Honest Agents in a Corrupt Equilibrium*

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Abstract

I construct a principal – agent – auditor taxation model with adverse selection in which the principal optimally allows bribery to occur due to the potential for extortion. This result mirrors the moral hazard model of Khalil, Lawarrée and Yun (2010). I introduce a probability that the agent is "honest" insofar as she cannot collude with the supervisor. Because the principal cannot distinguish who is honest and who is not a priori, he faces an additional dimension of adverse selection. Honest agents cannot reduce their expected penalties through bribery, and strategic agents can pretend to be honest, so the principal must allow additional rent for all dishonest agents. Or, he may shut down honest, low-income agents, avoiding the new adverse selection issue but losing revenue. In this way, honesty hurts the principal. Furthermore, I find that the principal may wish to audit the more productive, corrupt agent and induce extortion as a screening device to reduce the high-income honest agent's rent. I also explore how different types of honesty affect the principal's decision.

Keywords: Auditing, Corruption, Honesty, Multidimensional Screening

JEL Codes: D82, D03, H26

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1. Introduction

Hiring an auditor to inspect an agent can provide significant advantages in incentives, but the possibility of corruption poses varied challenges. Empirical evidence suggests that workers tend to migrate away from corrupt countries[1], strongly suggesting that corruption makes them worse off, all else equal. Bribery payments may especially hurt poor migrants (Dincer et al 2012) and reduce resources devoted to social welfare programs (Gupta et al 2002). These results suggest that access to the benefits of a corrupt society, and the costs of engaging in it, are heterogeneous. Even less corrupt countries tend to have regulatory holes where powerful agents can effectively pay for rents (Transparency International).

Schemes used to deter corruption are sensitive to the ability of the auditor to alter or hide evidence. North Korean refugee survey data suggests that where corruption is easy, relevant, and hard to detect, it is prevalent (Kim 2010). Additionally, the optimality of such schemes depends crucially on how often corruption would actually occur without any countermeasures. Consider two societies: One where auditors and agents are never capable of engaging in side contracts, and one where both were completely corruptible. In the incorruptible society, the principal need not impose costly restrictions to deter bribery. In the corrupt society, he may either incur significant cost deterring all corruption, or he may even allow corruption to occur[2].

I define a limited version of "honest" agents as having a high cost of corruption; "strategic" agents have zero cost of corruption. Even an agent who is willing to lie may be unwilling to engage in bribery, if the latter is against societal norms or requires particular technologies or resources to achieve[3]. A corruption-free society contains honest agents, and a corrupt society contains strategic agents. Clearly, the principal would prefer the honest society to the strategic one. In spite of this, increasing the proportion of honest of agents in a primarily-corrupt society will hurt the principal.

The literature tends to view prosocial behavior such as incorruptibility as weakly beneficial to the principal. Mittendorf (2008) demonstrates that ethical behavior has spillover effects on unethical agents in an environment where relative performance evaluation is optimal but agent

[1] See Dimant et al (2013), Cooray and Schneider (2014), and de Haas (2007) for recent evidence

[2] Kofman and Lawarrée (1993, 1996), Che (1995), Mookherjee and Png (1995), Strausz (1997), Olsen and Torsvik (1998), Lambert-Mogiliansky (1998), and Khalil and Lawarrée (2006), Acemoglu and Verdier (2000), and Auriol (2006) for some examples on optimally allowing corruption. Additionally, this paper bases its information structure on the work of Khalil, Lawarrée and Yun (2010).

[3] Alger and Renault (2007), for instance, develop a model where completely ethical agents are willing to misrepresent their ethics.

collusion is a potential threat. Kofman and Lawarrée (1996) find that the principal may benefit from allowing some collusion, if an auditor is incorruptible with enough likelihood. In their model, incorruptibility never hurts the principal's profits, and eventually improves them. Importantly, the agent's information about the possibility of collusion is symmetric with the principal, which means he is unsure of the possibility of corruption when signing the contract. So while the principal cannot screen between incorruptible and corruptible auditors, he can compensate by offering a contract which offers a payoff smaller than the agent's outside option upon the discovery that he cannot engage in bribery, as long as the agent's expected payoff is equal to his outside option *ex ante*.

If instead all auditors are corruptible, but some agents are honest[4], the agent clearly knows whether he can engage in bribery prior to signing of the contract. This creates an additional dimension of asymmetric information which is difficult for the principal to screen, as the only contractible signal related to honesty in any way is the auditor's report. If the principal compensates the honest agent for his inability to extract rent via bribery, he must also provide additional rent to the strategic agents who can mimic the honest agent. If only a small percentage of agents are honest, the principal will shut them down to reduce the strategic agents' rent; this means that the principal's profits decrease as honesty, and hence shutdown, becomes increasingly common.

Multidimensional screening has a broad literature in pricing and auctions[5], but its treatment in the case of prosocial behavior is relatively new. Benabou and Tirole (2006) develop a model with multidimensional screening and prosocial behavior, focusing on reputational, extrinsic, and intrinsic motivations to perform a good action. Severinov and Deneckere (2006) develop a "password mechanism" to screen agents with message space restrictions, taking advantage of the agent's ability to report repeatedly. I consider the benefits of "full honesty," i.e. full restriction in both side contracting and in message spaces, in an extension in Section 5.

In a society with some amount of corruption, the wealthy may benefit from their theoretical ability to engage in cheating and corruption. This is implicit in any incentive compatibility constraint, insofar as bad behavior is deterred through rent, even to agents who would not engage

[4] Or, equivalently, all agents were corruptible, and the agent knew if he was dealing with an honest or strategic auditor *ex ante.*

[5] Rochet and Choné (1998), Figalli et al (2011), and Manelli and Vincent (2007) represent a more technical portion of the literature.

bad behavior but merely appear so inclined. The tax literature[6] discusses how one effect of raising taxes is to encourage more tax evasion. Someone who would never engage in evasion or bribery could still benefit from the implicit threat of those who would. In a mostly corrupt society, the few wealthy honest agents still receive rent – in the form of tax breaks or otherwise – provided to deter cheating that is enhanced or enabled by corruption. Lambsdorff (2002) raises a similar argument, comparing lobbying efforts to actual bribery, noting that lobbying tends to be widely accessible and more wasteful, while actual bribery is more narrowly focused. In a similar vein, when behavior normally considered corrupt becomes legal, such as when campaign finance laws are deregulated and the wealthy have new ways to support their preferred political candidate, agents who would otherwise be unwilling or incapable of engaging in pure bribery can still obtain rents by emulating corrupt behavior in a safe way.

This is another example of the principal having difficulty screening in multiple type dimensions. Generally, he pools all wealthy agents together. There is, however, a way to screen honest agents in this case. If the principal implicitly[7] forces the strategic wealthy agent to engage in a side contract to obtain his rents, then the honest agent cannot mimic the strategic agent and obtain his full rents. Normally, auditing the wealthy, "productive" type is pointless, as no other type wishes to falsely submit that report. And it remains true that anyone submitting a report of high income does, in fact, have high income. In this case, the honest wealthy type wishes to emulate the strategic wealthy type, and the result of the auditor's report can separate those who can alter it from those who cannot.

The cost of this policy is the bribe sent to the auditor, which counts directly against the principal's revenue. The benefit is the reduction of the wealthy honest agent's rent. Suppose, for instance, one could find a way to criminalize all campaign contributions that entailed any sort of quid pro quo arrangement. Only those specially-connected, dishonest individuals who believed they could get away with their behavior would then attempt to do it. This limits the rents that the principal must allow wealthy agents to enjoy.

Consider the information structure developed by Khalil, Lawarrée and Yun (2010), hereafter referred to as KLY. In their moral hazard model, a supervisor inspects the agent's

[6] See Andreoni et al (1998) for a review of the literature
[7] Clearly it could not be explicit, as the principal cannot contract directly on the ability to engage in illegal activity. He can, however, contract upon the auditor's report, even if he understands it is likely falsified.

behavior after production has occurred. The supervisor obtains either hard evidence[8] of the agent's effort, or finds nothing conclusive. If the supervisor wishes to alter his report, he can unilaterally hide evidence, or he can negotiate an illegal side contract with the agent and collaboratively alter the signal to any value. If the principal wishes to deter all corruption, he must deter both bribery – i.e. the supervisor-agent coalition altering the signal to improve both of their payoffs – and extortion – i.e. the supervisor demanding a payment simply to report what he found, using a credible threat to hide evidence. This creates non-separabilities in the constraints that deter corruption (Tirole, 1992) which make it optimal to allow bribery for an accurate-enough supervisor. Extortion, however, is never optimal, as it punishes the agent for good behavior.

I use the information framework developed by KLY in a simple adverse selection model of taxation and find similar results. I then include the probability that the agent is honest, and I develop two main contributions: Honesty hurts the principal through optimal shutdown of the low income honest type; and the principal may wish to audit the wealthy strategic agent and induce extortion to separate honest and strategic wealthy agents. When the principal is in a primarily corrupt society, policies to develop honesty in some agents (or to cut their ties with corrupt auditors) may backfire by forcing these honest agents out of the society. In a more honest society, auditing may take on the secondary purpose of deterring honest agents from extracting rents, as opposed to actually finding out information on income.

Scott (2014) shows that extortion may be allowed when the supervisor's threats can be credible even when he incurs a cost of executing them, focusing on the trade-off between informational and corruption rents. This paper restricts the auditor to rational behavior while inducing extortion for the purpose of screening.

Yun (2012) creates a regulator-inspector-firm model based on Mookherjee and Png (1995) to examine optimal contracting when falsifying reports and side-contracting are possible but costly. He finds that forms of corruption can exist in equilibrium, including extortion and framing, as even a falsified report is informative when falsification is costly. Additionally, increasing the cost of this corrupt behavior, including both information distortion and side-contracting, can harm social welfare. Yun emphasizes the resources wasted in engaging in corrupt behavior; even if corruption is reduced by making these behaviors more costly, more resources end up being devoted to corrupt behavior overall. He concludes that a fight against corruption ideally increases the cost

[8] KLY provides a thorough discussion of hard versus soft evidence.

of corruption high enough that it is deterred entirely. My paper's insights diverge from Yun's in the following ways: Limitations on corruption can be harmful even when they entail no direct waste of resources. Even a cost of corruption high enough to deter all corruption, i.e. honesty, can be harmful if it is heterogeneous and creates a new dimension of asymmetric information. If a policy increases the population of incorruptible agents, i.e. increasing the probability the agent is honest, as opposed to increasing the cost of corruption for everyone, and the auditing technology is relatively strong, corruption will not be deterred in equilibrium.

The rest of the paper is organized as follows: Section 2 describes the model setup. Section 3 describes benchmark contracts and a replication of KLY's main results without honesty. Section 4 describes optimal contracts under various parameter conditions, and the main results. Section 5 discusses extensions, and Section 6 concludes.

2. The Setup

A principal (it) contracts with an agent (she) to form a productive relationship. The agent can pay an initial investment c to enter the relationship[9], and then collect θ as productive income. The agent is the residual claimant of θ. The principal then collects a portion of the income t. I interpret t to be a tax, and set limited liability such that $t \leq \theta$ in any circumstance. Alternatively the agent can reject the relationship and collect an outside option normalized to 0.

θ can take two forms, θ_1 (referred to as a "poor" agent) or θ_2 (a "wealthy" agent), known privately to the agent before signing the contract. Note that $\theta_2 - \theta_1 = \Delta\theta > 0$. The probability that $\theta = \theta_1$ is f_1, and the probability that $\theta = \theta_2$ is $f_2 = 1 - f_1$. In the first best case, the principal simply extracts all the income less the agent's investment cost, $\theta - c$. When the principal does not observe income, in the absence of auditing the principal grants full rent to the wealthy type in a pooling contract, setting $t_1 = t_2 = \theta_1 - c$; $u_2 = \Delta\theta$. I refer to this as the second best contract[10].

[9] Alternative interpretations of c include: A reduced form cost of effort; a fixed non-pecuniary penalty reimbursed by the principal in some circumstances; an outside option, making it an opportunity cost of contracting with the principal instead of an accounting cost. An alternative model that eliminates c could generate similar results as long as it allowed the principal to enact some form of punishment when the agent is neither caught nor exonerated.

[10] Even here, where the wealthy agent receives maximum rent through pooling, the poor agent lacks an incentive to mimic the wealthy agent. This will be important when considering whether to disregard more complicated IC constraints later on. Note that this is the optimal contract only when shut-down of the low income type is suboptimal, which I later assume in parameter constraints.

I present a model with no other income-based screening devices in order to focus on the issues the principal faces with auditing and corruption.

The principal can hire a costless, corruptible, risk neutral auditor (he) to collect a signal of the agent's type. Following KLY and Tirole (1986), the signal shows the agent's correct type (1 or 2) with probability p and shows no information ($\emptyset$) with probability $1-p$. The auditor can freely hide information, i.e. change any signal into $\emptyset$, but he requires the agent's help to change the signal to 1 or 2. The auditor then submits his potentially-modified report to the principal, who can collect a transfer depending on both the agent's and the auditor's report[11]. The principal may wish to award a transfer $w \geq 0$ to the auditor.

I use the definitions of bribery and extortion discussed in KLY:

> "**Definition 1.** *Bribery* occurs when one party accepts a payment in return for misreporting information in favor of the other party.
>
> **Definition 2.** *Extortion* occurs when the supervisor obtains a payment from the agent by threatening to misreport evidence that was favorable to the agent. I say *framing* has occurred if the attempt at extortion fails and the supervisor misreports information that was favorable to the agent."

The agent is potentially "honest," in that he cannot engage in a side contract with the auditor, with probability q. One way to interpret this is that the agent has a cost of engaging in a side contract α, where $P(\alpha = \infty) = q$ and $P(\alpha = 0) = 1 - q$.

The order of the game is as follows:

1. Nature determines θ and α, known to the agent.
2. The principal offers a take-it-or-leave-it contract to the agent representing a menu of transfers $\{t_i \dots w_i \dots\}$, where i represents agent and auditor reports, and the agent accepts or rejects.
3. The agent reports his types.
4. The auditor learns α[12] and collects the signal of θ.

[11] As noted by Kofman and Lawarrée (1996) (in which they thank Eric Maskin for the line of thought), while it may not be possible to directly contract on the ability to engage in illegal behavior, there is an equivalent contract that refers to corruptibility in an oblique fashion. Their example is to wear different colored hats which signify different levels of α and contracting on the color of the hats. Equivalently, offering the agent four different contracts, and having the agent simply pick one without announcing α, is equivalent in our analysis. This intuition also lends credence to the idea that an honest agent could mimic another type but be unwilling to engage in corruption.

[12] I assume the auditor's report is limited to the agent's income, as he has no hard evidence of α.

5. The auditor and agent potentially make side-transfers and alter the auditor's report.
6. The principal receives t and pays w according to the reports.

I make the following parameter assumptions to focus our attention on the interesting cases:

$$\text{A1: } \frac{f_1}{1-f_1} > \frac{\Delta\theta}{\theta_1}$$

$$\text{A2: } p \leq 1 - \frac{c}{\Delta\theta}$$

$$\text{A3: } p > \frac{f_1}{1-f_1}$$

A1 ensures that the principal does not shut down the poor agent in the absence of auditing. This is primarily to confirm that our result of shutting down honest poor agents is not simply because the principal prefers to shut down all poor agents, but also helps eliminate full-shutdown contracts that complicate further analysis.

A2 ensures that the wealthy agent's Incentive Compatibility constraints will bind. As I will show, this condition is stronger than necessary to ensure that the principal will not achieve the first best when deterring all corruption, but its imposition simplifies the analysis.

A3 ensures that, when $q = 0$, allowing bribery is superior to deterring all corruption.

3. Benchmark Contracts

I first examine the case where $q = 0$ and show that my results closely mirror those of KLY. Note that t_i is the transfer from the agent given the combined reports i of the agent and auditor, and w_i is the transfer to the auditor given the same i. In the case where $q = 0$, the relevant information is the agent's income report and the auditor's income report, meaning i encompasses both the agent and the auditor's report. For example, $t_{1,\emptyset}$ represents the transfer from the agent to the principal when the agent reports $\theta = \theta_1$, and the auditor reports no evidence.

Auditing without corruption

If the auditor is incorruptible, the principal can punish the agent if the auditor's report does not match the agent's claim, and the auditor requires no transfer or incentive compatibility to report the original signal.

Because of limited liability, the only punishment the principal can inflict upon a report of no evidence is to tax the entire income of the agent, and not compensate him for his initial cost c. In other words, the largest transfer the principal can collet is $t_{1,\emptyset} = \theta_1$. Upon catching the lying agent, the principal can tax the agent's entire income $t_{1,2} = \theta_2$. So the principal can fail to cover c when encountering a suspicious signal, but is not allowed to charge more than the agent's proven level of income.

Setting $t_{1,\emptyset} = \theta_1$ is not costly even though the truthful low income type is penalized by the auditor's mistake. To see this, note that $pt_{1,1} + (1-p)t_{1,\emptyset}$ appears both in IR and the objective function, and everyone is risk neutral.

Here I note the relevant constraints and solution:

$$IR_1: \theta_1 - c - pt_{1,1} - (1-p)t_{1,\emptyset} \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$IC_2: \theta_2 - c - t_2 \geq \theta_2 - c - pt_{1,2} - (1-p)t_{1,\emptyset}$$

$$LLC_{1,\emptyset}: t_{1,\emptyset} \leq \theta_1$$

By A1 and A2, the principal avoids shutdown, and IR_2 is slack, respectively[13]. Hence, the principal's optimal incorruptible auditor contract is thus:

$$t_{1,\emptyset} = \theta_1$$

$$t_{1,2} = \theta_2$$

$$t_{1,1} = \theta_1 - \frac{c}{p}$$

$$t_2 = \theta_2 - \Delta\theta(1-p)$$

$$u_2 = \Delta\theta(1-p) - c$$

Note that c hurts the principal, with binding or non-binding IR_2. When IR_2 is non-binding, the rich agent's transfer does not change with c, as opposed to the binding case where it does. But the transfer to the poor agent decreases in c either way. So in short, c helps incentives, but hurts overall profits.

Auditing With Corruption, No Extortion

[13] This contract gives up less rent than the second best, and hence has less reason for shutdown; additionally, notice that a binding A2 parameter constraint sets $u_2 = 0$.

If the auditor is corruptible but has no power to hide evidence unilaterally, the principal can turn the auditor into a bounty hunter. To deter corruption, the principal institutes Coalition Incentive Compatibility (CIC) constraints:

$$w_{1,1} - t_{1,1} = w_{1,2} - t_{1,2} = w_{1,\emptyset} - t_{1,\emptyset}$$

Note that the principal maximizes

$$f_1\left(p(t_{1,1} - w_{1,1}) + (1-p)(t_{1,\emptyset} - w_{1,\emptyset})\right) + (1 - f_1)t_2$$

Subject to the following constraints:

$$IR_1: \theta_1 - c - pt_{1,1} - (1-p)t_{1,\emptyset} \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$IC_2: \theta_2 - c - t_2 \geq \theta_2 - c - pt_{1,2} - (1-p)t_{1,\emptyset}$$

And the CICs and LLCs.

Notice that $w_{1,2}$ does not enter the maximand or constraints except via the $CICs$, and $t_{1,2}$ only enters in the $CICs$ and slackens IC_2. Holding $w_{1,2} - t_{1,2}$ constant (and hence not affecting the $CICs$), the principal would prefer to increase both $t_{1,2}$ and $w_{1,2}$ equally. Therefore the principal will set $t_{1,2} = \theta_2$ and $w_{1,2} = \theta_2 + w_{1,1} - t_{1,1} = \theta_2 + w_{1,\emptyset} - t_{1,\emptyset}$.

Without corruption the principal could set $t_{1,\emptyset} > t_{1,1}$ and $w_{1,1} = w_{1,\emptyset} = 0$, but this violates $CIC_{\emptyset,1}$. If the principal wishes to separate $t_{1,\emptyset}$ and $t_{1,1}$, he must do so by keeping $w_{1,\emptyset} - t_{1,\emptyset}$ constant, i.e. increasing both $w_{1,\emptyset}$ and $t_{1,\emptyset}$. Increasing $t_{1,\emptyset}$ tightens IR_1 such that $t_{1,1}$ must decrease by a factor of $\frac{1-p}{p}$; this along with the increase in $w_{1,\emptyset}$ means that transfers from the poor agent decrease by a factor of $1 - p$. Increasing $t_{1,\emptyset}$ also increases t_2 by a factor of $1 - p$ for binding IC_2.

So if $f_1 < 0.5$, which is required by A3, and the poor agent is still profitable to retain, i.e. $c < \theta_1 p$, then the principal wishes to set $w_{1,\emptyset} = t_{1,\emptyset} + w_{1,1} - t_{1,1} = t_{1,\emptyset} + w_{1,2} - t_{1,2}$. I will assume this from here on. If IC_2 does not bind, the principal can freely increase $t_{1,\emptyset}$ and decrease $t_{1,1}$ until it does bind, and then increase $w_{1,\emptyset}$ to satisfy $CIC_{\emptyset,1}$. Also note that increasing $w_{1,1}$ only tightens $CIC_{\emptyset,1}$, so the principal keeps $w_{1,1} = 0$.

Solution given A1-A3:

$$t_{1,\emptyset} = \theta_1$$

$$w_{1,\emptyset} = \frac{c}{p}$$

$$t_{1,1} = \theta_1 - \frac{c}{p}$$

$$w_{1,1} = 0$$

$$t_{1,2} = \theta_2$$

$$w_{1,2} = \theta_2 - \theta_1 + \frac{c}{p}$$

$$u_2 = \Delta\theta(1-p) - c$$

Auditing With the Possibility of Bribery and Extortion:

If the auditor can hide evidence, the principal must include an additional set of No Extortion constraints if he wishes to deter all bribery:

$$NE_2: w_{1,2} \geq w_{1,\emptyset}$$

$$NE_1: w_{1,1} \geq w_{1,\emptyset}$$

Notice that the bounty hunter contract violates NE_1 so long as

$$c \leq \Delta\theta \frac{1-p}{p}$$

Which is true given A2.

Least-Cost Corruption Proof contract

While the No Extortion constraints make the principal's problem more difficult, he can still deter all corruption. I will use KLY's naming convention and call this the Least-Cost Corruption Proof (LCCP) contract. Unlike the other contracts in this section, the LCCP contract remains both feasible and competitive given the restrictions in later sections, so I will reference the maximization problem with these constraints as P_0, and its solution as the LCCP contract, later.

As NE_1 binds (if it did not, the principal could increase $w_{1,\emptyset}$ and decrease $w_{1,1}$ until it did for reasons stated in the bounty hunter contract), I can set $w_{1,1} = w_{1,\emptyset} = w_1$. This modifies our CIC constraints as follows:

$$CIC_{\emptyset 1}: -t_{1,\emptyset} \geq -t_{1,1}$$

$$CIC_{1\emptyset}: -t_{1,1} \geq -t_{1,\emptyset}$$

Therefore

$$t_{1,1} = t_{1,\emptyset} = t_1$$

Note that the principal can still set $w_{12} = t_{12} + w_1 - t_1$ to satisfy the proper CICs without violating NE, as the auditor cannot fake evidence; he can only hide it. In fact, increasing w_{12} causes NE_2 to go slack. With this in mind, the principal will set $t_{1,2} = \theta_2$ and $w_{1,2} = \theta_2 + w_1 - t_1$.

Increasing w_1 decreases the net transfer to the principal, tightens CIC_{21} and $CIC_{2\emptyset}$, and otherwise does nothing. Therefore the principal will set $w_1 = 0$. Knowing this I can derive the full solution from the binding constraints:

$$IR_1: \theta_1 - t_1 - c \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$IC_2: \theta_2 - c - t_2 \geq \theta_2(1-p) - c - (1-p)t_1$$

If IR_2 is slack,

$$u_2 = \Delta\theta(1-p) - pc$$

$$\theta_2 - c - t_2 = \Delta\theta(1-p) - pc$$

$$t_2 = \theta_2 - \Delta\theta(1-p) - (1-p)c$$

This occurs when $c \leq \Delta\theta \frac{1-p}{p}$, which is satisfied by A2. The principal can achieve the first best while deterring all corruption (replicating the bounty hunter contract) when $c \geq \Delta\theta \frac{1-p}{p}$

Full solution for $\leq \Delta\theta \frac{1-p}{p}$ [14]:

$$t_2 = \theta_2 - \Delta\theta(1-p) - (1-p)c$$

$$t_{1,1} = t_{1,\emptyset} = t_1 = \theta_1 - c$$

$$w_{1,1} = w_{1,\emptyset} = w_1 = 0$$

$$t_{1,2} = \theta_2$$

$$w_{1,2} = \Delta\theta + c$$

Agent-Auditor Side Contracting

The agent's bargaining power is represented by λ, $0 < \lambda < 1$ in the Nash bargaining solution. If the net transfer from the auditor-agent coalition to the principal before report-alteration is $T_i = t_i - w_i$, and the net transfer from the coalition to the principal after report-alteration is $T_j = t_j - w_j < t_i - w_i$, then the agent collaborates with the auditor and effectively pays a transfer $t_i' =$

[14] Note that this is the necessary condition for LCCP not to replicate the first best, as opposed to A2.

$t_i + \lambda\left(\left(t_j - w_j\right) - (t_i - w_i)\right) = (1-\lambda)t_i + \lambda\left(t_j - \left(w_j - w_i\right)\right)$. If the signal is already the most profitable for the coalition (as is the case in LCCP), $t_i' = t_i$. This is derived in Appendix A. Note that this derivation applies to any strategic agent when $q > 0$ as well.

Allowing Extortion is Never Optimal

See Appendix B for the full proof. Intuitively, when extortion is allowed, the agent obtains the same payoffs as in the LCCP contract for various signals, but the auditor receives rent. This rent makes any extortion-allowing contract more costly than the LCCP contract at the same levels of effort, so the extortion-allowing contract is suboptimal. Extortion imposes an expected penalty for working instead of shirking, whereas bribery still imposes an expected penalty for shirking. Therefore one might expect a contract to allow bribery, but never extortion. From now on I will re-introduce the NE constraints.

Bribery Allowed, Extortion-Proof Contract

I refer to the following problem as P_1:

$$\max_{t_i, w_i} f_1(T_M) + (1-f_1)(t_2)\ \ s.t.$$

$$T_M = \min\left(t_{1,1} - w_{11}; t_{1,\emptyset} - w_{1,\emptyset}; t_{1,2} - w_{1,2}\right)$$

$$IR_1: \theta_1 - c - p\left(t_{1,1} + \lambda\left(T_M - t_{1,1} + w_{1,1}\right)\right) - (1-p)\left(t_{1,\emptyset} + \lambda\left(T_M - t_{1,\emptyset} + w_{1,\emptyset}\right)\right) \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$\begin{aligned} IC_2: \theta_2 - c - t_2 & \\ &\geq \theta_2 - c - p\left(t_{12} + \lambda\left(T_M - t_{1,2} + w_{1,2}\right)\right) \\ &- (1-p)\left(t_{1,\emptyset} + \lambda\left(T_M - t_{1,\emptyset} + w_{1,\emptyset}\right)\right) \end{aligned}$$

$$NE_1: w_{1,1} \geq w_{1,\emptyset}$$

And non-negativity constraints

Case 1: $T_M = t_{1,1} - w_{1,1}$

The full derivation of the contract, along with alternate cases, are in Appendix C. The solution to the contract is as follows:

$$w_{1,1} = w_{1,\emptyset} = 0$$

$$t_{1,2} = \theta_2$$

$$w_{1,2} = \theta_2 - \theta_1 + \frac{c}{p + (1-p)\lambda}$$

$$t_{1,1} = \theta_1 - \frac{c}{p + (1-p)\lambda}$$

$$t_{1,\emptyset} = \theta_1$$

$$t_2 = p\theta_2 + (1-p)\theta_1 - \frac{(1-p)\lambda}{p + (1-p)\lambda} c$$

$$u_2 = (1-p)\Delta\theta - \frac{p}{p + (1-p)\lambda} c$$

This contract is superior to the LCCP contract when $p > \frac{f_1}{1-f_1}$, which is assumed in A1.

4. Optimal Contracts when Agents may be Honest

The introduction of honest (H) and strategic (S) types creates a new dimension of asymmetric information. There are now four types, signified as $\alpha\theta \in \{H1, H2, S1, S2\}$. For example, S2 represents the strategic wealthy agent. Transfers and constraints now refer to the agent's report $\alpha\theta \in \{S2, H2, S1, H1\}$ and the auditor's cost report of $\theta \in \{1,2\}$. For example, $t_{S1,\emptyset}$ refers to the transfer when an agent reports S1 and the auditor reports no evidence.

IR constraints are now IR_i where $i \in \{H1, H2, S1, S2\}$. IC constraints are presented as $IC_{i\to j}$ where $i, j \in \{H1, H2, S1, S2\}$, with some constraints ignored as nonbinding[15]. While IC constraints represent the agent picking the best type to mimic, it is conceptually useful and mathematically innocuous to carefully separate each IC constraint into its component possibilities.

Transfers are now written as $t_{i,j}$ and $w_{i,j}$ where i is the agent's report and j is the auditor's report. For simplicity, $t'_{i,j}$ refers to the net transfer paid by the agent. If $T_M = t_{i,j} - w_{i,j}$ then $t'_{i,j} = t_{i,j}$. For now, I will assume that the rich agent does not get audited. Later, I will break this normally-innocuous assumption and find how it changes the contract. The new constraints are as follows:

[15] Refer to the second best contract, where the poor agent has no rent, and the rich agent has a rent of $\Delta\theta$, which is larger than any other contract presented. In this case, the poor agent still cannot profitably mimic the rich agent. Hence, all constraints of type $IC_{i1\to j2}$, where i and j represent honesty types, are nonbinding.

$$IR_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq 0$$
$$IR_{S1}: \theta_1 - c - pt'_{S1,1} - (1-p)t'_{S1,\emptyset} \geq 0$$
$$IR_{H2}: \theta_2 - c - t_{H2} \geq 0$$
$$IR_{S2}: \theta_2 - c - t_{S2} \geq 0$$
$$IC_{H1-S1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq \theta_1 - c - pt_{S1,1} - (1-p)t_{S1,\emptyset}$$
$$IC_{S1\to H1}: \theta_1 - c - pt'_{S1,1} - (1-p)t'_{S1,\emptyset} \geq \theta_1 - c - pt'_{H1,1} - (1-p)t'_{H1,\emptyset}$$
$$IC_{H2\to S1}: \theta_2 - c - t_{H2} \geq \theta_2 - c - pt_{S1,2} - (1-p)t_{S1,\emptyset}$$
$$IC_{H2-H1}: \theta_2 - c - t_{H2} \geq \theta_2 - c - pt_{H1,2} - (1-p)t_{H1,\emptyset}$$
$$IC_{H2\to S2}: \theta_2 - c - t_{H2} \geq \theta_2 - c - t_{S2}$$
$$IC_{S2\to S1}: \theta_2 - c - t_{S2} \geq \theta_2 - c - pt'_{S1,2} - (1-p)t'_{S1,\emptyset}$$
$$IC_{S2-H1}: \theta_2 - c - t_{S2} \geq \theta_2 - c - pt'_{H1,2} - (1-p)t'_{H1,\emptyset}$$
$$IC_{H2\to S2}: \theta_2 - c - t_{S2} \geq \theta_2 - c - t_{H2}$$

Along with potential new NE, CIC, LLC and non-negativity constraints for each type.

LCCP Revisited

Note that P_0 and the LCCP contract do not change when $q > 0$; when the principal deters all corruption, the strategic agent's ability to bribe is rendered moot, and all agents of the same income level are pooled.

Shutting down H1 (SNA)

The Bribery-Allowed contract for $q = 0$ is infeasible when $q > 0$ because it violates IR_{H1}. To see this, consider the solution in the KLY contract:

$$t_{1,1} = \theta_1 - \frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}\Delta\theta$$
$$t_{1,\emptyset} = \frac{p+(1-p)\lambda}{p(1-\lambda)}\Delta\theta + \theta_1 - \frac{c}{(1-p)(1-\lambda)}$$

Plug into IR_{H1}:

$$\theta_1 - c - pt_{1,1} - (1-p)t_{1,\emptyset} \geq 0$$
$$\theta_1 - c - p\left(\theta_1 - \frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}\Delta\theta\right) - (1-p)\left(\frac{p+(1-p)\lambda}{p(1-\lambda)}\Delta\theta + \theta_1 - \frac{c}{(1-p)(1-\lambda)}\right) \geq 0$$

$$\theta_1 - \theta_1 - c + \frac{c}{1-\lambda} + \Delta\theta\left(\frac{p(1-p)(1-\lambda)}{p+(1-p)\lambda} - \frac{(1-p)(p+(1-p)\lambda)}{p(1-\lambda)}\right) \geq 0$$

$$c\frac{\lambda}{1-\lambda} + \Delta\theta(1-p)\left(\frac{p^2(1-\lambda)^2 - (p+(1-p)\lambda)^2}{(p+(1-p)\lambda)p(1-\lambda)}\right) \geq 0$$

Note $p + (1-p)\lambda = \lambda + p(1-\lambda)$

$$c\frac{\lambda}{1-\lambda} + \Delta\theta(1-p)\left(\frac{p^2(1-\lambda)^2 - \lambda^2 - p^2(1-\lambda)^2 - 2p\lambda(1-\lambda)}{(p+(1-p)\lambda)p(1-\lambda)}\right) \geq 0$$

$$\left(\frac{\lambda}{p(1-\lambda)}\right)\left(pc - \Delta\theta(1-p)\left(\frac{\lambda+2p(1-\lambda)}{p+(1-p)\lambda}\right)\right) \geq 0$$

$$c \geq \Delta\theta\frac{1-p}{p}\left(1 + \frac{p(1-\lambda)}{p+(1-p)\lambda}\right)$$

This is assumed false from parameter constraints[16]. To remedy this, the principal could decrease $pt_{H1,1} + (1-p)t_{H1,\emptyset}$, but this causes various ICs to tighten, including $IC_{S1\to H1}$. Alternatively the principal could offer the old contract and violate IR_{H1}, effectively shutting down the poor honest agent.

Note that if the agent bribes to change the signal, the tax the agent pays to the principal is less than the agent's total expenditure. Given $IC_{S2\to S1}$ and $IC_{S2\to H1}$, $IC_{H2\to S1}$ and $IC_{H2\to H1}$ are slack. This would imply that S2 receives more rent, but due to $IC_{H2\to S2}$ their rent is the same[17].

Given that $IC_{H2\to S2}$ binds, $t_{H2} = t_{S2} = t_2$. Given that $H1$ is excluded, there is only one remaining poor type, S1. Therefore, the principal can solve a modified version of P_1 where the probability of obtaining a poor transfer is $(1-q)f_1$ instead of f_1. The solution is as follows:

$$w_{S1,1} = w_{S1,\emptyset} = 0$$

$$t_{S1,2} = \theta_2$$

$$w_{S1,2} = \Delta\theta + \frac{c}{p+(1-p)\lambda}$$

$$t_{S1,1} = \theta_1 - \frac{c}{p+(1-p)\lambda}$$

$$t_{S1,\emptyset} = \theta_1$$

[16] If it were true, the principal could achieve first best profit with the LCCP contract.
[17] In other contracts where the principal audits the high type, $H2$ may receive less rent.

$$t_{H2} = t_{S2} = p\theta_2 + (1-p)\theta_1 - \frac{(1-p)\lambda}{p+(1-p)\lambda}c$$

$$u_{H2} = u_{S2} = (1-p)\Delta\theta - \frac{p}{p+(1-p)\lambda}c$$

Similar to the KLY contract, S1 never actually pays $t_{1,\emptyset}$ to the principal, because in the case of a $\emptyset$ signal he prefers to bribe the auditor $\frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}c$. Were the principal to include H1 by satisfying his IR constraint, H1 would occasionally pay $t_{H1,\emptyset}$, because H1 cannot collude to alter the signal.

Including H1 with Bribery Allowed (INA)

As q increases and encountering $H1$ becomes more likely, the principal will eventually prefer to abandon the SNA contract. He will either switch to the LCCP contract or continue to allow bribery *and* avoid shutdown. Compared to SNA, both contracts increase income to be taxed through $H1$, but tighten other constraints.

Recall that the SNA contract violated IR_{H1}. To accommodate $H1$, the principal must decrease $pt_{H1,1} + (1-p)t_{H1,\emptyset}$ relative to the transfers allowed in the SNA contract. This, in turn, tightens all IC constraints related to mimicking $H1$, including $IC_{S1\to H1}$. Given the principal does not violate any IR, the principal faces a new problem, P_3, with the following constraints:

$$IR_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq 0$$

$$IC_{S1\to H1}: \theta_1 - c - pt'_{S1,1} - (1-p)t'_{S1,\emptyset} \geq \theta_1 - c - pt'_{H1,1} - (1-p)t'_{H1,\emptyset}$$

$$pt'_{H1,1} + (1-p)t'_{H1,\emptyset} \geq pt'_{S1,1} + (1-p)t'_{S1,\emptyset}$$

$$IC_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq \theta_1 - c - pt_{S1,1} - (1-p)t_{S1,\emptyset}$$

$$IC_{H2\to S2}, IC_{S2\to H2}: t_2^S = t_2^H = t_2$$

$$IC_{S2\to H1}: \theta_2 - c - t_2 \geq \theta_2 - c - pt'_{H1,2} - (1-p)t'_{H1,\emptyset}$$

$$IC_{S2-S1}: \theta_2 - c - t_2 \geq \theta_2 - c - pt'_{S1,2} - (1-p)t'_{S1,\emptyset}$$

The full derivation of the optimal contract under these restrictions is present in Appendix D. Below I present the solution:

$$t_{S1,2} = t_{H1,2} = \theta_2$$

$$w_{S1,2} = w_{H1,2} = \Delta\theta - \frac{c}{p}$$

$$w_{H1,\emptyset} = w_{S1,\emptyset} = w_{H1,1} = w_{S1,1} = 0$$
$$t_{H1,\emptyset} = t_{S1,\emptyset} = \theta_1$$
$$t_{H1,1} = t_{S1,1} = \theta_1 - \frac{c}{p}$$
$$t_{H2} = t_{S2} = \theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p}c$$
$$u_{H2} = u_{S2} = (1-p)\Delta\theta - \frac{p-(1-p)\lambda}{p}c$$

Notice how, compared to the SNA contract, all agents pay fewer taxes except H1.

Auditing the Wealthy Agent

Normally the principal does not gain anything from auditing the "high type," as a report of 2 is definitely true, and poor agents do not profit from reporting high income. That said, even though an audit's signal only describes income, which is already known, it can indirectly reveal the agent's cost of collusion if collusion is induced. For high enough q and λ the principal may wish to audit S2 and induce him to bribe the auditor. Any inducement of bribery works as a screening device, but for simplicity of presentation we suppose the principal induces collusion by allowing extortion.

Specifically, the principal pays the auditor a penny to report $\emptyset$ upon the agent's report of S2, and nothing otherwise, and set transfers[18] to $t_{S2,2} > t_{S2,\emptyset}$. This grants the auditor a credible threat of framing, and provides the agent the incentive to pay the bribe. Given some u_{S2} governed by transfers to the low type, I can examine the relevant constraints:

$$u_{S2} = \theta_2 - c - t_{S2,\emptyset} - \lambda\left(t_{S2,2} - t_{S2,\emptyset}\right)$$
$$IC_{H2\to S2}: \theta_2 - c - t_{H2} \geq \theta_2 - c - t_{S2,\emptyset}$$
$$IC_{H2\to H1}: \theta_2 - c - t_{H2} \geq \theta_2 - c - pt_{H1,2} - (1-p)t_{H1,\emptyset}$$
$$IC_{H2\to S1}: \theta_2 - c - t_{H2} \geq \theta_2 - c - pt_{S1,2} - (1-p)t_{S1,\emptyset}$$

If $t_{S2,\emptyset} \leq t_{S2,2}$ then the principal essentially does not use the audit, as we assumed before. Notice that the principal must increase the net transfer to S2 as he decreases $t_{S2,2}$ and increases

[18] As long as $t_{S2,1} - w_{S2,1} \geq t_{S2,2}$, $t_{S2,1}$ and $w_{S2,1}$ are irrelevant, as the poor agents will not mimic the wealthy agents.

$t_{S2,\emptyset}$, but H2's rent decreases up until the other IC constraints bind. Given $IC_{H2\to S2}$ binds, the principal's high type transfers can be described as follows:

$$t_{S2,2} = \frac{\theta_2 - u_{S2} - c - (1-\lambda)t_{S2,\emptyset}}{\lambda}$$

$$t_{H2} = t_{S2,\emptyset}$$

$$E(t|2) = qt_{S2,\emptyset} + (1-q)\frac{\theta_2 - u_{S2} - c - (1-\lambda)t_{S2,\emptyset}}{\lambda}$$

Taking a derivative with respect to $t_{S2,\emptyset}$:

$$q - (1-q)\frac{1-\lambda}{\lambda}$$

If the derivative is positive, the principal will increase $t_{S2,\emptyset}$ and decrease $t_{S2,2}$ until $H2$'s other ICs bind, so long as he does not prefer to use the LCCP contract instead. If the derivative is negative, the principal will avoid auditing the high type as normal. The derivative is positive when:

$$q > 1 - \lambda$$

Notice, however, that the ICs for H2 and S2 are the same when the principal deters all corruption, making this auditing scheme irrelevant in that scenario. This insight leads to the first lemma:

Lemma 1: *When allowing bribery is optimal and $q > 1 - \lambda$, the principal will audit a report of S2 and induce extortion.*

Also note that $IC_{S2\to H2}$ is nonbinding if bribery is allowed for the poor agent:

$$IC_{S2\to H2}: u_{S2} \geq \theta_2 - c - t_{H2} = u_{H2}$$

$$IC_{H2\to H1}: u_{H2} \geq \theta_2 - c - pt_{H1,2} - (1-p)t_{H1,\emptyset}$$

$$IC_{S2\to H1}: u_{S2} \geq \theta_2 - c - pt'_{H1,2} - (1-p)t'_{H1,\emptyset}$$

No one has an incentive to mimic H2; therefore, the principal still has no reason to audit H2.

Auditing S2 and Including H1 (IA)

Given $q > 1 - \lambda$ and the principal induces collusion in $S2$, the optimal contract is altered. For now I assume that $c \leq \Delta\theta(1-p)$ so that IR_{H2} is still slack, but the results are similar in other respects. The optimal contract for this scheme is derived in Appendix D; I present the optimal contract below:

$$t_{S1,\emptyset} = t_{H1,\emptyset} = \theta_1$$

$$t_{S1,1} = t_{H1,1} = \theta_1 - \frac{c}{p}$$

$$t_{H1,2} = t_{S1,2} = \theta_2$$

$$t_{S2,1} > t_{S2,2}$$

$$t_{S2,\emptyset} = t_{H2} = \theta_2 - (1-p)\Delta\theta$$

$$t_{S2,2} = \theta_2 - (1-p)\Delta\theta - \frac{1-p}{p}c$$

$$w_{S1,1} = w_{H1,1} = w_{H1,\emptyset} = w_{S1,\emptyset} = w_{S2,1} = w_{S2,2} = w_{S2,\emptyset} = 0$$

$$w_{S1,2} = w_{H1,2} = \Delta\theta + \frac{c}{p}$$

Audit S2, Shut Down H1 (SA)

I will show that it is never optimal under our initial parameter restrictions to both violate IR_{H1} and audit S2. This contract is presented in Appendix D, and its suboptimal nature is proven in Appendix E.

Results

To generate my results, I first compare the profits of all the above contracts and show when each one is optimal in Appendix E.

Lemma 2: *The SA contract is never optimal given parameter restrictions A1 and A2.*

The proof is conceptually straightforward. The conditions for superior profit never hold simultaneously given our parameter restrictions. Especially if A1 was violated, it may be optimal to shut down all poor types, so SA may be the best of five suboptimal contracts in that case. The proof appears in Appendix E.

Proposition 1: *Honesty hurts the principal given q is small.*

The proof is in Appendix E. Consider the case where q is close to 0. The cost of shutting down H1 is her tax revenue, which is proportional to $f_1 q$. The cost of allowing H1 to produce is granting rent to all other agents, which is roughly proportional to $1 - f_1 q$. Hence, for small q, the principal will find it worthwhile to shut down H1 and emulate the KLY contract. While small, clearly the cost of shutting down H1 increases in q, since no other aspect of the contract changes, and more and more agents are shut down.

This represents the issue presented to a reformer in a corrupt society. There is an implied dynamic effect of this model where honest individuals are continuously pushed out of corrupt societies towards less corrupt ones. Conventionally negative norms of behavior may be enforced for the sake of homogeneity. Hence, if policies do not generally increase the costs of corruption and instead have a heterogeneous effect on individuals, the affected individuals may simply be sorted out, at a cost to the home country.

Proposition 2: *The principal will optimally audit S2 and induce extortion, given q is large.*
The proof takes the following steps:

1. Given Lemma 2, and given the IA contract is only valuable if bribery is allowed, the principal's optimal contract when inducing extortion for S2 is the IA contract.
2. The IA contract is superior for some $\underline{q} < q < 1$, given Lemma 2 and the profit comparison between IA and LCCP.

Step 1 is evident. For step 2, Lemma 1 shows that IA is superior to SNA and IA when $q > 1 - \lambda$. Additionally, IA is superior to LCCP when $q > f_1 + (1 - f_1)(1 - p)$. Define $\underline{q} = \max(1 - \lambda, f_1 + (1 - f_1)(1 - p)\,)$. The IA contract is optimal when $\underline{q} < q < 1$.

When most agents do not engage in corrupt behavior, the principal is more willing to pay more to accommodate corrupt agents, so long as it maximizes honest revenue. In particular, forcing strategic wealthy agents to engage in actual corruption to obtain their rents allows the principal to screen wealthy honest agents and reduce their rent significantly. For a primarily-honest society, not allowing honest agents to emulate corrupt practices through legal means can provide significant societal benefits.

5. Extensions

Honesty as habitual compliance

This paper's main two results stem from two separate problems with honesty as incorruptibility. The first problem is that strategic agents have an advantage mimicking poor honest agents, as H1's taxes must be lower overall to compensate for their inability to bribe and alter the signal. The second problem is that wealthy honest agents may freely emulate wealthy strategic agents unless the principal imposes a costly extortion scheme.

Consider a more absolute form of honesty, where with probability q the agent cannot engage in bribery or misrepresent her type. This new definition solves the second problem, but not the first one. Recall that, in the main model, H1 had no binding IC constraint; she could not profitably emulate anyone. However, H2 did have a binding IC constraint, and in particular wished to mimic S2 in the absence of auditing S2. Limiting the honest agent's message space to truthful messages eliminates the need to impose incentive compatibility for those agents.

Clearly, there is no more reason to induce extortion in S2, as its sole purpose was to prevent H2 from choosing S2's contract, which H2 can no longer do. As noted, however, H1's existence still poses an issue. H1 cannot emulate anyone, but the strategic agents still exist. I will demonstrate that complete honesty still hurts the principal.

First, note that for all contracts, including the LCCP, with probability $q(1 - f_1)$ the agent automatically reports as H2. Hence, H2 no longer has to receive rent, binding her IR and generating the following transfer schedule:

$$t_{H2} = \theta_2 - c$$

LCCP revised

As it is otherwise determined by constraints that still bind, the LCCP contract has not changed in any other respect. I present the solution to the modified P_0 here:

$$t_{H2} = \theta_2 - c$$

$$t_{S2} = \theta_2 - c - \Delta\theta(1 - p) + pc$$

$$u_{S2} = \Delta\theta(1 - p) - pc$$

$$t_{1,1} = t_{1,\emptyset} = t_1 = \theta_1 - c$$

$$w_{1,1} = w_{1,\emptyset} = w_1 = 0$$

$$t_{1,2} = \theta_2$$

$$w_{1,2} = \Delta\theta + c$$

Recall that H1 and S1 are pooled, and hence the contract does not depend on the agent's report of H or S in the case of low income. The principal's profit is hence:

$$\Pi^{LCCP} = f_1(\theta_1 - c) + (1 - f_1)\big(\theta_2 - c - (1 - q)(\Delta\theta(1 - p) - pc)\big)$$

SNA revised

In spite of this new advantage to the LCCP contract, the principal may still wish to allow bribery, but as noted will no longer audit S2 for any q. Hence, the two other potentially-optimal contracts are SNA and INA. For SNA, the principal solves a further-modified version of P_1 where IR_{H1} is violated and IC_{H2} is eliminated. The solution is as follows:

$$w_{S1,1} = w_{S1,\emptyset} = 0$$

$$t_{S1,2} = \theta_2$$

$$w_{S1,2} = \Delta\theta + \frac{c}{p + (1 - p)\lambda}$$

$$t_{S1,1} = \theta_1 - \frac{c}{p + (1 - p)\lambda}$$

$$t_{S1,\emptyset} = \theta_1$$

$$t_{H2} = \theta_2 - c$$

$$t_{S2} = p\theta_2 + (1 - p)\theta_1 - \frac{(1 - p)\lambda}{p + (1 - p)\lambda}c$$

$$u_2 = (1 - p)\Delta\theta - \frac{p}{p + (1 - p)\lambda}c$$

The principal's profit is:

$$\Pi^{SNA} = f_1(1 - q)\left(\theta_1 - \frac{c}{p + (1 - p)\lambda}\right) + (1 - f_1)\left(\theta_2 - c - (1 - q)\left((1 - p)\Delta\theta - \frac{p}{p + (1 - p)\lambda}c\right)\right)$$

INA Revised

The INA contract solves a modified version of P_1 with the relevant new IC constraints, and once again no IC_{H2}. Like in the previous INA contract, S1 and H1 will pool, and hence the transfers do not depend on the announcement of honesty for low income agents. I present the non-LCCP solution here:

$$w_{1,1} = w_{1,\emptyset} = 0$$

$$t_{1,2} = \theta_2$$

$$w_{1,2} = \Delta\theta + \frac{c}{p + (1 - p)\lambda}$$

$$t_{1,1} = \theta_1 - \frac{c}{p}$$

$$t_{H2} = \theta_2 - c$$

$$t_{S2} = \theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p} c$$

$$u_{S2} = (1-p)\Delta\theta - \frac{p-(1-p)\lambda}{p} c$$

$$\Pi^{INA} = f_1\left(\theta_1 - \left(1 - q(1-p)\right)\frac{c}{p}\right) + (1-f_1)\left(\theta_2 - c - (1-q)\left((1-p)\Delta\theta - \frac{p-(1-p)\lambda}{p} c\right)\right)$$

Proposition 3: *Even when honest agents cannot collude or lie, honesty hurts the principal for small q.*

The proof is in Appendix F. For small q, SNA is still optimal. This is clear when considering the case where $q \to 0$; under parameter assumption A1, the KLY contract is optimal for $q = 0$, so a small increase in q, should not make LCCP optimal instead, and as established in the main model, including the low type bears significant costs when q is small. Additionally, the marginal effect of shutting down agents, also displayed in the proof of Proposition 1, outweighs the marginal rent reduction in wealthy types as q increases.

Honest agents as truth-telling, but willing to engage in corruption

While habitual compliance helps the principal, the agent's incorruptibility can be harmful. This intuition holds when honesty is strictly a message space restriction; i.e., agents must tell the truth with probability q, but any agent can engage in corrupt behavior. When corruption is allowed at all, the only signal falsification that occurs on the equilibrium path changes the signal from no evidence to hard evidence of the agent's actual income. While the report is falsified, it conveys the underlying truth. Because of this, the agent may be willing to collude with the auditor even if she is unwilling to or incapable of mimicking other types, because the only time she colludes is to essentially "correct" the auditor's report. This particular type of agent, when contrasted with the strategic agent, makes the principal strictly better off.

Like in the completely honest case, H2 receives no rent. The important difference is that H1 is willing to bribe to alter the signal, and so the strategic agents cannot exploit a difference in their ability to manipulate reports to obtain rents. Hence, a compliant agent who is still willing to abide by corrupt social norms is ideal for the principal.

6. Conclusion

Policies that combat corruption by increasing the relative population of honest agents in a mostly-corrupt population may be counterproductive. This result is tied to the issue that honesty creates an additional dimension of adverse selection. Khalil, Lawarree and Yun (2010) created a novel way for corruption to be optimal, but in the presence of honesty, allowing corruption in equilibrium creates rents for agents who can exploit it. The principal must choose between offering these rents and shutting down some agents. This contribution helps explain the losses corrupt societies face from out-migration, and why these losses may be acceptable to those in power.

To be clear, the principal is not necessarily a maximizer of social welfare in this model. It is reasonable to doubt that corrupt societies are optimally designed at all; however, if one views the principal as a local authority who wishes to maximize his own income, the intuition clarifies. Such an authority is more than willing to forgo a small amount of revenue due to out migration, in favor of schemes that maximize income sent to him as opposed to those under him. Also notice how shutdown, and hence migration, acts as a homogenizing force. A population that has some tendency to move towards honesty may remain corrupt, as much of the honest population moves away.

The contributions in this paper provide sharp contrast to insights developed by similar research. In Kofman and Lawarrée (1996), potential incorruptibility complements lax enforcement of corruption, whereas here, honesty in the agent makes lax enforcement more costly. Yun (2012) advocates for increasing the cost of corruption past a threshold that deters all corruption lest the costs lead to wasted resources, but this paper shows even an infinite cost of corruption, with zero cost when implemented, can be harmful to the principal, as long as there is heterogeneity.

Honest and strategic agents are difficult to separate; in fact, the principal cannot screen less productive honest and strategic types at all. In more honest societies, I have found that the principal may use corruption itself as a screening device in an unlikely fashion, by auditing and inducing extortion in wealthy strategic types. The main difference between honest wealthy agents and strategic wealthy agents is their ability to engage in corruption. Normally, this allows honest wealthy agents to obtain large rents by emulating corrupt behavior, but the principal can exploit these agents' one difference to reduce honest rents, at the cost of extortion payments. This result mirrors an intuition in the rent-seeking literature that contrasts broad, wasteful lobbying with focused, limited bribery.

This paper emphasizes the role of an ethical minority in a society, and how power and productivity change her and the principal's fate. When corruption is prevalent, poor honest agents are mistreated, and wealthy honest agents try their best to blend in. When honesty is prevalent, powerful corrupt agents may optimally obtain more rents than anyone else, but only through illegal means.

Appendix A: Derivation of side payments in the auditor-agent coalition

$$\max_{t_i',w_i'}(t_i - t_i')^{\lambda}(w_i' - w_i)^{1-\lambda} \ s.t.$$

$$w_i' - t_i' = w_j - t_j$$

Re-stating the problem:

$$\max_{t_i',w_i'}(t_i - t_i')^{\lambda}(w_i' - w_i)^{1-\lambda}$$

$$+\phi\left(w_j - t_j - w_i' + t_i'\right)$$

First order conditions:

$$[t_i']: -\lambda(t_i - t_i')^{\lambda-1}(w_i' - w_i)^{1-\lambda} + \phi = 0$$

$$[w_i']\ (1-\lambda)(t_i - t_i')^{\lambda}(w_i' - w_i)^{-\lambda} - \phi = 0$$

Solving:

$$\phi = \lambda(t_i - t_i')^{\lambda-1}(w_i' - w_i)^{1-\lambda}$$

$$\phi = (1-\lambda)(t_i - t_i')^{\lambda}(w_i' - w_i)^{-\lambda}$$

$$\lambda\left(\frac{t_i - t_i'}{w_i' - w_i}\right)^{\lambda-1} = (1-\lambda)\left(\frac{t_i - t_i'}{w_i' - w_i}\right)^{\lambda}$$

$$\lambda = (1-\lambda)\frac{t_i - t_i'}{w_i' - w_i}$$

$$\lambda(w_i' - w_i) = (1-\lambda)(t_i - t_i')$$

$$t_i' = w_i' - w_j + t_j$$

$$\lambda w_i' - \lambda w_i = (1-\lambda)t_i - (1-\lambda)\left(w_i' - w_j + t_j\right)$$

$$w_i' = \lambda w_i + (1-\lambda)\left(w_j + t_i - t_j\right)$$

$$t_i' = (1-\lambda)t_i + \lambda\left(t_j - \left(w_j - w_i\right)\right)$$

Also note that if $i = j$, $t_i' = t_i(1 - \lambda + \lambda) - \lambda(w_i - w_i) = t_i$.

Appendix B: Allowing extortion is suboptimal

I prove this in steps. In step (i), I show that the agent receives the same payoff from Nash bargaining for $\sigma \in \{\emptyset, 1\}$ if the constraint NE_1 is violated. In step (ii), I compute the profit of a general contract where NE_1 is violated. In step (iii) I show that the principal can achieve the same profit with a corruption-proof contract which is different from the LCCP. Because the LCCP is the optimal corruption-proof contract, this proves that allowing extortion is always inferior to the LCCP.

Step (i):

If the auditor has an incentive to hide exonerating evidence, i.e. $w_{1,\emptyset} > w_{1,1}$, and $T_{1,1} < T_{1,\emptyset}$, then the agent will bribe the auditor *not* to alter the signal using the same Nash bargaining solution as I derived previously. The threat point is $\sigma = \emptyset$, because without collusion the auditor will unilaterally change the signal to $\emptyset$. I can re-state this case given the Nash bargaining solution derived previously:

$$t'_{1,1} = (1-\lambda)t_{1,\emptyset} + \lambda\left(t_{1,1} + w_{1,1} - w_{1,\emptyset}\right) = t'_{1,\emptyset}$$

If $T_1 \leq T_\emptyset$, the auditor will frame the agent and no bribery will occur. In either case, $t'_{11} = t'_{1\emptyset}$.

Step (ii): compute the profit of a contract that violates NE_1 with transfers $\widehat{t_2}, \widehat{t_{11}}, \widehat{t_{1\emptyset}}, \widehat{t_{12}}, \widehat{w_{11}}, \widehat{w_{1\emptyset}}, \widehat{w_{12}}$:

$$f_1\left(\widehat{T_m}\right) + (1-f_1)(\widehat{t_2})$$

Where $\widehat{T_m}$ is the smallest of $\widehat{T_{1,1}}, \widehat{T_{1,2}}, \widehat{T_{1,\emptyset}}$,

Subject to IR_1 and IC_2, respectively:

$$\theta_1 - p\widehat{t'_{11}} - (1-p)\widehat{t'_{1\emptyset}} - c \geq 0$$

$$\theta_2 - c - \widehat{t_2} \geq \theta_2 - c - p\widehat{t'_{12}} + (1-p)\widehat{t'_{1\emptyset}}$$

Given step (i), I can simplify:

$$\widehat{t'_{11}} = \widehat{t'_{1\emptyset}} \geq \theta_1 - c$$

$$\widehat{t_2} \leq p\widehat{t'_{12}} + (1-p)\widehat{t'_{1\emptyset}}$$

Note that $\widehat{T_m} = \widehat{t'_{1,\emptyset}} - \widehat{w'_{1,\emptyset}}$. Since $\widehat{w_{1,\emptyset}} > 0$ due to violation of NE_2 and $\widehat{w'_{1,\emptyset}} \geq \widehat{w_{1,\emptyset}}$ due to Nash bargaining, $\widehat{T_m} < \widehat{t'_{1\emptyset}}$.

Step (iii): I construct a contract with all CIC and NE constraints that induces some transfers $\widetilde{t_2}, \widetilde{t_{1,1}}, \widetilde{t_{1,\emptyset}}, \widetilde{t_{1,2}}, \widetilde{w_{11}}, \widetilde{w_{1,\emptyset}}, \widetilde{w_{1,2}}$ and set:

$$\widetilde{t_2} = \widehat{t_2}$$

$$\widetilde{t_{1,1}} = \widetilde{t_{1,\emptyset}} = \widehat{t'_{1,\emptyset}}$$

$$\widetilde{t_{1,2}} = \widehat{t'_{1,2}}$$

$$\widetilde{w_{1,\emptyset}} = \widetilde{w_{1,1}} = \widehat{w'_{1,\emptyset}} = \widehat{w'_{1,1}}$$

$$\widetilde{w_{1,2}} = \widetilde{t_{1,1}} + \widetilde{w_{1,1}} - \widetilde{t_{1,2}}$$

IR_1 is satisfied because the transfers and effort levels are the same as in the extortion contract, which satisfies its IR_1. The same logic applies to IC_2; to illustrate:

$$u_2 = \theta_2 - \widetilde{t_2} - c = \theta_2 - \widehat{t_2} - c$$

$$\theta_2 - c - p\widetilde{t_{1,2}} - (1-p)\widetilde{t_{1,\emptyset}} = \theta_2 - c - p\widehat{t'_{1,2}} + (1-p)\widehat{t'_{1,\emptyset}}$$

$CICs$ hold because $\widetilde{w_{1,1}} = \widetilde{w_{1,\emptyset}}$ and $\widetilde{t_{1,1}} = \widetilde{t_{1,\emptyset}}$, and $\widetilde{w_{1,2}} = \widetilde{t_{1,1}} + \widetilde{w_{1,1}} - \widetilde{t_{1,2}}$.

NEs hold because $\widetilde{w_{1,2}} \geq \widetilde{w_{1,\emptyset}}$ and $\widetilde{w_{1,1}} = \widetilde{w_{1,\emptyset}}$

The cost of this contract is equal to the cost of the extortion contract, since $\widetilde{t_{11}} - \widetilde{w_{1,1}} = \widehat{T_m}$ and $\widetilde{t_2} = \widehat{t_2}$. Note that $\widetilde{w_{1,1}} = \widetilde{w_{1,\emptyset}} > 0$, whereas the optimal solution derived in the LCCP contract sets $w_{1,1} = w_{1,\emptyset} = 0$. Therefore this corruption-proof contract and any extortion contract are strictly dominated by the LCCP contract.

Appendix C: Derivation of the KLY contract

Note that the principal can still set $w_{1,2} = t_{1,2} + w_{1,1} - t_{1,1}$ to make $T_M - t_{1,2} + w_{1,2} = 0$. Increasing $w_{1,2}$ and $t_{1,2}$ has no effect on net transfers except to slacken IC_2, so the principal still sets $t_{1,2} = \theta_2$ and $w_{1,2} = \theta_2 + w_{1,1} - t_{1,1}$.

$$\max_{t_i, w_i} f_1(t_{1,1} - w_{1,1}) + (1 - f_1)(t_2) \;\; s.t.$$

$$IR_1: \theta_1 - c - pt_{1,1} - (1-p)\left(t_{1,\emptyset} + \lambda(t_{1,1} - w_{1,1} - t_{1,\emptyset} + w_{1,\emptyset})\right) \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$\begin{aligned} IC_2: \theta_2 - c - t_2 & \\ &\geq \theta_2 - c - p\left(t_{1,2} + \lambda(t_{1,1} - w_{1,1} - t_{1,2} + w_{1,2})\right) \\ &- (1-p)\left(t_{1,\emptyset} + \lambda(t_{1,1} - w_{1,1} - t_{1,\emptyset} + w_{1,\emptyset})\right) \end{aligned}$$

$$NE_1: w_{1,1} \geq w_{1,\emptyset}$$

Re-stating constraints:

$$IR_1: \theta_1 - c - (p + (1-p)\lambda)t_{1,1} - (1-p)(1-\lambda)t_{1,\emptyset} + (1-p)\lambda(w_{1,1} - w_{1,\emptyset}) \geq 0$$

$$IC_2: u_2 \geq (1-p)\theta_2 - c - (1-p)(1-\lambda)t_{1,\emptyset} - (1-p)\lambda(t_{1,1} - w_{1,1} + w_{1,\emptyset})$$

Re-stating the maximization problem:

$$\max_{t_i, w_i} L = f_1(t_{1,1} - w_{1,1}) + (1 - f_1)(t_2)$$

$$+\phi_1\left(\theta_1 - c - (p + (1-p)\lambda)t_{1,1} - (1-p)(1-\lambda)t_{1,\emptyset} + (1-p)\lambda(w_{1,1} - w_{1,\emptyset})\right)$$

$$+\phi_2\left(p\theta_2 - t_2 + (1-p)(1-\lambda)t_{1,\emptyset} + (1-p)\lambda\left(t_{1,1} - (w_{1,1} - w_{1,\emptyset})\right)\right)$$

$$+\phi_3(\theta_2 - c - t_2)$$

$$+\phi_4(w_{1,1} - w_{1,\emptyset})$$

$$+\phi_5(w_{1,\emptyset})$$

$$+\phi_6(\theta_1 - t_{1,\emptyset})$$

First Order Conditions:

$$[t_2]: (1 - f_1) - \phi_2 - \phi_3 = 0$$

$$[t_{11}]: f_1 - \phi_1(p + (1-p)\lambda) + \phi_2(1-p)\lambda = 0$$

$$[t_{1\emptyset}]: -\phi_1(1-p)(1-\lambda) + \phi_2(1-p)(1-\lambda) - \phi_6 = 0$$

$$[w_{11}]: -f_1 + \phi_1(1-p)\lambda - \phi_2(1-p)\lambda + \phi_4 = 0$$

$$[w_{1\emptyset}]: -\phi_1(1-p)\lambda + \phi_2(1-p)\lambda - \phi_4 + \phi_5 = 0$$

Solving:

$$\phi_5 = f_1; w_{1,\emptyset} = 0$$

$$\phi_1(1-p)\lambda - \phi_2(1-p)\lambda + \phi_4 = f_1$$

$$\phi_1(p + (1-p)\lambda) - \phi_2(1-p)\lambda = f_1$$

$$\phi_4 = \phi_1 p; w_{1,1} = 0$$

$$\phi_1 = \frac{f_1 + \phi_2(1-p)\lambda}{p + (1-p)\lambda}$$

$$\phi_6 = \phi_2(1-p)(1-\lambda) - \frac{f_1 + \phi_2(1-p)\lambda}{p + (1-p)\lambda}(1-p)(1-\lambda)$$

$$\phi_6 \frac{p + (1-p)\lambda}{(1-p)(1-\lambda)} = \phi_2(p + (1-p)\lambda) - f_1 - \phi_2(1-p)\lambda$$

$$\phi_6 \frac{p + (1-p)\lambda}{(1-p)(1-\lambda)} = \phi_2 p - f_1$$

$$\phi_2 = 1 - f_1 - \phi_3$$

$$(1 - f_1 - \phi_3)p - f_1 = \phi_6 \frac{p + (1-p)\lambda}{(1-p)(1-\lambda)}$$

$$p = \frac{f_1}{1 - f_1 - \phi_3} + \phi_6 \frac{p + (1-p)\lambda}{(1-p)(1-\lambda)}$$

If $\phi_6 > 0$, $t_{1,\emptyset} = \theta_1$. For this to be true,

$$\boldsymbol{p > \frac{f_1}{1 - f_1}}$$

Which is assumed in A1. If $p < \frac{f_1}{1-f_1}$, the principal prefers to implement the LCCP contract.

Re-stating IR_1:

$$\theta_1 - c - (p + (1-p)\lambda)t_{1,1} - (1-p)(1-\lambda)t_{1,\emptyset} = 0$$

$$\theta_1(p + (1-p)\lambda) - t_{1,1}(p + (1-p)\lambda) - c = 0$$

$$t_{1,1} = \theta_1 - \frac{c}{p + (1-p)\lambda}$$

$$p\theta_2 - t_2 + (1-p)(1-\lambda)t_{1,\emptyset} + (1-p)\lambda(t_{1,1}) = 0$$

$$t_2 = p\theta_2 + (1-p)\theta_1 - \frac{(1-p)\lambda}{p + (1-p)\lambda}c$$

Full solution for $\phi_6 > 0$:

$$w_{1,1} = w_{1,\emptyset} = 0$$
$$t_{1,2} = \theta_2$$
$$w_{1,2} = \theta_2 - \theta_1 + \frac{c}{p + (1-p)\lambda}$$
$$t_{1,1} = \theta_1 - \frac{c}{p + (1-p)\lambda}$$
$$t_{1,\emptyset} = \theta_1$$
$$t_2 = p\theta_2 + (1-p)\theta_1 - \frac{(1-p)\lambda}{p + (1-p)\lambda}c$$
$$u_2 = (1-p)\Delta\theta - \frac{p}{p + (1-p)\lambda}c$$

This is the solution so long as

$$(1-p)\Delta\theta \geq \frac{p}{p + (1-p)\lambda}c$$

Which is true as long as A2 holds.

If $\phi_3 > 0$, $\phi_6 = 0$, $t_{1,\emptyset} < \theta_1$. In this case $t_{1,\emptyset}$ is determined by the minimum amount it can be while still having a binding IR_2. Solving:

$$\boldsymbol{u_2 = 0; t_2 = \theta_2 - c}$$
$$(1-p)\theta_2 - c - (1-p)(1-\lambda)t_{1,\emptyset} - (1-p)\lambda t_{1,1} = 0$$
$$\theta_1 - c - (p + (1-p)\lambda)t_{1,1} - (1-p)(1-\lambda)t_{1,\emptyset} = 0$$
$$t_{1,1} = \frac{\theta_1 - c - (1-p)(1-\lambda)t_{1,\emptyset}}{p + (1-p)\lambda}$$
$$(1-p)\theta_2 - c - (1-p)(1-\lambda)t_{1,\emptyset} - (1-p)\lambda\frac{\theta_1 - c - (1-p)(1-\lambda)t_{1,\emptyset}}{p + (1-p)\lambda} = 0$$
$$(1-p)\theta_2 - c\left(1 - \frac{(1-p)\lambda}{p + (1-p)\lambda}\right) - t_{1,\emptyset}(1-p)(1-\lambda)\left(1 - \frac{(1-p)\lambda}{p + (1-p)\lambda}\right)$$
$$(1-p)\theta_2 - \frac{(1-p)\lambda}{p + (1-p)\lambda}\theta_1 - \frac{p}{p + (1-p)\lambda}c - (1-p)(1-\lambda)\frac{p}{p + (1-p)\lambda}t_{1,\emptyset} = 0$$
$$\frac{(1-p)(1-\lambda)p}{p + (1-p)\lambda}t_{1,\emptyset} = (1-p)\theta_2 - \frac{(1-p)\lambda}{p + (1-p)\lambda}\theta_1 - \frac{p}{p + (1-p)\lambda}c$$
$$t_{1,\emptyset} = \frac{(1-p)(p + (1-p)\lambda)}{(1-p)(1-\lambda)p}\theta_2 - \frac{(1-p)\lambda}{(1-p)(1-\lambda)p}\theta_1 - \frac{p}{(1-p)(1-\lambda)p}c$$
$$t_{1,\emptyset} = \frac{p + (1-p)\lambda}{p(1-\lambda)}\theta_2 - \frac{\lambda}{p(1-\lambda)}\theta_1 - \frac{c}{(1-p)(1-\lambda)}$$

$$\boldsymbol{t_{1,\emptyset} = \frac{p + (1-p)\lambda}{p(1-\lambda)}\Delta\theta + \theta_1 - \frac{c}{(1-p)(1-\lambda)}}$$

$$t_{1,1} = \frac{\theta_1 - c - (1-p)(1-\lambda)\left(\frac{p + (1-p)\lambda}{p(1-\lambda)}\Delta\theta + \theta_1 - \frac{c}{(1-p)(1-\lambda)}\right)}{p + (1-p)\lambda}$$

$$\boldsymbol{t_{1,1} = \theta_1 - \frac{(1-p)(1-\lambda)}{p + (1-p)\lambda}\Delta\theta}$$

$$\boldsymbol{w_{1,1} = w_{1,\emptyset} = 0}$$

$$\boldsymbol{t_{1,2} = \theta_2}$$

$$\boldsymbol{w_{1,2} = \frac{\Delta\theta}{p + (1-p)\lambda}}$$

Case 2: $T_M = t_{1\emptyset} - w_{1\emptyset}$

Note that the principal can still set $w_{12} = t_{12} + w_{1\emptyset} - t_{1\emptyset}$ to make $T_M - t_{12} + w_{12} = 0$. Increasing w_{12} and t_{12} has no effect on net transfers except to slacken IC_2, so the principal still sets $t_{12} = \theta_2$ and $w_{12} = \theta_2 + w_{1\emptyset} - t_{1\emptyset}$.

Re-stating the problem:

$$\max_{t_i, w_i} f_1(t_{1\emptyset} - w_{1\emptyset}) + (1 - f_1)(t_2) \ s.t.$$

$$IR_1 \colon \theta_1 - c - p\Big(t_{11} + \lambda(t_{1\emptyset} - w_{1\emptyset} - t_{11} + w_{11})\Big) - (1-p)t_{1\emptyset} \geq 0$$

$$IR_2 \colon \theta_2 - c - t_2 \geq 0$$

$$IC_2 \colon \theta_2 - c - t_2 \geq \theta_2(1-p) - c - (1-p)t_{1\emptyset}$$

$$NE_1 \colon w_{11} \geq w_{1\emptyset}$$

Suppose NE_1 does not bind. Then the principal can freely decrease w_{11}, slackening IR_1, until NE_1 does bind. Hence $w_{11} = w_{1\emptyset}$. With that in mind, increasing $w_{1\emptyset}$ only decreases the principal's profits, so the principal sets $w_{11} = w_{1\emptyset} = 0$. t_{11} only slackens IR_1, so the principal will set it as low as possible while still maintaining $T_M = t_{1\emptyset} - w_{1\emptyset}$. This means $t_{11} = t_{1\emptyset}$. This is the LCCP contract.

Case 3: $T_M = t_{12} - w_{12}$

$$\max_{t_i, w_i} f_1(t_{12} - w_{12}) + (1 - f_1)(t_2) \ s.t.$$

$$IR_1 \colon \theta_1 - c - p\big(t_{11} + \lambda(t_{12} - w_{12} - t_{11} + w_{11})\big) - (1-p)\Big(t_{1\emptyset} + \lambda(t_{12} - w_{12} - t_{1\emptyset} + w_{1\emptyset})\Big) \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$IC_2: \theta_2 - c - t_2 \geq \theta_2 - c - pt_{12} - (1-p)\Big(t_{1\emptyset} + \lambda(t_{12} - w_{12} - t_{1\emptyset} + w_{1\emptyset})\Big)$$

$$NE_1: w_{11} \geq w_{1\emptyset}$$

Holding $t_{11} - w_{11}$ constant, IR_1 slackens when the principal decreases t_{11} and w_{11}. So the principal will decrease both until NE_1 binds and $w_{11} = w_{1\emptyset}$. With that in mind, decreasing t_{11} only slackens IR_1, so the principal will decrease t_{11} up until the point where $t_{12} - w_{12} = t_{11} - w_{11}$. With that in mind, the principal can set $t_{12} = \theta_2$ and $w_{11} = \theta_2 - t_{11} + w_{11}$ like in the previous two cases, and the principal can re-write the problem as follows:

$$\max_{t_i, w_i} f_1(t_{11} - w_{11}) + (1 - f_1)(t_2)$$

$$IR_1: \theta_1 - c - pt_{11} - (1-p)\Big(t_{1\emptyset} + \lambda(t_{11} - w_{11} - t_{1\emptyset} + w_{1\emptyset})\Big) \geq 0$$

$$IR_2: \theta_2 - c - t_2 \geq 0$$

$$IC_2: \theta_2 - c - t_2 \geq \theta_2(1-p) - c - (1-p)\Big(t_{1\emptyset} + \lambda(t_{11} - w_{11} - t_{1\emptyset} + w_{1\emptyset})\Big)$$

$$NE_1: w_{11} \geq w_{1\emptyset}$$

This is the same as Case 1.

Hence, I conclude that allowing bribery is superior to deterring all corruption, given the parameter constraints.

Appendix D: Derivation of Optimal Contracts for $q > 0$

INA Contract

Note that the principal can set $t'_{S1,2} = t'_{H1,2} = t_{1,2} = \theta_2$ by setting $w_{S1,2} = w_{H1,2} = \theta_2 + T_M$, like before.

$$-t_2 \geq -p\theta_2 - (1-p)t'_{H1,\emptyset}$$

$$-t_2 \geq -p\theta_2 - (1-p)t'_{S1,\emptyset}$$

Case 1: $T_M^H = t_{H1,1} - w_{H1,1}$, $T_M^S = t_{S1,1} - w_{S1,1}$

$$t'_{H1,1} = t_{H1,1}$$

$$t'_{S1,1} = t_{S1,1}$$

$$t'_{H1,\emptyset} = t_{H1,\emptyset} + \lambda\left(t_{H1,1} - w_{H1,1} - t_{H1,\emptyset} + w_{H1,\emptyset}\right) = (1-\lambda)t_{H1,\emptyset} + \lambda\left(t_{H1,1} - \left(w_{H1,1} - w_{H1,\emptyset}\right)\right)$$

$$t'_{S1,\emptyset} = t_{S1,\emptyset} + \lambda\left(t_{S1,1} - w_{S1,1} - t_{S1,\emptyset} + w_{S1,\emptyset}\right) = (1-\lambda)t_{S1,\emptyset} + \lambda\left(t_{S1,1} - \left(w_{S1,1} - w_{S1,\emptyset}\right)\right)$$

$$\max_{t_i,w_i} f_1\left(q\left(p\left(t_{H1,1} - w_{H1,1}\right) + (1-p)\left(t_{H1,\emptyset} - w_{H1,\emptyset}\right)\right) + (1-q)\left(t_{S1,1} - w_{S1,1}\right)\right)$$
$$+ (1-f_1)(t_2)\ s.t.$$

$$IC_{S2\to H1}: p\theta_2 + (1-p)\left((1-\lambda)t_{H1,\emptyset} + \lambda\left(t_{H1,1} - \left(w_{H1,1} - w_{H1,\emptyset}\right)\right)\right) \geq t_2$$

$$IC_{S2\to S1}: p\theta_2 + (1-p)\left((1-\lambda)t_{S1,\emptyset} + \lambda\left(t_{S1,1} - \left(w_{S1,1} - w_{S1,\emptyset}\right)\right)\right) \geq t_2$$

$$IR_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq 0$$

$$IC_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq \theta_1 - c - pt_{S1,1} - (1-p)t_{S1,\emptyset}$$

$$IR_{S1}: \theta_1 - c - \left[(p + (1-p)\lambda)t_{S1,1} + (1-p)\left((1-\lambda)t_{S1,\emptyset} - \lambda\left(w_{S1,1} - w_{S1,\emptyset}\right)\right)\right] \geq 0$$

$$IC_{S1\to H1}: (p + (1-p)\lambda)t_{H1,1} + (1-p)\left((1-\lambda)t_{H1,\emptyset} - \lambda\left(w_{H1,1} - w_{H1,\emptyset}\right)\right)$$
$$\geq (p + (1-p)\lambda)t_{S1,1} + (1-p)\left((1-\lambda)t_{S1,\emptyset} - \lambda\left(w_{S1,1} - w_{S1,\emptyset}\right)\right)$$

$$NE_{S1}: w_{S1,1} \geq w_{S1,\emptyset}$$

$$NE_{H1}: w_{H1,1} \geq w_{H1,\emptyset}$$

And non-negativity constraints, and LLCs.

Holding $w_{S1,1} - w_{S1,\emptyset}$ constant, decreasing $w_{S1,1}$ increases the maximand without altering the constraints. So the principal will decrease $w_{S1,1}$ and $w_{S1,\emptyset}$ in equal amounts until

$w_{S1,\emptyset} = 0$. Holding $t_{S1,1} - w_{S1,1}$ constant, decreasing $w_{S1,1}$ and $t_{S1,1}$ in equal measure has no effect on the maximand, slackens IR_{S1} and $IC_{S1\to H1}$, and tightens NE_{S1}, which cannot be violated when $w_{S1,\emptyset} = 0$. Therefore the principal will set $w_{S1,1} = w_{S1,\emptyset} = 0$.

Holding $w_{H1,1} - w_{H1,\emptyset}$ constant, decreasing $w_{H1,\emptyset}$ increases the maximand without changing the constraints. Therefore the principal will set $w_{H1,\emptyset} = 0$. Given this, decreasing $w_{H1,1}$ increases the maximand, slackens $IC_{S2\to H1}$ and $IC_{S1\to H1}$, and tightens NE_{H1}, which cannot be violated when $w_{H1,\emptyset} = 0$. Therefore the principal will set $w_{H1,1} = w_{S1,\emptyset} = 0$.

Note that $IC_{S1\to H1}$ is tighter than IR_{S1}.

Since

$$\theta_1 - c - pt'_{H1,1} - (1-p)t'_{H1,\emptyset} > \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq 0$$

for any

$$t_{H1,1} - w_{H1,1} < t_{H1,\emptyset} - w_{H1,\emptyset}$$

So if $IC_{S1\to H1}$ was slack, the principal could increase $pt'_{S1,1} + (1-p)t'_{S1,\emptyset}$, increasing transfers to the principal, slackening various IC constraints and not tightening any other IC constraint, until $IC_{S1\to H1}$ was binding. Therefore $IC_{S1\to H1}$ binds for $t_{H1,1} - w_{H1,1} < t_{H1,\emptyset} - w_{H1,\emptyset}$.

IR_{H1} binds. Suppose it did not. Then the principal could increase $pt_{H1,1} + (1-p)t_{H1,\emptyset}$ until $IC_{H1\to S1}$ was binding:

$$pt_{S1,1} + (1-p)t_{S1,\emptyset} \geq pt_{H1,1} + (1-p)t_{H1,\emptyset}$$

Binding $IC_{S1\to H1}$:

$$(p + (1-p)\lambda)t_{H1,1} + (1-p)(1-\lambda)t_{H1,\emptyset} \geq (p + (1-p)\lambda)t_{S1,1} + (1-p)(1-\lambda)t_{S1,\emptyset}$$

Note that $IC_{S1\to H1}$ binds, and I suppose that $IC_{H1\to S1}$ also binds, and combine:

$$(1-p)\lambda\big(t_{H1,1} - t_{H1,\emptyset}\big) = (1-p)\lambda\big(t_{S1,1} - t_{S1,\emptyset}\big)$$

Meaning the principal could increase $t_{H1,1}$ and $t_{H1,\emptyset}$ indefinitely (as long as he increased them in equal measure) without violating any IC constraint. But clearly this will eventually violate IR_{H1} and other IR constraints. Therefore IR_{H1} binds. I assume $IC_{H1\to S1}$ is slack and see that it is not violated. To re-state the constraints:

$$\begin{aligned} IC_{S1\to H1}: (p + (1-p)\lambda)t_{H1,1} + (1-p)(1-\lambda)t_{H1,\emptyset} \\ = (p + (1-p)\lambda)t_{S1,1} + (1-p)(1-\lambda)t_{S1,\emptyset} \end{aligned}$$

$$IR_{H1}: pt_{H1,1} + (1-p)t_{H1,\emptyset} = \theta_1 - c$$

$$IC_{S2\rightarrow H1}: p\theta_2 + (1-p)\left((1-\lambda)t_{H1,\emptyset} + \lambda t_{H1,1}\right) \geq t_2$$

$$IC_{S2-S1}: p\theta_2 + (1-p)\left((1-\lambda)t_{S1,\emptyset} + \lambda t_{S1,1}\right) \geq t_2$$

Suppose $IC_{S2\rightarrow S1}$ does not bind. Given that $IC_{S1\rightarrow H1}$ binds the principal can maintain $S1$'s rent but decrease the net transfer to the auditor-agent coalition (by reducing the bribe paid to the auditor) by increasing t_{11}^S and decreasing $t_{1\emptyset}^S$. Therefore $IC_{S2\rightarrow S1}$ binds. Re-writing S1's rent given binding IR_{H1} and $IC_{S1\rightarrow H1}$:

$$t_{H1,1} = \frac{\theta_1 - c - (1-p)t_{H1,\emptyset}}{p}$$

$$(p + (1-p)\lambda)t_{S1,1} + (1-p)(1-\lambda)t_{S1,\emptyset} = (p + (1-p)\lambda)t_{H1,1} + (1-p)(1-\lambda)t_{H1,\emptyset}$$

$$(p + (1-p)\lambda)t_{S1,1} + (1-p)(1-\lambda)t_{S1,\emptyset} = \frac{p + (1-p)\lambda}{p}(\theta_1 - c) - \frac{(1-p)\lambda}{p}t_{H1,\emptyset}$$

Suppose $IC_{S2\rightarrow H1}$ does not bind. Then the principal could increase $t_{1\emptyset}^H$ and decrease t_{11}^H to decrease $S1$'s rent until $IC_{S2\rightarrow H1}$ became binding. Therefore $IC_{S2\rightarrow H1}$ binds. Combining $IC_{S2\rightarrow H1}$ and $IC_{S2\rightarrow S1}$:

$$(1-\lambda)t_{H1,\emptyset} + \lambda t_{H1,1} = (1-\lambda)t_{S1,\emptyset} + \lambda t_{S1,1}$$

Multiply by $(1-p)$

$$(1-p)(1-\lambda)t_{H1,\emptyset} + (1-p)\lambda t_{H1,1} = (1-p)(1-\lambda)t_{S1,\emptyset} + (1-p)\lambda t_{S1,1}$$

Combine with $IC_{S1\rightarrow H1}$

$$pt_{H1,1} = pt_{S1,1}$$

$$t_{H1,1} = t_{S1,1} = t_{1,1}$$

$$t_{H1,\emptyset} = t_{S1,\emptyset} = t_{1,\emptyset}$$

Given this knowledge I can solve the problem as follows:

$$\max_{t_i, w_i} L = f_1\left(q\left(pt_{1,1} + (1-p)t_{1,\emptyset}\right) + (1-q)t_{1,1}\right) + (1-f_1)(t_2)$$

$$+\phi_1\left(\theta_1 - c - pt_{1,1} - (1-p)t_{1,\emptyset}\right)$$

$$+\phi_2\left(p\theta_2 + (1-p)\left((1-\lambda)t_{1,\emptyset} + \lambda t_{1,1}\right) - t_2\right)$$

$$+\phi_3\left(\theta_1 - t_{1,\emptyset}\right)$$

First order conditions:

$$[t_{11}]: f_1\left(qp + (1-q)\right) - \phi_1 p + \phi_2(1-p)\lambda = 0$$

$$[t_{1\emptyset}]: f_1 q(1-p) - \phi_1(1-p) + \phi_2(1-p)(1-\lambda) - \phi_3 = 0$$

$$[t_2]: (1-f_1) - \phi_2 = 0$$

Solving:

$$\phi_2 = 1 - f_1$$

$$\phi_1 p = (1-f_1)(1-p)\lambda + f_1\big(1-q(1-p)\big)$$

$$\phi_1 = \frac{(1-f_1)(1-p)\lambda + f_1\big(1-q(1-p)\big)}{p}$$

$$\phi_3 = f_1 q(1-p) - \phi_1(1-p) + \phi_2(1-p)(1-\lambda)$$

$$\phi_3 = (1-p)\left[f_1 q - \frac{(1-f_1)(1-p)\lambda + f_1\big(1-q(1-p)\big)}{p} + (1-f_1)(1-\lambda)\right]$$

$$\phi_3 = \frac{1-p}{p}\left[f_1\big(qp - 1 + q(1-p)\big) + (1-f_1)\big(p(1-\lambda) - (1-p)\lambda\big)\right]$$

$$\phi_3 = \frac{1-p}{p}\left[-f_1(1-q) + (1-f_1)(p-\lambda)\right]$$

$\phi_3 > 0$ if $(1-f_1)(p-\lambda) > f_1(1-q)$

In terms of p:

$$\boldsymbol{p > \lambda + \frac{f_1}{1-f_1}(1-q)}$$

In terms of q:

$$\boldsymbol{q > 1 - \frac{1-f_1}{f_1}(p-\lambda)}$$

If $\phi_3 < 0$, the contract reverts to the LCCP contract.

If $\phi_3 > 0$, $\boldsymbol{t_{1,\emptyset} = \theta_1}$. The solutions are bolded:

$$t_{1,1} = \frac{\theta_1 - c - (1-p)t_{1\emptyset}}{p}$$

$$\boldsymbol{t_{1,1} = \theta_1 - \frac{c}{p}}$$

$$t_2 = p\theta_2 + (1-p)\Big((1-\lambda)t_{1\emptyset} + \lambda t_{11}\Big)$$

$$t_2 = p\theta_2 + (1-p)\theta_1 - \frac{(1-p)\lambda}{p}c$$

$$\boldsymbol{t_2 = \theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p}c}$$

$$u_2 = \theta_2 - c - t_2$$

$$u_2 = \theta_2 - c - \theta_2 + (1-p)\Delta\theta + \frac{(1-p)\lambda}{p}c$$

$$u_2 = (1-p)\Delta\theta - \frac{p-(1-p)\lambda}{p}c$$

This contract is valid when $(1-p)\Delta\theta \frac{p}{p-(1-p)\lambda} \geq c$, which abides by A2. The principal's profit for this contract is as follows:

$$\Pi^{INA} = f_1\left(\theta_1 - \big(1-q(1-p)\big)\frac{c}{p}\right) + (1-f_1)\left(\theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p}c\right)$$

Case 2: $T_M^H = t_{H1,\emptyset} - w_{H1,\emptyset}$, $T_M^S = t_{S1,1} - w_{S1,1}$

$$t'_{H1,\emptyset} = t_{H1,\emptyset}$$

$$t'_{S1,1} = t_{S1,1}$$

$$t'_{H1,1} = t_{H1,1} + \lambda\big(t_{H1,\emptyset} - w_{H1,\emptyset} - t_{H1,1} + w_{H1,1}\big) = (1-\lambda)t_{H1,1} + \lambda\left(t_{H1,\emptyset} - \big(w_{H1,\emptyset} - w_{H1,1}\big)\right)$$

$$t'_{S1,\emptyset} = t_{S1,\emptyset} + \lambda\big(t_{S1,1} - w_{S1,1} - t_{S1,\emptyset} + w_{S1,\emptyset}\big) = (1-\lambda)t_{S1,\emptyset} + \lambda\left(t_{S1,1} - \big(w_{S1,1} - w_{S1,\emptyset}\big)\right)$$

Given previous solutions I can also state:

$$t'_{H1,2} = t'_{S1,2} = t_{H1,2} = t_{S1,2} = \theta_2$$

$$w_{H1,2} = \theta_2 + w_{H1,\emptyset} - t_{H1,\emptyset}; w_{S1,2} = \theta_2 + w_{S1,1} - t_{S1,1}$$

$$\max_{t_i,w_i} f_1\left(q\left(p\big(t_{H1,1} - w_{H1,1}\big) + (1-p)\big(t_{H1,\emptyset} - w_{H1,\emptyset}\big)\right) + (1-q)\big(t_{S1,1} - w_{S1,1}\big)\right)$$
$$+ (1-f_1)(t_2) \;\; s.t.$$

$$IC_{S2\to H1}: p\theta_2 + (1-p)t_{H1,\emptyset} \geq t_2$$

$$IC_{S2\to S1}: p\theta_2 + (1-p)t'_{S1,\emptyset} \geq t_2$$

$$IR_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq 0$$

$$IC_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq \theta_1 - c - pt_{S1,1} - (1-p)t_{S1,\emptyset}$$

$$IR_{S1}: \theta_1 - c - \left[(1-p)t_{S1,\emptyset} + p\left(t_{S1,1} + \lambda\big(t_{S1,\emptyset} - w_{S1,\emptyset} - t_{S1,1} + w_{S1,1}\big)\right)\right] \geq 0$$

$$IC_{S1\to H1}: (1-p)t_{H1,\emptyset} + p\left(t_{H1,1} + \lambda\big(t_{H1,\emptyset} - w_{H1,\emptyset} - t_{H1,1} + w_{H1,1}\big)\right)$$
$$\geq (1-p)t_{S1,\emptyset} + p\left(t_{S1,1} + \lambda\big(t_{S1,\emptyset} - w_{S1,\emptyset} - t_{S1,1} + w_{S1,1}\big)\right)$$

$$NE_{S1}: w_{S1,1} \geq w_{S1,\emptyset}$$

$$NE_{H1}: w_{H1,1} \geq w_{H1,\emptyset}$$

First, I take IC_{H1} to be nonbinding once again.

For reasons equivalent to Case 1, the principal will set $w_{S1,1} = w_{S1,\emptyset} = 0$. Notice that $w_{H1,\emptyset}$ enters into the objective function, $IC_{S1\to H1}$, and NE_{H1} negatively, and in no other constraint. Hence, the principal will set $w_{H1,\emptyset} = 0$, meaning NE_{H1} cannot be violated.

Holding $t_{H1,1} - w_{H1,1}$ constant, increasing $t_{H1,1}$ only tightens IR_{H1}. Hence, the principal will decrease $t_{H1,1}$ until $w_{H1,1} = 0$. Holding IR_{H1} to be binding, the principal can set

$$t_{H1,\emptyset} = \frac{\theta_1 - c - pt_{H1,1}}{1-p}$$

And hence the H1 portion of the objective function can be written as

$$f_1 q\big(pt_{H1,1} + \theta_1 - c - pt_{H1,1}\big) = f_1 q(\theta_1 - c)$$

In other words, as long as IR_{H1} binds, increasing one transfer (and decreasing another proportionally) will not affect the objective function. Plugging binding IR_{H1} into other constraints:

$$IC_{S2\to H1}: p\theta_2 + \theta_1 - c - pt_{H1,1} \geq t_2$$

$$IC_{S1\to H1}: (1-p+p\lambda)\frac{\theta_1 - c - pt_{H1,1}}{1-p} + p(1-\lambda)t_{H1,1}$$
$$\geq (1-p)t_{S1,\emptyset} + p\left(t_{S1,1} + \lambda\big(t_{S1,\emptyset} - w_{S1,\emptyset} - t_{S1,1} + w_{S1,1}\big)\right)$$

Re-writing:

$$\frac{1-p(1-\lambda)}{1-p}(\theta_1 - c) + t_{H1,1}\left(\frac{p}{1-p}\right)\Big((1-p)(1-\lambda) - \big(1-p(1-\lambda)\big)\Big)$$
$$\frac{1-p(1-\lambda)}{1-p}(\theta_1 - c) + t_{H1,1}\left(\frac{p}{1-p}\right)(1-p-\lambda+p\lambda-1+p-p\lambda)$$
$$\frac{1-p(1-\lambda)}{1-p}(\theta_1 - c) - t_{H1,1}\left(\frac{p}{1-p}\right)(\lambda)$$

Meaning that decreasing $t_{H1,1}$, when IR_{H1} binds, slackens both $IC_{S1\to H1}$ and $IC_{S2\to H1}$. In other words, if $t_{H1,\emptyset} \geq t_{H1,1}$, it is best that $t_{H1,\emptyset} = t_{H1,1} = \theta_1 - c$.

Note that, if this is the case, $u_{S1} = 0$, since there is no profit from bribery. Hence I can also take IR_{S1} to bind, and

$$(p + (1-p)\lambda)t_{S1,1} + (1-p)(1-\lambda)t_{S1,\emptyset} = \theta_1 - c$$

Note that $H1$'s LCCP-like solution weakens incentives for the high type.

$$t_2 = p\theta_2 + (1-p)(\theta_1 - c) = \theta_2 - c - (1-p)\Delta\theta + pc$$

This means that the principal may wish to weaken S1's incentives to avoid redundant overpayment. In other words, if $IC_{S2\to S1}$ is slack, the principal may increase $t_{S1,1}$ and decrease $t_{S1,\emptyset}$, decreasing net payment to S1.

$$IC_{S2,S1}: t_2 = p\theta_2 + (1-p)\left((1-\lambda)t_{S1,\emptyset} + \lambda t_{S1,1}\right)$$

$$p\theta_2 + (1-p)(\theta_1 - c) = p\theta_2 + \theta_1 - c - pt_{S1,1}$$

$$t_{S1,1} = \theta_1 - c$$

$$t_{S1,\emptyset} = \theta_1 - c$$

The principal arrives at the LCCP solution.

Case 3: $T_M^H = t_{H1,1} - w_{H1,1}$, $T_M^S = t_{S1,\emptyset} - w_{S1,\emptyset}$

As I discussed in the KLY section, if $T_M^S = t_{S1,\emptyset} - w_{S1,\emptyset}$, the principal optimally sets $w_{S1,\emptyset} = w_{S1,1} = 0$ and $t_{S1,\emptyset} = t_{S1,1} = t_{S1}$. The difference here is whether S1 obtains rent from mimicking $H1$.

$$IC_{S1\to H1}: \theta_1 - c - t_{S1}$$
$$\geq \theta_1 - c - (p + (1-p)\lambda)t_{H1,1} - (1-p)(1-\lambda)t_{H1,\emptyset}$$
$$+ (1-p)\lambda\left(w_{H1,1} - w_{H1,\emptyset}\right)$$

$$IR_{H1}: \theta_1 - c - pt_{H1,1} - (1-p)t_{H1,\emptyset} \geq 0$$

$$IC_{S2\to S1}: \theta_2 - c - t_{S2} \geq \theta_2(1-p) - c - (1-p)t_{S1}$$

$$IC_{S2\to H1}: \theta_2 - c - t_{S2}$$
$$\geq \theta_2(1-p) - c - (1-p)\lambda t_{H1,1} - (1-p)(1-\lambda)t_{H1,\emptyset}$$
$$+ (1-p)\lambda\left(w_{H1,1} - w_{H1,\emptyset}\right)$$

Also note the objective function:

$$f_1\left(q\left(p\left(t_{H1,1} - w_{H1,1}\right) + (1-p)\left(t_{H1,\emptyset} - w_{H1,\emptyset}\right)\right) + (1-q)(t_{S1})\right) + (1-f_1)(t_2)$$

$w_{H1,1}$ enters the objective function and all relevant constraints negatively, except for NE_{H1}. This means NE_{H1} binds, and $w_{H1,1} = w_{H1,\emptyset}$. Given that, $w_{H1,1} = w_{H1,\emptyset}$ only enters into the objective function negatively. Hence the principal sets $w_{H1,1} = w_{H1,\emptyset} = 0$. Given that IR_{H1} binds,

$$t_{H1,1} = \frac{\theta_1 - c - (1-p)t_{H1,\emptyset}}{p}$$

$$IC_{S1\to H1}: t_{S1} \le (p+(1-p)\lambda)t_{H1,1} + (1-p)(1-\lambda)t_{H1,\emptyset}$$
$$= \frac{(p+(1-p)\lambda)\big(\theta_1 - c - (1-p)t_{H1,\emptyset}\big)}{p} + (1-p)(1-\lambda)t_{H1,\emptyset}$$
$$= \frac{p+(1-p)\lambda}{p}(\theta_1 - c) - \frac{(1-p)\lambda}{p}t_{H1,\emptyset}$$

If $t_{H1,1} > t_{H1,\emptyset}$, then $IC_{S1\to H1}$ binds. Suppose $IC_{S2\to H1}$ does not bind. Then the principal could increase $t_{H1,1}$ and decrease $t_{H1,\emptyset}$, decreasing t_{S1} and u_{S1}, until it did. So $IC_{S2\to H1}$ binds.

$$IC_{S2\to H1}: t_{S2} \le p\theta_2 + (1-p)\lambda t_{H1,1} + (1-p)(1-\lambda)t_{H1,\emptyset}$$
$$= p\theta_2 + (1-p)\left(\frac{\theta_1 - c - (1-p)t_{H1,\emptyset}}{p}\lambda + (1-\lambda)t_{H1,\emptyset}\right)$$
$$= p\theta_2 + (1-p)\left(\frac{\theta_1 - c}{p}\lambda + \frac{p-\lambda}{p}t_{H1,\emptyset}\right)$$
$$IC_{S2\to S1}: t_{S2} \le p\theta_2 + (1-p)\left(\frac{p+(1-p)\lambda}{p}(\theta_1 - c) - \frac{(1-p)\lambda}{p}t_{H1,\emptyset}\right)$$

If both ICs bind,

$$\frac{\theta_1 - c}{p}\lambda + \frac{p-\lambda}{p}t_{H1,\emptyset} = \frac{p+(1-p)\lambda}{p}(\theta_1 - c) - \frac{(1-p)\lambda}{p}t_{H1,\emptyset}$$
$$\frac{p(1-\lambda)}{p}t_{H1,\emptyset} = \frac{p(1-\lambda)}{p}(\theta_1 - c)$$
$$t_{H1,\emptyset} = t_{H1,1} = \theta_1 - c$$

Suppose $IC_{S2\to S1}$ instead does not bind. This would imply that

$$\frac{\theta_1 - c}{p}\lambda + \frac{p-\lambda}{p}t_{H1,\emptyset} > \frac{p+(1-p)\lambda}{p}(\theta_1 - c) - \frac{(1-p)\lambda}{p}t_{H1,\emptyset}$$

Meaning

$$t_{H1,\emptyset} > \theta_1 - c$$

Which is not allowed given binding IR_{H1} and $t_{H1,1} > t_{H1,\emptyset}$

So, $IC_{S2\to S1}$ also binds, and the principal's solution is the LCCP contract.

Case 4: $T_M^H = t_{H1,\emptyset} - w_{H1,\emptyset}$, $T_M^S = t_{S1,\emptyset} - w_{S1,\emptyset}$

Without re-iterating steps, I conjecture that this restriction also leads to the LCCP contract.

IA Contract

For brevity I assert that the logic has not changed from the previous contracts for the following results for both H and S:

$$t_{12} = \theta_2$$

$$w_{12} = \theta_2 + T_M$$

$$w_{11} = w_{1\emptyset} = 0$$

Case 1: $T_M^H = t_{H1,1} - w_{H1,1}; T_M^S = t_{S1,1} - w_{S1,1}$

Using the same logic as in the INA contract we can conclude that $t_{H1,1} = t_{S1,1} = t_{1,1}$ and $t_{H1,\emptyset} = t_{S1,\emptyset} = t_{1,\emptyset}$, and we have determined that $t_{H2} = t_{S2,\emptyset}$.

$$\max_{t_i,w_i} f_1\big(q\big(pt_{1,1} + (1-p)t_{1,\emptyset}\big) + (1-q)t_{1,1}\big) + (1-f_1)\left(q\big(t_{S2,\emptyset}\big) + (1-q)\big(t_{S2,2}\big)\right)$$

s.t.

$$IR_{H1}: \theta_1 - c - pt_{1,1} - (1-p)t_{1,\emptyset} \geq 0$$

$$IC_{S2\to H1}: \theta_2 - c - (1-\lambda)t_{S2,\emptyset} - \lambda t_{S2,2} \geq \theta_2(1-p) - c - (1-p)\big(\lambda t_{1,1} + (1-\lambda)t_{1,\emptyset}\big)$$

$$IC_{H2\to H1}: \theta_2 - c - t_{S2,\emptyset} \geq \theta_2(1-p) - c - (1-p)t_{1,\emptyset}$$

$$LLC_{1,\emptyset}: \theta_1 - t_{1,\emptyset} \geq 0$$

Since it is established that $q > 1-\lambda$ and $c \leq \Delta\theta(1-p)$ we know that all of the above constraints bind as long as $LLC_{1,\emptyset}$ binds. So we can solve:

$$\max_{t_i,w_i} L = f_1\big(q\big(pt_{1,1} + (1-p)t_{1,\emptyset}\big) + (1-q)t_{1,1}\big) + (1-f_1)\left(q\big(t_{S2,\emptyset}\big) + (1-q)\big(t_{S2,2}\big)\right)$$

$$+\phi_1\big(\theta_1 - c - pt_{1,1} - (1-p)t_{1,\emptyset}\big)$$

$$+\phi_2\left(\theta_2 - c - (1-\lambda)t_{S2,\emptyset} - \lambda t_{S2,2} - \theta_2(1-p) + c + (1-p)\big(\lambda t_{1,1} + (1-\lambda)t_{1,\emptyset}\big)\right)$$

$$+\phi_3\big(\theta_2 - c - t_{S2,\emptyset} - \theta_2(1-p) + c + (1-p)t_{1,\emptyset}\big)$$

$$+\phi_4\big(\theta_1 - t_{1,\emptyset}\big)$$

First order conditions:

$$[t_{1,1}]: f_1\big(qp + (1-q)\big) - \phi_1 p + \phi_2(1-p) = 0$$

$$[t_{1,\emptyset}]: f_1 q(1-p) - \phi_1(1-p) + \phi_2(1-p)(1-\lambda) + \phi_3(1-p) - \phi_4 = 0$$

$$[t_{S2,\emptyset}]: (1-f_1)q - \phi_2(1-\lambda) - \phi_3 = 0$$

$$[t_{S2,2}]: (1-f_1)(1-q) - \phi_2\lambda = 0$$

Solving:

$$\phi_2 = \frac{(1-f_1)(1-q)}{\lambda}$$

$$\phi_1 p = \phi_2(1-p) + f_1\big(1-q(1-p)\big)$$

$$\phi_1 = \frac{(1-f_1)(1-q)(1-p) + \lambda f_1\big(1-q(1-p)\big)}{\lambda p}$$

$$\phi_3 = (1-f_1)q - \phi_2(1-\lambda)$$

$$\phi_3 = (1-f_1)q - \frac{(1-f_1)(1-q)(1-\lambda)}{\lambda}$$

$$\phi_4 = f_1 q(1-p) - \phi_1(1-p) + \phi_2(1-p)(1-\lambda) + \phi_3(1-p)$$

$$\phi_4 = (1-p)\left(f_1 q - \frac{(1-f_1)(1-q)(1-p) + \lambda f_1\big(1-q(1-p)\big)}{\lambda p} + \frac{(1-f_1)(1-q)(1-\lambda)}{\lambda} \right.$$
$$\left. + (1-f_1)q - \frac{(1-f_1)(1-q)(1-\lambda)}{\lambda}\right)$$

$$\phi_4 = (1-p)\left(q - \frac{(1-f_1)(1-q)(1-p) + \lambda f_1\big(1-q(1-p)\big)}{\lambda p}\right)$$

$\phi_4 > 0$ if

$$q\lambda p - (1-f_1)(1-q)(1-p) - f_1\lambda\big(1-q(1-p)\big) > 0$$

In terms of p:

$$p(q\lambda + (1-f_1)(1-q) - f_1\lambda q) - (1-f_1)(1-q) - f_1\lambda(1-q) > 0$$

$$p\big(q\lambda(1-f_1) + (1-f_1)(1-q)\big) > (1-f_1)(1-q) + f_1\lambda(1-q)$$

$$p > \frac{(1-q)\big(1-f_1(1-\lambda)\big)}{(1-f_1)\big(1-q(1-\lambda)\big)}$$

In terms of q:

$$q\big(\lambda p + (1-f_1)(1-p) + f_1\lambda(1-p)\big) - (1-f_1)(1-p) - f_1\lambda > 0$$

$$q\left(p(1-f_1)(1-\lambda) + \big(1-f_1(1-\lambda)\big)\right) > (1-f_1)(1-p) + f_1\lambda$$

$$q > \frac{1-f_1(1-\lambda) - p(1-f_1)}{p(1-f_1)(1-\lambda) + \big(1-f_1(1-\lambda)\big)}$$

Full solution for $\phi_4 > 0$ bolded:

$$\boldsymbol{t_{1\emptyset} = \theta_1}$$

$$\boldsymbol{t_{11} = \theta_1 - \frac{c}{p}}$$

$$\boldsymbol{t_{12} = \theta_2}$$

$$\boldsymbol{t_{21} > t_{22}}$$

$$-(1-\lambda)t_{2\emptyset}^S - \lambda t_{22}^S + \theta_2 p + (1-p)\left(\theta_1 - \frac{c\lambda}{p}\right) = 0$$

$$\boldsymbol{t_{2\emptyset} = \theta_2 - (1-p)\Delta\theta}$$

$$(1-\lambda)(\theta_2 - (1-p)\Delta\theta) + \lambda t_{22}^S = \theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p}c$$

$$\boldsymbol{t_{22}^S = \theta_2 - (1-p)\Delta\theta - \frac{1-p}{p}c}$$

$$\boldsymbol{w_{1,1} = w_{1,\emptyset} = w_{S2,1} = w_{S2,2} = w_{S2,\emptyset} = 0}$$

$$\boldsymbol{w_{1,2} = \Delta\theta + \frac{c}{p}}$$

The principal's profit is:

$$\Pi^{IA} = f_1\left(\theta_1 - c - (1-q)\frac{1-p}{p}c\right) + (1-f_1)\left(\theta_2 - (1-p)\Delta\theta - (1-q)\frac{1-p}{p}c\right)$$

Other Cases

The same logic from the INA contract holds here; specifically, other cases lead to the LCCP contract.

SA Contract

First, note it will be optimal to set $t_{H2} = t_{S2,\emptyset}$, $t_{S1,2} = \theta_2$, $w_{S1,2} = \theta_2 + T_M^{S2}$, and $w_{S1,1} = w_{S1,\emptyset} = 0$.

Case 1: $T_M^{S1} = t_{S1,1} - w_{S1,1}$

$$\max_{t_i, w_i} L = f_1(1-q)\left(t_{S1,1}\right) + (1-f_1)\left(q\left(t_{S2,\emptyset}\right) + (1-q)\left(t_{S2,2}\right)\right)$$

$$+\phi_1\left(\theta_1 - c - (p + (1-p)\lambda)t_{S1,1} - (1-p)(1-\lambda)t_{S1,\emptyset}\right)$$

$$+\phi_2\left(\theta_2 - c - t_{S2,\emptyset} - \theta_2(1-p) + c + (1-p)t_{S1,\emptyset}\right)$$

$$+\phi_3\left(\theta_2 - c - \lambda t_{S2,2} - (1-\lambda)t_{S2,\emptyset} - \theta_2(1-p) + c + (1-p)\left(\lambda t_{S1,1} + (1-\lambda)t_{S1,\emptyset}\right)\right)$$

$$+\phi_4\left(\theta_1 - t_{S1,\emptyset}\right)$$

First order conditions:

$$\left[t_{S1,1}\right]: f_1(1-q) - \phi_1(p + (1-p)\lambda) + \phi_3(1-p)\lambda = 0$$

$$\left[t_{S1,\emptyset}\right]: -\phi_1(1-p)(1-\lambda) + \phi_2(1-p) + \phi_3(1-p)(1-\lambda) - \phi_4 = 0$$

$$[t_{S2,2}]: (1-f_1)(1-q) - \phi_3\lambda = 0$$

$$[t_{S2,\emptyset}]: (1-f_1)q - \phi_2 - \phi_3(1-\lambda) = 0$$

Solving:

$$\phi_3 = \frac{(1-f_1)(1-q)}{\lambda}$$

$$\phi_2 = (1-f_1)q - \frac{(1-f_1)(1-\lambda)(1-q)}{\lambda}$$

$$\phi_2 = \frac{1-f_1}{\lambda}(q\lambda - 1 + \lambda + q - q\lambda)$$

$$\phi_2 = \frac{(1-f_1)\big(q-(1-\lambda)\big)}{\lambda}$$

$$\phi_1 = \frac{f_1(1-q) + (1-f_1)(1-p)(1-q)}{p+(1-p)\lambda}$$

$$\phi_1 = \frac{1-q}{p+(1-p)\lambda}\big(1-p(1-f_1)\big)$$

$$\phi_4 = (1-p)\big(\phi_2 + \phi_3(1-\lambda) - \phi_1(1-\lambda)\big)$$

$$\phi_4 = (1-p)\Bigg(\frac{(1-f_1)\big(q-(1-\lambda)\big)}{\lambda} + \frac{1-\lambda}{\lambda}(1-f_1)(1-q)$$

$$- \frac{(1-q)(1-\lambda)}{p+(1-p)\lambda}\big(1-p(1-f_1)\big)\Bigg)$$

$$\phi_4 = \frac{1-p}{\lambda}\Bigg((1-f_1)q - (1-f_1)(1-\lambda) + (1-f_1)(1-\lambda) - (1-f_1)(1-\lambda)q$$

$$- \frac{(1-\lambda)\lambda\big(1-p(1-f_1)\big)}{p+(1-p)\lambda} + \frac{q(1-\lambda)\lambda\big(1-p(1-f_1)\big)}{p+(1-p)\lambda}\Bigg)$$

$$\phi_4 = \frac{1-p}{(p+(1-p)\lambda)}\bigg(q\Big(\big((1-f_1)(p+(1-p)\lambda) + (1-\lambda)\big(1-p(1-f_1)\big)\Big)$$

$$- (1-\lambda)\big(1-p(1-f_1)\big)\bigg)$$

$\phi_4 > 0$ if

$$q\Big((1-f_1)\big(p+(1-p)\lambda - p(1-\lambda)\big) + 1 - \lambda\Big) > (1-\lambda)\big(1-p(1-f_1)\big)$$

$$q > \frac{(1-\lambda)\big(1-p(1-f_1)\big)}{1-f_1\lambda}$$

Note that $(1-\lambda)\big(1-p(1-f_1)\big) < 1-f_1\lambda$

In terms of p:

$$q(1-f_1\lambda) > (1-\lambda)\big(1-p(1-f_1)\big)$$

$$p(1-f_1)(1-\lambda) > 1-\lambda-q(1-f_1\lambda)$$

$$p > \frac{1-\lambda-q(1-f_1\lambda)}{(1-f_1)(1-\lambda)}$$

Solving for $\phi_4 > 0$:

$$t_{S2,\emptyset} = t_{H2} = \theta_2 p + (1-p)t_{S1,\emptyset} = \theta_2 p + (1-p)\theta_1 = \theta_2 - \Delta\theta(1-p)$$

$$\theta_2 p + (1-p)\big(\lambda t_{S1,1} + (1-\lambda)t_{S1,\emptyset}\big) = \lambda t_{S2,2} + (1-\lambda)t_{S2,\emptyset}$$

$$t_{S1,\emptyset} = \theta_1$$

$$t_{S1,1} = \theta_1 - \frac{c}{p+(1-p)\lambda}$$

$$\lambda t_{S2,2} + (1-\lambda)(\theta_2 p + (1-p)\theta_1) = \theta_2 p + (1-p)\left(\theta_1 - \frac{\lambda c}{p+(1-p)\lambda}\right)$$

$$\lambda t_{S2,2} = \theta_2 p - (1-\lambda)\theta_2 p - (1-\lambda)(1-p)\theta_1 + (1-p)\theta_1 - \frac{(1-p)\lambda c}{p+(1-p)\lambda}$$

$$\lambda t_{S2,2} = \theta_2 p\lambda + \theta_1(1-p)\lambda - \frac{(1-p)\lambda c}{p+(1-p)\lambda}$$

$$t_{S2,2} = \theta_2 - \Delta\theta(1-p) - \frac{1-p}{p+(1-p)\lambda}c$$

Full solution for nonbinding IR_{H2}:

$$t_{S1,\emptyset} = \theta_1$$

$$w_{S1,1} = w_{S1,\emptyset} = w_{S2,2} = 0$$

$$w_{S2,\emptyset} \to 0$$

$$t_{S1,2} = \theta_2$$

$$w_{S1,2} = \theta_2 + t_{S1,1}$$

$$t_{S1,1} = \theta_1 - \frac{c}{p+(1-p)\lambda}$$

$$t_{S2,\emptyset} = \theta_2 - \Delta\theta(1-p)$$

$$t_{S2,2} = \theta_2 - \Delta\theta(1-p) - \frac{1-p}{p+(1-p)\lambda}c$$

Profit for SA:

$$\Pi^{SA} = f_1(1-q)\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)\left(\theta_2 - \Delta\theta(1-p) - \frac{(1-q)(1-p)}{p+(1-p)\lambda}c\right)$$

Other cases:

This follows the logic of the SNA contract and KLY contract; specifically, other cases would lead to the LCCP contract.

Appendix E: Contract Optimality and Proofs of Lemma 2 and Proposition 1

The contracts of concern are:

LCCP, Least-Cost Corruption-Proof.

$$\Pi^{LCCP} = f_1(\theta_1 - c) + (1 - f_1)(\theta_2 - \Delta\theta(1 - p) - (1 - p)c)$$

INA, Bribery-Allowed while obeying all IR constraints

$$\Pi^{INA} = f_1\left(\theta_1 - \big(1 - q(1 - p)\big)\frac{c}{p}\right) + (1 - f_1)\left(\theta_2 - (1 - p)\Delta\theta - \frac{(1 - p)\lambda}{p}c\right)$$

SNA, Bribery-Allowed while shutting down $H1$

$$\Pi^{SNA} = f_1(1 - q)\left(\theta_1 - \frac{c}{p + (1 - p)\lambda}\right) + (1 - f_1)\left(\theta_2 - (1 - p)\Delta\theta - \frac{(1 - p)\lambda}{p + (1 - p)\lambda}c\right)$$

IA, or Bribery-Allowed while auditing $S2$

$$\Pi^{IA} = \Pi^{IA} = f_1\left(\theta_1 - c - (1 - q)\frac{1 - p}{p}c\right) + (1 - f_1)\left(\theta_2 - (1 - p)\Delta\theta - (1 - q)\frac{1 - p}{p}c\right)$$

SA, Bribery-Allowed while auditing $S2$ and shutting down $H1$

$$\Pi^{SA} = f_1(1 - q)\left(\theta_1 - \frac{c}{p + (1 - p)\lambda}\right) + (1 - f_1)\left(\theta_2 - \Delta\theta(1 - p) - \frac{(1 - q)(1 - p)}{p + (1 - p)\lambda}c\right)$$

The LCCP contract is optimal under four conditions:

Condition 1: $\Pi^{LCCP} > \Pi^{INA}$

$$f_1(\theta_1 - c) + (1 - f_1)(\theta_2 - \Delta\theta(1 - p) - (1 - p)c)$$

$$> f_1\left(\theta_1 - \big(1 - q(1 - p)\big)\frac{c}{p}\right) + (1 - f_1)\left(\theta_2 - (1 - p)\Delta\theta - \frac{(1 - p)\lambda}{p}c\right)$$

$$f_1 c\left(\frac{1 - q(1 - p)}{p} - 1\right) + (1 - f_1)(1 - p)c\left(\frac{\lambda}{p} - 1\right) > 0$$

$$f_1\left(\frac{1 - q + qp - p}{p}\right) > (1 - f_1)(1 - p)\left(\frac{p - \lambda}{p}\right)$$

$$f_1(1 - q)(1 - p) > (1 - f_1)(1 - p)(p - \lambda)$$

$$f_1(1 - q) > (1 - f_1)(p - \lambda)$$

$$\boldsymbol{q < 1 - \frac{1 - f_1}{f_1}(p - \lambda)}$$

Condition 2: $\Pi^{LCCP} > \Pi^{SNA}$

$$f_1(\theta_1 - c) + (1 - f_1)(\theta_2 - \Delta\theta(1-p) - (1-p)c)$$
$$> f_1(1-q)\left(\theta_1 - \frac{c}{p + (1-p)\lambda}\right)$$
$$+ (1 - f_1)\left(\theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p + (1-p)\lambda}c\right)$$

$$f_1\left(q\theta_1 - c\left(1 - \frac{1-q}{p + (1-p)\lambda}\right)\right) > (1 - f_1)(1-p)c\left(1 - \frac{\lambda}{p + (1-p)\lambda}\right)$$

$$f_1\left(q\theta_1 + c\frac{(1-p)(1-\lambda)}{p + (1-p)\lambda} - \frac{qc}{p + (1-p)\lambda}\right) > (1 - f_1)(1-p)c\left(\frac{p(1-\lambda)}{p + (1-p)\lambda}\right)$$

$$qf_1\left(\theta_1 - \frac{c}{p + (1-p)\lambda}\right) > \frac{c(1-p)(1-\lambda)}{p + (1-p)\lambda}\big((1 - f_1)p - f_1\big)$$

$$qf_1(\theta_1(p + (1-p)\lambda) - c) > c(1-p)(1-\lambda)\big((1 - f_1)p - f_1\big)$$

$$\boldsymbol{q > \frac{(1-p)(1-\lambda)\big((1-f_1)p - f_1\big)c}{f_1(\theta_1(p + (1-p)\lambda) - c)}}$$

Condition 3: $\Pi^{LCCP} > \Pi^{IA}$

$$f_1(\theta_1 - c) + (1 - f_1)(\theta_2 - \Delta\theta(1-p) - (1-p)c)$$
$$> f_1\left(\theta_1 - c - (1-q)\frac{1-p}{p}c\right) + (1 - f_1)\left(\theta_2 - (1-p)\Delta\theta - (1-q)\frac{1-p}{p}c\right)$$

$$f_1 c(1-q)\left(\frac{1-p}{p}\right) > (1 - f_1)(1-p)c\left(1 - \frac{1-q}{p}\right)$$

$$f_1(1-q) > (1 - f_1)(p - 1 + q)$$

$$f_1 + (1 - f_1)(1-p) > (1 - f_1)q + f_1 q$$

$$\boldsymbol{q < f_1 + (1 - f_1)(1-p)}$$

Condition 4: $\Pi^{LCCP} > \Pi^{SA}$

$$f_1(\theta_1 - c) + (1 - f_1)(\theta_2 - \Delta\theta(1-p) - (1-p)c)$$
$$> f_1(1-q)\left(\theta_1 - \frac{c}{p + (1-p)\lambda}\right)$$
$$+ (1 - f_1)\left(\theta_2 - \Delta\theta(1-p) - \frac{(1-q)(1-p)}{p + (1-p)\lambda}c\right)$$

$$f_1 q(\theta_1 - c) + f_1(1-q)\left(\frac{(1-p)(1-\lambda)}{p + (1-p)\lambda}c\right) > (1 - f_1)(1-p)\left(\frac{p + (1-p)\lambda - (1-q)}{p + (1-p)\lambda}\right)c$$

$$f_1 \frac{(1-p)(1-\lambda)}{p+(1-p)\lambda} c + (1-f_1) \frac{(1-p)^2(1-\lambda)}{p+(1-p)\lambda} \ c$$

$$> q\left(f_1 \frac{(1-p)(1-\lambda)}{p+(1-p)\lambda} c + (1-f_1) \frac{1-p}{p+(1-p)\lambda} c - f_1(\theta_1 - c)\right)$$

$$(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c$$

$$> q\,\Big((1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c + (p+(1-p)\lambda)(1-f_1)c$$

$$- f_1(\theta_1 - c)\Big)$$

$$\boldsymbol{q < \frac{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c}{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c + (1-f_1)(p+(1-p)\lambda)c - f_1(\theta_1 - c)}}$$

The INA contract is optimal under four conditions:

Condition 1: $\Pi^{INA} > \Pi^{LCCP}$

This is the opposite of Condition 1 for LCCP.

$$\boldsymbol{q > 1 - \frac{1-f_1}{f_1}(p-\lambda)}$$

Condition 2: $\Pi^{INA} > \Pi^{SNA}$

$$f_1\left(\theta_1 - \big(1-q(1-p)\big)\frac{c}{p}\right) + (1-f_1)\left(\theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p} c\right)$$

$$> f_1(1-q)\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right)$$

$$+ (1-f_1)\left(\theta_2 - (1-p)\Delta\theta - \frac{(1-p)\lambda}{p+(1-p)\lambda} c\right)$$

$$f_1\left(q\theta_1 - \frac{c}{p} + qc\frac{1-p}{p} + \frac{(1-q)c}{p+(1-p)\lambda}\right) > (1-f_1)(1-p)\lambda c\left(\frac{1}{p} - \frac{1}{p+(1-p)\lambda}\right)$$

$$qf_1\left(\theta_1 + \frac{c(1-p)}{p} - \frac{c}{p+(1-p)\lambda}\right) - f_1\left(\frac{c}{p} - \frac{c}{p+(1-p)\lambda}\right)$$

$$> (1-f_1)(1-p)\lambda\left(\frac{c}{p} - \frac{c}{p+(1-p)\lambda}\right)$$

$$qf_1\left(\theta_1 p(p+(1-p)\lambda) + c\big((1-p)(p+(1-p)\lambda) - p\big)\right)$$

$$> c(p+(1-p)\lambda - p)(f_1 + (1-f_1)(1-p)\lambda)$$

$$qf_1\left(\theta_1 p(p+(1-p)\lambda)+c(p+\lambda-p\lambda-p^2-p\lambda+p^2\lambda-p)\right)$$
$$>c(1-p)\lambda(f_1+(1-f_1)(1-p)\lambda)$$
$$\boldsymbol{q>\frac{(1-p)\lambda(f_1+(1-f_1)(1-p)\lambda)c}{f_1\left(\theta_1 p(p+(1-p)\lambda)+c\left(\lambda-2p\lambda-p^2(1-\lambda)\right)\right)}}$$

Condition 3: $\Pi^{INA}>\Pi^{IA}$

As implied by Lemma 1,

$$\boldsymbol{q<1-\lambda}$$

Condition 4: $\Pi^{INA}>\Pi^{SA}$

Conditions 2 and 3 are sufficient as $\Pi^{SA}<\Pi^{SNA}$ when $q<1-\lambda$ and $\Pi^{SNA}<\Pi^{INA}$ when Condition 2 holds.

The SNA contract is optimal under four conditions:

Condition 1 is the opposite of condition 2 for LCCP:

$$\boldsymbol{q<\frac{(1-p)(1-\lambda)\left((1-f_1)p-f_1\right)c}{f_1(\theta_1(p+(1-p)\lambda)-c)}}$$

Condition 2 is the opposite of condition 2 for INA:

$$\boldsymbol{q<\frac{(1-p)\lambda(f_1+(1-f_1)(1-p)\lambda)c}{f_1\left(\theta_1 p(p+(1-p)\lambda)+c\left(\lambda-2p\lambda-p^2(1-\lambda)\right)\right)}}$$

Condition 3: $\Pi^{SNA}>\Pi^{IA}$

Satisfying Conditions 2 and 4 (see below) is sufficient, as if condition 4 holds then $\Pi^{INA}>\Pi^{IA}$, and if condition 2 holds then $\Pi^{SNA}>\Pi^{INA}$.

Condition 4: $\Pi^{SNA}>\Pi^{SA}$

As implied by Lemma 1,

$$\boldsymbol{q<1-\lambda}$$

The IA contract is optimal under four conditions:

Condition 1 is the opposite of Condition 3 for LCCP:

$$\boldsymbol{q>f_1+(1-f_1)(1-p)}$$

Condition 2 is the opposite of Condition 3 for INA:

$$\boldsymbol{q>1-\lambda}$$

Condition 3: $\Pi^{IA} > \Pi^{SNA}$

Conditions 2 and 4 holding are sufficient for Condition 3 to hold, as Condition 2 implies $\Pi^{SA} > \Pi^{SNA}$ and Condition 4 states $\Pi^{IA} > \Pi^{INA}$.

Condition 4: $\Pi^{IA} > \Pi^{SA}$

$$f_1\left(\theta_1 - \big(1-q(1-p)\big)\frac{c}{p}\right) + (1-f_1)\left(\theta_2 - (1-p)\Delta\theta - (1-q)\frac{1-p}{p}c\right)$$

$$> f_1(1-q)\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right)$$

$$+ (1-f_1)\left(\theta_2 - \Delta\theta(1-p) - \frac{(1-q)(1-p)}{p+(1-p)\lambda}c\right)$$

$$f_1\left(\theta_1 q + \frac{(1-q)c}{p+(1-p)\lambda} - \frac{(1-q+qp)c}{p}\right) > (1-f_1)(1-q)(1-p)c\left(\frac{1}{p} - \frac{1}{p+(1-p)\lambda}\right)$$

$$q\left(f_1\left(\theta_1 - \frac{c}{p+(1-p)\lambda} + \frac{c(1-p)}{p}\right) + (1-f_1)(1-p)c\left(\frac{1}{p} - \frac{1}{p+(1-p)\lambda}\right)\right)$$

$$> f_1\left(\frac{c}{p} - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)(1-p)\left(\frac{c}{p} - \frac{c}{p+(1-p)\lambda}\right)$$

$$q\left(f_1\left(\theta_1 p(p+(1-p)\lambda) - c\big(p-(1-p)(p+(1-p)\lambda)\big)\right)\right.$$

$$\left. + (1-f_1)(1-p)c(p+(1-p)\lambda - p)\right)$$

$$> f_1 c(p+(1-p)\lambda - p) + (1-f_1)(1-p)c(p+(1-p)\lambda - p)$$

$$q\left(f_1\big(p(p+(1-p)\lambda)\big)(\theta_1 - c) + c(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)\right)$$

$$> c(1-p)\lambda)\left(f_1 + (1-f_1)(1-p)\right)$$

$$\boldsymbol{q} > \frac{\boldsymbol{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c}}{\boldsymbol{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c + f_1\big(p(p+(1-p)\lambda)\big)(\theta_1 - c)}}$$

For the SA contract to be optimal, it must satisfy the following four conditions:

Condition 1 is the opposite of Condition 4 for LCCP:

$$\boldsymbol{q} > \frac{\boldsymbol{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c}}{\boldsymbol{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c + (1-f_1)(p+(1-p)\lambda)c - f_1(\theta_1 - c)}}$$

Condition 2: $\Pi^{SA} > \Pi^{INA}$

Conditions 3 and 4 are sufficient for Condition 2, as when $q > 1 - \lambda$, $\Pi^{IA} > \Pi^{INA}$ and when Condition 4 holds, $\Pi^{SA} > \Pi^{IA}$.

Condition 3: $\Pi^{SA} > \Pi^{SNA}$

$$\boldsymbol{q > 1 - \lambda}$$

Condition 4 is the opposite of Condition 4 for IA:

$$\boldsymbol{q < \frac{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c}{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c + f_1\big(p(p + (1-p)\lambda)\big)(\theta_1 - c)}}$$

Proof of Lemma 2

A1: $\frac{f_1}{1-f_1} > \frac{\Delta\theta}{\theta_1}$

A2: $c \leq \Delta\theta(1-p)$

Comparing conditions:

$$\frac{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c}{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c + f_1\big(p(p + (1-p)\lambda)\big)(\theta_1 - c)}$$
$$> \frac{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c}{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c + (1-f_1)(p + (1-p)\lambda)c - f_1(\theta_1 - c)}$$

$$\frac{\lambda}{(1-p)\lambda\big(f_1 + (1-f_1)(1-p)\big)c + f_1\big(p(p + (1-p)\lambda)\big)(\theta_1 - c)}$$
$$> \frac{1-\lambda}{(1-p)(1-\lambda)\big(f_1 + (1-f_1)(1-p)\big)c + (1-f_1)(p + (1-p)\lambda)c - f_1(\theta_1 - c)}$$

$$\lambda(1-\lambda)(1-p)\big(f_1 + (1-f_1)(1-p)\big)c + \lambda(1-f_1)(p + (1-p)\lambda)c - \lambda f_1(\theta_1 - c)$$
$$> \lambda(1-\lambda)(1-p)\big(f_1 + (1-f_1)(1-p)\big)c$$
$$+ (1-\lambda)f_1\big(p(p + (1-p)\lambda)\big)(\theta_1 - c)$$

$$\lambda(1-f_1)(p + (1-p)\lambda)c > f_1(\theta_1 - c)\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big)$$

Meaning

$$\lambda(p + (1-p)\lambda)c > \frac{\Delta\theta}{\theta_1}(\theta_1 - c)\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big)$$

Meaning

$$\lambda(p + (1-p)\lambda)(1-p)\Delta\theta > \frac{\Delta\theta}{\theta_1}(\theta_1 - (1-p)\Delta\theta)\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big)$$

$$(p + (1-p)\lambda)(1-p)\lambda > \left(1 - (1-p)\frac{\Delta\theta}{\theta_1}\right)\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big)$$

$$\begin{aligned}(p + (1-p)\lambda)(1-p)\lambda & \\ &> \lambda + p(p + (1-p)\lambda) - \lambda p(p + (1-p)\lambda) \\ &- (1-p)\frac{\Delta\theta}{\theta_1}\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big)\end{aligned}$$

$$(1-p)\frac{\Delta\theta}{\theta_1}\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big) > (1-p)\lambda(1-\lambda) + p(p + (1-p)\lambda)$$

Noting $p > \frac{f_1}{1-f_1} > \frac{\Delta\theta}{\theta_1}$

$$(1-p)p\big(\lambda + (1-\lambda)p(p + (1-p)\lambda)\big) > (1-p)\lambda(1-\lambda) + p(p + (1-p)\lambda)$$

Noting $\lambda + (1-\lambda)p(p + (1-p)\lambda) < p + (1-p)\lambda = \lambda + (1-\lambda)p$

$$(1-p)p(p + (1-p)\lambda) > (1-p)\lambda(1-\lambda) + p(p + (1-p)\lambda)$$

$$0 > (1-p)\lambda(1-\lambda) + p^2(p + (1-p)\lambda)$$

Violated. Hence, these conditions cannot hold for our basic parameter conditions, and SA is never optimal.

Proof of Proposition 1

The proof takes the following steps:

1. Recall that allowing extortion is suboptimal and the LCCP is strictly superior to the Baron Myerson, making the above contracts the only possible optimal contracts.
2. The SNA contract is optimal for some $0 < q < \bar{q}$
    a. Each condition for the optimality of SNA is attainable for some small q.
3. The derivative of the principal's profits with respect to q is negative.

Step 1 is evident.

Step 2:

Consider the conditions for SNA optimality:

$$1.\, q < \frac{(1-p)(1-\lambda)\big((1-f_1)p - f_1\big)c}{f_1(\theta_1(p + (1-p)\lambda) - c)}$$

$$2.\, q < \frac{(1-p)\lambda(f_1 + (1-f_1)(1-p)\lambda)c}{f_1\left(\theta_1 p(p + (1-p)\lambda) + c\big(\lambda - 2p\lambda - p^2(1-\lambda)\big)\right)}$$

$$3.\, q < 1 - \lambda$$

As long as the numerators and denominators are positive these are the true conditions.

<u>Condition 1</u>

Numerator:

Note that $p > \frac{f_1}{1-f_1}$ by earlier assumption. Therefore $(1 - f_1)p > f_1$, and the numerator is positive.

Denominator is positive if

$$c \leq \theta_1(p + (1-p)\lambda)$$

Which is required to avoid total shutdown for the low type in all the bribery-allowed cases.

Since both the numerator and denominator in Condition 1 are positive, there is some $\bar{q}$ such that

$$\overline{q_1} = \frac{(1-p)(1-\lambda)\big((1-f_1)p - f_1\big)c}{f_1(\theta_1(p + (1-p)\lambda) - c)}$$

And therefore Condition 1 is met for $0 < q < \overline{q_1}$

<u>Condition 2</u>

Numerator: $(1-p)\lambda(f_1 + (1-f_1)(1-p)\lambda)c > 0$

Denominator: $f_1\left(\theta_1 p(p + (1-p)\lambda) + c\big(\lambda - 2p\lambda - p^2(1-\lambda)\big)\right)$

Re-writing: $f_1\left(\theta_1 p(p + (1-p)\lambda) + c\big((1-p)(p + (1-p)\lambda) - p\big)\right)$

$$f_1\big(p(\theta_1(p + (1-p)\lambda) - c) + c(1-p)(p + (1-p)\lambda)\big)$$

$$c \leq \theta_1(p + (1-p)\lambda)$$

Meaning $f_1\left(\theta_1 p(p + (1-p)\lambda) + c\big((1-p)(p + (1-p)\lambda) - p\big)\right) > 0$

Since both the numerator and denominator in Condition 2 are positive, there is some $\bar{q}$ such that

$$\overline{q_2} = \frac{(1-p)\lambda(f_1 + (1-f_1)(1-p)\lambda)c}{f_1\left(\theta_1 p(p + (1-p)\lambda) + c\big(\lambda - 2p\lambda - p^2(1-\lambda)\big)\right)}$$

And therefore Condition 2 is met for $0 < q < \overline{q_2}$

<u>Condition 3</u>

Clearly $1 - \lambda > 0$

So for $\overline{q_3} = 1 - \lambda$, Condition 3 is met for $0 < q < \overline{q_3}$.

Set $\bar{q}_m = \min(\bar{q}_1, \bar{q}_2, \bar{q}_3)$

The SNA contract is optimal for $0 < q < \bar{q}_m,\ \bar{q}_m > 0$

Step 3:

The SNA profits are:

$$f_1(1-q)\left(\theta_1-\frac{c}{p+(1-p)\lambda}\right)+(1-f_1)\left(\theta_2-(1-p)\Delta\theta-\frac{(1-p)\lambda}{p+(1-p)\lambda}c\right)$$

The derivative of the SNA profits with respect to q are:

$$-f_1\left(\theta_1-\frac{c}{p+(1-p)\lambda}\right)<0$$

Honesty hurts the principal in the SNA contract. The SNA contract is optimal for $0<q<\bar{q}_m$. Therefore honesty hurts the principal for $0<q<\bar{q}_m$.

Appendix F: Proof of Proposition 3

I will now show that increasing q hurts the principal for small q. First, I will show that SNA is optimal for small q. Then, I will show that SNA's profits decrease in q.

$$\Pi^{SNA} > \Pi^{LCCP}$$

$$f_1(1-q)\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)\left(\theta_2 - c - (1-q)\left((1-p)\Delta\theta - \frac{p}{p+(1-p)\lambda}c\right)\right)$$

$$> f_1(\theta_1 - c) + (1-f_1)\big(\theta_2 - c - (1-q)(\Delta\theta(1-p) - pc)\big)$$

$$(1-f_1)\left(\frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}pc\right) - f_1\left(\frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}c\right)$$

$$\geq q\left(f_1\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)\frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}pc\right)$$

$$q \leq \frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}c\left(\frac{(1-f_1)p - f_1}{f_1\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)\frac{(1-p)(1-\lambda)}{p+(1-p)\lambda}pc}\right)$$

Since $p > \frac{f_1}{1-f_1}$, there is some $q > 0$ which satisfies this condition.

$$\Pi^{SNA} > \Pi^{INA}$$

$$f_1(1-q)\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)\left(\theta_2 - c - (1-q)\left((1-p)\Delta\theta - \frac{p}{p+(1-p)\lambda}c\right)\right)$$

$$> f_1\left(\theta_1 - \big(1 - q(1-p)\big)\frac{c}{p}\right)$$

$$+ (1-f_1)\left(\theta_2 - c - (1-q)\left((1-p)\Delta\theta - \frac{p-(1-p)\lambda}{p}c\right)\right)$$

$$f_1\left(\frac{c}{p} - \frac{c}{p+(1-p)\lambda}\right) + (1-f_1)c\left(\frac{p}{p+(1-p)\lambda} - \frac{p-(1-p)\lambda}{p}\right)$$

$$\geq q\left(f_1\left(\theta_1 - \frac{c}{p+(1-p)\lambda} + \frac{1-p}{p}c\right)\right.$$

$$\left.+ (1-f_1)c\left(\frac{p}{p+(1-p)\lambda} - \frac{p-(1-p)\lambda}{p}\right)\right)$$

$$\frac{p}{p+(1-p)\lambda}-\frac{p-(1-p)\lambda}{p}=\frac{p^2-(p^2-p(1-p)\lambda+p(1-p)\lambda-(1-p)^2\lambda^2)}{p(p+(1-p)\lambda)}$$

$$=\frac{(1-p)^2\lambda^2}{p(p+(1-p)\lambda}$$

$$c(1-p)\lambda(f_1+(1-f_1)(1-p)\lambda)$$
$$\geq q\left(\theta_1 f_1 p(p+(1-p)\lambda)\right.$$
$$\left.+c\left(f_1\left((1-p)(p+(1-p)\lambda)-p\right)+(1-f_1)(1-p)^2\lambda^2\right)\right)$$

$$c(1-p)\lambda(f_1+(1-f_1)(1-p)\lambda)$$
$$\geq q\left(\theta_1 f_1 p(p+(1-p)\lambda)+c(f_1((1-p)^2\lambda-p^2)+(1-f_1)(1-p)^2\lambda^2)\right)$$

$$q\leq\frac{c(1-p)\lambda(f_1+(1-f_1)(1-p)\lambda)}{\theta_1 f_1 p(p+(1-p)\lambda)+c(f_1((1-p)^2\lambda-p^2)+(1-f_1)(1-p)^2\lambda^2)}$$

The denominator is positive, and hence this holds from some $q>0$.

Hence, the SNA contract is optimal for small q.

$$\frac{d\Pi^{SNA}}{dq}=\frac{d}{dq}\left[f_1(1-q)\left(\theta_1-\frac{c}{p+(1-p)\lambda}\right)\right.$$
$$\left.+(1-f_1)\left(\theta_2-c-(1-q)\left((1-p)\Delta\theta-\frac{p}{p+(1-p)\lambda}c\right)\right)\right]$$

$$\frac{d\Pi^{SNA}}{dq}=-f_1\left(\theta_1-\frac{c}{p+(1-p)\lambda}\right)+(1-f_1)\left((1-p)\Delta\theta-\frac{p}{p+(1-p)\lambda}c\right)$$

$$\frac{d\Pi^{SNA}}{dq}<0$$

$$(1-f_1)\left((1-p)\Delta\theta-\frac{p}{p+(1-p)\lambda}c\right)<f_1\left(\theta_1-\frac{c}{p+(1-p)\lambda}\right)$$

Re-writing A1-A3

$$1-\frac{c}{\Delta\theta}>p>\frac{f_1}{1-f_1}>\frac{\Delta\theta}{\theta_1}$$

I will make substitutions using these parameter constraints to tighten the inequality, and show that it can still hold.

$$(1-f_1)\left((1-p)\Delta\theta - \frac{p}{p+(1-p)\lambda}c\right) < f_1\left(\theta_1 - \frac{c}{p+(1-p)\lambda}\right)$$

$$(1-p)\Delta\theta - \frac{c}{p+(1-p)\lambda}p < \frac{f_1}{1-f_1}\theta_1 - \frac{c}{p+(1-p)\lambda}\frac{f_1}{1-f_1}$$

$$(1-p)\Delta\theta - \frac{f_1}{1-f_1}\theta_1 < \frac{c}{p+(1-p)\lambda}\left(p - \frac{f_1}{1-f_1}\right)$$

If I increase the LHS and the inequality still holds, then the previous inequality holds as well. In particular, note by parameter restriction that $\frac{f_1}{1-f_1}\theta_1 > \Delta\theta$, so substituting $-\Delta\theta$ in for $-\frac{f_1}{1-f_1}\theta_1$ should increase the LHS.

$$(1-p)\Delta\theta - \Delta\theta < \frac{c}{p+(1-p)\lambda}\left(p - \frac{f_1}{1-f_1}\right)$$

Also note that $p > \frac{f_1}{1-f_1}$, so RHS is positive. Therefore, this stricter inequality holds for our initial parameter restrictions, and honesty hurts the principal.

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