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Firm's Tax Evasion in a Principal-Agent Model with Self-Protection

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Abstract

Gatekeepers have an increasing role in taxation and regulation. Whereas burdening them with legal liability for misconducts that benefit those who resort to their services actually discourages wrongdoings – as will be clarified in the article – an alienation effect can also arise. The gatekeeper might become more interested in covering up the illegal behavior. This article studies the problem with respect to tax evasion by firms in a principal-agent framework. The article highlights the role of legal rules pertaining to liability for tax evasion in shaping the parties choices, as concealment costs vary according to whether the risk-neutral principal or the risk-averse agent are held responsible when tax evasion is detected. The main result of the analysis is that there is a simple *ex post* test that can be run to infer whether harnessing the agent was socially beneficial.

Keywords: tax evasion, firm, agency, risk aversion
JEL classification: H26, H32, D81, K42

1 Introduction

There is by now a large positive and normative literature available on tax evasion – dealt at the levels of either individuals or firms (for an assessment by a founder of this literature, see Sandmo, 2005). But not too many papers deal with the role of gatekeepers,[1] like a lawyer or a tax manager, without whose presence and active support, it may not be possible to evade tax, whatever the underlying causes are. The efficacy of tax enforcement can thus vary according to the extent of the gatekeeper's liability vis-à-vis that of the evader.

In case of firms' tax evasion most models[2] internalize a costly concealment technology, which, however, is not specifically described. A significant concealment cost can instead be studied within a principal-agent framework, as one can focus upon the compensation and the incentives needed for securing the cooperation of tax officers, employees, consultants,[3] experts

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[1] According to Kraakman (1986), p. 53, gatekeepers are "private parties who are able to disrupt misconduct by withholding their cooperation from wrongdoers". For an analysis of gatekeepers liability see Hamdani (2003).

[2] For a survey, see Cowell, 2004.

[3] On the role of consultancy firms see Lipatov (2005) who resorts to a game-theoretic approach.

etc. An important role that these subjects can play, in exchange for remuneration, is that of exerting effort in order to reduce the probability of audit. This can be done, *e.g.*, by suitably blurring the signals of misconduct that usually trigger the intervention of the tax officials, thus helping the entrepreneur avoid the more standard hiding techniques and design new schemes for evasion.

The agency problem of the evading firm has been studied by Chen and Chu (2005) and Crocker and Slemrod (2005). Both papers focus on problems of asymmetry of information. Chen and Chu (2005) consider the relationship between a firm's owner and a risk-averse agent who is hired for productive purposes. If only the risk neutral principal is legally liable, no efficiency problem arises. If, however, also the agent is liable, the principal must pay her an *ex ante* compensation for the risk, as insuring the agent against sanctions is not legally permissible. Thus the agent's salary can differ from the one needed to provide the proper incentives for production, and a loss of control on the agent might arise. The authors, however, do not discuss the effects of changes in the liability regime.

Crocker and Slemrod (2005) assume that both the shareholders (the principal) and the manager (the agent) are risk neutral. They show that sanctioning the agent is always more effective than sanctioning the principal, because in the latter case the effect is only indirect – through contractual incentives[4] upon the agent – and is weakened by the second best nature of the agency contract. An implication of the Crocker and Slemrod's model that is problematic is that the agent's remuneration drops to zero (or to a lump sum if the reservation utility is larger than zero) as long as only the principal is liable, since in this case the agent can costlessly disclose the information she possesses. In the real world, however, firms are likely to provide incentives even in this case to the agent in order to induce her to actively use her information and skills in dealing with the specific firm's case. This suggests that an approach addressing the problem of the agent's effort and remuneration would be more realistic.

A second stream of literature to which this article aims at contributing is that on self-protection (the terminology was invented by Ehrlich and Becker, 1972), *i.e.*, an activity that reduces the probability of occurrence of a bad outcome at a given cost (Sévi and Yafil, 2005). The effort performed by the agent in the model presented in this article is actually aimed at producing self-protection.[5] It is now well-established that an increase in risk-aversion does not necessarily lead to higher self-protection expenditures (Ehrlich and Becker, 1972; Sweeney and Beard, 1992; Chiu, 2000). This is so because, as observed by Briys and Schlesinger (1990), expenditure on self-protection reduces the income in all states and therefore does not necessarily lead to less risky income prospects.

An agency model with self-protection has been studied by Privileggi et al. (2001), who consider an (all or nothing) illegal activity that benefits the principal. The resort to self-protection – in addition to self-insurance – by a risk-averse evading taxpayer has also been studied by Lee (2001), who finds that – unlike in the standard model – under given assumptions, the reported income is decreasing in the tax rate.

In this article we present a principal-agent model in which an agent is hired by an entrepreneur to exert effort in covering tax evasion. We allow the legal regime to span from exclusive liability of the principal to that of the agent, including the intermediate cases of shared liability. When liability is shifted – either fully or partially – from the principal to the agent, the latter

[4] The link between managerial compensation and aggressive tax planning has also been studied in a big way in empirical literature, focussing mainly on costly but risk-free tax avoidance. See, *e.g.*, Deasi and Dharmapala (2006).

[5] As long as the agent is liable she protects herself. Also with reference to the liable principal one may speak of self-protection because the principal expends resources to pay the agent in order to reduce the probability of the bad outcome.

might be pushed to exert a higher effort in covering it and thus the likelihood of detection might decrease. Hence there is a problem of "excessive loyalty" of the agent with respect to the principal, often discussed in the psychological literature. Whereas the economic literature on agency has mainly focussed on the opposite problem – *i.e.*, the agent's opportunistic behavior – in a more general perspective it is interesting also to apply the economic analysis to the non-optimal loyalty problem in all its forms (see, *e.g.*, Morck, 2009).

The article bridges some gaps in the previous literature, on the one hand by focussing on the specific contribution to tax evasion provided by agents in terms of effort (and not of information as in Crocker and Slemrod, 2005), while on the other by directly addressing the role of gatekeepers (and not of productive agents, as in Chen and Chu, 2005). We also allow for different attitudes toward risk of the parties, and include a full description of the firm's tax evasion problem, in which evasion is a continuous variable (whereas the wrongdoing's benefit was discrete in Privileggi et al., 2001).

Our results provide relevant indications about the relationship between the agent's remuneration and the legal incentives in a risky environment. Whereas the standard hint coming from the available literature is that the agent's remuneration is increasing in her liability (see, *e.g.*, Hamdani, 2003, and, with reference to marginal bonuses, Crocker and Slemrod, 2005), we show that there are cases in which her compensation decreases in response to an expansion of her liability.

Our main result is that whenever *ex post* it is observed that the agent's compensation is lower in the (full or partial) agent's liability than in the principal's, then both evasion and effort must be lower as well. Hence, a simple *ex post* test can be run in order to ascertain the effectiveness of a reform that harnesses gatekeepers with legal liability. If a fall of their income arises, the reform is working in the right direction. As relevant information about compensations can be gathered from standard data sources,[6] such test about the effectiveness of the liability shift can be designed.[7]

The article is organized as follows: in Section 2 the model is presented. Section 3 examines the implications of liability shifts from the principal to the agent. Section 4 concludes. All technicalities regarding the non-trivial constrained maximization techniques used in the text and the computation of the numeric examples are available in the Appendix of Biswas et al. (2009), the working paper version of this article.

2 The model

We assume as usual that the principal is risk neutral and the agent is risk-averse.[8] Moreover, the principal cannot pursue her evasion design without securing the agent's cooperation, either for technical or legal reasons, as, *e.g.*, only the agent possesses the needed expertise or has the signatory authority for the needed documents. A problem that arises when the principal aims at eliciting the agent's cooperation in cheating taxes is that the contract has an illicit content and thus is not legally enforceable. If, however, the parties have a long lasting relationship it seems plausible that they can trust each other and can conclude and honor a contract in which

[6] Cfr.,*e.g.*, the data on managerial compensation and incentives reported in the Standard and Poor's Compustat ExecuComp database. The applied literature in this field also relies on surveys and on IRS data about audited firms (see, *e.g.*, Rego and Wilson, 2011).

[7] Of course this is a *ceteris paribus* prediction and thus other factors that might explain income changes should be controlled for.

[8] This standard assumption hinges upon the idea that the principal has larger opportunities for risk diversification than the agent, whose assets are mainly represented by her specialized skills.

the agent performs the effort in covering up and the principal pays a remuneration that includes *ex ante* a risk premium. Trust might be based on repeated interactions, that would arise if, *e.g.*, the agent is an employee or a consultant with a strong link with the enterprise. Moreover, it is more likely if the principal knows the agent's preferences and can observe the agent's effort. It is interesting now to note how full information plays a crucial role in the model that we set up in this context. Trust is less plausible if information is imperfect. Moreover, full information of both parties can sustain all liability assignments independently of the specific legal definition of the tax evasion wrongdoing. That is, if the principal's information is imperfect, this might give her a chance to distance herself, *e.g.*., from the accusation of tax fraud, alleging that on her part there was just ignorance or mistake.[9] Thus, in this section and for most of the paper we focus upon the case of full information[10]. An extension to the case of asymmetrical information is briefly presented in Subsection 3.4.

In order to study the effects of various liability assignments, let us assume that in case of audit the principal has to pay the due tax and bears a share $0 \leq \lambda \leq 1$ of sanctions, whereas the agent has to pay the remaining share $(1-\lambda)$. Hence, full principal's liability arises when $\lambda = 1$, full agent's liability when $\lambda = 0$, while intermediate λ values refer to shared liability.

The principal's problem then is:

$$\max \{[1 - p(x)(1 + \lambda s)] tE - r\}$$
$$\text{s.t.} \begin{cases} [1 - p(x)] u(r) + p(x) u[r - (1-\lambda) stE] - g(x) \geq u_0 \\ E \leq Y \\ x \geq 0, \; r \geq 0, \; E \geq 0. \end{cases} \tag{1}$$

where x is the agent's effort in covering up, $p : \mathbb{R}_+ \to [0,1]$ denotes the probability of audit as a function of the agent's effort x, $s > 0$ is the sanction rate, $0 < t < 1$ is the tax rate, $Y > 0$ denotes the principal's income, $E \leq Y$ is the evaded amount, r is the agent's remuneration, $u : \mathbb{R} \to \mathbb{R}$ is the agent's utility function, u_0 is her reservation utility, while $g : \mathbb{R}_+ \to \mathbb{R}_+$ denotes the cost of effort x borne by the agent. Y is assumed to be exogenous.[11] The first constraint allows for the agent's participation.

In order to problem (1) be viable, evasion must be profitable, that is,

$$[1 - p(x)(1 + \lambda s)] tE - r > 0 \tag{2}$$

must hold. As $r \geq 0$, from (2) immediately follows that necessarily $E > 0$ must hold, so that the last inequality constraint in (1) can be dropped.

A. 1 *In the following we shall assume:*

i) $u'(w) > 0$ *and* $u''(w) < 0$*, for all* $w \in \mathbb{R}$*,*

ii) $0 < p(x) < 1$*,* $p'(x) < 0$ *and* $p''(x) > 0$ *for all* $x \geq 0$*,*

[9] The agent instead is informed by definition as long as she expends effort in cheating. But it is equally true that the law might exclude her legal responsibility on the ground that she is the weaker party in a capital-labour relationship or she may not have a deep pocket or she does not directly benefit from evasion.

[10] While the agency model is routinely associated with the idea of asymmetrical information, the original formulation of the problem includes also the full information case (see, *e.g.*, some classical papers such as Shavell, 1979, pp.55-56 and Arrow, 1985, p. 37). We interpret the term agency here without any moral hazard component. In other words, it is a benchmark case of agency where the principal has full information.

[11] In order to ensure that the agent has a pocket deep enough for sustaining her liability, one might assume that she too has an exogenous income – coming, *e.g.*, from a legal activity. Because the inclusion of such constant term is immaterial with respect to our theoretical results, for simplicity we have dropped it.

iii) $g'(x) > 0$ *and* $g''(x) \geq 0$ *for all* $x > 0$,

iv) $u(0) \leq u_0$, $g(0) = 0$, $g'_+(0) = 0$.

Assumption A.1(iv) is a technical condition which, joint with the feasibility assumption in (2), is sufficient to rule out corner solutions[12] in problem (1).

The agent's compensation must be larger than her expected sanction, as stated in the following Lemma.

Lemma 1 *Under Assumption A.1 and condition (2) the risk-averse agent must receive a salary larger than her expected liability, and evasion must have an overall positive expected return. Specifically:*

$$r > p(x)(1-\lambda)stE \qquad \text{for all } x \geq 0 \text{ and } E \leq Y \tag{3}$$

$$1 - p(x)(1+s) > 0 \qquad \text{for all } x \geq 0. \tag{4}$$

Proof. To establish (3) assume the contrary: $r \leq p(x)(1-\lambda)stE$. Hence,

$$\begin{aligned}[1-p(x)]u(r) + p(x)u[r-(1-\lambda)stE] - g(x) &< u[r - p(x)(1-\lambda)stE] - g(x) \\ &\leq u(0) - g(x) \\ &\leq u_0,\end{aligned}$$

where the first inequality follows from strict concavity of $u(\cdot)$, the second inequality from monotonicity of $u(\cdot)$ joint with the contradiction $r \leq p(x)(1-\lambda)stE$ and the last inequality from Assumptions A.1 (iii) and (iv). Therefore, the agent's participation constraint – the first inequality in (1) – implies (3).

Joining (2) and (3) easily yields (4). ■

The agent's expected utility,

$$\mathbb{E}U(x,r,E) = [1-p(x)]u(r) + p(x)u[r-(1-\lambda)stE] - g(x),$$

is concave in each relevant variable, E, r and x, taken alone, but concavity jointly in all three variables could lack because of cross-effects. In the Appendix 6.A of Biswas et al. (2009) sufficient conditions for assuring quasiconcavity of $\mathbb{E}U$ – and thus convexity of the constraint – are put forth and discussed. Convexity of the constraint in problem (1) implies that for every given evasion and effort combination, there is just one compensation r representing the minimal cost the principal has to bear for implementing such combination without violating the agent's participation constraint. Large families of functions, such as, *e.g.*., HARA (Hyperbolic Absolute Risk Aversion) utility functions, hyperbolic probability functions and quadratic effort cost, satisfy these conditions.

Proposition 1 *Under Assumption A.1 a solution* (x^*, r^*, E^*) *for problem (1) is completely characterized by the following necessary K.T. conditions:*

$$[1-p(x^*)]u(r^*) + p(x^*)u[r^*-(1-\lambda)stE^*] - g(x^*) = u_0 \tag{5}$$

$$\begin{gathered}-p'(x^*)\{(1+\lambda s)tE^*[(1-p(x^*))u'(r^*) + p(x^*)u'(r^*-(1-\lambda)stE^*)] \\ +u(r^*) - u[r^*-(1-\lambda)stE^*]\} = g'(x^*)\end{gathered} \tag{6}$$

$$\frac{[1-p(x^*)]u'(r^*)}{p(x^*)u'[r^*-(1-\lambda)stE^*]} \geq \frac{(1-\lambda)s}{1-p(x^*)(1+\lambda s)} - 1. \tag{7}$$

[12] Actually, Assumption A.1(iv) is not strictly needed and in specific examples the condition that $g'_+(0) = 0$ may be dropped whereas interiority of solution can be obtained directly through a suitable choice of parameters' values.

The proof of Proposition 1 is based on standard tedious computations and thus it is omitted.

Condition (6) pertaining to effort combines elements relevant for the principal – the agent's marginal utility of income in the two states of the world, that drives the monetary remuneration – and elements relevant for the agent – the difference between the utility levels in the two states of the world, which provides the personal motivation for exerting effort. Condition (7) pertaining to the tax evasion amount holds as a strict inequality when the second constraint, $E \leq Y$ in (1), is binding, *i.e.*, when $E^* = Y$.

One can interpret tax evasion as a choice of a risk-averse agent, as the LHS in (7) has the standard form it takes in individual tax evasion problems. Relative prices, however, are distorted. That is, now the slope in absolute value of the budget constraint facing the agent – the RHS of (7) – is lower than in a standard evasion problem (where it would be equal to s) because the agent is only partially liable for sanctions and does not have to pay the tax on the evaded amount.[13]

As long as $\lambda = 1$ – *i.e.*, only the principal is liable – problem (1) highly simplifies. Calling (x_P^*, r_P^*, E_P^*) the solution in this case, one gets the following necessary and sufficient conditions:

$$E_P^* = Y, \tag{8}$$

$$u(r_P^*) - g(x_P^*) = u_0, \tag{9}$$

$$-p'(x_P^*)(1+s)\,tY = \frac{g'(x_P^*)}{u'(r_P^*)}. \tag{10}$$

Condition (8) states that, at the optimum, the whole income Y will be hidden, whereas conditions (9) and (10) say respectively that the agent must receive her reservation utility[14] and that the marginal benefit of effort for the principal, in terms of reduction of the expected sanctions, $-p'(x_P^*)(1+s)\,tY$, must equal the marginal rate of substitution between effort and compensation, $g'(x_P^*)/u'(r_P^*)$, for the agent.

The agent's risk-aversion plays a decisive role in explaining why results differ under shared liability and under exclusive principal's liability. If the agent were risk neutral, a corner solution with full evasion – *i.e.*, $E^* = Y$ – would arise also under shared liability because in this case the LHS in (7) becomes $[1-p(x^*)]/p(x^*)$ and it is straightforward to show that condition (4) implies

$$\frac{1-p(x^*)}{p(x^*)} > \frac{(1-\lambda)s}{1-p(x^*)(1+\lambda s)} - 1 \qquad \text{for all } 0 \leq \lambda < 1.$$

Moreover, condition (6) boils down to (10). Hence, with a risk neutral agent, the same tax evasion and effort would arise independently of the liability assignment, whereas the agent's salary would be larger under shared liability by a share $1-\lambda$ of the expected amount of sanctions.

3 The consequences of a liability shift

If the legal regime is changed from full liability of the principal to shared or full agent's liability, what are the consequences on effort?

[13] Even assuming a full shift of liability for sanctions onto the agent, when $\lambda = 0$, condition (4) implies that the RHS in (7) satisfies $s/[1-p(x^*)] - 1 < s$. In other words, the absolute value of the slope of the agent's budget constraint is smaller than s, as tax evasion must have positive expected total rate of return.

[14] The agent that cooperates in tax cheating without any personal risk might threaten the principal of disclosing the wrongdoingand and demand more than her reservation utility. We assume that the relationship based on trust between the parties is strong enough to exclude this possibility.

As under Assumption A.1 $-g'(x)/p'(x)$ is increasing in effort x, by comparing the FOCs for effort (6) and (10), it turns out that an effort smaller than under the exclusive principal's liability occurs if and only if

$$\begin{aligned}(1+\lambda s)\,tE^*\left\{[1-p(x^*)]\,u'(r^*)+p(x^*)\,u'[r^*-(1-\lambda)\,stE^*]\right\} \\ +u(r^*)-u[r^*-(1-\lambda)\,stE^*]\leq u'(r^*_P)\,(1+s)\,tY\end{aligned} \tag{11}$$

where the subscript P characterizes the case of full principal's liability. Because in the LHS the choice can be traced back to a risk-averse agent,[15] whereas in the RHS to a risk neutral one, the well-known problem of self-protection is at stake; that is, in general one cannot say whether inequality (11) will be satisfied or not (see Privileggi et al., 2001). Hence, the only possible hint is that, whenever $E^*\to 0$, then the LHS $\to 0$ as well and thus a smaller effort will occur under shared liability. One can thus guess that, as long as the agent's risk-aversion induces the choice of a small evasion level, at the limit this will also drive the effort downwards. This fact suggests the idea that the evasion level influences the amount of effort performed in the diverse liability regimes. In the following subsections this idea is checked within a more general scenario; as a matter of fact, besides the limit relationship between evasion level and effort performed just considered, we shall establish a sufficient condition linking the decrease of both evasion level and effort to the decrease of optimal remuneration.

3.1 Effects on the principal's profit

When liability is partially or fully shifted from the principal to the agent, the latter might be pushed to exert a larger effort, thus giving rise to positive externalities for the principal. On the other hand, both effort and the residual risk command a compensation. The combined effect on the principal's profit is described in Proposition 2.

Proposition 2 *Ceteris paribus, the principal profit is maximal when she is fully liable, and is decreasing in the agent's liability share.*[16]

Proof. Differentiating the Lagrangian L of problem (1) with respect to r and noting that, as $r^*>0$, the Lagrange multiplier of the fourth constraint is zero, one gets:

$$-1+\mu\left\{[1-p(x^*)]\,u'(r^*)+p(x^*)\,u'[r^*-(1-\lambda)\,stE^*]\right\}=0$$

where μ is the Lagrange multiplier of the agent's participation constraint – the first constraint in (1). Hence:

$$\mu=\frac{1}{[1-p(x^*)]\,u'(r^*)+p(x^*)\,u'[r^*-(1-\lambda)\,stE^*]}.$$

By the envelope theorem,

$$\begin{aligned}\frac{\partial L}{\partial\lambda}&=-p(x^*)\,stE^*+\mu p(x^*)\,u'[r^*-(1-\lambda)\,stE^*]\,stE^*\\&=-p(x^*)\,stE^*\left\{1-\mu u'[r^*-(1-\lambda)\,stE^*]\right\}\\&=-p(x^*)\,stE^*\left\{1-\frac{u'[r^*-(1-\lambda)\,stE^*]}{[1-p(x^*)]\,u'(r^*)+p(x^*)\,u'[r^*-(1-\lambda)\,stE^*]}\right\}.\end{aligned}$$

[15] Remember the similarity with a standard evasion choice under a distorted budget constraint.

[16] We are indebted to an anonymous referee for suggesting this approach as an alternative to our original weaker result.

If $\lambda < 1$, then $u'(r) < u'[r - (1-\lambda)stE]$, and thus $\partial L/\partial\lambda > 0$; if $\lambda > 1$, then $\partial L/\partial\lambda < 0$, while if $\lambda = 1$, then $\partial L/\partial\lambda = 0$. Therefore, the principal's profit is maximal when she has full liability, $\lambda = 1$, while it is decreasing in λ as long as $\lambda > 1$.[17] ■

Proposition 2 extends Proposition 2 in Privileggi et al. (2001) to the case of a continuous wrongdoing. The intuition about this result is that under full liability of the principal the whole risk si allocated to the risk-neutral party, which is the one more able at bearing it. As the principal chooses the effort level, she does not need to put the agent at risk to provide incentives, as happens in models with asymmetrical information.[18]

The marginal cost of tax evasion, however, might be lower under shared liability.[19] Moreover, even if in response to a liability shift a lower tax evasion is chosen, the expected tax revenue,

$$G(E,x) = tY - tE[1 - p(x)(1+s)], \tag{12}$$

does not necessarily increase, because also the expected sanctions must be accounted for. Thus, one cannot *a priori* exclude that $G(E,x)$ decreases even if there is more tax compliance, because the countervailing effect of an x increase might be stronger.

3.2 A simple test

Let us focus upon the potentially favorable case in which the principal's response to the liability shift, which negatively impacts her profit, leads to a smaller tax evasion. More specifically, we consider a bold cut, so large that actually a reduction of the agent's compensation ensues. Recall that a subscript 'P' indicates the optimal solution (x_P^*, r_P^*, E_P^*) of (1) when liability is fully borne by the principal, while (x^*, r^*, E^*) denotes the optimal solution when liability is shared with the agent.

Proposition 3 *If it is observed that $r^* \leq r_P^*$, then both $x^* < x_P^*$ and $E^* < E_P^* = Y$ must hold.*

Proof. From (9) we get

$$r_P^* = u^{-1}[u_0 + g(x_P^*)], \tag{13}$$

where $u^{-1}(\cdot)$ denotes the (strictly increasing and strictly convex) inverse function of $u(\cdot)$. Strict concavity of $u(\cdot)$ and condition (5) imply:

$$\begin{aligned} u[r^* - p(x^*)(1-\lambda)stE^*] &> [1 - p(x^*)]u(r^*) + p(x^*)u[r^* - (1-\lambda)stE^*] \\ &= u_0 + g(x^*), \end{aligned}$$

which, again using $u^{-1}(\cdot)$, itself yields:

$$r^* > u^{-1}[u_0 + g(x_P^*)] + p(x^*)(1-\lambda)stE^* > u^{-1}[u_0 + g(x^*)]. \tag{14}$$

Under the assumption $r^* \leq r_P^*$ (13) and (14) lead to

$$u^{-1}[u_0 + g(x^*)] < r^* \leq r_P^* = u^{-1}[u_0 + g(x_P^*)],$$

which, as both $u^{-1}(\cdot)$ and $g(\cdot)$ are strictly increasing, immediately yields $x^* < x_P^*$, and the first part of the Proposition is established.

[17] The case $\lambda > 1$ would imply an overshift of sanctions onto the agent and is not relevant in practice.
[18] On this case see Subsection 3.4.
[19] We thank Sam Bukovetsky for raising this point.

To show that $E^* < E_P^* = Y$ holds as well, note that $-g'(x)/p'(x)$ is increasing in effort x, so that $x^* < x_P^*$ implies $-g'(x^*)/p'(x^*) < -g'(x_P^*)/p'(x_P^*)$, and thus conditions (6) and (10), in turn, imply

$$(1+\lambda s)\,tE^*\left[(1-p(x^*))\,u'(r^*)+p(x^*)\,u'(r^*-(1-\lambda)\,stE^*)\right]+u(r^*)-u\left[r^*-(1-\lambda)\,stE^*\right] < (1+s)\,tYu'(r_P^*)\,. \tag{15}$$

By strict concavity of $u(\cdot)$, both

$$u'\left[r^*-(1-\lambda)\,stE^*\right] > u'(r^*)$$

and (superdifferentiability property)

$$u(r^*)-u\left[r^*-(1-\lambda)\,stE^*\right] > (1-\lambda)\,stE^*u'(r^*)\,,$$

hold. Substituting the last two inequalities in (15) and rearranging terms yields

$$\begin{aligned}(1+s)\,tYu'(r_P^*) &> (1+\lambda s)\,tE^*u'(r^*)+(1-\lambda)\,stE^*u'(r^*)\\ &= (1+s)\,tE^*u'(r^*)\\ &\geq (1+s)\,tE^*u'(r_P^*)\,,\end{aligned}$$

where in the last inequality we used the assumption $r^* \leq r_P^*$ and again concavity of $u(\cdot)$. Simplifying common (positive) terms in both sides yields $Y > E^*$, as was to be shown. ■

The proof of Proposition 3 resorts to a revealed preferences approach. The intuition is that if a compensation decrease is observed after the liability shift, effort must also be lower, since now such compensation not only pays for the effort but it must also include an ex-ante premium for the risk. Moreover, the choice for a smaller effort implies that its marginal cost drops and thus the effort marginal benefit must also be lower than beforehand. Since the agent's utility function is concave, the effort marginal benefit can be lower than under the full principal's liability only if the potential loss is actually smaller,[20] that is if tax evasion is lower as well.

Proposition 3 provides the basics for running *ex post* tests aimed at assessing if a liability shift was beneficial from a social point of view. If a (weak) decrease in the gains of the agent is observed, there is an unequivocal signal of the success of the policy because a decrease of both tax evasion and effort imply that Government revenue in (12) will increase. An increase in the agent's compensation, on the other hand, is not a signal in the opposite direction: one cannot infer what is going on in terms of tax evasion and effort without further information.

3.3 Examples

In order to build some tractable examples we shall use a CARA utility function, a hyperbolic probability function and a quadratic effort function, as specified below:

$$\begin{aligned}u(w) &= -e^{-\rho w}, \qquad \rho > 0\\ p(x) &= \frac{\alpha}{(\beta x+1)}, \qquad 0<\alpha<1,\ \beta>0\\ g(x) &= \zeta x^2, \qquad \zeta > 0.\end{aligned}$$

[20] Remember that effort benefits only the principal under full principal's liability, while it affects also the agent's utility under shared liability.

Whenever parameter ζ is chosen sufficiently large, such specification guarantees that the participation constraint in the maximization problem (1) is convex.[21] As can be seen in Appendix 6.C of Biswas et al.(2009) the model's specification above guarantees that the optimal solution (x^*, r^*, E^*) of problem (1) is unique, thus allowing for a meaningful comparison among scenarios characterized by different degrees of liability borne by the agent – spanning from the case in which only the principal is liable to the opposite case in which the agent bears full liability.

We shall fix all the parameters' values except for the sanction rate s and the coefficient of absolute risk-aversion ρ. Specifically, we set $Y = 100$, $u_0 = -0.9$, $t = 0.4$, $\alpha = 0.1$, $\beta = 1$ and $\zeta = 0.556$ (see Example 1 in Appendix 6.A in Biswas et al., 2009 for the compatibility of these values with the convexity of the constraint). The cases of exclusive principal liability ($\lambda = 1$), exclusive agent's liability ($\lambda = 0$) and shared liability (with $\lambda = 0.5$) will be considered.

We shall investigate how the optimal solutions (x^*, r^*, E^*) characterized by conditions (5) – (7) of Proposition 1, together with the principal's net benefit π, change for different values of the absolute risk-aversion coefficient ρ and the sanction rate s. The results are computed with the support of Maple 13 (see Appendix 6.C in Biswas et al., 2009). Table 1 reports the results for $s = 2.1$ whereas either $\rho = 10$ or $\rho = 0.5$. Table 2 reports the results for $s = 1$ whereas again either $\rho = 10$ or $\rho = 0.5$.

Risk-aversion coefficient	Principal fully liable: $\lambda = 1$	Shared liability: $\lambda = 0.5$	Agent fully liable: $\lambda = 0$
$\rho = 10$	$x^*_P = 1.233$ $r^*_P = 0.290$ $E^*_P = 100$ $\pi_P = 34.158$	$x^* = 0.577$ $r^* = 0.225$ $E^* = 1.078$ $\pi = 0.150$	$x^* = 0.305$ $r^* = 0.073$ $E^* = 0.286$ $\pi = 0.032$
$\rho = 0.5$	$x^*_P = 0.839$ $r^*_P = 1.352$ $E^*_P = 100$ $\pi_P = 31.906$	$x^* = 0.577$ $r^* = 4.510$ $E^* = 21.570$ $\pi = 2.997$	$x^* = 0.305$ $r^* = 1.469$ $E^* = 5.715$ $\pi = 0.642$

Table 1: optimal solutions and principal's net benefit in three regimes (full principal's liability, equally shared liability and full agent's liability) when the sanction rate is $s = 2.1$ for risk-aversion coefficents $\rho = 10$ and $\rho = 0.5$.

Note that when the agent is fully or partially liable and the solutions are interior – *i.e.*, $0 < E^* < Y$ hold – the optimal efforts x^* turns out to be independent of the absolute risk-aversion coefficient ρ, as explained at the end of Appendix 6.C in Biswas et al. (2009). Intuition suggests the following explanation: because with CARA the desired amount of tax evasion does not depend on income, the latter can always be adjusted to accommodate the preferred effort while also securing the reservation utility. Hence the salary r^* and the evasion E^* change in response to changes in risk aversion, whereas effort does not. This property does not hold for corner solutions, *i.e.*, when $E^* = Y$.

Numerical examples confirm that a liability shift from the principal onto the agent can actually entail a reduction of the agent's remuneration, which in turn implies that both evasion and effort are smaller. This effect is more likely at high sanction and/or high risk aversion levels. The relevant sanction severity depends on both the rate s and the amount of risk shifted upon the agent. On the other hand, an increase in the agent's compensation may entail either

[21] See condition conditions (38), (42) of Remark 2, and (47) of Remark 4 in Appendix 6.A in Biswas et al. (2009).

Risk-aversion coefficient	Principal fully liable: $\lambda = 1$	Shared liability: $\lambda = 0.5$	Agent fully liable: $\lambda = 0$
$\rho = 10$	$x_P^* = 1.213$ $r_P^* = 0.249$ $E_P^* = 100$ $\pi_P = 36.136$	$x^* = 1.198$ $r^* = 19.918$ $E^* = 100$ $\pi = 17.352$	$x^* = 0.550$ $r^* = 0.311$ $E^* = 1.369$ $\pi = 0.202$
$\rho = 0.5$	$x_P^* = 0.729$ $r_P^* = 1.005$ $E_P^* = 100$ $\pi_P = 34.367$	$x^* = 0.774$ $r^* = 15.384$ $E^* = 100$ $\pi = 21.234$	$x^* = 0.550$ $r^* = 6.214$ $E^* = 27.385$ $\pi = 4.033$

Table 2: optimal solutions and principal's net benefit when the sanction rate is $s = 1$ in the three regimes again for risk-aversion coefficents $\rho = 10$ and $\rho = 0.5$.

a decrease in effort and evasion, as in the third column of the second row in table 2, or an increase in effort, as in the case of full evasion (corner solution) reported in the second column of the second row of Table 2. The latter case is more likely when the sanction is lower and/or the agent is less risk-averse.

3.4 Extension: the effects of a liability shift under asymmetrical information

In this subsection we briefly discuss the case in which the principal cannot observe the agent's effort. If trust between the parties is so strong that the principal can condition the agent's salary on the outcome, the consequences are straightforward: the principal can design a second best contract for the agent, and, according to the principal-agent model under moral hazard,[22] the standard result will arise; *i.e.*, the agent will receive a higher salary if cheating is not found out and a lower salary in the opposite case. In such a framework liability shifts provided for by the law have no effect, since any consequence can be corrected *via* modifications of the agent's compensation scheme. This case, however, seems too extreme, since the detection of the wrong-doing might disrupt the trust relationship between the parties and the principal can refuse to bail out the agent in the bad state of the world without bearing any legal consequence.

A more realistic case is when there is information asymmetry but no possibility of conditioning the agent's compensation on the outcome. If the principal is fully liable, she can hire the agent just to secure that she accepts renouncing her role as gatekeeper, with no effort aimed at reducing the probability of detection. The agent, in fact, being not liable, has no motivation for exerting effort, so the principal's problem reduces to:

$$\max_{r,E} \left\{ \left[1 - p(0)(1+s)\right] tE - \left[1 - p(0)\right] r \right\}$$
$$\text{s.t. } u(r) \geq u_0,$$

that is, the principal needs to give a compensation large enough to secure the agent's reservation utility. Hence the result will be full evasion and no effort as long as $\left[1 - p(0)(1+s)\right] tY - \left[1 - p(0)\right] u^{-1}(u_0) > 0$, and no evasion in the opposite case.

[22] Note that the so called first order approach can be applied to solve this problem, as the agent's utility is concave in x for given r and E, while with only two possible outcomes the first order stochastic dominance is implied by the fact that a larger effort entails a larger probability of success for the principal.

If liability is shared, the law actually provides incentives for the agent's effort, as pointed out by Shavell (1997). However, the agent will request an *ex-ante* compensation for the risk. In this framework, the principal's problem becomes:

$$\max_{r,E} \{[1 - p(x)(1 + \lambda s)] tE - r\}$$
$$\text{s.t.} \begin{cases} [1 - p(x)] u(r) + p(x) u[r - (1 - \lambda) stE] - g(x) = u_0 \\ -p'(x) \{u(r) - u[r - (1 - \lambda) stE]\} = g'(x), \end{cases}$$

where the second constraint represents the FOC for the agent's expected utility with respect to the effort x for r and E given.[23] That is, the principal recognizes that she is not able to motivate the agent to exert effort by providing incentives through the compensation scheme, and thus simply takes as given that the agent will choose the optimal effort from her point of view. Substituting the second constraint into the first one we get:

$$\max_{r,E} \{[1 - p(x)(1 + \lambda s)] tE - r\}$$
$$\text{s.t. } u(r) + p(x) \frac{g'(x)}{p'(x)} - g(x) = u_0$$

where x refers to the optimal effort from the agent's point of view. Since the profit function is linear in E, a variable that does not appear in the unique equality constraint above, either the return is positive and $E = Y$ or no evasion occurs.

Note also that the principal's profit can be larger under shared liability than under exclusive liability when information is asymmetrical. In fact the sanction share $(1 - \lambda)$ placed on the agent may imply a difference between the agent's net compensations in case of success and in case of failure that exactly implements a standard principal-agent contract under moral hazard, thus providing the best arrangement for the principal. Hence Proposition 2 cannot be extended to the case of asymmetric information.

Differentiating the agent's FOC's with respect to λ, one gets:

$$p'(x) u'[r - (1 - \lambda) stE] stE < 0$$

Because the second order condition implies a negative derivative of the FOC with respect to x, by the implicit function theorem $\partial x / \delta \lambda < 0$; *i.e.*, the agent exerts a larger effort the larger her liability share. This means that as long as tax evasion stays worthwhile[24], the larger the agent's liability share, the worse the result in terms of expected tax revenue for the state and the larger the agent's compensation. In the opposite case tax evasion is discontinued[25] and compensation drops to zero. Note that these results (even if extreme and thus not very realistic) stay within the provisions of Proposition 3 in the paper.

4 Conclusion

Tax evasion by firms is a very complicated phenomenon that can be understood only by tracing back its roots to the firm's internal organization which describes how the responsibilities and the

[23] Because, under our assumptions, the agent's expected utility is concave in x when r and E are held fixed, the FOC completely characterizes the unique solution of the agent's maximization problem.

[24] Evasion might even become worthwhile under shared liability while it was not under full principal's liability, as long as the incentives on the agent due to the liability shift benefit the principal.

[25] This might happen, e.g., if the liability shift is too large, thus implying inefficient and too costly incentives.

incentives are allocated and how they interact in producing the firm's behavior. The principal-agent model offers a natural framework for studying this problem. It also represents a very flexible framework in which different scenarios can be studied according to the assumptions made about the parties' attitudes toward risk, the information they possess and the type of activity that the agent is expected to do within the firm.

In this article we have studied the case in which the cooperation of a risk-averse agent (such as an employee or a consultant) is needed in order to evade taxes. Moreover, the agent can exert effort in order to reduce the ensuing risk. In this framework policies aimed at curbing tax evasion can target either the principal or the agent or both of them.

The immediate policy aspects of this article are as follows: when liability is shifted from the principal to the agent, a problem of excessive loyalty might arise, and the agent might be pushed to help the principal in concealing tax evasion. However, we are also able to show that there are win-win scenarios, in which both tax evasion and effort in covering decrease. A tough enforcement policy and an agent's high risk-aversion render these scenarios more likely. An indicator that the win-win case has arisen is a decrease in the agent's remuneration. Thus, a signal of success of policies that crack on tax officers, consultants and tax preparers, in order to moralize their conduct and to curb tax evasion, would be a shrinking of their remunerations and income share, *ceteris paribus*. Indirect signals might be represented by the shrinking of the share of the population involved in activities pertaining to tax preparation and in the share of students demanding education in this field, of course once again controlling for other possible explanatory factors.

One might in principle also consider going the other way round, *i.e.*, setting caps on the compensations for assistance to the taxpayers, in order to discourage risky cooperation with evaders. However, because the ceilings should not fall short of the remuneration level adequate for legally permissible assistance, the information needed to design them seem beyond the reach of the regulator. What is sometimes done,[26] and might be advisable to do to a larger extent, is setting penalties as an increasing function of the gatekeepers illegitimate gains, in order to cap at least the expected benefits that gatekeepers receive if they contribute to illegal activities.

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