Corporate Tax Evasion: the Case for Specialists

Lipatov, Vilen

European University Institute, Hannover University

May 2005

Corporate Tax Evasion: the Case for Specialists

Vilen Lipatov*

Frankfurt University, Grüneburgplatz 1, 60323 Germany

Email address: lipatov@em.uni-frankfurt.de

Tel: 069/ 798-34777 Fax: 069/ 798-35015

September 2009

Abstract

Economists agree that accounting specialists are helpful in avoiding taxes. We argue that such help can often be called *sophisticated* evasion. We analyze it in a game of incomplete information played by tax authority, corporate taxpayers and accounting specialist. When sophisticated evasion is very common, marginal changes in enforcement are not effective, so radical measures are needed for improving compliance. Fines on firms as opposed to specialists are more effective in facilitating such measures. When the evasion is modest, auditing and accounting costs as opposed to fines are more effective in curbing it.

JEL Classification: H26, H32

Keywords: tax evasion, tax avoidance, sophisticated evasion

1 Introduction

The literature usually draws a line between lawful underreporting of tax obligations, also known as *tax avoidance*, and illegal understatement, referred to as *tax evasion*[1].

*The paper is based on the second chapter of my doctoral thesis at European University Institute. I am thankful to Chaim Fershtman, Gregor Langus, Rick van der Ploeg, Ronny Razin and Karl Schlag for discussion, as well as participants in seminars at EUI, Universities of Amsterdam, Frankfurt, Hannover and EEA 2007 Meeting in Budapest.

[1] As stated, for example, in the survey by Andreoni et al. (1998)

In reality, though, it is virtually impossible to distinguish between the two. In this situation it makes sense to break down underreporting into simple and sophisticated rather than into evasion and avoidance. We define *simple tax evasion* as understatement that does not require special expertise (accounting or financial). Correspondingly, understatement of tax liability that requires such special knowledge will be called *sophisticated tax evasion*. It can be brought to existence by accounting firms that provide evasion among other services, which is the case in CIS countries. Alternatively, it can be done by auditing firms that have to approve corporate reports in the developed countries. The academic literature in this sphere is very scarce, so we have to refer mostly to anecdotal evidence and newspaper articles.

The corporate tax evasion, as opposed to individual, can hardly be simple. For one thing, corporations undergo regular (every three to five years in most countries) audits by the tax authorities. Thus, in order to hide simple evasion, a firm has to either not perform a transaction legally, facing the problems of contract enforcement and depriving itself from the benefits of legislation, or to officially close down before the corresponding check, rendering it impossible to gain reputation which is crucial for successful functioning in many markets.

This does not mean that the corporate world is perfectly compliant, and the most striking evidence comes from corporate scandals that keep "entertaining" us every year[2]. They become possible with sophisticated evasion which is hard to detect, as it requires counter-checking of many legal entities, some of which may be in a different tax jurisdiction (another city, state, country) or even liquidated by the time of audit.

There are no exact figures about any kind of tax evasion at our disposal. For the simple evasion, the shadow sector estimations presented, e.g. in Schneider (2006) are a good proxy. The sophisticated evasion is eluding such attempts, as it is reported and does look legal up to the moment the whole complicated arrangement is uncovered. Thus, what we can observe here are really big cases, the results of firm audits, and changes in the proportion of corporate tax revenues in total tax revenues. The latter, as noted by Slemrod (2004) for the US, has fallen from 6.4 percent of GDP in 1951 to less than 1.5 percent of GDP in the recent years. An indirect evidence for growing sophisticated evasion is provided by the fact that "America's largest and most profitable companies paid less in corporate income taxes in last three years,

[2]A recent example being perhaps the German tax scandal related to Liechtenstein as a tax haven, details available in *the Economist* (Feb 21, 2008), online at `http://www.economist.com/world/europe/displaystory.cfm?story_id=10733044`

even as they increased profits", as Browning (2004) states.

In CIS countries, the study by Movshovich (1999) shows that sophisticated evasion accounts for about 90% of all corporate tax evasion. Moreover, the famous scandal with Yukos has opened up a bit the mechanism of such evasion for the general public. In two words, the oil giant managed to reduce its corporate tax liability virtually to zero by shifting its operations on paper to a small republic within Russia and making special arrangements with the regional government. It is common knowledge that other Russian corporations were not far from Yukos in terms of tax arrangements, but avoided prosecution.

The corporate scandals are not a rarity in the more "civilized" countries, either. A broad collection of material about such scandals[3] is prepared by Roy Davies and includes Enron and Parmalat as probably most famous cases. An excellent collection of US corporations involved in scandals is due to Citizen Works[4].

The principle feature of the corporate scandals is that fictitious contracts are made to overstate performance of a company. This is used to boost benefits of chief executives and stock price, and tax fraud comes as a by-product of such efforts. Despite being a secondary goal, the tax evasion in these cases is very substantial and it is currently increasing, as anecdotal evidence suggests (Johnston 2003a,b).

Apart from the scandals, sophisticated evasion is represented by conventional tax shelters. The following examples of common in the US shelters may seem benign, but taken at a large scale are very detrimental to the social welfare[5]: (i) deferring taxes to later years; (ii) obtaining leverage through various financing arrangements; (iii) deducting prepaid interest; (iv) not including prepaid income.

How can the auditors help in sophisticated evasion[6]? First, they have to certify the tax reports for public corporations. This also means that the auditors are an essential part of sophisticated evasion schemes. Secondly, they may actually assist smaller corporations, providing tax consulting that may include evasion. That is why in our paper the key role is played by the accounting specialist, modelled as a local monopolist (alternatively, it can be a number of tacitly colluded specialists) providing

[3]Available at `http://www.exeter.ac.uk/~RDavies/arian/scandals/classic.html#credit.`

[4]Can be found on `http://www.citizenworks.org/enron/corp-scandal.php`

[5]The list and a discussion of tax shelters vs IRS measures to curb them can be found at `http://www.lowtax.net/lowtax/html/offon/usa_new/usashelt.html`

[6]For a last year scandal involving KPMG (one of the four big auditors) check `http://www.itcinstitute.com/display.aspx?id=2021`

sophisticated evasion service for a set of real sector firms.

Another application of our setup is even more direct: in CIS countries the evasion service is usually provided by an accounting firm associated with a commercial bank. This way every client of a bank has an option to arrange its accounts to "minimize" its tax obligations. The accounting firm is a local monopolist, as there are substantial costs of changing a bank, and hence the evasion specialist. There is a lot of anecdotal evidence for money laundering through the Russian banks. The sophisticated evasion goes hand in hand with laundering; in most cases it is difficult or impossible to separate the two phenomena[7].

The economic literature to date has accumulated a number of contributions to the analysis of tax evasion in presence of tax specialists. On the side of the theory, a representative paper is by Reinganum and Wilde (1993) who focus on the potential of the specialists to lower the costs of filing reports. Using a game of perfect information, they come to the conclusion that the tax authority audits reports prepared by tax specialists more intensively. The empirical research is represented by studies of Klepper at al. (1991) and Erard (1993). The principle finding here is that the specialists inhibit evasion on unambiguous items (simple evasion in our terms), but stimulate it on ambiguous items (sophisticated evasion).

We are extending the existing literature by including another type of tax specialists in the analysis. We are not describing the certified lawyers and accountants that help to fill in tax reports. Rather, we have in mind financial firms (or divisions) that run accounts of the real sector firms in case of the developing countries, or the auditors that verify the accounts of public corporations in the developed countries. Therefore, we assume that the firms cannot opt for simple evasion, and that is a special feature of corporate as opposed to personal tax evasion.

The academic interest in *corporate* tax evasion is growing, and we present three recent examples here. Kopczuk and Slemrod (2006) provide a general macroeconomic framework for analyzing tax evasion by firms, showing that standard equivalencies of different taxes break down. Crocker and Slemrod (2005) study incentives of chief financial officers (CFO) and shareholders to engage into evasion activities in a principal - agent framework. They characterize the optimal contract in presence of asymmetric information about the magnitude of the legal tax deductions and find out that the penalties imposed on the tax manager reduce evasion more than do those imposed

[7] An example of a bank connected to an evasion specialist can be found in Zheglov (2006).

on the shareholders.

Chen and Chu (2005) look instead at the incentives of chief executive officers when the contracts between them and shareholders are not enforceable. They assume that the rewards can be conditioned on the reported, but not on the actual profit, and show that the gain from evasion may only come at the expense of the loss in internal control at the firm.

Though their insights are interesting, we believe the setup chosen by Crocker and Slemrod is more realistic. First, it is the financial and not executive officers who actually run the accounts. The production (or organization) process is fairly separated from the financial flow, so that fiddling accounts does not interfere with the top managers' incentives[8]. Secondly, tax evasion and informal sector in general do exhibit contract enforcement methods other than court decision. In particular, personal and long-term relations are important.

To further the analysis of corporate tax evasion, we endogenize the response of tax authority to the reporting behaviour of the firms and model financial specialists in a novel way. The reason for the former is that exogenous audit probability seems a too strong assumption, for the latter - that we want to target the auditor firms or external accounting specialists rather than internal financial services. Both the auditors and the accounting specialists are relevant players in the sophisticated tax evasion phenomenon, as the public corporations are obliged to undergo external auditing, whereas smaller corporations do not usually have resources to arrange sophisticated tax evasion internally.

Featuring the role of tax specialists in corporate tax evasion, our paper establishes the relation between tax collection parameters and the amount of evasion. We do not aim at explaining how the evasion industry comes to existence, or whether the evasion specialists play some useful role in society. We take this sector as given and look at how tax rates, fines and industry structure can affect it. The interaction between tax authority, firms and evasion specialists is modelled as a static game of incomplete information in spirit of Reinganum and Wilde (1986). The perfect Bayesian equilibrium is used as a solution concept, and simple intuition is used for equilibrium selection.

First, we find equilibria of the evasion game with an exogenous price for specialist

[8] Or may even run in the opposite direction, as CEO's remuneration packages often depend on the official profit figures.

service. In addition to the separating equilibrium analyzed by Reinganum and Wilde, we discuss a pooling equilibrium, in which everybody evades everything, and a hybrid equilibrium, in which low profit firms are pooling their reports and high profit firms are separating. We only select equilibria with pooling at zero report being a natural focal point for the firms. The ratio of auditing costs to enforcement parameters determines whether only pooling is possible or separating and hybrid equilibria may exist.

Secondly, we provide a full description of the selected equilibrium of the whole game for both monopolistic and competitive structure of the industry of tax specialists. We show that the monopolistic specialist chooses either full cheating situation, or separating (hybrid) equilibrium with a constant across incomes evasion level. Competitive specialists may additionally find themselves in a separating equilibrium with evasion level decreasing in income. Tax evasion volume when the specialists compete is at least as large as in the monopolistic situation.

The fines on firms are more effective in driving economy away from complete evasion than those on the specialist. This is in contrast to the result in Crocker and Slemrod (2005), stating that the fines on managers (agents) are preferable to those on firms (principals). Intuitively, in their framework higher CFO fines lead to the restructuring of the evasion favouring contract. In our setting, the firms play a role of agents (the specialist being a principal), and it is better to fine firms, as they prefer high evasion regime. The finding provides rationale for little effort Russian government made in identifying and punishing evasion specialists.

For the developed countries with low levels of evasion our model points out the importance of compliance enhancing factors other than conventional enforcement. Indeed, in the separating equilibrium it is infinitely costly to ensure extinction of specialists by raising fines or simple auditing intensity. Moreover, with higher compliance it is increasingly costly to reduce sophisticated evasion by tougher punishment - a more promising way to fight it is through an increase in costs of muddling accounts.

The model setup is presented in section 2, the description of equilibria for an exogenous price follows in section 3. Price setting by the specialist is considered in the section 4, followed by the government problem in section 5. Section 6 contains a discussion of alternative specifications of the model. In conclusion the results are summarized and policy implications are suggested.

2 The Model

Imagine the world in which there is a continuum of firms with measure one, each characterized by some profit π. The magnitude of this profit is a realization of a random variable $\boldsymbol{\pi}$ distributed over the interval $[\pi_{\min}, \pi_{\max}]$ according to a cdf F that has a finite mean and strictly positive density everywhere on its domain. We require $\pi_{\min}$ be nonnegative.

There is a profit tax with a flat rate t, together with surcharge rates *per unit of evaded tax*, s_1 on the firms and s on the specialist, set by the government. After observing its profit, each firm has to decide how much tax it wants to evade. To do so, the firm has to ask the tax specialist for assistance, e. g. to forge some bills issued by fictitious firms.

There is a tax authority that visits firms costlessly with a basic frequency r_1. Conditioned upon a visit, the probability to detect sophisticated evasion is r. The tax authority can choose this probability, but it is costly. The simple auditing probability r_1 is exogenous to the decision of the tax authority, as we think about it as reflecting resources that the government decided to invest in tax compliance monitoring, e.g. a law determines how often the authority should visit the firms. As long as the tax authority has a limited budget, we have to assume $r_1 < 1$, though we shall also discuss a degenerate case in which $r_1 = 1$.

2.1 Sequence of moves and information

The evasion specialist moves first, quoting the price p *per unit of unreported income* at which it is ready to forge documents. The second move is made by nature, which assigns a type embodied in the profit level π for each of the firms. The firms move third, deciding on how much profit to report π_r. The tax authority moves last, deciding on the auditing probability r after observing the firms' reports. After this, payoffs to the tax specialist, firms, and tax authority are realized. The tax rate t, surcharge rates s_1 and s, and basic auditing frequency r_1 are exogenous parameters characterizing institutional arrangement of the game.

All these parameters are common knowledge. The realization of its own profit π is known to the firm and to the tax specialist, the distribution F of the random variable $\boldsymbol{\pi}$ is common knowledge.

2.2 Players and strategies

1. Specialist. Consider a local monopolist who sets price $p \in (0, 1)$ to maximize its expected profit, taking into account the response of the real sector $\pi_r(p, \pi)$ (further we drop the arguments for brevity) and a punishment for soliciting evasion s. The realized profit of the specialist is

$$\Pi = pE(\boldsymbol{\pi} - \pi_r) - c_s(E(\boldsymbol{\pi} - \pi_r)) - str_1Er(\boldsymbol{\pi} - \pi_r), \tag{1}$$

where $E(\boldsymbol{\pi} - \pi_r)$ is the total evaded income, $c_s(.)$ is the cost function of the specialist. Note that the realized and the expected profit are equal, as the specialist serves an infinite population of the real sector firms.

2. Taxpayers. Each of the firms characterized by profit $\pi \in [\pi_{\min}, \pi_{\max}]$ maximizes the expected after-tax profit I by choosing the tax report $\pi_r(p, \pi) \in [0, \pi]$:

$$I(\pi, \pi_r) = \pi - t\pi_r - p(\pi - \pi_r) - t(1 + s_1)r_1r(\pi - \pi_r). \tag{2}$$

3. Tax authority. It chooses $r(\pi_r, p)$ given a belief about π, observed report π_r and known profit distribution F to maximize expected revenue

$$R(\pi_r, r; \nu) = t\pi_r + rr_1t(1 + s + s_1)(E_\nu\{\boldsymbol{\pi}|\pi_r\} - \pi_r) - c(r), \tag{3}$$

where $\nu(\pi|\pi_r)$ is a belief about the distribution of true profits given the reported profits:

$$E_\nu\{\boldsymbol{\pi}|\pi_r\} = \int_{\pi_{\min}}^{\pi_{\max}} \pi d\nu(\pi|\pi_r).$$

In the case of separating equilibrium there are point beliefs

$$E_\nu\{\boldsymbol{\pi}|\pi_r\} = \hat{\pi}(\pi_r) : [0, +\infty) \to [\pi_{\min}, \pi_{\max}].$$

Notice that despite of complete revelation in a separating equilibrium, the tax authority has to incur the auditing costs in order to prove that the sophisticated evasion has actually taken place. Sending letters to the taxpayers with claims about their hidden income would not be credible.

3 Exogenous price

We first consider exogenous specialist price, i.e. the subgame that excludes the specialist from the list of players. We call a perfect Bayesian Nash equilibrium of this subgame *complete pooling*, if everybody submits zero reports; we call it *complete separating*, if each firm submits a different report; we call it *hybrid*, if some reports are distinct and some are pooled. In any perfect Bayesian Nash equilibrium (i) the reporting strategy of each firm is maximizing its expected after-tax profit given the verification policy of the authority; (ii) the verification strategy of the authority is maximizing its tax revenue given the beliefs about the reporting strategy; (iii) the beliefs about the reporting strategy are consistent with the actual reports by the firms.

We take the audit cost function from an example in Reinganum and Wilde (1986) with $c(r) = -c\ln(1-r)$. We first characterize a complete separating equilibrium, in which we greatly borrow from Reinganum and Wilde (1986) (they have derived our strict equilibrium in a setting without specialist price). We call the separating equilibrium strict, if each firm strictly prefers to make its equilibrium report; we call it weak, if all the firms are indifferent between making the equilibrium report and some other report.

Denote the equilibrium values of report π_r^*, which is a function of profit π, and probability of deep auditing r^*; equilibrium point belief about the true income $\hat{\pi}^*(\pi_r)$. Before characterizing the equilibria of our subgame, we state a lemma that specifies how the tax authority responds to a profit report (denote $\mu := (1+s+s_1)\, tr_1$):

Lemma 1 Consider a subgame defined by given specialist price p. The best response of the tax authority with a belief ν to a tax report π_r is

$$r(\pi_r;\nu) = 1 - \frac{c}{\mu\left(E_\nu\{\boldsymbol{\pi}\,|\pi_r\} - \pi_r\right)}. \tag{4}$$

The proof of the lemma and the propositions 1-3 can be found in the appendix.

In the following proposition we establish the existence conditions for the separating equilibrium in our subgame (denote $B := \mu - (t-p)(1+s+s_1)/(1+s_1)$):

Proposition 1 (separating equilibrium) *Consider a subgame defined by given specialist price p. Assume the auditing is cheap, $c/\mu < \pi_{\min}$.*
(i) If $t(1 - r_1(1+s_1)) < p \leq \min\left\{t\left(1 - r_1(1+s_1)\left(1 - c(\mu\pi_{\min})^{-1}\right)\right), t\right\}$, there exists a complete separating (strict) equilibrium characterized by the triple $\{\pi_r^*, r^*; \hat{\pi}^*\}$ with π_r^* defined by

$$\pi - \pi_r^*(\pi) = \left(\frac{c}{\mu} - \frac{c}{B}\right) e^{\frac{B}{c}\left(\pi_r^*(\pi) - \pi_r^*(\pi_{\max})\right)} + \frac{c}{B}; \tag{5}$$

$$
\begin{aligned}
r^* &= 1 - \frac{c}{\mu\left(\hat{\pi}^* - \pi_r^*\right)}, \qquad (6)\\
\hat{\pi}^*\left(\pi_r\right) &= \begin{cases} \pi_{\min}, & \pi_r < \pi_r^*\left(\pi_{\min}\right), \\ \pi_r^{*-1}\left(\pi\right), & \pi_r \in \left[\pi_r^*\left(\pi_{\min}\right), \pi_r^*\left(\pi_{\max}\right)\right], \\ \pi_{\max}, & \pi_r > \pi_r^*\left(\pi_{\max}\right). \end{cases}
\end{aligned}
$$

(ii) If $t\left(1 - r_1\left(1+s_1\right)\left(1 - c\left(\mu\pi_{\min}\right)^{-1}\right)\right) < p \leq t$, *there exists a complete separating (weak) equilibrium characterized by the triple* $\{\pi_r^*, r^*; \hat{\pi}^*\}$ *with* π_r^* *defined by*

$$
\pi - \pi_r^*\left(\pi\right) = \frac{c}{\mu}\left(1 - \frac{t-p}{(1+s_1)tr_1}\right)^{-1} \qquad (7)
$$

and expressions (6).

(iii) If $p > t$ *there exist a complete separating (honesty) equilibrium characterized by*

$$
\begin{aligned}
\pi_r^* &= \pi, \qquad (8)\\
r^* &\equiv 0,\\
\hat{\pi}^*\left(\pi_r\right) &= \begin{cases} \pi_r^{*-1}\left(\pi\right), & \pi_r \in \left[\pi_r^*\left(\pi_{\min}\right), \pi_r^*\left(\pi_{\max}\right)\right], \\ \pi_{\max}, & \pi_r \notin \left[\pi_r^*\left(\pi_{\min}\right), \pi_r^*\left(\pi_{\max}\right)\right]. \end{cases}
\end{aligned}
$$

The analysis of the pooling equilibria in our game is complicated by the fact that there is a continuum of them[9]. However, we choose the pooling at zero report as an obvious focal point. We also do not consider all kinds of hybrid equilibria that could potentially arise in the subgame except for the pooling at zero report for the types below certain profit and separating for the types above it. The reason for this is that we want to distinguish clearly high evasion regime (complete pooling) and low evasion regime (complete separation or hybrid).

Proposition 2 (hybrid equilibrium) *Consider a subgame defined by given specialist price p. Assume the auditing is not very expensive,* $\pi_{\min} < c/\mu < E\left(\boldsymbol{\pi}|\pi \leq \pi^0\right)$, *where* π^0 *simultaneously solves (5) and the indifference condition* $I(\pi^0, \pi_r^*\left(\pi^0\right)) = I(\pi^0, 0)$.

(i) If $t\left(1 - r_1\left(1+s_1\right)\right) < p \leq \min\left\{t\left(1 - r_1\left(1+s_1\right)\left(1 - c\left(\mu E\left(\boldsymbol{\pi}|\pi \leq \pi^0\right)\right)^{-1}\right)\right), t\right\}$, *there exists a hybrid (strict) equilibrium characterized by the triple* $\{\pi_r^*, r^*; v^*\}$ *with* π_r^* *defined by (5),* r^* *defined by (6) for any* $\pi \geq \pi^0$ *and*

$$
\begin{aligned}
\pi_r^*\left(\pi\right) &= 0, \qquad (9)\\
r^* &= 1 - \frac{c}{\mu E\left(\boldsymbol{\pi}|\pi \leq \pi^0\right)}
\end{aligned}
$$

[9] Note that intuitive or divinity criteria are not applicable in our subgame, as it has a continuum of types.

for any $\pi < \pi^0$. The beliefs are

$$
\begin{aligned}
\nu^*(\pi\,|\pi_r) &= \begin{cases} F\left(\pi|\pi \le \pi^0\right), & \text{if } \pi_r = 0, \\ D, & \text{if } 0 < \pi_r < \pi_r^*\left(\pi^0\right), \\ \pi_r^{*-1}\left(\pi\right), & \pi_r \in \left[\pi_r^*\left(\pi^0\right), \pi_r^*\left(\pi_{\max}\right)\right], \\ \pi_{\max}, & \pi_r > \pi_r^*\left(\pi_{\max}\right); \end{cases} \qquad (10) \\
\forall D | E_D\left\{\boldsymbol{\pi}\,|\pi_r\right\} &\ge E\left(\boldsymbol{\pi}|\pi \le \pi^0\right) + \pi_r.
\end{aligned}
$$

(ii) If $t\left(1 - r_1\left(1+s_1\right)\left(1 - c\left(\mu E\left(\boldsymbol{\pi}|\pi \le \pi^0\right)\right)^{-1}\right)\right) < p \le t$, there exists a hybrid (weak) equilibrium characterized by the triple $\{\pi_r^*, r^*; v^*\}$ defined by (6)-(7) for any $\pi \ge \pi^0$ and (9) for any $\pi < \pi^0$. The beliefs are determined according to (10).
(iii) If $p > t$ there exist a complete separating (honesty) equilibrium characterized by (8).

The following proposition establishes existence conditions for the complete pooling at zero equilibrium:

Proposition 3 (pooling equilibrium) *If $p \le t\left(1 - r_1\left(1+s_1\right)\right)$ or $c/\mu > E\boldsymbol{\pi}$, there exists a complete pooling equilibrium characterized by the triple $\{\pi_r^*, r^*; \nu^*\}$ with*

$$
\begin{aligned}
\pi_r^* &\equiv 0, \qquad (11) \\
r^* &= \max\left\{0, 1 - \frac{c}{\mu E\boldsymbol{\pi}}\right\}, \\
\nu^*(\pi\,|\pi_r) &= \begin{cases} F\left(\pi\right), & \text{if } \pi_r = 0 \\ D, & \text{if } \pi_r > 0 \end{cases}, \\
\forall D|E_D\left\{\boldsymbol{\pi}\,|\pi_r\right\} &\ge \max\left\{E\boldsymbol{\pi}, \pi_{\max} - \left(\frac{\pi_{\max}}{E\pi} - 1\right)\frac{c}{\mu}\right\}.
\end{aligned}
$$

A separating equilibrium does not exist.

We see that there two factors that determine what kind of equilibrium exists: (i) relative auditing costs c/μ, (ii) specialist price p. When the auditing costs are very small, $c/\mu < \pi_{\min}$, there may be complete separating or complete pooling equilibrium, depending on the specialist price. When the costs are higher, $\pi_{\min} < c/\mu < E\left(\boldsymbol{\pi}|\pi \le \pi^0\right)$, complete separating equilibrium does not exist; the specialist price determines whether hybrid or pooling equilibrium is played. For substantial auditing costs, $c/\mu \ge E\left(\boldsymbol{\pi}|\pi \le \pi^0\right)$, the equilibrium is either pooling or in mixed strategies, so in our subsequent analysis we assume $c/\mu < E\left(\boldsymbol{\pi}|\pi \le \pi^0\right)$.

For a small specialist price there is complete pooling equilibrium, i.e. no firm submits a truthful report and the tax authority picks the firms for auditing with uniform probability. For a higher price there is separating or hybrid equilibrium, in which each firm with high enough profit evades a part of it, and the tax authority can deduce the profit of such firms from their reports. When the price is prohibitively high, all the firms submit truthful reports and the tax authority does not perform deep auditing, so we have full honesty equilibrium.

Intuitively, in the pooling equilibrium any firm should prefer submitting zero report to submitting a positive one. Thus, the gain from decreased auditing probability at higher report should not outweigh the loss of the profit from foregone evasion. If the authority believes that any positive report implies higher than average profit, it will not reduce its optimal auditing effort enough to make non-zero report attractive. Then for such out-of-equilibrium belief of the authority pooling at zero is equilibrium with the correct equilibrium belief being unconditional distribution of profits.

In any equilibrium, a firm plays the best response to both verification strategy of tax authority and reporting behavior of other firms. In a separating equilibrium with $\pi_r(\pi)$ strictly increasing, every firm chooses the report in such a way that it reveals its profit level. This happens, if $p > t\left(1 - r_1\left(1 + s_1\right)\right)$. When the price of auditing is high enough, $t\left(1 - r_1\left(1 + s_1\right)\left(1 - c\left(\mu\pi_{\min}\right)^{-1}\right)\right) < p \leq t$, the firms are indifferent between evading and reporting, so we have weak separating equilibrium.

The same logic applies to the hybrid equilibrium. The difference is that all firms with the profit below π^0 submit zero reports. This allows for more intensive auditing of the lowest reports than in complete separation case. Hence, hybrid equilibrium exists when auditing is costly enough for complete separation to fail. Hybrid equilibrium is not distribution-independent: the threshold level of profit π^0 at which a firm is indifferent between submitting zero or positive report is determined by the shape of profit distribution.

For $p > t$ evasion would not make sense, so the firms report full profit. The lower threshold for price, $t\left(1 - r_1\left(1 + s_1\right)\right)$ defines whether there is pooling or separating equilibrium (recall that we select pooling at zero whenever separating or hybrid equilibrium does not exist). This threshold is determined by the the tax rate and the fine faced by a firm in case of detection: the higher the fine, the smaller is the range where the separating (hybrid) equilibrium does not exist.

At the extreme, when all the firms are visited ($r_1 = 1$) the threshold becomes

$-ts_1$, that is separation exists for any specialist price, given that the auditing is not too expensive. The threshold is very intuitive, as t can be thought of as marginal benefit from evasion, whereas $p + tr_1 (1 + s_1)$ as marginal costs for an audited firm $(r = 1)$. Thus, when the benefits are higher even for a detected evader, no separation can exist (everybody evades everything). However, in reality the tax authority never has the resources to inspect all the firms, so $r < 1$. In fact, the evidence summarized in Andreoni et al (1998) implies that in reality $r_1 (1 + s_1) < 1$, that is the auditing probability is on average below its Nash equilibrium counterpart[10].

This completes the description of the game between tax authority and taxpayers. It is valid for any industrial structure of the specialist service ranging from perfect competition to monopoly. In any case, for low specialist price an equilibrium with firms evading everything is played; for higher price a separating equilibrium with firms evading some part of their profit is played; for a price higher than the tax rate all firms report honestly.

Before looking more closely at the price setting behaviour of the specialist, we formulate two results that characterize the evasion behaviour in the separating or hybrid equilibrium considered.

Define equilibrium evasion volume $e^* (\pi) := \pi - \pi_r^* (\pi)$.

Proposition 4 *In the complete separating equilibrium defined by the reporting function (5), evasion volume is a decreasing and concave function of profit,* $\frac{de^*(\pi)}{d\pi} < 0, \frac{d^2 e^*(\pi)}{d\pi^2} < 0$.

The proof is left to the appendix E. The decreasing evasion is a counter-intuitive result, as we would expect the rich to evade more. After all, their reports are audited less. In our setting though, if they evade more, they get audited disproportionately more, thus preferring to stay at their separating equilibrium report. This does not contradict a common sense that evasion makes the tax system more regressive. Indeed, without evasion the linear tax rate implies a neutral tax system. In separating equilibrium though the tax system becomes regressive, as after tax expected income is increasing faster than before-tax income. Formally, this leads us to the following corollary:

[10] We do not endogenize the basic auditing probability r_1, as we believe this decision has substantially longer horizon than the auditing intensity r. Moreover, it is likely to be a government, not a tax authority decision. Hence, it is may be chosen to maximize welfare and not the tax revenue.

Corollary 1 In the complete separating equilibrium defined by the reporting function (5), the linear tax is regressive, $\frac{d^2 I}{d\pi^2} = (t - p - t(1+s_1)r_1)\frac{\partial^2 e^*(\pi)}{\partial \pi^2} > 0.$

This result can be obtained by direct differentiation of the expected after-tax profit (2).

4 Price setting

In the previous section we considered evasion subgame equilibria for any fixed specialist price p. The interesting question is though which price would specialist want to charge, if it were a monopolist[11]. For simplicity we assume here a linear cost function of the specialist, $c_s(x) = c_s x$. Clearly, if $c_s \geq t$, the honesty prevails, so there is no space for the specialist. Otherwise, if $c_s < t$, the specialist can choose any price $p \in (t(1 - r_1(1+s_1)), t)$ to get a separating or hybrid equilibrium, or any price $p \leq t(1 - r_1(1+s_1))$ to get pooling, or else close down ensuring zero profit and complete honesty. Formally, the specialist maximizes its profit by choosing p:

$$\int_{\pi_{\min}}^{\pi_{\max}} (p - c_s - str_1 r^*(\pi_r^*(p,\pi)))(\pi - \pi_r^*(p,\pi))\, dF(\pi). \tag{12}$$

The following condition turns out to be important for the specialist's decision:

$$t - c_s < \mu. \tag{13}$$

The next proposition characterizes the equilibrium play in our game:

Proposition 5 *The specialist is anticipating the subgame play given by Propositions 1-3. Its profit is maximized at*
(i) a separating equilibrium with the price t, if the condition (13) is satisfied.
(ii) a pooling equilibrium with the price $p^p = t(1 - r_1(1+s_1))$, if the condition (13) is not satisfied and the following relation holds:

$$(p^* - c_s - str_1)\int_{\pi_{\min}}^{\pi_{\max}} e^*(p^*,\pi)\, dF(\pi) < (t - c_s - \mu)\, E\boldsymbol{\pi} + \frac{cs}{1+s+s_1}. \tag{14}$$

[11]Monopolistic structure seems most realistic for the evasion industry. For the details see introduction.

Here p^* is determined by the following relation:

$$\int_{\pi_{\min}}^{\pi_{\max}} e\left(p^*, \pi\right) dF\left(\pi\right) + \left(p^* - c_s - str_1\right) \int_{\pi_{\min}}^{\pi_{\max}} e_p\left(p^*, \pi\right) dF\left(\pi\right) = 0.$$

(iii) a separating equilibrium with the price $p^* \in (p^p, t]$, if the conditions (13) and (14) are not satisfied.

The formal proof of (i) is left to the appendix F. If the condition (13) is satisfied, the profits from separating or hybrid equilibrium are maximized at the highest possible separating price, t. In (ii) and (iii) the condition (13) is not satisfied, so the specialist's profit from separating equilibrium may be maximized at an interior. That is why in (14) we implicitly compare profits from separation and pooling. Note that positive profit in pooling equilibrium is assured by the violation of condition (13), and this implies that whenever the condition (14) is satisfied, there is a positive profit in separation as well.

Intuitively, if the fines are too low, $t - c_s > \mu$, either pooling or separation can be played depending on the structure of the fines. If $t - c_s < \mu$, the system ends up in a separating or hybrid equilibrium with $p = t$.

4.1 Payoffs and comparative statics

The proposition above characterizes the equilibrium of the game with a specialist. In the following we discuss the factors that (i) affect cheating and auditing in the separating equilibrium; (ii) influence the behaviour of agents in the pooling equilibrium; (iii) drive the system into separation or pooling.

4.1.1 Separation at $p = t$

The specialist profits under separation or hybrid equilibrium can be obtained by substituting $p = t$ into (12):

$$\Pi^s = \frac{c}{\mu}\left(t - c_s\right). \tag{15}$$

The profit is increasing in the tax rate, auditing costs and decreasing in enforcement parameters and specialist's costs. Notice that the specialist extracts all the rent from the tax evasion, leaving the firms indifferent between cheating and being honest.

In this equilibrium the auditing never happens, and evasion $e^*(t) = c/\mu$ is minimal and constant across income levels (apart from the pooled types in a hybrid equilibrium). The comparative statics is conventional here: evasion is increasing in auditing costs and decreasing in enforcement parameters; fines on firms and the specialist have an equivalent impact.

4.1.2 Pooling

Substituting $p = t(1 - r_1(1 + s_1))$ into (12), we get specialist profits in pooling

$$\Pi^p = (t - c_s - \mu) E\boldsymbol{\pi} + \frac{cs}{1 + s + s_1}. \tag{16}$$

The profit is trivially decreasing in the specialist's costs and increasing in auditing costs. It is increasing in the tax rate if the enforcement is not sufficiently strong $(1 + s + s_1) r_1 < 1$ and decreasing otherwise. The fine on the firms unambiguously decreases specialist's profitability, but the fine on the specialist may actually increase it. This happens whenever

$$c\frac{1 + 2s + s_1}{1 + s + s_1} < \mu E\boldsymbol{\pi},$$

and hence guarantied for small auditing costs. Notice that in the pooling equilibrium a part of the rent is left with the firms to make sure they do not prefer partial evasion of separating equilibrium. Everybody evades everything in this case: $\pi_r \equiv 0$.

The deep auditing probability is given by $r = 1 - c/(\mu E\boldsymbol{\pi})$, and it approaches unity as the auditing costs approach zero. The probability has conventional properties: it is decreasing in auditing costs and decreasing in enforcement parameters, tax rate and firms' profit.

4.1.3 Separation versus pooling

We have seen that the low auditing costs and high fines are good for separation. The higher specialist costs give more chances for separation as well. The impact of the enforcement mix is ambiguous: stricter enforcement in terms of s_1 decreases "marginal attractiveness" of separation at $p = t$ by $(t - c_s) c/\mu^2$, but also decreases that of pooling by $E\pi + cs/(1 + s + s_1)^2$. Thus, the condition for a stricter enforcement to work into the direction of separation is $E\boldsymbol{\pi}(1 + s + s_1)^2/c + s > (t - c_s)/(tr_1)^2$. This is only not satisfied for small values of r_1.

5 Government

Now, consider the government that cares about reduction of evasion. Similarly to Crocker and Slemrod (2005), we look at the effectiveness of different fines in deterring evasion and get a non-equivalence result. In separating equilibrium both fines are equally effective, as can be seen from (15). In pooling equilibrium, they are equally ineffective, as the evasion volume is locally insensitive to the enforcement parameters. An interesting case is a jump from pooling equilibrium (ii) to separating or hybrid equilibrium (iii), and here fines on the real sector firms do a better job, as the following proposition states.

Proposition 6 *If the condition (13) is not satisfied and there is a pooling equilibrium, the fines on the real firms are more effective in pushing the system to a separating equilibrium then the fines on the specialist are.*

Proof. We prove the proposition for the corner case $p^* = t$. The more general case is considered in the appendix G. Let us go back to the condition (14). In the corner case the condition takes the form $(t - c_s - str_1)\, c/\mu < (t - c_s - \mu)\, E\boldsymbol{\pi}$. The term $-str_1$ tells us that s has an additional push back from separation to pooling in comparison to s_1. Indeed, if $s = 0$, the additional term disappears. Formally, define a function P that takes negative values if and only if the equilibrium of the game is pooling, $P := c\,(t - c_s - str_1) - \mu\,(t - c_s - \mu)\, E\boldsymbol{\pi}$. The effectiveness of a fine in the sense of the present proposition is then just a derivative of the function P with respect to the corresponding fine. It can easily be seen that $\frac{dP}{ds} = -ctr_1 + \frac{dP}{ds_1} < \frac{dP}{ds_1}$, Q.E.D. ■

This provides a rationale for the recent situation in Russia when the specialist firms were not liable for the evasion of their clientele. Our model indeed predicts that the whole burden of punishment should lie on the firms actually evading tax. The intuition for not punishing specialists even though they take all the rents in a separating equilibrium is simple: the firms are favouring full cheating more, because they get a part of the pie in the pooling equilibrium. Thus, a fine on firms that drags the system out of full cheating is not sufficient to reach separating equilibrium when put on the specialists.

Apart from this finding, we summarize the comparative statics for the two types of equilibria we have. The auditing probability in the pooling equilibrium $1 - c/\left(\mu E\boldsymbol{\pi}\right)$ is increasing in fines, tax rate, and the superficial auditing frequency. It is decreasing in the costs of auditing. The intuition is straightforward: the former factors increase the direct benefits of a deep audit, the latter increase its costs. The evasion volume is obviously not sensitive to parameter changes in the pooling equilibrium.

In separation with $p = t$, there is no auditing, so the auditing probability is insensitive to the parameters shifts. The cheating volume c/μ is a standard result also obtainable from conventional models without specialists. Of course, we should keep in mind that relatively cheap auditing is crucial for all our results, as otherwise full cheating is an unchallengeable outcome.

Having looked at what it takes to go from full cheating to separation, it is natural to also ask the question of what it takes to go from separation to full honesty. In other words, if the government wants to destroy specialists, as many newspapers recommend, how costly would it be? As the evasion in separating equilibrium is fixed to c/μ, it is obviously infinitely costly to get rid of it completely by raising fines. A much more effective way to make specialists inactive is to raise their costs all the way up to the tax rate. This could be achieved through employing better accounts monitoring and cross-checking systems, or by increasing the costs of running accounts (in a fashion of Sorbannes-Oxley act).

Another testable hypothesis that stems from our analysis is the clustering effect the specialist has on evasion. When firms are evading taxes on their own, we can observe any evasion volume in separating equilibrium, from full honesty to full cheating. With the specialist acting strategically, the equilibrium is never characterized by the intermediate volumes of evasion: either there is full cheating, or evading c/μ, which is relatively little, or not evading anything. Thus, we expect evasion to be more clustered at the extreme levels in countries or regions where specialists are more widespread.

Finally, let us emphasize how the optimal tools for fighting evasion depend on the extent to which the evasion is spread in a society. When the sophisticated evasion is pervasive, the marginal increase in enforcement is not likely to affect compliance behaviour. In terms of our model, the system exhibits inertia with respect to compliance, when in the pooling equilibrium. It is the specialist who adjusts the price and the tax authority that adjusts auditing - the firms keep evading everything. In such circumstances, the system should be pushed to the separating equilibrium in order to achieve any reduction in evasion. This can be done by the means of conventional enforcement (fines and auditing intensity), but the corresponding change is bound to be non-trivial.

When the sophisticated evasion is rare, marginal changes in enforcement are effective in reducing it, but at increasingly lower rate. In our model, the separating equilibrium exhibits full honesty only at the limit of infinitely high fines. This happens because no matter what fines are, the specialist can effectively insure herself against them and provide as little evasion service as is profitable for given fines. On the other hand, if the specialist faces high costs of producing the evasion service, it will decide to close down anyway. Therefore, with small evasion rates the government may be better off by making falsification of accounts more costly.

6 Discussion: alternative specifications

6.1 Industry structure

One may wonder what happens in an industry plagued with sophisticated evasion, if the specialists are not local monopolists as we have assumed above, but rather compete in prices. In the first stage of the game then each specialist quotes a price, and the subgame with the lowest price as a fixed price for specialist service follows. As in a simplest Bertrand setting, the competition will drive the prices down to the marginal costs. A complication in our model is that the marginal costs are increasing, and the demand is kinked. Namely, the specialist's marginal cost is $c_s + str_1 r(\pi_r, p)$, and the demand for the service is the subgame equilibrium evasion, whenever $p \leq t$.

One equilibrium candidate is charging minimal marginal cost c_s. This is an equilibrium only in a very special case of $t = c_s$. If $t > c_s$, the specialists charging $p = c_s$ gets a loss of $str_1 rE(\boldsymbol{\pi} - \pi_r^*(\boldsymbol{\pi}))$, and has a profitable deviation of not providing the service at all. The following proposition characterizes the equilibrium in this case:

Proposition 7 *If the specialists compete in prices à la Bertrand in anticipation of the subgame play given by Proposition 1-3 and $t > c_s$, the equilibrium is characterized by the following specialist price:*
(i)

$$p^{wc} = \frac{c_s(1+s_1)+st}{1+s+s_1}, \tag{17}$$

if $c_s(1+s_1)+st > (\mu - ce^{-1}(\pi_{\min}))\left(r_1^{-1} - (1+s_1)\right)$. The weak separating equilibrium of the subgame is played.

(ii)

$$p^{sc} = c_s + str_1\left(1 - \frac{c}{\mu e\left(p^{sc}\right)}\right), \tag{18}$$

$$e\left(p^{sc}\right) = \int_{\pi_{\min}}^{\pi_{\max}} \left(\pi - \pi_r^*\left(p^{sc}, \pi\right)\right) dF\left(\pi\right), \tag{19}$$

if $t\left(1 - r_1\left(1 + s_1\right)\right) < p^{sc} \leq t\left(1 - r_1\left(1 + s_1\right)\left(1 - c\left(\mu e\left(\pi_{\min}\right)\right)^{-1}\right)\right)$. *The strict separating equilibrium is played.*

(iii)

$$p^{pc} = c_s + str_1\left(1 - \frac{c}{\mu E\boldsymbol{\pi}}\right), \tag{20}$$

if $c_s - str_1c\left(\mu E\boldsymbol{\pi}\right)^{-1} < t - \mu$. *The pooling equilibrium is played in the subgame.*

(iv) No pure strategy Bayesian SPNE exists, if none of the conditions (i)-(iii) is satisfied.

Sketch of the proof. Any competitive equilibrium in our game must be characterized by zero profit condition for the specialists. Depending on the subgame equilibrium, this is expression (17), (18), or (20). Indeed, the cost of serving the firms is $\int_{\pi_{\min}}^{\pi_{\max}} \left(c_s + str_1r^*\left(\pi_r^*\left(p, \pi\right)\right)\right)\left(\pi - \pi_r^*\left(p, \pi\right)\right) dF\left(\pi\right)$, whereas the revenue is $p\int_{\pi_{\min}}^{\pi_{\max}} \left(\pi - \pi_r^*\left(p, \pi\right)\right) dF\left(\pi\right)$. After equating and rearranging we get the expressions above.

Consider possible deviations of any of the specialists (there can be any finite number of them larger than one) charging the price specified by the proposition. The deviations to any higher price bring about the same payoff, i.e. zero. The deviations to any lower price bring about losses. Note that rationing consumers at a lower price does not help to reduce costs, as the tax authority observes the price, not the quantity, and audits according to the best response specified in the subgame. Thus, we indeed have an equilibrium strategy for all the specialists, if the specified price corresponds to the subgame equilibrium.

Finally, we provide the conditions under which each of the subgame equilibria is played. When the specialist costs are relatively high, the separating equilibrium results in zero profit. When the cost are low, a separating equilibrium brings about positive profits, so the firms charge a price low enough to trigger a pooling equilibrium. When any separating equilibrium brings about positive profit, but the pooling equilibrium results in a negative profit, the specialists randomize, and no pure strategy equilibrium obtains. ■

Competition is effective in our setting: it drives the profits of the specialists to zero independently of parameter values. Contrary to the monopolistic case, the real sector firms are left with an expected surplus from evasion. In pooling equilibrium this is of the magnitude $(t(1-r_1(1+s_1)) - p^{pc})\,\pi$.

We want to compare the two industry structures according to the volume of evasion they generate. First, the condition for the pooling is $c(t-c_s-str_1) < (t-c_s-\mu)\,\mu E\boldsymbol{\pi}$ in the monopoly case versus $-str_1c < (t-c_s-\mu)\,\mu E\boldsymbol{\pi}$ in the competition case. It can be seen that the former condition is more stringent. Thus, competition results in a larger evasion volume than a monopoly does, whenever $-str_1 < (t-c_s-\mu)\,\mu E\boldsymbol{\pi}/c < t-c_s-str_1$. Second, in a separating equilibrium the evasion volume is larger with competition whenever $p^c < t$, as the monopolist chooses a minimum of c/μ. This leads us to the following corollary.

Corollary 2 If the condition (13) is satisfied, evasion volume with competition among the specialists is at least as high as with a monopoly.

The usual intuition from industrial organization theory goes through in our model: monopoly leads to a reduction of production relative to competitive benchmark. In our setup, it is the sophisticated evasion service that is being produced. Hence, in so far as we do not like monopoly in production of "goods", we should like it in production of "bads", in case it is too costly to eliminate such production altogether.

As we can see, our previous result about the relative effectiveness of the fines still holds in the absence of monopoly power. Namely, the same term $-str_1$ makes fining specialists better for the pooling. In the weak separating equilibrium the fines are equally ineffective: their impact is completely offset by the adjustment of price, and the evasion level stays at constant $c(1-(t-c_s))^{-1}$. Remarkably, evasion level here is increasing in tax rate, contrary to the monopolistic case.

6.2 Specialist cost function

One of the assumptions that restrict applicability of our analysis is the linear cost function of the specialists. Indeed, one may believe that it becomes increasingly costly to muddle through the accounts as the evasion volume increases both on the firm and the industry levels. While the cost rise on the firm level is partially reflected in the detection probability increase, the industry level cost rise is left out of our model so far.

At the same time, there can be the opposite spillover effect: it is costly to develop a complicated evasion scheme, but, once developed, it can be applied to many firms relatively inexpensively. This technology effect may actually provide an additional justification for the monopolistic structure of the industry of sophisticated evasion.

We shall think about the spillover effect as some fixed costs needed to start the business. The opposite effect can be captured by a convex cost function. The specialist's objective function (12) then becomes

$$\int_{\pi_{\min}}^{\pi_{\max}} \left(p - str_1 r^* \left(p, \pi\right)\right) e\left(p, \pi\right) dF\left(\pi\right) - c_s \left(\int_{\pi_{\min}}^{\pi_{\max}} e\left(p, \pi\right) dF\left(\pi\right)\right) - C. \tag{21}$$

Consider the fixed costs C first. As they do not distort the pricing decision of the monopolist, all our results go through with a qualification that for high enough fixed costs full honesty equilibrium results.

The convexity does introduce additional complications, but the condition for profits to be maximized at $p = t$ can be reduced to an expression like (13), where instead of c_s we use $c_s'\left(e\right)$. A more precise condition can be written as $e\left(t\right) + \left(t - str_1 - c_s'\left(e\right)\right) e'\left(t\right) \geq 0$, which is of course a familiar inverse elasticity rule of the monopolist adapted to our setting. Intuitively, depending on whether equilibrium evasion is larger or smaller than that in the linear cost case, the condition will be correspondingly less or more restrictive. The separating equilibrium will be preferred for a larger set of parameter values, as full cheating becomes relatively more costly. The rest of the story is virtually unaltered.

6.3 The authority cost function

The cost function of the authority used in our model may seem very specific. However, Reinganum and Wilde (1986) have shown that the separating equilibrium of the type that we discuss exists for a large class of auditing function. Namely, they assume $c\left(0\right) = 0$, twice continuous differentiability with $0 < c'\left(r\right) < \infty, 0 < c''\left(r\right) < \infty, \lim\limits_{r\to 1} c'\left(r\right) = \infty$, and $c'\left(r\right)/c''\left(r\right) + r > 1/\left(1+s\right)$. The best response of the tax authority is then

$$r\left(\pi_r; v\right) = c'^{-1}(\mu(E_\nu\left\{\boldsymbol{\pi}\left|\pi_r\right.\right\} - \pi_r)), \tag{22}$$

which is a generalized form of the expression (25).

Obviously, our strict separating equilibrium of the subgame is valid under the same restrictions, as it completely mimics the equilibrium of Reinganum and Wilde.

The weak separating equilibrium also exists under these conditions, with

$$e = \frac{1}{\mu} c' \left(\frac{t - p}{(1 + s_1) t r_1} \right). \tag{23}$$

Finally, the pooling at zero equilibrium also survives the generalization, with the existence conditions modified appropriately.

We have chosen a specific function for a clear characterization of the subgame equilibrium, but it can be seen that our equilibrium structure admits generalization to the class of auditing functions in Reinganum and Wilde (1986).

7 Conclusion

The game between tax authority, taxpayers and a tax specialist featuring stylized reality of corporate scandals and sophisticated evasion is analyzed in the paper. We consider illiterate firms, i.e. the firms that do not know how to evade taxes. We identify three types of equilibria for given specialist price: (i) complete pooling at zero report; (ii) complete separation with true profit revelation; (iii) hybrid equilibrium with low types submitting zero reports and high types revealing their profit. Furthermore, complete separating and hybrid equilibria can be of two different types, strict or weak. As suggested by the term, in strict equilibrium the firms strictly prefer to submit equilibrium report; in weak equilibrium the firms are indifferent between cheating and reporting honestly. Finally, there is a special case of the separating equilibrium in which all firms report truthfully.

Introducing the specialist who can choose the price for her services reduces the number of equilibrium types for a large set of parameter values: the specialist chooses between complete pooling and separating or hybrid equilibrium at the highest possible price. That is why in separating or hybrid equilibrium the specialists gets all the evasion rent, whereas in case of complete pooling she has to share it with the firms. This, in turn, makes firms prefer pooling over separation.

The main result of the paper is twofold. First, for the high evasion regimes (developing countries, pooling equilibrium) the fines on the evading firms are more effective in driving the system out of full evasion than the fines on the specialist preparing documents for this evasion. Secondly, for the low evasion regimes (developed countries, separating or hybrid equilibrium) increasing costs of complicating accounts is more effective than conventional enforcement measures.

The success of Russian tax law enforcement policy seems to be well in line with the former prediction of the model: the "flat tax" reform was accompanied with both large increase in punishment for evasion for the firms and no change in responsibility of accounting specialists. Sorbannes-Oxley act in the US, on the other hand, may be justified in light of the latter insight from the model.

Another result of our analysis is that auditing costs play a positive role in driving the system to separating equilibrium. This gives a following policy advice: when the situation with evasion is really bad, trying to invest in tax inspectors' effectiveness may be a bad idea. It is wiser to make the enforcement stricter. On the other hand, when the evasion is moderate, the inspectors' costs become a more effective tool of fighting non-compliance than fines and auditing intensity.

To eliminate sophisticated evasion completely is infinitely costly according to our model. In light of this the populist goals to get rid of money laundering and corporate tax avoidance seem unrealistic. A promising step in this way, however, is increasing costs of muddling through accounts.

Our results are robust to a number of changes in the model specification. Competition between the specialists expands the set of possible equilibria and increases tax evasion, but it does not change the equilibrium structure and the effectiveness of the enforcement instruments. Convex cost function of the specialist does not alter the analysis. Finally, the equilibrium structure is preserved for a rather broad class of monotonically increasing convex auditing functions[12].

The analysis presented is by no means limited to the tax avoidance - evasion phenomenon. A very similar problem arises, for example, in the interaction of competition authority and firms that are colluding. Most often collusion agreement are bound to be detected if not done through intermediaries - specialist firms. The same story applied, these intermediaries should not be punished.

The paper could be extended in a number of ways. First, the firms could be given opportunity to evade by themselves. Secondly, the government could be added as an active first mover to set institutional parameters in a way to maximize social welfare or some other objective. Thirdly, the model could be extended to general equilibrium in order to study welfare aspects of enforcement policies. Finally, it would be interesting to consider dynamics of evasion in a context of repeated game.

[12] The equilibrium structure is also robust to introducing (not too high) risk aversion - the equilibrium prices are just shifted down from t and $t\,(1-(1+s_1)\,r_1)$.

References

[1] Andreoni J., Erard J. and Feinstein J., June 1998. Tax Compliance. Journal of Economic Literature, 818-860.

[2] Browning, L., Study Finds Accelerating Decline in Corporate Taxes, The New York Times, 23 September 2004

[3] Chen, K-P., Cyrus Chu C. Y., 2005. Internal Control versus External Manipulation: a Model of Corporate Income Tax Evasion, RAND Journal of Economics, 36, 151-164.

[4] Cowell, F.,1990. The Economics of Tax Evasion, MIT Press.

[5] Crocker, K., Slemrod, J., 2005. Corporate Tax Evasion with Agency Costs. Journal of Public Economics, vol. 89(9-10), 1593-1610.

[6] Erard, B., 1993. Taxation with Representation, Journal of Public Economics, 52, 163-197.

[7] Johnston, D., Tax Moves by Enron Said to Mystify the I.R.S., New York Times, February 13, 2003a.

[8] Johnston, D., Tax Inquiries Fall as Cheating Increases, New York Times, April 14, 2003b.

[9] Klepper, S., Mazur, M., Nagin D., 1991. Expert Intermediaries and Legal Compliance: the Case of Tax Preparers, The Journal of Law and Economics, 34, 205-229.

[10] Kopczuk, W., Slemrod, J., 2006. Putting Firms into Optimal Tax Theory, American Economic Review, 96, 130-134.

[11] Levin, M., Movshovich, S., 2001. Modelling Tax Evasion with Penalties and Credit Constraints, EERC Working Paper 99-306R.

[12] McIntyre R. Tax Cheats and Their Enablers, Economic Policy Institute Tax Enforcement Forum, April 2005.

[13] Reinganum, J., Wilde L., 1986. Equilibrium Verification and Reporting Policies in a Model of Tax Compliance, International Economic Review, 27, 739-60.

[14] Reinganum, J., Wilde L., 1991. Equilibrium Enforcement and Compliance in the Presence of Tax Practitioners. The Journal of Law, Economics, and Organization, 7, 163-181.

[15] Schneider, F., Enste, D., 2000. Shadow Economies: Size, Causes, and Consequences, Journal of Economic Literature, 77-114.

[16] Schneider, F., 2006. Shadow Economies and Corruption All Over the World: What Do We Really Know? IZA Discussion Paper No. 2315.

[17] Slemrod, J., 2004. The Economics of Corporate Tax Selfishness, NBER Working Paper Series, WP 10858.

[18] Zheglov, A., Tax Evasion Through a Side Door (in Russian), Kommersant, 28 March 2006.

Appendices

A - Proof of Lemma 1 - Tax authority best response

As we have seen, the tax authority maximizes

$$R(\pi_r, r; \mu) = t\pi_r + r\mu(E_\nu \{\pi \,|\pi_r\} - \pi_r) - c(r),$$

the first order condition is hence

$$\mu \left(E_\nu \{\boldsymbol{\pi} \,|\pi_r\} - \pi_r\right) - c'(r) = 0, \tag{24}$$

and the second order condition is simply $c''(r) > 0$.

For the assumed cost function $c(r) = -c\ln(1-r)$ the FOC can be rewritten as is

$$r\left(\pi_r; \nu\right) = 1 - \frac{c}{\mu\left(E_\nu \{\boldsymbol{\pi} \,|\pi_r\} - \pi_r\right)}, \tag{25}$$

which is the statement of the Lemma. In a separating equilibrium $E_\nu \{\boldsymbol{\pi} \,|\pi_r\} = \hat{\pi}$; in case of pooling at zero or any other report below $\pi_{\min}$, we have $E_\nu \{\boldsymbol{\pi} \,|\pi_r\} = E\boldsymbol{\pi}$, as the only consistent belief of the authority is the true underlying distribution $\nu(\pi \,|\pi_r) = F(\pi)$. When the pooling is at a report above $\pi_{\min}$, the belief is updated according to Bayes formula $\nu(\pi \,|\pi_r) = (F(\pi) - F(\pi_r)) / (1 - F(\pi_r))$ for $\pi \geq \pi_r$ and $\nu(\pi \,|\pi_r) = 0$ for $\pi < \pi_r$ as the tax authority knows that the taxpayers are rational. But in this paper we restrict our attention to the pooling at zero equilibrium.

B - Proof of Proposition 1 - Separating equilibrium

The separating equilibrium has to satisfy the following conditions: 1) absence of deviation incentives for the taxpayer when the tax authority audits each report with equilibrium probability; 2) absence of deviation incentives for the tax authority when every taxpayer submits equilibrium report; 3) consistent beliefs of the tax authority about the true income of the taxpayers who submit equilibrium reports; 4) arbitrary beliefs of the tax authority about the true income of the taxpayer who submits out-of-equilibrium report.

Concerning 2), the best response of the authority given its belief $\hat{\pi}(\pi_r)$ is given by (25). This is straightforward from the authority maximization problem (the payoff is concave in r). The restriction on r is obviously $0 \leq r \leq 1$, and it is satisfied whenever

$$(\hat{\pi}(\pi_r) - \pi_r)\,\mu \geq c \tag{26}$$

In words, each report should bring more revenue than costs. If this condition does not hold, the authority's best response is not to audit the report.

For 1) and 3) we have to consider two cases, strict and weak equilibrium.

strict equilibrium

In the strict equilibrium (the firms strictly prefer the equilibrium reporting strategy) the firms maximize their after-tax expected profit

$$\pi - t\pi_r - (p + t(1+s_1)r_1 r)\,(\pi - \pi_r)\,.$$

The first order condition to this problem is

$$-t - t(1+s_1)r_1 r'(\pi_r)\,(\pi - \pi_r) + p + t(1+s_1)r_1 r = 0,$$

and the second order condition is

$$-r''(\pi_r)\,(\pi - \pi_r) + 2r'(\pi_r) \leq 0.$$

One can check that it is satisfied in equilibrium for our auditing function $c(r) = -c\ln(1-r)$.

Plugging in the tax authority best response (assume $\hat{\pi} - \pi_r > \frac{c}{\mu}$), we can rewrite the first order condition as

$$1 - \frac{c}{\mu\,(\hat{\pi} - \pi_r)} - (\pi - \pi_r)\,\frac{c}{\mu\,(\hat{\pi} - \pi_r)^2}\,(\hat{\pi}'(\pi_r) - 1) = \frac{t-p}{t(1+s_1)r_1}.$$

Using the consistent beliefs in the candidate equilibrium $\hat{\pi} = \pi$, we get

$$-\frac{c}{\mu\left(\hat{\pi}-\pi_r\right)}\hat{\pi}'\left(\pi_r\right) = \frac{t-p}{t(1+s_1)r_1} - 1,$$

For convenience denoting evasion associated with a given report as $e(\pi_r) \equiv \pi(\pi_r) - \pi_r, e'(\pi_r) \equiv \pi'(\pi_r) - 1$, we have

$$c\left(e'+1\right) = \left(1 - \frac{t-p}{t(1+s_1)r_1}\right)\mu e.$$

Using B defined as in the text $(B := \mu - (t-p)\left(1+s+s_1\right)/\left(1+s_1\right))$ we have

$$ce' - Be + c = 0. \tag{27}$$

This is a first order ordinary differential equation (DE). Its solution is a sum of general solution to the corresponding homogenous DE and a particular solution to the non-homogenous DE. Homogenous equation is $ce'(\pi_r) - Be(\pi_r) = 0$. Its solution is

$$e(\pi_r) = A\exp\left\{\rho\pi_r\right\}; \rho = \frac{B}{c}.$$

To find a particular solution, put $e'(\pi_r) = 0$ to get $e(\pi_r) = \frac{c}{B}$. Thus, the general solution of our equation will be $e(\pi_r) = A\exp\left\{\frac{B}{c}\pi_r\right\} + \frac{c}{B}$. To pin down the constant A we need an initial condition, $r\left(\pi_{r\max}\right) = 0$ reflecting the fact that the maximal report should not be audited (we assume that it is not profitable, which, strictly speaking, does not have to be true unless $\max\int R(\pi_r\left(\pi\right), e\left(\pi_r\left(\pi\right)\right))dF\left(\pi\right)$ is achieved at $r\left(\pi_{r\max}\right) = 0$). Thus,

$$\begin{aligned} 1 - \frac{c}{\mu\left(\pi_{\max} - \pi_{r\max}\right)} &= 0 \\ \pi_{r\max} &= \pi_{\max} - \frac{c}{\mu}. \end{aligned}$$

After rearrangement, we have

$$A = \left(\frac{c}{\mu} - \frac{c}{B}\right)\exp\left\{-\frac{B}{c}\pi_{r\max}\right\}.$$

This provides us with the expression (**??**).

For 3) we need the consistency of beliefs, that is the authority's belief about $\pi(\pi_r)$ must coincide with actual reporting strategy $\pi_r(\pi)$. This is only possible, if $\pi(\pi_r)$ is increasing, and in this case consistency is actually ensured by the best responses in our formulation. Then, the following condition should be satisfied:

$$\pi'(\pi_r) = 1 + \left(\frac{c}{\mu} - \frac{c}{B}\right)\frac{B}{c}e^{\frac{B}{c}\left(\pi_r - \pi_{\max} + \frac{c}{\mu}\right)} > 0 \forall \pi_r \in [\pi_{r\min}, \pi_{r\max}]$$

It turns out to be useful to look at the coefficient of the exponent, $B/\mu - 1$. It is negative for $p < t$, and hence the coefficient is negative. Using this to simplify the condition for positive derivative, we get $\mu < \mu - B$ in case of $B > 0$, which is obviously true. In case of $B < 0$ the condition is $\pi_{\max} < c/\mu$, but then the strict separating equilibrium does not exist for $p < t$, as $r^* \equiv 0$ and all firms prefer evading.

To sum up the argument, $B > 0 \Rightarrow y' > 0, B < 0 \Rightarrow \nexists y$, so the separating equilibrium may only exist for $B > 0$ or

$$p > t\left(1 - r_1\left(1 + s_1\right)\right). \tag{28}$$

What happens if the reporting is decreasing in the profit? Then the initial condition is

$$\begin{aligned} 1 - \frac{c}{\mu\left(\pi_{\min} - \pi_{r\max}\right)} &= 0 \\ \pi_{r\max} &= \pi_{\min} - \frac{c}{\mu} \end{aligned}$$

And so A is the same. The difference is that there is no problem for $\pi'(\pi_r) < 0$, so that

$$\begin{aligned} \pi'(\pi_r) &= 1 + \left(\frac{c}{\mu} - \frac{c}{B}\right)\frac{B}{c}e^{\frac{B}{c}\left(\pi_r - \pi_{\max} + \frac{c}{\mu}\right)} < 0 \\ \left(\frac{B}{\mu} - 1\right)e^{\frac{B}{c}(\pi_r - \pi_{r\max})} &< -1 \end{aligned}$$

with $B < 0$ satisfied for sure. So the really binding in this case is of course $\pi_r(\pi_{\max}) \geq 0$

$$\left(\frac{c}{\mu} - \frac{c}{B}\right)\exp\left\{\frac{B}{c}\pi_{r\max}\right\} + \frac{c}{B} \leq \pi_{\max}$$

We have to also respect the individual rationality constraint, that is the above described reporting strategy should be preferred to honest reporting:

$$\pi - t\pi_r^* - (p + t(1+s_1)r_1 r)\left(\pi - \pi_r^*\right) > (1-t)\,\pi,$$

which can be rearranged to obtain

$$p < t\left(1 - r_1\left(1 + s_1\right)r^*\right).$$

Since $\max r^* = 1 - \frac{c}{\mu(\pi_{\min} - \pi_{r\min})}$, we have

$$p < t\left(1 - r_1\left(1 + s_1\right)\left(1 - \frac{c}{\mu\left(\pi_{\min} - \pi_{r\min}\right)}\right)\right). \tag{29}$$

The last check is for the equilibrium reports to be positive, as the negative reports are not allowed (or do not make sense, since no negative tax is paid). The corresponding restriction can be formulated as

$$\left(\frac{c}{\mu} - \frac{c}{B}\right) \exp\left\{\frac{B}{c}\left(\frac{c}{\mu} - \pi_{\max}\right)\right\} \leq \pi_{\min} - \frac{c}{B}.$$

Since $0 < B < \mu$ (the positivity required by consistency of beliefs discussed later), the condition is satisfied for $c/B < \pi_{\min}$, that is when $p \in \left(t - \left(1 - \frac{c}{\mu\pi_{\min}}\right) t(1 + s_1)r_1, t\right)$ - exactly when the rationality constraint is not satisfied.

When $c/B > \pi_{\min} > c/\mu$, the condition is actually satisfied for the interval $p \in \left(t\left(1 - r_1\left(1 + s_1\right)\right), t - \left(1 - \frac{c}{\mu\pi_{\min}}\right) t(1 + s_1)r_1\right)$, as can be directly checked at the borders ($B = 0$ and $B = \frac{c}{\pi_{\min}}$) and by monotonicity and continuity applies to the whole interval.

Collecting the restrictions, we have $c/\mu < \pi_{\min}, p \in \left(t\left(1 - r_1\left(1 + s_1\right)\right), t - \left(1 - \frac{c}{\mu\pi_{\min}}\right) t(1 + s_1)r_1\right)$ as necessary and sufficient conditions for complete separating (strict) equilibrium existence.

weak equilibrium

In the weak equilibrium the firms are indifferent between submitting reports truthfully and engaging into evasion. Formally,

$$\pi - t\pi_r - \left(p + t(1 + s_1)r_1 r\left(\pi_r\right)\right)\left(\pi - \pi_r\right) = \pi - t\pi. \forall\pi$$

After rearranging this condition using the tax authority best response (25), which with the constant evasion takes the form $1 - \frac{c}{\mu\hat{e}}$, we arrive at

$$\hat{e} = \frac{c}{\mu}\left(1 - \frac{t - p}{t(1 + s_1)r_1}\right)^{-1}.$$

Imposing the consistency of beliefs $\hat{e} = e$ we get the expression in the proposition.

Note that restriction on evasion volume in this case is

$$\frac{c}{\mu} < e < \pi_{\min},$$

which in terms of the price looks like

$$t\left(1-\left(1+s_1\right)r_1\left(1-\frac{c}{\mu\pi_{\min}}\right)\right)<p<t.$$

In this equilibrium the expected punishment is exactly equal to the expected gain from the evasion regardless of the evasion level: $t(1+s_1)r_1r\left(\pi_r\right)=t-p$. Profitable deviations are impossible, as any report brings about the same payoff.

To complete the characterization of subgame equilibrium (requirement 4)), out-of-equilibrium beliefs of the tax authority (for both strict and weak equilibrium) are specified as $\pi\left(\pi_r\right)=\begin{cases}\pi_{\min}, & \pi_r<\pi_{r\min}\\ \pi_{\max}, & \pi_r>\pi_{r\max}\end{cases}$. Note that we do not have to specify beliefs for any possible deviation to reports in $\left[\pi_{r\min},\pi_{r\max}\right]$, as the tax authority has no chance of observing such a deviation.

C - Proof of Proposition 2 - Hybrid equilibrium

We have shown that for $c/\mu>\pi_{\min}$, the complete separation equilibrium does not exist. Here we are interested whether a hybrid equilibrium with the following properties exists: (i) all the taxpayers with $\pi\in\left[\pi_{\min},\pi^0\right]$ submit zero reports; (ii) all the taxpayers with $\pi\in\left(\pi^0,\pi_{\max}\right]$ submit different reports $\left(\pi_r^0,\pi_{r\max}\right]$; (iii) $r\left(\pi_r>0\right)<r\left(\pi_r=0\right)$; (iv) $I\left(\pi^0,0\right)=I\left(\pi^0,\pi_r^0\right)$. The first two are defining properties, the second is the decreasing in report auditing, the third follows from continuity of the distribution. let us look at (iii) more closely.

Since we know the auditing has to be a best response in equilibrium, from (24) we get for our auditing cost function $r\left(\pi_r>0\right)=1-\frac{c}{\mu\left(\hat{\pi}-\pi_r\right)}<1-\frac{c}{\mu E\left(\boldsymbol{\pi}|\pi\leq\pi^0\right)}=r\left(\pi_r=0\right)$ or, in particular,

$$E\left(\boldsymbol{\pi}|\pi\leq\pi^0\right)>\hat{\pi}^0-\pi_r^0. \tag{30}$$

This is a consistency requirement on the side of the tax authority.

For the firm's consistency, we need

$$\begin{aligned}I\left(\pi^0,0\right) &= \pi^0-\left(p+t(1+s_1)r_1r\left(0\right)\right)\pi^0\\ &= \pi^0-t\pi_r^0-\left(p+t(1+s_1)r_1r\left(\pi_r^0\right)\right)\left(\pi^0-\pi_r^0\right)=I\left(\pi^0,\pi_r^0\right)\end{aligned}$$

we need the equality, because otherwise by continuity there is incentive to deviate. Working out this condition, we arrive at

$$\frac{\pi^0-\pi_r^0}{\left(\hat{\pi}^0-\pi_r^0\right)}-\frac{\pi^0}{E\left(\boldsymbol{\pi}|\pi\leq\pi^0\right)}=-\frac{B}{c}\pi_r^0$$

using consistency of beliefs, we get

$$\frac{B}{c}\pi_r^0 = \frac{\pi^0 - E\left(\boldsymbol{\pi}|\pi \le \pi^0\right)}{E\left(\boldsymbol{\pi}|\pi \le \pi^0\right)} \tag{31}$$

This actually defines the level of report π_r^0 as a function of p and π^0 in the hybrid equilibrium. This also immediately imposes $B > 0$ on the parameters. The problem is that nothing pins down π^0. However, if profit is distributed uniformly over $[0, \pi_{\max}]$, this becomes $\pi_r^0 = \frac{c}{B}$. Here the profit does not enter, because with uniform distribution the ratio $\frac{\pi^0 - E\left(\boldsymbol{\pi}|\pi\le\pi^0\right)}{E(\boldsymbol{\pi}|\pi\le\pi^0)}$ is constant, which is not true for a general distribution. We have to make sure that after-tax income is increasing in pre-tax income plus check incentive and participation constraints as in case of complete separation.

strict equilibrium

Since the separation part of the problem is identical to the previous one (complete separation), we get the same result up to π^0, only cut at the point defined by (31). So solving two equations simultaneously, we get π^0 and π_r^0. For the uniform, we have

$$\pi^0 = \left(\frac{c}{\mu} - \frac{c}{B}\right)\exp\left\{\frac{B}{c}\left(\frac{c}{B} - \pi_{\max} + \frac{c}{\mu}\right)\right\} + 2\frac{c}{B}.$$

Combining the consistency conditions of the tax authority (30) and the firms (31), we get

$$\frac{c}{B} > E\left(\boldsymbol{\pi}|\pi \le \pi^0\right) > \pi^0 - \pi_r^0.$$

For the uniform distribution, for example, it takes the form $\pi^0 < c/B$, which is satisfied.

The report is positive by construction, and evasion must be also positive. And it is, since it is decreasing in report and at the maximal profit is positive c/μ. We have to modify rationality constraint (29) to the analogous expression for the polled types in hybrid equilibrium:

$$p \le t\left(1 - r_1\left(1+s_1\right)r\left(0, \pi_r^0\right)\right).$$

To check for absence of deviation from the pooling part, we have

$$\begin{aligned} I\left(\pi^-, 0\right) &= \pi^- - \left(p + t(1+s_1)r_1 r\left(0\right)\right)\pi^- \\ &> \pi^- - t\pi_r^0 - \left(p + t(1+s_1)r_1 r\left(\pi_r^0\right)\right)\left(\pi^- - \pi_r^0\right) = I\left(\pi^-, \pi_r^0\right) \end{aligned}$$

or

$$\left(\frac{t-p}{t(1+s_1)r_1} - r\left(\pi_r^0\right)\right)\pi_r^0 > \left(r\left(0\right) - r\left(\pi_r^0\right)\right)\pi^-$$

Since $r(0) - r\left(\pi_r^0\right) > 0$, the rhs increases in π^-. At π^0 it reaches maximum with equality, so the condition is indeed satisfied.

From the separating part,

$$\begin{aligned} I\left(\pi^+, 0\right) &= \pi^+ - \left(p + t(1+s_1)r_1 r\left(0\right)\right)\pi^+ \\ &< \pi^+ - t\pi_r^+ - \left(p + t(1+s_1)r_1 r\left(\pi_r^+\right)\right)\left(\pi^+ - \pi_r^+\right) = I\left(\pi^+, \pi_r^+\right) \end{aligned}$$

or

$$\left(\frac{t-p}{t(1+s_1)r_1} - r\left(\pi_r^+\right)\right)\pi_r^+ < \left(r\left(0\right) - r\left(\pi_r^+\right)\right)\pi^+$$

by the same logic works for π_r^0. Thus also true for π_r^+, as $I\left(\pi^+, \pi_r^+\right) > I\left(\pi^+, \pi_r^0\right)$ by the separating part condition.

To complete the characterization of the hybrid equilibrium, out-of-equilibrium beliefs of the tax authority should be specified. It is sufficient that $\forall \pi_r \in \left(0, \pi_r^0\right)$ $r(0) \leq r(\pi_r) \Longrightarrow E_D\left(\boldsymbol{\pi}|\pi_r\right) \geq \pi_r + E\left(\boldsymbol{\pi}|\pi \leq \pi^0\right)$. Actually, for the pooled types it suffices to have $E_D\left(\boldsymbol{\pi}|\pi_r\right) \geq E\left(\boldsymbol{\pi}|\pi \leq \pi^0\right)$ by the same logic as considered below for complete pooling. For the separated types, a weaker sufficient condition is a mess, so we do not state it here.

weak equilibrium

In the weak hybrid equilibrium the types below π^0 evade everything; the types above are indifferent between honesty and cheating. Using the same logic, we arrive at (7) for the separating part. The restriction is slightly different,

$$p > t - t(1+s_1)r_1 r\left(0, \pi^0\right),$$

and complements the rationality constraint for the strict hybrid equilibrium.

D - Proof of Proposition 3 - Pooling equilibrium

A pooling equilibrium has to satisfy the following conditions: 1) absence of deviation incentives for the taxpayer when the tax authority audits any report with equilibrium probability; 2) absence of deviation incentives for the tax authority when every taxpayer submits zero report; 3) arbitrary beliefs of the tax authority about the true income of the taxpayer who submits out-of-equilibrium report.

As mentioned in the text, we only consider the pooling at zero equilibrium, as we consider zero report a natural focal point for underreporting.

As far as 1) is concerned, the payoff from zero report should be preferred to any deviation for any profit level. As for 2), tax authority chooses the auditing probability (11) that maximizes its revenues given zero report. Finally, for 3) we need an analogous expression for a deviator, and that should depend on the out-of-equilibrium beliefs of the tax authority, that is it can be any belief. We consider an arbitrary belief D, but notice that the most adverse for the deviator belief (and hence most favourable for the equilibrium) is that the deviator has maximum profit $\pi_{\max}$.

So, the net expected profit of the firm with gross profit π and a report π_r can be written as

$$I(\pi_r, \pi) = \pi - t\pi_r - p(\pi - \pi_r) - t(1+s_1)(\pi - \pi_r) r_1 r(\pi_r),$$

where the tax authority auditing is given by (24):

$$r(\pi_r, D) = \begin{cases} 1 - \frac{c}{\mu E\boldsymbol{\pi}}, & \pi_r = 0; \\ 1 - \frac{c}{\mu(E_D\{\boldsymbol{\pi}|\pi_r\} - \pi_r)}, & \pi_r \in \left(0, E_D\{\boldsymbol{\pi}|\pi_r\} - \frac{c}{\mu}\right]; \\ 0, & \pi_r \geq E_D\{\boldsymbol{\pi}|\pi_r\} - \frac{c}{\mu}. \end{cases}$$

We have to then consider three cases:

$$\begin{aligned} I(0, \pi) &= \pi - p\pi - t(1+s_1)\pi r_1\left(1 - \frac{c}{\mu E\boldsymbol{\pi}}\right), \\ I(\pi_r, \pi) &= \pi - t\pi_r - p(\pi - \pi_r) - t(1+s_1)(\pi - \pi_r) r_1\left(1 - \frac{c}{\mu\left(E_D\{\boldsymbol{\pi}|\pi_r\} - \pi_r\right)}\right), \\ I(\pi_r \geq, \pi) &= \pi - t\pi_r - p(\pi - \pi_r). \end{aligned}$$

First, we show that $I(0, \pi) \geq I(\pi_r \geq, \pi)\, \forall \pi, \pi_r \geq E_D\{\boldsymbol{\pi}|\pi_r\} - \frac{c}{\mu}$. As $I(\pi_r \geq, \pi)$ is decreasing in π_r, it is enough to show that the inequality holds for $\pi_r = E_D\{\boldsymbol{\pi}|\pi_r\} - \frac{c}{\mu}$:

$$\pi - p\pi - t(1+s_1)\pi r_1\left(1 - \frac{c}{\mu E\boldsymbol{\pi}}\right) \geq (1-p)\pi - (t-p)\left(E_D\{\boldsymbol{\pi}|\pi_r\} - \frac{c}{\mu}\right)$$

Thus, a sufficient condition for no deviation with a belief D such that $E_D\{\boldsymbol{\pi}|\pi_r\} > \pi_{\max} - \left(\frac{\pi_{\max}}{E\pi} - 1\right)\frac{c}{\mu}$ is

$$t(1+s_1)r_1 \leq t - p,$$

which as we have seen is complementary to the separating equilibrium existence condition. A necessary one for a belief D is

$$\frac{t(1+s_1)r_1}{t-p}\pi_{\max}\left(1-\frac{c}{\mu E\boldsymbol{\pi}}\right)+\frac{c}{\mu}\leq E_D\left\{\boldsymbol{\pi}\left|\pi_r\right.\right\}$$

Secondly, we show that $I\left(0,\pi\right)\geq I\left(\pi_r,\pi\right)\forall\pi,\pi_r\in\left(0,E_D\left\{\boldsymbol{\pi}\left|\pi_r\right.\right\}-\frac{c}{\mu}\right]$. Note first that $I\left(\pi_r,\pi\right)$ is decreasing in π_r, if the condition $t(1+s_1)r_1\leq t-p$ is satisfied and if $\partial E_D\left\{\boldsymbol{\pi}\left|\pi_r\right.\right\}/\partial\pi_r\leq 1$. Then it is enough to consider a marginal deviation:

$$\pi-p\pi-t(1+s_1)\pi r_1\left(1-\frac{c}{\mu E\boldsymbol{\pi}}\right)\geq\pi-p\pi-t(1+s_1)\pi r_1\left(1-\frac{c}{\mu E_D\left\{\boldsymbol{\pi}\left|\pi_r\right.\right\}}\right).$$

This is clearly satisfied for any out-of-equilibrium belief D such that $E_D\left\{\boldsymbol{\pi}\left|\pi_r\right.\right\}\geq E\boldsymbol{\pi}$. So with $p\leq t\left(1-(1+s_1)r_1\right)$ the pooling at zero equilibrium exists.

In the rest of the paper we assume that the pooling at zero equilibrium is played whenever the separating equilibrium (or considered hybrid equilibrium) does not exist. As we have seen, this is only true for certain out-of-equilibrium beliefs. However, (i) there is no complete pooling equilibrium that exists for any out-of-equilibrium beliefs, (ii) considering all possible hybrid equilibria complicates the analysis substantially; moreover, they are not likely to be more robust or realistic than the equilibria considered, (iii) having two extreme cases of separation (or hybrid) and pooling provides a clear benchmark for the analysis of factors that affect evasion volume in our setting.

E - Proof of proposition 4

Taking the reporting strategy (**??**), we differentiate evasion volume with respect to profit

$$\frac{de\left(\pi\right)}{d\pi}=1-\frac{d\pi_r^*}{d\pi}=\left(\frac{B}{\mu}-1\right)e^{\frac{B}{c}\left(\pi_r^*(\pi)-\pi_r^*(\pi_{\max})\right)}\frac{d\pi_r^*}{d\pi}.$$

We know that for $p<t$, $B/\mu-1<0$. As $\frac{d\pi_r^*}{d\pi}>0$ and the exponent is positive, $\frac{de(\pi)}{d\pi}<0$.

Differentiating the evasion volume second time, we obtain

$$\frac{de^2\left(\pi\right)}{d\pi^2}=-\frac{d^2\pi_r^*}{d\pi^2}=\left(\frac{B}{\mu}-1\right)e^{\frac{B}{c}\left(\pi_r^*(\pi)-\pi_r^*(\pi_{\max})\right)}\left(\left(\frac{d\pi_r^*}{d\pi}\right)^2+\frac{d^2\pi_r^*}{d\pi^2}\right).$$

Rearranging, we get

$$\frac{de^2\left(\pi\right)}{d\pi^2}=\left(\frac{B}{\mu}-1\right)e^{\frac{B}{c}\left(\pi_r^*(\pi)-\pi_r^*(\pi_{\max})\right)}\left(\frac{d\pi_r^*}{d\pi}\right)^2/\left(\left(\frac{B}{\mu}-1\right)e^{\frac{B}{c}\left(\pi_r^*(\pi)-\pi_r^*(\pi_{\max})\right)}+1\right).$$

As the nominator is negative, the second derivative can only be positive, if the denominator is negative. Since the minimum of the first term of denominator is achieved at $\pi = \pi_{\max}$, we must have $\frac{B}{\mu} - 1 + 1 < 0$, which is impossible. Thus, the second derivative is negative, $\frac{de^2(\pi)}{d\pi^2} < 0$.

F - Proof of proposition 5

From the equilibrium structure in propositions 1-3 we can see that the specialist's profit maximization (12) can be split into three subproblems: pooling, strict separation and (possibly) weak separation. The maximization in the pooling equilibrium is trivial: since the evasion volume is fixed, the local profit maximizing price is $p = t\left(1 - r_1\left(1 + s_1\right)\right)$. For the weak separating equilibrium the profit function can be written as $\left(p - c_s - str_1 r\right) e$, the first derivative is

$$e + \left(p - c_s - str_1\right) e'.$$

Using the explicit expression for e from (7) in proposition 1 this can be rewritten as $\mu - t + c_s$, which is positive iff condition (13) is satisfied. Thus, in this case the local profit maximizing price is $p = t$. Correspondingly, the local maximizing price is the minimal price that supports weak separating or hybrid equilibrium, iff condition (13) is not satisfied.

The least tractable case is the strong separating or hybrid equilibrium. However, we are able to show that under condition (13) it is strictly dominated by an equilibrium with $p = t$. The condition for that is

$$\left(p - c_s - str_1\right) \int_{\pi_{\min}}^{\pi_{\max}} \left(\pi - \pi_r\left(p, \pi\right)\right) dF\left(\pi\right) < \left(t - c_s - str_1\right) \frac{c}{\mu} \tag{32}$$
$$\text{for } t\left(1 - r_1\left(1 + s_1\right)\right) < p < t\left(1 - r_1\left(1 + s_1\right) r\right).$$

After rearranging and using the fact that $\int_{\pi_{\min}}^{\pi_{\max}} dF\left(\pi\right) = 1$ and $p - c_s - str_1 \geq 0$ (otherwise the separating equilibrium brings about less than sure minimum of $\frac{cs}{1+s+s_1}$ to the specialist) we get

$$\int_{\pi_{\min}}^{\pi_{\max}} \left(\pi - \pi_r\left(p, \pi\right)\right) dF\left(\pi\right) < \frac{c\left(t - c_s - str_1\right)}{\mu\left(p - c_s - str_1\right)}. \tag{33}$$

From (**??**) we know that

$$\pi - \pi_r(p, \pi) < \frac{c}{B} \forall \pi,$$

(for a hybrid equilibrium this is only true for the separating part, and for the pooling part there is a weaker condition $E(\boldsymbol{\pi}|\pi \leq \pi^0) < c/B$, which is sufficient for us, as $\int_{\pi_{\min}}^{\pi_{\max}} (\pi - \pi_r(p,\pi))\, dF(\pi) = E(\boldsymbol{\pi}|\pi \leq \pi^0) + \int_{\pi^0}^{\pi_{\max}} (\pi - \pi_r(p,\pi))\, dF(\pi))$ so that

$$\int_{\pi_{\min}}^{\pi_{\max}} (\pi - \pi_r(p,\pi))\, dF(\pi) < \int_{\pi_{\min}}^{\pi_{\max}} \frac{c}{B} dF(\pi) = \frac{c}{B}. \tag{34}$$

Now, if also

$$\frac{c}{B} < \frac{c(t - c_s - str_1)}{\mu(p - c_s - str_1)}, \tag{35}$$

then the profit in any strict separating equilibrium is dominated by the profit at t. Simply rearranging (35) we get

$$0 < \mu + c_s - t$$

This is the condition (13), so it is only left to show that under this condition the full cheating equilibrium is never preferred:

$$\frac{c}{\mu}(t - c_s - str_1) > (t - c_s - \mu)\, E\boldsymbol{\pi}. \tag{36}$$

Since $c/\mu < E\pi$ and $str_1 < \mu$, $t - c_s - str_1 > t - c_s - \mu$. We have just established, that $t - c_s - \mu < 0$. If $t - c_s - str_1 \geq 0$, then (36) is clearly satisfied. If $t - c_s - str_1 < 0$, then notice that $0 < c/\mu < E\pi$ and hence (36) is satisfied again.

G - Proof of proposition 6

As we have shown in the text that the statement of proposition is true for the corner case of $p = t$, it is left to formulate a more general function P and show that $\frac{dP}{ds} < \frac{dP}{ds_1}$. Define

$$P := (p^* - c_s - str_1) \int_{\pi_{\min}}^{\pi_{\max}} e(p^*, \pi)\, dF(\pi) - (t - c_s - \mu)\, E\boldsymbol{\pi} - \frac{cs}{1 + s + s_1}.$$

This can be rewritten as

$$\frac{c}{\mu}(t - c_s - str_1) + \Delta - (t - c_s - \mu)\, E\boldsymbol{\pi}$$

with a $\Delta > 0$ standing for the difference between the specialist's profit at p^* and t. The condition for $\frac{dP}{ds} < \frac{dP}{ds_1}$ is then $\frac{d\Delta}{ds} - \frac{d\Delta}{ds_1} < \frac{c}{\mu} tr_1$, which is satisfied in our equilibrium (derivation is not straightforward and available upon request).