the hierarchy change. Most commanders were appointed by protectors in the national police and military hierarchy 2 years prior to our study as a result of city police organization reforms, but street-level police agents, and especially JPO's typically follow formal processes to obtain their job, sometimes with the help of a protector (which includes training and professional degrees). As a result, the average tenure in the police force for a commander is 2 years, against 10 years for street-level police agents. The (self-reported) average daily informal revenue of a street-level police agent is 17 USD, amounting to 445 monthly. This amounts to more than six times the formal wage, and 12 times the minimum wage (and thus constitutes 86% of total revenue for a street-level police agents). Accounting for all of their daily expenses, the average daily savings of street-level police agents is 2.50 USD. The last informal

payment to the commander coincided with the time they last received formal wage.[12] Poor savings technology implied that transitory income shocks lead to imminent income effects that alter the effort/leisure trade-offs.[13]

# 3 Data and descriptive statistics

We conducted the study during one month in a year between 2014 and 2017, in one of the city's battalions. Figure 2 presents the intersections in the study.

## 3.1 Data collection

Leveraging years of ethnographic work and the collaboration of an informant linked to the highest levels of the traffic police, we designed a system of observation that relies on the reports by 160 observers, who tracked the behavior and transactions of drivers, street-level police agents, police station-level officers, commanders, and FCA agents in police stations.[14] Figure 3 presents the data collection system and describes the data collection operations involved.[15]

First, we observed the behavior and revenue of police agents and the congestion properties of the intersections. We hired 30 observers and deployed them to each street intersection of the study.

[12]Table E.2 in the online appendix reports psychological outcomes of street-level police agents, and benchmarks them to a random sample of 662 civilians.

[13]In the open-ended questions, street-level police agents explicitly report to target a certain level of income in the day. As an example, the survey data suggests that the street-level police agents of one intersection try to get 2 beers a day (3 USD each), the cost of food for the household (7 USD), restaurant for the day (3 USD), and 3 USD for unexpected costs, which equals approximately 16 USD. One police agent of our study told us " Street-level police agents also have a quota internal to them. They said: each day, I must leave with 15, with 20, etc."

[14]The scale of the study was constrained by security considerations. The meeting notes of the first day of the study indicate " we really cannot afford any more security issues; we're really at our maximum here. More exposure might endanger the whole project." We did not record incidents that harmed the safety of our team nor of the subjects. However, we had to manage significant risks. For instance, the notes of the first day indicate "2 observers were being followed by secret service personnel. They noticed in time, left the carrefour, called their supervisor, and are now on their way here. Probably increased secret service presence because of the President's movement in town today." Similarly, we had to drop 2 intersections in the course of the study as a result of security concerns. For instance, the meeting notes of the study indicate: " The commander called our informant to say that street-level police officers felt that they were being spied upon. Commander says he can no longer control his men, and that we should pull out of the intersection. Decision: as of tonight, we are pulling out of Kyanza."

[15]Section A.1 in the online appendix describes the strategies to ensure validity of the data. For each component, we obtained the relevant authorization for conducting the activity. All activities were approved by the Committee for the Protection of Human Subjects at UC Berkeley, Harvard, and by the University of Antwerp. To further protect our team, we referred to "police officers" as "palm trees" and to police of the police as "thunderstorm" in all communications and all survey forms. Furthermore, our informant used multiple sim cards because we suspected his phone was tapped.

At each intersection, two observers tracked the behavior of two randomly selected police agents for that day.[16] Observers recorded the following properties for any interaction with drivers: type and time of interaction (conversation only, type of bribe, escort to the police station, failed arrest, salutation), duration of the interaction, payment made and properties of the car.[17] Observers also recorded properties of the traffic congestion for each hour.[18]

Second, we measure the quotas and transfers between police agents and their supervisors, as well as all transactions that occur inside police stations.[19] We measure the number of drivers that commanders require their street-level police agents to escort to the police station (the hierarchical corruption "quota"), the monetary transfers from street-level police agents to their commanders, and the cars escorted to the police station as well as the bribes paid inside the police station.

We obtained this information from three sources. First, in each station we worked with all of the JPOs (two per station). For each car that enters the office, each JPO reported the length of the negotiation, the initial offer, the actual bribe amount that the driver and the JPO agreed upon, the formal fine issued by the FCA agent (if any), the type of car, and the intersection where the car (and driver) was escorted from.[20] In addition, the JPO's recorded the quota that was

[16]Traffic police agents are required to wear an orange jacket and a helmet, which display their identifiers. Before the project, we drew a roster of police agents/intersections, which we used to instruct each observer who to follow.

[17]To complement the real time observers, we hired observers in minibuses, which we introduced for robustness given that minibuses are not stationed at the intersections. We hired observers in 10 minibuses, who traveled through the same intersections 20 times per day on average. The links between minibuses and our intersections occur at a few instances during the day, implying that the measurement of intersection properties is very noisy.

[18]We complement our measure of traffic jams with a measure of police agent effort. While we do not observe effort allocation nor whether a police agent is present at any point in time, we observe, for each interaction, whether the observer found the selected police agent at the intersection or instead had to observe another. Using this measure, we construct a proxy for the proportion of police agents in the team that are present at any given time.

[19]Our access was granted through a combination of forensic data collection methods of direct observation, as well as pre-existing personal relationships with different networks of the state. This allowed us, for instance, to gain access inside police stations through the police and through the JPO but also, separately through FCA. To coordinate the different activities, we hired a scientific coordinator and two assistants, in charge of the data collection system maintenance and data quality. We also hired an operations coordinator and two assistants, in charge of coordinating the activities that required contact with the state agencies. The scientific coordinator was hired among our networks from another province of the country, in order to prevent collusion with any component of the data collection team that is in contact with the police and that might have incentives to collude. The operations coordinator connections were central to access inside police stations and other state agencies, as well as to protect any individual part of the data collection system—if any threat occurred, the connections of the operations coordinator were enough to prevent anyone from being harmed. The latter actor yielded influence in the police hierarchy through his/her former high-level position in the government, and intervened within the police hierarchy when necessary. Access to the hierarchy was obtained by preceding ethnographic research of 3 years, through which trust was created with the key-actors.

[20]We hired three supervisors. The supervisors passed near the station multiple times per day, where they collected the forms and provided feedback if the form was not completed well. Data forms were collected outside of the station for discretion. Furthermore, JPO's kept notes on blank sheets during the day, copied them on forms once they left the office at night, and handed them over to their supervisors. Second, the supervisors brought the

decided in the morning for each intersection.[21] Because their authorization is required, this part of the data collection system was the only one that commanders are informed about (and knew about).[22] Second, we also hired the FCA agents to collect data of all the activities in the police station—totaling four data points per police station from two different agencies.[23] Third, when possible, an operations coordinator triangulated the JPO data with notebooks which were kept by the JPO's, in which they kept detailed notes about incoming cars and revenue. While we had permission to consult these data, we did not have the permission to copy them. Notes from an evening meeting during the study describe how we accessed these data:

> "The JPO's give us the register of bribes collected at the station. They have a register in which they keep the cars for the FCA agents; but they also have a single paper on which they have written the true entries. They show us the register every day. This register is for the commander, to show what is sent to the FCA agent and what is for the police. We can not copy this register, but we use it to see if the data of the JPO is correct. Since about the 27th of June, we have access."

It is important to consider the reliability of the data. For intersection-level data, our monitoring structure was designed to eliminate incentives for misreporting. Section A.1 in the online appendix provides a full description. We also have no reason to doubt that the police station data represent the actual quantities and contracts that took place inside police stations. It is worth noting that the data of police stations comes from sources that were never aware to be part of the same

data to the coordination unit of our data collection system every evening. The next day, the two assistants of the scientific coordinator entered the data on a tablet, and upload it into the data collection server. A graduate student in the US produced a report of data quality for the scientific coordinator, who distributed it one day later to the JPO's supervisors. Figure D.1 shows a typical traffic police station in the city. Since police stations are very small, FCA agents were able to directly observe and overhear the negotiations between JPO's and drivers.

[21] We also use additional sources of information to verify the quota for each intersection/day. First, a "wage team," described later as delivering cash to police agents on randomly selected days, obtain this information directly from the street-level police agents. Second, a "income intervention auditor" met the street-level police agents every evening, and verified the quota.

[22] See Table E.1 in the online appendix

[23] The FCA agents do not profit from the bribes that are paid at the office, so they have no incentive of under-reporting. The police agents and the FCA agents are indeed from conflicting networks, which prevents collusion. To supervise their work, we hired interns of the FCA, which we recruited through our own civilian networks from a different part of the country to prevent collusion. We designed a form for each FCA agent to fill, and the supervisor (working as an intern fro the FCA), passed by the police station every evening to collect the form and provide feedback from previous days. Since their supervisors are different from the JPOs' data collection supervisors, and since their supervisors are hired as interns of the FCA, the FCA agents never knew that they were part of a research project that had any link with what the JPOs were doing. Most importantly, the JPO did not know that the FCA agents were passing on the records through the hired FCA interns. FCA agents wrote this information on a paper, filled it into forms at the end of the day, and gave those to their supervisors outside the police station at night.

study, and complemented with the actual records kept by commanders inside police stations. Such records are a tool for managing the day-to-day operations of the police station, and as such there is no reason to believe that there were incentives to misreport this source. Although we are convinced of the validity of the data, it is prudent to view the revenue as lower bounds, because street observers may have missed certain interactions with drivers, especially those that occur in different locations, and because individuals int he hierarchy receive funds "off the books" from the sale of their protection to drivers. This income is the focus of a follow-up study.

## 3.2 Stylized facts

The data contains real-time breakdowns of payments and tasks at all levels of the hierarchy in one of the two battalions of the city, for the duration of one month.

### 3.2.1 Profits from street-level police agents' activities

Street-level police agents regularly collect three types of bribes. The first type of bribe (henceforth harassment bribe), involves the police agent threatening a driver with escorting him/her to the police station (and/or with violence or torture), where she/he will most likely pay a large bribe or fine and potentially lose her/his vehicle for days in the car pound. The second type of bribe amounts to a toll payment. It is the so-called "*Cola Nut Salute*: "in exchange for never arresting the car, the police agent requires a small fee every period, which saves him and the driver time wasted negotiating. The fee, which is non-negotiable, is 50 USD cents for minibus drivers and taxi drivers and 1 USD for truck drivers. The third type of bribe are called voluntary contributions. When the police agent clears a traffic jam, some drivers thank the police agent with a tip, typically of 1 USD. Drivers give a tip with an open hand, as a public gesture of recognition for the street-level police agents. Tips can also be paid to build relationships.

Figure 4, Panels A-C, present the frequency of payment for each type of bribe, the median amount paid, and the median duration of the negotiation, among all 18,885 police-agent/driver interactions in the data.[24] Toll fees are, by far, the most frequent transaction, but harassment bribes, which account for only 3% of transactions, yield 13 times more per transaction (6.5 USD).

[24]Figure D.2 in the online appendix shows the allocation of the different types of bribes by driver type. Figure D.3 shows the average number of events for the different types of bribes during the day. Arrests are more prevalent during the morning, as police agents meet the duties of the job that they have been assigned, and focus on generating revenues from tolls in the evening.

Reflecting that they are a negotiation, harassment bribes' median duration is 7 minutes. Table II, Panel A, presents the stylized facts of the intersections corruption. The data in this table are aggregated to the team of street-level police agents per intersection, and then averaged over intersections. Harassment bribes account, on average, for 1.6 transactions per street-level police agents' team per day, toll fees 38, and tips 11. The resulting daily revenues from harassment bribes, toll fees, and tips amount respectively to 7 USD, 22 USD, and 12 USD.[25] Table II, Panel A, also provides additional statistics which we use in the analysis. The typical team consumes 16 USD of beer in a day (2 large beers per police agent), 83% of observed transactions are made by the police agent that was randomly selected to be observed, and traffic jams occur 26% of the morning hours and 45% of the afternoon hours.

### 3.2.2 Profits generated by the police station

Table II, Panel B, presents the properties of hierarchical corruption that we observe, *per intersection* in the data. The average observed quota for one team of street-level police agents is 5.40 drivers per day.[26] The average observed number of drivers that are escorted from one intersection to the corresponding police station is 5, suggesting that the quota level is a binding constraint for street-level police agents, although escorts can be higher than the quota in some days. Of these: 2.9 settle by paying a bribe to the commander at the police station (through the JPO), whose average level is 11.60 USD; another 1.1 drivers settle by paying a formal fine to the FCA at the bank, whose average level is 6.30 USD; the remainder 1 driver leaves without paying (which typically occurs as a result of a powerful protector intervening by phone or in person). This implies that, each day, one *intersection* yields a total revenue from bribes paid inside the police station of 72 USD, and 25 USD in formal fines (implying that 75% of police station yielded by the typical intersection is corrupt revenue to the police).[27]

On average, a bribe at the police station is 4 times higher than its corresponding harassment bribe taken by a police agent at the intersection. The average time to escort a driver, which we estimate by comparing the time-stamp at which a police agent is seen departing to the police station for an escort, and the time-stamp of its next action at the intersection, is 42 minutes. Considering

[25] Table E.3 compares the properties of all bribes to the harassment bribes. Harassment bribes are significantly larger and involve longer negotiations.

[26] The median quota for a team of 4 street-level police agents is 6 cars per day, and the maximum is 11. Figure D.4 in the online appendix presents the distribution of quotas on average per intersection in the study.

[27] This is smaller than the total revenue of police station since police stations have on average 2 intersections.

all bribes revenues, the average revenue per minute for a police agent is 4 cents of USD, which implies that the estimated opportunity cost of escorting one driver to the police station is 1.43 USD on average. In contrast, considering the difference in harassment bribes between the station and the intersection is 4.09, each level of quota adds 2.66 USD of corrupt revenue. Considering that the average quota is 5.4, shutting down the quota system would cost of 12 USD daily.[28]

# 4 Economic returns of the traffic police gang

Our data suggests that team of street-level police agent makes 47.09 USD in informal revenue daily (Table II, Panel A), implying one street-level police agent makes 11.5 USD per day. Thus, every month (assuming he/she works every day excluding Sundays) a street-level police agent makes 310 USD of informal revenue, and 70 USD in formal revenue, totalling 380 USD monthly wage. Thus, informal revenue composes at least 81% of a police agent's gross income, most of it stems from the toll system. This is twelve times the city minimum wage at the time of our study and equivalent to the total income of a school teacher. Of these 380, we compute that 70 USD are given to the commander in financial transfers, thus the disposable income is 310 USD.

One police station generates, in contrast, 208 USD in bribe revenue every day (74% of police station revenue), and 73 USD in formal fine revenue (26%)—note that Table II, Panel B indicates the police station amounts *per intersection*. Monthly, this amounts to 5,438 USD in bribe revenue, and 1,830 revenues in formal fines for the Fine Collection Agency. The battalion, which has 14 police stations, generates 913,584 USD in bribe revenue yearly, and 307,440 USD of formal revenues in fines to the state coffers. Figure 4, Panel E, presents the monthly equivalent income for the typical police team at the police station. We present the pooled revenues of the JPO's and the commander since we cannot observe the distribution of the bribes between them.

Police station commanders and JPO's generate as a team 5,500 USD in bribe revenue monthly, which is 1,830 USD per capita. This system implies that police station-level officers derive, per capita, 94% of their total income from revenues from bribes. Given the allocation of bargaining power, it is likely that the commander derives a significantly larger share, and thus that his monthly revenue from bribes exceeds 1,830 USD. Accounting for the formal wage of commanders and JPO's (100 USD), the per capita revenue of police station staff is 1,930 USD, that is, 64 times

[28]Figure D.5 in the online appendix shows the hourly revenue generated by the hierarchy at each of its levels.

the minimum wage and 4.3 times the total income of a school teacher. Of that, police station commanders only pass a minimal share to higher-level protectors during the period of our study according to our data. In addition, according to a survey we conducted after the study, the average payment between a police station commander and his protector is 92 USD monthly (maximum 250 USD), but is close to zero for commanders who have a protector from their kin.[29]

It is possible that this income represents the compensating differential for doing a particularly difficult job. Our ethnographic evidence suggests that the work of a street-level police agent is difficult, and officers are often drunk to overcome the physical and emotional difficulties of their work. However, the career path of a street-level police agent it often to rise up in the hierarchy. The extremely skewed distribution of income, the expectations of going up in the hierarchy, resonate with (Levitt and Venkatesh, 2000) and are consistent with the organization of a gang although nonstandard preferences are not required to explain entry into this gang.

# 5 A simple model of the corrupt hierarchy

We present a model to answer three questions. First, consistent with our ethnographic evidence, we provide conditions under which the observed contracts emerge as a result of rational economic maximization, and why this organization may not exist elsewhere. These are: informational advantage of street-level police agents over their commander, limited liability of street-level police agents, limited liability of drivers, and complementarity between the quota instrument and the amount that street-level police agents can extract. Second, the model provides a path to test that the observed organizational structure emanates from economic maximization of informal revenue, in contrast to its counterpart, fiscal revenues or social efficiency. Third, the model provides guidance to design two randomized experiments, aimed at illustrating the value of decentralized corruption, and measuring the effect of introducing collusion/extortion by the commanders.

[29]See Figure D.6 in the online appendix.

## 5.1 Setup

There are two actors — a police agent (the agent) and a commander (the principal), operating from a police station.[30] The agent derives utility from income, $y$, and leisure, $l = 1 - e$, where $e$ is the agent's effort. Utility from income $u$ and utility from leisure $v_l$ are respectively strictly increasing and weakly concave functions of $y$ and $l$. Payoff from harassment bribes follows a common knowledge distribution with probability $p$ of high payoff $b_i = b_H$, where $\bar{b} = pb_H + (1-p)b_L$. The agent's total income $y$ is the sum of a fixed and an effort-dependent income. Fixed income is $\overline{w} = w + b^I - T$, where $w$ is the government wage, $b^I$ (I for institutionalized) is the predictable revenue from toll fees (not affected by the current level of effort), and $T$ is a monetary transfer from the police agent to the commander in USD. Variable income is $\tilde{y} = (1-s)b_i e$, where $b_i \in \{b_L, b_H\}$ is the maximum feasible revenue per unit of effort from harassment bribes, and $s$ is the share of "arrestable" cars that the police agent must escort to the police station.[31] Escorting cars to the police station costs the police agent $c$ USD per car. The expected utility of the police agent is: $V_{\text{agent}}(e) = Eu(w + b^I + (1-s)b_i e - cs - T) + v_l(1-e)$. The principal's objective function is $W = T + s(1+\gamma)[pb_H + (1-p)b_L]$, where $\gamma$ is the relative productivity of the principal to extract harassment bribes. Timing is as follows. First, the principal offers a "protection racket" contract $(s, T)$. Second, the police agent accepts or rejects the contract. If the agent accepts the contract, he chooses effort $e$ so as to maximize his expected utility from income and from leisure, taking $s$ and $T$ as given. If the agent rejects it, the commander retrieves his "protection" and the optimal effort for the agent is zero.[32] In that case, the agent receives only share $\alpha \in [0, 1]$ of government wage.[33] Third, the level of the harassment bribe is revealed (private information of the police agent), the police agent pockets the bribe revenue, escorts $s$ cars, and transfers $T$ to the principal. The equilibrium contract is characterized by:

$$\max_{s,T} T + s(1+\gamma)\bar{b}$$

[30] We present a unitary model of the police agents' team at the intersections. In so doing, we assume that the team of street-level police agent is able to solve moral hazard in teams problems (Alchian and Demsetz, 1972, Holmstrom, 1982). It follows that $e$ can be interpreted as the share of street-level police agents providing effort at any given point, and the decision to take or leave the corruption contract is taken by the team.

[31] Institutionalized fees $b^I$ may capture in a static form the reduced form of effect of street-level police agents' reputation with drivers in repeated interaction, and thus the static effect of effort on $b^I$ is neglible.

[32] This will happen, for instance, if the agent risks being arrested and the expected cost of effort through the risk of arrest is sufficiently large that there is no agent corruption if the agent is not protected.

[33] Where $1 - \alpha$ can be the share that the commander can retain from the police agent. Thus $\alpha$ is a measure of commander's power over the police agent.

$$\text{PC: } E\left[u(w+b^I+(1-s)b_i e^* - cs - T)\right] + v_l(1-e^*) = u(\overline{v}+\alpha w)$$

$$\text{ICFOC: } E\left[(1-s)b_i u'(w+b^I+(1-s)b_i e^* - cs - T)\right] - v_l'(1-e^*) = 0$$

$$\text{WC: } w+b^I+(1-s)b_L e^* - cs - T \geq -K$$

Corruption revenue is the sum of police agent and the principal's corruption revenue: $R = b^I + e^*\bar{b} + s^*\left[(1-e^*+\gamma)\bar{b} - c\right]$. Drivers' choices are exogenous, and driver surplus is given by: $DS = \theta_C C(e^*(w,s,T),s) + \theta_H H(e^*(w,s,T),s) - b^I - e^*(w,s,T)\bar{b} - s(1-e^*(w,s,T)+\gamma)\bar{b} - t$, where $\theta_C < 0, \theta_H < 0$, where $C$ stands for Congestion and $H$ stands for Harassment. Bribe revenue $b^I$, $b^H$, $b^L$, all depend potentially on $s$ through the bargaining process between agent and driver.[34]

## 5.2 Propositions

Section B in the online appendix provide the mathematical formulation and proofs for the following assumptions and propositions respectively. Assumption 1 is used in all propositions, while assumptions 2 and 3 are used when indicated. In addition, for the remainder of the paper, we ignore equilibria where $s = 0$, since, as shown in Section 3.2, this is not empirically relevant.

**Assumption 1)** [There exists a unique interior solution for effort, given $(s,T)$ pair]

**Assumption 2)** [The substitution effect dominates the income effect for changes in the quota][35]

**Assumption 2')** [The elasticity of effort with respect to $1-s$ is higher than $-1$.]

**Assumption 3)** [The participation constraint is convex in the $(s,T)$ space]

Proposition 1 allows to test whether quotas are an instrument of hierarchical corruption.

**Proposition 1.** *[Equilibrium quota and total corruption revenue] Let $s^M$ be the quota level that maximizes total corrupt revenue subject to agent's incentive and participation constraints, and $s^*$*

[34]Consider that the street-level police agent's outside option under bargaining breakdown increases positively in $s$, which would be the case if he/she benefits from reducing the likelihood that he/she misses the quota. In that case, consider the Nash bargaining solution to the static problem of street-level police agents and drivers bargaining. The equilibrium harassment bribe depends positively on $s$. Now consider that $b^I$ is determined through repeated interaction between street-level police agent and the driver. For drivers who have a sufficiently long time horizon, there exist a range of $b^I$ such that $b^I$ can be sustained in grimm-trigger strategies, saving the time waste of the harassment bribe. It is straightforward to show that the upper and lower bounds of that range increase in $s$, through the out of equilibrium payoffs from harassment bribes. As a result, it is straightforward to show that, even when a quota of zero may be optimal when $b^I$, $b^L$ and $b^H$ are given, it may not be optimal when these are allowed to increase in $s$. This result illustrates the complementarity between the vertical extraction tools: higher quotas allow the commander to extract more through $T$.

[35]The effect of $s$ on the marginal monetary return to effort (substition effect) must dominate the indirect effect (income effect) through a decrease in income. This also implies that the wealth constraint is convex in $(s,T)$ space.

*be the quota chosen by principal.*
*a) As $\gamma b - c$ increases, both $s^M \to 1$ and $s^* \to 1$. As $\gamma b - c$ decreases, both $s^M \to 0$ and $s^* \to 0$. If $\gamma b - c$ is sufficiently large (or sufficiently small) $s^*$ - $s^M$ is 0 for any set of other parameters.*
*b) Suppose that the wealth constraint binds (ensured by $K$ being low enough) and that assumption 2' holds. Then we have: 1) Equilibrium quotas do not maximize total feasible corruption revenue: $s^* \geq s^M$; 2) Increasing $p(b_H - b_L)$, ceteris paribus, weakly increases principal's quota $s^*$ and $s^* - s^M$.*

Part a) indicates that if the police station is sufficiently more efficient than the intersection at extracting harassment bribes, the optimal quota is the maximum and this maximizes revenue from corruption. The reverse is true if the police station is sufficiently ineffective, with quotas set at zero. Our first objective empirically, thus, is to examine whether high quotas are more likely in places with high $\gamma b - c$. Ruling out extreme low values of $\gamma b - c$ from part a (there are no zero quota equilibria), we can then interpret part b as: if $\gamma b - c$ is low, equilibrium quota is "too high" (corrupt revenue is not maximized), and in that case, higher variance of $b_i$ increases the equilibrium quota. This is because, when the wealth constraint is binding, the principal relies on the "low" report of the agent. The larger $p(b_H - b_L)$, the larger is the expected revenue loss to the principal from relying on the agent's report, and thus, the more total revenue the principal would be willing to sacrifice so as to increase his revenue by increasing the quota. Our second objective empirically, thus, is to examine whether equilibrium quota increases with $p(b_H - b_L)$ in locations where $\gamma b - c$ is small.

**Proposition 2.** *[Higher income/fixed contract (no hierarchy above or below)] Suppose the contract $(s, T)$ is given (no principal), and $b^I = 0$ (no contracts with drivers). If (and only if) the agent is risk averse, an increase in income has the following effect: a) $e^*$ decreases, and leisure $l$ increases; b) total corrupt revenue decreases.*

Proposition 2 establishes that, ignoring the organization of corruption (both contracts with the principal and institutionalized contracts with drivers), higher income of the police agent decreases corrupt revenue-generating effort. We use this as the benchmark (strawman view) against which we then empirically gauge the effect of the hierarchy to dampen this effect.

**Proposition 3.** *[Higher income/institutionalized fees] Suppose the contract $(s, T)$ is fixed (no principal) and that the agent is risk-averse and has strictly concave utility from leisure:*

***Part a)*** *Suppose $R$ is the expected bribe revenue that agent gets. Denote as $r_H = \frac{(1-s)b_H}{b^I+(1-s)b_H} = r$ and $r_L = \frac{(1-s)b_L}{b^I+(1-s)b_H} = r\frac{(1-s)b_L}{(1-s)b_H} = r\psi$, the ratios of maximum possible revenues from performance and harassment bribes in two states to maximum possible bribe revenue, with $\psi = \frac{(1-s)b_L}{(1-s)b_H} < 1$ as the ratio of earnings from harassment bribes in two states. Holding $b^I + (1-s)b_H$ and $\psi$ constant: 1) As long as non-institutionalized bribes exist ($r > 0$), higher income reduces effort ($de^*/dw$) and corrupt revenue ($dR/dw$). 2) $de^*/dw \to 0$ and $dR/dw \to 0$ as $r \to 0$; if the share of institutionalized revenue is large, the effect of income on effort is small.*

***Part b)*** *If there is repeated interaction between drivers and the police agent, which lead to additional strictly benefit from current effort $F(e)$, then results of a) hold and additionally: $\lim_{r\to 0}[e^*(r)] \neq 0$ as long as $F'(0) > v_l'(1)$.*

Proposition 3 expands Proposition 2 by introducing institutionalized contracts of corruption with drivers. The larger the share of institutionalized revenues from corruption, the smaller the effect on effort and on total corruption revenue. If the share of non-institutionalized bribes is sufficiently small, the effect on corruption revenue approaches zero.[36] Since institutionalized revenues are the largest fraction of the agent's revenue, compared to the "naive" case of Proposition 2, an increase in income should only affect the total street-level corruption revenue mildly, while effort and harassment bribes should decrease. Institutionalized corruption at the bottom of the hierarchy should reduce the effect of transitory changes in income on corruption effort and revenue.

**Proposition 4.** *[Higher income effect/full hierarchy] Consider a small increase in the agent's income and allow for the contract $(s^*, T^*)$ to adjust in response. If the initial equilibrium quota is a corner solution ($s = 1$ or $s = 0$), the agent's effort decreases, the quota does not change, and corrupt revenue decreases. For sufficiently small levels of $\alpha$ (powerful principal), $T^*$ increases and the absolute effects on effort and corrupt revenue are smaller than without adjustment in contracts. If $\alpha \to 0$ the effects on effort and total corruption go to 0.*

Proposition 4 establishes that, allowing for the bottom and the top of the hierarchy, endogenous adjustment of hierarchical corruption further dampens the effect of income on corruption. The stylized facts suggest that the hierarchy is at $s = 1$. Thus Proposition 4 implies that the hierarchy, by taxing away a share of the extra income, leads extra income to have an even smaller effect on

[36]The proposition also provides an explanation (part b) for why effort might be observed in equilibrium if total revenue from corruption is unaffected by contemporaneous effort: repeated interaction and police agent reputation.

effort. Empirically, since we observe $T$, we can thus compare the effect of higher agent income, some of it being taxed in equilibrium, to the effect that keeping all extra income would have induced. This allows us to quantify the effect of endogenous hierarchical corruption contracts on the effectiveness of transitory income shocks. The next proposition provides empirically testable bounds for which hierarchical corruption has a negative effect on social welfare.

**Proposition 5.** *[Social efficiency] Suppose that the wealth and the participation constraints are both binding. Then, social welfare is optimized when the sum of the principal and the drivers surplus are maximized. This sum is given by:* $DS + W = \theta_C C(e^*(w,s,T),s) + \theta_H H(e^*(w,s,T),s) - cs - (1-s)p(b_H - b_L)e^*(w,s,T) + K$. *At a given level of monetary transfers between the principal and the agent, an increase in the quota decreases social welfare as long as:* $\theta_C \frac{d}{ds} C(e^*(w,s,T),s) + \theta_H \frac{d}{ds} H(e^*(w,s,T),s) + c > p(b_H - b_L)\left[e^*(w,s,T) - (1-s)\frac{\partial e^*}{\partial s}\right]$.

Proposition 5 shows that if quotas increase congestion and harassment, and if they have a negligible impact on the effort of the agent, then the hierarchical corruption, through the quota system, has a negative externality on social welfare. This suggests that the principal does not internalize the effect of his quota contract on drivers' welfare.[37]

The propositions inform the empirical strategy in the paper as follows. First, we test that equilibrium quotas are optimally set reflecting the motive of principal's corruption revenue maximization. To achieve that goal, we first estimate the model parameters using our data. Second, to quantify the implication of hierarchical corruption, we experimentally introduce police agent transitory income shocks, and examine their effect on effort and on corruption revenue from different sources. We then compare these effects to the effects transitory income shocks would have had, had they not been taxed by the hierarchy. Third, to establish whether hierarchical corruption, through the quota system, has a negative effect on welfare, we experimentally reduce the quotas to measure their effect on harassment of drivers, congestion, and effort.

# 6 Is organization structure consistent with maximization?

In this section, we estimate the model parameters and consider the testable implications of Proposition 1: intersections where the benefit of allocating a car to the police station is higher (rather

[37] Proposition 6 in Section B provides conditions under which the quota affects the agent's effort positively or negatively. Section C presents extensions and discusses the interpretation in light of existing frameworks.

than intersections that yield the highest fines) must have higher quotas in equilibrium.

We directly measure the parameters in the data. To measure $\bar{b}_i$, we obtain, for each intersection, the average yield of a harassment bribe. In addition, we observe, for each driver escorted to the police station, the bribe paid to the JPO. We thus estimate $(1+\gamma)\bar{b}_i$ as the average bribe paid at a police station, across drivers escorted from a particular intersection. We can thus back out $\gamma = \frac{(1+\gamma)\bar{b}_i - \bar{b}_i}{\bar{b}_i}$. The parameter $c$ captures the opportunity cost, in US Dollars, of escorting one driver to the police station. This opportunity cost has two components: a. the time away from the intersection, in minutes b. the cost, in US Dollars, in terms of foregone revenue in bribes for the police agent at this particular intersection.[38] Finally, we measure the dispersion in harassment bribes with the standard deviation of harassment bribes, averaged by intersection.[39]

To examine the equilibrium determination of corruption contracts, we use our parameters estimate averaged over the days for each intersection/team $i$.[40] We run the following specification:

$$s_{it}, T_{it} = \alpha + \beta_1 \left(\gamma \bar{b}_i - c_i\right) + \beta_2 p \left(b_H - b_L\right) + \eta_t + e_{it} \tag{1}$$

where $s_{it}$ and $T_{it}$ are respectively the actual quota treatment and agent-supervisor monetary transfer for intersection $i$ at day $t$ (per 100 USD assigned to the team), $\gamma\bar{b}_i - c_i$ is the marginal benefit per car allocated to the police station estimated from the data, and $p\left(b_H - b_L\right)_i$ is an estimate of the variance of harassment bribes at intersection $i$ and $\eta_t$ are day fixed effects. To examine whether $p\left(b_H - b_L\right)_i$ leads to higher quotas especially when $\gamma\bar{b}_i - c_i$ is low, we run the regression in a sample where $\gamma\bar{b}_i - c_i$ is above the mean, and then in a sample where $\gamma\bar{b}_i - c_i$ is below the mean. Since $\gamma\bar{b}_i - c_i$ and $p\left(b_H - b_L\right)_i$ are intersection-level properties that are invariant over time, we cluster the standard errors at the level of the intersection/team $i$. Since there are 17 intersections in this half of the city, we use Wild-Bootstrapping to estimate the standard errors.

Table IV implements specification 1, and regresses the observed quota level $s$ (Panel A) and police agent-supervisor monetary transfers $T$ (Panel B) at day $t$ and intersection $i$ on time-invariant

[38] To measure the time loss, we use the timestamp at which a police agent is detected to quit the intersection when he/she escorts a driver to the police station, and link it to the timestamp of the next occurrence of the police agent at the intersection. To measure the foregone bribe revenue per unit of time, we compute the average revenue that police agents make when working at this intersection per unit of time. The product of the two yields the opportunity cost, in US Dollars per car escorted.

[39] Figures D.7, D.8, D.9 and D.10 in the online appendix present the estimated parameters, their evolution over the study period for each intersection, and uses self-reported data to benchmark those parameters.

[40] This is because daily estimates exhibit high variance due to measurement error and daily shocks that are impossible for the supervisor to predict. Furthermore, contracts are known to be relatively stable for each intersection and to reflect stable intersection characteristics

intersection properties. Column (1) uses $\gamma\bar{b}_i - c_i$ as a regressor and includes the experimental treatments as controls, Column (2) adds the formal fine revenue per car as a control, Column (3) adds $p(b_H - b_L)_i$ as a control. Columns (4) and (5) test for part b) of Proposition 1: column (4) restricts the sample to $\gamma\bar{b}_i - c_i < 0$ and column (5) to $\gamma\bar{b}_i - c_i > 0$. Since $s = 0$ is never observed, we assume below that the hierarchy is either in a $s = 1$ regime or in an interior solution, and therefore $p(b_H - b_L)_i$ should only increase the quota in the low productivity intersections. Columns (6) through (8) implement specification 2.

An increase in one dollar of net marginal benefit of allocating the car to the police station increases the quota in .5 cars on average. In contrast, the average per car formal fine revenue has no effect on equilibrium quota. Consistent with proposition 1, part b), columns (4) and (5) show that higher variance of harassment bribes increases the quota only among intersections where the intersection is relatively more effective at extracting bribes.[41]

These results suggest that quotas are chosen in a manner consistent with profit maximization of commanders. They also suggest a potential mis-allocation of detainment effort. Indeed, escorting the drivers who commit the most socially costly violations of the law would produce the largest marginal social benefit on safety, through equilibrium incentives to comply with the legislation—assuming the legislation has the correct prices. However, the results in this table suggest that drivers are arrested/escorted as a function of how much revenue they generate in bribes (ability to pay). This result mirrors in the hierarchical setting the finding of Bertrand, Djankov, Hanna, and Mullainathan (2008).

[41] Table E.4 in the online appendix validates that quotas are a meaningful instrument of the commander. Panel A, columns (1)-(5) regress the total number of cars escorted to the police station (column 1), the total number of cars that end up paying a bribe at the police station (column 2), the total number of cars that end up paying a fine in the police station (column 3), as well as the police station revenue from bribes (column 4) and from fines (column 5) on the observed quota. Columns (6) and (7) regress the police station revenues from bribes and fines on the observed number of cars escorted. All regressions include day fixed effects and cluster the standard errors at the level of the intersection, estimated through Wild-Bootstrap, to account for across day within intersection correlation. Panel B replicates Panel A, but instruments the observed quota level and the number of cars escorted with the experimental quota reduction. This allows to exploit within intersection but causally identified variation in quota levels and number of cars escorted. Regressions in Panel B include intersection and day fixed effects and use the vector of experimental treatments as instruments. A one car increase in the level of the quota is associated with a .7 increase in the number of cars escorted to the police station, most of which (.6) are for the generation of police bribe revenue at the police station. Police station revenue from bribes is also disproportionately increased by the quota: a one car increase in the quota increases the revenue from bribes at the police station by 14 USD in contrast to 3 USD for the revenue from fines. The relationship holds when instead regressing police station revenues on the actual number of cars escorted. Panel B, which draws only on within-intersection variation but that is causally identified, confirms the effectiveness of the quota as a supervisor tool.

# 7 Experimenting with the corrupt hierarchy

## 7.1 Intervention and assignment to treatment

*Income treatment.* In some days of the study, street-level police agents received an amount in cash that was equivalent to seven times their daily equivalent of the formal wage, and similar in magnitude to what they expected to generate that day collecting bribes.[42] We randomly assigned the days in which each intersection-level team of 4 agents received the income treatment, blocking by team and using the team/days units as clusters of randomization, so that each team received the income treatment an equal number of times.[43] While the modal delivery hour is 11am, the majority of intersection/days were given the income surplus after 11am.[44] However, because of the logistical challenges of distributing cash across the city, and due to the resistance of commanders, most income treatments were delivered after the end of the morning. For that reason, we separate morning and afternoon effects in the analysis, and expect to find no effect in the morning.[45]

The income treatment was introduced by the battalion hierarchy in a meeting where the battalion colonel invited all street-level police agents in the presence of our contacts to introduce the intervention. Because the colonel feared that framing the income intervention as coming from an external team would lead him to lose power over his staff, he introduced the income intervention as part of the police reforms that were ongoing in the city during that time. The research team did not intend this to be the case, but befitted from the fact that the income was perceived as not attached to any conditionality nor expectations of behavior.

*Quota reduction treatment.* In each police station, we instructed commanders, every day, to halve the quota of randomly selected intersections among their own. To make this incentive compatible, and since commanders typically derive substantial benefits from the quota system, we

[42]The level of the income treatment was computed based on prior estimation of the daily revenues from bribe-taking made at each intersection for each street-level police agent.

[43]Based on the randomization procedure, we consolidated an "income calendar," which specified, for each day, which teams received an income treatment. The randomization calendar was kept by the researchers, and no individual of the research team was informed of the allocation in advance. Every morning, the PI's communicated the assignment to treatment for that day to the "scientific coordinator." Then, the scientific coordinator delivered the instructions and the cash in hand to an "income delivery team."

[44]Figure D.12 presents the hours at which the income treatment was delivered. Section A.2 in the online appendix describes the strategies we deployed to ensure validity of the intervention.

[45]The following supervisor recounts in one of our project meetings the resistance of commanders: "They [the commanders] were responsible. The palm trees [street-level police agents] received the income around 12pm or after. They [the commanders] did not want them to get the income as soon as possible contrary to our will, since this would be a way to ask them to go home."

had to compensate commanders in an amount equivalent to the corruption losses that we created through the quota reduction. To estimate the loss of monetary revenue to commanders induced by our quota reduction, prior to the study, we implemented in depth qualitative work in each station using our local observers to derive an estimate, per police station, for the average revenue made by a commander per day. Then, after being asked to collaborate, commanders were informed of the selected intersections in the evening before, giving them sufficient time to communicate this to the street-level police agent at the intersection. By the start of each day in which a commander had been selected to reduce the quota in one or more intersections, the JPO's supervisors delivered the funds to the commander, which an auditor (from different networks) then verified. Randomization of the quota treatment was made within intersection*income treatment blocks (factorial design).[46] Ethnographic evidence from our study suggests that the first stage was strong. An observer of the study noted: "[The quota reduction] has a huge impact on the ground. When you reduce the quota, it totally reduces the revenues of police stations." The impact was so large that, in one intersection, our operations coordinator recounted: "The commander at intersection X: he goes down to the intersection himself to circumvent the quota reduction. Only at intersection X. That way he arrests cars himself and gets more money."

*Randomization balance*: Randomization was blocked within intersection/police team so that each police team is assigned to the same number of days in treatment and control. Thus any constant characteristic of police teams was balanced by construction.[47] Table III reports the results of a balance test for variables that may vary within intersection/team across treatment status (day of the week, month, day of the month, day rank in study, and treatment status lags). The characteristics summarized in Table III appear fairly well-balanced across the groups. There are, however, some systematic imbalances: by chance, quota and income treatments are less likely to fall on Fridays, and assignment to the income treatment is less likely if it was assigned two days earlier to the same team. Excluding the first leaves the results unaffected. We directly control for those in the analysis, by including calendar date fixed effects, the first and second treatment lags, and randomization block fixed effects.

[46]Figure D.11 presents dynamically the allocation of both treatments over time.

[47]The logistics of delivering cash and reducing the quota led us to slightly deviate from the calendar in some days/intersections. We use the actual assignment but first show that allocation is fairly balanced.

## 7.2 Econometric specification

We implement the following specification:

$$y_{it} = \alpha + \beta_I \, T_{it}^{income} + \beta_Q \, T_{it}^{quota} + \eta_i + \eta_t + e_{it} \tag{2}$$

where $y_{oit}$ is the outcome of street-level police agents' team in intersection $i$ observed on day $t$, $T_{it}^{income} \in \{0, 1\}$ is the actual income surplus treatment dummy, $T_{it}^{quota} \in \{0, 1\}$ is the actual quota reduction treatment dummy. The term $\eta_i$ indicates intersection fixed effects (the randomization blocks). Both treatment indicators are invariant across street-level police agents within intersection $i$ day $t$. Standard errors can be under-estimated if within intersection/team*day correlation is not taken into account through appropriate clustering of standard errors. In all regressions, we thus present the data collapsed at the team-level $i$ * day $t$ outcomes (aggregating over street-level police agent in the team that day) to eliminate concerns arising from within team-level $i$ *day $t$ correlation. Treatment is assigned at the team-level $i$ * day $t$ level within team-level $i$ randomization blocks, and thus once the data have been appropriately averaged at the team-level $i$ * day $t$ level no clustering of standard errors is necessary. However, to demonstrate that results are not driven by across-day within-team spillovers, we also present the results with leads and lags as robustness. For intersection-level data and street-level police agent behavior, we use the street observers data.[48] Finally, we exploit within-day variation in the timing of the income treatment:

$$y_{ith} = \alpha + \beta \, T_{it}^{income} \times POST_{hit} + \omega \, T_{it}^{quota} + \eta_h + \eta_t + e_{ith} \tag{3}$$

where $h$ indicates the clock hour in the day, $POST_{hit} \in \{0, 1\}$ indicates whether the team has received the wage intervention by hour $h$ and $\eta_t$ indicates day $t$ fixed effects. The coefficient $\beta$ estimates the difference in behavior of street-level police agents before and after the wage delivery. In all regressions that use the hourly specification, we cluster the standard errors at the intersection $i$ and day $t$ to account for correlation across hours within a day for an intersection/team.

[48] This is the only source in real time and where we invested most supervision efforts. We also present, as robustness, regressions using the data from mini-bus observers linked to the intersections $i$ and days $t$ of the study for the variables which are available from that source.

## 7.3 Experimental results

### 7.3.1 Productive decentralized corruption

Figure 5, Panels A and B, shows the results graphically. Table V reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Each column gives the results of the OLS regression of the dependent variable listed in that column on dummy variables indicating the income and quota treatment status. Column (1) uses the amount in USD consumed by each police team/intersection $i$ at day $t$ in beer purchases, columns (2) through (4) decompose the number of observed bribes into respectively harassment bribes, toll fees, and tips. Columns (5) through (8) present the results on productive effort and output: column (5) shows the rates of presence of the police team, column (6) shows the occurrence of harassment events, column (7) shows the occurrence of traffic jams, column (8) shows the occurrence of accidents. Harassment events include negotiations for escorting a driver to the police station (successful), negotiations for escorting a driver to the police station (unsuccessful), and negotiations that end in a harassment bribe. We measure unsuccessful negotiations by exploiting the reported conversations by the observers. We inspect each conversation and note, for each interaction, and code as harassment those where the observer indicated that it was a negotiation and that it was tense. Panels A, B and C respectively present the results for the day, the morning, and the afternoon (beer consumption is only available at the day level). Panel A, in addition, displays the mean of the dependent variable and the estimated effect from a complete elimination of the quota, derived from the estimated coefficient and the baseline quotas.

Column (1) confirms that street-level police agents do not smooth consumption perfectly, and thus the income shock is likely to induce a change in the marginal utility of effort. An income intervention of 100 additional USD to the team of street-level police agents increases beer consumption for each street-level police agent by 3.65 USD, a 70% increase. Column (2) shows the associated effect on effort to collect harassment bribes. As expected, institutionalized bribes do not change (columns 3 and 4). The results thus suggest, in line with Proposition 3, that in contrast to harassment bribes, toll fees and tips reflect existing agreements orthogonal to daily changes in effort. However, street-level police agents reduce harassment bribes.[49]

[49]Table E.6 in the online appendix uses data from a separate source, the minibus observers, to validate this result (although observers in minibuses are much less frequently at the corresponding intersection). Figure D.13, Panels A and B in the online appendix examines the effect exploiting non-experimental variation in the timing

Columns (5)-(8) (and Figure 5, Panel B) establish that bribe revenue by street-level police agents finances productive public service. As a result of receiving higher income, street-level police agents are more absent (column 5), and traffic jams increase in the afternoon (column 7). For each 100 USD transferred to the police team, traffic jams in the afternoon decrease from their baseline frequency of 45% to 56%. Consistent with the fact that more than 50% of income treatment interventions are given after 11am, the effects of the income treatment on absenteeism and traffic jams are concentrated in the afternoon. Harassment bribes, however, tend to occur in the morning, and the adjustment comes from the morning. Since the total revenues from tips are unaffected, and in line with the qualitative evidence of the project, the results are consistent with the view that police agent absenteeism creates traffic jams. By dis-incentivizing police agents' attendance, our intervention thus established two facts: a. police agents are (in part) present at the intersections because they derive corruption benefit from it b. their presence reduces traffic congestion.

The ethnographic data we gathered during the study strongly supports our findings.[50] One of the project observers of street-level police agents recounted:

> "When they get a lot of money they go get a beer and eat. One of them took 7 beers after the cash withdrawal, then got drunk and could not work the day after. Commanders sometimes prefer us to pay in the evening because of that."

The incentive problem generated by the higher income was so severe that commanders attempted to prevent morning payments, but they also developed new rules for their street-level police agents:

> "The commander of intersection X was upset that his staff was drunk and not doing their work as a result of the intervention. He proposed the following solution: you can pay in the morning, but I tell my staff that if they take the break too long, or if they come back too drunk from it, I take their jacket away."

To confirm this quantitative and ethnographic evidence, at the end of the study, we implemented a survey of street-level police agents. Surveyors asked them how the income treatment changed

of the income delivery within the day. To construct this figure, we use process tracking supervision documents which the income team had to complete, indicating the time of delivery for each intersection. The effects are generally concentrated after the income isColumnsssselivered, with the exception of harassment bribes, for which there appears to be some anticipation.

[50] One supervisor of street-level police agents observers recounts: "In my experience, in these three intersections, as soon as they get the cash they go out to eat and drink. At least 6-7 beers per person."

their behavior. The large majority of respondents indicate that they worked less, drunk more, and harassed drivers less. The responses are summarized by the following examples:

> "Personally I felt very well when I received your money, I did not have many worries and so I was not forced to ask money on the back of drivers" "It did so well to us, we felt in security, and we begun finding something to eat in the evening. We were not much at the intersection and we only arrested drivers if they did very bad infractions." "I was not seeking money from drivers anymore because I already had my own."

### 7.3.2 Quantifying the intervening role of the hierarchy

These effects, however, are mediated by hierarchical corruption. As described in Section 2, the commanders did not regularly ask for financial transfers during the period of our study. However, as soon as commanders had knowledge that the street-level police agents made unusually large revenue from a tip, or from the income surplus, they systematically taxed a share of it. Indeed, as a share of the income that we gave to street-level police agents during this study, police station commanders are able to "tax" 29% of the income supplement given to police agents by the end of the day.[51] This likely reduces the effectiveness of higher income at reducing corruption. To quantify the importance of hierarchical corruption, Table VI, replicates Table V but uses the income treatment as instrument for *disposable* extra income of the street-level police agents at the intersections (the amount they are able to keep from the income treatment, after making a vertical transfer to their commander), and for observed quota level. The 2SLS coefficient presented in the table is the effect of keeping 100 extra USD for a police team, and of being subject to one extra car in the quota.[52] Compared to the ITT coefficients, the IV coefficients for beer consumption, attendance, and harassment bribes are respectively 2.2, 2, and 2.3 times larger. This suggests that endogenous commander taxation decreases the marginal propensity to consume additional income by 45% and cuts in half the effectiveness of income shocks.

Overall, the results show that, examining the effect of transitory shocks, hierarchical corruption cuts in half the effectiveness of higher income of a street-level police agent at reducing corruption. Furthermore, they indicate that the largest share of corrupt revenues, which arises from toll fees

[51] See Figure D.14 in the online appendix.

[52] The first stage yields an F statistic for the endogenous variables "income retained" and "quota level" respectively of 50 and 51 with p-values of 0.00.

and tips, is institutionalized, in the sense that it is independent of the effort of police agents in any given day—and likely reflects reputation and the value of relationships. However, by disincentivizing effort to collect bribes, higher transitory income generated absenteeism.

### 7.3.3 The cost of collusion with supervisors

In this section, we test for Proposition 5 using the experimental manipulation of the quota.

Proposition 5 showed that if quotas create more congestion and more harassment and do not have a strong effect on police agents' effort on corruption, then the overall effect of hierarchical corruption on social welfare was negative, through the fact that commanders do not internalize the cost of quotas for society. As long as arrests are arbitrary, which, as we argue in Section 3.2, is the case here, this result is unambiguous.

Figure 6 present the experimental results on public service outcomes from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Consistent with Table IV result that the quota reduction intervention significantly decreased actual quotas, Figure 6, and Table V show that reducing the quotas reduces the number of cars observed at the police station (especially in the afternoon, since the quotas are not fully eliminated by our intervention). Reducing the quotas decreases the occurrences of harassment of drivers, mostly linked to attempts to escort cars. Finally, as a result of decreasing the quotas, the occurrence of traffic jams in the day decreases by 3% per car, but an elimination of the quota would reduce traffic jams from 50% to 35%, a 30% reduction in the frequency of traffic jams. Our study ethnographic evidence supports this finding:

> In police station [...], the JPO say that our intervention is having a huge effect. The OPJ says that commanders now say to only detain cars when they really committed a bad violation."

This result suggests that a large share of traffic jams is in fact attributable to the existence of vertically organized corruption. It resonates with Akbar, Couture, Duranton, and Storeygard (2018), who find that the variation in congestion must be explained by the properties of the location, rather than the time. Table VI uses the income and quota treatments as instruments for actual quota level. The IV results provide even additional evidence to support the ITT results.[53]

[53]As before, we examine the minibus observers' data that we linked to the study intersections for each day. Table E.7 replicates Table V using such data. Consistent with the estimates using real time observers' data, the

Combined with the testable implication of Proposition 5, these results show that the quota system creates traffic congestion and increases harassment, while it does not affect the effort of police agents at extracting bribes, suggesting that the quota system reduces total social welfare. This inefficiency can arise for two reasons—both of which emerge from contracting failures.

A possible explanation is that the failure to internalize the social cost of quotas arises because commanders do not internalize the effect of the quota on drivers' welfare through congestion and harassment. A second, alternative, explanation is that payments in private provision of the public good can be inefficiently low due to free-rider problems among drivers. This problem is likely reduced for drivers engaged in repeated interactions with the street-level police agents (those who pay the toll fee). The problem is likely more serious, however, for drivers who are infrequently at particular intersection. In that case, the effect on congestion would not be internalized because the drivers-policeman interactions are not sufficiently organized.

# 8 Conclusion

Limited by access to data on hierarchical corruption, economists typically view corruption as explained by incentives of state officials, who independently interact in markets for corruption. This omits that corruption is typically organized, which matters for efficiency, but also interacts with policy. We find that, through an institutionalized system of toll fees, corruption incentivizes harassment of drivers, but it also finances street-level police agents productive effort to reduce traffic congestion. Furthermore, the supervisors set vertical corruption contracts in kind and cash optimally to maximize their private revenue, at the cost of total corruption revenue, and at the cost of society, above and beyond the costs induced by typical petty corruption. Through an informal monetary tax, the supervisor is able to extract a significant share of the agent's additional income, dampening the effect of changes to the agent's income, and through an in-kind quota

results of Table E.7 show that reducing the quotas decreases harassment and traffic jams (although the results are weaker). In addition, columns (10)-(12) use the number of times that the driver chose to pass by the corresponding intersection in a given day. Observers in minibuses had a pre-determined line path prompted by the survey application in the smartphone, and for each intersection at which they were supposed to pass, indicate whether the driver passed by the intersection or instead took a detour. While these are only suggestive results, and we do not model the behavior of drivers, they suggest that reducing the quota endogenously increases drivers' willingness to drive through the intersection. This result is consistent with the interpretation that quotas increase congestion and risk of arrest, and some drivers decide to avoid the intersection. The coefficients in Panel B, in which the quota level is instrumented with the treatments, are stronger in economic and statistical significance (but the effects on the decision to drive-through are insignificant).

system, supervisor-agent interaction has a negative externality on social welfare.

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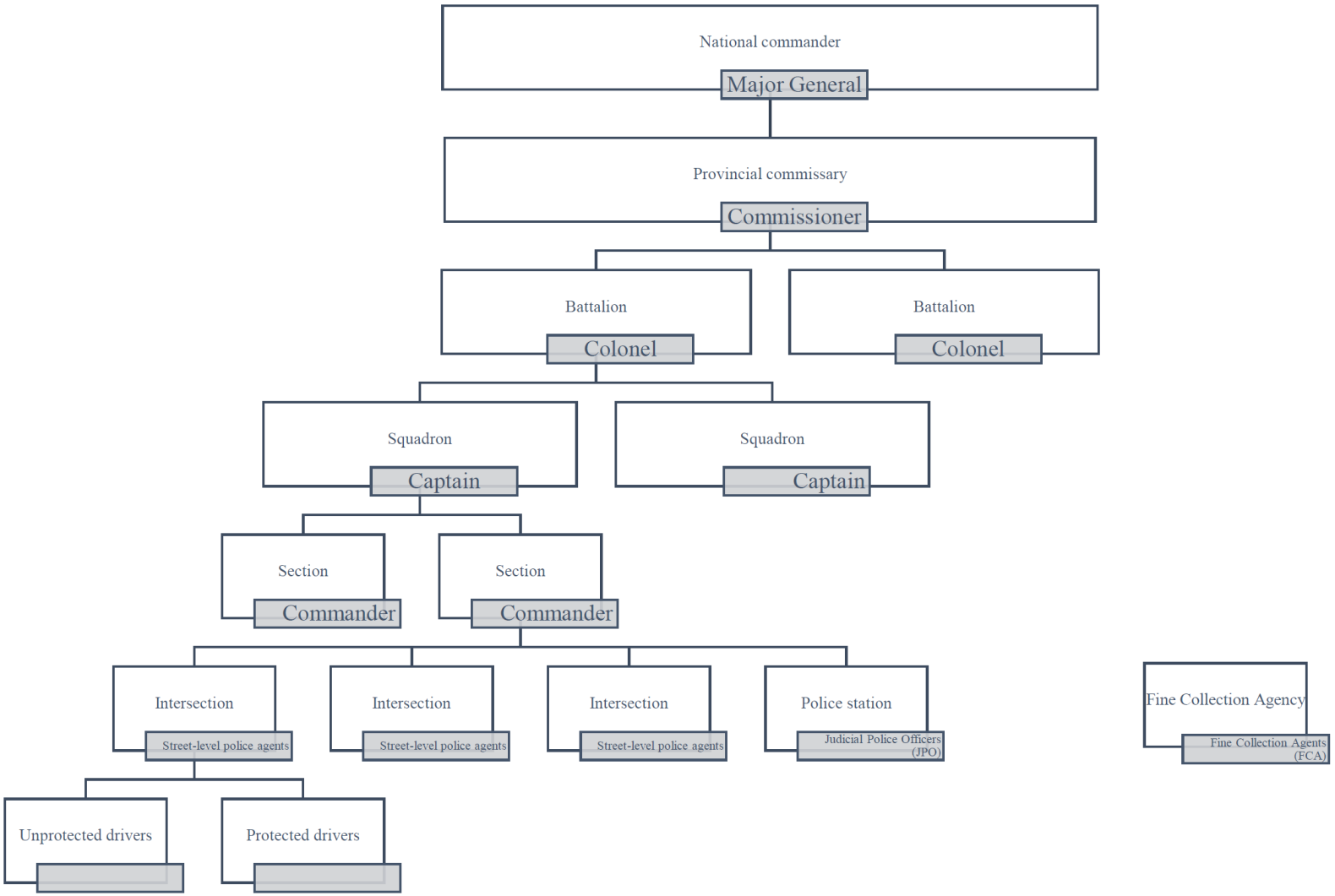
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Figure 1: Organizational structure



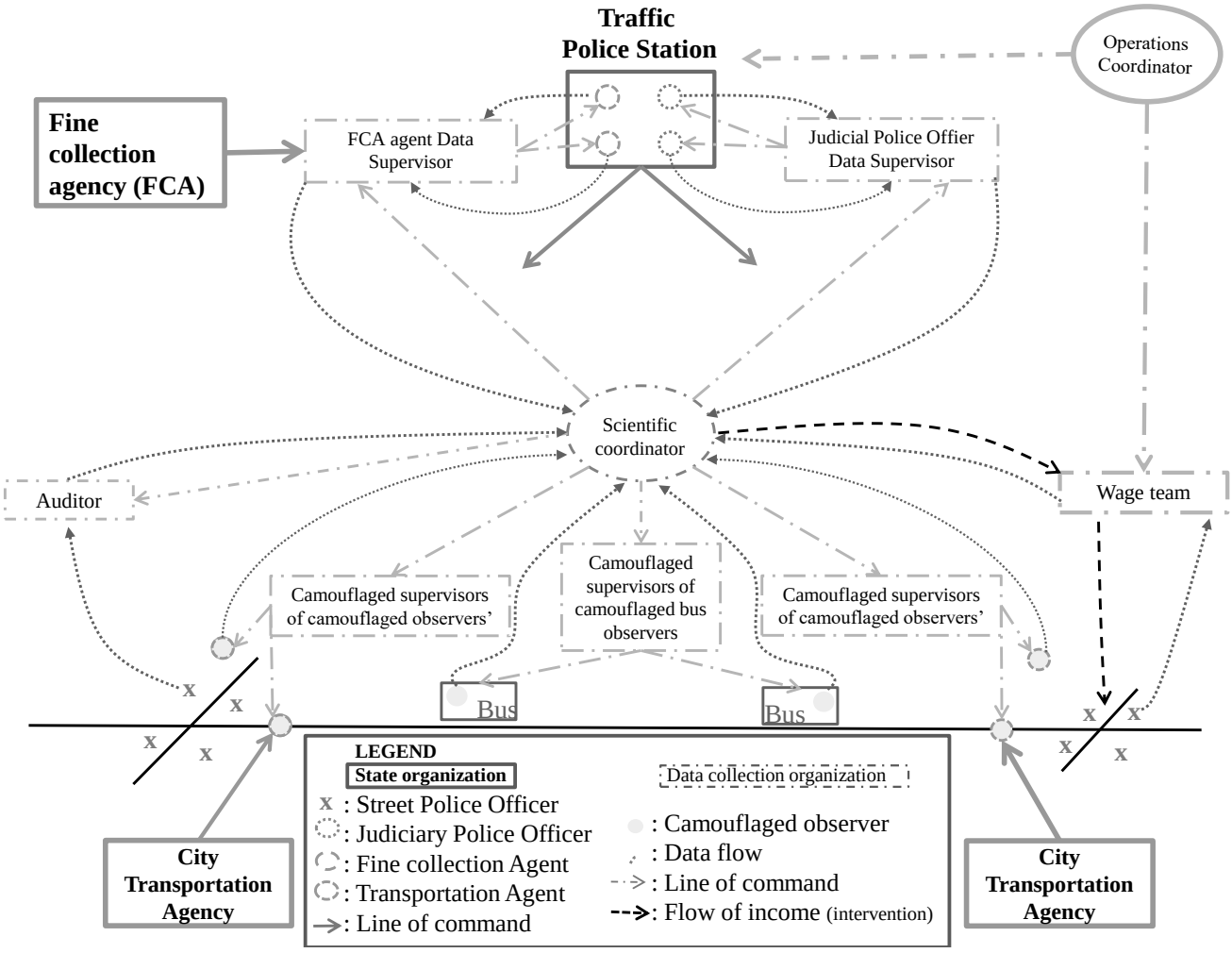

*Notes*: This figure presents the organizational structure of the traffic police agency in the study.

Figure 2: Sample intersections




*Notes*: This figure presents the sample of intersections that are part of the study. We conduct the study in one of the two battalions of the city. The battalion accounts for half of the traffic police force in the city: 60 police street-level police agents, dispatched into 17 strategic locations. These locations are intersections with the major traffic flows, where police agents are charged with managing traffic flows and identifying drivers in potential violation of the law and escort them to their corresponding police station.

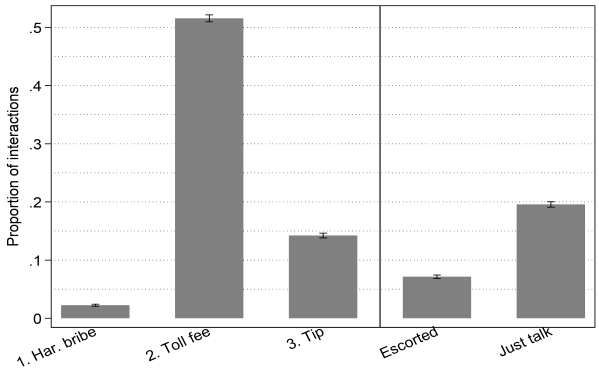
Figure 3: Data collection system



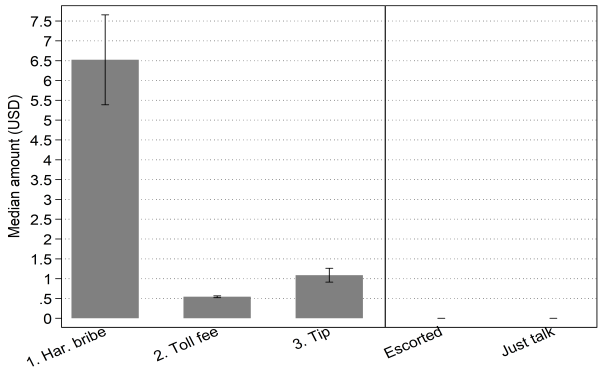

*Notes*: This figure presents the data collection system. **Overview.** 10 minibus observers traveled daily in each of 10 bus lines, each bus driving on average 15 times daily by at least 4 of our intersections; 30 street observers from the Transportation Agency, who tracked police agents' behavior and traffic properties from 7am to 5pm on smartphones, were dispatched daily to randomly selected intersections. Each of the two JPO's in each station collected data on the cars escorted to the station, the intersection in which they were taken, and the payments drivers made in the intersection. The FCA agents in the stations report the same data (the police was not informed of this activity). FCA agents were assigned a data collection supervisor working for the research team. The wage team and the auditor separately obtained information about the daily quotas and upstream transfers. **Operations**. The scientific coordinator met daily at 6am with the wage team, the operations coordinator, the FCA agents' supervisors and the JPOs' supervisors and at 7pm with intersection supervisors, minibus supervisor, the wage team and the auditor. For security reasons, both meetings took place at a secret location not communicated to any observer, FCA agent, or member of the police force. To prevent being tracked, the team used multiple sim cards. *Morning meeting.* The scientific coordinator instructed the wage team about which intersections were going to receive an income treatment on this day and paid the wage team to distribute to street-level police agent. The JPOs and FCA agents' supervisors shared the data they had received the day before from the police stations to the scientific coordinator. The scientific coordinator communicated the feedback to them about the data that he had received from them the previous day and that they were to communicate to the JPOs and FCA agents. All other actors handed over their daily data in the evening. The PI communicated every morning the quota reduction assignments for that day to the scientific coordinator was, who then communicated it to the supervisors of the JPO's. The PI's pointed out problems or mistakes in the data of the previous day and discussed operational challenges. At 7am the data collection activities began. *Activities.* First, the JPO's supervisors were dispatched to the police stations where a quota reduction had been assigned on this day and compensated the commander for the loss. This was done before the commander communicated (by phone) the level of the quota to the police agents. The JPO's and FCA agents' supervisors then visited all their assigned police stations to meet with the JPO' and FCA agents, provide feedback on the data collected the previous day, and gather the data. Supervisors would call the FCA agents (and different supervisors would call the JPO agents) to meet them outside of the station where no other actor was able to see them. The JPO's and FCA agents did their work according to their daily routine. To reduce suspicions, FCA agents and JPO's noted down on paper during the day what they were observing, copied this data into forms at night at home and then gave the data to their supervisors. The JPO's and FCA agents were also compensated for their work. Once a week, they received the equivalent of 5 USD per day of work. Second, the wage team went to the intersections selected to receive a income treatment. Third, the auditor visited all the stations and intersections, and verified that assistants and supervisors had distributed the funds. The auditor obtained from police agents the amount of the income treatment that was extracted by supervisors by the end of the day—by asking them directly. Fourth, each night, the street-level supervisors received the list of assignments of observers to intersections, which the supervisors shared with surveyors in the morning around 6 am prior to dispatching them. Fifth, the minibus supervisor met all the minibus surveyors. During that time, the scientific coordinator read the documents that he had received from all the supervisors and took notes about the quality of the data, in order to provide feedback back to the data collectors. *Evening meeting.* Supervisors of the JPO's, FCA agents, minibus observers, and street observers met the scientific coordinator in the office. The difficulties faced in the day were discussed. The wage team and the auditor handed in the data that had been collected by talking to the street-level police agents, and the street-level supervisors were informed of the allocation of the surveyors at the intersections the next day. Morning and evening meeting detailed notes were kept by the PI's as records of implementation.

Figure 4: Stylized facts: revenues from police agent bribe-taking

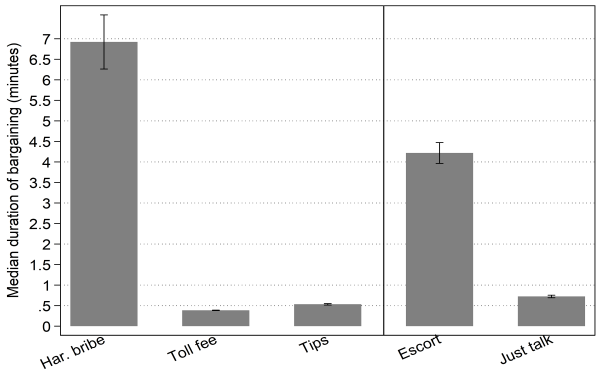
**PANEL A:** Bribes' frequency



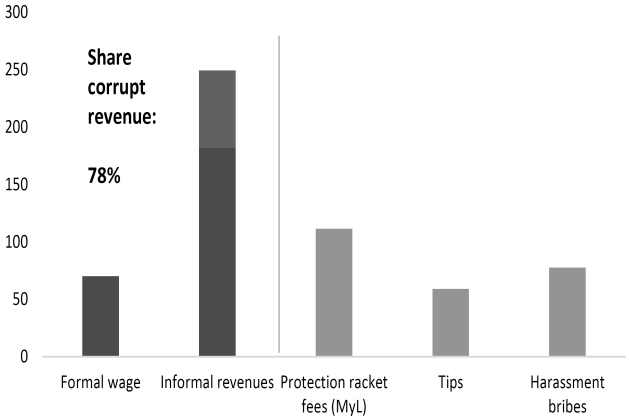

**PANEL B:** Bribes' amount



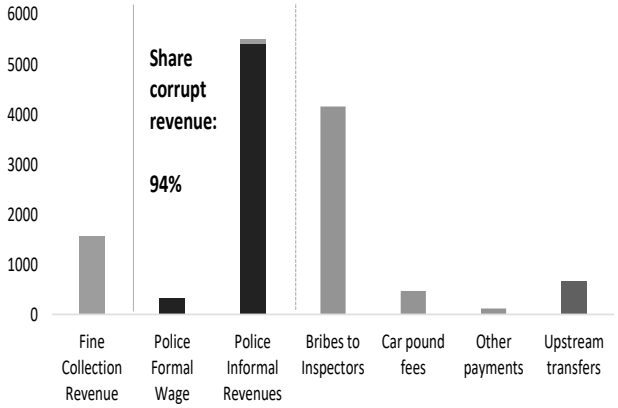

**PANEL C:** Bribes' negotiation length



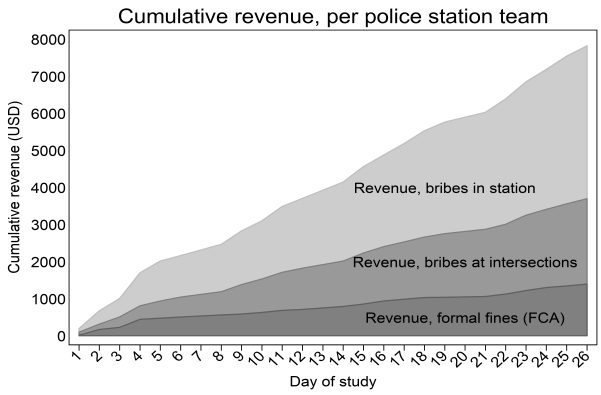

**PANEL D:** Monthly revenue, police agents




**PANEL E:** Monthly revenue, police station




**PANEL F:** Monthly revenue, hierarchy

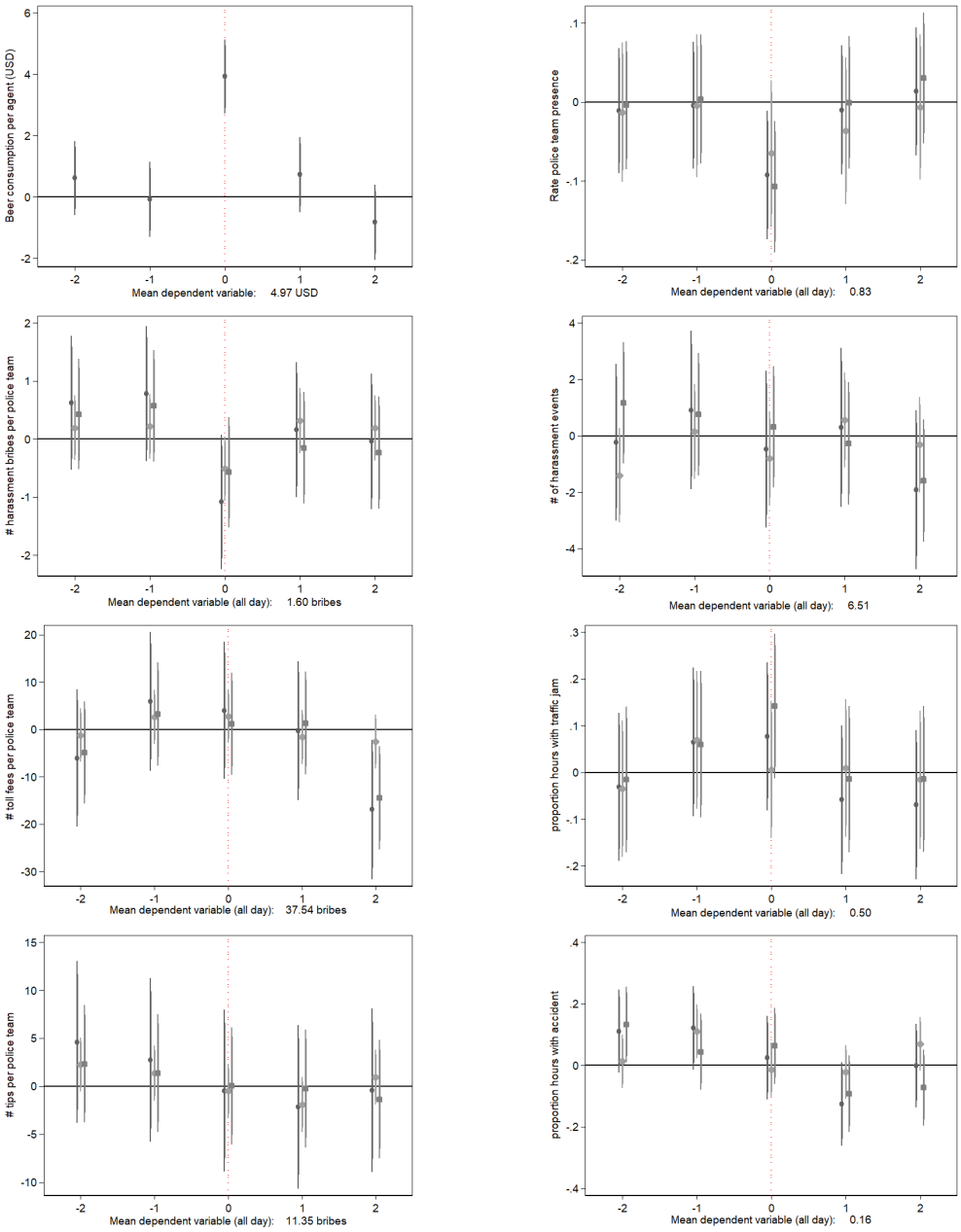



*Notes*: This figure describes the corrupt hierarchy in the data. Panel A shows the proportions of the different types of interactions between police agents and drivers in the data. There are 18,885 police-agent/driver interactions in the data, divided in five types: harassment bribe, toll fee, tip, escorting to the police station, and conversation only. If conversation only, observers reported the entire content of the conversation and the tone of it, which we use to code whether a harassment took place (interdependently of whether it translated into a bribe). Panel B shows the amount paid in USD for each interaction type. Panel C shows the time of negotiation in minutes for each type of interaction. Panels D through F present the monthly aggregates. Panel D shows the monthly revenue for a typical police station, arising from three sources: a. the revenue in formal fines issued by FCA agents inside the police station, b. the revenue from street bribes collected by police agents assigned to this police station that are in the intersections c. the revenue from bribes paid to JPOs inside the police stations. Panel E shows the estimated monthly revenue for a typical police agent, in terms of formal revenues (formal wage) and informal revenues (bribes). The informal revenues are disaggregated into total revenues from harassment bribes, toll fees, and tips. Finally, Panel F shows the estimated monthly revenue for a typical police station. The first bar indicates the revenue generated by the FCA agents in formal fines, the second and third bars indicate the two sources of revenues for the police staff in police stations (two JPOs and one commander) in formal wage and in informal revenues. Informal revenues are then disaggregated into bribes paid to inspectors, informal car pound fees, other payments, and transfers from the street-level police agents.

Figure 5: Income treatment effect

**Panel A:** Consumption and corruption effort

**Panel B:** Productive effort

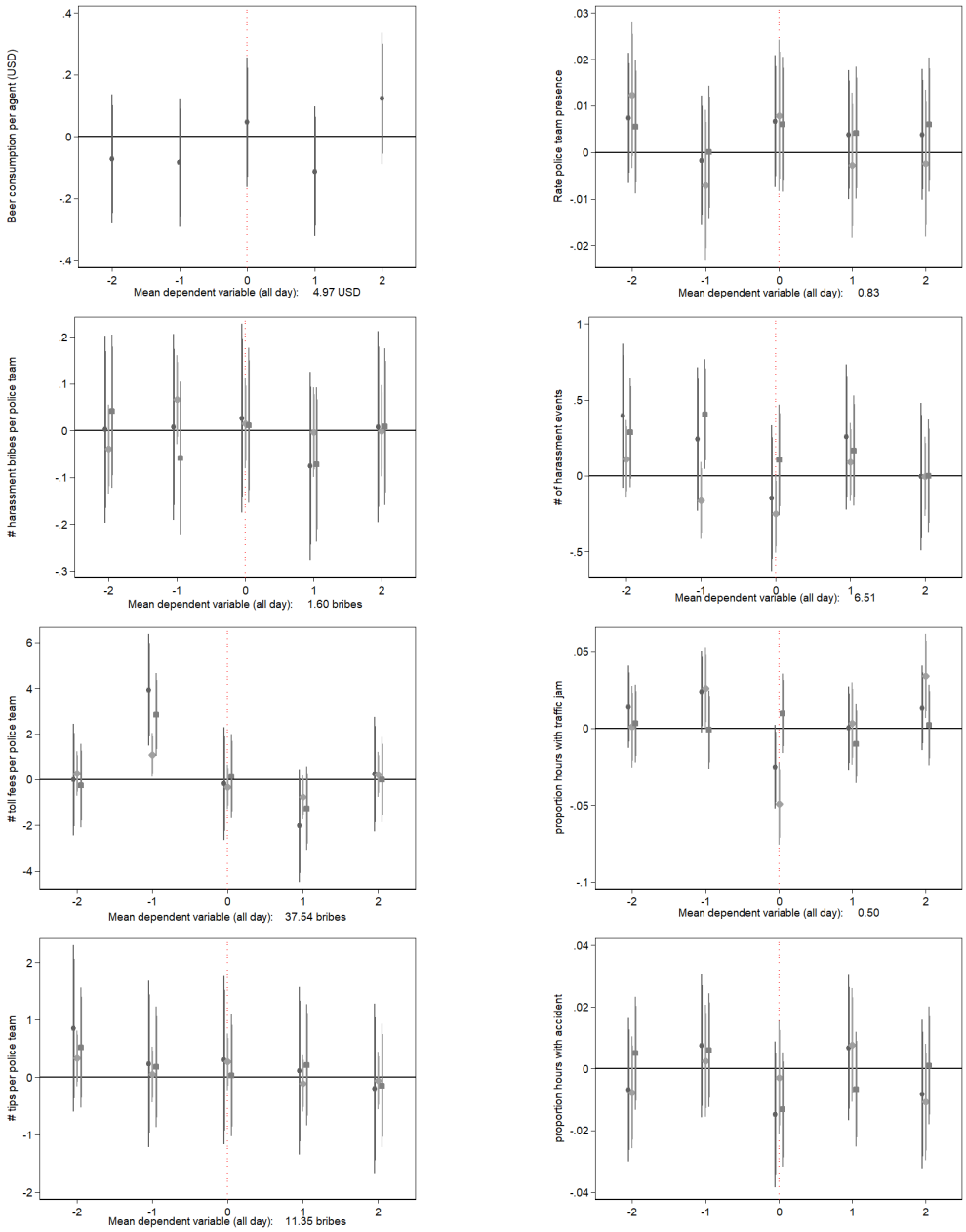



*Notes*: This figure reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Each panel gives the results of the OLS regression of the dependent variable listed in the panel title on dummy variables indicating the contemporaneous, lagged, and lead income treatment status (the quota treatment is omitted and available upon request, since it is not significant). All regressions include, in addition, intersection/team of street-level police agent fixed effects, day fixed effects as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. The dependent variables are as follows.

Figure 6: Quota treatment effect

**Panel A:** Consumption and corruption effort

**Panel B:** Productive effort




*Notes*: This figure reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Each panel gives the results of the OLS regression of the dependent variable listed in the panel title on dummy variables indicating the contemporaneous, lagged, and lead income treatment status (the quota treatment is omitted and available upon request, since it is not significant). All regressions include, in addition, intersection/team of street-level police agent fixed effects, day fixed effects as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. The dependent variables are as follows.

Table I: Summary statistics of the battalion staff

| | Mean outcomes | | | Difference |
|---|---|---|---|---|
| | Traffic police | | | |
| | Street agents | Commander | JPO's | Commander-Street agents |
| | (1) | (2) | (3) | (4) |
| *Panel A: Police agents* | | | | |
| Age | 41.25 | 39.86 | 45.11 | -1.40 |
| | (5.60) | (28.94) | (7.00) | (4.13) |
| Is female | 0.24 | 0.14 | 0.20 | -0.09 |
| | (0.43) | (0.38) | (0.41) | (0.17) |
| Highest education level is primary education | 0.38 | . | 0.56 | 0.00 |
| | (0.49) | (.) | (0.51) | (0.00) |
| Highest education level is secondary education | 0.63 | . | 0.31 | 0.00 |
| | (0.49) | (.) | (0.48) | (0.00) |
| Is married | 0.85 | 0.86 | 0.86 | 0.01 |
| | (0.36) | (0.38) | (0.35) | (0.15) |
| Number of children | 4.90 | 8.29 | 5.55 | 3.39*** |
| | (1.78) | (3.99) | (1.85) | (0.83) |
| Speaks language of the capital | 0.66 | 1.00 | 1.00 | 0.34* |
| | (0.48) | (0.00) | (0.00) | (0.18) |
| Speaks regional language of the south | 0.20 | 0.29 | 0.41 | 0.08 |
| | (0.40) | (0.49) | (0.50) | (0.16) |
| Speaks regional language of the east | 0.24 | 0.86 | 0.50 | 0.62*** |
| | (0.43) | (0.38) | (0.51) | (0.17) |
| *Panel B: Job properties* | | | | |
| Formal recruitment process | 0.87 | 0.14 | 1.00 | -0.73*** |
| | (0.33) | (0.38) | (0.00) | (0.13) |
| Appointed by protector | 0.13 | 0.86 | 0.00 | 0.73*** |
| | (0.33) | (0.38) | (0.00) | (0.13) |
| Works in the traffic police since (number of years) | 10.12 | 2.07 | 8.98 | -8.05*** |
| | (5.18) | (1.46) | (5.46) | (1.98) |
| Formal wage in 2015 | 70.00 | 100.00 | 105.58 | 30.00 |
| | (0.00) | (0.00) | (5.89) | (0.00) |
| Delay since last wage (number of days) | 98.06 | 110.00 | 98.84 | 11.94 |
| | (21.69) | (3.65) | (15.16) | (8.27) |
| Daily informal revenue (USD) | 17.69 | . | 15.09 | 0.00 |
| | (4.13) | (.) | (5.05) | (0.00) |
| Daily savings | 2.69 | . | 2.21 | 0.00 |
| | (2.16) | (.) | (1.89) | (0.00) |
| Days can survive with current savings | 13.34 | . | 17.00 | 0.00 |
| | (20.06) | (.) | (30.98) | (0.00) |
| Obs | 79 | 7 | 44 | . |

*Notes*: This table presents summary statistics of the police agents' population in the sample. The data source for this table are two exit surveys. The exit surveys were implemented in private at the end of the study and 2 year after the study, by individuals that took part of the study and developed a relationship of trust with the police agents. Panel A shows properties of the police agents themselves, and Panel B of the job they hold. The answers are separated across street staff (column 1) and office staff (column 2). Column (3) shows the differences in means between street staff and police staff and reports the standard errors in parentheses from an OLS regression of the outcome on a dummy indicating the type of police agent. $*$ indicates the difference is statistically significant at the 10% level, $**$ at the 5% level, and $***$ at the 1% level.

Table II: Stylized facts of corruption in the hierarchy

| | Mean outcomes |
|---|---|
| | (1) |
| *Panel A: Daily corruption revenue per intersection police team - 4 police agents* | |
| Harassment bribe, count | 1.60 |
| | (3.16) |
| Toll fee, count | 37.54 |
| | (48.71) |
| Tip, count | 11.35 |
| | (20.62) |
| Daily harassment bribe revenue, USD | 7.04 |
| | (22.46) |
| Daily tip revenue, USD | 12.36 |
| | (21.77) |
| Daily toll revenue, USD | 21.95 |
| | (27.60) |
| Total revenue from bribes paid to street police agents, USD | 47.09 |
| | (56.83) |
| Beer consumption, USD | 16.52 |
| | (8.94) |
| Share police staff present | 0.83 |
| | (0.32) |
| A traffic jam took place am | 0.26 |
| | (0.44) |
| A traffic jam took place pm | 0.45 |
| | (0.50) |
| *Panel B: Vertical corruption properties per intersection police team - 4 police agents* | |
| Share income surplus kept by commander | 0.30 |
| | (0.37) |
| Quota level (number of drivers per day) | 5.40 |
| | (3.68) |
| Number of drivers from the intersection agents escort to the police station | 5.02 |
| | (6.21) |
| Of those, number who settle at the station by paying to the commander | 2.86 |
| | (3.95) |
| Average level of police station bribe, to commander | 11.58 |
| | (5.80) |
| Of those, number who settle at the station by paying the formal fine issued by F | 1.12 |
| | (2.34) |
| Average level of police station fine, issued by FCA agents | 6.30 |
| | (4.82) |
| Total revenue from bribes to commander at police station | 71.63 |
| | (103.65) |
| Total fiscal revenue from fines issued by FCA agents at police station | 25.05 |
| | (54.17) |
| Difference between harassment bribe at station and harassment bribe at intersect | 4.09 |
| | (8.56) |
| Time lost escorting a driver, in minutes | 41.93 |
| | (41.88) |
| Revenue per minute, police agent at intersection | 0.04 |
| | (0.04) |
| Estimated opportunity cost of escorting one driver to the corresponding police s | 1.44 |
| | (1.49) |
| Corresponding opportunity cost of the quota of drivers at its equilibrium level | 9.85 |
| | (9.44) |
| Obs | 527 |

*Notes*: This table presents the stylized facts of the corrupt hierarchy. Panel A presents the daily corruption revenue sources for a typical intersection police team, on average. A typical team is composed of 4 police street-level police agents. Panel B presents the properties of the vertical corruption contracts and of the corrupt hierarchy. Data of Panel A is gathered from the street observers, and data of Panel B is gathered from the police station observers.

Table III: Randomization balance

| | Mean outcomes | | | | Difference | |
|---|---|---|---|---|---|---|
| | Baseline | | Treatments | | | |
| | Full sample | Pure control | Income | Quota | Income-Pure control | Quota-Pure control |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Monday | 0.20 | 0.19 | 0.19 | 0.22 | 0.00 | 0.03 |
| | (0.40) | (0.39) | (0.40) | (0.41) | (0.05) | (0.05) |
| Tuesday | 0.12 | 0.14 | 0.12 | 0.11 | -0.02 | -0.03 |
| | (0.33) | (0.34) | (0.33) | (0.32) | (0.04) | (0.04) |
| Wednesday | 0.16 | 0.13 | 0.17 | 0.18 | 0.05 | 0.05 |
| | (0.37) | (0.33) | (0.38) | (0.38) | (0.05) | (0.05) |
| Thursday | 0.16 | 0.14 | 0.15 | 0.19 | 0.01 | 0.05 |
| | (0.36) | (0.34) | (0.36) | (0.39) | (0.05) | (0.05) |
| Friday | 0.16 | 0.25 | 0.14 | 0.10 | -0.11** | -0.15*** |
| | (0.37) | (0.43) | (0.35) | (0.30) | (0.05) | (0.05) |
| Saturday | 0.20 | 0.16 | 0.22 | 0.20 | 0.06 | 0.04 |
| | (0.40) | (0.37) | (0.42) | (0.40) | (0.05) | (0.05) |
| June | 0.34 | 0.36 | 0.31 | 0.31 | -0.05 | -0.07 |
| | (0.47) | (0.48) | (0.46) | (0.47) | (0.06) | (0.06) |
| July | 0.66 | 0.64 | 0.69 | 0.69 | 0.05 | 0.07 |
| | (0.47) | (0.48) | (0.46) | (0.47) | (0.06) | (0.06) |
| Date | 13.51 | 13.93 | 12.81 | 13.09 | -1.20 | -1.14 |
| | (7.60) | (7.65) | (7.75) | (7.63) | (0.99) | (0.94) |
| Day of Market | 0.36 | 0.41 | 0.36 | 0.30 | -0.05 | -0.10* |
| | (0.48) | (0.49) | (0.48) | (0.46) | (0.06) | (0.06) |
| Agents present, first visit | 4.14 | 4.09 | 4.19 | 4.14 | -0.00 | 0.00 |
| | (0.51) | (0.42) | (0.59) | (0.51) | (0.00) | (0.00) |
| Rank of day | 12.75 | 12.47 | 12.75 | 12.91 | 0.15 | 0.81 |
| | (7.31) | (7.23) | (7.10) | (7.55) | (0.90) | (0.89) |
| Income | 0.43 | 0.00 | 1.00 | 0.46 | 1.00 | 0.47*** |
| | (0.50) | (0.00) | (0.00) | (0.50) | (0.00) | (0.05) |
| Income(t-1) | 0.43 | 0.39 | 0.44 | 0.46 | 0.02 | 0.07 |
| | (0.50) | (0.49) | (0.50) | (0.50) | (0.07) | (0.06) |
| Income(t-2) | 0.44 | 0.52 | 0.40 | 0.41 | -0.14** | -0.10 |
| | (0.50) | (0.50) | (0.49) | (0.49) | (0.07) | (0.07) |
| Quota | 0.49 | 0.00 | 0.52 | 1.00 | 0.53*** | 1.00 |
| | (0.50) | (0.00) | (0.50) | (0.00) | (0.05) | (0.00) |
| Quota(t-1) | 0.48 | 0.48 | 0.44 | 0.52 | -0.05 | 0.01 |
| | (0.50) | (0.50) | (0.50) | (0.50) | (0.07) | (0.06) |
| Quota(t-2) | 0.47 | 0.53 | 0.47 | 0.45 | -0.06 | -0.11* |
| | (0.50) | (0.50) | (0.50) | (0.50) | (0.07) | (0.07) |
| Obs | 359 | 110 | 155 | 175 | . | . |

*Notes*: This table presents a balance test for the income and quota treatments. Randomization of the income treatment was made within intersection blocks, and randomization of the quota treatment was made within intersection*income treatment blocks (factorial design). Columns (1) and (2) present respectively the mean outcomes (with standard deviations in parentheses) for the variables in the full sample, then pure control intersection*day observations. Columns (3) and (4) show the same for the intersection*day observations in the income, then quota treatment conditions. Columns (5) and (6) present the coefficients of and OLS regression (and their standard errors in parentheses) using as dependent variable the corresponding variable and as regressor a dummy indicating whether a given treatment was assigned, separately. The control group in columns (5) and (6) is intersection*day observations where no treatment was assigned. While treatment assignment is fairly well-balanced across the groups, there are some systematic imbalances: both quota and income treatments are less likely to fall on Fridays, and both quota and income treatments are less likely to be given if there were also given two days earlier. We directly control for those in the analysis.

Table IV: Determination of equilibrium vertical corruption contracts

Panel A: Observed quota level $s$

| VARIABLES | (1) s | (2) s | (3) s | (4) s | (5) s |
|---|---|---|---|---|---|
| $\gamma\bar{b}_i - c_i$ | 0.48*** | 0.49*** | 0.51*** | | |
| | (0.12) | (0.13) | (0.13) | | |
| p$(b_H - b_L)$ | | | 0.30** | 0.49** | -0.12 |
| | | | (0.15) | (0.24) | (0.27) |
| Formal fine revenue per car (i) | | 0.01 | | | |
| | | (0.16) | | | |
| Constant | 6.08*** | 6.02*** | 4.09*** | 2.29* | 9.92*** |
| | (0.62) | (1.35) | (1.01) | (1.26) | (2.62) |
| Observations | 321 | 321 | 321 | 171 | 150 |
| R-squared | 0.46 | 0.46 | 0.54 | 0.49 | 0.29 |
| Sub-sample | full | full | full | $\gamma b - c \leq 0$ | $\gamma b - c \geq 0$ |
| Mean dep var | 5.402 | 5.402 | 5.402 | 4.006 | 6.942 |

Panel B: Observed monetary transfer $T$ from police agent team to police commander

| VARIABLES | (1) T | (2) T | (3) T | (4) T | (5) T |
|---|---|---|---|---|---|
| $\gamma\bar{b}_i - c_i$ | 0.29 | 0.19 | 0.29 | | |
| | (0.65) | (0.68) | (0.62) | | |
| p$(b_H - b_L)$ | | | 0.08 | 0.02 | -0.18 |
| | | | (0.98) | (1.83) | (1.55) |
| Formal fine revenue per car (i) | | -0.36 | | | |
| | | (0.56) | | | |
| Constant | 2.77 | 5.39 | 2.26 | 1.71 | 6.16 |
| | (2.14) | (5.04) | (4.74) | (9.94) | (8.82) |
| Observations | 300 | 300 | 300 | 160 | 140 |
| R-squared | 0.23 | 0.24 | 0.23 | 0.32 | 0.30 |
| Sub-sample | full | full | full | $\gamma b - c \leq 0$ | $\gamma b - c \geq 0$ |
| Mean dep var | 8.866 | 5.402 | 8.866 | 7.176 | 7.176 |

*Notes*: This table implements specification 1, and regresses the observed quota level $s$ (Panel A) and police agent-supervisor monetary transfers $T$ (Panel B) at day $t$ and intersection $i$ on time-invariant intersection properties. Column (1) uses $\gamma\bar{b}_i - c_i$ as a regressor and includes the experimental treatments as controls, Column (2) adds the formal fine revenue per car as a control, Column (3) adds $p(b_H - b_L)_i$ as a control. Columns (4) and (5) test for part b of Proposition 1: column (4) restricts the sample to $\gamma\bar{b}_i - c_i < 0$ and column (5) to $\gamma\bar{b}_i - c_i > 0$. All regressions include day fixed effects. Standard errors are clustered at the level of the intersection and, since there are 17 intersections, are estimated using Wild-Bootstrap.

Table V: Treatment effects, ITT estimates

Panel A: all day

| VARIABLES | (1) Consumption Beers (USD) | (2) # Bribes harassment | (3) # Bribes toll fee | (4) # Bribes tip | (5) Effort Attendance | (6) Harassment # events | (7) Congestion dummy | (8) Accidents dummy |
|---|---|---|---|---|---|---|---|---|
| T income | 3.79*** | -1.23** | 6.47 | -0.60 | -0.07* | 0.21 | 0.07 | 0.03 |
| | (0.58) | (0.57) | (6.94) | (4.05) | (0.04) | (1.54) | (0.08) | (0.07) |
| T quota | 0.04 | -0.05 | -0.23 | 0.10 | 0.00 | -0.37 | -0.02* | -0.03** |
| | (0.10) | (0.10) | (1.18) | (0.69) | (0.01) | (0.26) | (0.01) | (0.01) |
| Observations | 300 | 300 | 300 | 300 | 264 | 300 | 295 | 295 |
| R-squared | 0.57 | 0.28 | 0.51 | 0.21 | 0.53 | 0.43 | 0.41 | 0.22 |
| Mean d. var | 4.969 | 1.601 | 37.54 | 11.35 | 0.830 | 0.830 | 0.830 | 0.830 |
| Quota removal | 0.271 | -0.283 | -1.424 | 0.589 | 0.00751 | -2.234 | -0.149 | -0.157 |

Panel B: am

| VARIABLES | (1) Consumption Beers (USD) | (2) # Bribes harassment | (3) # Bribes toll fee | (4) # Bribes tip | (5) Effort Attendance | (6) Harassment # events | (7) Congestion dummy | (8) Accidents dummy |
|---|---|---|---|---|---|---|---|---|
| T income | 3.79*** | -0.61** | 3.63 | -0.40 | -0.06 | -0.76 | -0.01 | 0.00 |
| | (0.58) | (0.27) | (2.70) | (1.36) | (0.05) | (0.86) | (0.07) | (0.04) |
| T quota | 0.04 | -0.01 | -0.56 | 0.20 | 0.00 | -0.07 | -0.00 | -0.01 |
| | (0.10) | (0.05) | (0.46) | (0.23) | (0.01) | (0.15) | (0.01) | (0.01) |
| Observations | 300 | 300 | 300 | 300 | 241 | 300 | 294 | 292 |
| R-squared | 0.57 | 0.22 | 0.42 | 0.25 | 0.49 | 0.31 | 0.30 | 0.21 |

Panel C: pm

| VARIABLES | (1) Consumption Beers (USD) | (2) # Bribes harassment | (3) # Bribes toll fee | (4) # Bribes tips | (5) Effort Attendance | (6) Harassment # events | (7) Congestion dummy | (8) Accidents dummy |
|---|---|---|---|---|---|---|---|---|
| T income | 3.79*** | -0.62 | 2.84 | -0.20 | -0.08** | 0.97 | 0.14* | 0.05 |
| | (0.58) | (0.47) | (5.22) | (2.92) | (0.04) | (1.12) | (0.07) | (0.06) |
| T quota | 0.04 | -0.03 | 0.32 | -0.10 | 0.00 | -0.30 | -0.03*** | -0.02* |
| | (0.10) | (0.08) | (0.89) | (0.50) | (0.01) | (0.19) | (0.01) | (0.01) |
| Observations | 300 | 300 | 300 | 300 | 264 | 300 | 294 | 295 |
| R-squared | 0.57 | 0.23 | 0.49 | 0.22 | 0.52 | 0.38 | 0.43 | 0.16 |

*Notes*: This table reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Each column gives the results of the OLS regression of the dependent variable listed in that column on dummy variables indicating the income and quota treatment status. All regressions include intersection/team of street-level police agent fixed effects, day fixed effects, and the first and second lags of the income and quota treatment indicators, as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. Panel A presents the results using the whole day, Panel B uses the results using the morning, and Panel C presents the results using the afternoon. Column (1) uses the amount in USD consumed by each police team/intersection $i$ at day $t$ in beer purchases, columns (2) through (4) decompose the number of observed bribes into respectively harassment bribes, toll fees, and tips. Columns (5) through (8) present the results on productive effort and output: column (5) shows the rates of presence of the police team, column (6) shows the occurrence of harassment events, column (7) shows the occurrence of traffic jams, column (8) shows the occurrence of accidents. Harassment events include negotiations for escorting a driver to the police station (successful), negotiations for escorting a driver to the police station (unsuccessful), and negotiations that end in a harassment bribe. We measure unsuccessful negotiations by exploiting the reported conversations by the observers. We inspect each conversation and note, for each interaction, and code as harassment those where the observer indicated that it was a negotiation and that it was tense. The table displays the mean of the dependent variable and the equivalent estimated effect from a complete elimination of the quota, derived from the estimated coefficient (which measures the effect per car reduced) and using each intersection baseline quota level. The first stage in Panel B yields an F statistic for the endogenous variables "income retained" and "quota level" respectively of 50 and 51 with p-values of 0.00.

Table VI: Treatment effects, IV estimates

Panel A: all day

| VARIABLES | (1) Consumption Beers (USD) | (2) # Bribes harassment | (3) # Bribes toll fee | (4) # Bribes tip | (5) Effort Attendance | (6) Harassment # events | (7) Congestion dummy | (8) Accidents dummy |
|---|---|---|---|---|---|---|---|---|
| Extra 100 USD | 7.94*** | -2.60** | 14.21 | -1.41 | -0.15* | 0.79 | 0.16 | 0.07 |
| | (1.43) | (1.27) | (14.82) | (8.69) | (0.09) | (3.29) | (0.17) | (0.15) |
| Quota level | -0.06 | 0.07 | 0.40 | -0.25 | -0.00 | 0.58 | 0.03* | 0.04** |
| | (0.17) | (0.15) | (1.78) | (1.05) | (0.01) | (0.39) | (0.02) | (0.02) |
| Observations | 296 | 296 | 296 | 296 | 263 | 296 | 291 | 291 |
| R-squared | 0.43 | 0.24 | 0.51 | 0.21 | 0.50 | 0.43 | 0.40 | 0.17 |

Panel B: am

| VARIABLES | (1) Consumption Beers (USD) | (2) # Bribes harassment | (3) # Bribes toll fee | (4) # Bribes tip | (5) Effort Attendance | (6) Harassment # events | (7) Congestion dummy | (8) Accidents dummy |
|---|---|---|---|---|---|---|---|---|
| Extra 100 USD | 7.94*** | -1.30** | 8.31 | -0.80 | -0.13 | 1.33 | 0.29* | 0.10 |
| | (1.43) | (0.61) | (5.89) | (2.91) | (0.10) | (1.64) | (0.17) | (0.11) |
| Quota level | -0.06 | 0.02 | 0.88 | -0.31 | -0.00 | 0.48** | 0.07*** | 0.01 |
| | (0.17) | (0.07) | (0.71) | (0.35) | (0.01) | (0.20) | (0.02) | (0.01) |
| Observations | 296 | 296 | 296 | 296 | 240 | 296 | 290 | 291 |
| R-squared | 0.43 | 0.16 | 0.40 | 0.25 | 0.48 | 0.29 | 0.34 | 0.16 |

Panel C: pm

| VARIABLES | (1) Consumption Beers (USD) | (2) # Bribes harassment | (3) # Bribes toll fee | (4) # Bribes tip | (5) Effort Attendance | (6) Harassment # events | (7) Congestion dummy | (8) Accidents dummy |
|---|---|---|---|---|---|---|---|---|
| Extra 100 USD | 7.94*** | -1.30 | 5.90 | -0.61 | -0.17* | -0.54 | 0.01 | -0.02 |
| | (1.43) | (1.02) | (11.13) | (6.27) | (0.09) | (2.45) | (0.15) | (0.12) |
| Quota level | -0.06 | 0.05 | -0.48 | 0.06 | 0.00 | 0.10 | -0.02 | 0.03** |
| | (0.17) | (0.12) | (1.34) | (0.75) | (0.01) | (0.29) | (0.02) | (0.01) |
| Observations | 296 | 296 | 296 | 296 | 263 | 296 | 291 | 291 |
| R-squared | 0.43 | 0.21 | 0.49 | 0.22 | 0.48 | 0.39 | 0.41 | 0.16 |

*Notes*: This table reports the experimental results on police-driver interactions from instrumenting extra disposable income at the level of police team/intersection $i$ * day $t$ using the amount of extra income assigned (prior to taxation by commanders). Each column gives the results of the IV regression of the dependent variable listed in that column on disposable extra income instrumented by assigned extra income. All regressions include intersection/team of street-level police agent fixed effects, day fixed effects, and the first and second lags of the income and quota treatment indicators, as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. Panel A presents the results using the whole day, Panel B uses the results using the morning, and Panel C presents the results using the afternoon. Column (1) uses the amount in USD consumed by each police team/intersection $i$ at day $t$ in beer purchases, columns (2) through (4) decompose the number of observed bribes into respectively harassment bribes, toll fees, and tips. Columns (5) through (8) present the results on productive effort and output: column (5) shows the rates of presence of the police team, column (6) shows the occurrence of harassment events, column (7) shows the occurrence of traffic jams, column (8) shows the occurrence of accidents. Harassment events include negotiations for escorting a driver to the police station (successful), negotiations for escorting a driver to the police station (unsuccessful), and negotiations that end in a harassment bribe. We measure unsuccessful negotiations by exploiting the reported conversations by the observers. We inspect each conversation and note, for each interaction, and code as harassment those where the observer indicated that it was a negotiation and that it was tense. The table displays the mean of the dependent variable and the equivalent estimated effect from a complete elimination of the quota, derived from the estimated coefficient (which measures the effect per car reduced) and using each intersection baseline quota level. The first stage in Panel B yields an F statistic for the endogenous variables "income retained" and "quota level" respectively of 50 and 51 with p-values of 0.00.

# Online Appendix

## A Study design appendix

### A.1 Threats do data quality and strategies to address them

*Hawthorne effects.* Street-level police agents were not informed that they were being monitored by observers. In addition, we are confident that they never knew they were being observed. None in the police force was, in fact, informed of the presence of observers at intersections or in minibuses.[54] From an ethical and legal perspective, their activity, approved by the IRB as not requiring consent, consists in naturalistic observation of publicly observable behavior on which there is no expectation of privacy, and as such, is typically human subjects exempt. Most ethical and legal concerns were linked to the process of transmission of data and storage of identifiers. Similarly, JPO's (nor anyone else in the police station) were not aware that they were being monitored by FCA agents.

We ensured that street-level police agents were not aware of the presence of t observers, which we can confirm from the independent access we had inside the police agency. First, we developed a smartphone survey that allowed to record in real time the behavior of police agent behavior. Using this application, the observers could record the data while seemingly texting.[55] Second, we randomly re-assigned the observers every day to a new intersection. This allowed us to reduce the risk that the observers presence is noticed and that the observers developed ties with the police. Third, to reduce the risk that observers were discovered, instead of hiring civilians, we hired civil servants from the municipal transportation authority, whose presence was considered not suspicious at the intersection.[56] The transportation authority is in charge of verifying properties of traffic and sometimes registration papers of drivers.[57] The observers blended in with the

[54]Suspicions arose in one intersection, which led us to drop it from the study. Because we had collaborated with the agency from other channels for the purpose of the police station data and income intervention, we were informed in real time of what happened at the police stations. Street supervisors and street observers also played a central role at passing-up information about the atmosphere among police agents at the intersections.

[55]Taking notes on paper can catch the attention of the police agents and the security services.

[56]Observers would indeed be exposed to discovery if they were simple civilians—questioning of observers by the police or the secret service happened rarely, but if it did, it could have threatened our data collection system. If officials from the transportation authority were interrogated about the nature of their activity, they simply displayed their state official card and deterred any suspicion.

[57]We agreed to pay a wage supplement to the Transportation Authority officers in exchange for their time working. Civil servants in the country are severely underpaid, and mostly do not have their transport cost paid. A significant number of civil servants do not receive a regular salary, and work sporadically. As a result, we

population of intersections. These are generally crowded by traders, phone credit sellers, food sellers, and drivers.

*Observers' collusion.* To reduce the risk of collusion between observers and police agents, we hired three supervisors from our own networks in a different province of the country in order to independently monitor the observers. Every day, the supervisors were then deployed to secretly monitor five intersections each.[58] Observers knew they were being observed: every day the scientific coordinator announced detected misbehavior from the previous day.[59] We further tackled the risk that supervisors and observers might collude. First, since social networks and repeated interaction can sustain collusion between supervisors and observers against the research team, we hired supervisors from other social networks (other kinship networks of regions in the extreme other end of the country). Second, to prevent the formation of new relationships between observers and supervisors, we randomly reassigned every day the supervisors to different intersections. Supervisors' monitoring made it less likely that observers would collude with police agents.

*Data quality.* To ensure that observers had incentives to gather true data, we developed a system of daily feedback and pay for performance.[60] This ensured that observers knew their work quality was also being monitored.[61]

*Tackling leakage of data collection activities:* Strict measures were taken to control the flow of information. Table E.1 in the online appendix describes who was informed of each activity. First,

believe that our hiring did not have an impact on their own effort to provide public service, which was severely compromised due to the institutionalized lack of funding. We regularly consulted with their supervisor to ensure that their services were not being needed during our study. As many civil servants in the country, having a position in the administration allows to generate income from other sources, including small businesses and agriculture.

[58] A tracking sheet allows the supervisor to record any irregularity.

[59] Observers were very motivated, for two reaons. First, incentives. At the beginning of the survey, one observer was caught slacking and was immediately replaced. Other observers were aware of this risk, which reinforced motivation in the teams. Second, observers wanted to please the scientific coordinator, who is in charge of a data collection firm and can offer future employment to good performers. As a result, observers were eager to collect good data and had developed a strong sense of duty in doing so.

[60] At the end of the day, the observers were required to uploaded the data for the day. In the evening, the scientific coordinator downloaded the data, and a graduate student in the United States went through the data, producing a data quality report, which included information on missing variables and specific questions about the data. The scientific coordinator then gathered such reports, and in the 6 am meeting the following day, he distributed reports for each observer.

[61] For minibus observers, we put in place a similar system for addressing measurement challenges. First, minibus observers were civilians hired from our own civilian networks from a distant province of the country in order to prevent collusion with the police. Second, they bought a daily ticket in the front seat of minibuses, where they were entering data on each intersection on a smartphone. Third, a minibus supervisor intercepted the minibuses along the way, and traveled behind the observer, often seating at the back and observing their behavior. Fourth, every evening, the data collector was required to upload the data, and the same feedback mechanism was in place, in which a feedback document was sent to supervisors at 6am. This document was distributed it to each data collector before the start of their day.

actors were only informed about their own subset of the data collection. For example, the FCA agents were not aware of the operations with the JPO's, at the intersections, or in minibuses. Similarly, the street-level police agents were not aware data collection took place with the JPO's and with the FCA agents. Also, the police commanders, the JPO's, and the FCA agents were unaware of data gathering activity at the intersection level. Second, for each part of the data collection, we ensured that the active actor had the necessary authorization if he or she was caught. In some cases (municipal transportation authority and FCA agents) this involved presenting their operations with the purpose of their otherwise daily job. In other cases this involved contacting the relevant actor within the police hierarchy.

Actors of different operations were trained in separated workshops. First, surveyors, minibus surveyors and street-level surveyors were trained. Second, FCA agents received their instructions in a training solely attended by them. Third, all the supervisors (including wage team and auditor) were trained together. Fourth, the street-level police agents were trained in the morning, from 6:30 to 7:30, on their respective intersections in presence of their commander. Fifth, JPO's and commanders were trained together. This separation was established to prevent information leakage and Hawthorne effects. In training, actors were informed separately that we were conducting a scientific study. Moreover, we informed them about their compensation and their tasks, and instructed them about how to complete the forms (JPO's, FCA agents) or how to handle the smartphones.

## A.2 Strategies to address threats to experiment validity

*Risk of collusion within our ranks.* We designed the delivery of income surplus in a way that was concered with minimizing the risk of collusion among our ranks. First, collusion at the withdrawal step was tightly monitored. The scientific coordinator withdraws cash from the project, and upon distributing it to the income intervention team, obtains a receipt from the income intervention team. We matched the receipts to the movements in the account and to the randomization calendar. In addition, the income intervention team was from a different social network, and was rewarded on their performance at delivering the wage. It was thus in the interest of the income intervention team to report the scientific coordinator were he to pocket part of the cash. Second, collusion at the delivery step was also tightly monitored. Street-level police agent were given a hotline to voice complaints about the intervention—the project's operations coordinator. Since

each police team was assigned one known level for the wage increase, this constrained the ability of the income intervention team to hide some of the cash without leading police agents to complain. Furthermore, to verify that the cash had been delivered as planned in the calendar, we hired an auditor to conduct an independent audit on all police teams every day. Third, collusion between the income intervention team and the auditor was also tightly controlled. To reduce the risk of collusion, we intentionally hired an auditor from social networks of a different part of the country.[62] Pre-existing animosity between the networks made collusion impossible.[63] As a last monitoring mechanism, we verified that the police agents had received the treatment as planned in an exit survey at the end of the study.[64]

*Expectations.* We precluded the possibility that anticipation of future shocks may lead to a change in behavior in control days. By restricting access to the wage calendar, neither were police agents, nor anyone in the implementation team, informed which days they were receiving this salary intervention. Thus, the experimental design allows us to examine the effect of surprise transitory income shocks, *conditional on the knowledge that the total income for the month would be higher*—agents knew the number of selected days but not which ones.

*Framing of the intervention.* While the intervention was designed and presented as being for research purposes, it was ultimately perceived to be part of real police reforms. The framing of the income intervention, which was presented to the police force in a meeting organized by the kernel of the battalion, was likely later appropriated as originating from the police agency efforts to reform the police.[65] This perception occurred because of the following three factors. First,

[62]In doing so, we apply basic lessons from the theory of collusion in organizations (Tirole, 1986) to the design of our own data collection organization aimed at measuring collusion. While the income intervention team belonged to informal police networks originally from the Bandundu Province (and thus loyal to the operations coordinator), the auditor was drawn from our own civilian networks in a different province of the country. Furthermore, through career incentives and the expectation of future projects, the auditor was incentivized to provide verifiable information in case the income intervention team may keep some of the wage from the street-level police agents.

[63]Major conflicts arose inside the teams that led one of the co-authors to return to the country to prevent the conflict from breaking down the study. The income intervention team, part of a network in conflict with the scientific coordinator, was eager to hold him accountable, and collusion between auditor and scientific coordinator did not occur.

[64]We also designed a tracking system to collect process data from the income intervention team and auditor. Using the tracking system from the income intervention team, we obtain information on the exact time at which the compensation was delivered, absenteeism at the intersections, a verification of the level of the quota for each intersection, as well as precise information on the number of beers consumed by each street-level police agent of the team the previous day. Using the tracking system for the auditor, we obtain information on the delivery of the compensation top-off, how much of it the street-level police agents were able to retain, and where the rest was distributed inside the police hierarchy (often to the chief of the police team, called "Gradé d'élite," and more generally to the police station commander).

[65]Some anecdotal evidence suggests why this may have been the case: "So the commander fears that your money will buy the agents' loyalty there. When you give them money, they become too weak vis-à-vis yourself, and you

the income distribution project was introduced by the police commanders to the police agents in an introductory workshop convoked by the battalion kernel. The battalion kernel issued sealed authorizations for the income intervention team and the auditor. Second, the income intervention team was drawn from former civil servant networks. Third, at the time of the intervention, the police hierarchy was going through a major reshuffling, in which many commanders were being promoted, and in which a salary restructure was taking place. As a result of this strategy, the income intervention team was perceived to be tied to senior levels of the police hierarchy, and the police agents considered the salary interventions to be a state measure which was part of the ongoing reforms. Furthermore, since the income intervention team was untied from measurement of police agent behavior, police agents never learned that they were part of a study that independently observed their behavior.

*Spillovers and jealousies.* In a few intersections, more than one team of police agents was active. To reduce spillovers, in addition to randomizing at the team level, we selected all intersections of the battalion, but when an intersection had more than one police team, we selected only one team. In a handful of cases, the policemen who received a compensation top-off shared it with other policemen of equal rank, who were aware of the top-off but were not part of the intervention. Sometimes this transfer was instructed by the commander.[66] Side-transfers occurred mostly to teams of the same intersections which were not part of the experimental sample, and therefore amount for attenuation of the treatment intensity rather than spillovers.

# B Model Appendix

## B.1 Assumptions

**Assumption 1)** [Regularity condition on the effort] For any level of $(s, T)$:

$$(1-s)(pb_H + (1-p)b_L)u'(\overline{w} - cs - T) > v_l'(1),$$
$$p(1-s)pb_H u'(\overline{w} + (1-s)b_H - cs - T) + (1-p)(1-s)b_L u'(\overline{w} +$$
$$+(1-s)b_L - cs - T) < v_l'(0)$$

can start giving them orders."

[66] Commanders were sometimes indeed concerned that de-motivation in his teams at an intersection might arise from inequality, a mechanism observed in Breza, Kaur, and Shamdasani (2017).

The first ensures existence and uniqueness of an interior solution for effort, given $(s, T)$ pair.

**Assumption 2)** [Substitution effect dominates income effect for quota][67]

$$pb_H u'(\overline{w} + ((1-s)b_H)e - cs - T) + (1-p)b_L u'(\overline{w} + (1-s)b_L e - cs - T) + \\ + p(b_H e + c)(1-s)b_H u''(\overline{w} + (1-s)b_H e - cs - T) + \\ + (1-p)(b_L e^* + c)(1-s)b_L u''(\overline{w} + (1-s)b_L e - cs - T) > 0$$

**Assumption 2')** The elasticity of effort with respect to $1-s$ is higher than $-1$.

**Assumption 3)** [Convex participation constraint][68]

$$\frac{de^*}{ds}\left[1 + \frac{p(b_H - b_L)u'_H}{pb_L u'_H + (1-p)b_L u'_L}\right] + e^* \frac{d}{ds}\left[\frac{p(b_H - b_L)u'_H}{pb_L u'_H + (1-p)b_L u'_L}\right] < 0$$

## B.2 Additional propositions

**Proposition 6.** *[Change in quota] Consider a small decrease in quota $s$ from principal's optimally chosen level $s^* > 0$ . a) If $T^*$ is fixed, lowering the quota increases effort and the agent's corruption revenue as long as assumption 2 holds (substitution effect dominates). The effect on total corruption revenue is ambiguous. If the income effect dominates, effort decreases.*
*b) If $T^*$ is allowed to adjust, the decrease in quota leads to an increase in $T^*$. Furthermore, if assumption 2 holds, effort increases. The effect on the agent's corruption revenue and total corruption revenue is ambiguous.*

## B.3 Proofs of model in paper

**Proof of proposition 1:**

a) Let's compare contracts $(s', T')$ with $s' < 1$ and contract $(1, T'')$. Principal prefers the first contract to first as long as: $T' - T'' > (1-s')(1+\gamma)\bar{b}$. Note that $T' - T''$ can be bounded from the above by: $(1-s')(c + b_H)$. Then inequality holds only if: $0 > (1-s')(\gamma\bar{b} - c - p(b_H - b_L))$. Then as $\gamma\bar{b} - c$ increases, any efficient contract must have $s'$ that is sufficiently close to 1.

[67] The direct effect of $s$ on effort through lowering the power of incentives must dominate the indirect effect through decrease in income. This also implies that wealth constraint is convex in $(s, T)$ space.

[68] The first term is negative by assumption 2), while the second term is ambiguous. It must be sufficiently small, if $p(b_H - b_L)$ is not too large or ratio of marginal utilities $u'_L/u'_H$ does not respond strongly to increase in $s$.

Let's compare contracts $(s', T')$ with $s' > 0$ and contract $(0, T'')$. Principal prefers the first contract to first as long as: $T'' - T' < s'(1+\gamma)\bar{b}$. Note that $T'' - T'$ can be bounded from the below by: $s'(c - b_H)$. Then inequality holds only if: $0 < s'(\gamma\bar{b} - c + b_H + \bar{b})$. Then as $\gamma\bar{b} - c$ decreases, any efficient contract must have $s'$ that is sufficiently close to 0.

The proof follows similar reasoning for $s^M$.

b) If wealth constraint is binding, then principal's objective function ($W$) can be rewritten in the following way:

$$W(s,T) = s(1+\gamma)[pb_H + (1-p)b_L] + \overline{w} + (1-s)b_L e^*(s,T) - cs + K$$

Marginal benefit from increasing $s$ and $T$ for principal is given by:

$$\frac{\partial W}{\partial s} = (1+\gamma)[pb_H + (1-p)b_L] - c + \frac{\partial e^*}{\partial s} - b_L\left(e^*(s,T) - (1-s)\frac{\partial e^*}{\partial s}\right),$$

$$\frac{\partial W}{\partial T} = (1-s)b_L\frac{\partial e^*}{\partial T}$$

At the same time, the derivative of the total corrupt revenue with respect to $s$:

$$\frac{\partial R}{\partial s} = (1+\gamma)[pb_H + (1-p)b_L] - c + \frac{\partial e^*}{\partial s} - [pb_H + (1-p)b_L]\left(e^*(s,T) - (1-s)\frac{\partial e^*}{\partial s}\right) =$$
$$= \frac{\partial W}{\partial s} - p[b_H - b_L]\left(e^*(s,T) - (1-s)\frac{\partial e^*}{\partial s}\right),$$

$$\frac{\partial R}{\partial T} = (1-s)\bar{b}\frac{\partial e^*}{\partial T}$$

Taking these equations together we get that difference in total effect of changing $s$ on $W$ and $R$ is given by:

$$\frac{dW}{ds} - \frac{dR}{ds} = \left(\frac{\partial W}{\partial s} - \frac{\partial R}{\partial s}\right) + \left(\frac{\partial W}{\partial T}\frac{dT}{ds} - \frac{\partial R}{\partial T}\frac{dT}{ds}\right) =$$
$$= p(b_H - b_L)\left(e^* - (1-s)\left(\frac{\partial e^*}{\partial s} + \frac{\partial e^*}{\partial T}\frac{dT}{ds}\right)\right)$$

Note that term $\frac{\partial e^*}{\partial T}$ is positive due to income effect, and $dT/ds$ is negative for any binding constraint for the principal (or total revenue maximizer), so their product is negative. Then as long as elasticity of effort with respect to $1-s$ is larger than $-1$ (so income effect does not dominate substitution effect by large margin), then $e^* - (1-s)\frac{\partial e^*}{\partial s}$ is positive, and hence the principal would always be choosing higher level of $s$ than optimal from the revenue maximizing perspective. Statement 2) follows from the result in a) and expression for $dW/ds - dR/ds$.

**Proof of proposition 2:** The optimal level of effort is given by first order condition of incentive compatibility. Applying implicit function theorem to it, we get the following expression:

$$\frac{de^*}{dw} = -\frac{p(1-s)b_H u''_H + (1-p)(1-s)b_L u''_L}{p((1-s)b_H)^2 u''_H + (1-p)((1-s)b_L)^2 u''_L + v''_l}$$

Here $u''_H$ and $u''_L$ are second derivatives of utility of money in high and low states, while $v''_l$ is the second derivative of the utility from leisure. Given the concavity of $u(\cdot)$ and $v_l(\cdot)$, if $u(\cdot)$ is strictly concave, then $\frac{de^*}{dw} < 0$, and if $u(\cdot)$ is linear, then $\frac{de^*}{dw} = 0$. Other results directly follow from $\frac{de^*}{dw} < 0$. The proof holds in the specific case of $b^I = 0$.

**Proof of proposition 3:** a) $R$ denotes expected total informal revenue that agent gets gets and let $b^I + (1-s)b_H = B$. Given the introduced notation it is equal to:

$$R = p[(1-r)B + rBe^*] + (1-p)[(1-r)B + rB\psi e^*]$$

Effect of local wage increase on $TR$ is given by:

$$\frac{dR}{dw} = rB[p + (1-p)\psi]\frac{de^*}{dw} = -rB[p + (1-p)\psi]\frac{prBu''_H + (1-p)r\psi Bu''_L}{p(rB)^2 u''_H + (1-p)(r\psi B)^2 u''_L + v''_l} < 0$$

Note that as $r \to 0$, $\frac{dTR}{dw} \to 0$ and $\frac{de^*}{dw} \to 0$. As $r$ increases, the change in effect of wage on total revenue can be characterized by the mixed derivative:

$$\frac{d^2R}{dwdr} = B[p + (1-p)\psi]\frac{de^*}{dw} + rB[p + (1-p)\psi]\frac{d^2e^*}{dwdr}$$

Using implicit function theorem and taking the limit we get:

$$\lim_{r\to 0}\left[\frac{d^2e^*}{dwdr}\right] = -\frac{pBu''_H + (1-p)\psi Bu''_L}{v''_l} < 0$$

Combining these expressions we get that for sufficiently small $r$: $\frac{d^2R}{dwdr} < 0$

b) Suppose that there is additional term in agent's utility $F(e)$ that is strictly concave and increasing in $e$. Then:

$$\frac{de^*}{dw} = -\frac{p(1-s)b_H u''_H + (1-p)(1-s)b_L u''_L}{p((1-s)b_H)^2 u''_H + (1-p)((1-s)b_L)^2 u''_L + v''_l + F''}$$

All the statements of the a) follow, while $\lim_{r\to 0}[e^*(r)] \neq 0$ as long as $F'(0) > v'_l(1)$.

**Proof of proposition 4:**

a) If a corner solution is strictly preferred by the principal, a small change in the wage would not change the level of quota chosen by the principal and all the adjustment would happen along the dimension of $T$.

Suppose that the participation constraint binds ($K$ is large enough). As long as $\alpha \geq 0$, the change in $T$ cannot be larger than change in wage, and due to the income effect as outlined in the proposition 1 effort $e^*$ is decreasing. For sufficiently small $\alpha$, change in $T$ in response to change in wage is positive and hence income effect on effort is weaker than with constant levels of $s$ and $T$. Finally, if $\alpha \to 0$, the change in $T$ is converging to the same level as change in the wage, so income effect on the effort disappears.

If wealth constraint binds, then change in wage is fully offset by change in $T$ and there is no effect on effort and corrupt revenue.

This reasoning implies the statements made in the proposition.

b) Given assumptions 2 and 3 participation and wealth constraint are convex decreasing curves in $(s, T)$ space, the interior solution is only possible at the intersection of the two constraints. The participation constraint is more steep as:

$$-e^* b_L \left(\frac{p\frac{b_H}{b_L}u'_H + (1-p)u'_L}{pu'_H + (1-p)u'_L}\right) - c < -e^* b_L - c.$$

Consider an increase in the wage from the level $w$ to some $w + dw$. Then wealth constraint is moving up by $dw$ in $(s, T)$ space, while the participation constraint moves up by $pu'_H dw + (1 -$

$p)u'_L dw - \alpha u'(\overline{v} + \alpha w)$. If it responds stronger than the wealth constraint, it shifts choice of $s$ to the right, with effort decreasing (given the assumption 2). The opposite happens if the wealth constraint responds stronger. This creates ambiguity in the direction of the effort adjustment. One special case is when $u'(-K) < 1 + \alpha u'(\overline{v} + \alpha w)$ and $b_H$ is sufficiently close to $b_L$: then quota decreases, monetary payment $T$ goes up, inducing higher effort provided by the agent and higher level of corruption revenue.

**Proof of proposition 5:**

a) The result follows directly from the form of assumption 2. As long as decrease in $s$ causes effort to increase, it increases agent's corruption revenue as well given the fixed level of $T$. From proposition on the choice of quota, initial level of quota could be maximizing corrupt revenue and then decrease in $s$ decreases the total corrupt revenue, if initial level of quota is at higher level than corrupt maximizing level, decrease in quota could increase the total corrupt revenue.

b) In addition to a), the decrease in $s$ makes principal increase the level of $T^*$: this would happen for any binding constraint as they have to be decreasing in $(s, T)$ space. The increase in $T^*$ has additional income effect that increases effort of the agent, and then as long as assumption 2 holds, the effort is increasing with decreasing $s$. The effect on agent's revenue is ambiguous as change in bribes that agent is getting could be more than fully offset by the increase in $T$.

**Proof of proposition 6:**

There are three actors in our model: principal, agent and drivers. Given that the participation constraint is binding the agent's utility is fixed and equal to $u(\overline{v}+\alpha w)$. Then maximizing the social welfare is achieved by maximizing joint welfare of principal and drivers. As both have utilities linear in money, we need to maximize the sum of the utilities. Given the wealth constraint the principal's utility $W$ is equal to $R + w + K - cs - (1 - s)p(b_H - b_L)e^*(w, s, T)$, where $R$ is total corrupt revenue. Then $DS + W$ is given by:

$$\begin{aligned} DS + W = \theta_F F(e^*(w,s,T),s) + \theta_H H(e^*(w,s,T),s) - \\ - R - w + R + w + K - cs - (1-s)p(b_H - b_L)e^*(w,s,T) = \\ = \theta_F F(e^*(w,s,T),s) + \theta_H H(e^*(w,s,T),s) - cs - (1-s)p(b_H - b_L)e^*(w,s,T) + K \end{aligned}$$

The second statement then just follows from the direct differentiation

# C Model extensions

## C.1 Endogenous bribe levels

The constraints are now written as follows:

$$\text{PC: } E\left[u(w+b^I(s)+(1-s)b_i(s)e^*-cs-T)\right]+v_l(1-e^*)=u(\overline{v}+\alpha w)$$

$$\text{ICFOC: } E\left[(1-s)b_i(s)u'(w+b^I(s)+(1-s)b_i(s)e^*-cs-T)\right]-v_l'(1-e^*)=0$$

$$\text{WC: } w+b^I(s)+(1-s)b_L(s)e^*-cs-T\geq -K$$

where $b'^I(s)>0$ and $b_i'(s)>0$. These conditions can be derived as follows. In the first period, the commander sets $s,T$ forever. Agent and driver are then matched with probability $q$ every period. The stage game has two choices: cooperate or defect. If the driver defects, he/she refrains from paying $b^I$. If the agent defects, he imposes a time cost on the driver (and himself) and derives a harassment bribe determined through Nash bargaining. Parameters can be set so that in the stage game, defect, defect is always the only Nash equilibrium in pure strategies, and cooperate, cooperate can be sustained with repeated interaction as long as the time preference parameter is sufficiently high (for frequent drivers). When harassing a driver, the outside option if bargaining breaks down increases in $s$, as the higher is the quota, the higher the value to the agent of escorting the driver to the station (bargaining breakdown). As a result $b'^I(s)>0$ and $b_i'(s)>0$.

One can directly show that, even if $s=0$ is optimal when when $b^I(s)=b^I$ and $b_i(s)=b_i$, a positive quota can be optimal if $b'^I(s)>0$ and $b_i'(s)>0$. This captures the complementarity between quota and $T$: a higher quota enables the commander to extract more in bribes.

## C.2 Classical efficiency wage augmented to include income effects

There are no savings. A street-level police agent receives a legal wage $w$ from the government, and derives additional revenues from his bribe-taking activity at an intersection. He pockets a share $e\in\{0;1\}$ of $m$ in illegal tolls paid by cars, where $m>0$ is the maximum revenue from bribes he can derive in a day if he exerts maximal effort. Pocketing the share $e$ costs him $g(e)$, where $g'(e)>0$. Engaging in bribe-taking, however, is risky, and the police agent is caught with

probability $qe, q > 0$. If he does not get caught, the police agent continues with his job to the next period, and, if he gets caught, he gets dismissed at the end of this period, and obtains $V(0)$ forever. He discounts next period by $0 < \beta < 1$. The agent's value function is:

$$\begin{aligned} V(w,q) &= \max_{e} \{u(w+me) - g(e) + \beta\left((1-qe)V(w,q) + qeV(0)\right)\} \\ s.t.\ & e \leq 1 \end{aligned} \tag{4}$$

**Proposition 7.** *[Permanent income shock vs transitory income shock] If $w$ increases permanently for each period, $\frac{\partial e^*}{\partial w} < 0$. If $u''(x) = 0$ and $q > 0$ (no income effect), $\frac{\partial e^*}{\partial w} = -\frac{qV_w(w,q)}{g''(e)} = -\frac{u'(w+me)}{e^* g''(e^*)}\beta$ and $\frac{\partial^2 e^*}{\partial w \partial q} < 0$. If $u''(x) < 0$ and $q = 0$ (no efficiency wage effect), $\frac{\partial e^*}{\partial w} = -\frac{u''(w+me)m}{u''(w+me)m^2 - g''(e^*)}$. If $w$ increases permanently one period, $\frac{\partial e^*}{\partial w} \leq 0$. If $u''(x) = 0$ and $q > 0$ (no income effect), $\frac{\partial e^*}{\partial w} = 0$, and if $u''(x) < 0$ and $q = 0$ (no efficiency wage effect), $\frac{\partial e^*}{\partial w} = -\frac{u''(w+me)m}{u''(w+me)m^2 - g''(e^*)} < 0$.*

Proposition 7 isolates two mechanisms through which higher income of civil servants decreases petty corruption. First, a higher wage increases the gap between the legal revenues from holding office, and the dismissal value, $V(w,q) - V(0)$, hence make corruption costlier through the probability of detection, $q$—an efficiency wage channel (Becker and Stigler, 1974). The equilibrium level of corruption is smaller when the government's monitoring capacity $q$ is larger, $\frac{\partial e^*}{\partial q} < 0$. Furthermore, the wage and government monitoring are complements, that is, governments with better monitoring capacity, $q$, have more leverage to trigger efficiency wage channels, $\frac{\partial^2 e^*}{\partial w \partial q} < 0$. Second, even with no government monitoring, $q = 0$, when utility is concave, increasing wages decreases the marginal utility of income and decreases corruption effort, a pure income effect channel. An important implication of Proposition 7 is that transitory income shocks have no efficiency wage channel, but produce the same income effect on contemporaneous corruption.

The efficiency wage channel is only effective if the government has some monitoring capacity, if $q = 0$. Furthermore, the efficiency wage channel is less effective if the government has small monitoring capacity. Many governments in so-called fragile states have weak monitoring capacity and thus cannot easily leverage efficiency wages. However, low-level civil servants are usually very poorly paid, and thus are more likely to be vulnerable to income effects. This has led some governments in those countries to attempt to leverage income effects with the hope of reducing the temptation to engage in corruption.

*Proof of Proposition 7.* We first establish the results for a permanent income shock, then examine

transitory income shocks.

*Permanent income shock.* The first order condition of the police agent's problem is:

$$u'(w + me^*)m - g'(e^*) - q\beta(V(w,q) - V(0)) = 0$$

Implicitly differentiating function $e^* = f(w,q)$ with respect to $w$:

$$\frac{\partial e^*}{\partial w} = -\frac{u''(w + me^*)m - q\beta V_w(w,q)}{u''(w + me^*)m^2 - g''(e^*)}$$

Then, we derive $V_w(w,q)$ applying the envelope's theorem to the agent's value function:

$$V_w(w,q) = u'(w + me) + (1 - qe)V_w(w,q)\beta$$

Which implies:

$$V_w(w,q) = -\frac{u'(w + me)}{e^*q}$$

Thus, replacing in the expression for $\frac{\partial e^*}{\partial w}$, we obtain:

$$\frac{\partial e^*}{\partial w} = -\frac{u''(w + me)m - \frac{u'(w+me)}{e^*}}{u''(w + me^*)m^2 - g''(e^*)}\beta$$

This estabishes that $\frac{\partial e^*}{\partial w} < 0$, that $\frac{\partial e^*}{\partial w} = -\frac{\frac{u'(w+me)}{e^*}}{g''(e^*)} < 0\beta$ if $u''(x) = 0$. Furthermore, from:

$$\frac{\partial e^*}{\partial w} = -\frac{u''(w + me^*)m - q\beta V_w(w,q)}{u''(w + me^*)m^2 - g''(e^*)}$$

If follows that if $q = 0$:

$$\frac{\partial e^*}{\partial w} = -\frac{u''(w + me^*)m}{u''(w + me^*)m^2 - g''(e^*)} < 0$$

We then show that $\frac{\partial^2 e^*}{\partial w \partial} < 0$ when $u''(x) = 0$. To do so, consider the expression for $\frac{\partial e^*}{\partial w}$ when $u''(0) = 0$:

$$\frac{\partial e^*}{\partial w} = -\frac{\frac{u'(w+me)}{e^*}}{g''(e^*)}\beta$$

Implicitly differentiating $e = f(w, q)$ with respect to $q$ in this expression, it follows that:

$$\frac{\partial^2 e^*}{\partial w \partial q} = -\frac{\beta}{(e^*)^2 g''(e^*)^2}\left(e^* g''(e^*)u''(w+me^*) - u'(w+me)(g''(e^*) + e^* g'''(e^*))\right)\frac{\partial e^*}{\partial q}$$

To derive $\frac{\partial e^*}{\partial q}$, we implicitly differentiate the first order condition of the police agent, with respect to q:

$$u''(w+me)m\frac{\partial e^*}{\partial q} - g''(e^*)\frac{\partial e^*}{\partial q} - (V(w,q) - V(0)) - qV_q(w,q) = 0$$

This gives:

$$\frac{\partial e^*}{\partial q} = \frac{(V(w,q) - V(0)) + qV_q(w,q)}{u''(w+me)m - g''(e^*)}$$

To obtain an expression of $\frac{\partial e^*}{\partial q}$ that does not depend on $Vq(w, q)$, we apply the envelope theorem to the police agent's value function:

$$V_q(w,q) = -\beta e^*(V(w,q) - V(0)) + \beta(1 - qe)V_q(w,q)$$

And thus:

$$V_q(w,q) = -\beta e^* \frac{V(w,q) - V(0)}{1 - \beta(1 - qe^*)}$$

We then use this expression of $V_q(w, q)$ to substitute for $V_q(w, q)$ in $\frac{\partial e^*}{\partial q}$:

$$\frac{\partial e}{\partial q} = \frac{(V(w,q) - V(0))(1-\beta)}{u''(w+me^*)m - g''(e^*)} < 0$$

Finally, we substitute $\frac{\partial e}{\partial q}$ into the expression for $\frac{\partial^2 e^*}{\partial w \partial q}$, which gives the result:

$$\frac{\partial^2 e^*}{\partial w \partial q} = \frac{-\beta(1-\beta)}{(e^*)^2 g''(e^*)^2} \left(e^* g''(e^*) u''(w+me^*) - u'(w+me)(g''(e^*) + e^* g'''(e^*))\right) \frac{(V(w,q) - V(0))}{u''(w+me^*)m - g''(e^*)}$$

A sufficient condition for $\frac{\partial^2 e^*}{\partial w \partial q}$ is $g'''(e^*) \geq 0$.

*Transitory income shock.* The first order condition of the police agent's problem is:

$$u'(w+me^*)m - g'(e^*) - q\beta(V(w,q) - V(0)) = 0$$

Implicitly differentiating function $e^* = f(w,q)$ with respect to $w$:

$$\frac{\partial e^*}{\partial w} = -\frac{u''(w+me^*)m}{u''(w+me^*)m^2 - g''(e^*)}$$

With respect to permanent income shocks, the term $-q\beta V_w(w,q)$ disappears when implicitly differentiating the first order condition, because the wage in the future no longer changes. From there it follows that $\frac{\partial e^*}{\partial w} = 0$ if $u''(x) = 0$. □

## C.3 Classical efficiency wage augmented to include a supervisor

In this section, we present the implications of vertical organization of corruption for optimal wage setting of state officials, and discuss the example of the country we study.

Consider the incentives of a bandit to engage in criminal activity. In the legal sector, the bandit can get wage $w$, while instead if he engages in criminal activity (for instance stealing), he gets $b$, in which case he might get caught with probability $q$. If he gets caught, he gets his outside option, which is $v > 0$. It is straightforward to see that there is a legal efficiency wage beyond which the bandit decides not to engage in criminal activities

$$\bar{w} = b\frac{1-q}{q} + v$$

That is, given that he is only caught with some probability, to forgo his criminal activities, he needs to be given rents. Consider now that it is the state who hands over the asset to the bandit,

so that the bandit is a bureaucrat. The bureaucrat gets his legal wage $w$ from the state and can gain $b$ from malfeasance. This is the classic framework of corruption and bureaucrat compensation in economics Becker and Stigler (1974).[69]

Bandits, however, often have supervisors. The bandit's supervisor can use informal power on the bandit, which he derives from the property rights over the asset, in exchange for a transfer $T$. The supervisor can make the bandit's life worse by holding a share of the wage that the bureaucrat receives from the state by $\alpha w$ if the bandit does not engage in profitable criminal activities.[70] In this framework, the supervisor would like to set the highest possible transfer, but is constrained by the bandit's participation constraint, $qv + (1-q)(b+w-T) \geq v$. Furthermore, the supervisor is constrained by the bureaucrat's incentives: if $T$ is too high, the bandit may no longer have incentives to engage in criminal activity, which generates profit. That is, he must set $T$ so as to satisfy the bandit's incentive compatibility constraint, $qv + (1-q)(b+w-T) \geq (1-\alpha)w$.[71] If the supervisor is too strong ($\alpha > q$), wage setting alone cannot deter malfeasance by the bandit or bureaucrat. As long as the supervisor is not too strong ($\alpha < q$), the new efficiency wage level is

$$\bar{\bar{w}} = \bar{w}\frac{q}{q-\alpha} > \bar{w}$$

Above that level, there exist no positive transfer to the supervisor that induces the bandit to engage in criminal activity.[72] The "efficiency wage" compatible with no malfeasance by the bandit is now higher than in the absence of a supervisor.[73] The effect of adding the supervisor is reduced by the probability of detection — and thus supervisor collusion has stronger impacts in weak states. In

[69]Here, we are assuming that the punishment for malfeasance is simply dismissal, which is the most frequent threat for enforcers. See Becker and Stigler (1974): "We assume that enforcers discovered committing such acts are simply dismissed. Although occasionally imprisonment and fines are imposed on enforcers discovered in the most flagrant bribe-taking, by far the most common sanction, if any, is dismissal."

[70]The supervisor can also make the bandit's life difficult by decreasing his payoff in $c$ if the bandit does not engage in criminal activities, in which case the efficiency wage changes by the inclusion of a new additive term.

[71]Finally, the supervisor cannot extract more than what the bandit collects, that is, he is subject to a resource constraint $T \leq b+w$, which as long as $v > 0$ never binds in equilibrium.

[72]In scenario 1, when $w < \frac{v}{1-\alpha}$, $T^* = b+w-v$ and the supervisor is residual claimant of criminal and legal revenues.The participation constraint binds, but the incentive compatibility constraint doesn't. All the surplus is absorbed by the supervsior, who can keep the bandit at his outside option if he gets caught and does not need to worry about his incentives. In scenario 2, when $w > \frac{v}{1-\alpha}$, the transfer to the supervisor is $T^* = (1-q)+qv+w(\alpha-q)$. The incentive compatibility constraint of the bandit binds, but the participation constraint does not. In that case, the higher is the legal revenue of the bandit, the less the supervisor can extract from him so as to protect the bandit's incentive for malfeasance (increases in bandit's compensation walk the supervisor down the incentive compatibility constraint).

[73]This is because the supervisor can hurt the bandit if he does not engage in criminal activity, so the higher is the cost that the supervisor can inflict on the bandit to incentivize him (as long as the share that the agent is able to keep is larger than $\frac{v}{w}$), the higher the "efficiency wage" compatible with no malfeasance.

the limit, if the bandit is always caught, the efficiency wage with and without supervisor are equal $v$ and there is no information asymmetry. Supervisor collusion increases the cost of preventing malfeasance as in Tirole (1986).[74]

If the bandit (the bureaucrat) can engage in multiple tasks, the government's objective function is $\theta = \sum_{i=1}^{i=n} \theta_i - w$, where $\theta_i > 0$ is the value in the government's objective function of task $i$.[75] If the government's information set is coarse (the government only observes whether a payment is made to the bureaucrat, but does not observe the task it is meant to distort), the government can write a contract whereby the bureaucrat is fired whenever a payment is observed. Of course, more tasks increase the cost of the government to deter malfeasance. The efficiency wage is

$$\bar{\bar{\bar{w}}} = \frac{1-q}{q-\alpha} \sum_{i=1}^{i=n} b_i + \frac{q}{q-\alpha} v$$

The government choice is reduced to setting a wage that deters malfeasance, or instead permitting malfeasance at the lowest possible wage allowed by law.[76] That is, the government's choice is limited to choosing between $w = 0$ and $w = \bar{\bar{\bar{w}}}$. In the second case, the bureaucrat receives a

[74] In this setting, we have assumed away the possibility that the government can offer a contract to the supervisor that is conditional on whether the government observes supervisor's corruption, which occurs with probability $q$. Suppose that the government offers to the supervisor a wage $w^s$. If the government observes corruption, the supervisor loses his job and gets outside option $v^s$, otherwise he gets $w^s + T^*$. The supervisor's efficiency wage is $\bar{w}^s = v^s + \frac{1-q}{q} T^*$. In that case, the government first chooses whether to disengage, in which case the government pays $w = 0$ and $w^s = 0$, or whether to curb corruption with wage policy. If the government chooses to curb corruption, it chooses between an efficiency wage for the supervisor ($w = v$ and $w^s = v^s + \frac{1-q}{q}(1-q)b$), which has a total cost of $TC^S = v + v^s + \frac{1-q}{q}(1-q)b$, or an efficiency wage for the agent, which has a total cost of $TC^A = \frac{1-q}{q-\alpha} b + \frac{q}{q-\alpha} v + v^s$. It is straightforward to see that as long as the probability of detection of supervisor's corruption, $q$, is smaller than the probability of street-level police agent's detection, $p$, the cost to the government of deterring corruption, $TC^{NS} barw = v + \frac{1-q}{q} b$, is lower in the absence of a supervisor than $TC^S$ and $TC^A$.

[75] Consider first problem of the bureaucrat. The supervisor takes this problem as given to set his vertical transfer, and the government takes the solution to both to set the wage. If the bureaucrat refrains from malfeasance, he gets $(1-\alpha)w$. If he engages in malfeasance, however, he risks getting caught independently of the tasks he engages in. The bureaucrat's problem in that case is to maximize $(1-p)(\sum_{i=1}^{i=n} b_i + w - T)$. By deterring malfeasance, the government reduces the provision of the socially efficient tasks. The bureaucrat engages in malfeasance if $pv + (1-p)(\sum_{i=1}^{i=n} b_i + w - T) > 1 - \alpha$. The supervisor then maximizes $T$ subject to the ICC $pv + (1-q)(\sum_{i=1}^{i=n} b_i + w - T) \geq 1 - \alpha$ and to the PC $qv + (1-q)(\sum_{i=1}^{i=n} b_i + w - T) \geq v$. In scenario 1, $w < \frac{v}{1-\alpha}$ and $T^* = (1-q)\sum_{i=1}^{i=n} b_i + w - v$, while in scenario 2, $c < w - v$ and $T^* = (1-q)\sum_{i=1}^{i=n} b_i + qv + w(\alpha - q)$ and ICC binds.

[76] To see this, consider the two following observations. First, the government will never set a strictly positive wage below $\bar{\bar{\bar{w}}}$, since for all such wages, malfeasance occurs independently of the wage. Thus, if the government sets a wage below $\bar{\bar{\bar{w}}}$, then it will be $w = 0$. This is a case of weak government and "informal taxation:" corruption occurs and the public good is provided through corruption. Furthermore, if the government has control over $q$ and sustaining a level of $q$ is costly, the government might choose to withdraw from monitoring corruption, since it is costly and keeps malfeasance and the public good unaffected. Second, the government will never set a wage above $\bar{\bar{\bar{w}}}$, since above this new efficiency wage threshold, the bureaucrat engages in no malfeasance.

lower wage than his outside option, but malfeasance is his "compensating differential."

When will the government prefer to "disengage" and permit malfeasance? If $\theta < \dddot{\bar{w}}$, that is if $\theta < \frac{1-q}{q-\alpha}\sum_{i=1}^{i=n} b_i + \frac{q}{q-\alpha}v$, the government chooses to withdraw and pay no (or minimal) compensation. Thus, the government chooses to compensate the civil servant when the cost of the efficiency wage is low (the illicit revenue is relatively small, the bureaucrat's outside option is small, the supervisor's power is small, and when monitoring is relatively strong) and when the value in the government's objective function of curbing malfeasance is high (for instance, if the government values social welfare, when malfeasance is costly for society).

Weaker governments will find it optimal to permit corruption. First, certain governments might be unable to monitor many dimensions of effort of the civil servants. If the only task of the enforcers is to enforce the law (punishing violators), and the fine for a violator is assumed to be at its social optimum, then enforcement is privately costly for individual violators, but a positive expected rate of enforcement is beneficial for society, because it deters violation in the efficient amount. Refraining from enforcing the law (for instance, in exchange for bribes) benefits individual violators while it is costly for society because it increases violations beyond the socially efficient level. However, for some tasks, the enforcer's malfeasance can be beneficial for society. For instance, the enforcer can provide public order at no additional cost (for instance, using his coercive power to coordinate the flow of traffic). Since public order is also private good for agents, the bandit (bureaucrat) can require a bribe for the provision of order which he would otherwise not produce. Given obvious commitment problems (the bureaucrat might anticipate that civilians would defect), this can be solved by implicit contracts and sustained through repeated interaction. In this case, society (the government) can be better off permitting malfeasance on this task. Second, states with tight budget constraints will likely have low levels of monitoring. Efficiency wages in weak states are therefore likely prohibitive, and thus the state will likely prefer to disengage. Monitoring and the paying the official's efficiency wage are complements.[77]

[77]Consider the decision of the government to set the monitoring capacity. Suppose that the government can set $q$ at cost $\Phi(q)$, with $\Phi'(q) = \phi(q) > 0$ and $\Phi''(q) = \phi'(q) > 0$, so that the government's objective function is: $\sum_{i=1}^{i=n} \theta_i E_i - w$. At $w = 0$, the government's objective function is strictly decreasing in $p$, since it is costly, and it only reduces the provision of the public good, which the government values positively. Thus, at $w = 0$, the government withdraws altogether from monitoring malfeasance. Corruption is tolerated, because even if it undermines enforcement, it allows some socially efficient goods to be provided. Let's consider the optimal enforcement rate when the government's optimal choice of $w$ is $\dddot{\bar{w}}$. The optimal rate of monitoring is set by the first order condition: $\phi(q^*) = \frac{1-\alpha}{(q-\alpha)^2}\sum_{i=1}^{i=n} b_i + \frac{\alpha}{(q-\alpha)^2}v$. Higher enforcement simply reduces the minimum efficiency wage, leaving malfeasance unaffected. The optimal level of $q$ for the government is increasing in $b_i$, $n$, $v$. Furthermore, if $\sum_{i=1}^{i=n} b_i - v < 2\Phi'(q)(q-\alpha)$, optimal monitoring increases in the power of the supervisor, $\frac{dp}{d\alpha}$.

This framework illustrates a major shortcoming of the typical approach to corruption. Optimal compensation depends on the structure of informal governance in the administration. Supervisors can use informal power to absorb the income of the bureaucrats they supervise and distort the bureaucrat's incentives to engage in corruption. This implies that compensation for state officials can be partly absorbed by their supervisors, reducing its desired effect and increasing the level of optimal compensation.

# D Appendix Figures

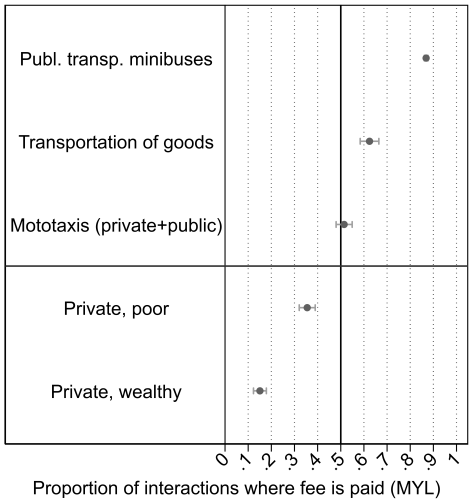
Figure D.1: Typical police station



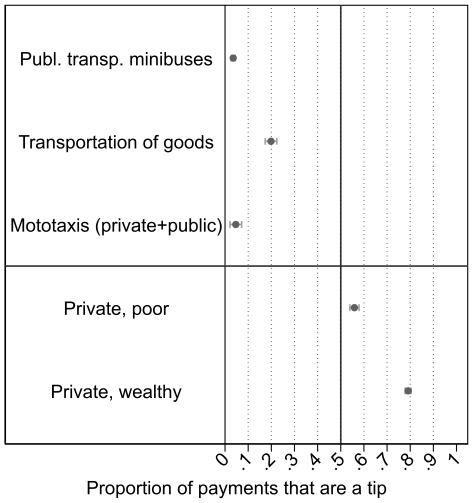

*Notes*: This figure shows a typical police station in the study's city. Police stations are small, which enabled the FCA agents to directly observe and overhear all negotiations between JPO's and drivers.

Figure D.2: Stylized facts—bribes by driver type

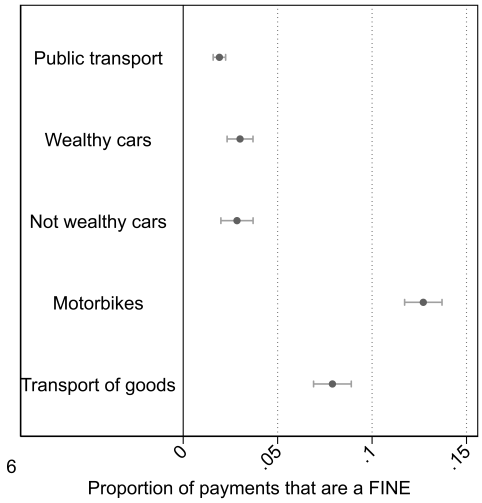
**PANEL A:** Drivers who pay toll fee




**PANEL B:** Drivers who pay tips



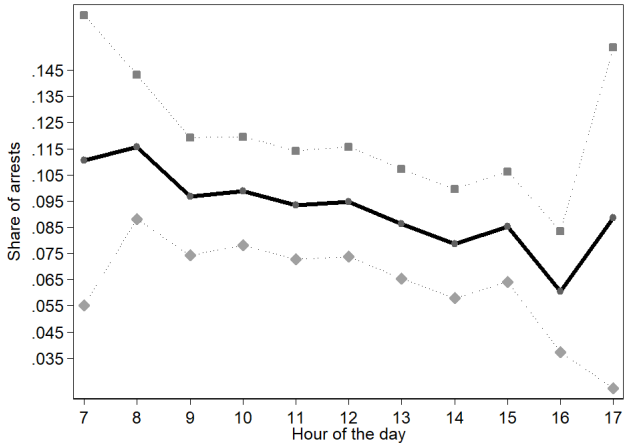

**PANEL C:** Drivers who pay harassment bribe



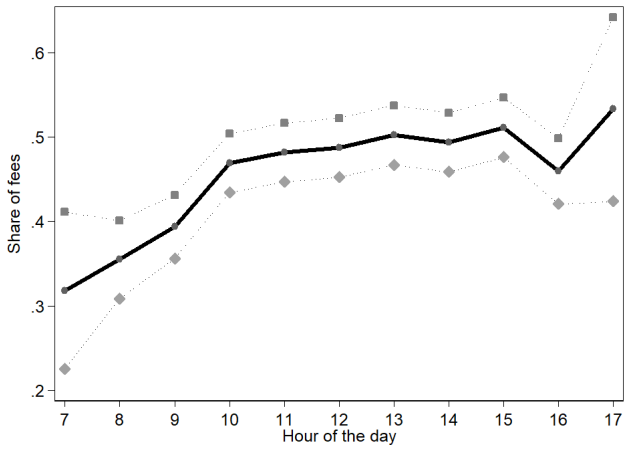

*Notes*: This figure shows properties of the typical bribes paid at the intersection, for different types of drivers. To construct this figure, we use the event dataset of 18,885 observed street interactions. We then regress a dummy for each bribe type on a dummy for whether the driver was of a given type, with no constant. The dots represent the coefficient on the driver type dummy, and the brackets represent the confidence intervals.

Figure D.3: Bribe-taking within the day

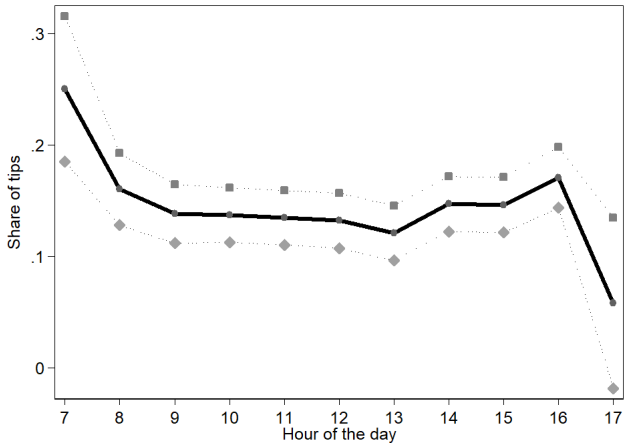
**Panel A:** Arrests




**Panel B:** Tolls

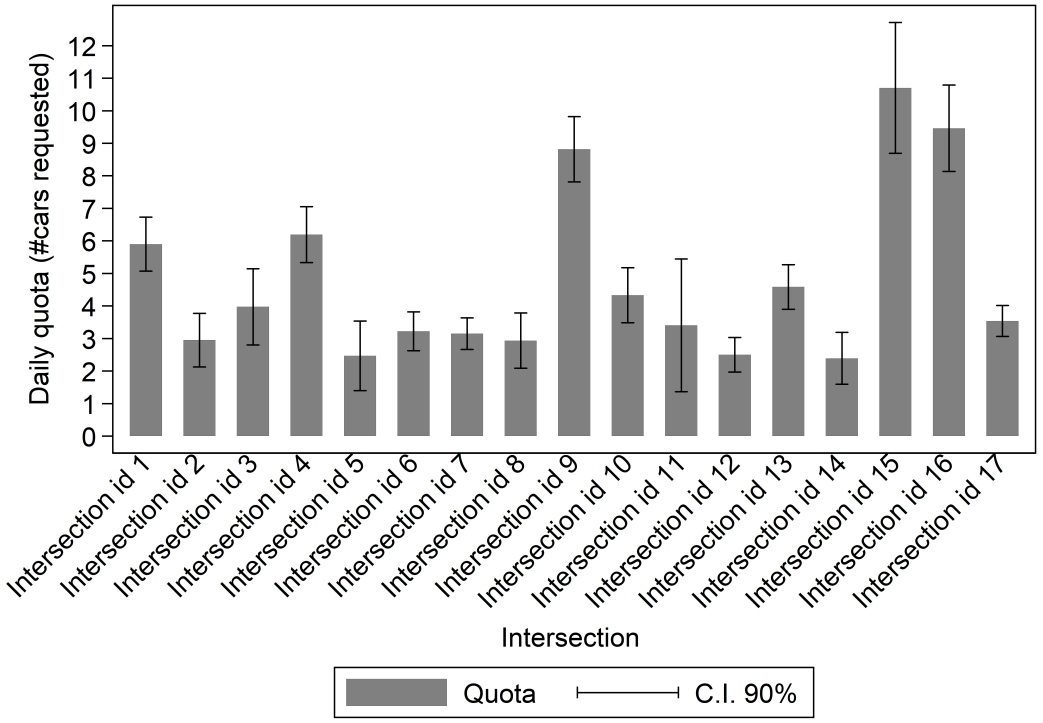



**Panel C:** Tips



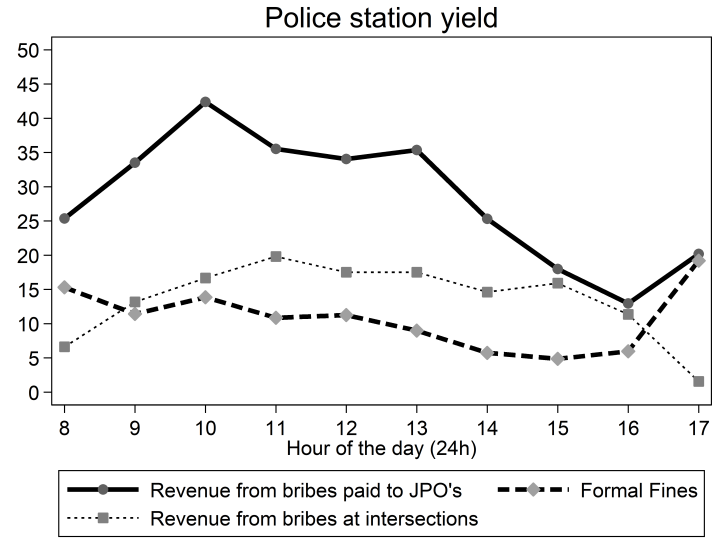

*Notes*: This figure shows the types of bribes paid to street police agents over the day. We aggregated (summed) the 18,885 interactions between police agents and drivers to an intersection*day*hour dataset, and regressed the number of bribes observed for each type on hour dummies. The figures present the coefficient magnitudes and the associated confidence intervals.

Figure D.4: Average observed quotas, per intersection



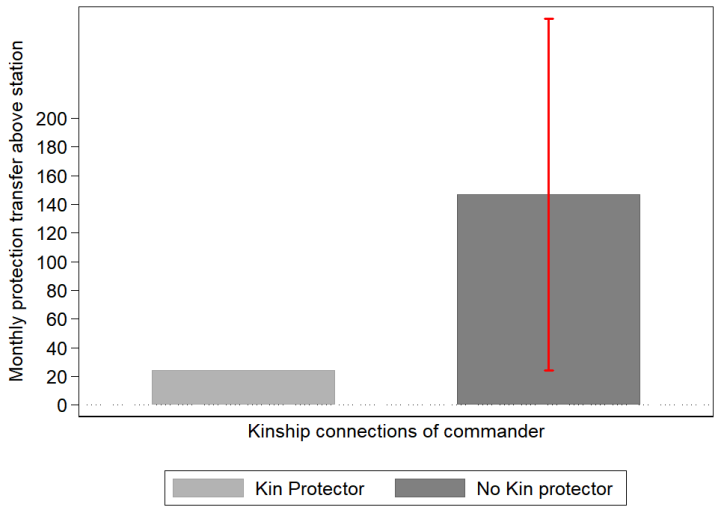

*Notes*: This figure shows the average quota for each intersection directly measured by the project. We regressed the quota level observed at day $t$ in intersection $i$ on intersection dummies, without a constant. The height of the coefficient indicates the intersection level average daily quota, and the brackets indicate 95% confidence intervals.

Figure D.5: Police station revenue within the day




*Notes*: This figure shows the average per hour police station yield in a day, computed averaging across police stations and study days. The thick black line indicates the hourly revenues from payments to the police at the police station (usually made directly to the JPO's in the police station). The dashed line indicates the hourly revenue in formal fines issued by the FCA agents in the police station (through a bank slip). The dotted line indicates the hourly revenue from street bribes for all the police teams associated to that particular police station (typically 2).

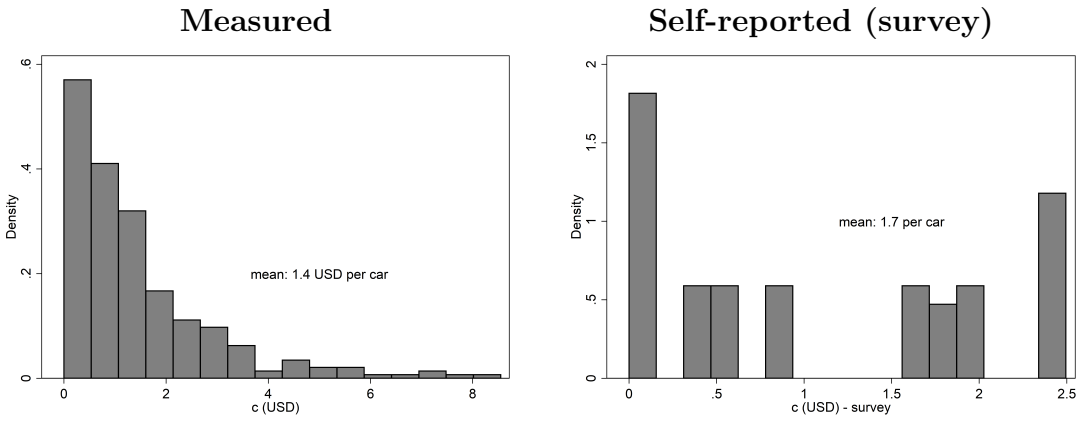
Figure D.6: Higher levels of the hierarchy



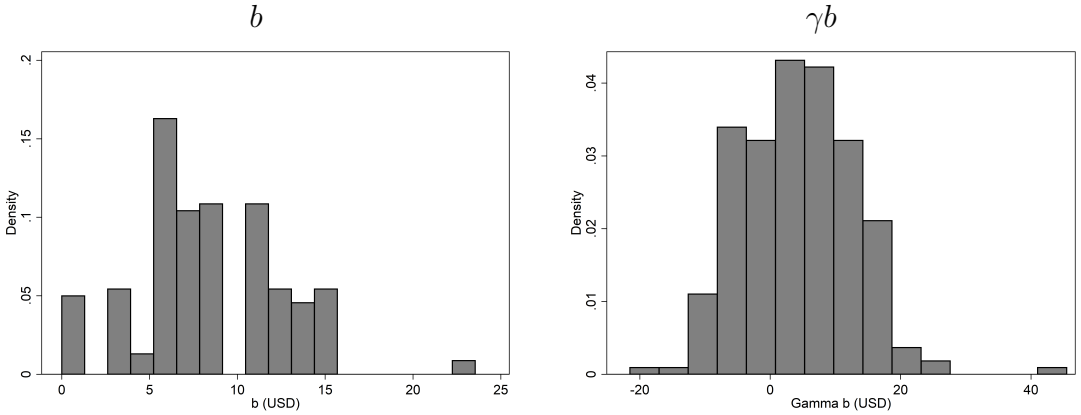

*Notes*: This figure presents the only data we were able to collect on transfers above the police station. Police commanders, to maintain the protection from their superiors in the police hierarchy, need to pay every month. The average payment is 92 USD monthly, and the maximum is 240 USD. The results from a survey implemented two years after the study suggest that payments are only made by police station commanders who do not have a kin protector at upper levels of the hierarchy, those having one pay 8 times less on average. This suggests that social networks and markets for protection may be substitutes inside the hierarchy for the holding of valuable assets that yield corrupt revenue.

Figure D.7: Parameters in sample

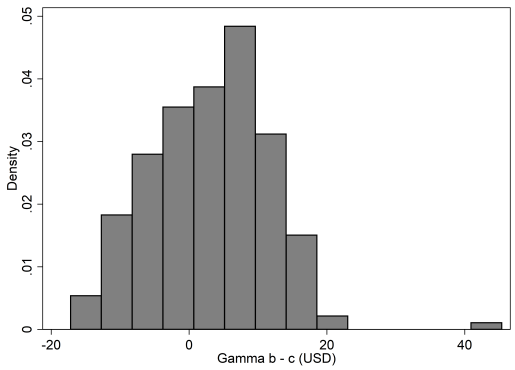
**Panel A:** Opportunity cost of escorting one driver, $c$ (USD)




**Panel B:** Revenue (USD)

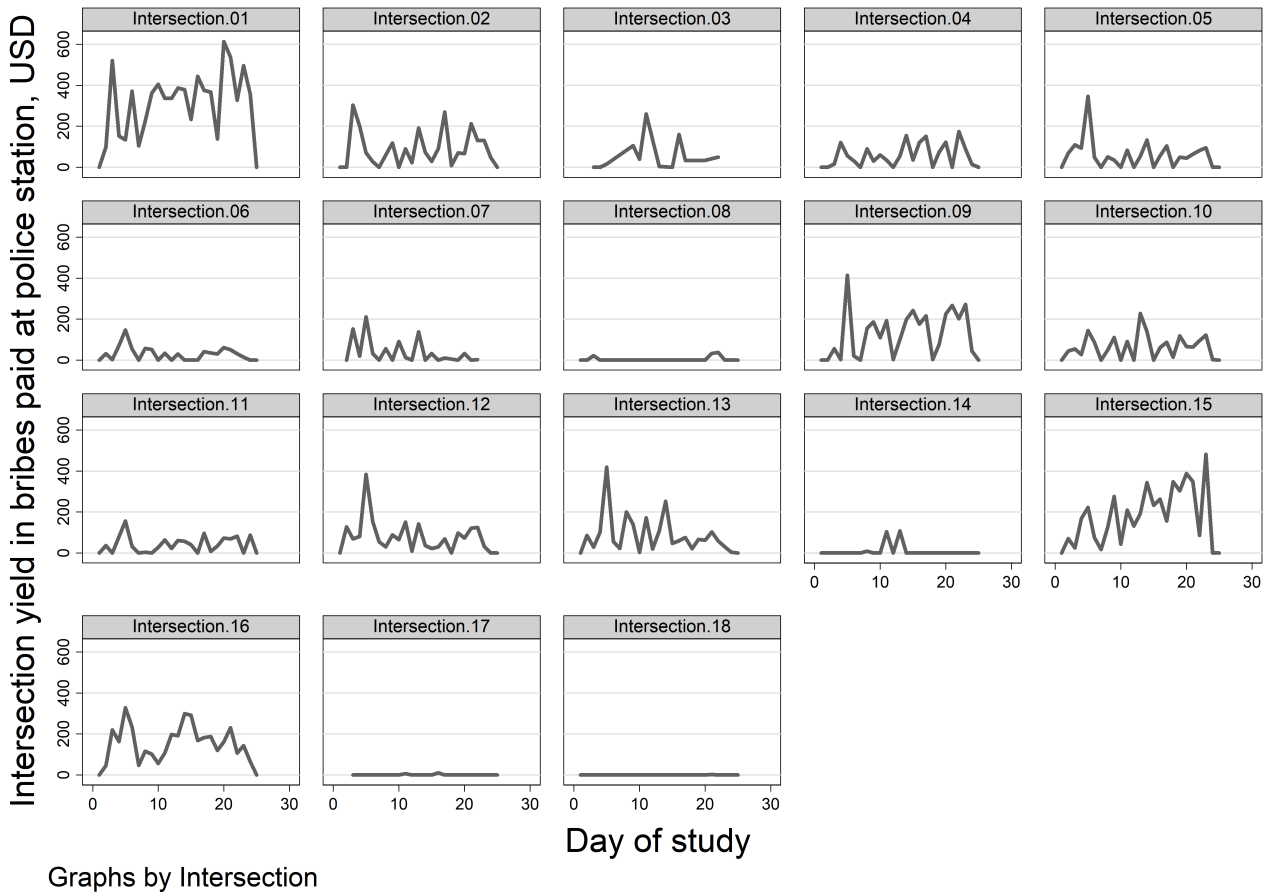



**Panel C:** $\gamma b - c$ (USD)



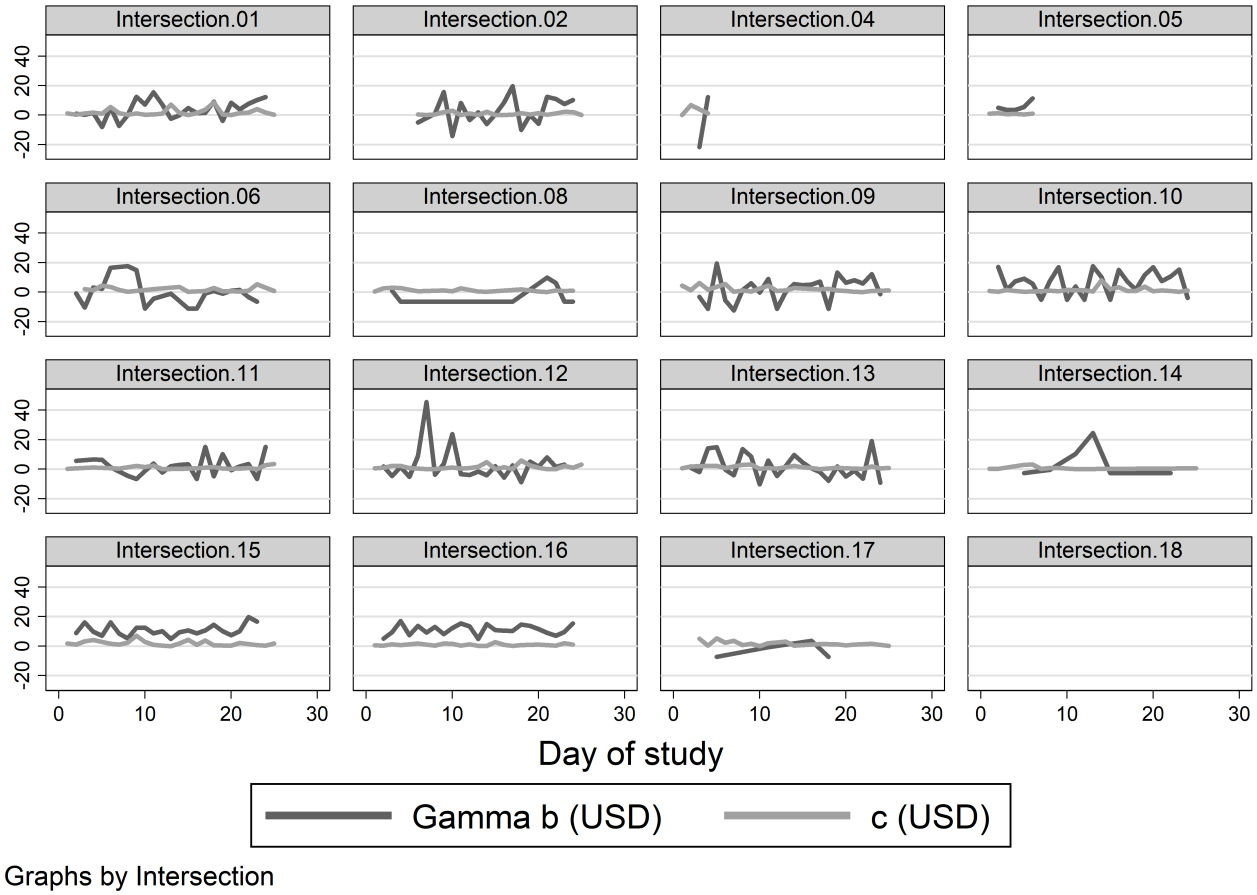

*Notes*: This figure shows the model coefficients estimated from the data through direct measurement and, when applicable, compares it to the distribution of self-reported outcomes in the exit survey. Panel A shows the estimated opportunity cost in USD of escorting a driver to the police station. To estimate this quantity in the data (left panel), we computed the average time it takes for a police agent to escort a driver until the police agent is seen again at the intersection, and multiplied it with the average revenue generated per unit of time by a street-level police agent at that intersection. The resulting opportunity cost is thus expressed in terms of USD per car escorted. The right panel presents the police agents' own guess for what the opportunity cost per car may be. The estimated opportunity cost per car is 1.4 in contrast to 1.7 for the self reported. Panel B shows the revenue per harassment bribe at the intersection (left panel) and the term $\gamma \bar{b}_{it}$, indicating marginal revenue gained from extracting a bribe at a police station instead of the intersection. Finally, Panel C shows the distribution of the term $\gamma \bar{b}_{it} - c_{it}$, indicating the marginal benefit of allocating a driver to the police station, net of the opportunity cost of escorting the driver.

Figure D.8: Estimated parameters: Intersection yield in bribes paid at police station per day $(1+\gamma)\bar{b}$, USD




*Notes*: This figure presents the daily aggregate revenues from bribes paid at the corresponding police station $(1+\gamma)\bar{b}$, for each intersection over the study period. We compiled all the payments observed inside the police station by JPO's and FCA agents and constructed a total revenue from bribes paid to the police at the police station for each day, and for each intersection. Since a police station can have multiple intersections, and since we observe the origin intersection where each driver at the police station was arrested, these indicate the yield of each intersection at its corresponding police station.

Figure D.9: Estimated parameters—Marginal revenue and marginal cost of allocating a car from the intersection to its police station for bribe-taking $\gamma\bar{b}$, $c$ in USD

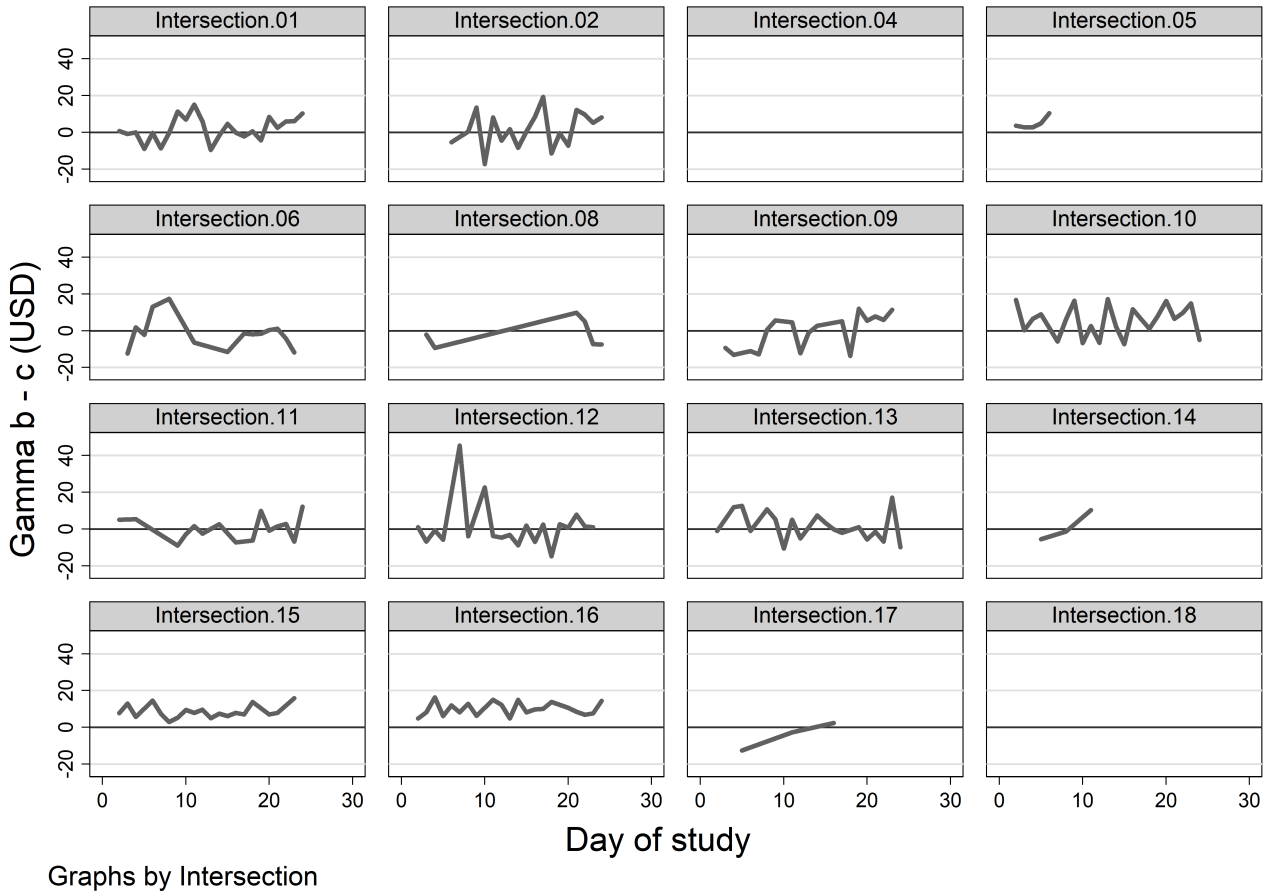



*Notes*: This figure shows the distribution over the days in the study of the estimated term $\gamma\bar{b}_{it}$, indicating marginal revenue gained from extracting a bribe at a police station instead of the intersection. Since a police station can have multiple intersections, and since we observe the origin intersection where each driver at the police station was arrested, these indicate the yield of each intersection at its corresponding police station.

Figure D.11: Allocation of treatments over time

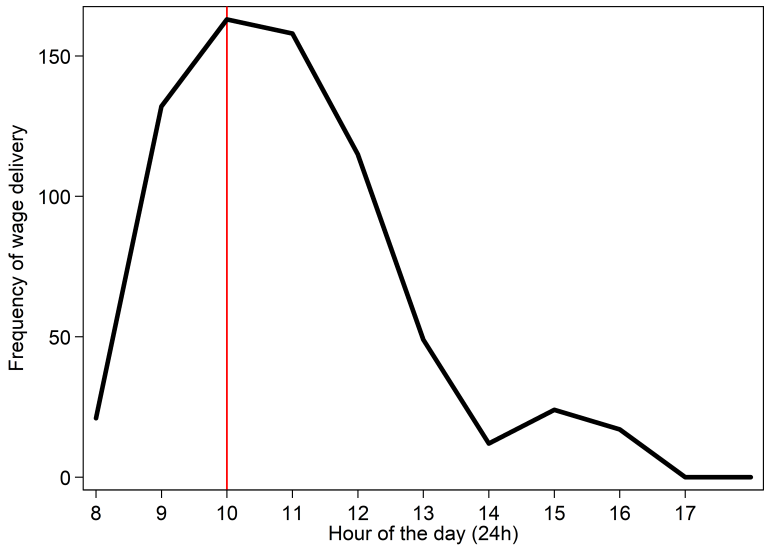
**Panel A:** Income intervention
**Panel B:** Quota reduction intervention

Figure D.10: Estimated parameters—Net marginal benefit of allocating a car from the intersection to its police station for bribe-taking $\gamma\bar{b} - c$, USD




*Notes*: This figure shows the distribution over the days in the study of the estimated term $\gamma\bar{b}_{it} - c_{it}$, indicating the marginal benefit of allocating a driver to the police station, net of the opportunity cost of escorting the driver. Since a police station can have multiple intersections, and since we observe the origin intersection where each driver at the police station was arrested, these indicate the yield of each intersection at its corresponding police station.

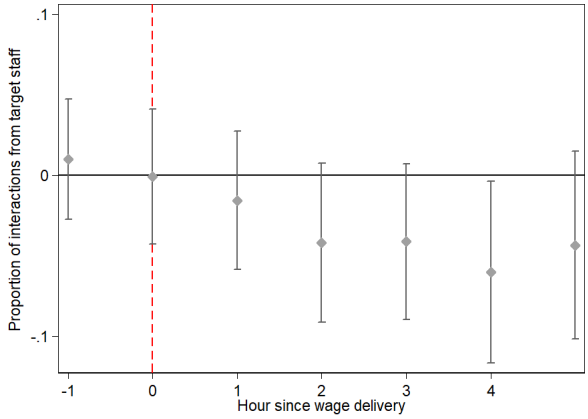
Figure D.12: Within day variation in the delivery of the income treatment



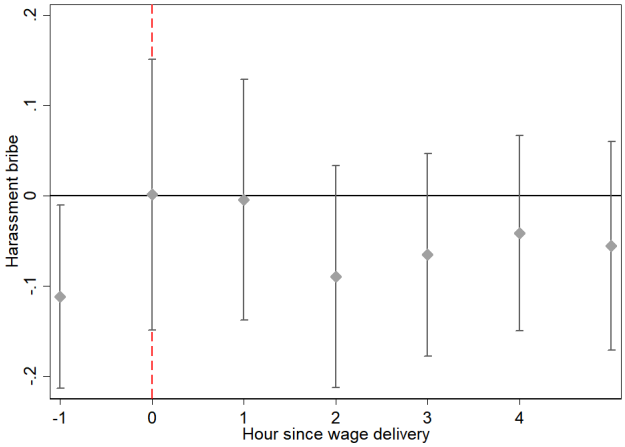

*Notes*: This figure shows the frequency of the hour at which the income treatment was distributed in a typical day. The modal delivery hour is 10 am. Not all intersections that are selected for the intervention in a given day receive it at 8am, reflecting that the income treatment team had to cover long distances.

Figure D.13: Productive corruption—Additional figures

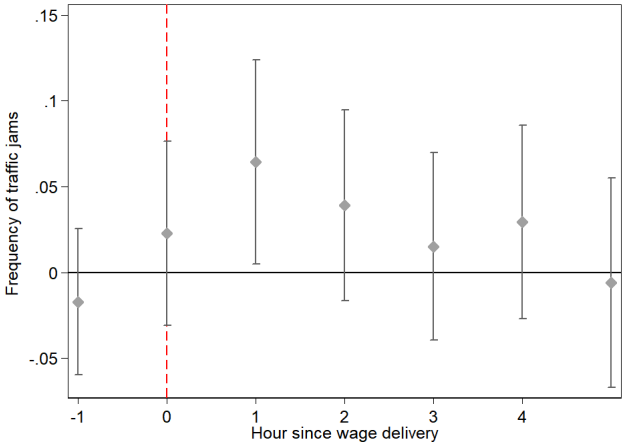
Panel A: Police agent presence at their intersection




Panel B: Frequency of harassment bribes

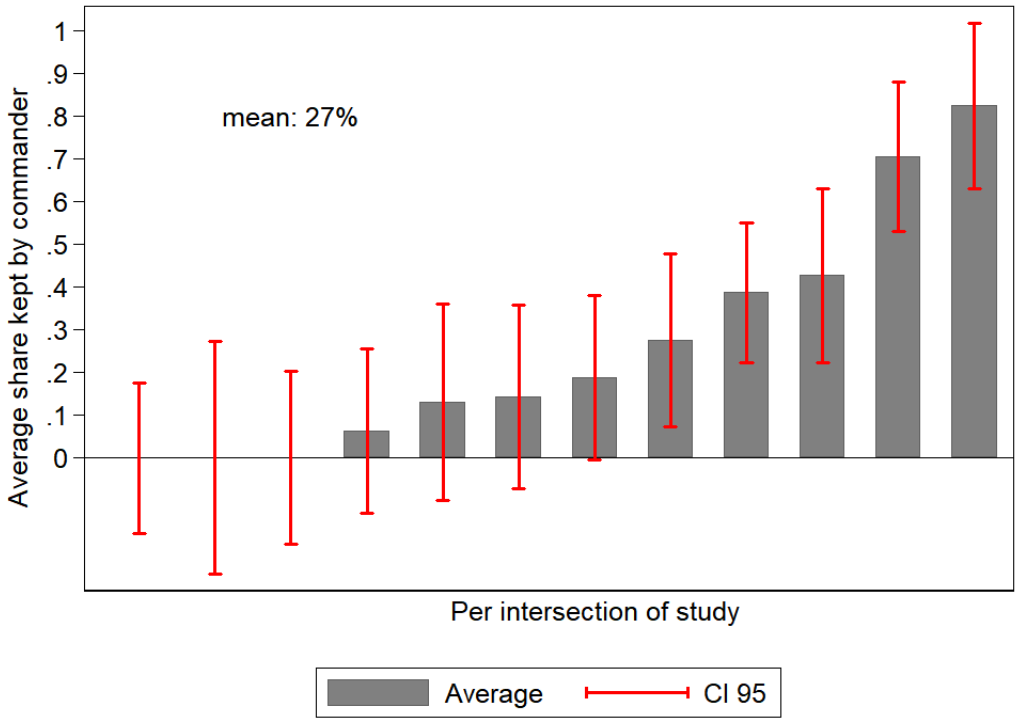



Panel C: Frequency of traffic jams



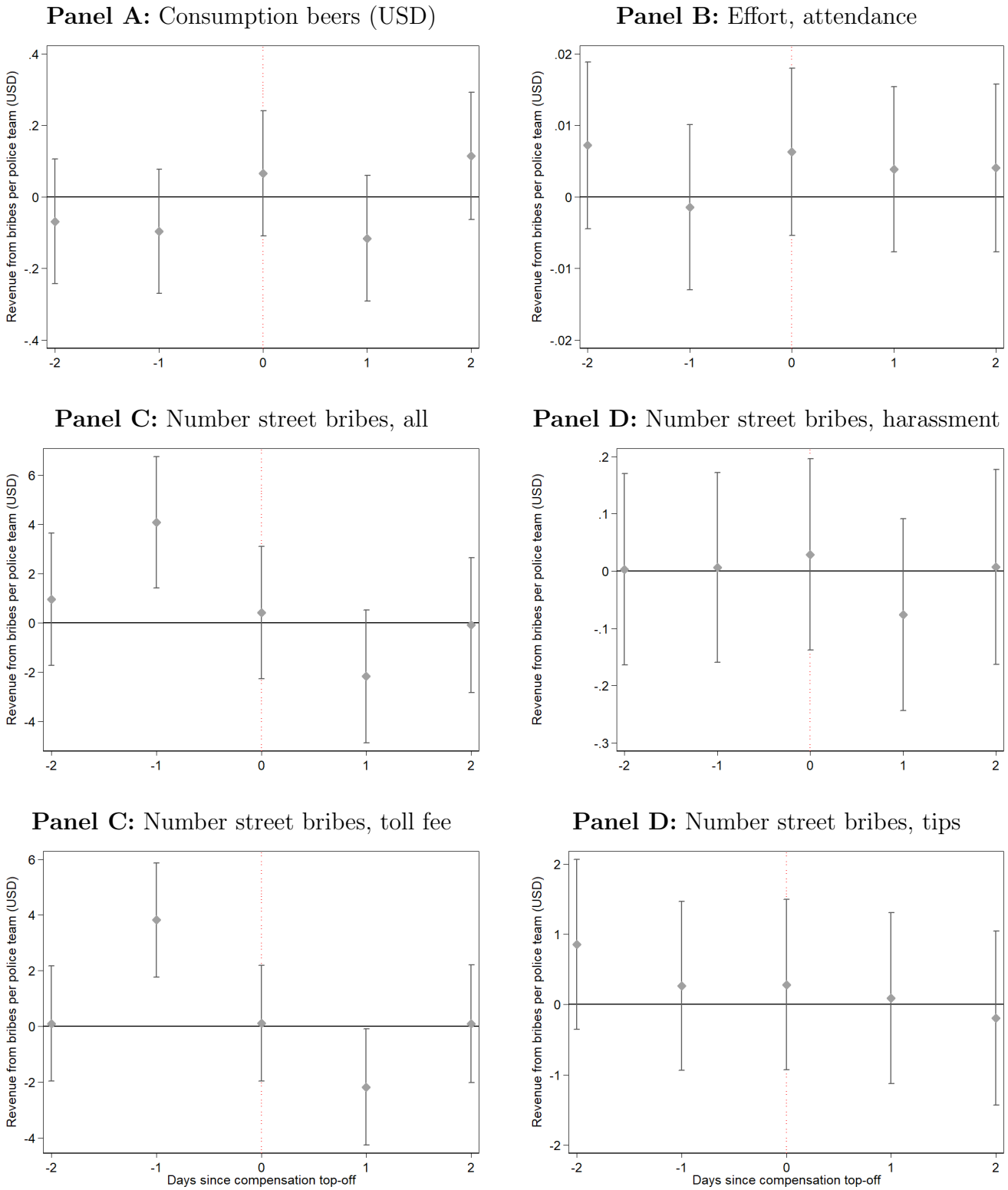

*Notes*: This figure presents the results from specification 3. We create a dummy which, for each intersection*day*hour, indicates whether the income has been delivered using the process tracking supervision sheets for the study. We then regress the hourly aggregates for presence of street-level police agents (Panel A), harassment bribes (Panel B), and occurrence of traffic jams (Panel C) on the contemporanous hour-level treatment, one lead and 5 lags. The dots indicate the size of the coefficient for each lead/lag, the brackets indicate the 95% confidence intervals, and the red dashed line indicates the hour at which the income treatment was delivered according to the process tracking sheets.

Figure D.14: Average share of wage absorbed byc commander




*Notes*: This figure shows the average share of the income intervention that was "taxed" by police station commanders, for each intersection of the study. We regressed the observed share at day $t$ for intersection $i$ on dummies for each intersection. The height of the bars indicates the coefficents magnitude for each different intersection and hence indicate the average for each intersection. The red bracketed line indicates the 95% confidence interval.

Figure D.15: Corrupt hierarchy – Implications for corruption effort and revenue (Effect of reducing the quota)




*Notes*: This figure reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$. The figure focuses on the effect of income to examine whether it arises from spurious trends, since the effect of quota is statistically insignificant. Each panel gives the results of the OLS regression of the dependent variable listed in the panel title on dummy variables indicating the contemporaneous, lagged, and lead income treatment status (the quota treatment is omitted and available upon request, since it is not significant). All regressions include, in addition, intersection/team of street-level police agent fixed effects, day fixed effects as described in Section 7.1. The sample is collapsed at the intersection/team ofstreet-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. The dependent variables are as follows. Panel A uses the amount in USD consumed by each police team/intersection $i$ at day $t$ in beer purchases, Panel B uses a proxy for street-level police agents' attendance at the intersections, Panel C uses the count of observed total bribe transactions by the police team, Panels D through F decompose it, respectively using the counts of harassment bribes, toll fees, and tips.

# E Appendix Tables

Table E.1: Data collection system—Information leakage management

| | Police officers | Police team leader | Station JPO's | Station F.C. Agent | Station Commander | Minibus driver | Minibus observer | Street Observer | Sup. street | Sup. Minibus | Sup. F.C. Agent | Sup. JPO's | Wage team | Auditor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Police officers | | | | | | | | | | | | | | |
| Police team leader | **yes**/**yes** | | | | | | | | | | | | | |
| JPO's | / | / | | | | | | | | | | | | |
| Station F.C. Agent | / | / | / | | | | | | | | | | | |
| Station Commander | / | **yes**/ | **yes**/ | / | | | | | | | | | | |
| Minibus driver | / | / | / | / | / | | | | | | | | | |
| Minibus observer | / | / | / | / | / | **yes**/**yes** | | | | | | | | |
| Street Observer | **yes**/ | **yes**/ | / | / | / | / | / | | | | | | | |
| Sup. Observer | / | **yes**/ | / | / | / | / | / | **yes**/**yes** | | | | | | |
| Sup. Minibus | / | / | / | / | / | **yes**/ | **yes**/**yes** | / | / | | | | | |
| Sup. F.C. Agent | / | / | / | **yes**/ | / | / | / | / | / | / | | | | |
| Sup. JPO's | / | / | **yes**/ | / | **yes**/**yes** | / | / | / | / | / | / | | | |
| Wage team | **yes**/**yes** | **yes**/**yes** | **yes**/ | / | **yes**/**yes** | / | / | **yes**/**yes** | / | / | / | **yes**/ | | |
| Auditor | **yes**/**yes** | **yes**/**yes** | **yes**/**yes** | / | **yes**/ | / | / | **yes**/ | / | / | / | **yes**/**yes** | **yes**/**yes** | |

*Notes*: This table shows the allocation of the information about the different research components across the different actors. The table reports whether the actor on the left was informed of the activity of the actor on the right

Table E.2: Summary statistics—Psychological traits

| | Mean outcomes | | Difference |
|---|---|---|---|
| | Police agents | Population | Police agents-Population |
| | (1) | (2) | (3) |
| *Panel C: Police agents* | | | |
| Z-score of State of Anxiety | 0.61 | -0.05 | 0.67*** |
| | (0.33) | (0.65) | (0.09) |
| Normalized Raven score | 131.14 | 97.33 | 33.81*** |
| | (23.54) | (10.35) | (1.66) |
| Z-score of Magic Beliefs | -0.03 | 0.00 | -0.04 |
| | (0.35) | (0.61) | (0.08) |
| Z-score of Rational Experiental Inventory | 0.48 | -0.06 | 0.54*** |
| | (0.37) | (0.55) | (0.08) |
| Z-score of Social Dominance Orientation | -0.03 | 0.00 | -0.03 |
| | (0.17) | (0.50) | (0.07) |
| Z-score of Right Wing Authoritarianism | 0.31 | -0.04 | 0.35*** |
| | (0.20) | (0.48) | (0.07) |
| Would prefer USD100 now over USD300 in a month | 0.09 | 0.42 | -0.33*** |
| | (0.29) | (0.49) | (0.07) |
| Would prefer USD100 now over USD300 in six months | 0.07 | 0.31 | -0.24*** |
| | (0.26) | (0.46) | (0.06) |
| Would prefer USD100 now over USD300 in twelve months | 0.07 | 0.28 | -0.21*** |
| | (0.26) | (0.45) | (0.06) |
| Z-score of Openess to experience | -0.64 | -0.02 | -0.62*** |
| | (0.50) | (0.45) | (0.06) |
| Z-score of Conscientiousness | -0.35 | 0.05 | -0.40*** |
| | (0.33) | (0.40) | (0.06) |
| Z-score of Agreeableness | 0.16 | 0.05 | 0.11** |
| | (0.29) | (0.37) | (0.05) |
| Z-score of Extraversion | -0.27 | 0.01 | -0.28*** |
| | (0.29) | (0.39) | (0.05) |
| Z-score of Neuroticism | 0.81 | 0.01 | 0.80*** |
| | (0.66) | (0.38) | (0.06) |
| Obs | 92 | 662 | . |

*Notes*: This table presents the psychological data collected in the exit survey to police agents, and compares it to the same data collected on a random sample of civilians. We implemented the standard anxiety scale, Raven's matrix 12 figures test, the scale of magical beliefs, which we adapted to the cultural context, the Rational Experiential Inventory, the Social Dominance Orientation scale, the support for Right Wing Authoritarianism scale, three standard survey-based time-preferences questions, and the Big 5 inventory list. For civilians, we implemented the 42 items list, while for street-level police agents we implemented the abbreviated 10 items list, due to the higher opportunity cost of time of street-level police agents. Psychological outcomes for civilians were measured separately in a random sample of villages and households in the province of North Kivu as part of another study. The difference in outcomes is thus only suggestive and can also capture regional differences. For more details on the sample, see Henn, Marchais, and Sánchez de la Sierra (2018). Their psychological characteristics coincide with the nature of their job: police agents are under pressure/stress to extract revenue and arrest cars, interact with the "customer" on a daily basis, and are significantly more exposed to currency and the associated counting and planning. Police agents have significantly more anxiety, IQ, are more rational (than intuitive), are more likely to support right wing authoritarianism, and are significantly more patient than the average civilian in the sample. Police agents also differ significantly on each of the Big 5 dimensions: they are less open to experience, less conscientious, and less extroverted, but they are significantly more agreeable and exhibit much larger levels of neuroticism.

Table E.3: Additional stylized facts of the corrupt hierarchy

| | Mean outcomes | | Difference | | |
|---|---|---|---|---|---|
| | All | Har. | Toll fee-Har. | Tip-Har. | Escorted-Har. |
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A: Properties of bribes* | | | | | |
| Amount | 0.67 | 7.98 | -7.39*** | -6.90*** | -7.98*** |
| | (1.63) | (6.96) | (0.07) | (0.14) | (0.19) |
| Duration (mins) | 1.01 | 6.92 | -6.54*** | -6.39*** | -2.70*** |
| | (2.98) | (8.24) | (0.09) | (0.16) | (0.36) |
| Hour of day | 12.19 | 11.99 | 0.29** | 0.30** | -0.25** |
| | (2.35) | (2.29) | (0.11) | (0.13) | (0.13) |
| Frequent driver | 0.56 | 0.37 | 0.42*** | -0.26*** | -0.00 |
| | (0.50) | (0.48) | (0.02) | (0.02) | (0.03) |
| Expensive car | 0.16 | 0.13 | -0.10*** | 0.42*** | -0.01 |
| | (0.37) | (0.34) | (0.01) | (0.02) | (0.02) |
| New car | 0.12 | 0.11 | -0.03** | 0.12*** | 0.03 |
| | (0.32) | (0.31) | (0.01) | (0.02) | (0.02) |
| Obs | 18885 | 425 | . | . | . |

*Notes*: This table presents stylized facts of the corrupt hierarchy. Panel A shows the properties of bribes paid to street police agents. There are 14,4439 bribes in the sample, observed from June 21st 2015 to July 20th 2015. Column (1) shows the mean properties of all bribes - amount in USD, hour at which it is observed, and properties of the driver: whether it is a frequent driver, whether he drivers an expensive car, and whether he drives a new car (standard deviation in parentheses). Column (2) does the same for those bribes which are harassment bribes, which is the typical bribe examined in the analysis of corruption in markets. Columns (3) to (5) report the difference in means between the three other types of police agent-driver interactions observed at the intersections (toll fees, tips, ad escorts) and harassment bribes (standard errors in parentheses). $*$, $**$ , and $***$ respectively indicate that the difference in means is statistically significant at the 1% level, 5% level, 10% level. Panel B shows the daily properties of bribes, street police agent behavior, and public service outcomes per intersection/police team. Panel C shows the daily properties, averaged at the intersection*day level, of police station corruption contracts and transactions from the intersection, the revenues from bribes paid inside the police station, and parameters estimating the relative performance of the police station with respect to the intersection to generate corruption revenue.

Table E.4: Identifying quotas as vertical corruption contracts

Panel A: OLS - Effect of actual quotas (observational)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | **Escorting** | | | **Revenue** | | | |
| VARIABLES | total # | commander | FCA | commander | FCA | commander | FCA |
| Quota level, s | 0.67*** | 0.56*** | 0.08** | 13.34*** | 3.08*** | | |
| | (0.11) | (0.09) | (0.03) | (2.34) | (1.13) | | |
| Escorting (Number cars to station) | | | | | | 15.03*** | 4.34*** |
| | | | | | | (2.79) | (1.32) |
| Constant | 2.37** | 0.52 | 0.98*** | 17.88 | 16.78** | 0.35 | 7.34 |
| | (1.20) | (0.74) | (0.34) | (20.98) | (7.47) | (10.14) | (5.30) |
| Observations | 325 | 325 | 325 | 325 | 325 | 334 | 334 |
| R-squared | 0.38 | 0.38 | 0.27 | 0.34 | 0.22 | 0.76 | 0.35 |
| Mean dep var | 5.018 | 2.865 | 1.115 | 71.63 | 25.05 | 71.63 | 25.05 |

Panel B: IV - Instrumenting actual quotas with experimental instruction to decrease the quota (# cars instructed)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| | **Escorting** | | | **Revenue** | | | |
| VARIABLES | total # | commander | FCA | commander | FCA | commander | FCA |
| Quota level, s | 0.39* | 0.20 | 0.10 | 2.95 | 2.54 | | |
| | (0.22) | (0.14) | (0.11) | (3.64) | (2.61) | | |
| Escorting (Number cars to station) | | | | | | 7.92 | 6.12 |
| | | | | | | (7.18) | (6.44) |
| Observations | 325 | 325 | 325 | 325 | 325 | 334 | 334 |
| R-squared | 0.65 | 0.66 | 0.39 | 0.66 | 0.36 | 0.81 | 0.44 |

*Notes*: This table validates that quotas are a meaningful instrument of the commander. Panel A, columns (1)-(5) regress the total number of cars escorted to the police station (column 1), the total number of cars that end up paying a bribe at the police station (column 2), the total number of cars that end up paying a fine in the police station (column 3), as well as the police station revenue from bribes (column 4) and from fines (column 5) on the observed quota. Columns (6) and (7) regress the police station revenues from bribes and fines on the observed number of cars escorted. All regressions include day fixed effects and cluster the standard errors at the level of the intersection, estimated through Wild-Bootstrap, to account for across day within intersection correlation. Panel B replicates Panel A, but instruments the observed quota level and the number of cars escorted with the experimental quota reduction. This allows to exploit within intersection but causally identified variation in quota levels and number of cars escorted. Regressions in Panel B include intersection and day fixed effects and use the vector of experimental treatments as instruments. Panel B yields an F statistic for the endogenous variable "quota level" of 103 with p-value of 0.00.

Table E.5: Corrupt hierarchy – Implications for corruption effort and revenue (morning and afternoon, decomposed)

Panel A: ITT - Effect of income received by street-level police agents and of quota reduction, am

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Consumption | # Bribes | # Bribes | # Bribes | Effort | Harassment | Congestion | Accidents |
| VARIABLES | Beers (USD) | harassment | toll fee | tip | Attendance | # events | dummy | dummy |
| T income | 3.79*** | -0.61** | 3.63 | -0.40 | -0.06 | -0.76 | -0.01 | 0.00 |
| | (0.58) | (0.27) | (2.70) | (1.36) | (0.05) | (0.86) | (0.07) | (0.04) |
| T quota | 0.04 | -0.01 | -0.56 | 0.20 | 0.00 | -0.07 | -0.00 | -0.01 |
| | (0.10) | (0.05) | (0.46) | (0.23) | (0.01) | (0.15) | (0.01) | (0.01) |
| Observations | 300 | 300 | 300 | 300 | 241 | 300 | 294 | 292 |
| R-squared | 0.57 | 0.22 | 0.42 | 0.25 | 0.49 | 0.31 | 0.30 | 0.21 |

Panel B: ITT - Effect of income received by street-level police agents and of quota reduction, pm

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Consumption | # Bribes | # Bribes | # Bribes | Effort | Harassment | Congestion | Accidents |
| VARIABLES | Beers (USD) | harassment | toll fee | tips | Attendance | # events | dummy | dummy |
| T income | 3.79*** | -0.62 | 2.84 | -0.20 | -0.08** | 0.97 | 0.14* | 0.05 |
| | (0.58) | (0.47) | (5.22) | (2.92) | (0.04) | (1.12) | (0.07) | (0.06) |
| T quota | 0.04 | -0.03 | 0.32 | -0.10 | 0.00 | -0.30 | -0.03*** | -0.02* |
| | (0.10) | (0.08) | (0.89) | (0.50) | (0.01) | (0.19) | (0.01) | (0.01) |
| Observations | 300 | 300 | 300 | 300 | 264 | 300 | 294 | 295 |
| R-squared | 0.57 | 0.23 | 0.49 | 0.22 | 0.52 | 0.38 | 0.43 | 0.16 |

*Notes*: This table reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Panel A does it for morning averages (before 12pm), and Panel B for afternoon average (after 12pm). Each column gives the results of the OLS regression of the dependent variable listed in that column on dummy variables indicating the income and quota treatment status. All regressions include intersection/team of street-level police agents fixed effects, day fixed effects, and the first lag of the income and quota treatment indicators, as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. Panel A presents the baseline specification 2, and Panel B uses the income and quota treatments as instruments for income actually retained by the police agents at the intersections, and for actual observed quota level. In both panels, the dependent variables are as follows. Column (1) uses the amount in USD consumed by each police team/intersection $i$ at day $t$ in beer purchases, column (2) uses a proxy for street-level police agents' attendance at the intersections, column (3) uses the count of observed total bribe transactions by the police team, columns (4) through (6) decompose it, respectively using the counts of harassment bribes, toll fees, and tips. Panel A, in addition, displays the mean of the dependent variable and the equivalent estimated effect from a complete elimination of the quota, derived from the estimated coefficient (which measures the effect per car reduced) and using each intersection baseline quota level.

Table E.6: Corrupt hierarchy – Implications for corruption effort and revenue (minibus data validation)

Panel A: Effect of income received by street-level police agents and of quota reduction, all day

| VARIABLES | (1) Effort Any Officer Seen | (2) Effort Correct Officers Detected | (3) # Bribes all | (4) # Bribes harassment | (5) # Bribes toll fee | (6) # Bribes tip |
|---|---|---|---|---|---|---|
| Extra income assigned (per 100 USD) | 0.00 | 0.01 | 0.00 | -0.03* | 0.04 | -0.01 |
| | (0.39) | (0.02) | (0.12) | (0.02) | (0.13) | (0.02) |
| Quota reduction (per car) | 0.16** | 0.02*** | -0.03 | 0.00 | -0.03 | 0.00 |
| | (0.07) | (0.00) | (0.02) | (0.00) | (0.02) | (0.00) |
| Observations | 1,138 | 1,138 | 1,138 | 1,138 | 1,138 | 1,138 |
| R-squared | 0.86 | 0.87 | 0.78 | 0.26 | 0.77 | 0.13 |
| Mean dep var | 5.685 | 0.201 | 0.848 | 0.0209 | 0.886 | 0.0151 |
| Quota reduction (in full) | 0.964 | 0.113 | -0.158 | 0.0273 | -0.182 | 0.0102 |

*Notes*: This table reports the experimental results on police-driver interactions from implementing specification 2 at the level of police team/intersection $i$ * day $t$, but uses the data from minibus observers as validation. Each column gives the results of the OLS regression of the dependent variable listed in that column on dummy variables indicating the income and quota treatment status. All regressions include intersection/team of street-level police agent fixed effects, day fixed effects, and the first lag of the income and quota treatment indicators, as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agent*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. Panel A presents the baseline specification 2 for all day, and Panel B presents it for morning averages, and Panel C for afternoon averages. In all three panels, the dependent variables are as follows. Column (2) uses a proxy for street-level police agents' attendance at the intersections. To construct this variable, we use a dummy indicating whether, for each drive-through, the minibus observer saw traffic police at the intersection. The dummies are then aggregated at an intersection*day level to the number of drive-throughs in which traffic police is observed. Column (2) uses a different proxy for attendance. If a payment is made, the observer notes the identifier of the street-level police agent. We construct a dummy indicating whether, at least once in the day, the observer noted that a payment was made to a street-level police agent that, according to our police roster, was supposed to be at that intersection. Column (3) uses the count of observed total bribe transactions by the police team, columns (4) through (6) decompose it, respectively using a dummy for whether a harassment bribe was made that day, the proportion of drive-throughs in which toll fees were paid, and the same for tips. All panels, in addition, display the mean of the dependent variable and the equivalent estimated effect from a complete elimination of the quota, derived from the estimated coefficient (which measures the effect per car reduced) and using each intersection baseline quota level.

Table E.6: Continued

Panel B: Effect of income received by street-level police agents and of quota reduction, morning

| VARIABLES | (1) Effort Any Officer Seen | (2) Effort Correct Officers Detected | (3) # Bribes all | (4) # Bribes harassment | (5) # Bribes toll fee | (6) # Bribes tip |
|---|---|---|---|---|---|---|
| Extra income assigned (per 100 USD) | -0.08 | -0.06* | 0.07 | -0.00 | 0.06 | 0.00 |
| | (0.22) | (0.03) | (0.06) | (0.01) | (0.07) | (0.01) |
| Quota reduction (per car) | 0.08** | 0.02*** | -0.02* | -0.00 | -0.02 | -0.00 |
| | (0.04) | (0.01) | (0.01) | (0.00) | (0.01) | (0.00) |
| Observations | 1,138 | 1,077 | 1,138 | 1,138 | 1,138 | 1,138 |
| R-squared | 0.71 | 0.74 | 0.52 | 0.10 | 0.51 | 0.08 |
| Mean dep var | 2.049 | 0.157 | 0.240 | 0.00502 | 0.255 | 0.00251 |
| Quota reduction (in full) | 0.484 | 0.122 | -0.118 | -0.00267 | -0.0944 | -0.000994 |

Panel C: Effect of income received by street-level police agents and of quota reduction, afternoon

| VARIABLES | (1) Effort Any Officer Seen | (2) Effort Correct Officers Detected am | (3) # Bribes all | (4) # Bribes harassment | (5) # Bribes toll fee | (6) # Bribes tip |
|---|---|---|---|---|---|---|
| Extra income assigned (per 100 USD) | 0.25 | 0.00 | -0.04 | -0.02 | 0.01 | -0.01 |
| | (0.24) | (0.03) | (0.09) | (0.02) | (0.11) | (0.02) |
| Quota reduction (per car) | 0.02 | 0.01*** | -0.03* | 0.00 | -0.03* | 0.00 |
| | (0.04) | (0.00) | (0.02) | (0.00) | (0.02) | (0.00) |
| Observations | 1,138 | 1,121 | 1,138 | 1,138 | 1,138 | 1,138 |
| R-squared | 0.81 | 0.80 | 0.66 | 0.15 | 0.65 | 0.08 |
| Mean dep var | 2.870 | 0.178 | 0.470 | 0.0125 | 0.495 | 0.0109 |
| Quota reduction (in full) | 0.142 | 0.0806 | -0.161 | 0.0141 | -0.177 | 0.00388 |

*Notes*: Notes for Panels B and C are provided in the previous page for the entire table.

Table E.7: Corrupt hierarchy – implications for welfare (minibus data validation)

Panel A: ITT - Effect of income received by street-level police agents

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Harassment** | | | **Congestion** | | | **Congestion** | | | **Drivers** | | |
| VARIABLES | Duration negotiation all day | Duration negotiation am | Duration negotiation pm | Traffic jam frequency all day | Traffic jam frequency am | Traffic jam frequency pm | time in traffic all day | time in traffic am | time in traffic pm | choice transit frequency all day | choice transit frequency am | choice transit frequency pm |
| Extra income assigned (per 100 USD) | -0.03 | -0.15** | 0.02 | 0.28 | 0.03 | 0.29* | 0.11 | 0.12 | 0.16 | 0.25 | 0.10 | 0.07 |
| | (0.05) | (0.06) | (0.06) | (0.22) | (0.11) | (0.15) | (0.08) | (0.10) | (0.12) | (0.41) | (0.28) | (0.27) |
| Quota reduction (per car) | -0.00 | 0.00 | -0.00 | -0.07* | 0.00 | -0.07*** | -0.01 | -0.01 | -0.01 | 0.10 | 0.16*** | 0.03 |
| | (0.01) | (0.01) | (0.01) | (0.04) | (0.02) | (0.03) | (0.01) | (0.02) | (0.02) | (0.07) | (0.05) | (0.04) |
| Observations | 737 | 629 | 659 | 1,138 | 1,138 | 1,138 | 1,095 | 1,074 | 1,071 | 1,138 | 1,138 | 1,138 |
| R-squared | 0.56 | 0.49 | 0.47 | 0.69 | 0.50 | 0.58 | 0.54 | 0.42 | 0.43 | 0.92 | 0.73 | 0.88 |
| Mean dep var | 0.427 | 0.363 | 0.413 | 1.595 | 0.538 | 0.855 | 0.818 | 0.756 | 0.876 | 11.80 | 4.384 | 5.975 |
| Quota reduction (in full) | -0.00305 | 0.0107 | -0.0250 | -0.425 | 0.0289 | -0.451 | -0.0471 | -0.0533 | -0.0564 | 0.602 | 0.987 | 0.165 |

Panel B: IV - Effect of income retained by street-level police agents (not taxed by commander)

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Harassment** | | | **Congestion** | | | **Congestion** | | | **Drivers** | | |
| VARIABLES | Duration negotiation all day | Duration negotiation am | Duration negotiation pm | Traffic jam frequency all day | Traffic jam frequency am | Traffic jam frequency pm | time in traffic all day | time in traffic am | time in traffic pm | choice transit frequency all day | choice transit frequency am | choice transit frequency pm |
| Income retained (per 100 USD) | -0.23** | -0.35** | -0.19 | 0.50 | 0.08 | 0.49 | 0.10 | 0.21 | 0.09 | 0.35 | 0.62 | -0.10 |
| | (0.09) | (0.14) | (0.14) | (0.59) | (0.30) | (0.39) | (0.17) | (0.16) | (0.25) | (0.82) | (0.57) | (0.59) |
| Quota level, s | -0.01 | -0.01 | -0.01 | 0.14* | 0.00 | 0.13*** | 0.00 | 0.00 | -0.00 | 0.06 | -0.03 | 0.05 |
| | (0.01) | (0.02) | (0.02) | (0.07) | (0.04) | (0.05) | (0.02) | (0.02) | (0.03) | (0.10) | (0.07) | (0.08) |
| Observations | 247 | 217 | 220 | 303 | 303 | 303 | 274 | 272 | 268 | 303 | 303 | 303 |
| R-squared | 0.59 | 0.44 | 0.47 | 0.67 | 0.53 | 0.57 | 0.29 | 0.30 | 0.30 | 0.95 | 0.83 | 0.92 |

*Notes*: This table replicates Table V using, data from minibus observers instead. This table reports the experimental results on public service outcomes from implementing specification 2 at the level of police team/intersection $i$ * day $t$. Each column gives the results of the OLS regression of the dependent variable listed in that column on dummy variables indicating the income and quota treatment status. All regressions include intersection/team of police street-level police agent fixed effects, day fixed effects, and the first lag of the income and quota treatment indicators, as described in Section 7.1. The sample is collapsed at the intersection/team of street-level police agents*day level to account for within intersection/team of street-level police agents*day correlation, and for comparison, since some variables are measured at the intersection/team of street-level police agents* day level. All standard errors are robust. Significance at the 10 percent level is represented by *, at the 5 percent level by **, and at the 1 percent level by ***. Panel A presents the baseline specification 2, and Panel B uses the income and quota treatments as instruments for income actually retained by the police agents at the intersections, and for actual observed quota level. In both panels, the dependent variables are as follows. Columns (1)-(3) use a proxy for harassment (the time spent negotiating with a street-level police agent) a given day at each police team/intersection $i$ at day $t$. Columns (4)-(6) use as dependent variable the number of passings by the minibus at the corresponding intersection in which a traffic jam was occurring. Columns (7)-(9) use as dependent variable the average time in minutes spent in transit at the corresponding intersection in the day. Finally Columns (10)-(12) use the number of times that the driver chose to pass by the corresponding intersection in a given day. Observers in minibuses had a pre-determined line path prompted by the survey application in the smartphone, and for each intersection at which they were supposed to pass, indicate whether the driver passed by the intersection or instead took a detour. Regressions for each outcome variable are shown as daily averages, morning averages, and afternoon averages. Panel A, in addition, displays the mean of the dependent variable and the equivalent estimated effect from a complete elimination of the quota, derived from the estimated coefficient (which measures the effect per car reduced) and using each intersection baseline quota level. The first stage in Panel B yields an F statistic for the endogenous variables "income retained" and "quota level" respectively of 50 and 51 with p-values of 0.00.