# Risk Attitudes and the Shift of Liability from the Principal to the Agent

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**Abstract:** This paper studies the problem of illegal behavior within a principal-agent framework. The agent performs an illegal activity which benefits the principal, and can exert an effort that negatively affects the likelihood of detection of the violation. Two opposite legal regimes are considered: in the first, only the risk neutral principal is strictly liable; in the second, only the risk averse agent is. The monetary sanction and the probability of detection function are the same in both cases. Our model shows that shifting the liability upon the risk averse agent reduces the principal net benefit, thus favoring deterrence of wrongdoing; however, it can also either increase or reduce the agent effort in cheating. For a specific model we are able to characterize cases in which a reduction in cheating prevails, and shifting the liability upon the agent has clear-cut beneficial effects on compliance.

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# 1 Introduction

This paper studies the problem of illegal activity perpetrated by corporations. Public opinion often considers corporations responsible for damage stemming from illegal activity in the fields of environment, taxation, financial markets, social risk, etc. The policy of curbing illegal behavior may take one of two main approaches: either corporate liability or liability of its wrongful agents.

We will examine this problem in the simplified framework of a principal-agent model, in which an agent is hired to perform an illegal activity which benefits the principal[1]. The extent of the agent effort can influence the likelihood of detection. Thus, effort can be interpreted as care in concealing the illegal nature of an activity. A real world example might be a case of tax evasion by a corporation[2], implemented through accounting tricks. The bookkeeper skill and effort in cheating can affect the probability of detection[3].

Agents who can either facilitate or disrupt misconduct (by withholding their cooperation) are called “gatekeepers” by Kraakam (1986). Sanctions (either civil or criminal) provided by the law upon gatekeepers may be seen as devices for

[1] In a closely held corporation, the owners, who are the decision makers, play the role of the principal.

[2] Other examples are fraud-on-the-market securities fraud, fraud on the government, bribery etc. We consider affirmative wrongful acts, done by the agent because the corporation wants the act committed. According to Cohen [1991], the majority of corporate crimes are “affirmative”.

[3] In the field of taxation, the agent effort in hiding can be extremely problematic. For example, Reinganum and Wilde (1991) note that raw evidence suggests a link between taxpayer use of preparers or practitioners and noncompliance. They report US data that show higher noncompliance, both as a percentage of number of reports and as a percentage of the amount of the reported tax, for taxpayers who resorted to third-party assistance. This happens in a legal regime in which the main penalties are provided for the evading taxpayer, but some are also imposed on the practitioner. Erard (1997) quotes survey evidence that indicates that some tax practioners believe that they are able to prevent detection of tax evasion. The same author, using a 1982 IRS TCMP data file, estimates a higher success of examiners in detecting deliberate evasion on self-prepared returns than on paid-prepared returns.

keeping principals honest. Is the gatekeeper liability the best way of curbing illegal behavior, or would it be better to provide sanctions directly upon the principal? Many facets of this problem have already been explored (Kraakam [1986]). The specific contribution of this paper is an analysis of the consequences of different attitudes toward risk of the principal and the agent.

For the sake of simplicity, two extreme alternatives are modeled: that is, either the principal or the agent is strictly liable, while the monetary sanction and the probability of detection function remain the same. Although actual legal regimes often provide rules for sharing liability, the study of extreme alternatives may shed some light upon the main issues involved[4]. In order to focus specifically upon the liability regime, it is also assumed that main enforcement parameters (pertaining to sanctions or the probability of detection) are given[5].

A rule providing for the principal liability seems justified, with reference to the circumstances described in the model, both on moral grounds, with reference to the retributive role of sanctions (since the illegal activity benefits the principal) and on efficiency grounds (since the principal can provide incentives for the agent to choose legal behavior). If, however, the principal is a corporation, then it is a person only in legal fiction, without a definable mind or intentions. The applicability of the retributive theory of sanctions can thus be questioned in this case (Byam [1982], Khanna [1996]), although efficiency considerations pertaining to the deterrence of future wrongdoing are still relevant.

The alternative approach, which envisages that the agent is liable, is less

[4] For a discussion about the use of fines upon employees as partial substitutes for sanctions upon corporations, see Polinsky and Shavell (1993).

[5] Note that this approach becomes necessary when constraints pertaining to available resources, need for marginal deterrence, etc. (see e.g. Stigler [1970]) restrict the number of

obvious, although it may also have moral justifications. The agent, who is skilled either on the grounds of technical, legal or deontological rules, may have an even clearer idea than the principal that an activity is illegal. On the other hand, from an equity point of view, the agent may be poorer than the principal and society may assign a higher weight to her utility.

We will focus however on efficiency problems. It has been argued from this point of view that, according to the Coase theorem, liability rules are irrelevant, as long as costless side payments and monetary compensations can be used to neutralize the effects of the liability rule on payoff allocation. It is widely recognized, however, that market imperfections may imply that liability rules do matter. For example, agents may be potentially insolvent with reference to substantial judgments against them (Sykes [1984]). This fact could reduce their incentive to avoid wrongdoing if they are personally liable.

In this paper we assume, again for the sake of simplicity, that both the principal and the agent can bear unlimited liability. We consider, however, another reason that may imply that rules establishing which subject is liable matters, namely transaction costs. We assume that the agreements between the principal and the agent pertaining to the complete or partial offsetting of the effects of the liability rule cannot be reached or enforced, or, equivalently, that transaction costs of these deals within the agency are prohibitively high. Moreover, it is impossible to buy insurance against sanctions. These are, again, extreme assumptions that should, however, provide some intuition about more realistic intermediate cases.

Illicit deals generally imply sheer difficulties of negotiating actions and compensation. In the subsequent analysis it is assumed, however, that these difficulties do not preclude the drafting and carrying out of an agency contract, provided that the agent effort is observable[6]. This framework, with unavoidable

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instruments that can be tuned to secure optimal enforcement.

[6] Standard agency models assume both uncertainty about the outcome and non-observability of the agent effort. In the case studied in this paper, as will become clear in the

simplifications, should depict the fact that, on the one hand, in many fields illicit deals do take place and illicit markets do work[7]; and that on the other hand, detection of wrongdoing would prevent the resort to legal devices for the further enforcement of the contract, and would also disrupt the functioning of self-enforcement or trust mechanisms[8]. Thus, it is assumed that the agent remuneration cannot be made conditional on the outcome (i.e. whether the wrongdoing is detected or not).

As far as risk aversion is concerned, according to standard agency theory, it is assumed that the principal is risk neutral and the agent is risk averse. The literature provides many justifications for this assumption: for example, a stockholder principal can neutralize risks, diversifying his portfolio through financial devices. The generality of this assumption may of course be questioned, in particular with reference to illegal activities. Agency models which consider problems of substitutability or jointness of the principal and agent liability (see e.g. Chu and Qian [1995], Polinsky and Shavell [1993], Arlen [1994]) have, however, generally assumed risk neutrality of both, and only put forth some conjecture about the effect of the agent risk aversion[9]. In this paper the consequences of shifting liability from a risk neutral principal to a risk averse agent are examined in depth.

When the agent is liable, the sanction is placed upon the subject who is more hurt by it (being risk averse); as a consequence, the decision of the principal about illegal behavior is indirectly negatively influenced, through the increase in the cost of compensating the agent. In general, if one party to a transaction is risk averse

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following, the first assumption is enough to originate a non trivial problem.

[7] According to Tirole [1992], the assumption of enforceability of side (illicit) contracts has the advantage of allowing the use of classical contract theory, while offering a realistic description.

[8] It is often assumed (see Tirole [1992]) that side transfers are not always possible, but instead somehow constrained (for example by technology).

[9] For example, Polinsky and Shavell (1993) maintain that risk averse liable agents will tend to exercise more effort than risk neutral ones.

and the other is risk neutral, then it is efficient for the risk neutral party to bear all the risks. Posner (1992) notes that a fine imposed with a given probability upon a risk averse agent gives him a disutility in excess with respect to that suffered in the case of risk neutrality, which is not translated into a revenue for the state. The same problem is pointed out by Yitzachi (1987), who assumes risk averse taxpayers, and speaks of an "excess burden" of tax evasion. However, this excess burden problem is of little importance if government does not care about revenue from fines, but simply wants to "encourage and achieve the highest possible degree of voluntary compliance[10]". Enforcing law upon risk averse agents could be a way of securing a degree of compliance that might not be reached otherwise.

The most important result established in this paper, indeed, shows that the legal regime in which the agent is liable reduces the principal net benefit, thus involving at the margin some exit from illegal behavior.

In general, one cannot exclude that shifting the responsibility upon the agent involves a greater effort, thus worsening the problem faced by the public sector with reference to the repression of illegal activity. On a specific model, however, we are able to characterize the cases in which the agent effort in covering up is lower than in the legal regime in which the principal is liable. When these circumstances occur, shifting liability upon the agent has clear-cut beneficial effects on compliance.

The paper is organized as follows. In Section 2 the agency model is introduced and optimal remunerations are calculated for the two legal regimes (i.e. either when the principal or the agent is liable). Section 3 shows that the principal net benefit is lower under the second legal regime. Section 4 completely characterizes optimal remunerations and efforts for the two legal regimes under standard assumptions of concavity for the functions involved, thus preparing for the subsequent analysis of Section 5, where a specific (exponential) model is

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[10] American Bar Association Commission on Taxpayer Compliance, quoted in Reinganum

studied. For this special case, conditions are put forth under which the second legal regime is the most effective in the repression of wrongdoing. Finally Section 6 reports the conclusions.

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and Wilde (1991).

## 2 A Principal-Agent Model under Full Information

In this section we set up two different principal-agent models describing the optimal behavior in implementing some illegal action. In the first model, strict liability is assumed only on the principal for any action performed by the agent, while in the second scenario the agent bears all the risks involved in a possible detection. First we introduce notation and the assumptions necessary for the description of both cases.

### 2.1 Notation and Assumptions

The principal, who is assumed to be risk neutral, may reap benefit that amounts to *B* from illegal behavior. Illegal activity is implemented by an agent who is paid for her effort to negatively affect the likelihood of detection. The agent who decides to perform the illegal activity is assumed to be risk-averse and receives utility from a remuneration *r* paid by the principal and faces a "disutility" due to the cost of the effort *x*. The agent total utility will be denoted by $H(x,r)$ and her reservation utility by $u_0$. Furthermore, we assume that the principal can observe the effort *x* performed by the agent and has a reservation utility of $\pi_0$.

Let $p(x)$ be the probability of being detected in performing the illegal activity and *S* the pecuniary sanction applied if offense is detected. Both the principal and agent know the function *p*. To prove the main result we need the following assumptions:

(A1) $B > 0$, $S > 0$, $u_0 > 0$ *and* $\pi_0 > 0$;

(A2) $H(x,r)$ *is defined over* $\mathbf{R}_+ \times \mathbf{R}$, *is continuous, decreasing in x, strictly increasing and strictly concave in r;*

(A3) $p(x)$ *is defined over* $\mathbf{R}_+$, *is continuous, decreasing and* $0 < p(x) < 1$ *for all x.*

In (A2) we use standard assumptions for a risk averse agent utility function. In (A3) we assume that detection is neither certain nor impossible, and the probability $p(x)$ of detection is decreasing in effort.

### 2.2 The Case where the Principal is Liable

In the first model the principal wants to maximize her expected net benefit

$$\begin{aligned}\mathbf{E}\pi(x,r) &= [1 - p(x)](B-r) + p(x)(B-r-S) \\ &= B - r - p(x)S\end{aligned}$$

subject to two constraints: the agent participation constraint and a “moral” constraint. Thus the problem of the principal is

$$\begin{aligned}&\pi_1 = \max_{x,r}[B - r - p(x)S] \\ &\text{s.t.}\quad (i)\ H(x,r) \geq u_0 \ \text{ and} \\ &\qquad\ (ii)\ B - r - p(x)S \geq \pi_0 .\end{aligned} \tag{1}$$

Since the principal is risk neutral, the objective function is quasi-linear. Constraint (*ii*) may be interpreted as follows: if the expected net benefit equals zero, then the principal chooses not to undertake any illegal action. Clearly, such a constraint becomes determinant in the choice of the principal: if $r$ and $p(x)S$ are large enough, legal behavior will ensue. Note that $p(x)S$ is the expected value of the sanction if the effort in hiding the offense is *x*: $p(x)S = \mathbf{E}_x(S)$.

Since the objective function is quasi-concave and constraint (*i*) is a convex set, if a solution $(x_1, r_1)$ exists for problem (1), it is unique and, by monotonicity of both the objective function and function $H(x,r)$, constraint (*i*) must be binding:

$$H(x_1, r_1) = u_0 .$$

Thanks to strict monotonicity of $H(x_1,\cdot)$, the optimal remuneration $r_1$ is given by calculating the (strictly increasing) inverse function $H^{-1}(x_1,\cdot)$ of both terms:

$$r_1 = H^{-1}(x_1, u_0)\,.$$

Since effort is observable, the principal can fix the contract with the agent by setting the payment function

$$w(x) = \begin{cases} r_1 = H^{-1}(x_1, u_0) \text{ if } x = x_1 \\ 0 \text{ otherwise.} \end{cases}$$

The agent receives a reward $r_1 = H^{-1}(x_1, u_0)$ for the effort performed $x_1$ and the principal receives a net benefit given by

$$\pi_1 = B - H^{-1}(x_1, u_0) - p(x_1)S.$$

### 2.3 The Case where the Agent is Liable

Now let us assume that the legal regime changes. The agent can be punished with the same sanction previously applied to the principal, and the principal is no longer liable. As the possibility of resorting to insurance (provided either by the principal or by a third party) has been excluded by assumption, the agent will consider the sanction as a cost or loss component, to be kept in mind when deciding whether to accept a contract which does not entail reimbursement of the sanction in case of detection.

Provided that the agent behaves according to the expected utility approach, in the legal regime where the agent is liable, her utility is

$$\mathbf{E}H(x,r) = [1 - p(x)]H(x,r) + p(x)H(x, r - S) \tag{2}$$

Under this new legal regime, the principal is no longer liable, and is therefore not interested in the effort of hiding the illegal action. Net benefit will be maximized independently of the effort *x* performed by the agent. Hence, the principal problem under this legal regime is:

$$\begin{aligned}
&\pi_2 = \max_r (B - r) \\
&\text{s.t.} \quad (i)\ \mathbf{E}H(x,r) \geq u_0, \\
&\qquad\ \ (ii)\ x \in \arg\max_x \mathbf{E}H(x,r) \text{ and} \\
&\qquad\ \ (iii)\ B - r \geq \pi_{\mathbf{0}}.
\end{aligned} \tag{3}$$

Constraint (*ii*) shows that, while in the previous legal regime the only contract available to the agent requires an amount of effort chosen by the principal, in this case the agent chooses a level of effort which maximizes her expected utility. Note that, since under (A1)-(A3) $\mathbf{E}H(\cdot,r)$ is not necessarily quasi-concave, in general there could be many optimal efforts $x_2$ that maximizes the objective function in problem (3), while there is only one optimal remuneration $r_2$.

Clearly, again, for any solution $(x_2, r_2)$, the expected utility of the agent defined in (2) is kept at her reservation utility:

$$\mathbf{E}H(x_2, r_2) = u_0. \tag{4}$$

Since, thanks to strict monotonicity of $H(x,\cdot)$, also $\mathbf{E}H(x,\cdot)$ is strictly increasing for each fixed *x*, the optimal remuneration $r_2$ is given by calculating the (strictly increasing) inverse function $\mathbf{E}H^{-1}(x_2,\cdot)$ of both terms:

$$r_2 = \mathbf{E}H^{-1}(x_2, u_0).$$

In this legal regime, since the principal is not interested in the effort performed by the agent, a contract will be set such that the payment function is

$$w(x) \equiv r_2 = \mathbf{E}H^{-1}(x_2, u_0),$$

and the principal receives a net benefit

$$\pi_2 = B - \mathbf{E}H^{-1}(x_2, u_0).$$

# 3 The "Moral" Constraint Effect of the Agent's Liability

In this section we prove that, given all the ingredients defined in Section 2.1, when liability is charged on the agent rather than on the principal, there is a monetary disincentive for the latter in pursuing illegal initiatives: that is, the net benefit earned under the legal regime of Section 2.3 is always smaller than the net benefit of the case in Section 2.2.

**Proposition 1** *Under (A1)-(A3),*

$$p_2 < p_1, \tag{5}$$

*where* $p_1$ *and* $p_2$ *are defined in (1) and (3) respectively.*

**Proof:** By assumption (A2), (2) may be rewritten as

$$\mathbf{E}H(x,r) = H\left[x, r - p(x)S\right] - \varepsilon(x,r),$$

where

$$\varepsilon(x,r) = H\left[x, r - p(x)S\right] - \left\{[1 - p(x)]H(x,r) + p(x)H(x, r - S)\right\} > 0$$

represents the cost, in terms of utility, of the risk of being liable in case of detection, which is strictly positive for all $x \geq 0$ and for all $r$ since, under (A1)-(A3), $H(x,\cdot)$ is strictly concave, $S > 0$ and $0 < p(x) < 1$.

Hence, given any solution $(x_2, r_2)$, constraint $(i)$ in problem (3) can be rewritten as follows:

$$\mathbf{E}H(x_2,r_2) = H[x_2,r_2 - p(x_2)S] - \varepsilon(x_2,r_2) = u_0$$

and by rearranging terms we get

$$H[x_2,r_2 - p(x_2)S] = u_0 + \varepsilon(x_2,r_2)\,.$$

By applying the inverse function $H^{-1}(x_2,\cdot)$ to both sides and rearranging, we have

$$r_2 = H^{-1}[x_2,u_0 + \varepsilon(x_2,r_2)] + p(x_2)S\,.$$

Therefore, the following holds:

$$\begin{aligned}
p_2 &= B - r_2 \\
&= B - H^{-1}[x_2,u_0 + e(x_2,r_2)] - p(x_2)S \\
&< B - H^{-1}(x_2,u_0) - p(x_2)S \\
&\leq \max_{x\geq 0}\left[B - H^{-1}(x,u_0) - p(x)S\right] \\
&= p_1,
\end{aligned}$$

where the strict inequality holds since $e(x_2,r_2)>0$ and $H^{-1}(x_2,\cdot)$ is strictly increasing.

Hence, (5) shows that the net benefit earned by the principal under the second regime is strictly inferior to the net benefit earned under the first regime when all other features of the model are kept the same.

An important consequence of this is that, under the new legal regime, the "moral" constraint (*ii*) can no longer be satisfied and the principal problem (3) could turn out to have no solution while (1) may have. In other words, if the utility cost $\varepsilon(x_2, r_2)$ is great enough or $H^{-1}(x_2, \cdot)$ is steep enough, under a legal regime that charges the agent rather than the principal for committing an illegal activity, the principal may find that the same illegal activity that was profitable under the previous legal regime is no longer profitable. The role played by the difference in attitudes toward risk exhibited by the principal and the agent should be evident: strict concavity of utility function $H(x_2, \cdot)$ versus linearity of the principal preferences plays the major role in reducing profit opportunities of the latter under the second legal regime[11].

[11] Straightforward calculations show that, by assuming linearity of function $H(x,\cdot)$, that is risk neutrality also of the agent, the optimal effort turns out to be the same under both legal regimes, while the difference between the optimal remunerations is exactly the same amount as the expected sanction.

## 4 The Strictly Concave Model: Uniqueness of the Effort

To infer the consequences of the latter legal regime upon illegal behavior, we must compare the optimal efforts $x_1$, $x_2$ solutions of (1) and (3) respectively. In order to do this, we need to restrict the analysis to strictly concave models for establishing uniqueness of the optimal effort $x_2$ in problem (3). Therefore, throughout the rest of the paper we shall assume that the agent utility is represented by a separable function of the form

$$H(x,r) = u(r) - d(x)$$

that satisfies (A2) plus the following:

(A4) $u(r)$ *and* $d(x)$ *are both differentiable;* $d(x)$ *is strictly increasing and strictly convex*;

(A5) $p(x)$ *is differentiable, strictly decreasing and strictly convex.*

To obtain interior solutions, we shall also use the following technical assumption:

(A6) $H(0,0) = u(0) - d(0) \leq u_0$ *and* $d'_+(0) = 0$.

The first inequality means that the agent can at most obtain her reservation utility by performing no effort and receiving nothing as remuneration.

**Lemma** *Under (A1)-(A6) and by assuming that constraint (ii) in problem* (1) *holds with strict inequality, the unique optimal solutions of problems* (1) *and* (3) *are two pairs* $(x_1, r_1)$ *and* $(x_2, r_2)$ *respectively such that*

$$\begin{cases} u(r_1) - d(x_1) = u_0 \\ -p'(x_1)S = \dfrac{d'(x_1)}{u'(r_1)} \end{cases} \tag{6}$$

$$\begin{cases} u(r_2) - p(x_2)\left[u(r_2) - u(r_2 - S)\right] - d(x_2) = u_0 \\ -p'(x_2)\left[u(r_2) - u(r_2 - S)\right] = d'(x_2) \end{cases} \tag{7}$$

*Furthermore* $x_1 > 0$, $r_1 > 0$, $x_2 > 0$ *and* $r_2 > 0$.

**Proof:** By differentiability assumptions, the solution $(x_1, r_1)$ of problem (1) is completely characterized by K. T. conditions, which lead to (6). The first equation in (7) is nothing other than (4), which has been already discussed. Strict concavity of *u* and strict convexity of *d* and *p* plus separability of function $H(x, r)$, imply strict concavity of function $\mathbf{E}H(\cdot, r)$ defined in (2); hence, for each given *r*, FOC expressed in the second equation of (7) is necessary and sufficient for optima. Finally, strict monotonicity of functions *d* and *p* plus assumption (A6) are sufficient for interiority of both $(x_1, r_1)$ and $(x_2, r_2)$.

The first equation in (6) implies that when the principal maximizes her expected net benefit, the agent receives her reservation utility; the second one establishes that, at the optimum, the marginal benefit of the principal due to a reduction of the expected sanction must equal the marginal rate of substitution between the effort disutility and the reward utility of the agent. The first equation in (7) shows that also when the agent is liable, at the optimum, the expected utility of the agent defined in (2) is kept at her reservation utility. The second one simply states that the marginal benefit of the agent must be equal to her marginal disutility at the optimal effort $x_2$.

Due to the number of functions and parameters involved, we are not able to establish general conditions under which effort $x_2$ turns out to be larger or smaller than effort $x_1$. Therefore in the next section we will construct and study an explicit model which allows for direct computation of the optimal solutions $(x_1, r_1)$ and $(x_2, r_2)$. We will see in the example that effort $x_2$ can be either larger or smaller than effort $x_1$. This should not be surprising, since it is not clear if, in the new legal regime, the agent will maximize her utility through harder work (which reduces the probability of detection) or, on the contrary, by reducing effort (when this would generate a "disutility effect" larger than the positive effect upon the expected sanction).

## 5 A Specific Case: The Exponential Model

Consider a model where the functions introduced in Section 4 are given by the following:

$$u(r) = 1 - e^{-\alpha r}, \; a > 0;$$

$$d(x) = \beta(e^x - 1), \; \beta > 0;$$

$$p(x) = \gamma e^{-x}, \; 0 < g < 1.$$

Moreover, let $0 < u_0 < 1$, $S > 0$ and $B > 0$ be given, and assume for simplicity that $B$ is large enough to let constraint (*ii*) in problem (1) always be satisfied. Note that (A1)-(A6) are all satisfied apart from interiority of the optimal efforts $x_1$, $x_2$ (since $d'_+(0) \neq 0$), which will be reached through an *ad hoc* assumption on the parameters $\alpha$, $\beta$, $\gamma$, $u_0$ and the sanction *S*.

The interpretation of the parameters $\alpha$, $\beta$, $\gamma$ is immediate: $\alpha$ denotes the (constant) absolute risk aversion of the agent, $\beta$ characterizes the magnitude of the disutility function of the agent[12] and $\gamma$ is a rough indicator of the "average" probability of detection[13].

In the following analysis we will show how the parameters $\alpha$, $\beta$, $\gamma$, $u_0$, as well as the size of the sanction *S*, affect the optimal efforts $x_1$ and $x_2$ in both models. In other words, our goal is to study how the specific features of the agent (parameters $\alpha$ and $\beta$), as well as the parameters controlled by the authority ($\gamma$ and the sanction *S*), determine whether the optimal effort in the model with agent

[12] Parameter $\beta$ is not particularly meaningful for our analysis, since we are interested in comparing variations of the optimal solutions rather than their values. Indeed, we do not introduce any measure of the effort; that is its size (and therefore the magnitude of the disutility) could be anything.

[13] Values of $\gamma$ close to one represent an efficient monitoring by the authority upon illegal behavior, while values close to zero imply inefficient monitoring.

liability is larger or smaller than the optimal effort in the case under principal liability. We shall see through an example that with different, but in both cases reasonable, values for the parameters above, effort $x_2$ can be either larger or smaller than effort $x_1$. We will then establish a condition under which the optimal effort in the model where the agent is liable is not larger than the optimal effort in the model where the principal is liable. This situation appears to be particularly attractive from the point of view of the decision-maker since, with respect to the model where the principal is liable, the model based on the agent liability exhibits not only the advantage of reducing the net benefit of the principal discussed in the previous section, but also the advantage of an increased probability of detection originated by a reduced effort in covering up the illegal action.

This model allows for a direct computation of the optimal solutions $(x_1, r_1)$ and $(x_2, r_2)$ under both legal regimes as solutions of the two systems of equations (6) and (7) respectively; that is, of the following:

$$\begin{cases} 1 - e^{-\alpha r} - \beta(e^x - 1) = u_0 \\ \gamma S e^{-x} = \dfrac{\beta e^x}{\alpha e^{-\alpha r}} \end{cases} \tag{8}$$

$$\begin{cases} 1 - e^{-\alpha r} - \gamma e^{-x}\left[1 - e^{-\alpha r} - 1 + e^{-\alpha(r-S)}\right] - \beta(e^x - 1) = u_0 \\ \gamma e^{-x}\left[1 - e^{-\alpha r} - 1 + e^{-\alpha(r-S)}\right] = \beta e^x \end{cases} \tag{9}$$

The computation gives the explicit solution for $x_1$, $r_1$, $x_2$ and $r_2$: see Proposition **4** in the Appendix.

The following example shows that in our model the optimal effort $x_2$ can be either larger or smaller than effort $x_1$.

### 5.1 An Example

Consider first the following values for the parameters: $B$=1, $S$=1, $a = 1$,

$\beta = 0.2$, $g = 0.3$ and $u_0 = 0.1$. Then, the optimal efforts are $x_1 = 0.1339$ and $x_2 = 0.2195$ for the first and the second model respectively. The optimal remunerations are $r_1 = 0.1377$ and $r_2 = 0.5078$. At the optimal efforts, the probabilities of detection and the net benefits for the principal are $p(x_1) = 0.2624$, $\pi_1 = 0.6039$ and $p(x_2) = 0.2409$, $\pi_2 = 0.4922$ respectively.

By keeping all the parameters at the same value but letting $g = 0.8$, the optimal efforts become $x_1 = 0.5512$ and $x_2 = 0.5303$. That is, in the latter case the effort for the model with the agent liability is smaller than the one under the principal liability. In this case, the optimal remunerations are $r_1 = 0.2838$ and $r_2 = 0.8670$, while the probabilities of detection and the net benefits for the principal are $p(x_1) = 0.4610$, $\pi_1 = 0.2552$ and $p(x_2) = 0.4707$, $\pi_2 = 0.1330$ respectively.

This example anticipates the main result of this section by showing that the difference $x_2 - x_1$ is a decreasing function of parameter $\gamma$, that is, of the “average” probability of detection. In particular, if $\gamma$ is large enough, this difference becomes negative, that is, $x_1 > x_2$. The interpretation of this situation may be the following: if the probability of detection is sufficiently high, the agent requires from the principal a compensation for the (high) risk of being detected great enough to balance even a reduction in the effort of hiding the illicit activity. From the principal point of view, this is equivalent to saying that the cost of compensating the agent for his effort to hide the action becomes higher than the cost of compensation for the risk of incurring the sanction.

Now let us see more in depth how changes in the parameters $\alpha$, $\beta$, $\gamma$, $u_0$ and the sanction *S* affect the difference in efforts $x_2 - x_1$.

### 5.2 A Comparative Static Analysis[14]

By using the explicit solutions for the optimal efforts obtained in (12) and (14) of Proposition **4** in the Appendix, let us define the difference $x_2 - x_1$ as a function of $\alpha$, $\beta$, $\gamma$, $u_0$ and *S*. For this purpose, note that in (12) and (14) the absolute risk aversion $\alpha$ and the sanction *S* appear everywhere as a unique product, therefore, from now on, we will reduce the dimension of the domain of functions to be defined by introducing a new variable:

$$\delta = \alpha S .$$

By the assumptions on $\alpha$ and *S*, it follows that $\delta > 0$. This entails that, from now on, an increase (decrease) of variable $\delta$ will equivalently mean an increase (decrease) either of the absolute risk aversion $\alpha$ or the sanction *S*. Hence let

$$\begin{aligned} f(\beta,\gamma,\delta,u_0) = \ln\left\{\frac{\gamma(e^{\delta}-1)}{\beta}\left[\sqrt{\beta^2+\frac{\beta}{\gamma(e^{\delta}-1)}(1-u_0+\beta)}-\beta\right]\right\} \\ -\ln\left\{\frac{\gamma\delta}{2\beta}\left[\sqrt{\beta^2+\frac{4\beta}{\gamma\delta}(1-u_0+\beta)}-\beta\right]\right\} \end{aligned} \tag{10}$$

where the right side uses the expressions of $x_1$ and $x_2$ obtained in Proposition **4** in the Appendix.

The next result confirms the intuition suggested by the example above.

**Proposition 2** *Under the assumptions of the exponential model, function f defined in (*10*) is strictly decreasing with respect to* $\gamma$. *As a consequence, variable* $\gamma$ *can be globally explicited with respect to the other variables for* $f(\beta,\gamma,\delta,u_0) = 0$ *obtaining the implicit function*

[14] In this section we relied on the Maple mathematical software.

$$\gamma^*(\beta,\delta,u_0) = \frac{1}{\beta}(1-u_0+\beta)\frac{\left(e^{\delta}-1-\delta\right)^2}{\delta\left(2e^{\delta}-2-\delta\right)\left(e^{\delta}-1\right)}, \tag{11}$$

*that is, for each fixed triplet* $\beta,\delta,u_0$, *there exists a unique value* $\gamma^*(\beta,\delta,u_0)$ *for the parameter* $\gamma$ *such that* $x_1 = x_2$.

**Proof:** See Appendix.

Thanks to monotonicity of *f* with respect to $\gamma$, the following corollary holds.

**Corollary** *The inequality* $x_1 \geq x_2$, *that is all the cases when the optimal effort in the regime of agent liability is not larger than the optimal effort under principal liability, is characterized by*

$$x_1 \geq x_2 \Leftrightarrow \gamma \geq \frac{1}{\beta}(1-u_0+\beta)\frac{\left(e^{\delta}-1-\delta\right)^2}{\delta\left(2e^{\delta}-2-\delta\right)\left(e^{\delta}-1\right)}.$$

This is in tune with the intuition given by our example: if the probability of detection is (in average) great enough, switching the burden of liability from the principal to the agent causes a reduction in the effort of hiding the wrongdoing, thus enhancing the probability of detection.

Figure 1 shows the behavior of optimal efforts $x_1$ and $x_2$ as functions of $\gamma$ while all other parameters are kept constant at the values of the previous example: $\beta = 0.2$, $\delta = 1$ and $u_0 = 0.1$: as $\gamma$ increases, $x_1$ rises faster than $x_2$. Note that in this case $g^* \cong 0.67$.

**Figure 1:** $x_1$ (black line) and $x_2$ (gray line) as functions of
γ for β=0.2, δ=1 and $u_0$=0.1.

However, the threshold γ* could also reach values greater than one, which are not compatible with the assumptions in our model, as is shown in Figure 2 for $\beta = 0.1$ while all the other parameters are kept the same. In this case it reaches a value of around 1.25, which is not feasible, since $0 < g < 1$ must hold.

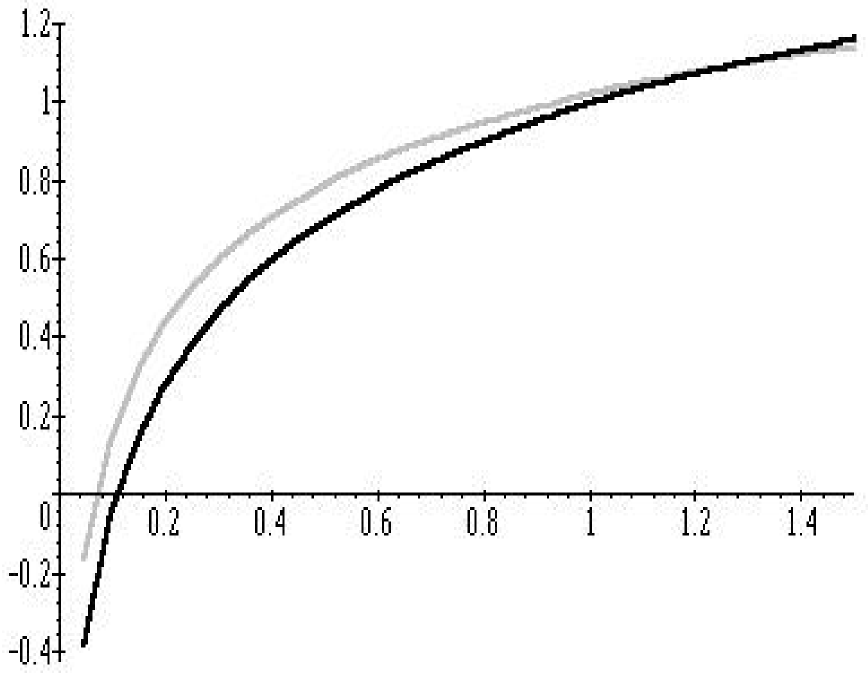


**Figure 2:** $x_1$ (black line) and $x_2$ (gray line) as functions of $\gamma$ for $\beta$=0.1, $\delta$=1 and $u_0$=0.1.

Thus, for $\beta = 0.1$, $\delta = 1$ and $u_0 = 0.1$, $x_2$ turns out always (i.e. for each feasible $\gamma$) to be larger than $x_1$; that is, the agent always works harder in the second legal regime than in the first. This should be clear, since a reduction in the intensity of her disutility function means that effort costs less[15], while everything else remains the same.

Now we study how changes in the parameters $\beta, \delta, u_0$ affect the threshold[16] $\gamma^*$ defined in (11). It is sufficient to study the sign of the partial derivatives of

[15] That is, each value *x* of effort gives to the agent half a disutility of the previous case.

[16] The choice of developing the analysis in such a direction is motivated mainly by the simplicity of computation and the fact that interpretation is facilitated by the availability of graphic representations.

function $\gamma^*(\beta, \delta, u_0)$ with respect to each parameter to see in which direction the threshold moves as the single parameter increases.

**Proposition 3** *Given the assumptions of the exponential model and condition (*16*), the following hold for the function* $\gamma^*(\beta, \delta, u_0)$*:*

$D_\beta \gamma^*(\beta, \delta, u_0)$ *is always negative,*

$D_\delta \gamma^*(\beta, \delta, u_0)$ *is positive for* $\delta < 1.93$ *and negative for* $\delta > 1.93$*,*

$D_{u_0} \gamma^*(\beta, \delta, u_0)$ *is always negative,*

*where* $D_\beta \gamma^*$*,* $D_\delta \gamma^*$ *and* $D_{u_0} \gamma^*$ *denote the partial derivatives of* $\gamma^*$*.*

**Proof:** See Appendix.

Negativity of the partial derivatives of $\gamma^*$ with respect to $\beta$ and $u_0$ implies that the threshold $\gamma^*$ decreases as $\beta$ or $u_0$ increases; that is, as the cost of effort rises and/or the agent becomes more demanding, a lower probability of detection is enough to switch from a situation where $x_1 < x_2$ to the case where $x_1 > x_2$.

In other words, positive variations in the cost of effort and/or in the reservation utility of the agent act in favor of law enforcement under the agent liability regime, since a smaller probability of detection is necessary to favor a reduction in effort of hiding the wrongdoing with respect to the other legal regime. Graphically, the intersection point of curves $x_1$ and $x_2$ in Figure 1 moves leftward.

Different is the case of variations of the threshold as either the sanction *S* or the absolute risk aversion of the agent $\alpha$ (both represented now by the single variable $\delta$) increase. For small values of $\delta$, an increase of $\delta$ itself shifts the threshold $\gamma^*$ upward; that is, for small sanctions and/or low absolute risk aversion of the agent, an increase of one or both of them has a negative effect (from the point of view of the effective probability of detection) on law enforcement in the regime which puts liability on the agent, thus making the other regime comparatively more efficient. The opposite happens for higher values of $\delta$ (greater than 1.93). In other words, the higher the sanction (or the risk aversion) is, the more efficient the second legal regime becomes with respect to the first one through a further increase in the sanction (or the risk aversion) itself.

## 6 Conclusions

The increase in the expected cost of illegal behavior seems to be the feature on which legal systems focus when penalties for agents that perform illegal activities benefiting their principal are provided for. The beneficial effect of tightening the principal “moral” constraint is confirmed in this paper, in a setting where the principal is risk neutral and the agent is risk averse. Indeed, the most important result shows that the legal regime in which the agent is liable reduces the principal net benefit, thus involving at the margin some exit from illegal behavior.

As the theoretical analysis has shown, however, the case for shifting responsibility onto agents is not clear-cut: while it could be a way of inducing some operators to renounce illegal behavior, it could worsen the problem of repressing those who still find illegal behavior worthwhile. Nevertheless, as we have shown in Section 5, it is not self-evident that the probability of detection eventually decreases; there are also cases where the opposite occurs, and either the greater cost for the principal and the reduced agent care in concealing the wrongdoing may favor law enforcement. This case occurs, in our specific model, when enforcement policy is characterized by high values of either sanctions or probability of detection[17]. Thus, under a “strong” enforcement policy, the shift of the responsibility upon the agent is beneficial, although it could fail – and even produce adverse effects - if it is considered as a remedy for a too weak public intervention. These results also suggest some *caveat* about policies that increase the agent liability as a substitute for tighter enforcement parameters[18].

The agent liability may in fact be the most effective regime in securing

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[17] Other favorable conditions are a high agent absolute risk aversion or reservation utility.

[18] As an example of this kind of policy, one may quote Decree number 472, December 18, 1997, issued by the Italian Government, which reduces monetary sanctions for tax evasion, while increasing the agent (i.e. corporate executives, tax practioners etc.) liability.

compliance, but specific conditions must be met, as the theoretical analysis has shown.

The framework presented in this paper can also be used to rationalize different cases from the one examined here. For example, it could be applied to strict tort liability for damages, provided that the assumptions about prohibitive transaction costs hold, and effort in hiding is reinterpreted as effort in avoiding harm. While in this case increases in the agent effort would be potentially advantageous for social welfare, the main conclusions, about the consequences on remuneration and effort of transferring liability from the principal upon the agent, would still carry on.

## Appendix

**Proposition 4** *The solutions of systems of equations (8) and (9) are:*

$$x_1 = \ln\left\{\frac{\alpha\gamma S}{2\beta}\left[\sqrt{\beta^2 + \frac{4\beta}{\alpha\gamma S}(1-u_0+\beta)} - \beta\right]\right\}, \tag{12}$$

$$r_1 = -\frac{1}{\alpha}\ln\left\{\frac{\alpha\gamma S}{2\beta}\left[\sqrt{\beta^2 + \frac{4\beta}{\alpha\gamma S}(1-u_0+\beta)} - \beta\right]^2\right\}, \tag{13}$$

$$x_2 = \ln\left\{\frac{\gamma(e^{\alpha S}-1)}{\beta}\left[\sqrt{\beta^2 + \frac{\beta}{\gamma(e^{\alpha S}-1)}(1-u_0+\beta)} - \beta\right]\right\}, \tag{14}$$

$$r_2 = -\frac{1}{\alpha}\ln\left\{\frac{\gamma(e^{\alpha S}-1)}{\beta}\left[\sqrt{\beta^2 + \frac{\beta}{\gamma(e^{\alpha S}-1)}(1-u_0+\beta)} - \beta\right]^2\right\}. \tag{15}$$

*Moreover, if*

$$\beta < \frac{\gamma(e^{\alpha S}-1)}{1+\gamma(e^{\alpha S}-1)}(1-u_0), \tag{16}$$

*then both $x_1$ and $x_2$ are strictly positive.*

**Proof:** The optimal solutions $(x_1, r_1)$ and $(x_2, r_2)$ are obtained by solving systems (8) and (9) directly. Condition (16) on positivity of the efforts follows from setting the arguments of the logs in (12) and (14) to be larger than one. The former leads to $\beta < (1-u_0)\alpha\gamma S$ and the latter to $\beta < \frac{\gamma(e^{\alpha S}-1)}{1+\gamma(e^{\alpha S}-1)}(1-u_0)$; the second prevails since $\frac{\gamma(e^{\alpha S}-1)}{1+\gamma(e^{\alpha S}-1)}(1-u_0) < (1-u_0)\alpha\gamma S$ boils down to $e^{aS} - 1 < \alpha S e^{\alpha S}$, which is always true.

**Proof of Proposition 2:** To establish monotonicity of function *f* defined in (10) with respect to $\gamma$, we study the sign of its partial derivative:

$$D_\gamma f(\beta,\gamma,\delta,u_0) = \frac{2\beta\gamma^{-2}(1-u_0+\beta)}{\delta\left[\sqrt{\beta^2+\frac{4\beta}{\gamma\delta}(1-u_0+\beta)}-\beta\right]\sqrt{\beta^2+\frac{4\beta}{\gamma\delta}(1-u_0+\beta)}}$$
$$-\frac{\beta\left[2(e^\delta-1)\gamma^2\right]^{-1}(1-u_0+\beta)}{\left[\sqrt{\beta^2+\frac{\beta}{\gamma(e^\delta-1)}(1-u_0+\beta)}-\beta\right]\sqrt{\beta^2+\frac{\beta}{\gamma(e^\delta-1)}(1-u_0+\beta)}}.$$

To prove that, under the assumptions of the exponential model, the expression on the right is always negative, we eliminate (strictly) positive common factors and rearrange terms, obtaining the following inequality:

$$4(e^\delta-1)\sqrt{1+\frac{(1-u_0+\beta)}{\beta\gamma(e^\delta-1)}}-\delta\sqrt{1+\frac{4(1-u_0+\beta)}{\beta\gamma\delta}}-4(e^\delta-1)+\delta>0\,. \qquad (17)$$

Unfortunately such inequality does not allow for direct algebraic treatment, thus we must rely on a graphic solution. In order to transform the term on the left in a

function of only two variables, let

$$k = \frac{1 - u_0 + \beta}{\beta\gamma}.$$

Note that *k* must be larger than one, since, as $\beta > 0$, $0 < \gamma < 1$ and $0 < u_0 < 1$,

$$k = \frac{1 - u_0 + \beta}{\beta\gamma} > \frac{1 - u_0 + \beta}{\beta} > 1 + \frac{1 - u_0}{\beta} > 1.$$

Consider the function $g(\delta, k)$ defined as

$$g(\delta, k) = 4(e^{\delta} - 1)\sqrt{1 + \frac{k}{(e^{\delta} - 1)}} - \delta\sqrt{1 + \frac{4k}{\delta}} - 4(e^{\delta} - 1) + \delta.$$

By plotting the graphic of *g* for $\delta > 0$ and $k > 1$, it turns out that function *g* is always positive, that is inequality (17) holds under our assumption and this completes the first part of the proposition.

The second part follows immediately by noticing that strict monotonicity of the function *f* with respect to γ implies that for each triplet $\beta, \delta, u_0$ there exists at most one γ* such that $f(\beta, \gamma, \delta, u_0) = 0$. The value of the threshold γ* reported in (11) is obtained directly through algebraic manipulation on the right side of (10) set equal to zero.

**Proof of Proposition 3:** A direct computation of the partial derivatives of $\gamma^*(\beta, \delta, u_0)$ gives the following:

$$D_\beta \gamma^*(\beta,\delta,u_0) = \frac{1}{\beta}\left[1-\frac{1}{\beta}(1-u_0+\beta)\right]\frac{\left(e^\delta-1-\delta\right)^2}{\delta\left(2e^\delta-2-\delta\right)\left(e^\delta-1\right)},$$

$$D_\delta \gamma^*(\beta,\delta,u_0) = \frac{1}{\beta}(1-u_0+\beta)\frac{e^\delta-1-\delta}{\delta\left(2e^\delta-2-\delta\right)}\left[2-\frac{e^\delta-1-\delta}{\delta\left(e^\delta-1\right)}\right.$$

$$\left.-\frac{\left(e^\delta-1-\delta\right)\left(2e^\delta-1\right)}{\left(2e^\delta-2-\delta\right)\left(e^\delta-1\right)}-\frac{\left(e^\delta-1-\delta\right)e^\delta}{\left(e^\delta-1\right)^2}\right],$$

$$D_{u_0} \gamma^*(\beta,\delta,u_0) = -\frac{1}{\beta}\frac{\left(e^\delta-1-\delta\right)^2}{\delta\left(2e^\delta-2-\delta\right)\left(e^\delta-1\right)}.$$

The sign of the first line clearly depends on the sign of $1-\beta^{-1}(1-u_0+\beta)$, since the fraction on the right is always positive, and it is immediately seen that this is negative as, by our assumptions and by condition (16), both $\beta<1$ and $u_0<1$. The sign of the second derivative depends on the sign of the expression into squared brackets; again it is not possible to study its sign by direct analysis, thus we need to rely on graphic inspection, which confirms the statement in the proposition. Finally, the sign of the partial derivative of $\gamma^*$ with respect to $u_0$ is clearly always negative.

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