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Corruption in Hierarchies

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ABSTRACT. – We study the efficiency of measures to fight bribery in a three-tier organization when corruption can propagate within the hierarchy and officials privately know their propensity for corruption. We show that if the organization relies on internal labor markets or superiors choose the effort exerted in monitoring, then increasing wages and stiffening supervision may have perverse effects in the incentives of officials to act honestly, and therefore end up increasing the overall level of bribery.

Corruption dans les hiérarchies

RÉSUMÉ. – Il est admis, aujourd'hui, que la corruption peut être réduite en augmentant les salaires ou le degré de supervision des employés. Nous montrons que ces politiques peuvent, cependant, induire des effets pervers sur les incitations des agents à rester honnêtes si l'organisation repose sur un système de promotions internes ou si les supérieurs sont libres de choisir leur effort de supervision. En particulier, ces politiques peuvent augmenter le niveau global de corruption.

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1 Introduction

"*Next to tyranny, corruption is the great disease of governments. Skillful surgeons need more than a single way of curing the disease*".[1] Two questions naturally follow from this assertion. Which are the most effective medicines against this sickness? Are they equally effective in every situation? Intuitively, individuals in an organization are more prone to engage in corrupt activities when control is poor and when punishments are weak. Therefore, sticks and carrots that take the form of tight supervision and high wages respectively, are, at a first sight, measures that should always impair the development of corruption.

The purpose of this work is to analyze the relative efficiency of different anticorruption instruments. We show that, although some measures are likely to succeed in fighting corruption, none of them is *per se* effective: their incentive properties crucially depend on the structure of the organization considered. The aim of this exercise is not to discourage the practice of anti-corruption campaigns but rather to help in understanding how to maximize their efficiency. We focus on individuals who offer bribes in exchange for a good or a service that either cannot be obtained legally or bribing is the cheapest way to get it (say, because it accelerates the process). Examples include payments to custom bureau officers for overlooking illegal imports, bribes to tax examiners for reducing payments owed to the government, bribes to bureaucrats to avoid long delays in obtaining licenses and permits, farmers' payments to officials to get water diverted to their land from other parts of the system, etc. For our analysis, we build a model of corruption in a three-tier organization with the following characteristics.

i) The model is dynamic: at each period, agents compute their present discounted value of accepting a bribe (if they do, hereafter they are called "*corrupt*") and refusing it (hereafter "*honest*") and behave accordingly.

ii) The organization has a hierarchical structure. Superiors monitor the actions of agents who can engage in corrupt activities with clients. Corrupt agents should be denounced and fired. But corruption can propagate within the hierarchy. We capture this recursive property of corruption by assuming that agents can share the bribe with their superiors in exchange for not being denounced.

iii) There is heterogeneity both among agents and among superiors, who have different personal moral costs of engaging in corrupt activities (or, equivalently, different willingness to pay for keeping their job). As a result, two officials facing the same situation may behave differently.

iv) In a second step, we introduce the possibility of promotions within the hierarchy. Instead of hiring agents and superiors from different external populations, the organization replaces departing superiors with incumbent agents.

1. Many of the examples and motivations for this research, as well as this quotation, are taken from KLITGAARD's [1988] excellent book.

Then, promotions serve the purpose of screening agents and inducing honesty of those who desire to rise in the hierarchy.

v) Finally, we extend the analysis to include a cost of monitoring in terms of effort.

The contribution of the paper is twofold. From a methodological viewpoint, we propose an implicit-incentives, dynamic model of a three-tier organization with asymmetric information at two levels. This model allows for an analysis of promotions and optimal allocation of effort. Although it turns out to be particularly convenient for studying corruption, this framework can help in analyzing a wide variety of issues in organizations. From a policy viewpoint, we obtain original results on the efficiency of anticorruption campaigns. More precisely, we show that increasing wages or supervision of officials within organizations may increase the level of bribery in the economy.

Our conclusions can be summarized as follows. First, in the benchmark case where no promotions are possible, tightening supervision of agents by superiors and of superiors by principals makes corruption (as presumed) a more risky and therefore less attractive activity . Similarly, a rise in the officials' wage increases the opportunity cost of losing one's job and thus also deters corruption. Second, in an internal promotion system, new effects appear. For instance, higher wages at the top level (superiors) also *directly* encourages honesty at the bottom level (agents): the latter are concerned about their payoff in case of being promoted and therefore have even bigger incentives not to risk their current job. Interestingly, the result is different for a change in the supervision of superiors by the principal. Under internal labor markets, increasing the probability of detecting a corrupt superior *decreases the expected value of becoming a superior for agents who plan to accept bribes if they succeed in being promoted*. In consequence, these individuals have weaker incentives to obtain the reward of a promotion and hence to behave as honest agents; the global effect of that measure is, unlike in the case of no promotions, ambiguous. This conclusion has also nice applications for the theory of incentives. This literature has often been concerned with the differences between the incentive properties of sticks and carrots under a fixed budget constraint. Here, we argue that under a system of promotions, sticks (tough supervision) may be detrimental even if performed at no cost whereas carrots (high wages) are always effective in reducing corruption. Besides, it captures an important and often neglected issue: the returns of a job depend not just on the value of the job itself (wages, benefits, etc) but, also, on what can be obtained from that position. In developing countries, individuals accept low paid, public sector positions only as a necessary intermediary step towards a (possibly corrupt) highly valuable job.[2] This must be taken into account when designing measures to fight corruption. Last, we show that when superiors choose the monitoring effort, increasing the superiors' wage or probability of being detected has two effects. On the one hand, it prevents superiors from being corrupt (and therefore, it implicitly makes corruption at the agent's level more costly). But, on the other hand, for those

2. For example, manufacturers in Indonesia openly state: "*being a tax collector is better than owning a clove tree*" (*New York Times*, January 7, 1983, page A2).

superiors who still decide to be corrupt, it also decreases the incentives to monitor. This second effect fosters agent's dishonesty (less monitoring of superiors encourages corruption of agents) and may outweigh the first one. Overall, hard working (and possibly corrupt) supervisors can be less harmful for the organization than their lazy, honest peers. Once again, decision makers should internalize these effects when designing anticorruption policies.

Surprisingly, until recent years, little theoretical attention has been devoted to the problem of corruption and more specifically to the ways of fighting it.[3] Among the exceptions, most papers (LUI [1986], CADOT [1987], ANDVIG and MOENE [1990], SAH [1991] or CARRILLO [1999]) focus on the existence of multiple equilibria to explain why the extent of the corruption problem greatly differs among similar countries (Zaire and Kenya, Mexico and Costa Rica, etc). Other works (TIROLE [1986,1992], KOFMAN and LAWARRÉE [1993,1996], LAFFONT and MARTIMORT [1997] among others) examine collusion-proof contracts in different principal-agent frameworks. BASU *et al.* [1992] is the closest paper to our work. It introduces a hierarchical structure with the possibility of corruption at different levels and analyzes the penalty needed to avoid corruption. As in our model, they find that this value is greater when the complete hierarchical structure is considered. However, it is an exogenously given function (controlled by the government) of the size of the bribe. Besides, it has to be always higher than the agents' current payoff, which is possible because in their model agents are not cash constrained. Furthermore, they do not consider different types of agents, so in equilibrium all agents are honest or all are corrupt. In our study, the cost to the officials of the penalty is individually and implicitly determined by the dynamics of the model (it is the cost of losing the job in terms of foregone future payoffs). Moreover, because of the asymmetry of information, we can analyze the marginal effects on the proportion of corrupt officials of increases in the measures to control corruption. Further, as mentioned above, the concerns of our paper are different: we extend existing models of hierarchies to allow for different organizational structures (relying on external or internal labor markets) and discuss the optimality of anticorruption policies highlighting the emergence of potentially negative effects. To the best of our knowledge, none of the existing works deal with these issues.

The basic hierarchical model is presented in section 2. In section 3, we analyze how the results change when we rely in a system of internal promotions. In section 4, we discuss the negative effects of anticorruption measures when superiors are subject to moral hazard. Finally, section 5 concludes. Proofs of the main propositions are relegated to the Appendix.

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3. A number of reasons have been suggested. First, "*revisionists*" argue that corruption has also benefits; for example, it is an efficient way of avoiding red tape. When we consider cases such as grafts to policemen for overlooking prostitution, gambling or drug trafficking this argument is not very convincing. More importantly, as argued by ACEMOGLU and VERDIER [1998] and BANERJEE [1997], corruption has a more basic cost: it deters *ex ante* incentives to invest because *ex post* individuals do not reap the whole benefits of such investments. Second, corruption is usually considered a LDCs' problem due to their cultural and economic situation. The recent examples of scandals in Spain, France, Italy and Japan show that not a single country is immune to this disease. In our view, these reasons cannot justify the lack of interest.

2 The Model with External Labor Markets

We focus on an organization with a three-tier hierarchical structure. Agents are in direct contact with clients or customers and therefore may engage in corrupt practices (side trades). Superiors supervise the activity of agents. Unlike most analyses of corruption, we suppose that superiors can also be corrupt. For simplicity, we "*stop the chain*" at this level and suppose that superiors are themselves supervised by an incorruptible principal (Court, medias, etc). Parties face the following specific situation.

– *Clients*. At each period (time is discrete), new clients arrive and are randomly matched with agents. They have a fixed, known valuation or maximum willingness to pay y for a service or a good that cannot be obtained legally. We assume that they are not exposed to retaliation for offering bribes so, at every date, they are ready to offer up to y in order to obtain the service.

– *Agents*. They have all the bargaining power. Therefore, either they offer the service to the clients in exchange of the full surplus y or simply refuse any deal.[4] Taking the first action gives an instantaneous extra monetary gain. However, it exposes agents to be detected by superiors and possibly denounced and fired, in which case they lose all the future rents of the job. Per-period rents are formalized as:

(i) a wage w_A received at the end of each period,
(ii) a private information, non-monetary gain of keeping the job θ (where $\theta \in [\underline{\theta},\overline{\theta}]$ with c.d.f. $F(\theta)$).

The parameter θ may be interpreted as the moral cost of being fired (in terms of integrity, reputation, dishonor of a shameful action, etc.) or simply the personal willingness to pay for keeping the job. What matters for our theory is that individuals' total payoffs are private information. Therefore, two agents facing the same situation may behave differently. Finally, if an agent decides to be corrupt and he is not detected, he adds to the previous rents the value of the bribe y.

– *Superiors*. At each period, superiors are also randomly matched with agents. In many organizations, this assumption is not realistic. However, it allows us to refrain from considering strategies of reputation that arise in repeated games. On the other hand, rotating officials in jobs subject to corruption is a common practice (*e.g.* it has been one of the anticorruption measures adopted in the Bureau of Internal Revenue of Philippines, see KLITGAARD [1988]). Corrupt agents are caught by superiors with probability q (< 1). An alternative (but formally equivalent) interpretation is that superiors supervise agents with probability q and, whenever there is supervision, detection occurs

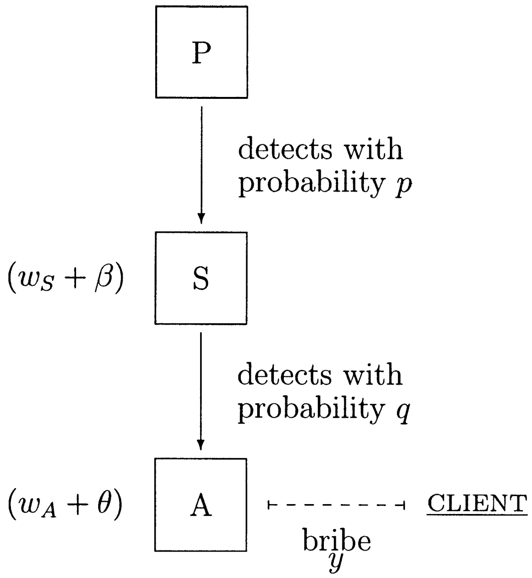
4. In a related paper (CARRILLO [1999]), I derive the optimal size of the bribe when clients have all the bargaining power. In that case, offering bigger bribes implies a higher probability of a profitable corrupt trade but a smaller residual gain of obtaining it. It is shown that there is a continuum of steady state equilibria where the same bribe is offered at every period.

with probability 1. A superior can denounce an agent when he has evidence of corruption. In that case, the agent is optimally fired, loses all future rents on the job (we do not model the outside market and simply suppose that, after being fired, he gets zero payoff thereafter) and the bribe is confiscated. However, the superior can also decide to get the agent's full bribe y in exchange of not denouncing him.[5] As noted by KLITGAARD [1988] in the examples of Philippines, Hong Kong and Singapore, there is considerable evidence that bribes spread up in the hierarchy. The rents of the superiors are formalized like the rents of the agents. As long as they stay on the job, they get:

(i) a wage w_S, and
(ii) a private gain of keeping the job β (where $\beta \in [\underline{\beta}, \overline{\beta}]$ with c.d.f. $G(\beta)$ has the same interpretation as θ previously).

Once again, superiors keep the bribe if they discover and do not denounce crooked agents, provided that they are themselves not caught.

FIGURE 1



5. We suppose that agents are cash constrained, so superiors cannot extract the agents' future gains of keeping the job. Besides, at each period agents consume all the rents so superiors cannot ask for past bribes or past wages either. In practice, this seems quite natural as it is hard for superiors both to know the agents' exact valuation of their job and to enforce any agreement of payment besides their cash-on-hand.

The fact that bribes are confiscated implies that agents strictly prefer to be detected by a corrupt superior (and lose the bribe) rather than by an honest superior (and lose the bribe *and* the job). Admittedly, in some situations it is possible to prove corruption but not to recoup the bribe. However, the situations analyzed in this paper involve frequent interactions (tax collectors, custom bureau officials). So, even in those cases, it is usually more valuable to keep only the job (anticipating that it will be possible to collect other bribes in future periods) than to keep the bribe but lose the job.

– *Principal*. He is incorruptible. With probability p he detects corrupt superiors, in which case there is prosecution and commitment to fire. We suppose that there is no domino effect in the detection of corruption: when a superior is caught, the agent matched with him cannot be identified. Nevertheless, this is purely conventional. Allowing identifiability of dishonest agents would only make corruption relatively more costly (for instance, agents would be directly harmed by an increase in the probability p of detecting superiors).

To sum up, we have a dynamic model where, at each period, clients offer a bribe equal to their valuation of the service. Agents who accept the trade are caught by superiors with some probability. The latter either denounce (and implicitly fire) the former or recoup the bribe. In the second case, superiors are themselves detected by the principal (and automatically fired) with some fixed probability. This structure is illustrated in Figure 1. At this point, a comment is in order. Admittedly, we have introduced several simplifying assumptions. Some of them relate to the dynamics of the model and are quite difficult to justify (*e.g.* random matching). Naturally, they diminish the value added of our dynamic setting. On the other hand, they help us to isolate and capture the differences in the dynamic effects between external and internal promotions. Other assumptions are conventional (no retaliation, no domino effect in detection, etc.) and do not affect the essence of the effects analyzed in the paper.

Independently of their behavior, both superiors and agents have an exogenous probability a of "*dying*" or leaving the organization at the end of each period. As in the efficiency wages literature (see *e.g.* SHAPIRO and STIGLITZ [1984]), this may be interpreted as a quit rate (outside opportunities, individuals stopping for personal reasons, exogenous relocation, etc.) and it is assumed constant. Fired and dead officials are immediately replaced. In a first step, we assume that superiors and agents are replaced by people in different pools (the "*pool of unemployed superiors*" and the "*pool of unemployed agents*"). In a later section, we analyze the more realistic case where every employee starts as an agent and can be later on promoted to the level of superior.

In the remainder of this section, we describe the behavior of agents and superiors and the equilibrium in a steady state economy.

2.1 Agents' and Superiors' Decisions

Let us denote H and I the proportion of corrupt agents and corrupt superiors in the organization, and $\delta (= \frac{1}{1+r})$ the discount factor. Assuming that the number of officials is "*large*", the behavior of a particular individual does not influence the behavior of the others. In this setting, we can state the following result.

LEMMA 1: An agent is indifferent between being honest and corrupt when

$$\theta = \hat{\theta}(I) = \frac{a+r}{1-a} \frac{1-q}{q} \frac{1}{1-I} y - w_A \tag{1}$$

Similarly, a superior is indifferent between being honest and corrupt when

(2) $$\beta = \tilde{\beta} = \frac{a+r}{1-a}\,\frac{1-p}{p}\,y - w_S$$

Proof: the present discounted value (p.d.v.) of payoffs when the agent of type θ is honest at every period and corrupt at every period are respectively:

$$V^H(\theta) = \frac{w_A + \theta}{1 - \delta\,(1-a)} \quad \text{and} \quad V^C(\theta, y) = \frac{w_A + \theta + y\,(1-q)}{1 - \delta\,(1-a)(1 - q(1-I))}$$

The cutoff corresponds to the agent who is indifferent between being honest and corrupt, *i.e.* $V^H(\hat{\theta}) = V^C(\hat{\theta}, y)$. The cutoff $\tilde{\beta}$ is obtained in a similar way. ■

The idea is simple. The agent's extra gain of being corrupt is the value of the bribe weighted by the probability of not being detected. The cost is the increase in the probability of being fired and therefore losing all the future rents of the job (the interpretation of the superior's case is the same). Naturally, officials are more willing to risk their job, the lower their private cost of losing it. Formally, it means that the agent (resp. superior) is honest when $\theta > \hat{\theta}$ (resp. $\beta > \tilde{\beta}$) and corrupt when $\theta < \hat{\theta}$ (resp. $\beta < \tilde{\beta}$). As expected, a higher proportion of agents and superiors decide to engage in corrupt activities, the higher the size of the potential bribe y, the lower their probability of being detected q and p, and the lower their wage w_A and w_S. This same trade-off and conclusions would be present in a static framework.

There is an important difference between the agents' and the superiors' decision problem. Since a corrupt agent strictly prefers to be matched with a corrupt superior (and lose at most the bribe rather than the bribe and the job), more agents will choose to be corrupt the higher the proportion of corrupt superiors. By contrast, the proportion of corrupt superiors *does not depend on the proportion of corrupt agents* because both the benefits (bribe) and the costs (possibility of detection) of recouping bribes are conditional on being matched with a corrupt agent.

2.2 Steady State Proportion of Corrupt Officials

Up to now, the proportions of corrupt agents and superiors (H and I) have been taken as given. Let us see how they are determined. We have.

LEMMA 2: The steady state proportion of corrupt agents as a function of the proportion of corrupt superiors is

(3) $$H = H^*(I) = \frac{F(\hat{\theta}(I))\dfrac{1}{a + (1-a)\,q\,(1-I)}}{F(\hat{\theta}(I))\dfrac{1}{a + (1-a)\,q\,(1-I)} + [1 - F(\hat{\theta}(I))]\dfrac{1}{a}}$$

Similarly, the steady state proportion of corrupt superiors as a function of the proportion of corrupt agents is

$$(4) \qquad I = I^*(H) = \frac{G(\tilde{\beta})\dfrac{1}{a+(1-a)\,q\,p\,H}}{G(\tilde{\beta})\dfrac{1}{a+(1-a)\,q\,p\,H} + [1-G(\tilde{\beta})]\dfrac{1}{a}}$$

Proof: Formally, $H_t^*(I)$ the proportion of corrupt agents at date *t*, is given by:

$$H_t^*(I) = \Big[1-(a+(1-a)q\,(1-I))\Big]\,H_{t-1}^*(I)$$

$$+\Big[(a+(1-a)q\,(1-I))\,H_{t-1}^*(I) + a\,(1-H_{t-1}^*(I))\Big]\,F(\hat{\theta})$$

In steady state, $H_t^*(I) = H_{t-1}^*(I) = H^*(I)$ and we get equation (3). The proof of (4) follows the same lines. ■

Agents whose type is above the cutoff $\hat{\theta}$ are corrupt, and fired when an honest superior detects them. Therefore, their per-period probability of leaving the organization is equal to $a+(1-a)q\,(1-I)$. Agents below the cutoff are honest and only leave the organization with probability *a*. Weighting the proportion of honest and corrupt agents by their expected lifetime determines the steady state distribution in the organization (the reasoning for I is analogous). From (4) note that there is a direct positive relation between the proportion of corrupt superiors and the proportion of corrupt agents. As the proportion of agents who decide to accept bribes increases, corrupt superiors have more chances to engage in bribery, and therefore they are also more frequently detected and fired.

2.3 Steady State Equilibrium

Using (1), (2), (3) and (4) we can determine the behavior of officials in equilibrium.

PROPOSITION 1: There is a unique steady state equilibrium.

The intuition is the following. An increase in the proportion of honest superiors implies an increase in the proportion of honest agents because being corrupt becomes more risky (equations (1) and (3)). But with many honest agents, corrupt superiors live longer as they have fewer opportunities to engage in illegal activities. This, in turn, implies that the steady state proportion of honest superiors decreases (equation (4)). According to this cyclical reasoning, the proportions of honest agents and honest superiors in our dynamic game are unique, for given wages and probabilities of detection.

More importantly, we can now analyze the effects of measures to combat corruption. The results are not surprising.

PROPOSITION 2: The proportion of corrupt agents decreases when the agents' and/or the superiors' wage w_A and w_S are increased and when the agents' and/or the superiors' probability of being detected q and p are increased.

Agents are more reluctant to undertake corrupt actions when their current wage (and therefore their future benefits of the job) is increased. An increase in w_S has the same effect on the superiors' behavior. This in turn affects the agents in two ways: first, fewer agents want to be corrupt because it is more risky and second, those who still decide to accept bribes are denounced and fired relatively more often. Both reasons imply a reduction in the proportion of corrupt agents.[6] An increase in q reduces the proportion of corrupt agents for the same reasons as an increase in w_A. Furthermore, it also deters corruption indirectly: corrupt superiors catch agents more often, and therefore are themselves exposed to detection also more frequently. Finally when p increases, fewer superiors decide to take bribes and those who still do it are detected more frequently. This affects negatively the agents' incentives to accept bribes for the same motives as previously. Basically, all these measures are sticks and carrots with the objective of making the corrupt activity *relatively less valuable* (because of a higher probability of detection or a bigger loss when it happens) and therefore also less attractive.

Remarks:

– The dynamics of the model magnifies the beneficial effects of anticorruption measures. For example, a static analysis would not capture the fact that increasing p reduces the steady state fraction of corrupt superiors *via* a decrease in their expected life. As a consequence, it would not capture the amplified negative effect on the incentives of agents to be corrupt either. Our conclusion is that sustained corruption-fighting mechanisms are more powerful than what standard analyses suggest.
– At the same time, compared to a model in which superiors are incorruptible (say, because p is close to 1), our model yields a higher fraction of corrupt agents. Therefore, by not capturing the recursive property of corruption, previous studies have systematically underestimated the extent of the bribery problem.

6. BESLEY and MCLAREN [1993] conduct a different analysis leading to optimal wage schedules for tax inspectors in the presence of corruption.

3 Hierarchies with Internal Promotions

Often, pay scales and size of penalties can hardly be manipulated. For instance, in some public organizations, measures such as monetary fines, prison or even job firing cannot always be undertaken.[7] In those cases, a system of rewards relying on promotions comes up as an alternative, incentive-based solution. The issue we want to explore is whether the tools to control corruption presented in the previous section have similar benefits in organizations relying on internal labor markets or not.

We include the issue of promotions by considering that officials always enter the organization as agents, who then have the chance to become superiors. As we want to focus on the incentive properties of promotions, we use the simplest possible setting. In particular, we assume that the "*age*" of agents (a proxy for the number of past opportunities for being corrupt) is not observable.[8] Thus, we exclude the possibility of promotions by seniority. We follow the second interpretation previously given of the probability of detection: supervision conveys hard evidence about the agent's behavior but it is costly, so it does not always take place. Of course, including promotions substantially enlarges the superiors' set of tools. Here, we focus exclusively on the new effects due to promotions. We suppose that, after a control, honest superiors promote "*clean*" agents and fire corrupt ones. Corrupt superiors promote both honest agents (extortion is not possible) and corrupt ones (in exchange of the bribe).[9] Note that, as honest superiors always promote or fire agents after a supervision, corrupt superiors cannot argue absence of evidence. Therefore when an agent is supervised, he is either fired or promoted but in any case he leaves his current position. At each date not every agent is supervised, otherwise all individuals would stay as agents just for one period. The rate at which superiors supervise agents, denoted α (and which may be assimilated to q in the previous section), is now (i) *endogenously determined* so that the expected fraction of promoted agents among the supervised ones equals the number of departing (dead and fired) superiors and (ii) imposed by the principal.[10] This allows the organization to keep a constant mass of officials.

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7. In Hong Kong, it is difficult to get crooked civil servants fired. Moreover, in cases of big scandals in the police force, no prison sentence ever exceeded seven years (see *1980 Annual Report of the Commissioner of the Independent Commission against Corruption, 34* and *1981 Annual Report of the Commissioner of the Independent Commission against Corruption, 36*).
8. This simplification is standard in the literature (see *e.g.* TIROLE [1996]) and should not be taken too literally: it just means that the number of past opportunities to engage in corruption cannot be perfectly observed by the principal.
9. For our results to hold, we only need to assume that honesty increases the chances of being promoted. We adopt this specific modeling of the promotion system just for simplicity.
10. For example, we can think of it as the principal telling randomly at the end of each period to a fraction of superiors to check the record of the agent with whom they were matched.

The issue of promotions adds new insights to our analysis only under the assumption that there is *some positive* correlation between the private benefit of keeping the job at the agent's and at the superior's level. If there is no correlation, promoting an agent is just like hiring him from a pool of unemployed superiors; *i.e.* promotion has no screening properties, and we get the same results as in section 2. Negative correlation would, in our context, make little sense. For simplicity, we consider perfect positive correlation between the private information parameters, namely $\beta = \lambda \theta$ (with $\lambda > 0$) for each individual.[11]

We consider that the number of agents and superiors in the organization is large, fixed and normalized to 1 and $\gamma (<< 1)$ respectively. Finally, we call L the proportion of promoted agents who become corrupt superiors at each period, and we use the superscript e to denote the equilibrium values of the parameters.

3.1 Agents' and Superiors' Decisions

An agent is promoted when he is honest or when he is corrupt and supervised by a corrupt superior. Once he has become a superior, and given that he does not internalize any collective interest of his behavior, he faces the same choices (and so behaves exactly) as in section 2. Therefore:

$$\beta = \tilde{\beta}^e = \lambda \tilde{\theta}^e = \frac{a+r}{1-a} \frac{1-p}{p} y - w_S \tag{5}$$

Contrary to the analysis previously conducted, we now need to impose a technical condition.

ASSUMPTION 1: There is an (exogenous) upper bound on the superiors' wage and probability of being detected $\bar{w}_S$ and $\bar{p}$. These values define the lower bound on the superiors' cutoff $\lambda \tilde{\theta}_L \equiv \frac{a+r}{1-a} \frac{1-\bar{p}}{\bar{p}} y - \bar{w}_S$. The cutoff $\tilde{\theta}_L$ satisfies:

$$F(\tilde{\theta}_L) + [F(\tilde{\theta}_L)]^2 = 1 \tag{A1}$$

Given this assumption, there will always exist a minimum fraction of corrupt superiors in the organization (those of type $\theta < \tilde{\theta}_L$). This ensures that, *in equilibrium*, it may be the case that an agent indifferent between honesty and corruption prefers to be dishonest once he is promoted to the superior's level.

The possibility of promotions affects directly the behavior of agents. We have the following result.

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11. The results of this section would hold if we just assumed imperfect correlation in the sense of First Order Stochastic Dominance.

LEMMA 3: In the analysis of corruption with internal labor markets, the agent is indifferent between being honest and being corrupt when:

$$\lambda\theta = \lambda\hat{\theta}_1^e(I,H) = \frac{a+r}{1-a}\frac{1-\alpha}{\alpha}\frac{y}{1-I} - w_S + p\,\alpha H y\left[\frac{1-\alpha}{\alpha\,(1-I)} - \frac{1-p}{p}\right] \qquad \text{if } \hat{\theta}_1^e < \tilde{\theta}^e \tag{6.1}$$

$$\lambda\theta = \lambda\hat{\theta}_2^e(I) = \frac{a+r}{1-a}\frac{1-\alpha}{\alpha}\frac{y}{1-I} - w_S \qquad \text{if } \hat{\theta}_2^e > \tilde{\theta}^e \tag{6.2}$$

Proof: The extra expected gains and costs of corruption are respectively $(1-\alpha)\,y$ and $\alpha\,(1-I)\,\delta\,(1-a)\,V_S(\hat{\theta}^e)$, where $V_S(\theta)$ is the p.d.v. of payoffs for a type θ individual at the superior level.

When $\hat{\theta}^e < \tilde{\theta}^e$, the agent at the cutoff plans to be a corrupt superior. Therefore, $V_S(\hat{\theta}^e) = V_S^C(\hat{\theta}^e, y) = \dfrac{w_S + \lambda\hat{\theta}^e + \alpha H\,(1-p)\,y}{1-\delta\,(1-a)(1-\alpha H\,p)}$ and we get (6.1).

When $\hat{\theta}^e > \tilde{\theta}^e$, the agent at the cutoff plans to be an honest superior. Therefore, $V_S(\hat{\theta}^e) = V_S^H(\hat{\theta}^e) = \dfrac{w_S + \lambda\hat{\theta}^e}{1-\delta\,(1-a)}$ and we get (6.2). ■

The agent is indifferent between honesty and corruption when the extra expected gain of being corrupt (the bribe weighted by the probability of not being supervised) equals the expected loss (the probability of being supervised by an honest superior and therefore fired instead of promoted). When $\hat{\theta}^e < \tilde{\theta}^e$, the agent at the cutoff realizes that if he succeeds in being promoted, he will be corrupt. Then, the cost of being fired is the p.d.v. of payoffs as a corrupt superior. Conversely, when $\hat{\theta}^e > \tilde{\theta}^e$, the agent at the cutoff will be an honest agent. Again, this is reflected in the p.d.v. of payoffs in case of promotion.

Equations (6.1) and (6.2) deserve further comments. First, the agents' decision between honesty and corruption does not depend on their actual wage w_A. This is an extreme result due to our specific modeling. However, an important and robust conclusion is that, in the presence of promotions, agents care relatively less about their current wage while they start taking into account the payoffs of superiors. Naturally this will have a direct effect in optimal budget balanced policies. Second, we can notice that in equation (6.1), $\hat{\theta}^e$ depends positively on p. Since being corrupt reduces the probability of becoming a superior, agents decide to be honest when their future p.d.v. as superiors is above a certain cutoff value. Now, suppose that the agent indifferent between honesty and corruption knows that he will be a corrupt superior. In that case, an increase in the superior's probability of being detected decreases the value of being promoted, which in turn decreases the incentives of behaving honestly as an agent. Third, corruption is relatively "*safer*" (so more likely to occur) at the agents' than at the superiors' level if and only if p

is bigger than a bounded and endogenously determined value.[12] Fourth, for some parameter values, agents could prefer to refuse a promotion.[13] Whether the incentives to refuse such promotion are higher for honest or corrupt agents will naturally be a function of the probabilities of detection (p and q). More importantly, they will also depend on the relative importance of wages and moral cost in the utility function of the individuals. For the rest of the paper, we will assume that all agents strictly prefer to become superiors rather than remain at their level or, alternatively, that they cannot refuse a promotion.

3.2 Steady State Proportion of Corrupt Officials

As already mentioned, one of the differences with our previous analysis is that all individuals have now the same expected life as agents. Formally, the proportion of corrupt agents is:

$$H = H^e = F(\hat{\theta}^e) \tag{7}$$

The possibility of promotions introduces a new variable: L, the proportion of promoted agents who become corrupt superiors. At each period, only corrupt agents matched with honest superiors are fired. Hence, the proportion of agents promoted is $HI + (1 - H)$.

When $\hat{\theta}^e < \tilde{\theta}^e$, all the corrupt agents promoted [HI] and a fraction $[F(\tilde{\theta}^e) - H]$ of the honest ones become corrupt superiors. Similarly, when $\hat{\theta}^e > \tilde{\theta}^e$ only a fraction $F(\tilde{\theta}^e)\, I$ of the corrupt agents remain corrupt superiors. That is,

$$L = L_1^e = \frac{HI + [F(\tilde{\theta}^e) - H]}{HI + [1 - H]} \qquad \text{if } \hat{\theta}^e < \tilde{\theta}^e \tag{8.1}$$

$$L = L_2^e = \frac{F(\tilde{\theta}^e)\, I}{HI + [1 - H]} \qquad \text{if } \hat{\theta}^e > \tilde{\theta}^e \tag{8.2}$$

Due to the particular up or out system of promotions adopted, the effect of H on the proportion of promoted agents who become corrupt superiors differs between (8.1) and (8.2).

If $\hat{\theta}^e < \tilde{\theta}^e$, then $\partial L_1^e / \partial H < 0$: promotions have a *directly positive screening effect*. Individuals below the cutoff $\tilde{\theta}^e$ are agents who will become corrupt superiors, so it is "*optimal*" for the organization to fire (instead of promoting) them. Among them, a fraction $[F(\tilde{\theta}^e) - H]$ are honest agents who therefore cannot be screened even when they are matched with honest superiors. Therefore, ideally we would like this fraction to be as small as possible; *i.e.* for a given $\tilde{\theta}^e$ we want $\hat{\theta}^e$ to be as high as possible. We call it a positive screening effect because it means that the higher the number of corrupt agents is, the smaller the proportion of promoted agents who become corrupt superiors.

12. Formally, $\hat{\theta}^e > \tilde{\theta}^e \Leftrightarrow \dfrac{1-p}{p} < \dfrac{1-\alpha}{\alpha\,(1-I)} \Leftrightarrow p > \dfrac{\alpha\,(1-I)}{1-\alpha\, I}$.

13. A sufficient condition for an honest agent to prefer being promoted is $w_S + \lambda\theta > w_A + \theta$.

If $\hat{\theta}^e > \tilde{\theta}^e$, then $\partial L_2^e / \partial H > 0$: the opposite argument applies and promotions have a *directly negative screening effect*. Individuals above the cutoff $\tilde{\theta}^e$ are agents who will become honest superiors. Then, no matter how they behave as agents, it is optimal to promote them. Among this fraction, $[H - F(\tilde{\theta}^e)]$ are currently corrupt and therefore will be fired whenever an honest superior supervises them. To avoid this inefficiency, we would like again $\hat{\theta}^e$ to be as close as possible to $\tilde{\theta}^e$.

One conclusion of our model is that corrupt superiors benefit from being surrounded by corrupt colleagues. For instance, a big proportion of corrupt superiors encourages corruption at the bottom level, which in turn increases their opportunities of getting bribes. Overall, there is a double gain of corruption: the bribe and the increase in the probability of reaping bribes in the future. Obviously, crooked superiors behave exclusively on the basis of their individual interest (*i.e.* the current bribe at stake). Therefore, from their viewpoint, promoting corrupt agents is a public good.[14]

Finally, the proportion of corrupt superiors I^e in equilibrium is determined as in (4). The fraction of agents promoted who become corrupt superiors is L. They are fired whenever they are caught promoting a corrupt agent, which occurs with probability αHp. Their expected life is therefore $\frac{1}{a + (1-a)\alpha Hp}$. Similarly, $(1 - L)$ agents become honest superiors and have an expected life of $\frac{1}{a}$. Hence:

$$I = I^e = \frac{L \dfrac{1}{a + (1-a)\alpha Hp}}{L \dfrac{1}{a + (1-a)\alpha Hp} + [1 - L]\dfrac{1}{a}} \tag{9}$$

Note that corrupt superiors' expected life is low (and hence the steady state proportion of them is also small) when they have a lot of opportunities of engaging in corrupt activities (α and H are high) or when these actions are more risky (p is high).

3.3 Rate of Supervision

As noted above, at each date all the honest agents who are supervised $(1 - H)\alpha$ and the corrupt agents supervised by corrupt superiors $HI\alpha$ are promoted. Besides, a fraction a of the honest superiors and a fraction $a + (1-a)\alpha Hp$ of the corrupt ones, leave the organization. In a steady state equilibrium, the expected number of agents promoted has to be equal to the expected number of departing superiors. Therefore, if the organization wants to keep a constant size, the rate at which the principal imposes superiors to supervise agents is given by:

14. This idea is somehow related to the multiple equilibria analysis of ANDVIG and MOENE [1991]. In their paper, individuals benefit from corruption of their peers because the more agents are corrupt, the more difficult it is to control each of them.

$$(10) \qquad [HI + (1 - H)]\,\alpha = \gamma\,[a + (1 - a)\,\alpha\,Hp\,I]$$

$$\Rightarrow \qquad \alpha = \frac{\gamma\,a}{(1 - H) + HI\,[1 - \gamma\,(1 - a)\,p]}$$

Note that the *direct effect* in the supervision rate α of an increase in the proportion of corrupt agents H is positive. Conversely, supervision is (endogenously) discouraged when the proportion of corrupt superiors is high, because these superiors promote low type agents (in exchange of the bribe) who are likely to become corrupt superiors themselves.

3.4 **Perverse Effects of Anticorruption Measures**

At this point, we can finally analyze the effects of different anticorruption instruments, namely increases in wages and in the probabilities of detection. To this purpose, we use equations (5) to (10). As the system has become fairly complex, we do not pretend to have clear cut unidirectional effects as we had in the absence of promotions. Our goal is rather to study the new effects due to promotions and explain which specific measures may, in some circumstances, be counter-productive. We focus on the case where p is "*sufficiently small*" (see footnote 12), so that $\hat{\theta}^e < \tilde{\theta}^e$: corruption at the top level of the hierarchy is relatively safer than at the bottom level. We start by studying the effects on the proportion of corrupt agents of increasing supervision. But of course, α is an endogenous variable. Then, adding the effects of the anticorruption measures on this rate of supervision, we obtain the new effects of the campaign under internal labor markets. Our preliminary result is the following.

LEMMA 4: If $\hat{\theta}^e < \tilde{\theta}^e$, an increase in the rate of supervision α decreases the proportion of corrupt agents H.

The probability of supervision affects the behavior of agents in several ways. First, when supervision is stiffened, agents find it less interesting to take the risk of accepting bribes. Second, the expected lifetime of corrupt superiors is reduced (the more they supervise, the more opportunities they have to get bribes) and then, the agents' chances of being paired with one of them are also reduced which also deters agents from being corrupt. Third, promotions also have some screening properties. As we saw in section 3.2, when corruption is a relatively safe activity for superiors, if the proportion of corrupt agents increases, the proportion of promoted agents who become corrupt superiors decreases. Because of all three effects, *the stimulation of supervision affects positively an honest attitude of agents*. Using this lemma, we can state.

PROPOSITION 3: When promotions are possible and $\hat{\theta}^e < \tilde{\theta}^e$, increasing the superiors' wage w_S *always reduces* the proportion of corrupt agents. In contrast, increasing the superiors' probability of being detected *p may increase* the proportion of corrupt agents.

In the benchmark case with no promotions, we obtained that increasing the superiors' wage and/or their probability of being caught reduced the incentives of being a dishonest agent (see Proposition 2). The possibility of promotions introduces two *new* interesting effects. First, as intuition suggests, if the fraction of corrupt superiors decreases, fewer corrupt agents have the possibility of being inefficiently promoted. Therefore, increasing w_S or p *indirectly* decreases agents' corruption *via* an (endogenous) increase in the supervision rate. We call it the *supervision effect*. Second, whenever an agent is promoted, he inherits the situation faced by superiors. Therefore, if w_S is increased there is a second *direct* incentive to be an honest agent, which is the possibility of enjoying this wage rise. We call it the *payoff effect*. Both effects add up and we can confirm that, just as under no promotion, the tool is fully efficient. In contrast, the payoff effect is reversed when the anticorruption tool employed is an increase in monitoring. Suppose that the agent indifferent between accepting bribes and not plans to be a corrupt superior whenever he is promoted. Then, an increase in the probability of detecting corrupt superiors diminishes his future expected payoff. Therefore, it also decreases his incentives as an agent to be honest so as to obtain the reward of a promotion. The underlying conclusion is that the overall efficiency of tools to fight corruption directly depends on the structure of the organization: under internal labor markets, a close monitoring (which is supposed to be always effective) may have perverse effects while an increase in wages (usually considered less efficient) is always beneficial.

This conclusion may have a more general interest. One stream of the incentives literature deals with the optimal combination of sticks and carrots and their relative efficiency. For instance, it is well known that sticks may be ineffective when the individual has liquidity constrains or a sufficiently high degree of risk aversion. The argument here goes beyond this remark. It says that sticks may even be counter-productive when the system of rewards and punishments is considered from the perspective of a *potential future rent*. In other words, an incentive measure which is regarded by superiors as a stick (increase of p) is considered by agents as a *decrease in the future carrot*.

The reader may wonder whether this negative payoff effect can, in practice, offset the standard benefits of close monitoring. After all, it applies only to the fraction of honest low ranked individuals who plan to become corrupt high ranked officials. Obviously, only a careful empirical analysis may provide compelling evidence about the relative importance of the different effects. However, we believe that specially in LDCs, it is common to start in jobs at a low level. An honest behavior increases the chances of going up in the hierarchy where the stakes (and, at the same time, the possibilities of corruption) are more attractive. In terms of our specific modeling, we could slightly modify our setting and assume that superiors have control over several agents at every period. Corruption would therefore become relatively more interesting at the level of superiors than at the level of agents. This in turn would increase the cases in which an honest agent becomes a corrupt superior.

Proposition 3 deserves some other comments. First, it has an important policy implication. From a pure efficiency viewpoint, in a system relying on internal promotions, optimality requires to increase the wage inequality between superiors and agents.[15] As in the efficiency wages literature, this

15. In fact, given our extreme modeling of promotions, the optimal budget balanced policy is to defer all payments to top level officials $(w_A = 0)$.

exercise stresses the fundamental tradeoff between efficiency and equity. Note also the similarities between this conclusion and the idea of postponing part of the officials' current wage by, for example, accumulating a non vested pension which can be enjoyed only if they retire with a "*spotless name*". Second, we want to emphasize that our conclusions are not directly influenced by the system of promotions considered. The same payoff effects as described previously would be present if, for example, promoted agents were randomly drawn among agents alive at the end of each period. Last, but not least, suppose that corrupt agents had some cash-on-hand. Naturally, they would be willing to pay more than the value of the bribe in exchange of not being denounced. Corruption would therefore be relatively less valuable at the agent level and, at the same time, relatively more valuable at the superior level. Our insights would still hold, the main difference being that once again it would become more likely to observe honest agents who become corrupt superiors.

4 Supervision as a Deterrent Device

In this section, we explore a second case where measures apparently effective in the control of corruption distort the incentives of officials and may indeed be harmful. Supervision by honest superiors is beneficial for the organization because it inflicts a *public punishment* to corrupt agents, which consists of firing them. However, supervision has another property: it deters agents from being corrupt. This occurs even when supervision is undertaken by corrupt superiors: these individuals inflict a *private punishment* on agents which consists of confiscating their bribe.[16] As a result, if superiors choose their level of monitoring, strengthening the control from the principal on superiors influences the incentives of the latter. It is, *a priori*, unclear how this affects the final level of honesty.

To formalize this moral hazard problem, we extend the basic model by assuming that the decision of superiors has two dimensions. First, they choose whether they put effort 0 in supervision and detect agents with probability q_L, or effort e (where the cost $e > 0$ enters additively the payoff function) and detect agents with probability q_H (with $\Delta q \equiv q_H - q_L > 0$). Second, they decide if they accept bribes for not denouncing agents or not.

16. This idea of supervision with the main objective of deterring (rather than punishing) undesirable activities has been highlighted by Kofman and Lawarrée [1993]: "*... we introduce a second supervisor whose sole purpose is to discourage deviant coalitions*". From a practical perspective, Plana (the tax commissioner of Philippines) also emphasizes the deterrent effects of his anticorruption campaign: "*More than what they actually accomplished through these reviews was the impact on other examiners of the possibility that their work would be subjected to review*", Klitgaard [1988], p. 53.

This organization is illustrated in Figure 2. For simplicity, we consider a *static* version of the model presented in section 2: officials live for one period and receive their wage at the end of it only if they are not denounced.

Note that only some corrupt superiors will choose to put effort in monitoring since the gain of doing so is to increase the chances of getting bribes. This idea, although modeled in an extreme way, seems to fit with casual observation. For example, custom bureau officers who look for grafts usually perform their tasks with great enthusiasm; they are willing to check as many import products as possible and to examine permits carefully. Policemen seeking "*mordidas*" are usually more reluctant to overlook small infractions except, of course, if they receive some compensation, etc. When we include this possibility, we have.

LEMMA 5: A corrupt superior is indifferent between putting effort in supervision and not when

$$\beta = \tilde{\beta}_1 = \frac{1-p}{p} y - e \left[\frac{1}{\Delta q \, Hp} \right] - w_S \tag{11}$$

and a superior is indifferent between being corrupt (and put 0 effort) and being honest when

$$\beta = \tilde{\beta}_2 = \frac{1-p}{p} y - w_S \qquad (> \tilde{\beta}_1) \tag{12}$$

Once we consider this moral hazard issue, we have three intervals. Superiors with private value in $[\underline{\beta}, \tilde{\beta}_1]$ have a small benefit of not being detected compared to the gain of recouping bribes. Therefore, not only they are corrupt but they are even willing to spend a costly effort in order to increase the probability of catching crooked agents. In $[\tilde{\beta}_1, \tilde{\beta}_2]$ superiors are still corrupt. However, the effort necessary to increase the probability of detection is now too costly. Finally, in $[\tilde{\beta}_2, \overline{\beta}]$ superiors are honest and exert no effort. Note that the smaller the cost of effort *e* is, the higher the fraction of corrupt superiors willing to monitor tightly. As $e \to 0$, all corrupt agents decide to exert effort in supervision ($\tilde{\beta}_1 \to \tilde{\beta}_2$).

Let us call $G_H = G(\tilde{\beta}_1)$ the proportion of corrupt superiors who put effort *e* and $G_T = G(\tilde{\beta}_2)$ the total proportion of corrupt superiors. We have.

LEMMA 6: An agent is indifferent between being honest and corrupt when

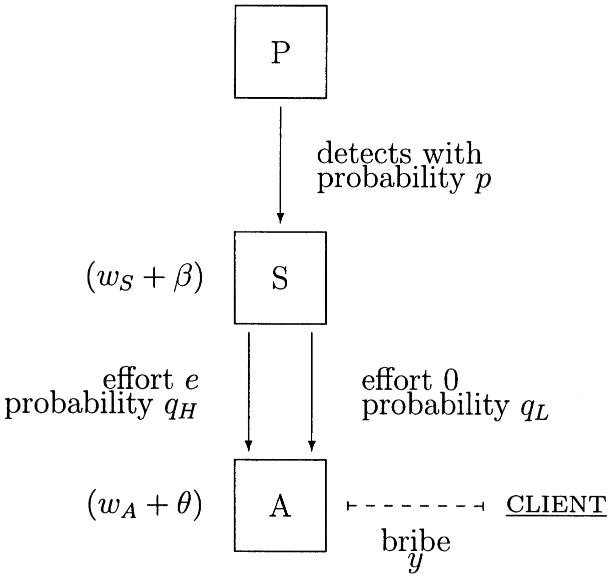
$$\theta = \check{\theta} = \left[\frac{1-q_L}{q_L} \frac{1}{1-G_T} - \frac{G_H}{1-G_T} \frac{\Delta q}{q_L} \right] y - w_A \tag{13}$$

Proof: We have

$$w + \check{\theta} = G_H \left[w + \check{\theta} + (1-q_H)\, y \right] + (G_T - G_H) \left[w + \check{\theta} + (1-q_L)\, y \right]$$
$$+ (1-G_T)(1-q_L)(w + \check{\theta} + y)$$

and (13) follows. ■

FIGURE 2



Compared to the case where all corrupt superiors exert no effort ($G_H = 0$), now there is *less* corruption. The total proportion of honest superiors is the same. However, when part of the crooked ones detect corruption with a high probability, agents are worse-off: they bear (i) the same public cost or probability of being denounced but (ii) a higher private cost or probability of losing the bribe. This is precisely the deterrence property of monitoring.

From (12), we see that anticorruption instruments such as increasing the control from the principal on superiors or increasing the superiors' wage have the usual effect of lowering the global proportion of corrupt superiors G_T. Hence, they make agents less willing to accept grafts. Nevertheless, these measures have a second effect: among the remaining corrupt superiors, *fewer* are willing to put effort in monitoring; detection has still a valuable private value, but it has become relatively less interesting (see equation (11)). The following conclusion is therefore immediate.

PROPOSITION 4: When superiors choose the effort of monitoring, increasing their wage w_S or their probability of being detected p may increase the proportion of corrupt agents if the differential Δq between the probability of being caught by a superior who puts effort and another who does not is big and if the distribution of superiors $G(\cdot)$ is biased towards low values of β.

When Δq is high, agents at the cutoff are relatively more sensitive to the proportion of corrupt superiors who put effort in monitoring G_H than to the overall proportion of corrupt superiors G_T (see equation (13)). This idea is easy to grasp. Suppose that the differential between the probability of being caught by a superior who puts effort and another who does not is big. In that case, it is certainly good for crooked agents to face few honest superiors (and hence to lose the wage in few occasions). Nevertheless, it is even more interesting that, among the corrupt superiors, few supervise with effort because otherwise being a corrupt agent monitored by a corrupt superior almost never implies keeping the bribe. The interesting conclusion is that increasing p or w_S increases the proportion of honest superiors but turns the remaining corrupt superiors more *"passive"* on average. As a result, these measures may foster rather than impair corruption at the agent's level. Similarly, when the distribution of agents $G(\cdot)$ is biased towards low values of β, the number of corrupt superiors who decide to exert no effort after the anti-corruption campaign is relatively high compared to the number of superiors who become honest. Again, we get the same conclusion as previously. Notice that a wage increase is more likely to have a perverse effect in reducing corruption than an increase in the probability of detection (*i.e.* $\frac{\partial H(\cdot)}{\partial w_S} > \frac{\partial H(\cdot)}{\partial p}$).

5 Conclusion

Until recent years, corruption was often considered in some academic circles as an alternative (and efficient) way of allocating resources among agents in regulated markets. Indeed, when those corrupt practices were conducted by governments, they were deemed as a sort of taxation, with similar distorting properties. Now, it is widely accepted that, in many circumstances, bribery and corruption impair economic growth and efficiency. Many countries, inspired by the US Foreign Corrupt Practices Act and the OECD anticorruption convention, are considering to pass similar legislations to prohibit the bribing of foreign officials to secure business. Unfortunately, illegal trades are so embedded and well organized that fighting them is not an easy task.

In most organizations, officials at different hierarchical levels differ in their career prospects but share a cost-benefit attitude when deciding whether to engage in bribery. We have captured this recursive property of the corruption problem, combined it to a hierarchical structure in the organization and analyzed the original effects that naturally emerge. The first conclusion of this paper is that, in the absence of promotions, increasing wages and strengthening the control on superiors and agents have the foreseeable property of reducing the level of corruption. Keeping this benchmark, we have analyzed the effects of including the possibility of promotions within our hierarchy. We have shown that, under internal labor markets, an increase in the superiors' probability of being detected has the perverse effect of discouraging honesty of agents who, as superiors, will be impaired by this measure; the global effect is not unidirectional anymore. We have also proved that if superiors choose how much effort they put in monitoring, it can be optimal at a certain point to overlook their actions; taking advantage of this situation, more superiors decide to be corrupt but they supervise agents so closely that the overall incentives of the latter to accept bribes decrease.

In this research, we have assumed that direct side trades between clients and superiors are not possible. Future work should endogenize the level in which corruption takes place. It would also be of interest to endogenize the organizational structure and, in particular, to study in which type of hierarchies firms are more likely to promote from within, instead of hiring from outside. Last, pessimists may view this whole analysis as an argument reinforcing the idea that corruption can hardly be eliminated. We prefer to consider it as a warning against policies that blindly adopt "*intuitively efficient*" measures.

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APPENDIX

A1. Proof of Proposition 1

Straightforward: From (2) and given w_S and p, $\tilde{\beta}$ is unique.

From (3) and (4), $\dfrac{\partial I(.)}{\partial \hat{\theta}} = \dfrac{\dfrac{\partial I^*(.)}{\partial H}\dfrac{\partial H^*(.)}{\partial \hat{\theta}}}{1 - \dfrac{\partial I^*(.)}{\partial H}\dfrac{\partial H^*(.)}{\partial I}} < 0$

So from (1), $\hat{\theta}$ is unique and therefore I^* is unique and H^* is unique. ■

A2. Proof of Proposition 2

Using equations (1) to (4), we get

$$\frac{\partial H(.)}{\partial w_A} = \frac{\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial w_A}}{1 - \left[\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H} + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H}\right]} < 0$$

$$\frac{\partial H(.)}{\partial w_S} = \frac{\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial \tilde{\beta}}\dfrac{\partial \tilde{\beta}(.)}{\partial w_S} + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial \tilde{\beta}}\dfrac{\partial \tilde{\beta}(.)}{\partial w_S}}{1 - \left[\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H} + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H}\right]} < 0$$

$$\frac{\partial H(.)}{\partial q} = \frac{\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\left(\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial q} + \dfrac{\partial \hat{\theta}(.)}{\partial q}\right) + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial q} + \dfrac{\partial H^*(.)}{\partial q}}{1 - \left[\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H} + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H}\right]} < 0$$

$$\frac{\partial H(.)}{\partial p} = \frac{\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\left(\dfrac{\partial I^*(.)}{\partial \tilde{\beta}}\dfrac{\partial \tilde{\beta}(.)}{\partial p} + \dfrac{\partial I^*(.)}{\partial p}\right)}{1 - \left[\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H} + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H}\right]}$$

$$+ \frac{\dfrac{\partial H^*(.)}{\partial I}\left(\dfrac{\partial I^*(.)}{\partial \tilde{\beta}}\dfrac{\partial \tilde{\beta}(.)}{\partial p} + \dfrac{\partial I^*(.)}{\partial p}\right)}{1 - \left[\dfrac{\partial H^*(.)}{\partial \hat{\theta}}\dfrac{\partial \hat{\theta}(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H} + \dfrac{\partial H^*(.)}{\partial I}\dfrac{\partial I^*(.)}{\partial H}\right]} < 0$$

■

A3. Proof of Lemma 4

$$\frac{\partial H(.)}{\partial \alpha} = \frac{\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha} + \dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial I}\left(\dfrac{\dfrac{\partial I^e(.)}{\partial\alpha}}{1-\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial I}}\right)}{1-\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial H} - \dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial I}\left(\dfrac{\dfrac{\partial I^e(.)}{\partial H}+\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial H}}{1-\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial I}}\right)}$$

If $\hat{\theta}^e < \tilde{\theta}^e$,

$$\frac{\partial I^e(.)}{\partial L}\frac{\partial L_1^e(.)}{\partial I} = \frac{H^e(1-F(\tilde{\theta}^e))(I^e)^2(1+\dfrac{1-a}{a}\,p\,\alpha\,H^e)}{(H^e I^e + [F(\tilde{\theta}^e)-H^e])^2} < \frac{1-[F(\tilde{\theta}^e)]^2}{F(\tilde{\theta}^e)}$$

Using (A1), we get $1-\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial I} > 0.$

To complete the proof note that when $\hat{\theta}^e < \tilde{\theta}^e$ $(L^e = L_1^e)$, then $\dfrac{\partial L_1^e(.)}{\partial H} < 0$: the screening effect is positive and we have $\partial H(.)/\partial\alpha < 0$. ■

A4. Proof of Proposition 3

- $\dfrac{\partial H(.)}{\partial w_S} =$

$$\frac{\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial w_S} + \dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\left[\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}+\dfrac{\partial\hat{\theta}^e(.)}{\partial I}\right]A}{1-\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial H} - \dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial H} - \dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\left[\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}+\dfrac{\partial\hat{\theta}^e(.)}{\partial I}\right]B}$$

where $A = \dfrac{\partial I^e(.)}{\partial w_S} = \dfrac{\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial\tilde{\theta}^e}\dfrac{\partial\tilde{\theta}^e(.)}{\partial w_S}}{1-\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial I}-\dfrac{\partial I^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}}$

and $B = \dfrac{\partial I^e(.)}{\partial H} = \dfrac{\dfrac{\partial I^e(.)}{\partial H}+\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial H}+\dfrac{\partial I^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial H}}{1-\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial I}-\dfrac{\partial I^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}}$

For $L^e = L_1^e$ we have $\dfrac{\partial H(.)}{\partial w_S} < 0.$ ■

- $\dfrac{\partial H(.)}{\partial p} =$

$$\frac{\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial p}+\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial p}+\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\left[\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}+\dfrac{\partial\hat{\theta}^e(.)}{\partial I}\right]A'}{1-\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial H}-\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial H}-\dfrac{dH^e(\hat{\theta}^e)}{d\hat{\theta}^e}\left[\dfrac{\partial\hat{\theta}^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}+\dfrac{\partial\hat{\theta}^e(.)}{\partial I}\right]B}$$

where $A' = \dfrac{\partial I^e(.)}{\partial p} = \dfrac{\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial\tilde{\theta}^e}\dfrac{\partial\tilde{\theta}^e(.)}{\partial p}+\dfrac{\partial I^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial p}+\dfrac{\partial I^e(.)}{\partial p}}{1-\dfrac{\partial I^e(.)}{\partial L}\dfrac{\partial L^e(.)}{\partial I}-\dfrac{\partial I^e(.)}{\partial\alpha}\dfrac{\partial\alpha(.)}{\partial I}}$

For $\hat{\theta}^e < \tilde{\theta}^e$, $\dfrac{\partial\hat{\theta}_1^e(.)}{\partial p} > 0$. This effect leaves the sign of the function undetermined.

A5. Proof of Proposition 4

$$\frac{\partial H(.)}{\partial p} = \frac{\dfrac{\partial H^*(.)}{\partial\check{\theta}}\dfrac{\partial\check{\theta}(.)}{\partial G_T}\dfrac{\partial G_T(.)}{\partial\tilde{\beta}_2}\dfrac{\partial\tilde{\beta}_2(.)}{\partial p}+\dfrac{\partial H^*(.)}{\partial\check{\theta}}\dfrac{\partial\check{\theta}(.)}{\partial G_H}\dfrac{\partial G_H(.)}{\partial\tilde{\beta}_1}\dfrac{\partial\tilde{\beta}_1(.)}{\partial p}}{1-\left[\dfrac{\partial H^*(.)}{\partial\check{\theta}}\dfrac{\partial\check{\theta}(.)}{\partial G_H}\dfrac{\partial G_H(.)}{\partial\tilde{\beta}_1}\dfrac{\partial\tilde{\beta}_1(.)}{\partial H}\right]}$$

$$\Rightarrow \text{SIGN}\frac{\partial H(.)}{\partial p} = \text{SIGN} -\frac{\partial G_T(.)}{\partial\tilde{\beta}_2}\left[\frac{1-q_L-\Delta q\, G_H}{1-G_T}\right]+\frac{\partial G_H(.)}{\partial\tilde{\beta}_1}\left[\Delta q-\frac{e}{y\,H}\right]$$

and the result follows.

Similarly, we have

$$\text{SIGN}\,\frac{\partial H(.)}{\partial w_S} = \text{SIGN}\,-\frac{\partial G_T(.)}{\partial\tilde{\beta}_2}\left[\frac{1-q_L-\Delta q\, G_H}{1-G_T}\right]+\frac{\partial G_H(.)}{\partial\tilde{\beta}_1}\,\Delta q. \quad \blacksquare$$