Public Finance Review
39(1) 103-123

DOI: 10.1177/1091142110386214
http://pfr.sagepub.com

Taxpayer Behavior When Audit Rules Are Known: Evidence from Italy

Alessandro Santoro[1] and Carlo V. Fiorio[2]

Abstract
Italy adopted in 1998 a peculiar audit scheme (*Studi di Settore*), for small and medium enterprises and the self-employed. This scheme is based on a particular interaction between the tax agency and taxpayers, where the agency unveils only part of the information used to develop its audit rule. The authors study this scheme by means of a simple theoretical model and they test it using a sample of 23,000 firms in manufacturing sectors in the 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 that are expected to influence the behavior of taxpayers have no or an ambiguous impact on reporting behavior.

[1]University of Milan–Bicocca and Econpubblica, Milan, Italy
[2]University of Milan and Econpubblica, Milan, Italy

Corresponding Author:
Alessandro Santoro, University of Milan–Bicocca and Econpubblica, DSGE, Piazza dell'Ateneo Nuovo, 1, 20126, Milan, Italy
Email: alessandro.santoro@unimib.it

Keywords
audit, Italy, Studi di settore, tax evasion

As emphasized by Andreoni, Erard, and Feinstein (1998), there is a need for work on tax evasion to synthesize theory with empirical research, especially in a way that recognizes the complicated institutional framework in which individuals and tax authorities interact. In this article, we attempt to provide this synthesis, by developing a simple model of taxpayer behavior when the tax authority and the taxpayers interact and then by testing this framework using Italian data. In Italy, the size of the shadow economy ranges at top levels among Organisation for Economic Co-operation and Development (OECD) countries, accounting for 20 to 30 percent of the gross domestic product (GDP), according to Schneider and Enste (2000). To combat tax evasion, since 1998, Italy has adopted a tax auditing scheme that is focused on small-scale economic activities of firms and 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.

SdS has two noticeable features. First, the agency can audit and fine only firms whose reports are below a threshold that is known to the taxpayer, similar to a cutoff auditing rule. This means that a firm whose report is above the threshold knows that it will not be audited. Second, and contrary to what happens with a standard cutoff rule, such a value is a presumptive one determined by the tax agency based on output, which depends on the value of inputs (as reported by the taxpayer) and on their presumptive productivity (as determined by the agency). Thus, the determinants of the probability to be audited are at least somewhat 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. Consequently, the agency reveals to each taxpayer how much he or she should pay for avoiding a tax audit. To our knowledge, this is the only case where the audit rule is, to a considerable extent, known to taxpayers. 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' behavior can be addressed. Do taxpayers behave as predicted by the economic theory? What variables influence the taxpayers' reporting behavior? Santoro (2008) provides only a partial answer to these questions. He presents a model of taxpayers' behavior 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 article is a step in this direction.

In this article, we present a simplified model to describe the behavior of a rational taxpayer when the audit rule is partially known. Our main objective is to test some relations between taxpayers' reporting behavior and variables such as the audit probability, the tax rate, and the concealment costs. We use a sample of 23,000 observations to test these relations, taking into account the problem of endogeneity that naturally arises in this field of research. 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 that are expected to influence the behavior of taxpayers have no or an ambiguous impact on reporting behavior.

The article is organized as follows. The section on Audit Rules in Theory and Practice summarizes the literature on optimal audit policies and the relatively scant evidence on real-world audit practices by tax agencies. The section on The Italian Cutoff Auditing Rule introduces the main institutional features of *SdS.* In the section on The Model, the theoretical model is illustrated and its main predictions are commented. The Empirical Application section describes the empirical model, the data set, and the choice of proxies adopted for measuring the key variables of the model, and it discusses results. The Concluding Comments section provides some concluding remarks.

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, Erard, and Feinstein 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 commitment remain totally unknown to taxpayers. The existing literature on optimal tax audits (Sanchez and Sobel 1993; Scotchmer 1987) suggests that if the agency can commit to the audit rule, then the optimal audit rule typically involves a threshold (i.e., a value of the target variable such as income or profit) that 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 than or equal to 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, then 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.

Cutoff rules are an example of an endogenous tax audit rule or rules where the probability of audit varies across taxpayers and depends upon the behavior of taxpayer (Alm and McKee 2004). The experimental literature (Alm, Cronshaw, and McKee 1993; Kirchler 2007) generally confirms that cutoff rules yield higher compliance rates than random audits, although cutoff rules may trigger some kind of coordination between taxpayers (Alm and McKee 2004).

Apparently, many tax agencies adopt cutoff auditing rules and concentrate their audit resources on firms declaring returns below given thresholds, but the exact formulation of these cutoff points is not publicly known (Andreoni, Erard, and Feinstein 1998). Many countries adopt a statistical approach to tax auditing without disclosing the determinants of the probability of an audit. For example, the U.S. tax authorities use a "Discriminate Information Function" (DIF) score, a computer-generated score designed to predict tax returns most likely to result in additional taxes if audited. U.S. 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 recognized its main features (Alm and McKee 2004). According to Macho-Stadler and Perez-Castrillo (2002), other countries follow similar cutoff rules although the methodology adopted for their definition is never revealed.

The Italian Cutoff Auditing Rule

Since 1998, Italy has adopted the *Studi di Settore* tax auditing scheme, which is mainly focused on small-scale economic activities or those reporting an annual output below 5,164,569 euros. As our empirical analysis uses data about manufacturing firms only, we briefly describe how *SdS* work for firms (corporated and unincorporated companies and individual entrepreneurs), hence avoiding the *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 that are statistically more significant in explaining 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 input 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, by $\hat{X}_i^j$ the value of input $j, j = 1, \ldots J$ as reported by firm i, $i = 1, \ldots, I$, and by B^j the presumptive productivity parameter associated to input j. Presumptive output for firm j is thus equal to $\mathbf{B\hat{X}}_i = \sum_j B^j \hat{X}_i^j, j = 1, \ldots, J$.

Formally, in *SdS*, two distinct audit procedures are defined, one focusing on output and the other on input reports. Audits on output reports are characterized 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

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

The idea embodied in equation (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 equals zero when the ratio is greater than or equal to 1. The subjective part is reflected by δ_i: the higher this value, the lower the probability is 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 ignore 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 the section on Audit Rules in Theory and Practice because the threshold varies across taxpayers, being dependent for each taxpayer on his or her own value of inputs.

The Model

The model we present here modifies that of 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 that aims at minimizing the amount of its expected tax liability 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 (e.g., manipulation of current accounts and implementation of a collusion agreement between employers and employees) and possibly also psychological costs.

To account for the specific institutional framework of *SdS*, 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 $\hat{R}_i$ and of $\hat{\mathbf{X}}_i$. 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 $H'(.) > 0$ and $H''(.) > 0$. This is equivalent to assuming 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

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

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

In equation (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 equation (1), and f_i is the (gross) fine paid by the taxpayer if audited, expressed as a share of the difference between presumptive and reported output, with $0 < f < 1$.[1] $\mathbf{B}\hat{\mathbf{X}}_i$ is presumptive output as reported by the taxpayer, and $H_i(.)$ is i's output concealment cost function.

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 equation 1), and the value of P_i when $\hat{R}_i \geq \mathbf{B}\hat{\mathbf{X}}_i$ so that $q_i = 0$ (again see equation 1).

Let us introduce the following notation:

$$\tilde{R}_i \equiv \arg\ \min\ P_i \text{ if } \hat{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$$
$$\bar{R}_i \equiv \arg\ \min\ P_i \text{ if } \hat{R}_i \geq \mathbf{B}\hat{\mathbf{X}}_i$$

so that $\tilde{R}_i$ is the optimal value of $\hat{R}_i$ if the taxpayer decides to report below presumptive output while $\bar{R}_i$ is the optimal value of $\hat{R}_i$ if the taxpayer decides to report at least presumptive output. It can be shown[2] that

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

Equation (3) says 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 concealment cost H' and decreases in the tax rate τ_i.

To proceed further, we introduce two assumptions:

Assumption 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.

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

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

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

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

Finally, Assumption 1 has two further implications for the interpretation of equation (3). First, the ratio $\tilde{R}_i/\mathbf{B}\hat{\mathbf{X}}_i$ is decreasing in δ_i: the higher the perceived probability of an audit for a given difference between $B\hat{\mathbf{X}}_i$ and $\hat{R}_i$, the higher the reported output for a given report of inputs. Second, the ratio $\tilde{R}_i/\mathbf{B}\hat{\mathbf{X}}_i$ is increasing in f: the higher the gross fine, the higher the reported output.

To evaluate the meaning of Assumption 2, consider that the average value of f observed in our data is around 0.6. If we take the latter as the value relevant for a representative taxpayer, then equation (1) generates a perceived probability of an audit that varies as illustrated in Table 1. Now, the actual probability of an audit if a taxpayer declares $\hat{R}_i < B\mathbf{X}_i$ is around 4 percent. On the contrary, even when the deviation from presumptive output is very small, Table 1 displays very high values of the subjective

Table 1. Values of q when $\delta_i \in (0.6; 1.2)$

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

probability of an audit. For example, this probability ranges from 4.2 percent to 16.7 percent as the ratio $\hat{R}_i/\mathbf{B}\hat{\mathbf{X}}_i$ varies between 90 and 95 percent. This means that we assume that a representative taxpayer believes that the tax agency is very sensitive to small deviations from presumptive output. Thus, our assumption embodies a possible misperception, that is, an overestimation of the probability of an audit when *SdS* is used. There is anecdotal evidence that such a misperception 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 2, when evaluated jointly with Assumption 1, are several. First, $\tilde{R}_i < \mathbf{B}\hat{\mathbf{X}}_i$. To see this, just use Assumptions 1 and 2 in equation (3). Second, the variables that determine the choice of the value of $\tilde{R}_i$ are also those that 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 that is below the presumptive value if and only if

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

Inequality says that i is more likely to report output below the presumptive 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 Assumption 2 in equation (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.

To sum up, under Assumptions 1 and 2, the model states that the ratio $\hat{R}_i/\mathbf{B}\hat{\mathbf{X}}_i$ is increasing in $1/\delta$ (the perceived probability of an audit for a given difference $\mathbf{B}\hat{\mathbf{X}}_i - R_i$), is increasing in the expected fine f, is increasing in the marginal concealment cost H', and is decreasing in the tax rate, τ.

Empirical Application

The Empirical Model

Ideally, the model outlined in the previous section should be tested using a structural model of firms and tax agency behavior, with data 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 caught underreporting, and 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:

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

where $\{\alpha, \beta, \psi, \gamma, \eta\}$ are coefficients to be estimated and 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 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. All our estimates of model (6) report cluster-corrected standard errors. Second, the variables providing proxies of concealment costs might be endogenous and cause biased estimates of the coefficients. Hence, we perform a standard Durbin-Wu-Hausman endogeneity test of the hypothesis that an ordinary least squares (OLS) estimator of the model would yield consistent estimates, that is, 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). 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 analyzing, there is a third issue to consider, namely, the estimation method. As will be clearer after the data description (next subsection), the data we use are upper-censored at 1, where a large spike emerges. Hence, we use maximum likelihood for estimating upper-censored Tobit models.

The Data Set

Data for the analysis of *SdS* are produced by Società per gli Studi di Settore (SOSE), the specialized firm that, on behalf of the Italian tax agency, administers the entire statistical process of data collection and development of *SdS*.[3] Each year, SOSE selects the number of firms by a stratifying sampling procedure based on clusters, that is, on groups of firms that, within each sector, are considered 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, and degree of specialization among other variables.

Our data set includes only *SdS* for manufacturing firms, which are obtained by 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), and a file reporting the presumptive output that was known by the firm at the time of declaring its output.

To estimate model (6), we define 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 the 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 beliefs are that the larger the physical dimension and the workforce of a firm, the more costly to hide output,[4] 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 (Slemrod 2007; Kleven, Kreiner and Saez 2009).

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 accounting regime and zero otherwise) and 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 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, evaluated for the business sector (two digits) of firm *i*.[5] The same data set is used to calculate the variable *fine*, which is the average value (for the two 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*).[6] In all regressions, we also control for two-digit industry classification code (*ateco*) and for the firm's macro-region 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 regional propensity to evade that, according to the existing literature on Italy, is higher and more tolerated in southern than in northern regions (Bernardi and Bernasconi 1996; Fiorio and Zanardi 2008).

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

Table 2. Descriptive Statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Ratio[a]	22,558	0.06	0.44	−9.33	9.84
sq_meter[a]	22,071	5.15	1.49	0.00	9.58
empl_ft[a]	22,716	0.97	1.09	0.00	4.70
sh_family	22,716	0.03	0.12	0.00	0.80
sh_subcontract	19,018	46.45	46.79	0.00	100.00
account_reg	22,716	0.52	0.50	0.00	1.00
Fine	15,192	0.60	0.08	0.31	0.93
prob_audit	15,716	0.04	0.01	0.00	0.11
Irap	22,825	0.11	0.14	0.00	0.60
2.area3	22,700	0.21	0.41	0.00	1.00
3.area3	22,700	0.24	0.43	0.00	1.00

[a] The variable is measured in log units.

A quick look at the descriptive statistics in Table 2 might wrongly suggest a symmetric distribution of the dependent variable, that is, the (log) ratio of declared output and the threshold for firm *i*. In fact, the nonparametric distribution on bounded support 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 toward the threshold from above, which is consistent with the interpretation of the theoretical model discussed in the previous section.[7] See Figure 1.

Due to the peculiar distribution of the dependent variable, we select only those firms whose ratio variable $\hat{R}_i/\mathbf{B}\hat{\mathbf{X}}_i$ is below or close to unity. According to the theoretical model, the only reason for a firm to declare an output value much larger than the threshold is because of some mistake in the output reporting, wrong advice from the tax consultant, or a strong moral motivation that induces 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 capture their contribution to explain the ratio of reported output of firms over the threshold.

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 data set with other data as described in Table 3.

Results

As mentioned earlier, model (6) could possibly be flawed by an endogeneity problem. In particular, as our dependent variable is the ratio of declared

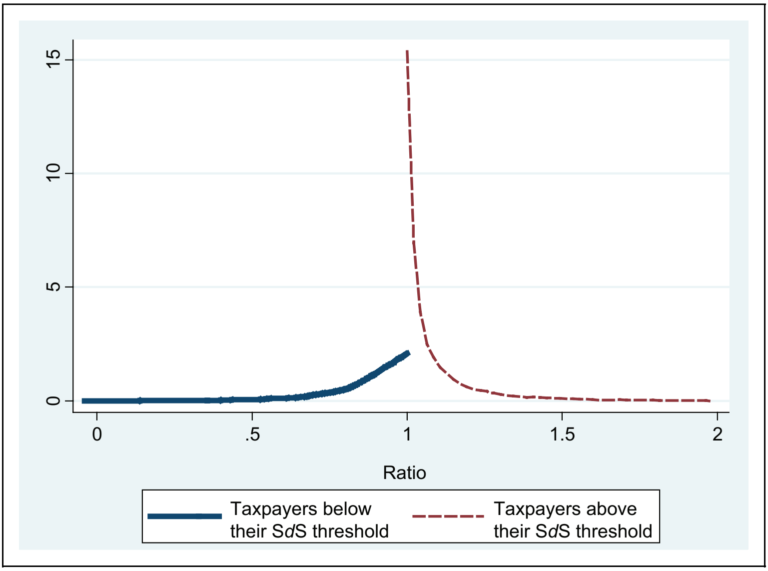

Figure 1. Nonparametric distribution of $\hat{R}_i/\mathbf{B}\hat{\mathbf{X}}_i$

Table 3. Description of Variables (as Reported by the Taxpayer Unless Specified)

Variable in equation (3)	Measure	Theoretical correlation with dependent 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

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 test the endogeneity of those variables using the Durbin-Wu-Hausman endogeneity test. These

Table 4. Description of Variables (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 are corrected for clusters in *ateco*.

results are presented in Table 4. In neither case is the null hypothesis of exogenous regressors rejected, suggesting that IV methods are not required.

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 the previous subsection, and of the inability of our model to explain the behavior of those declaring more than their *SdS* threshold. These results are presented in Table 5, where we regress the dependent variable first on size variables only (column 1); then we introduce also the accountancy regime and the effective tax rate measures (column 2), and finally we introduce also the fine and the audit probability measures (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.

Consistent with our expectations, 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, consistent with expectations, although it is not statistically significant when we also control for fine and audit probability. We find very little impact of the share of subcontractors, while regional

Table 5. Tobit Models with Censoring of Dependent Variable at 0

Dependent variable: Ratio	(1)	(2)	(3)	(4)
sq_meter	0.015 (0.110)	0.019* (0.091)	0.015 (0.188)	0.014 (0.202)
empl_ft	0.054*** (0.000)	0.038*** (0.000)	0.040*** (0.000)	0.041*** (0.000)
sh_family	0.167*** (0.000)	0.236*** (0.000)	0.225*** (0.000)	0.228*** (0.000)
sh_subcontract		0.000 (0.417)	0.000 (0.367)	0.000 (0.285)
1.namod		−0.032*** (0.006)	−0.031** (0.046)	−0.031** (0.048)
irap		0.277*** (0.000)	0.265*** (0.000)	0.266*** (0.000)
fine			0.312 (0.480)	0.353 (0.421)
prob_audit				−1.098 (0.353)
2.area3	−0.010 (0.551)	−0.008 (0.625)	0.000 (0.994)	−0.001 (0.960)
3.area3	−0.046*** (0.008)	−0.045** (0.023)	−0.045*** (0.009)	−0.047*** (0.003)
14b.natec02d	0.000	0.000	0.000	0.000
Constant	−0.512*** (0.000)	−0.528*** (0.000)	−0.691*** (0.007)	−0.672*** (0.004)
Observations	6,888	5,538	3,906	3,906
Pseudo R^2	0.086	0.086	0.086	0.086

Note: Robust standard errors are in parentheses. Standard errors are adjusted for clusters *ateco*. Weighted estimates are presented.
*$p < .1$. **$p < .05$. ***$p < .01$.

controls highlight the fact that underdeclaration is on average larger in the southern regions.

We test these results (in particular those in columns 2–4 of Table 5) for robustness in two ways. First we tried other, less conservative, trimming rules, that is, the log ratio of declared output and *SdS* threshold was trimmed for values above 0.01 (increasing the original sample size over 30 percent), 0.02 (increasing the original sample size by over 40 percent), and 0.04 (increasing the sample size by nearly 50 percent). Results are largely unchanged for the (log) number of employees and for the family workers share. The square meter variables are found with significant positive values and the share of subcontracting has a very small but significantly negative coefficient. See Table 6.

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 extract additional information on the idiosyncratic error term, we followed a different strategy based on analyzing variability of our dependent variable between industry codes

Table 6. Robustness Check: Setting a#Different Trimming Rule

Dependent variable: Ratio	Censoring ratio at 0.01			Censoring ratio at 0.02			Censoring ratio at 0.04		
	(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	10,325	7,369	7,369	11,810	8,409	8,409	13,486	9,562	9,562
Pseudo R^2	0.061	0.061	0.061	0.056	0.056	0.056	0.052	0.053	0.053

Note: Robust standard errors are in parentheses. Standard errors are adjusted for clusters *ateco*. Weighted estimates are presented.
*p < .1. **p < .05. ***p < .01.

Table 7. Robustness Check: OLS Estimation of Observations Collapsed by Ateco Codes

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

Note: Robust standard errors are in parentheses. OLS = ordinary least squares.
*$p < .1$. **$p < .05$. ***$p < .01$.

(*ateco*) setting at zero the variability within it. Hence, we generate a new data set, collapsing all variables in our original data set by industry codes and estimating model (6) by OLS. 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 percent, which is relevant considering the type of relation estimated. See Table 7.

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: where information can be reported by a third party (e.g., when a firm reports to the tax agency the information about salaries and wages paid to its employees) and where only interested parties are involved, as 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, Erard, and Feinstein 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 article, we tested some simple theoretical predictions about the behavior 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 that 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 results are only partly in line with the theoretical model, which may occur because 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 the propensity to evade decreases in the number of employees (Kleven, Kreiner and Saez 2009). This result is also consistent with Slemrod's (2007) U-turn relationship between the propensity to evade and size, although in this article we only observe small and medium enterprises and we have no information on the behavior 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 for taxpayers operating in Southern regions. Other factors expected to influence the behavior by taxpayers, such as the probability of audit, the amount of fine observed in the past, or the expected tax rate, have no or an ambiguous impact on reporting behavior.

Acknowledgment

Financial support from Italian Ministry of Education (PRIN 2007) is gratefully acknowledged. Authors thank participants to the Muenster Conference on the Shadow Economy, Jim Alm, and two anonymous referees for comments and suggestions on previous version of this article. The usual disclaimers apply.

Declaration of Conflicting Interests

The author(s) declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research and/or authorship of this article: Italian Ministry of Education PRIN 2007HEWTBE.

Notes

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, by assuming $0 < f < 1$, and we define f as a gross fine since it includes this discount. All results are unchanged by admitting $f \geq 1$.
2. Proofs of this and of the other results can be obtained upon request.
3. More details about SOSE are available from website: http://www.sose.it.
4. This assumption is consistent with the idea that any single employee can denounce collusive tax cheating, i.e. the whistleblowing threat hypothesis by Kleven, Kreiner and Saez (2009) and also with the 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.
5. Note that this time lag is appropriate since reports made in a given year are usually audited four or five years later so that reports made in 2000 were presumably audited in 2004 and 2005, that is, slightly before reports for tax year 2005 were made.
6. 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.
7. For an introductory discussion of density estimation on bounded support, see Silverman (1986).

References

Allingham, Michael G., and Agnar Sandmo. 1972. Income tax evasion: A theoretical analysis. *Journal of Public Economics* 1:323-38.

Alm, James, Mark B. Cronshaw, and Micheal McKee. 1993. Tax compliance with endogenous audit-selection rules. *Kyklos* 46:27-45.

Alm, James, and Michael McKee. 2004. Tax compliance as a coordination game. *Journal of Economic Behaviour and Organization* 54:297-312.

Andreoni, James, Brian Erard, and Jonathan Feinstein. 1998. Tax compliance. *Journal of Economic Literature* 36:818-60.

Arachi, Giampaolo, and Alessandro Santoro. 2007. Tax enforcement for SMEs: Lessons from the Italian experience? *Atax-Ejournal of Tax Research* 5:224-42.

Bernardi, Luigi, and Michele Bernasconi. 1996. L'evasione fiscale in Italia: evidenze empiriche. *Il Fisco* 38:19-36.

Cameron, Adrian C., and Pravin K. Trivedi. 2006. *Microeconometrics. Methods and applications.* Cambridge: Cambridge University Press.

Cowell, Frank A. 2003. Sticks and carrots, DARP Discussion Paper N. 68, Distributional Analysis and Research Programme, London School of Economics and Political Science.

Fiorio, Carlo V., and Alberto Zanardi. 2008. It's a lot but let it stay: How tax evasion is perceived across Italy. In *Shadow economy, corruption and governance*, ed. Michael Pickhardt and Edward Shinnick, 210-39. Cheltenham, UK: Edward Elgar.

Kirchler, Erich. 2007. *The economic psychology of tax behaviour.* Cambridge: Cambridge University Press.

Kleven, Henrik J., Claus T. Kreiner, and Emmanuel Saez. 2009. *Why can modern governments tax so much? An agency model of firms as fiscal intermediaries*. National Bureau of Economic Research Working Paper Series, Working Paper 15218, National Bureau of Economic Research.

Macho-Stadler, Ines, and David Perez-Castrillo. 2002. Auditing with signals. *Economica* 69:1-20.

Sanchez, Isabel, and Joel Sobel. 1993. Hierarchical design and enforcement of income tax policies. *Journal of Public Economics* 50:345-69.

Santoro, Alessandro. 2008. Taxpayers' choices under Studi di Settore: What do we know and how can we explain it? *Il Giornale degli Economisti* 67:161-84.

Schneider, Friedrich, and Dominique Enste. 2000. Shadow economies: size, causes and consequences. *The Journal of Economic Literature* 38:77–114.

Scotchmer, Suzanne. 1987. Audit classes and tax enforcement policy. *American Economic Review* 77:229-23.

Silverman, Bernard V. 1986. *Density estimation for statistics and fata analysis*. London: Chapman & Hall.

Slemrod, Joel. 2007. Cheating ourselves: The economics of tax evasion. *The Journal of Economic Perspectives* 21:25-48.

Bios

Alessandro Santoro is an Assistant Professor of Public Finance at the University of Milan–Bicocca and has worked for eight years as Tax Expert at the Italian Ministry of Finance. His main research interests are in tax evasion and the relationship between taxation and inequality.

Carlo V. Fiorio is an Assistant Professor of Public Finance at the University of Milan. His research interests are in Public Economics, Applied Econometrics, Inequality Analysis, and Labor Economics.