Endogenous Audit Rules and Taxpayers'behaviour: Evidence From Italy.

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Abstract

With an endogenous tax audit rule the probability of audit is variable across taxpayers and depends in part upon the taxpayers'reports. The theoretical literature on tax evasion suggests that endogenous audit rules are preferable to random audits, where the probability of audit is fixed across taxpayers. The experimental literature generally confirms this result, but empirical evidence on the actual impact of endogenous audit rules on taxpayers'behaviour is still missing, especially since the Tax Authorities generally do not disclose details about these rules. The present paper aims to start filling in this gap by looking at the Italian experience where an endogenous and manipulable audit rule was adopted. A theoretical model is constructed and estimated, and the results show that the taxpayers seem to respond to the introduction of an endogenous audit rule by rationally manipulating their reports.

JEL: H25, H26, K42.

keywords: tax, evasion,audit.

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1. Introduction

The simplest way to audit tax returns is to use a random audit rule, in which the probability of an audit is fixed across taxpayers and does not depend on taxpayers'reports. On the contrary, with an *endogenous* tax audit rule, the probability of audit is variable across taxpayers and endogenous, depending in part upon the behavior of both the taxpayer and the tax agency (Alm and McKee, 2003). The literature on tax evasion suggests that endogenous audit rules are preferable to random audits. The theoretical literature (summarized in Andreoni et al., 1998) has identified optimal audit rules for both the committment case, i.e. when the Tax Agency can commit to the audit rule, and the non-committment case. In both cases, optimal strategies depend upon the reports made by taxpyers. In particular, 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 a given positive probability, while other taxpayers will not be audited at all. The experimental literature (Alm et al., 1993; Kirchler, 2007) generally confirms the dominance of cut-off rules over random audits, although cut-off rules may trigger some kind of coordination between taxpayers (Alm and McKee, 2003). However, the empirical evidence on the actual impact of endogenous audit rules on taxpayers'behaviour is still missing, mainly since the Tax Authorities generally do not disclose details about these rules. How do taxpayers actually react to an endogenous audit rule? This question is left virtually unanswered in the current literature. The present paper aims at start filling in this gap by looking at the Italian experience.

When tax evasion is considered, Italy is not the least interesting case. In Italy the size of the shadow economy ranges at top levels among OECD countries, between 24% and 30% of the GDP (Schneider and Enste, 2000). Now, Italy has adopted, since 1998, a tax auditing scheme which is focused on small-scale economic activities (ran by firms and by self-employed people). This scheme is known as *Studi di Settore* (*Sds* in this paper) and it has been described in details by Arachi and Santoro (2007) and by Santoro (2008). The scheme has two noticeable features. First, the Tax Agency is committed to audit and fine, with positive probabilities, only firms whose reports are below a threshold which is known to the taxpayer, similarly to what happens with a cut-off rule. Second, the value of this threshold as well as the probability to be audited varies across taxpayers and depend also on the information provided by the taxpayer to the Tax Agency. Thus, contrarily to what happens in the majority of other countries, the determinants of the probability to be audited are, though only partially, known to taxpayers, and, moreover, these determinants are manipulable, to some extent, by taxpayers. In particular, the probability to be audited depends (also) on the value of inputs as reported by every taxpayer.

The design and implementation of Italian *Sds* provide a good framework where some of the most fundamental questions concerning taxpayers' behaviour can be addressed: how do taxpayers react to endogenous audit policies when the features of the latter are (at least partly) known? how do taxpayers manipulate the information that they know it is used by the Tax Agency to define the probability of audit? do taxpayers act rationally in response to endogenous audit rules?. Santoro (2008) provides only a partial answer to these questions. He presents a model of taxpayers'behaviour under *Sds* where it is shown that the extent of manipulation by taxpayers 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.

In this paper we do two things. First, we extend the previous model (Santoro, 2008) to make it more realistic and apt for an empirical application. Second, we use a dataset comprising tax reports of 18,320 firms for fiscal year 2005 to test some of the empirical predictions of the model, and, in particular, the relationship between, on the one hand, the manipulation of information and, on the other hand, the reporting behaviour, the cost of concealing true values of output and inputs and the tax rate. This empirical analysis, though preliminary, seems to indicate that the predictions of the model are well-rooted, so that Italian taxpayers have reacted to the new endogenous audit rule by adopting a rational strategy of reports manipulation.

The paper is organized as follows. Section 2 summarizes the literature on optimal audit policies and introduces the main institutional features of *Sds*. In Section 3 the theoretical model is illustrated and its main predictions are commented. In Section 4 the model is estimated by means of OLS regressions. Section 5 provides some concluding remarks.

2. Audit policies and taxpayers'behaviour

The existing literature on optimal tax audits (Andreoni et al., 1998; 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 a given 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, so that no taxpayer will report an income higher than the threshold. 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 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 unitary 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.

In the real-world, many tax agencies apparently do establish cut-off points and focus their audit resources on returns falling below the cut-offs, 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, in the US, the DIF is a computer-generated score designed to predict tax returns most likely to result in additional taxes if audited. Taxpayers are aware of the use of this statistical method in selecting taxpayers to audit, but the exact equation of DIF (and hence the score generated by taxpayers themselves) is unknown to them, although many tax professionals have long recognized the broad outlines of this audit process (Alm and McKee, 2003). Other countries follow a similar practice (Macho-Stadler and Perez-Castrillo, 2002). To sum up, cut-offs are used, but they are not fully known by taxpayers and there is no commitment in a proper sense. More in general, endogenous audit rules are often used but, even if some taxpayers may be competently adviced by tax professionals, the relevant information is not disclosed and therefore it is quite difficult to test empirically how taxpayers adjust their behaviour in response to these rules.

Italy has adopted, since 1998, a tax auditing scheme, *Sds,* which is mainly focused on small-scale economic activities, i.e. those reporting an annual output not greater than 5.164.569 euros.We now describe a typical *Sds* for a given business sector limiting the attention to firms (corporated and unincorporated companies, individual entrepreneurs) thus excluding self-employed workers. Data include structural variables- such as surface area of offices and warehouses, number of employees, type of customers and so on- and accounting variables, mainly referring to the value and cost of inputs. A number of statistical analyses are performed to select reliable data, to group firms together within every business sector and to select those inputs which are statistically more significant in explaining the variance of reported output within every business sector.

Then, a parameter reflecting presumed productivity is calculated for each of the selected inputs and for each business sector. At this stage, the reports of inputs and outputs are made. Presumed output is obtained for every firm as the weighted sum of the reported value of selected inputs, where weights are the productivity parameters. In the paper, we denote by $\widehat{X_i^j}$ the value of input $j, j = 1, ...J$ as reported by firm i and we denoted by B^j the productivity paramater associated to input j. Presumed output for firm j is thus equal to $\mathbf{B}\widehat{\mathbf{X}}_i = \sum_j B^j \widehat{X_i^j}, j = 1, ...J$ while we denote by $\widehat{R}_i$ and by R_i the reported and true value of output, respectively. Two types of audits can be generated, which we label as type I and type II. Type I audit concerns output reports. It is type I audit which possesses the two noticeable features mentioned in the introductory section. First, the Tax Agency is committed to audit and fine, with positive probabilities, only firms whose output reports are below a threshold which is known to the taxpayer. Second, the value of this threshold as well as the probability to be audited depend also on the information provided by the taxpayer to the Tax Agency. More precisely, the legal and institutional framework of type I audits can be summarized by the following subjective probability function (see Santoro, 2008)

$$\begin{aligned} q_i &= q(\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}) = \frac{1}{\delta_i}\left[1 - \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right], \; \widehat{R}_i \leq \mathbf{B}\widehat{\mathbf{X}_i} \\ q_i &= 0, \; \widehat{R}_i > \mathbf{B}\widehat{\mathbf{X}_i}, \mathbf{B}\widehat{\mathbf{X}}_i = \sum_j B^j \widehat{X_i^j}, j = 1, ..., J \end{aligned} \tag{1}$$

In other words, q_i is a linear decreasing audit subejctive probability function satisfying $q_i(1) = 0$ where δ_i is inversely related to the steepness function . Thus, a steeper type I audit function is associated with a smaller δ_i, and viceversa. The parameter δ_i defines, therefore, the probability of type-I audit as it is perceived by the taxpayer for a *given* difference between presumed and reported output.

Type II audits may be based on the difference between the true and the reported value of input. Type II audits are the logical counterpart of type I audits. Clearly, if $B^j > 0$, as it generally happens, firms can reduce the expected probability and sanction of type I audits by simply underreporting X^j. Therefore, reports of inputs should be audited.Since there are no explicit legal constraints, it is assumed that there is a nonnegative constant probability p_i of a type II audit and that the corresponding penalty applies to the weighted difference between the true and the reported value of input, i.e to $\mathbf{BX}_i - \mathbf{B}\widehat{\mathbf{X}}_i^j$ where $\mathbf{X}_i$ is the vector of true values of J inputs.

3. The model

The model we present here extends that proposed by Santoro (2008). It is based on a combination of the models by Scotchmer (1987) and Cowell (2003), adapted to take account of the legal and institutional framework of the design and implementation of Sds. The taxpayer (TP from here in after) 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. Thus, along with the subjective probability functions defined in the previous Section, we include in the TP's objective function two concealment cost functions, that we denote as $H(.)$ for output and $G(.)$ for inputs. In both cases, the argument is the difference between the true and reported value, i.e., respectively, $R_i - \widehat{R}_i$ for output and $\mathbf{X}_i - \widehat{\mathbf{X}}_i$ for inputs. We assume, without loss of generality, that, since there are no tax abatements for overreporting, these differences are never negative. We also assume, following Cowell (2003), that both functions are increasing in their arguments, i.e. that $H'(.) > 0$ and $G'(.) > 0$, and weak-convexity, i.e. that $H''(.) \geq 0$ and $G''(.) \geq 0$.This is equivalent to assume that there are no economies of scale in the concealing activity of both inputs and output.We follow the literature on tax evasion by firms (see Myles, 1997 for a summary) by assuming proportional taxes. Finally, we have to take into account the possibility that some (or all) of the inputs entering in $\widehat{\mathbf{X}}_i$ are costs deductible from the tax base. To this purpose, we use the binary variable λ^j, which is equal to 1 when j is a cost-input, while it is equal to 0 when it is not a cost. Thus, the TP minimizes

$$\begin{aligned} EP &= \tau\left(\widehat{R}_i - \sum_j \lambda^j X_i^j\right) + q_i(1+f_1)\tau\left(\mathbf{B}\widehat{\mathbf{X}_i} - \widehat{R}_i\right) \\ &\quad + p_i(1+f_2)\tau\left(\mathbf{B}\mathbf{X}_i - \mathbf{B}\widehat{\mathbf{X}_i^j}\right) + G(\mathbf{X}_i - \widehat{\mathbf{X}}_i) + H(R_i - \widehat{R}_i) \end{aligned} \quad (2)$$

with respect to $\widehat{R}_i$ and with respect to every component of $\widehat{\mathbf{X}}_i$,where q_i is defined by (1), while $\mathbf{B}\mathbf{X}_i = \sum_j B^j X_i^j$, $\left(\mathbf{X}_i - \widehat{\mathbf{X}}_i\right) = \sum_j \left(X_i^j - \widehat{X_i^j}\right)$, $j = 1, ..., J$.

In (2), τ is the tax rate, λ^j is a binary variable such that $\lambda^j = 1$ when input j is a deductible cost and $\lambda^j = 0$ when it is not, q_i is the probability of a type I audit as perceived by the TP, f_1 is the sanction expected if a type I audit is successfully conducted, $\mathbf{B}\widehat{\mathbf{X}}_i$ is presumed output as reported by the TP, p_i is the probability of a type II audit, f_2 is the sanction expected if a type II audit is successfully conducted, $\mathbf{B}\mathbf{X}_i$ is the true value of presumed output, while $G(.)$and $H(.)$ are the concealment cost functions for, respectively, inputs and output. We assume that all B^j's are positive, which corresponds to what observed in reality.

There are two differences with respect to Santoro (2008). First, in (2) we account for the fact that the presumed output depends on J inputs rather than on only one as assumed in Santoro (2008). Second, as we already mentioned, we include in the objective function the cost for concealing output, $H(.)$, along with the cost of concealing inputs, i.e $G(.)$. Failing to do so, it would be impossible to explain, under risk -neutrality, the fact that a significant share of taxpayers report a output higher than the presumed one.

Differentiating (2) with respect to $\widehat{R}_i$ yields the following[1]

$$\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i} = \left[1 - \frac{\delta_i}{2(1+f_1)}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)\right] \tag{3}$$

[1] Proofs of this and of the other results obtained in the paper can be obtained upon request.

Thus, for any given value of input reports, i.e. of $\widehat{\mathbf{X}}_i$, the taxpayer chooses $\widehat{R}_i$ in a way which depends upon three variables: the ratio $\delta_i/(1+f_1)$, the marginal concealment cost function for output, $H^{'}$ and the tax rate τ. Consider first the ratio $\delta_i/(1+f_1)$. By looking at (1) and (2) it is evident that this ratio is inversely related to the expected toughness of type I audit policy: as δ_i decreases, the reaction function q_i gets steeper while, as f_1 increases the TP expects to be sanctioned more heavily in the event of a successful type I audit. The effect of an increase in the expected toughness of a type I audit policy, (lower δ_i and/or higher f_1), depends on the *natural* propension to evade, i.e. on the ratio $H^{'}(R_i - \widehat{R}_i)/\tau$.If $H^{'}(R_i - \widehat{R}_i) < \tau$, the TP tends naturally to evade more, since the marginal concealment cost of output, $H^{'}(R_i - \widehat{R}_i)$, is lower than the marginal expected gain from evading output, i.e. τ. In such a case he TP would underreport output if there were no audits, and thus an increase in the expected toughness generates more "compliance", i.e. a higher value of reported output. In the opposite case, i.e. when $H^{'}(R_i - \widehat{R}_i) > \tau$,audits are wasteful, since the TP would naturally tend not to evade, and an increase in the expected toughness does not generate more compliance. In a sense, $H(.)$ is a simple way to capture, in this framework, the attitude towards honesty which is observed in the real world (Andreoni et al., 1998). Finally, the ratio $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$ is increasing in $H^{'}(R_i - \widehat{R}_i)$, since an increase in the latter signals that the concealing activity is becoming more costly, and decreasing in τ, since this means that underreporting output is becoming more appealing.

Expression (3) describes the behaviour of the TP for every value of $\mathbf{B}\widehat{\mathbf{X}_i}$. This would be fully satisfactory if we could assume that $\widehat{\mathbf{X}_i} = \mathbf{X}_i$ which, however, is not true in general. Thus we focus on the manipulation of inputs values. Ideally, this manipulation should be expressed as a function of δ_i. This can easily be done, but its pratical usefulness is strongly limited by the fact that δ_i, i.e. the steepness of type I audit function as subjectively perceived by the TP is *unobservable.* Tto proceed further, we use (3) to express the manipulation of inputs as a function of the (observable) ratio $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$. By doing so one obtains

$$G'(X_i - \widehat{\mathbf{X}}_i) = \left[1 + \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}_i}}\right] \tau B^j \frac{1}{2}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) - \tau \left[B^j p(1+f_2) + \lambda^j\right] \quad (4)$$

for every $,j = 1, ..., J$. The optimal value of every input report, $\widehat{X_i^j}$ is such that, given the other $J-1$ input reports, the marginal concealment cost of inputs equates the expression on the right hand side of expression (4). Under convexity of G, expression (4) indicates that aggregate manipulation, i.e. the difference $X_i - \widehat{\mathbf{X}}_i$, should be increasing in the ratio $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$ if $H'(R_i - \widehat{R}_i) < \tau$ and decreasing in the opposite case.On the other hand, aggregate manipulation should be decreasing in the marginal cost of concealing output $H^{'}$,in the cost parameter α, in the probability, p, and sanction, f_2, of a type II audit. Finally, the impact of τ and of B^j is ambiguous.

These results all are quite intuitive, although the predicted impact of $\widehat{R}_i/\widehat{\mathbf{BX}_i}$ and of $H^{'}$ deserve some comments. If the manipulation of output is not too costly, aggregate input manipulation is increasing in the ratio $\widehat{R}_i/B\widehat{\mathbf{X}_i}$. The intuition behind this result is quite straightforward. As we noted above, if the manipulation of output is not too costly, i.e. if $H^{'}(R_i - \widehat{R}_i) < \tau$, the ratio $\widehat{R}_i/B\widehat{\mathbf{X}_i}$ increases in the expected toughness (lower δ_i and/or higher f_1) of a type I audit policy. However, increasing $\widehat{R}_i/\widehat{\mathbf{BX}_i}$ without modifying $\widehat{\mathbf{X}}_i$ would imply higher output report and higher taxes. If type II audit probabilities and sanctions are not large enough, the TP offsets this potential increase in taxes by a more intense manipulation of inputs, i.e. by lowering the value of $\widehat{\mathbf{X}}_i$. In other words, given a"small enough" expected cost of a type II audit, the TP adjusts his input reports so that they are low enough to allow for a low report of output without increasing too much the expected probability and sanction of a type I audit. This balancing behaviour holds only if $H^{'}(R_i - \widehat{R}_i) < \tau$, i.e. if concealing output is not too costly. In the opposite case, i.e. if $H^{'}(R_i - \widehat{R}_i) > \tau$ there is no balancing at all.

The model also predicts a negative relationship between the amount of manipulation of *inputs* and the marginal cost of concealing *output*. We recall that in (4) the *indirect* effect of $H^{'}$ on manipulation, the one which is channelled through $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$, cannot be seen. In (4) only the *direct* effect of $H^{'}$on manipulation can be appreciated. By *direct* effect we mean the impact of $H^{'}$ which is not channelled through $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$: according to (4) this should be negative. The reasoning is as follows. When (3) is used to express δ_i as a dependent variable, it can be seen that, for any given value of the ratio $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$, a higher $H^{'}$ is associated to a higher value of $\delta_i/(1+f_1)$ since, as concealing output becomes costly, an unchanged value of $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$ can be justified only if the expected cost of a type I audit is also lower. Thus, since the manipulation activity is decreasing in $\delta_i/(1+f_1)$, this manipulation is also decreasing in $H^{'}$ for any given value of $\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$.

4. Estimation of the model

In this Section we use a dataset comprising 18,320 observations, each referring to a single firm (self-employed workers are excluded) operating in the manifacturing sector. More precisely, the observations belong to 49 different industrial sectors, and the sample is representative of tax reports made in fiscal year 2005 by approximately 363,500 Italian SMEs operating in the manifacturing sector. The sample provides reported, $\widehat{R}_i$, and presumed, $\mathbf{B}\widehat{\mathbf{X}_i}$, output levels along with some variables which are directly or indirectly related to some values of $\widehat{X_i^j}$'s. There also are information about the region of operation, the accounting regime (distinguished between ordinary and simplified) and the size of the firm.

To have a single equation to estimate, we assume that $G(.)$ takes the following specification

$$G(\mathbf{X}_i - \widehat{\mathbf{X}}_i) = (\mathbf{X}_i - \widehat{\mathbf{X}}_i)^{\alpha}, \alpha > 1 \tag{5}$$

so that (4) rewrites as

$$X_i^j - \widehat{X_i^j} = \left[\frac{1}{\alpha} g(\widehat{R}_i / \mathbf{B}\widehat{\mathbf{X}_i}, \tau, B^j, H^{'}, p, f_2)\right]^{1/(\alpha-1)} - \sum_{s \neq j} \left(X_i^s - \widehat{X_i^s}\right) \tag{6}$$

where

$$g(.) = \left[1 + \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}_i}}\right] \tau B^j \frac{1}{2} \left(1 - \frac{H^{'}(R_i - \widehat{R}_i)}{\tau}\right) - \tau \left[B^j p(1 + f_2) + \lambda^j\right]$$

for $j = 1, ..., J$. The major problem is to find out a way to measure true values of inputs, i.e. the vector $\mathbf{X}_i$. We do so by selecting a variable which has two features: i) the reported value is likely to be the true one, ii) it is likely to be positively correlated with the values of each input included in $\mathbf{X}_i$. This variable is the *physical size* of the firm, which we denote by S_i i.e. the sum, in squared metres, of surfaces used by the firm to produce, sell and store goods and products. In other words, S_i is the total surface of offices, shops, laboratories and warehouses used by the firm. The reported value of this variable, $\widehat{S}_i$ which is included in the dataset, is likely to be equal to its true value since underreporting of the latter is unlikely. The value of $\widehat{S}_i$ is not a component of $\widehat{\mathbf{X}}_i$ and its true value is easy to be checked by the Tax Agency either by inspecting administrative data (all transactions of buildings and surfaces are recorded in Italy) or through a special audit procedure (called *accesso*). Moreover, it is reasonable to assume that all inputs used by the firm (labour and capital, essentially) are positively correlated with $\widehat{S}_i$.

Thus we apply (6) under the following specifications:

-$\widehat{X_i^j}$ is the reported value of capital stock (machinery, equipment, computers and so on);

- $X_i^j = \alpha \widehat{S}_i$ where $F(\alpha) = 0.9$ and $F(.)$ is the distribution of the ratio $X_i^j / \widehat{S}_i$

within the same industrial sector as i's; in other words, we assume that $\widehat{X_i^j}$ is *not* manipulated by firms belonging to the highest decile of the distribution of the ratio $X_i^j/\widehat{S}_i$ and it is manipulated by all others;

-τ is calculated on the basis of the features of the tax system, assuming, for unincorporated business, that the applicable bracket is not altered even when output is underreported;

-H' is assumed to be measured by the share, denoted as $SHARE$, of sales made in *conto terzi*: the latter is a particular organization of production where the firm produces for another firm which has a tax interest in receiving the invoice, thus it is conventionally assume that the higher is this share the more difficult (costly) is for a firm to underreport output;

-$\widehat{R}_i/\mathbf{B}\widehat{\mathbf{X}_i}$ is calculated directly from the data and it is denoted by $RATIO$;

-$\sum_{s\neq j}\left(X_i^s - \widehat{X_i^s}\right)$ is assumed to be correlated with the reported ratio between the value of residual costs (*oneri diversi di gestione*) and $\widehat{S}_i$ since there is, according to the Italian Tax Agency, residual costs are overreported when the value of cost-inputs is manipulated[2]. We denote this variable by $MANIP$.

The expected signs are as anticipated above: positive for $RATIO$ when H'

[2]The reason is that residual costs do not enter in $\widehat{\mathbf{X}_i}$ but they can be deducted from the tax base.

is low and viceversa; also positive since in this case$\lambda^j = 0$, for τ; negative for $SHARE$ and $MANIP$. To capture possible determinants of the cost of concealing the true value of inputs, which in (6) is reflected in the cost parameter α, we insert in the regression the dummy variable *dumord*, which is equal to 1 when the firm adopts an ordinary accounting system and 0 when it adopts a simplified accounting system. In principle, we should expect the cost of manipulation to be higher for firms adopting an ordinary accounting system, since the latter is less flexible. This would imply a negative sign on *dumord*. However, in the fiscal year 2005 the ordinary accounting system acted as a (partial) legal shield against both type I and type II audits, since firms adopting this accounting system could be audited only if their reported output had been lower than its presumed levels for at least 2 years out of 3. Thus, *dumord* could capture a lower probability to be audited as (correctly) perceived by firms adopting an ordinary accounting system and the sign could turn to be positive. Finally, we cannot observe the value of B^j and we assume p_i is constant across taxpayers but we insert in the regressions a set of regional dummys relating to the location of the firm -*dummyno*, *dummyne*, *dummys*, *dummyc* reflecting, respectively, the location in the north-western, north-eastern, southern and central regions of Italy- and the total amount of depreciation, which we denote by $TOTDEP$, and that we expect to have a positive sign.

We present here the results of two separate regressions, one concerning 8,738 firms reporting $\widehat{R}_i \leq \mathbf{B}\widehat{\mathbf{X}_i}$ (see Table 1) and the other concerning 9,582 firms reporting $\widehat{R}_i > \mathbf{B}\widehat{\mathbf{X}_i}$ (see Table 2). The dependent variable is written as $\alpha\widehat{S}_i$ -$\widehat{X_i^j}$, where $F(\alpha) = 0.9$ and $F(.)$ is the distribution of the ratio $X_i^j/\widehat{S}_i$ within the same industrial sector as i's. Thus, it is the amount of concealment of the true value of capital stock. The regressors are those explained above.

INSERT TABLE 1 ABOUT HERE

INSERT TABLE 2 ABOUT HERE

For both regressions, the sign of the variables τ and $TOTDEP$ is positive as expected, while the sign of the variables $SHARE$ and $MANIP$ is negatively as expected. Moreover, in both regressions all these variables are generally significant ($MANIP$ is usignificant at 98% confidence level in the first regression). The variable $RATIO$ has a positive sign in the first regression, i.e. for firms reporting $\widehat{R}_i \leq \mathbf{B}\widehat{\mathbf{X}_i}$, and a negative sign in the second regression, i.e. for firms reporting $\widehat{R}_i > \mathbf{B}\widehat{\mathbf{X}_i}$.This may be consistent with the model, since in the first case we should have $H^{'}(R_i - \widehat{R}_i) < \tau$ while in the latter case the opposite should hold. However, in both cases the coefficient on $RATIO$ is largely unsignificant. Finally, *dumord* has a positive impact in both cases, denoting that it captures the ordinary accounting system as a legal shield, while regional dummys are, in general, unsignificant, with the exception of *dummys* which is significant at a 90% confidence level in the first regression. In the latter case, the sign is negative indicating, somewhat surprisingly, that the amount of concealment of the true value of capital stock is larger in the southern regions.

5. Concluding remarks

This paper suggests that some of the determinants of taxpayers' reaction to the introduction of an endogenous audit rule can be captured by means of a simple theoretical model. By assuming risk-neutrality, which seems less unrealistic for business taxation, as well as the rational use of the information available to taxpayers on the institutional and legal constraints concerning the audit rule, we construct a model in which taxpayers are predicted to use strategically this information. Namely, they are predicted to manipulate the reports to minimize the expected payment of taxes gross of concealment costs. The empirical application shows that many, although not all, the predictions about the sign and significance of the potential determinants of manipulation behaviour arising from the theoretical model are correct. This work can be considered as a first step in the investigation of actual taxpayers'response to endogenous audit rules. Two further directions of research can be identified. First, empirical results need to be confirmed for different sectors and different input reports, since in this work only one type of input reports has been considered. Second the model can be used to derive the conditionally-optimal fully-committing audit strategy by the Tax Agency. This would imply to embody the taxpayer's reaction into a Tax Agency's objective function and to derive the audit strategy under a set of institutional and legal constraints.

References

[1] ALM, J., CRONSHAW, M.B and MCKEE, M., (1993), "Tax Compliance with Endogenous Audit-Selection rules", Kyklos, 46,1, pp. 27-45.

[2] ALM, J. and MCKEE, M., (2003), "Tax Compliance as a Coordination Game", Andrew Young School of Policy Studies, Research Paper Series, WP 06-32.

[3] ANDREONI J.,ERARD, B. and FEINSTEIN J (1998), "Tax Compliance", Journal of Economic Literature, 36, 2, pp. 818-860.

[4] ARACHI G and SANTORO A., (2007) "Tax Enforcement for SMEs: Lessons from the Italian Experience?", Atax-Ejournal of Tax Research, 5, 2, pp. 224-242.

[5] COWELL F, A. (2003), "Sticks and Carrots", DARP Discussion Paper N. 68, Distributional Analysis and Research Programme, London School of Economics and Political Science.

[6] KIRCHLER, E., (2007), "The Economic Psychology of Tax Behaviour", Cambridge University Press.

[7] MACHO-STADLER, I. and PEREZ-CASTRILLO, D., (2002), "Auditing with Signals", Economica, 69, pp. 1-20.

[8] MARCHESE, C. AND PRIVILEGGI, F., (2007), "Increasing the efficiency of Studi di settore might backfire", POLIS Working Papers, 105.

[9] MYLES G. (1997), "Public Economics", Cambridge, Cambridge University Press.

[10] SANCHEZ I. and SOBEL J., (1993), "Hierarchical design and enforcement of income tax policies", Journal of Public Economics, 50, pp. 345-369.

[11] SANTORO A., (2006), ”Evasione e studi di settore: quali risultati? quali prospettive?”, in Rapporto di finanza pubblica 2006, ed. by Guerra M.C - Zanardi A., il Mulino, pp. 297-320.

[12] SANTORO A. (2008), "Taxpayers' choices under studi di settore: what do we know and how can we explain it?", il Giornale degli Economisti, 3, 2008.

[13] SCOTCHMER S. (1987), ”Audit Classes and Tax Enforcement Policy”, The American Economic Review, 77, 2, pp. 229-23.

[14] SCHNEIDER, F., and ENSTE, D. (2000), "Shadow Economies: Size, Causes and Consequences", The Journal of Economic Literature, 38,1,pp. 77-114.

[15] SLEMROD J. (2007), "Cheating Ourselves: The Economics of Tax Evasion", Journal of Economic Perspectives, 21, 1, 25-48.

Table 1: Dependent variable MANIPSTOCK, N=8738 $\left(\widehat{R_i} \leq \mathbf{B}\widehat{\mathbf{X}_i}\right)$, R^2=8,6%

Model		Unstandardized coefficient		Standardized Coefficient	t	Sig.
		B	Std. error	Beta		
1	CONSTANT	-474326,480	154301,930		-3,074	,002
	RATIO	119629,110	97792,853	,013	1,223	,221
	τ	2226799,586	454828,161	,066	4,896	,000
	SHARE	-1547,754	363,481	-,045	-4,258	,000
	MANIP	-46,417	19,888	-,024	-2,334	,020
	DUMORD	255530,543	42698,304	,078	5,985	,000
	DUMMY NO	33507,475	72063,436	,009	,465	,642
	DUMMYS	-136055,500	72325,778	-,033	-1,881	,060
	DUMMYC	-79000,423	72825,449	-,020	-1,085	,278
	DUMMYNE	-17064,664	70680,973	-,005	-,241	,809
	TOTDEP	7,384	,408	,203	18,114	,000

Table 2: Dependent variable MANIPSTOCK, N=9,582 $\left(\widehat{R_i} > \mathbf{B}\widehat{\mathbf{X}_i}\right)$, R^2=10,2%

Modello		Unstandardized coefficient		Standardized Coefficient	t	Sig.
		B	Std. error	Beta		
1	CONSTANT	-208809,907	133234,788		-1,567	,117
	RATIO	-10,724	64,809	-,002	-,165	,869
	τ	1362711,362	405986,176	,043	3,357	,001
	SHARE	-1235,939	340,906	-,036	-3,625	,000
	MANIP	-13,247	4,725	-,027	-2,804	,005
	DUMORD	223837,781	40478,377	,070	5,530	,000
	DUMMY NO	27391,954	79954,608	,007	,343	,732
	DUMMYS	-85249,111	84126,522	-,018	-1,013	,311
	DUMMYC	-44151,604	80057,201	-,012	-,552	,581
	DUMMYNE	-5591,973	78361,438	-,002	-,071	,943
	TOTDEP	7,685	,312	,259	24,633	,000

Proofs of results (not to be published)

We first show how (3) is derived. From (2) we have

$$\frac{\partial EP}{\partial \widehat{R_i}} = \tau[1 - q_i(1+f_1)] - \frac{1}{\delta \widehat{\mathbf{BX}_i}}(1+f_1)\tau\left(\widehat{\mathbf{BX}_i} - \widehat{R}_i\right) - H'(R_i - \widehat{R}_i)$$

$$\frac{\partial EP}{\partial \widehat{R_i}} = \tau\left[1 - \frac{1}{\delta}(1+f_1)\right] + \tau(1+f_1)\frac{1}{\delta}\frac{\widehat{R}_i}{\widehat{\mathbf{BX}_i}} + \frac{\widehat{R}_i}{\delta \widehat{\mathbf{BX}_i}}(1+f_1)\tau - \frac{1}{\delta}(1+f_1)\tau - H'(R_i - \widehat{R}_i)$$

$$\frac{\partial EP}{\partial \widehat{R_i}} = \tau\left[1 - \frac{1}{\delta}(1+f_1)\right] + 2\tau(1+f_1)\frac{1}{\delta}\frac{\widehat{R}_i}{\widehat{\mathbf{BX}_i}} - \frac{1}{\delta}(1+f_1)\tau - H'(R_i - \widehat{R}_i)$$

thus we can write

$$\frac{\partial EP}{\partial \widehat{R_i}} = 0 \Leftrightarrow 2\tau(1+f_1)\frac{1}{\delta}\frac{\widehat{R}_i}{\widehat{\mathbf{BX}_i}} = \tau\left[\frac{2}{\delta}(1+f_1) - 1\right] + H'(R_i - \widehat{R}_i)$$

Note that (3) is a necessary and sufficient condition since

$$\frac{\partial^2 EP}{\partial \widehat{R_i}^2} = \frac{2\tau(1+f_1)}{\delta \widehat{\mathbf{BX}_i}} + H''(R_i - \widehat{R}_i) > 0$$

which is always satisfied provided that $H''(R_i - \widehat{R}_i) \geq 0$ i.e. that the cost of concealing output is convex everywhere.

We now show why and how (4) is derived. From (2) we have (we omit notation $j = 1, \ldots, J$)

$$\frac{\partial EP}{\partial \widehat{X_i^j}} = \tau\{B^j[q_i(1+f_1) - p(1+f_2)] - \lambda^j\} +$$

$$B^j \frac{\widehat{R}_i}{\delta\left(\mathbf{B}\widehat{\mathbf{X}}_i\right)^2}(1+f_1)\tau\left(\mathbf{B}\widehat{\mathbf{X}}_i - \widehat{R}_i\right) - G'(X_i - \widehat{\mathbf{X}}_i)$$

so that

$$\frac{\partial EP}{\partial \widehat{X_i^j}} = 0 \Leftrightarrow G'(\mathbf{X}_i - \widehat{\mathbf{X}}_i) = \tau B^j\{B^j[q_i(1+f_1) - p(1+f_2)] - \lambda^j\}$$

$$- \tau B^j \frac{\widehat{R}_i}{\delta \mathbf{B}\widehat{\mathbf{X}}_i}(1+f_1) + \tau B^j \frac{1}{\delta}(1+f_1)\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i} - \frac{1}{\delta}B^j(1+f_1)\tau\left(\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right)^2$$

and

$$\frac{\partial EP}{\partial \widehat{X_i^j}} = 0 \Leftrightarrow G'(X_i - \widehat{\mathbf{X}}_i) = \tau B^j \frac{1}{\delta}(1+f_1)\left[1 - \left(\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right)^2\right] - \tau[B^j p(1+f_2) - \lambda^j]. \quad \text{A.1}$$

Note that this is a sufficient a necessary condition for a minimum since

$$\frac{\partial^2 EP}{\partial \widehat{X_i^j}^2} = 2\tau B^j \frac{1}{\delta}(1+f_1)\frac{B^j}{\mathbf{B}\widehat{\mathbf{X}}_i}\left(\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right)^2 + G''(X_i - \widehat{\mathbf{X}}_i) > 0$$

which is always satisfied provided that $G''(\mathbf{X}_i - \widehat{\mathbf{X}}_i) \geq 0$ i.e. that the also cost of concealing inputs is convex everywhere. Using (3), (A.1) can be rewritten as

$$\frac{\partial EP}{\partial \widehat{X_i^j}} = 0 \Leftrightarrow G'(X_i - \widehat{\mathbf{X}}_i) = \tau B^j \frac{1}{\delta}(1+f_1)\left[1 - \left[1 - \frac{\delta_i}{2(1+f_1)}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)\right]^2\right]$$

$$-\tau[B^j p(1+f_2) + \lambda^j].$$

$$G'(X_i - \widehat{\mathbf{X}}_i) = \tau B^j \frac{1}{\delta_i}(1+f_1)\left[1 - \left[1 - \frac{\delta_i}{(1+f_1)}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) + \left(\frac{\delta_i}{2(1+f_1)}\right)^2\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)^2\right]\right]$$
$$-\tau[B^j p(1+f_2) + \lambda^j]$$

$$G'(\mathbf{X}_i - \widehat{\mathbf{X}}_i) = \tau B^j \frac{1}{\delta_i}(1+f_1)\left[\frac{\delta_i}{(1+f_1)}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) - \frac{\delta_i^2}{4(1+f_1)^2}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)^2\right]$$
$$-\tau[B^j p(1+f_2) + \lambda^j]$$

$$G'(\mathbf{X}_i - \widehat{\mathbf{X}}_i) = \tau B^j \left[\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) - \frac{\delta_i}{4(1+f_1)}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)^2\right]$$
$$-\tau[B^j p(1+f_2) + \lambda^j]$$

or equivalently as

$$G'(\mathbf{X}_i - \widehat{\mathbf{X}}_i) = \tau\left\{B^j\left[\gamma h(R_i, \widehat{R}_i, \tau)^2 + h(R_i, \widehat{R}_i, \tau) - p(1+f_2)\right] - \lambda^j\right\}, \qquad \text{A.2}$$
$$\gamma \equiv -\frac{\delta_i}{4(1+f_1)}, h(R_i, \widehat{R}_i, \tau) = \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right).$$

This would be the structural expression for every optimal input report.

We now show how (5) is derived. From (3) one has

$$\frac{\delta}{2(1+f_1)} = \left[1 - \frac{\widehat{R}_i}{\widehat{\mathbf{B}\mathbf{X}_i}}\right] / \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)$$

which implies

$$\frac{2}{\delta}(1+f_1) = \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) / \left[1 - \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right]$$

which can be used in (x) to obtain

$$G'(X_i - \widehat{\mathbf{X}}_i) = \tau B^j \frac{1}{2}\left\{\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) / \left[1 - \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right]\right\}\left[1 - \left(\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right)^2\right]$$

$$- \tau[B^j p(1+f_2) + \lambda^j], j = 1, \ldots, J$$

$$G'(X_i - \widehat{\mathbf{X}}_i) = \left[1 - \left(\frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right)^2\right] \tau B^j \frac{1}{2}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) / \left[1 - \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right]$$

$$- \tau[B^j p(1+f_2) + \lambda^j], j = 1, \ldots, J$$

$$G'(X_i - \widehat{\mathbf{X}}_i) = \left[1 + \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right] \tau B^j \frac{1}{2}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) - \tau[B^j p(1+f_2) + \lambda^j], j = 1, \ldots, J$$

$$G'(X_i - \widehat{\mathbf{X}}_i) = \left[1 + \frac{\widehat{R}_i}{\mathbf{B}\widehat{\mathbf{X}}_i}\right] \tau B^j \frac{1}{2}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right) - \tau[B^j p(1+f_2) + \lambda^j], j = 1, \ldots, J$$

which is (4).

To check that (A.2) and (4) are equivalent , just use again (3) in (4) to obtain

$$G'(X_i - \widehat{\mathbf{X}}_i) = \left[1 + \left[1 - \frac{\delta_i}{2(1+f_1)}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)\right]\right] \tau B^j \frac{1}{2}\left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau}\right)$$

$$- \tau[B^j p(1+f_2) + \lambda^j], j = 1, \ldots, J$$

$$G'(X_i - \widehat{\mathbf{X}}_i) = \left[2 - \frac{\delta_i}{2(1+f_1)} \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau} \right) \right] \tau B^j \frac{1}{2} \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau} \right)$$

$$- \tau\left[B^j p(1+f_2) + \lambda^j\right], j = 1, \ldots, J$$

$$G'(X_i - \widehat{\mathbf{X}}_i) = \tau B^j \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau} \right) - \tau B^j \frac{1}{2} \frac{\delta_i}{2(1+f_1)} \left(1 - \frac{H'(R_i - \widehat{R}_i)}{\tau} \right)^2$$

$$- \tau\left[B^j p(1+f_2) + \lambda^j\right], j = 1, \ldots, J$$

which is (A.2).