Business Tax Audit Schemes, Firm Size and Productivity.

Alessandro Santoro,

Università degli studi di Milano-Bicocca & Econpubblica

Abstract

Small and medium Italian firms are audited, since 1998, according to an audit scheme known as *Studi di settore.* It is based on the idea to distinguish between *normal* and *hard-core* evaders and to focus on the latter. We generalize the scheme and analyze the relationship between the effective (ex-post) tax rate, firm size and productivity. We compare this generalized scheme with the optimal audit with commitment (OAWC) scheme suggested in the literature.

1. Introduction

Italy belongs to the group of OECD countries where the size of the shadow economy ranges between 24% and 30% of the GDP (Schneider and Enste, 2000). The Italian economy is characterized by a disproportionately high share of small enterprises (Arachi and Santoro, 2007) and, since the propensity to evade increases among very small and very large firms (the U-hypothesis: see Slemrod, 2007), the structure of the Italian economy may provide an explanation for massive tax evasion.

Small and medium Italian firms are audited, since 1998, according to a scheme known as *SdS* (*Studi di settore,* see Santoro, 2008; Arachi and Santoro, 2007). Firms are divided according to the business sector they belong. In every business sector, the Tax Agency distinguishes, according to a pre-specified set of criteria, *normal* firms from *hard-core* evaders. Evasion is assumed to be generated almost exclusively by unreported sales, not by overreported costs. In general, normal firms are those which presumably evade less than hard-core evaders.

Then, firms are asked to report profits as well as the value of their inputs (input value). A productivity parameter is calculated as the average input productivity of normal firms. Then, presumed profits are calculated for every firm as the product of the inputs value, reported by the firm, and this productivity parameter. Therefore, for every firm there are two reports (profits and inputs) and a value of presumed profits. Both profits and inputs reports may be audited, thus there are two types of audits: type-I audits on profits and type-II audits on inputs value. However, type-I audits concern only the difference between presumed profits and reported profits. This implies a commitment for the Tax Agency that the firm which reports profits at least equal to presumed profits is not audited. The scheme is completely transparent, since the firm knows the value of its presumed profits and audit probabilities.

The obvious question is: what is a rationale for SdS? We believe that the most convincing answer is based on the idea of "hitting the hard-core". In Italy tax evasion is so widespread that it can be assumed that the vast majority of firms do evade. However, not all firms evade to the same extent, i.e there is some heterogeneity in the propensity to evade. SdS were designed in an attempt to reduce this heterogeneity by reducing hard-core evasion. If evasion can be accomplished only through unreported sales, and not by overreporting costs, the propensity to evade by a single firm is captured by the ratio between true and reported input productivity. If one assumes, for a moment, that reported inputs are truthful, so that there is no need for the Tax Agency to audit inputs, presumed profits as defined within SdS are profits *that a representative firm evading less than hard-core evaders would obtain from given inputs.* Thus, by selecting an appropriately high probability of auditing profits, the hard-core evaders should be hit.

However, in this scheme there is a clear incentive for firms to manipulate, namely to underreport, the inputs value. By doing so, given a positive productivity parameter, presumed profits are reduced. Thus, to verify the claim that SdS actually hit the hard-core evaders, we have to add a constraint to the Tax Agency's problem: audits of input reports should be such that truthful reporting of input values is ensured. This is not immaterial, though, since input audits increase presumed profits but are costly. Thus, the Tax Agency may find it profitable to audit input less intensively, though always ensuring truthful reports, when presumed profits are low comparatively to audit costs. This generates a bias in favour of small firms and this bias limits the ability of SdS to hit the hard-core evaders. Namely, under SdS, it would be irrational for a revenue-maximizer constrained (to generate truthful input reports) Tax Agency to hit the hard-core evaders when they are very small firms, so that small firms will converge to an evasion rate which is likely to be higher than the present one.

This is quite an uncommon outcome of an audit scheme. To see this, consider the optimal audit with commitment (OAWC) scheme suggested in the literature (Scotchmer, 1987). Under OAWC, firms are asked to report (only) profits and they know that will be audited with given probabilities. When audit costs are assumed to be positive and constant, only firms reporting a profit lower than a given threshold are audited. Thus, OAWC and SdS are similar since they are both based on a threshold which the Tax Agency is committed to respect. However, the threshold is entirely exogenous in OAWC while it depends on input reports and thus it is partly endogenous in GSdS. In terms of resulting equilibria, OAWC, contrarily to GSdS, produce a bias against small firms since, unless they are very productive, their reported profits will be under the threshold so that the expected tax rate will be decreasing in size (regressive bias).

In this paper we do two things. First, we derive the optimal implementation of a generalized version of *Studi di Settore,* that we denote with GSdS, when the Tax Agency is constrained to maximize expected revenues and to induce truthful reporting of input values. Second, we analyze the relationship between the effective tax rate under the two audit schemes, firm size and productivity.

The paper is organized as follows. In Section 2 we describe the general features of the legal and institutional framework for SdS. In Section 3, audit probabilities and profit reports are derived for GSdS. In Section 4, optimal audit with commitment (OAWC) is described. In Section 5, the effective tax rate under GSdS and under OAWC are compared. Section 6 concludes.

2. The legal and institutional framework

Studi di settore are audit selection mechanisms adopted in Italy since 1998. They have been described in details by Santoro (2008) and Arachi and Santoro (2007). Here, we generalize the legal and institutional framework.

Every firm has true profits π_i, and true value of inputs X_i, thus $\pi_i = \beta X_i$. Reported profits and inputs are respectively denoted by $\hat{\pi}_i$ and $\widehat{X_i}$. The tax liability is given by $\tau\hat{\pi}_i$. Evasion is accomplished through underreported sales, but true sales, and thus true profits cannot be observed by the Tax Agency. However, the Tax Agency can distinguish two groups: *normal* firms which allegedly evade less than *hard-core* evaders. Thus, the Tax Agency calculates the average level of inputs' productivity reported by normal firms. We denote this average level by $\tilde{\beta}$ so that i's presumed profits are given by $\widetilde{\beta}\widehat{X_i}$.[1]

The legal framework is such the Tax Agency commits to a given audit scheme in every business sector. This scheme includes two types of audits: type-I audits on reported profits $\widehat{\pi}_i$ and type-II audits on reported inputs $\widehat{X_i}$. Type-I audits are characterized by partial legal enforceability of presumed profits $\widetilde{\beta}\widehat{X_i}$: the firm may be fined on the difference, if any, between presumed and reported profits, and the announced probability of a type-I audit should be decreasing in the ratio between reported and presumed profits and zero if $\widehat{\pi}_i/\widetilde{\beta}\widehat{X_i} = 1$. To make GSdS consistent, we also assume that type-II audits generate truthful input reports. These constraints are summarized as follows:

$$q(\delta_i)(1+f_1)\tau\left(\widetilde{\beta}\widehat{X_i} - \widehat{\pi}_i\right) + p_i(1+f_2)\tau\widetilde{\beta}\left(X_i - \widehat{X_i}\right) \qquad (1)$$

$$q(\delta_i) = \frac{1}{\delta_i}\left(1 - \frac{\widehat{\pi_i}}{\widetilde{\beta}\widehat{X_i}}\right), \delta_i > 0,\ \widehat{\pi_i} \le \widetilde{\beta}\widehat{X_i}; q = 0,\ \widehat{\pi_i} > \widetilde{\beta}\widehat{X_i} \qquad (2)$$

$$p_i : \widehat{X}_i = X_i \qquad (3)$$

where $q(.)$ is type-I audit probability, and f_1 is type-II unitary sanction, p_i is type-II audit probability and f_2 is type-II audit probability. Looking at (1)-(3), it is clear that Tax Agency really commits to the functional form of $q(.)$, as well as to values of δ_i, p_i, f_1, f_2 and $\widetilde{\beta}$ for every taxpayer . This commitment must be ex-post verifiable to be credible. Note that δ_i can be interpreted as the inverse of the slope of *q(.)* with respect to the ratio between reported and presumed profits. The lower δ_i is, the more "reactive" is the announced type-I audit probability function to a divergence between reported and presumed profits.

Before deriving GSdS, let us focus on the legal structure embodied in (1)-(3). The key point is the distinction between normal and hard-core evaders. The Tax Agency uses the information on

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[1] Note that we shall treat $\widetilde{\beta}$ as exogeneous even if , stricly speaking, it is endogenous. It seems implausible that a single normal firm chooses its reports of profits and of inputs by taking into account the effect that this will have on a

average profitability reported by *normal* firms , i.e. those which allegedly evade less than hard-core evaders, $\widetilde{\beta}$, along with the information provided by the firm, $\widehat{X_i}$, to calculate for each firm presumed profits, $\widetilde{\beta}\widehat{X_i}$. The legal structure reflects the "hitting the hard-core" idea: once $\widehat{X}_i = X$ is ensured, only the difference between profits by a representative normal firm, $\widetilde{\beta}X_i$ and reported profits, if any, can be audited and sanctioned.

Let us assume that f_I and f_{II} are set by the law[2]. Then the Tax Agency's problem can be written as

$$\max_{\delta_i,p_i} NTP = \sum_i \left\{ \begin{array}{c} \tau\widehat{\pi}_i^* + q(\delta_i)\left[(1+f_1)\tau\left(\tilde{\beta}\hat{X}_i^* - \widehat{\pi}_i^*\right) - c_I\right] \\ + p_i(1+f_2)\left[\tau\tilde{\beta}\left(X_i - \hat{X}_i^*\right) - c_{II}\right] \end{array} \right\}, i = 1,\ldots,n \qquad (4)$$

where NTP stands for net tax proceeds c_I is the unitary cost of type-I audits while c_{II} is the unitary cost of type-II audits and where

$$\widehat{\pi}_i^* = \arg\min_{\widehat{\pi}_i} EP; \hat{X}_i^* = \arg\min_{\widehat{X}_i} EP \qquad (5)$$

$$EP = \tau\widehat{\pi}_i + q(1+f_1)\tau\left(\tilde{\beta}\widehat{X}_i - \widehat{\pi}_i\right) + p_i(1+f_2)\tau\tilde{\beta}\left[X_i - \widehat{X}_i\right] + G(X_i - \widehat{X}_i) \qquad (6)$$

To understand (5) and (6), consider that the Tax Agency has to anticipate the fact that every firm will choose $\widehat{\pi}_i$ and $\hat{X}_i$ by minimizing its expected payment. We write the latter as the amount of expected taxation (Scotchmer, 1987) gross of the concealment cost G generated by tax evasion and equal for all firms. The idea is (Cowell, 2003) that tax-evasion is a costly activity since it entails organizational costs (manipulation of current accounts, implementation of a collusion agreement between employers and employees) and possibly also psychological costs. In Cowell (2003) the crucial feature of G is its convexity with respect to the amount of tax evasion. The increasing marginal concealment cost allows to reach interesting results even when risk-aversion is not explicitly accounted for. The sign of the second derivative of G plays an important role also in this

value calculated on the entire population of *normal* firms.

[2] The scheme we present here is a generalization rather than an exact description of Studi di Settore since, in the latter, i) turnover is reported rather than profits; ii) sanctions are the outcome of a settlement, i.e. a bargaining between the firm and the Tax Agency.

model (see Santoro (2008)).

Finally, truth-revelation of inputs is written as

$$\widehat{X}_i^* = X_i \tag{7}$$

3 Derivation of GSdS

The Tax Agency's problem is (4) under (5) and (7). The full derivation of results can be found in the Appendix. Main results can be summarized as follows.

Every firm should report profits and inputs so that

$$\frac{\hat{\pi}_i^*}{\tilde{\beta}\widehat{X}_i^*} = \left[1 - \frac{\delta_i}{2(1+f_1)}\right] \tag{8}$$

Equation (8) is saying that the value of δ_i influences the wedge between reported and presumed profits: as δ_i tends to zero, reported profits tend to presumed profits. To see why, recall that, as we noted above, the lower δ_i, the more "reactive" is the announced type-I audit probability function to a divergence between reported and presumed profits. When truthful reports of inputs value is ensured, the value of reported profits, and thus of tax revenues, depends entirely on δ_i.

Using (8) in (2) it can be seen that the fraction of profit reports which will be audited equals

$$q^{\text{GSdS}} = \frac{1}{2(1+f_I)}, \forall \hat{\pi}_i^* \tag{9}$$

Equation (9) is saying that the number of type-I audits does not depend on the value of δ_i and thus on the chosen ratio between presumed and reported profits. This result is entirely due to the linearity of q.

Type-II audit probability which ensures truthful input reports is given by

$$p_i = \phi(\delta_i) = \left[1 - \frac{G'(0)}{\tau\tilde{\beta}} - \frac{\delta_i}{4(1+f_1)}\right]\frac{1}{(1+f_2)} \tag{10}$$

The function $\phi(\delta_i)$ ensures that, for any given value of δ_i, p_i is high enough to ensure truthful reports of input values. Note that p_i is inversely related to δ_i. To understand this relationship, consider that, as δ_i decreases, the firm has an incentive to reduce $\hat{X}_i$ (just calculate the derivative of EP with respect to $\hat{X}_i$ to see this). To offset this incentive it is necessary to increase p_i.

When truthful input reports are ensured, the optimal choice of δ_i depends on the balance between reported profits and audit costs. As c_{II} increases, it is preferable for the Tax Agency to induce truthreporting by and increasing δ_i thus lowering p_i. Clearly, this needs to be balanced against the fact that increasing δ_i has a negative impact on reported profits, see (8), and thus on tax revenues.

The optimal solution is (see the Appendix)

$$\delta_i = \delta_i^{\min} \text{ iff } \tau\tilde{\beta}X_i > c_{II}; \delta_i = \delta_i^{\max} \text{iff } \tau\tilde{\beta}X_i < c_{II}, i = 1,\dots,n \tag{11}$$

where $\delta^{\min}$ and $\delta^{\max}$ are, respectively, the minimum and the maximum value of δ_i consistent with the model and $\delta^{\min} < \delta^{\max}$.

When the revenue expected from truthreporting is small, i.e. when X_i is small, it may happen that $\tau\tilde{\beta}X_i < c_{II}$. In this case the Tax Agency prefers to adopt a high value of δ_i and a low value of p_i. since the presumed profits are small compared to save audit costs c_{II}.

Then, the Tax Agency commits to the following type-II audit probability

$$p_i = \left[1 - \frac{G'(0)}{\tau\beta} - \frac{\delta_i^{\min}}{4(1+f_1)}\right]\frac{1}{(1+f_2)}, X_i > \widetilde{X} \tag{12}$$

$$p_i = \left[1 - \frac{G'(0)}{\tau\beta} - \frac{\delta_i^{\max}}{4(1+f_1)}\right]\frac{1}{(1+f_2)}, X_i \le \widetilde{X} \tag{13}$$

with

$$\widetilde{X} = \frac{c_{II}}{\tau\widetilde{\beta}} \tag{14}$$

Note that the commitment to the announced functional form of q and to the value of δ_i is ex-post verifiable through type-II audit probabilities and thus it is credible.

Now we can verify the claim that GSdS is able to "hit the hard-core". Reported profits will be equal to

$$\hat{\pi}_i = \tilde{\beta} X_i \left[1 - \frac{\delta_i^{\min}}{2(1+f_1)} \right], X_i > \widetilde{X} \tag{15}$$

$$\hat{\pi}_i = \tilde{\beta} X_i \left[1 - \frac{\delta_i^{\max}}{2(1+f_1)} \right], X_i \leq \widetilde{X} \tag{16}$$

If , for example, $\delta^{\min} = \varepsilon$ and $\delta^{\max} = 2(1+f_1) - \varepsilon$, where ε is a small but positive number we obtain these results

$$\hat{\pi}_i \approx \tilde{\beta} X_i, X_i > \widetilde{X} \tag{17}$$

$$\hat{\pi}_i \approx 0, X_i \leq \widetilde{X} \tag{18}$$

Thus, the claim that GSdS "hit the hard-core" is respected only when the size of the firm, and thus presumed profits, are large enough to offset the cost of the audit. In this case, i.e. when $X_i > \widetilde{X}$, reported profits will converge to $\tilde{\beta} X_i$. On the other hand, when the size of the firm, and presumed profits, are small relatively to the cost of the audit, i.e. when $X_i \leq \widetilde{X}$ [3], reported profits will converge to 0. Thus, we can see that there is a bias in favour of (very) small firms: if the Tax Agency implements optimally the legal structure of *Studi di settore*, (very) small firms will be allowed to increase tax evasion and to report zero profits.

This bias can clearly be seen in the effective tax rate which, from (17) and (18) and recalling that true profits are given by $\pi_i = \beta X_i$, can be written as

$$ER^{\text{GSdS}} \approx \tau \tilde{\beta} / \beta_i, X_i > \widetilde{X} \tag{19}$$

$$ER^{\text{GSdS}} \approx 0_i, X_i \leq \widetilde{X} \tag{20}$$

[3] Here we assume that the size of the firm can be approximated by the value of its inputs. This is similar to the idea that the size of the firm can be measured by size. However, part of the literature prefers to measure size by turnover, which it would not be consistent with our approach, where turnover depends on productivity.

4. Description of OAWC

The optimal audit scheme with commitment, OAWC, is largely studied in the literature (Andreoni et al., 1998; Sanchez and Sobel, 1993). Here, we take the version provided by Scotchmer (1987). Every firm has true profits π_i and report profits $\hat{\pi}_i$. The tax liability is given by $\tau\hat{\pi}_i$. True profits cannot be observed by the Tax Agency. However, the Tax Agency receives a signal which is statistically correlated to the true profit in the given sector and knows the distribution $H(.;.)$ of the true profit conditional on the signal in the given sector. For example, the Tax Agency knows that true profit is uniformly distributed on $[\bar{\pi}-a, \bar{\pi}+a]$ where $\bar{\pi}$ denotes the average true profit in the sector.

The legal framework is such the Tax Agency commits to a given audit scheme in every business sector. Therefore, audit probabilities are known to firms when they report profits. There are no additional legal or institutional constraints: the content of the commitment is chosen freely by the Tax Agency.

To find optimal audit probabilities, the Tax Agency maximizes a net revenue function, i.e. the differences between expected gross tax revenues and expected audit costs, by anticipating the reaction of profit-maximizers and risk neutral firms to the announced scheme. It turns out that this optimal scheme is based on an exogenous threshold (cut-off). By exogenous threshold we mean a value of profits which is chosen by the Tax Agency and cannot be manipulated by firms. We denote this exogenous threshold by $\tilde{\pi}$. More precisely, OAWC is summarized by the following probability to audit reported profits:

$$q^{\text{OAWC}} = \frac{1}{1+f} \text{ if } \hat{\pi}_i < \tilde{\pi} \tag{21}$$

$$q^{\text{OAWC}} = 0 \text{ if } \hat{\pi}_i \geq \tilde{\pi} \tag{22}$$

where $\tilde{\pi}$ threshold typically depends on the distribution $H(.;.)$,on the cost of the audit and amount of sanction paid by the firm if caught evading, and on tax parameters. Probabilities (21) and (22) are decreasing in reported profits because of the incentive-compatibility constraint: if probabilities were increasing in profits, underreporting of profits would be a rational strategy. Since profits are correlated with size, contrarily to what happens under GSdS, under OAWC a bias against small firms is generated. However, as we shall see in the next Section, a small and very productive firm may enjoy low tax rates. When true profit is uniformly distributed on $[\bar{\pi}-a, \bar{\pi}+a]$ one has (Scotchmer, 1987)

$$\tilde{\pi} = \bar{\pi} + a - \frac{c}{\tau(1+f)} \tag{23}$$

where f is the sanction for every \$ of detected evasion and c is the unitary audit cost. For given values of a and of τ, the threshold decreases in the cost of the audit and increases in the average value of profits and in the value of the unitary sanction. In this case, using the properties of uniform distributions, the share of firms which are not audited is given by

$$1 - H(\tilde{\pi}) = \frac{c}{2a\tau(1+f)} \tag{24}$$

which is positive if $c > 0$. Clearly, all these firms will simply report $\tilde{\pi}$.

On the other hand, the share $H(\tilde{\pi})$ of firms which report profits $\hat{\pi}_i \geq \tilde{\pi}$ are audited with a probability $1/(1+f)$ which, under risk-neutrality, ensures that they will not evade, so that these firms will report $\hat{\pi}_i = \tilde{\pi}$. In other words, audits should be pursued only to ensure that the Tax Agency's threat is credible, but they should all end up with no sanction, as it typically happens in these kind of Principal-Agent games with complete information.

Finally, the effective (ex-post) tax rate is given by

$$ER^{\text{OAWC}} = \tau, \pi_i < \tilde{\pi} \tag{25}$$

$$ER^{\text{OAWC}} = \tau\tilde{\pi}/\pi_i, \pi_i \geq \tilde{\pi} \tag{26}$$

5. Firm size and productivity

We analyze a very simplified economy which is made of a given number of business sectors. In each sector, there are n firms, $i = 1,..,n$. Each firm is characterized by the actual value of its inputs, X_i, and by their true productivity, β_i so that true profits are equal to $\pi_i = \beta X_i$.

We shall compare the effective tax rate under GSdS, i.e. (19) and (20), with the effective tax rate under OAWC, i.e. (25) and (26). To do so, we assume that true profits are uniformly distributed on $[\overline{\pi} - a, \overline{\pi} + a]$ where $\overline{\pi}$ is the average value of true profits in a given sector. To simplify calculations, we also assume that

$$a = \frac{c}{\tau(1+f)} \tag{27}$$

where c is the cost of either a profit (type-I under GSdS) or an input (type-II under GSdS) audit, while f is the sanction for underreporting profits in OAWC. This implies that the threshold in OAWC (see 23) can be written as

$$\tilde{\pi} = \overline{\pi} = \overline{\beta}\overline{X} + \text{cov}[\beta, X] \tag{28}$$

where upper bars denote mean values. Now, if we measure the size of the firm by the ratio

$$\gamma = \frac{X_i}{\overline{X}} \tag{29}$$

then the effective tax rate under OAWC can be written as

$$ER^{\text{OAWC}} = \tau, \beta_i < \frac{\overline{\beta}}{\gamma} + \frac{\text{cov}(\beta, X)}{\gamma \overline{X}} \tag{30}$$

$$ER^{\text{OAWC}} = \frac{\tau\overline{\pi}}{\beta_i \gamma \overline{X}}, \beta_i \geq \frac{\overline{\beta}}{\gamma} + \frac{\text{cov}(\beta, X)}{\gamma \overline{X}} \tag{31}$$

The effective tax rate under OAWC is non-increasing in size and non-increasing in input productivity. Size, as measured by γ, influences the effective tax rate in two different ways. First, it reduces the value of the productivity threshold, i.e. the value of $\frac{\overline{\beta}}{\gamma}+\frac{\mathrm{cov}(\beta,X)}{\gamma\overline{X}}$. Second, it reduces the effective tax rate when true profits are above the profit threshold, $\widetilde{\pi}$. This illustrates the bias against small firms which is implied in OAWC. However, the effective tax rate is decreasing in input productivity, for a given size. The joint influence of size and productivity is captured by the covariance. When this is positive, few, if any, small firms will reach the profit threshold, so that we will end up with small and unproductive firms being taxed a lot and large and productive firms being taxed very slightly. When covariance is negative, then the distribution of the effective tax rate is less polarized.

We turn now to examine the effective tax rate under GSdS. Under the above specified assumptions the threshold can be written as

$$\widetilde{X}=a(1+f)/\lambda\overline{\beta},\lambda\equiv\widetilde{\beta}/\overline{\beta} \tag{32}$$

The parameter λ measures the ratio between the average input productivity by *normal* firms and average true input productivity. Then we can write

$$ER^{\mathrm{GSdS}}\approx\tau\tilde{\beta}/\beta_i,\gamma\geq\frac{a(1+f)}{\lambda[\overline{\pi}-\mathrm{cov}(\beta,X)]} \tag{33}$$

$$ER^{\mathrm{GSdS}}\approx 0_i,\gamma<\frac{a(1+f)}{\lambda[\overline{\pi}-\mathrm{cov}(\beta,X)]} \tag{34}$$

The effective tax rate is non-decreasing in size and non-increasing in productivity. Size, as measured by γ, determines whether the firm is going to report positive profits or not. A very small firm reports zero profits and thus it is not taxed. If the firm is large enough to be audited and to report positive profits, then the effective tax rate depends only on productivity, so that most productive large firms enjoy lower tax rates. Again, the way size and productivity are related is important, since when the covariance is positive the size threshold decreases so that more small (and unproductive) firms will be taxed at a zero rate.

6. Concluding remarks

Business tax auditing policies influence taxpayers' behaviour and thus the effective tax rate. The latter, in turn, depends on firm size and productivity. In this paper, we focus the attention on GSdS, which is a generalization of *Studi di Settor*e, a policy adopted in Italy since 1998. This policy is based on the distinction, within every business sector, between normal firms which allegedly evade, through unreported sales, less than hard-core evaders. Presumed profits, are equal, for every firm, to the product of the input value, reported by the firm, and average input productivity reported by normal firms. The Tax Agency commits to audit only profit reports lower than presumed profits.

We believe this kind of policy has been chosen to accomplish the idea of "hitting the hard-core" evaders by inducing them to report at least presumed profits. The first objective of the paper is to very whether this objective is actually reached when the Tax Agency has to maximize expected tax revenues under the constraint of generating truthful input reports. It turns out that it is not so, since is optimal for the Tax Agency to let very small firms reporting almost-zero profits also when presumed profits are positive. In other words, GSdS generate a bias in favour of very small firms so that only hard-core evaders attaining a minimum size will actually be hit by GSdS.

This bias is opposite to the outcome of OAWC, the optimal audit with commitment suggested in the literature. Under OAWC, the Tax Agency commits to audit only some profit reports , namely those lower than a given, and exogenous, threshold. Audit probabilities under OAWC are such that firms with a true profit lower than the (exogenous) threshold will report true profits, while firms with true profits above the threshold will not be audited at all and they will report just the threshold value. Since, in general, profits and size are correlated, OAWC generates a bias against small firms.

The different outcome of the two schemes can be appreciated by analyzing the effective tax rate when some simplifying assumptions about the distribution of true profits are retained. It is then evident that the effective tax rate is non-increasing in size under OAWC while it is non-decreasing in size under GSdS. However, the role of productivity also emerges, since, while in both cases the effective tax rate is non-increasing in productivity, under GSdS productivity really matters only for firms which attain a minimum size.

In sum, our analysis suggest that the legal and institutional framework of GSdS is only partly consistent with the idea “hitting the hard-core” evaders. On the other hand, GSdS may be justified by political-economy reasons, i.e. the need to secure a favourable tax treatment for small firms, especially if they are very unproductive.

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6. Appendix

First we note that

$$\frac{\partial EP}{\partial \widehat{\pi_i}} = \tau\left[1 - q(\delta_i)(1+f_1)\right] - \frac{1}{\delta\tilde{\beta}\widehat{X_i}}(1+f_1)\tau\left(\tilde{\beta}\widehat{X_i} - \widehat{\pi}_i\right)$$

so that, using the definition of $q(\delta_i)$, we obtain

$$\frac{\partial EP}{\partial \widehat{\pi_i}} = 0 \Leftrightarrow \frac{\widehat{\pi}_i^*}{\tilde{\beta}\widehat{X}_i^*} = \left[1 - \frac{\delta_i}{2(1+f_1)}\right]$$

which is necessary and sufficient for a minimum since

$$\frac{\partial^2 EP}{\partial \widehat{\pi_i}^2} = \frac{2(1+f_1)\tau}{\delta\tilde{\beta}\widehat{X_i}} > 0$$

in other words, $\widehat{\pi}_i < \tilde{\beta}\widehat{X_i}$, but, for any given $\widehat{X_i}$, $\widehat{\pi}_i$ decreases in δ and increases in f_1. This is a quite standard result, given that the slope of q is decreasing in δ.

Second, we note that

$$\frac{\partial EP}{\partial \widehat{X_i}} = \tau\beta\left[q(\delta_i)(1+f_1) - p(1+f_2)\right] + \frac{\widehat{\pi}_i}{\delta\tilde{\beta}\widehat{X_i}^2}(1+f_1)\tau\left(\tilde{\beta}\widehat{X_i} - \widehat{\pi}_i\right) - G'(X_i - \widehat{X}_i)$$

or, using the definition of $q(\delta_i)$ and (8), (see Santoro, 2008, for a full derivation of this result)

$$\frac{\partial EP}{\partial \widehat{X_i}} = \tau\beta\left(1 - \frac{\delta_i}{4(1+f_1)} - p_i(1+f_2)\right) - G'(X_i - \widehat{X}_i)$$

Since audits are costly the necessary and sufficient condition to ensure $\widehat{X}_i = X_i$ is to ensure that there is no reduction in the expected payment by underreporting inputs i.e. that

$$p_i = \phi(\delta_i) = \left[1 - \frac{G'(0)}{\tau\beta} - \frac{\delta_i}{4(1+f_1)}\right]\frac{1}{(1+f_2)}$$

Using (8) and $\phi(\delta_i)$ in (4) the Tax Agency's problem is written as

$$\max_{\delta_i} NTP = \sum_i \tau\tilde{\beta}\widehat{X_i}\left[1 - \frac{\delta_i}{2(1+f_1)}\right] + q(\delta_i)\left[\tau\tilde{\beta}\widehat{X_i}\frac{\delta_i}{2} - c_I\right] - \phi(\delta_i)(1+f_2)c_{II}$$

To find the optimal solution, we first use (8) in $q(.)$ to obtain

$$q(\delta_i) = \frac{1}{\delta_i} - \frac{1}{\delta_i}\left[1 - \frac{\delta_i}{2(1+f_1)}\right] = \frac{1}{2(1+f_1)}$$

which it allows to rewrite the objective function as

$$\max_{\delta_i} NTP = \sum_i \tau\tilde{\beta}X_i\left[1 - \frac{\delta_i}{2(1+f_1)}\right] + \frac{1}{2(1+f_1)}\left[\tau\tilde{\beta}X_i\frac{\delta_i}{2} - c_I\right] - \phi(\delta_i)(1+f_2)c_{II}.$$

We note that

$$\frac{\partial NTP}{\partial \delta_i} = -\frac{\tau\beta X_i}{4(1+f_1)} + \frac{c_{II}}{4(1+f_1)} = \frac{1}{4(1+f_1)}\left(c_{II} - \tau\beta X_i\right)$$

so that there is no internal solution. In particular, if we assume that $\delta_i \in \left[\delta^{\min}, \delta^{\max}\right]$ where $\delta^{\min}$ and $\delta^{\max}$ are, respectively, the minimum and the maximum value of δ consistent with the model, the optimal solution for the Tax Agency is such that

$$\delta_i = \delta_i^{\min} \text{ iff } \tau\beta X_i > c_{II}$$
$$\delta_i = \delta_i^{\max} \text{iff } \tau\beta X_i < c_{II}$$

which is (11) in text.