Taxpayer behaviour when audit rules are known: evidence from Italy

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Abstract

Italy, which ranges among the OECD countries with the highest share of shadow economy, has adopted in 1998 a peculiar audit scheme (*Studi di Settore*), for small and medium enterprizes and self-employed. This scheme is based on a particular interaction between the Tax Agency and taxpayers, where the Tax Agency unveils part of the information used to develop its audit rule. We study this scheme by means of a simple theoretical model and test it using a sample of 23,000 firms in manufacturing sectors in 2005 tax year.

A number of theoretically relevant relations are confirmed. In particular, reports made by taxpayers seem to be positively associated to the firm's size. When taxpayers know that the probability to be audited decreases, they tend to report less. Other factors which are expected to influence the behavior by taxpayers, have no or ambiguous impact on reporting behavior.

1 Introduction

In the concluding section of their review, Andreoni et al. (1998, pp. 855-56) indicate four directions for future research in the field of tax

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evasion. The first of these is "a greater synthesis of theory with empirical research" while the third is to pay "a greater attention to the dynamic and complex institutional framework of tax compliance (...) including (...) the significance of various forms of interactions between the tax authority and the taxpayers such as (...) information reporting". In this paper, we aim to analyze the theoretical assessment of a simple model of taxpayers'behaviour when the tax authority and the taxpayers interact in a complex institutional framework.

In Italy the size of the shadow economy ranges at top levels among OECD countries, accounting for 20-30% of the GDP according to Schneider and Enste (2000). To contrast tax evasion, since 1998 Italy has adopted a tax auditing scheme which is focused on small-scale economic activities of firms or of self-employed people. This scheme is known as *Studi di Settore* (henceforth, *SdS*) and is based on a particular interaction between the Tax Agency and the taxpayers. A peculiar characteristic of the *SdS* is that the Tax Agency declares to use the information provided by the taxpayer and reveals to each taxpayer how much he should pay for avoring a tax audit. To our knowledge, this is the only case where the audit rule is, to a considerable extent, known to taxpayers, thus providing an interesting case study.

SdS has two noticeable features. First, the Tax Agency can audit and fine only firms whose reports are below a threshold which is known to the taxpayer, similarly to a cut-off auditing rule. This means that a firm whose report is above that threshold knows that it will not be be audited. Second, and contrarily to what happens with a standard cut-off rule, such a value is the output presumed by the Tax Agency which depends on the value of inputs (as reported by the taxpayer) and on their presumed productivity (as presumed by the Tax Agency). Thus the determinants of the probability to be audited are, though only partially, known to taxpayers. Moreover, the taxpayer can, to some extent, manipulate the information that determines the probability to be audited, which also depends on the value of inputs as reported by every taxpayer. For a detailed description of *SdS*, see Arachi and Santoro (2007) and Santoro (2008).

The design and implementation of Italian *SdS* provide a good framework where some key questions concerning taxpayers' behaviour can be addressed. Do taxpayers behave as predicted by the economic theory? What variables influence the taxpayers'reporting behaviour? Santoro (2008) provides only a partial answer to these questions. He presents a model of taxpayers' behaviour under *SdS* where it is shown that reports should depend on a number of features of the scheme such as audit probabilities, sanctions, tax rates and the cost of manipulation. This theoretical result seems in line with some stylized facts, but no empirical validation of the model predictions has been provided so far. This paper is a step in this direction.

In this paper, we present a simplified model to describe the behaviour of a rational taxpayer when the audit rule is (partially) known. Our main objective is to test some assessed relations between taxpayers' reporting behaviour and variables such as the audit probability, the tax rate, the concealment costs. We use a sample of 23,000 observations to test these relations, taking into account the problem of endogeneity which naturally arises in this field of research.

The paper is organized as follows. Section 2 summarizes the literature on optimal audit policies and the (relatively) scant evidence on real-world audit practices by tax agencies. Section 3 introduces the main institutional features of *SdS*. In Section 4 the theoretical model is illustrated and its main predictions are commented. Section 5 describes the empirical model, the dataset and the choice of proxies adopted for measuring the key variables of the model and it discusses results. Section 6 provides some concluding remarks.

2 Audit rules in theory and practice

The simplest way to audit tax returns is to use a random rule (as in Allingham and Sandmo, 1972), in which the probability of an audit is fixed across taxpayers and does not depend on taxpayers' reports. A more general framework has been developed where the probability of being audited varies across taxpayers according to reports made. This literature distinguishes between audit rules with and without commitment (Andreoni et al., 1998). Audit rules with commitment are pre-announced by the Tax Agency to taxpayers and implemented after taxpayer reports are made, while audit rules without committment remain totally unknown to taxpayers. The existing literature on optimal tax audits (Sanchez and Sobel, 1993; Scotchmer, 1987) suggests that, if the Tax Agency can commit to the audit rule, then the optimal audit rule typically involves a threshold, i.e. a value of the target variable (income or profit) which cuts off the taxpayers' population into two parts. Taxpayers reporting income lower than the threshold should be audited with some positive probability. This probability should be high enough to induce truthful reporting by these taxpayers. On the other hand, taxpayers reporting income higher or equal than the threshold should not be audited. The resulting equilibrium is such that all taxpayers whose true income is below the threshold will report their true income while all taxpayers whose true income is higher than the threshold will report the threshold and evade the difference between their true income and the threshold. The threshold depends on the distribution of taxpayers' true income, on the value of the sanction and on auditing costs.This result applies equally to all taxpayers, persons or firms, who behave as risk-neutral maximizers of after-tax income (or profit).

If the Tax Agency cannot commit to an audit rule, then the optimal audit policy becomes somewhat more complex. The optimal rule emerges as the equilibrium of a full-information sequential game. If the equilibrium is the fully separating one, in which each observed report is associated with a single true income level, all taxpayers evade taxes by the same amount and the audit rule is the solution of a linear first-order differential equation. However, many other (pooling) equilibria are possible.

Cut-off rules are an example of an endogenous tax audit rule, i.e. rules where the probability of audit varies across taxpayers and depend upon the behavior of taxpayer (Alm and McKee, 2003). The experimental literature (Alm et al., 1993; Kirchler, 2007, p. 109) generally confirms that cut-off rules yield higher compliance rates than random audits, although cut-off rules may trigger some kind of coordination between taxpayers (Alm and McKee, 2003).

Apparently, many tax agencies do adopt cut-off auditing rules and concentrate their audit resources on firms declaring returns below given thresholds, but the exact formulation of these cut-off points is not publicly known (Andreoni et al., 1998). Many countries adopt a statistical approach to tax auditing without disclosing the determinants of the probability of an audit. For example, the US tax authorities use the Discriminate Information Function (DIF), a computer-generated score designed to predict tax returns most likely to result in additional taxes if audited. US taxpayers are aware of the use of this statistical method for selecting taxpayers to audit but the exact derivation of DIF remains unknown, although many tax professionals claim to have recognised its main features (Alm and McKee, 2003). According to Macho-Stadler and Perez-Castrillo (2002, p. 3) other countries follow similar cut-off rules although the methodology adopted for their definition is never revealed.

3 The Italian cut-off auditing rule

Since 1998, Italy has adopted the *SdS* a tax auditing scheme, which is mainly focused on small-scale economic activities, i.e. on those reporting an annual output below 5,164,569 euros. As our empirical analysis uses data about manufacturing firms only, let us only briefly describe how *SdS* work for firms (corporated and unincorporated companies, individual entrepreneurs), hence avoiding to describe *SdS* for self-employed workers.

The Tax Agency collects information on structural variables (e.g. size of offices and warehouses, number of employees, main characteristics of customers and providers, etc.) and on accounting variables (mainly referring to amount and cost of inputs and the value of output). A number of statistical analyses are performed to identify and prune the outliers, to group firms in clusters within each business sector and to select inputs which are statistically more significant to explain the variance of reported output within each cluster of firms. Then, for each cluster within a business sector, a parameter reflecting the presumptive productivity of each inputs is calculated. Presumptive output is finally obtained for every firm as the weighted sum of the reported value of selected inputs, where weights are the presumptive productivity parameters.

Let us denote by $\hat{R}_i$ the reported value of output and by $\hat{X}_i^j$ the value of input j,j=1,...J as reported by firm i,i=1,...,I and by B^j the presumtive productivity parameter associated to input *j*. Presumptive output for firm *j* is thus equal to $\mathbf{B}\hat{\mathbf{X}}_i = \sum_j B^j \hat{X}_i^j,\ j = 1,...J$.

Formally, in *SdS* two distinct audit procedures are defined, one focussing on output the other on input reports.

Audits on output reports are characterised by two main features. First, the Tax Agency is committed not to audit firms whose output reports are above a given threshold, which is revealed to each firm. Second, this threshold is firm-specific as it depends on the information provided by the taxpayer to the Tax Agency. Following Santoro (2008) we can define the probability of being audited, q_i, for firm *i* as

$$\begin{aligned} q_i &= \frac{1}{\delta_i}\left[1 - \frac{\hat{R}_i}{\mathbf{B}\hat{\mathbf{X}}_i}\right] \quad \text{if} \quad \hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i \\ q_i &= 0 \qquad\qquad\quad\ \ \text{if} \quad \hat{R}_i \geq \mathbf{B}\hat{\mathbf{X}}_i \end{aligned} \tag{1}$$

The idea embodied in 1 is that the probability of an audit is a combination of objective and subjective elements. The objective part is the fact that, according to the Italian legislation, the probability of an audit based on *SdS* is decreasing in the ratio $\hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$ and zero when such a ratio is higher than or equal to 1. The subjective part is reflected by δ_i:, the higher this value, the lower the probability *i*'s perceived probability to be audited for a given value of the ratio $\hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$.

Input audits are based on the difference between the true and the reported value of input. As $B^j > 0$ for all *j*, firms can reduce the expected probability and sanction of output audits by simply underreporting the true vector of inputs. In *SdS* the probability of an input audit is assumed constant and the corresponding penalty applies to the weighted difference between the true and the reported value of input. On the basis of available evidence (Santoro, 2008) this probability has been very low at least until 2006. As we are using 2005 data, we are ignoring the role of input audits in *SdS* from now on.

Under *SdS*, the Tax Agency is committed to audit only reports under the threshold, but *SdS* differs from other committing audit schemes described in Section 2 since the threshold varies across taxpayers, being dependent, for each taxpayer, from his own value of inputs.

4 The model

The model we present here modifies that proposed by Santoro (2008) to account for the importance of concealment costs and to make it more suitable for empirical application. It is based on a combination of the models by Scotchmer (1987) and Cowell (2003), adapted to take into account the legal and institutional framework of the design and implementation of *SdS*. The taxpayer is a risk-neutral firm which aims at minimizing the amount of its expected tax liability (as in Scotchmer, 1987) gross of the concealment cost generated by tax evasion. The justification for the latter is provided by Cowell (2003): 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.

According to the description of *SdS* provided in Section 3, to account for the their specific institutional framework one should consider the audit rules and the concealment activity of both output and inputs. Santoro (2008) does this by considering two separate and independent audit rules (one for output and the other for inputs) and deriving optimal values of $\hat{R}_i$ taking $\hat{\mathbf{X}}_i$. Here, we ignore input audits and concealment costs and we focus only on the choice of $\hat{R}_i$ taking $\hat{\mathbf{X}}_i$ as given.

We denote as $H_i(.)$ the cost of concealing output for firm *i*, whose argument is the difference between the true and reported output, $R_i - \hat{R}_i$. We assume, without loss of generality that, since there are no tax abatements for overreporting, this difference is always nonnegative. We also assume, following Cowell (2003), that $H^{'}(.)$ and $H^{''}(.)$. This is equivalent to assume that there are no economies of scale in concealing output. If taxes are paid on (a function of) the difference between reported output and inputs, but inputs are given, the tax liability is simply equal to the product of the taxpayer's effective tax rate τ_i and the reported output. Thus, the taxpayer minimizes the payment written as

$$P_i = \tau_i \hat{R}_i + q_i f_i \tau_i \left[\mathbf{B}\hat{\mathbf{X}}_i - \hat{R}_i \right] + H_i(R_i - \hat{R}_i) \qquad (2)$$

with respect to $\hat{R}_i$, given $\hat{\mathbf{X}}_i$ where q_i is defined in (1).

In (2), τ_i is *i*'s effective the tax rate, q_i is the probability of an output audit as perceived by the taxpayer as defined in (1), f_i is the (gross) fine paid by the taxpayer if audited, expressed as a share of the difference between presumed and reported output, with $0<f<1$[1]. $\mathbf{B}\hat{\mathbf{X}}_i$ is presumed output as reported by the taxpayer, $H_i(.)$ is *i*'s output concealment cost function.

[1] When the taxpayer is willing to pay immediately, the audit is concluded by granting the taxpayer a 'discount' with respect to $\mathbf{B}\hat{\mathbf{X}}_i$. We generalize this possibility, which is very common in reality, by assuming $0<f<1$ and we define *f* as a 'gross' fine since it includes this discount. Note all results would be unchanged by admitting $f\geq1$.

To derive the optimal value of $\hat{R}_i$, we have to compare two values of P: that obtained if i chooses to report $\hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$ thus generating a positive probability whose exact value depends upon δ_i (recall (1)) and the value of P_i when $\hat{R}_i \geq \mathbf{B}\hat{\mathbf{X}}_i$ so that q_i=0 (see (1)).

Let us introduce the following notation

$$\begin{aligned}\tilde{R}_i &\equiv \arg\min P_i \text{ if } \hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i \\ \overline{R}_i &\equiv \arg\min P_i \text{ if } \hat{R}_i \geq \mathbf{B}\hat{\mathbf{X}}_i\end{aligned}$$

so that $\tilde{R}_i$ is the optimal value of $\hat{R}_i$ if the taxpayer decides to report below presumed output while $\overline{R}_i$ is the optimal value of $\hat{R}_i$ if the taxpayer decides to report at least presumed output .

It can be shown[2] that

$$\tilde{R}_i / \mathbf{B}\hat{\mathbf{X}}_i = \left[1 - \frac{\delta_i}{2 f_i}\left(1 - \frac{H_i^{'}(R_i - \hat{R}_i)}{\tau_i}\right)\right] \tag{3}$$

Equation (3) is saying that, when the taxpayer decides to report below presumptive output, the report depends on the probability to be audited, the fine, the marginal concealment cost and the tax rate. In particular, equation (3) shows that reported output increases in marginal

[2] Proofs of this and of the other results are in the Appendix.

concealment cost, *H'*, and decreases in the tax rate, τ_i. To proceed further, we introduce two assumptions:

A.1 $H^{'} < \tau, \forall (R_i, \hat{R}_i)$: the marginal concealment cost is always smaller than the effective tax rate, so that no output would be reported if there were no audits at all;

A.2 $0 < f < \delta_i < 2f$, $\forall \delta_i$: the probability of an audit has an upper bound (<1) and a lower positive bound which are chosen to mimic anecdotal evidence for a representative taxpayer.

The meaning of A.1 is to limit the importance of concealment costs: they can motivate the choice to report an output up to the presumed level, but not to report an output which is over this level. To see this, note that, contrarily to what happens using the conventional approach with risk neutrality and no concealment costs, in the model presented above one may have $\overline{R}_i > \mathbf{B}\hat{\mathbf{X}}_i$ if the marginal concealment cost function is such that $H_i^{'} \geq \tau$. But this would imply that this taxpayer would not evade even in the absence of audits: we believe such a behaviour can be explained (either by mistake or wrong advice or) by moral values and institutional features which cannot be measured and therefore we rule it out for the empircal application to follow. Therefore we write:

$$H' < \tau, \forall (R_i, \hat{R}_i) \Rightarrow \bar{R}_i / \mathbf{B}\hat{\mathbf{X}}_i = 1 \quad (4)$$

and we focus on the choice between reporting either $R_i < B\mathbf{X}_i$ or $R_i = B\mathbf{X}_i$.

Finally, A.1 has two further implications for the interpretation of (3):

i) the ratio $\tilde{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$ is decreasing in δ_i: the higher is the perceived probability of an audit for a given difference between $B\hat{\mathbf{X}}_i$ and $\hat{R}_i$ the higher is reported output for a given report of inputs;

ii) the ratio $\tilde{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$ is increasing in *f*: the higher is gross fine, the higher is reported output.

To evaluate the meaning of assumption A.2, consider that the average value of *f* observed in data is around 0.6. If we take the latter as the value relevant for a representative taxpayer, equation (1) generates a perceived probability of an audit which varies as illustrated in 1.

Table 1: values of *q* when $d_i \in (0.75;1.5)$.

$\hat{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$	$q_{min}(\delta_i=1.2=2f)$	$q_{\max}(\delta_i=0.6=f)$
99%	0.8%	1.7%
95%	4.2%	8.3%
90%	8.3%	16.7%
80%	16.7%	33.3%

Now, the actual probability of an audit if a taxpayer declares $\hat{R}_i < B\mathbf{X}_i$ is around 4%. On the contrary, even when the the deviation from presumed output is very small,Table 1 displays very high values of the subjective probability of an audit. For example, this probability ranges from 4.2% to 16.7% as the ratio $\hat{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$ varies between 90 and 95%. This means that we assume that a representative taxpayer believes that the Tax Agency is very sensitive to small deviations from presumed output. Thus, our assumption embodies a possible missperception, i.e. overestimate of the probability of an audit when *SdS* is used. There is anecdotal evidence that such a missperception was generated, at least until recent years, by tax consultants who spread around the idea that an audit was 'automatic' when the taxpayer did not report at least the presumptive output.

The most important implications of assumption A.2, when evaluated jointly with assumption A.1, are the following ones:

i) $\tilde{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$ consistently with the model: to see this, just use A.1 and A.2 in equation (3));

ii) the variables which determine the choice of the value of $\tilde{R}_i$ are also those which determine the choice between $\hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$ or

$\hat{R}_i = \mathbf{B}\hat{\mathbf{X}}_i$. To illustrate this point, consider that the taxpayer chooses to report an output which is below the presumed value if and only if

$$\underbrace{\tau\left[\mathbf{B}\hat{\mathbf{X}}\text{-}\tilde{\text{R}}\right]\left[1\text{-fq}\tilde{\text{R}}\right]}_{\text{taxes saved}} > \underbrace{\text{H}\left(\text{R-}\tilde{\text{R}}\right)\text{-H(R-}\mathbf{B}\hat{\mathbf{X}})}_{\text{concealment cost}} \qquad (5)$$

Inequality (5) is saying that *i* is more likely to report output below the presumed level as the gain in expected taxation (the left hand side) more than offsets the increase in concealment cost (the right hand side). Using equation (3) and A.2 in (5) ensures that the taxpayer is more likely to report $\tilde{R}_i$ rather than $\mathbf{B}\hat{\mathbf{X}}_i$ as the tax rate increases or as the probability of an audit, the gross fine or the marginal concealment cost decreases (see Appendix).

To sum up, under assumptions A.1 and A.2 the model states that the ratio $\hat{R}_i > \mathbf{B}\hat{\mathbf{X}}_i$ is:

(i) increasing in1/δ,i.e the perceived probability of an audit for a given difference $\mathbf{B}\hat{\mathbf{X}}_i - R_i$;

(ii)increasing in the expected fine, *f*;

(iii) increasing in the marginal concealment cost, $H^{'}$;

(iv) decreasing in the tax rate, τ.

5 Empirical application

5.1 The empirical model

Ideally, the model outlined in Section 4 should be tested using a structural model of firms and tax agency behaviour, with data on before and after a random implementation of *SdS*, where we could observe treated and untreated firms and test the difference in their reactions. Unfortunately the data we have do not allow a proper causal analysis and our results have to be interpreted only in descriptive terms. The empirical model we estimate regresses the ratio of reported output over the threshold on a set of variables providing measures of the effective tax rate, the sanction if cought underreporting, the cost of concealment.

Let y_{ic} be the ratio of reported output of firm *i* belonging to cluster *c* over the firm-specific threshold**,** $\mathbf{Z}_i$ be the vector of variables providing proxies of concealment costs for firm *i*, p_c be the cluster-specific average sanction if a firm belonging to cluster *c* is caught underreporting, and t_i be the firm-specific tax rate on the value of output. We estimate the model:

$$y_{ic} = \alpha + \boldsymbol{\beta}'\mathbf{Z}_i + \psi p_c + \gamma t_i + \eta c_i + \varepsilon_{ic}, \qquad (6)$$

where $\{\alpha,\boldsymbol{\beta},\psi,\gamma,\eta\}$ are coefficients to be estimated, ε_{ic} is the error term. The dependent variable and some regressors are transformed in logarithms to interpret coefficients as elasticities.

There are two main issues concerning the estimation of model (6). First, the estimation of model (6) should take care of within-cluster correlation and standard errors have to be cluster-corrected. Neglecting the clustered structure of the model would result in standard errors being biased downward and wrong inference on coefficients of interest. All our estimates of model (6) will report cluster-corrected standard errors. Second, the variables providing proxies of concealment costs might be endogeneous and cause biased estimates of the coefficients. Hence, we will perform a standard Durbin-Wu-Hausman endogeneity test of the hypotesis that an ordinary least squares (OLS) estimator of the model would yield consistent estimates, i.e. that any endogeneity among the regressors would not have deleterious effects on OLS estimates. A rejection of the null indicates that endogenous regressors' effects on the estimates are meaningful, and instrumental variable (IV) techniques are required (for a standard textbook reference, see Cameron and Trivedi, 2006, ch. 8). In case the null is not rejected, we do not adopt IV techniques, which are less efficient than OLS.

Related to the particular data set we are analysing there is a third issue to consider: the estimation method adopted. As will be clearer after the data description (next subsection), the data we are using are upper-censored at 1, where a large spike emerges. Hence, we use maximum likelihood for estimating upper-censored Tobit models.[3]

5.2 The dataset and the selection of independent variables

Data for the analysis of *SdS* are produced by SOSE,[4] the specialized firm which, on behalf of the Italian Tax Agency, administers the entire statistical process of data collection and development of *SdS*. Each year SOSE selects the number of firms by a stratifying sampling procedure based on clusters, i.e. on groups of firms that, within each sector, are considered to be sufficiently homogeneous with respect to a number of selected structural variables. For the manufacturing sector, clusters are formed on the basis of size, type of customers, type of products, degree of specialization among other variables.

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[3] For a standard textbook reference see again Cameron and Trivedi (2006).

[4] SOSE is the acronym of Società per gli Studi di Settore. More details about SOSE are available from web site: `http:\\www.sose.it`.

Our data set includes only *SdS* for manufacturing firms, which are obtained selecting about 23,000 units from a population of 380,154 firms operating in Italy in fiscal year 2005.

The data set contains, for each firm, a registry file including information on the macroarea of establishment of the firm, the sampling weight, the accounting regime (complete or simplified accounting), the industry classification code, a personnel file including information about number and status of employees and other stakeholders, an accounting file recording information about operating costs, a file describing the firm's structure (e.g.type of product and of market, size, number of subsidiaries, square meters of offices, warehouses and outlets), a file reporting the presumptive output which was known by the firm at the time of declaring its output.

To estimate model (6), we defined the dependent variable as the log of the ratio of total output declared and total presumptive output obtained by the application of *SdS* (we call this variable *ratio*). As proxies of the marginal concealment costs (*H'*), we use the log of firm's size defined as total square meters (*sq_meter*) and as number of full-time employees (*empl_ft*). We also consider the share of employees who are related by birth or marriage with the owner (*sh_family*). Our *a priori* are that the larger is the physical dimension and the workforce of a firm the more costly is to hide output,[5] and the contrary as for the share of family workers, among whom we expect a higher information sharing and agreement on concealment activities. The negative relationship between the number of employees and the propensity to evade is frequently postulated by the literature (see Slemrod, 2007).

As proxies of the probability of an audit for a given positive difference between the declared output ($\hat{R}_i$) and the firm's threshold ($\mathbf{B}\hat{\mathbf{X}}_i$) we use the type of accountancy regime used (where the variable *account_reg* takes a value equal 1 for a full accunting regime and zero otherwise) and the the share of output produced as subcontractor (*sh_subcontract*). We expect both variables to have a negative correlation with the dependent variable. In fact, firms with a large share of output coming from subcontracting are thought to have lower chances of reducing declared output, which is also stated in Italian laws (DPR 600/1973, art. 37 and DPR 633/1972, art. 51). On the other hand, firms with a complete accounting regime have been granted, until 2006, a sort

[5] This assumption is also consistent with the hypothesis of a U-shaped relationship between the size of the firm and the propensity to evade (Slemrod, 2007). Since large firms are not included in the dataset (recall that firms reporting an revenues larger than €5.1 millions cannot be audited on the basis of *SdS*) we assume that for smaller firms concealment costs are lower.

of legal shield against audits based on *SdS*, since a yearly deviation from presumptive output was not sufficient to make the firm eligible for an audit. We also use some aggregate statistics on audits conducted by the Tax Agency on reports made for fiscal year 2000. More precisely, for every firm *i* the variable *prob_audit* is the ratio between the number of audits conducted and the number firms reporting an output lower than threshold in year 2000[6], evaluated for the business sector (2 digits) of firm *i*. The same dataset was used to calculate the variable *fine*, which is the average value (for the 2 digits business sector) of f_i as specified in the theoretical model. These two variables present variability only across *SdS* but zero within them.

Finally, we measure τ_i as the effective tax rate applied to reported income and some costs (*irap*).[7] In all regressions, we also control for 2-digit industry classification code (ateco) and for the firm's macroregion of operation (area3, which is coded 1, 2 and 3 for North, Center and South, respectively). Controlling for area of operation, we take into account the possibility that reports are influenced by the

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[6] Note that this time-lag is appropriate since reports made in a given year are usually audited 4 or 5 years later, so that reports made in 2000 were presumably audited in 2004 and 2005, i.e. slightly before reports for tax year 2005 were made.

[7] Although *irap* accounts for only a part of the tax burden of firm *i*, it allows consistency with the theoretical model where proportional taxation is assumed.

regional propensity to evade which, according to the existing literature on Italy, is higher and more tolerated in Southern than in Northern regions (among others, see Bernardi and Bernasconi, 1996, and Fiorio and Zanardi, 2008).

Some summary statistics are presented in Table 2, showing that around 55% of firms operates in the North, more than half use a full accounting regime, have on average 5.3 full-time employees and are on average a 450 square meters large. Among firms following *SdS*, the share of family firms is on average around 3% while that of output coming from subcontracting is about 46%. Fine is around 60%, which reflects the discount granted by the Tax Agency to firms which accept to settle immediately the controversy. The average value of probabiliy is around 4%, while the effective tax rate is around 11%.

A quick look at the descriptive statistics in Table 2 might wrongly suggest a symmetric distribution of the dependent variable, i.e. the (log) ratio of declared output and the threshold for firm *i*. In fact, the nonparametric distribution on bounded support[8] of the density of the ratio $\hat{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$ where the boundary is at 1 allows us to appreciate that there is a strong convergence towards the threshold from above, which is

[8] For an introductory discussion of density estimation on bounded support, see Silverman (1986, p. 29).

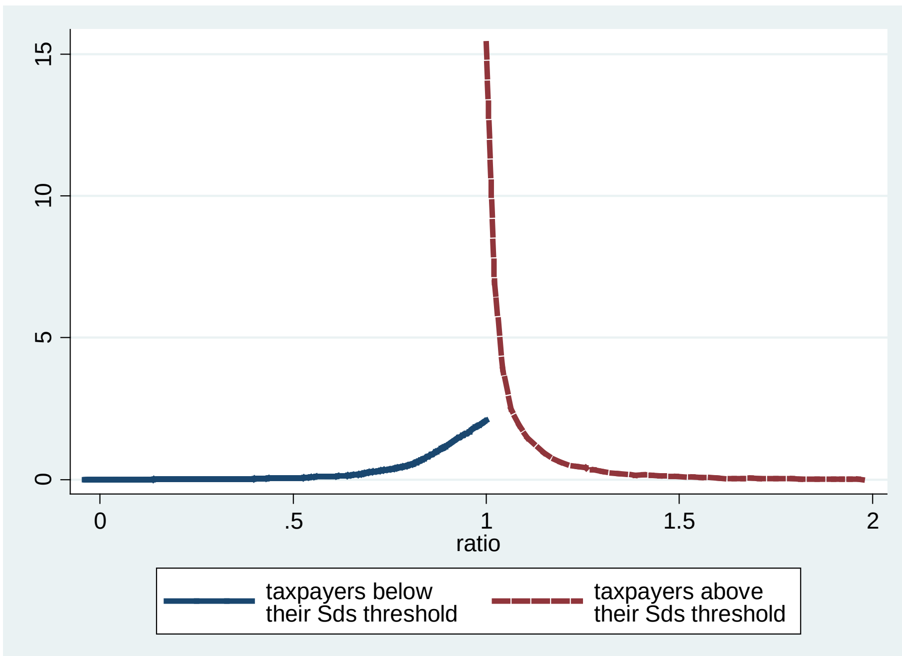
consistent with the interpretation of the theoretical model of Section 4. Due to the peculiar distribution of the dependent variable, we selected only those firms whose ratio variable, $\hat{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$, is below or close to the threshold. According to the model discussed in Section 4, the only reason for a firm to declare an output value much larger than the threshold is because of some unwanted mistake in the output reporting, wrong advice from the tax consultant or strong moral motivation that induce it not to underreport its true output up to the minimum required for not being audited. In model (6) all these elements necessarily fall in the error term as we do not have any variable that could possibly capture their contribution to explain the ratio of reported output of firms over the threshold.

Table 2: Descriptive statistics of the main variables used in the empirical analysis.

Variable	Obs	Mean	Std. Dev.	Min	Max
ratio (a)	22558	0.06	0.44	-9.33	9.84
sq_meter (a)	22071	5.15	1.49	0.00	9.58
empl_ft (a)	22716	0.97	1.09	0.00	4.70
sh_family	22716	0.03	0.12	0.00	0.80
sh_subcontract	19018	46.45	46.79	0.00	100.00
account_reg	22716	0.52	0.50	0.00	1.00
Fine	15192	0.60	0.08	0.31	0.93
prob_audit	15716	0.04	0.01	0.00	0.11
Irap	22825	0.11	0.14	0.00	0.60
2.area3	22700	0.21	0.41	0.00	1.00
3.area3	22700	0.24	0.43	0.00	1.00

Source: own calculations on SOSE data.
(a) in log-units.

Figure1: The nonparametric distribution of $\hat{R}_i / \mathbf{B}\hat{\mathbf{X}}_i$.



In an attempt to find proxies for the independent variables of the theoretical model, we have selected and combined some of the variables included in the dataset with other data as described in Table 3 below.

Table 3: Description of variables in the dataset (as reported by the taxpayer unless specified).

Variable (cf. eq. (3))	Measure	Theoretical correlation with dep. variable
$1/\delta$	sh_subcontract	negative
$1/\delta$	account_reg	negative for firms with a full-accounting regime
$1/\delta$	prob_audit	positive
H’	empl_ft	positive
H’	sq_meter	positive
H’	sh_family	negative
f	fine	positive
τ	irap	positive

5.3 Results

As mentioned in Section 5.1, model (6) could possibly be flawed by endogeneity problem, which would cause wrong estimation of our key parameters. In particular, as the dependent variable we are using is the ratio of declared output and a threshold obtained by *SdS* using data on inputs, it could be that some regressors (namely, the size of the firm, the number of full-time employees, the share of family workers and the share of subcontract of total output) are correlated with the error term. Hence, we tested the endogeneity of those variables using the Durbin-Wu-Hausman endogeneity test and results are presented in Table 4. In neither case the null hypothesis of exogenous regressors is rejected, suggesting that IV methods are not required. This comes at no surprise as the total output and in particular *SdS* thresholds are related to these input variables in highly nonlinear ways.

Hence, we estimate some Tobit models with censoring at zero, trimming our dependent variable for values over zero. This procedure was followed because of the peculiar distribution at zero of the dependent variable, described in Subsection 5.2, and of the inability of our model to explain the behaviour of those declaring more than their *SdS* threshold. Results are presented in Table 5, where we regress the dependent variable first on size variables only (column 1), then we introduced also the accuntancy regime and the effective tax rate measures (column 2) and finally also the fine and the audit probability measures, which we recovered from external data provided by the Tax Agency (columns 3 and 4). It should be noted that the last two columns present estimates on a much smaller sample size as *fine* and *prob_audit* variables present many missing values. Consistently with our *a priori*, the larger is a firm's work force the higher is its declared output although the sign of family workers share is opposite to our expectations meaning that the output declared is larger the higher is the share of family workers. The accounting regime is found to have a negative sign, consistently with our expectations, although it is not statistically significant when we also control for fine and audit probability. We find very little and not statistically significant effect of the share of subcontractors, while regional controls highlight the fact that underdeclaration is on average larger in the Southern regions, which is consistent with our expectations given the data on tax audits in different areas of the country.

We tested these results (in particular those in columns 2, 3 and 4 of Table 5) for robustness in two ways. First we tried other, less conservative, trimming rules, i.e. the log-ratio of declared output and *SdS* threshold was trimmed for values above 0.01 (increasing the original sample size over 30%), 0.02 (increasing the original sample size by over 30%) and at 0.04 (increasing the sample size by nearly 50%). Results are largely unchanged as for the (log) number of employees and for the family workers share. The square meter variables is found with significant positive values and the share of subcontracting with a very small but significantly negative coefficient, both consistently with our a priori expectations, discussed above.

A common feature of the models presented in Tables 5 and 6 is that covariates provide relatively little improvements on a simple model with the constant only, as shown by the pseudo R-squared index. Although not unusual in Tobit models estimated using maximum likelihood, this suggests that most of the variability of the dependent variable is not captured by the observed variables. As there is no possibility to extact additional information on the idyosincratic error term, we followed a different strategy based on analysing variability of our dependent variable between industry codes (*ateco*) setting at zero the variability within it. Hence, we generated a new data set, collapsing all variables in our original data set by industry codes and estimating model (6) by OLS. Interestingly, the sign and significance of the variables considered before remain largely unaltered, providing a further robustness check of our results. The goodness-of-fit of this model is over 20%, which is relevant considering the type of relation estimated.

Table 4: Description of variables in the dataset (as reported by the taxpayer unless specified).

Ho: variables sq_meter *and* empl_ft *are exogenous*	
Robust regression F(2,21)	0.003
p-value	0.997
Ho: variable sq_meter *is exogenous*	
Robust regression F(1,21)	0.000
p-value	0.997
Ho: variable empl_ft *is exogenous*	
Robust regression F(1,21)	0.001
p-value	0.973
Ho: variable sh_family *is exogenous*	
Robust regression F(1,21)	0.012
p-value	0.914
Ho: variable sh_subcontract *is exogenous*	
Robust regression F(1,21)	0.430
p-value	0.519

Note: standard errors corrected for clusters in ateco.

Table 5: Tobit models with censoring of dependent variable (ratio) at 0.

Dep. Variable: ratio	(1)	(2)	(3)	(4)
sq_meter	0.015	0.019*	0.015	0.014
	[0.110]	[0.091]	[0.188]	[0.202]
empl_ft	0.054***	0.038***	0.040***	0.041***
	[0.000]	[0.000]	[0.000]	[0.000]
sh_family	0.167***	0.236***	0.225***	0.228***
	[0.000]	[0.000]	[0.000]	[0.000]
sh_subcontract		0.000	0.000	0.000
		[0.417]	[0.367]	[0.285]
1.namod		-0.032***	-0.031**	-0.031**
		[0.006]	[0.046]	[0.048]
irap		0.277***	0.265***	0.266***
		[0.000]	[0.000]	[0.000]
fine			0.312	0.353
			[0.480]	[0.421]
prob_audit				-1.098
				[0.353]
2.area3	-0.010	-0.008	0.000	-0.001
	[0.551]	[0.625]	[0.994]	[0.960]
3.area3	-0.046***	-0.045**	-0.045***	-0.047***
	[0.008]	[0.023]	[0.009]	[0.003]
14b.nateco2d	0.000	0.000	0.000	0.000
Constant	-0.512***	-0.528***	-0.691***	-0.672***
	[0.000]	[0.000]	[0.007]	[0.004]
Observations	6888	5538	3906	3906
Pseudo R-squared	0.086	0.086	0.086	0.086

Robust in brackets. Standard errors adjusted for clusters ateco.
Weighted estimates. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Robustness check: setting a different trimming rule.

	Censoring ratio at 0.01			Censoring ratio at 0.02			Censoring ratio at 0.04		
Dep. var.: ratio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
sq_meter	0.039***	0.037***	0.036***	0.041***	0.039***	0.038***	0.039***	0.037***	0.037***
	[0.003]	[0.005]	[0.007]	[0.001]	[0.002]	[0.003]	[0.002]	[0.005]	[0.006]
empl_ft	0.033***	0.039***	0.040***	0.029***	0.034***	0.035***	0.025***	0.028***	0.029***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.002]	[0.001]
sh_family	0.318***	0.317***	0.320***	0.302***	0.295***	0.297***	0.300***	0.286***	0.288***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
sh_subcontract	-0.000**	-0.000***	-0.000***	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	[0.018]	[0.005]	[0.006]	[0.013]	[0.003]	[0.004]	[0.006]	[0.004]	[0.007]
1.account_reg	-0.010	-0.015	-0.015	-0.005	-0.006	-0.006	0.002	0.004	0.004
	[0.338]	[0.217]	[0.215]	[0.635]	[0.545]	[0.550]	[0.800]	[0.667]	[0.658]
irap	0.256***	0.200**	0.200**	0.248***	0.194**	0.194**	0.227***	0.170**	0.170**
	[0.000]	[0.013]	[0.013]	[0.001]	[0.017]	[0.017]	[0.002]	[0.035]	[0.036]
fine		0.457	0.515		0.506	0.566		0.520	0.573
		[0.358]	[0.260]		[0.314]	[0.224]		[0.288]	[0.206]
prob_audit			-1.617			-1.661			-1.456
			[0.146]			[0.149]			[0.193]
2.area3	-0.012	-0.003	-0.004	-0.016	-0.008	-0.009	-0.024	-0.016	-0.017
	[0.474]	[0.809]	[0.721]	[0.362]	[0.569]	[0.487]	[0.152]	[0.228]	[0.177]
3.area3	-0.131***	-0.137***	-0.139***	-0.146***	-0.155***	-0.157***	-0.168***	-0.181***	-0.183***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ateco	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	-0.219***	-0.469	-0.438*	-0.152***	-0.430	-0.399	-0.065	-0.350	-0.323
	[0.000]	[0.103]	[0.098]	[0.006]	[0.140]	[0.136]	[0.259]	[0.218]	[0.221]
Observations	10325	7369	7369	11810	8409	8409	13486	9562	9562
Pseudo R-sq.	0.061	0.061	0.061	0.056	0.056	0.056	0.052	0.053	0.053

Robust in brackets. Standard errors adjusted for clusters ateco.
Weighted estimates. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Robustness check: OLS estimation of observations collapsed by ateco codes.

		Censoring ratio at 0	
Dep. Variable: ratio	(1)	(2)	(3)
sq_meter	0.038***	0.038***	0.009
	[0.005]	[0.005]	[0.589]
empl_ft	0.090***	0.090***	0.187***
	[0.001]	[0.001]	[0.000]
sh_family	0.447	0.447	1.246***
	[0.156]	[0.156]	[0.007]
sh_subcontract	-0.001*	-0.001*	-0.000
	[0.068]	[0.068]	[0.339]
account_reg	-0.229***	-0.229***	-0.247***
	[0.000]	[0.000]	[0.001]
irap	0.131	0.131	-0.411**
	[0.336]	[0.336]	[0.041]
fine			-0.082
			[0.652]
prob_audit			1.563
			[0.284]
Constant	-0.404***	-0.404***	-0.336***
	[0.000]	[0.000]	[0.007]
Observations	214	214	108
R-squared	0.219	0.219	0.353

Robust in brackets.
*** p<0.01, ** p<0.05, * p<0.1

6 Concluding comments

The normative theory has not yet made much progress in providing concrete policy advice regarding the key tools of tax administration. Following Slemrod (2007) we can distinguish two cases: (i) the case where information can be reported by a third party, for example when a firm reports to the Tax Agency the information about salaries and wages paid to its employees, (ii) the case where only interested parties are involved, as it usually happens for transactions involving firms and self-employed workers. In this second case, compliance will be low unless costly audits are undertaken. The literature has discussed various audit schemes where the Tax Agency makes use of the information provided by the taxpayers, but they have been judged as rather poor descriptions of real-world tax audit systems (Andreoni et al. 1998). One of the main problems is the lack of data about the way the information is used and disclosed by the Tax Agency.

In this paper, we tested some simple theoretical predictions about the behaviour of a rational taxpayer who can anticipate the way the information he provides the Tax Agency is used to implement the audit rule. These predictions arise from a simple theoretical model which aims at generalizing the institutional features of the peculiar Italian audit scheme (*SdS*) where a report can be audited only if it is below a presumptive value, which depends on information reported by the taxpayer.

Our dataset comprises a large number of observations, approximately 23,000, but does not allow for a counterfactual analyis and thus cannot be used for a full causality analysis. Results are only partly in line with the theoretical model, and this may depend on the fact that many variables, such as the marginal concealment cost or the subjective probability of an audit, cannot be observed directly. However, a number of theoretically relevant relations seem confirmed. In particular, taxpayers' reports seem to be positively associated with size, as measured by number of employees and by some physical variables. This result is in line with the idea that, among small and medium enterprises, concealment costs increase with size. This is consistent with Slemrod (2007) U-turn relaltionship between propensity to evade and size, although in this paper we only observe small and medium enterprises and have no information on the behaviour of larger firms. The subjective probability to be audited is, at least in part, also relevant in a standard way: when taxpayers know that the probability to be audited decreases because of the availability of some legal shields, as the one provided to subcontractors and firms using complete accounting, they tend to report less. Also, regional differences in the propensity to underreport seem to matter, as reports are lower, relatively to the threshold, for taxpayers operating in Southern regions**.** On the contrary, other factors which are expected to influence the behaviour by taxpayers, such as the probability of audit and the amount of fine observed in the past, or the expected tax rate have no or ambigous impact on reporting behaviour.

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