Regional Tax Evasion and Audit Enforcement

Alfonso Carfora*, Rosaria Vega Pansini*, Stefano Pisani*

(DO NOT QUOTE WITHOUT AUTHORS' PERMISSION)**

Abstract

Using an original panel dataset on tax gap and audits, this paper tries to shed light on the role of audits and enforcement on the Italian regional tax evasion over the period 2001-2011. Spatial econometric models have been used to model regional tax gaps and to control for endogeneity issues and spatial patterns. Results provide additional evidence that grater enforcement increases tax compliance. A higher probability of targeted audits and additional schemes to increase the disclosure of declared income decrease the tax gap. Hence, the paper provides a general framework to study determinants of tax evasion at the regional level.

Key words: Tax evasion, Italian regional tax gap, spatial econometrics, panel estimation

JEL codes: C21; C23; E26; H26

*Italian Revenue Agency
alfonso.carfora01@agenziaentrate.it
rosariavega.pansini@agenziaentrate.it
stefano.pisani@agenziaentrate.it

** An extended version of the paper has been published on REGIONAL STUDIES, 2017 http://dx.doi.org/10.1080/00343404.2017.1299934

1. Introduction

From the first studies back in the late 70s, literature on tax compliance has extensively covered either theoretical or empirical aspects. Theoretical analyses have focused more on identifying what drives taxpayers behavior, while empirical and experimental studies have focused more on estimation and measurement issues related to shadow economy and tax evasion (see Alm, 2012 and Slemrod, 2007 for comprehensive reviews). Empirical analyses on the determinants of tax compliance have used both direct measures of income tax evasion (e.g. the tax gap) and indirect estimates derived from surveys, experimental analysis or other indirect indicators such as demand for currency or electricity consumption (Ardizzi et al., 2013; Clotfelter, 1983; Marino and Zizza, 2012; Mcgee, 2012). More recently, territorial aspects have also been taken into consideration in the analysis of the distribution of tax evasion across regions of the same country or to explain how geography can affect tax compliance (Schneider and Enste, 2000; Herwartz, Tafenau and Schneider, 2015; Torgler, Schneider and Schaltegger, 2009).

Academic literature has also focused on the role of administration and tax law enforcement policy (Slemrod and Yitzaky, 2002). In fact, the success of an auditing scheme and a tax enforcement policy relies on its capacity to measure tax evasion and to identify its determinants. Among these, it is crucial for tax authorities to understand how audits and enforcement provisions influence taxpayers' behavior.

The aim of our paper is to contribute to the literature on determinants of tax evasion at a regional level, focusing on the role of policies of revenue agencies on tax compliance. Our analysis is novel in two ways. First, we focus on tax gap rather than on shadow economy, due to the fact that there is a direct relationship between tax gap and stage budget. We calculate the share of tax gap on potential tax revenues rather than on the total shadow economy or tax collection. Second, our analysis is focused on Italy and employs a novel and original eleven-year panel dataset of tax gap estimates across Italian regions that has never published or used in any previous analysis on tax evasion. Our dataset also contains original information from the Italian Revenue Agency (IRA) that allows testing the effectiveness of enforcement strategies based on traditional tax audits rather than on the disclosure of information by taxpayers.

As a measure of non-compliance, we use the share of tax gap on potential tax revenues that corresponds to the sum of taxes paid and the tax gap. Given the regional dimension of our data, a spatial econometric approach was used to model regional tax gap shares and to obtain efficient estimates in the presence of spatial correlation of residuals. Additional variables were also inserted in order to provide robustness checks for the best choice of model specification.

Our analysis is mainly empirical and aims at responding to the following research questions: is tax gap at a regional level determined by the same structural and institutional characteristics that influence tax compliance at a national and international level? Are enforcement strategies by tax authorities effective for tax compliance? Is it possible to design region-based anti-evasion strategies to reach higher results in terms of fighting against tax evasion? Is it possible to construct a taxonomy of tax gap determinants at a regional level?

Tax evasion in Italy is widespread. The latest available estimates for 2014 show a tax gap of 5.6% of the GDP and 90 billion euros in absolute value (Italian Ministry of Finance, 2016). Despite the fact that tax evasion is a worldwide phenomenon, in Italy the size of the shadow economy and tax evasion ranges at the highest levels among EU and OECD countries. Tax compliance is a major concern for Italian policymakers and tax authorities. In fact, it affects the efficiency of tax revenues collection and the management of public budget. Moreover, high and persistent levels of tax evasion highlight the need for more effective policy instruments and auditing schemes to fight against fraud and tax cheating behavior.

Previous analyses focused on the determinants of tax evasion in Italy. Marino and Zizza (2012) estimate the propensity to evade personal income tax by comparing per capita income from a survey data with that from tax records. Using survey data to derive indirect measures of the propensity to tax evasion, Cannari and D'Alessio (2007) show a negative correlation between tax compliance and unemployment, social capital, criminality and education. Combining data from the balance sheets of Italian municipalities with individual data from a properly designed survey on tax morale, Barone and Mocetti (2011) analyze how inefficiency in public spending affects tax morale. They find that tax compliance is higher when public resources are spent more efficiently. Di Caro and Nicotra (2014) study the determinants of personal income tax at regional level. They find that tax evasion depends on regional structural factors such as the labor market and personal aspects such as social capital.

Our analysis differs from previous studies due to the fact that it employs original data not only on personal income tax evasion but on the total tax gap. Moreover, we combine novel estimates on tax evasion with original data on audits and tax enforcement to test if tax authority's policies effectively influence taxpayers' behavior.

The remaining of the paper is organized as follows. Section 2 provides some theoretical considerations on the relationship between tax evasion behavior and law enforcement. Section 3 sketches some evidence on the distribution of the tax gap across Italian regions, describes the empirical strategy and presents the data. Section 4 shows our results. Section 5 concludes.

3. Data and Methodology

3.1 Measure of tax evasion

Our empirical analysis employs a panel of 20 Italian regions, defined by the NUTS 2 classification level and with administrative power, observed during the period 2001 to 2011. As a measure of tax evasion, we use regional tax gap rates estimated by the Italian Revenue Agency (IRA) as tax gap shares (*TG*). Tax gap is defined as "the difference between the amount of taxes the tax administration should collect if no taxpayers voluntary breach the law and involuntary errors amount to zero" (potential tax revenues - *PTR*) and actual tax revenues. *TG* is then calculated as the ratio of the total tax gap[i] and potential tax revenues that correspond to the sum of taxes actually paid and the tax gap itself:

$$TG_{it} = \frac{Tax\ Gap_{it}}{PTR_{it}} \quad [3.1]$$

where *i* is the regional and *t* the tax year index, respectively. Hence, *TG* can be considered as an indicator of the regional propensity to non-compliance:

$$TG_{it} = \begin{cases} = 0 & \text{absence of evasion} \\ 0 < TG \leq 1 & \text{Tax Gap} \leq PTR \end{cases} \quad [3.2]$$

Figure 1 shows the 2001-2011 distribution of regional tax gap shares. Tax evasion exhibits a certain degree of heterogeneity throughout the Italian regions and over the eleven-year period considered. The median values of *TG* vary among the two extremes of Basilicata (0.47) and Lazio (0.13). It should be noted that due to the fact that Rome is located in Lazio, a large share of its potential tax revenues is from the public administration whose tax gap is null. In some regions, such as Emilia Romagna, Lazio, Liguria and Tuscany, the tax gap shares remained quite stable while other regions, such as Calabria, Sardinia and Sicily experienced a large variation in *TG* shares. The *TG* time change can be due to large yearly differences either of potential tax revenues or of the tax gap. Southern regions (Basilicata, Calabria, Campania, Apulia, Sardinia, and Sicily) experienced a large dispersion of tax gap shares over time. Figure 1 shows very few outliers represented by some yearly observations of *TG* in four regions.

Regional differences also emerge by calculating the 2001-2011 average values of *TG*s[ii]. The map in Figure 2 shows the distribution of average tax gap shares throughout the Italian regions during the last eleven years. Southern regions experienced the highest incidence of tax gap on potential tax revenues while Lazio, Emilia Romagna, Lombardy and Friuli-Venetia Giulia show the lowest averages. Regions in the Central Italy exhibit tax gap shares between these two extremes. In the southern regions, a small variation can also be observed between Campania, Apulia and Sicily and Molise, Calabria and Basilicata. At a glance, the descriptive analysis provides evidence that the geographical distribution of tax evasion is characterized by an uneven regional pattern. We take into account regional heterogeneity and control for it inserting the neighbor regions' tax gap shares as additional variable in the econometric model.

3.2 Empirical issues and econometric strategy

Several econometric issues must be addressed when dealing with regional tax gaps. Among these, the most important relates to unobserved characteristics such as institutional environment, tax morale, historical legacy and tastes that can be spatially correlated among neighboring regions. Therefore, the spatial dimension of tax gap should not be neglected if we want to control for possible spatial dependence in the residuals. Given the availability of an eleven-year panel dataset, we use a dynamic spatial panel framework to model regional tax gap shares. We estimate several non-spatial and spatial model specifications in order to test the hypothesis of spatially correlated tax gaps.

We first estimate a pooled linear OLS model:

$$TG_{it} = \alpha + x'_{it}\beta + u_{it} \quad [3.3]$$

where u_{it} is a random disturbance term of mean 0. This specification ignores the spatial error dependence and considers regional tax gap as being dependent only on its own regional characteristics. In the presence of heteroschedasticity, the model [3.3] may be mis-specified and lead to inconsistent coefficients. Therefore, we introduce an individual (region-specific) unobserved effect in the error component:

$$TG_{it} = \alpha + x'_{it}\beta + u_i + \epsilon_{it} \quad [3.4]$$

The idiosyncratic error ϵ_{it} is assumed to be independent with regressors x_{it}, while the individual (time-invariant regional) error component u_i may be correlated or independent with regressors. In the first case, equation [3.4] becomes:

$$TG_{it} = \alpha_i + x'_{it}\beta + \epsilon_{it} \quad [3.5]$$

and consistent estimates can be obtain from a fixed effects model. In the second case (error component uncorrelated with explanatory variables), a random effects model should be used to estimate [3.4]. We employ the family of generalized least squares (GLS) estimators to avoid correlations across composite error terms (within individuals).

In order to control for serial correlation and for the effect of a time-lagged dependent variable, a dynamic panel model with a GMM estimator à la Arellano and Bond (1991) has been also used [3.6]:

$$TG_{it} = \alpha + \lambda TG_{it-1} + x'_{it}\beta + u_i + \epsilon_{it} \quad [3.6]$$

Model [3.6] takes into consideration the dynamic but neglects the spatial effect. Moreover, given the limited cross-sectional dimension of our panel dataset, the GMM estimator may be inconsistent.

In order to control for unobservable geographical heterogeneity, a spatial dynamic panel model should be specified. The extent of cross-sectional correlation is measured using a given "spatial matrix" W that is a nonnegative $N \times N$ matrix (where N is the number of regions) of known constants. It describes the spatial arrangement of the units in the sample (Anselin, 1988). The non-zero element w_{ij} specifies the strength of the relationship between cross-sectional units i and j and indicates whether two locations can be considered neighbors. The diagonal elements w_{ii} are all set to zero to exclude self-neighbors by convention. Such a weighting spatial matrix is not symmetric and is generally used in a row standardized form.

The weights of the Italian regional spatial matrix (W) were obtained calculating proximities using the *k*-nearest neighbors algorithm. We discarded either the contiguity weights matrix method (w_{ij} = 1 if regions i and j have a common boundary; otherwise w_{ij} = 0) due to the presence of islands (without common boundaries with other regions) in the sample and the distance-based binary weights matrix method (w_{ij} = 1 if the

distance between regions *i* and *j* is less than a threshold cut-off distance, otherwise w_{ij} = 0) since the setting of the thresholds is highly arbitrary. Using geo-spatial coordinates, the algorithm sets w_{ij} = 1 if the geographical center of region *j* is one of the *k* nearest to region *i*, otherwise w_{ij} = 0. The choice of parameter *k* follows a stepwise procedure. After setting a range of possible values for *k* from 1 to 10, we first constructed 10 W matrices. Successively, we iteratively calculated a Moran's I index for each W matrix. The optimal choice is the value of *k* that gives a Moran's index closest to the average value. The w_{ij} elements were used to measure spatial correlations using the Global Moran *I*-index (Moran, 1950):

$$I = \left(\frac{N}{\sum_i \sum_j w_{ij}}\right)\left(\frac{\sum_i \sum_j w_{ij}(TG_i - \overline{TG})(TG_j - \overline{TG})}{\sum_i (TG_i - \overline{TG})^2}\right) \quad [3.7]$$

that measures the extent to which high values of a characteristic are located near other high values and vice-versa. It varies from -1 to 1 and its expected value equals $-1/(N-1)$ under the null hypothesis of no spatial autocorrelation. The nearer the *I*-index to the value of 1, the stronger the positive spatial autocorrelation. High negative values signal a strong negative spatial autocorrelation.

When residuals are spatially correlated, GLS and GMM estimators are inefficient. Hence, we use a spatial lag model with spatial error autocorrelation (hereafter SARSAR) [3.8] (Anselin, 2009; Kelejian and Prucha, 1999) to capture spatial interactions across units and over time. We can write the structural form of the SARSAR model as :

$$TG_{it} = \alpha + \lambda \sum_{j \neq i}^{N} w_{ij}\, TG_{jt} + x'_{it}\beta + \rho \sum_{j \neq i}^{N} w_{ij}\, u_i + \epsilon_{it} \quad [3.8]$$

The seminal contribution of Kapoor, Kelejian, and Prucha, (2007) follows an approach that does not include the spatial lag of the dependent variable. In this paper, we extend it to include both the spatial lagged dependent variable and the spatial error component. We then estimate model [3.8] (Mutl and Pfaffermayr, 2011) using a generalization of the estimation method that employs a two-step procedure. First, within and between two stage least squares, the coefficients were estimated. The two sets of corresponding residuals were then used in the spatial generalized moments estimator (GM) where the moments conditions were modified accordingly.

3. 3 Data and Variables

The Italian Revenue Agency (IRA) maintains a database with its own estimates of regional tax gaps and other indicators of taxpayers' risk of evasion. Together with data on regional tax gap shares, we select two indicators of the efficacy of the IRA's role: *IRA_ss* and *IRA_enforcement*. The first is the ratio of the number of non-congruous on total taxpayers who joined the 'studi di settore'[iii]. This is an auditing scheme in which the agency reveals only part of the information used to develop its audit rule. It provides

the criteria employed to determine the amount of taxpayers' tax debt. The adherence to this scheme defines the number of taxpayers congruous with its criteria[iv]. We use the one-year lag of *IRA_ss* as the effects of the application of 'studi di settore' are perceived by taxpayers during the successive fiscal years. Non-congruous taxpayers have a higher probability to be audited by the IRA. Moreover, the adherence to the *studi di settore* can be a costly activity for taxpayers. Hence, we consider variable *IRA_ss* as a proxy of an extra cost of an audit and of the penalty for taxpayers caught cheating. Following [2.5], we expect a negative sign for the estimated coefficient due to the fact that a higher number of non-congruous taxpayers directly relates to the strength of the audit scheme and its capacity to detect tax gap.

The variable *IRA_enforcement* is a governance indicator calculated as the ratio of audited on total taxpayers. It can be considered as a proxy of the audit probability and as a measure of IRA's enforcement. The variable is inserted as contemporary to the dependent variable. Following [2.4], we expect a negative coefficient: a higher probability to be audited should lower tax gap shares.

Additional covariates were inserted to capture the socio-economic and institutional characteristics of regional economies and the effect of geography on tax gap shares. We use the spatial lag of the tax gap share to control for the effect of geography on regional tax evasion. Variable *Lag_TG* was constructed using matrix W described in section 3.2. *Q_Agriculture* and *Q_Industry* measure the incidence of the value added by agriculture and manufacturing sectors on total regional value added. *Q_Self-employed* is the weight of self-employed on total regional employees. These are the sum of self-employed and employees across all sectors, including public administration. These variables describe the regional production sector. We expect a positive sign for agriculture and self-employment quotas and a negative sign for industry given the different sectoral incidence of tax gap on potential tax revenues.

Size is the log of the average number of employees per firm considered as a proxy of the average firm size. Given that the Italian production system is distributed among a large number of micro firms and SMEs, we expect a negative sign: the bigger the firm size the less the opportunities to hide a portion of the value added. *Pos-ATM_pc* is the log of total points of sale terminals and ATM machines per resident and can be considered as a proxy of the availability of electronic money in the region. We expect that the higher tax gap especially in sectors connected to the use of cash (such as for example, retail), would entail lower transactions with electronic money. Hence, a negative coefficient would mean that a more widespread use of traceable means of payment would reduce tax gap.

Deposits is the share of bank deposits with banks located in the region on regional value added. Unlike cash, bank deposits are traceable and are often used by revenue agencies in taxpayers' risk assessment. We expect a negative correlation between tax gap and deposits. Taxpayers who wanted to hide part of their revenues would not use official channels like banks where transactions can be easily traced. *Crime* is the number of crimes by organized crime associations for every 1000 inhabitants. It has been included to control for the level of social risk of the region and as a dimension of social capital. We expect a positive sign: the higher the crime rate of the region the more the opportunities to conceal production activities and the higher the tax gap.

D_Gdp is a binary variable taking value 1 if in the *t*-year an increase of regional GDP

occurred, otherwise 0. It was included as a proxy of the business cycle and used in substitution to the regional GDP growth rate to avoid multicollinearity issues. The sign of the coefficient states whether regional tax gap shares are pro- or counter-cyclical. We believe that during a period of GDP growth there is less necessity to evade taxes. Hence, we expect a negative sign for this variable.

Tax_amnesties is the share of taxes paid by taxpayers that qualified for the amnesty and shelter[v] on regional tax revenues. We expect a positive sign given the hypothesis that regions with a higher level of taxes paid after a write-off indicate a higher incidence of tax gap.

Table A.1 in Annex 1 summarizes the description of variables and data sources.

4. Results

Table 1 shows the results of the pooled OLS, random effects, dynamic panel and spatial panel models, diagnostics and correlation tests. Given that the sign of coefficients is similar across model specifications, we provide an interpretation of the results only with respect to the SARSAR model.

The pooled OLS model (column 1) ignores the longitudinal features of the dataset and may suffer from mis-specification. Moreover, the analysis of residuals and the results of the Breusch-Pagan and Wooldridge tests confirm the presence of unobserved regional effects. Hence, they suggest that OLS estimators are inconsistent.

Column 2 reports the results of the panel random effects model and of the serial correlation tests. We test the hypotheses of both the serial correlation, i.e. if u_{it} is independent from u_{it+s} for s=1,…T, using the Baltagi-Li (Baltagi and Li, 1995) and Breusch-Goedfrey (Godfrey, 1978) tests, and the cross-sectional independence, i.e. if u_{it} is independent from u_{ij} every $i \neq j$ using the Pesaran CD test (Pesaran, 2004). This test was implemented on the residuals of model [3.4] pre-treated as an AR structure to avoid serial correlation. The results suggest that the null hypothesis of time and cross-sectional independence is rejected. Therefore, we use a dynamic panel specification [3.6] and a GMM estimator à la Arellano and Bond. Results are shown in column 3. The Sargan test supports our choice of the instruments, i.e. the lagged values of the dependent variable. Moreover, given the results of AR(1), AR(2) and of the Breusch-Goedfrey and Pesaran CD tests, specification [3.6] still does not permit a correction of serial and cross sectional dependence. Considering also the limited cross-sectional dimension of our panel, this result raises serious issues in relation to the consistency of coefficients and suggests using a model specification that explicitly considers the spatial dimension of our data.

We first check if spatial correlation exists. Table 2 shows the values of Moran's *I*-statistics calculated for Italian regional *TG*s for every year (2001-2011). The results of the Moran's test (Cliff and Ord, 1981) obtained using W as a spatial weighting matrix indicate that we reject the null hypothesis of no spatial correlation across regional *TG*s. We also perform a local variant of the CD test (Pesaran and Tosetti., 2011) to test the null of non-cross-sectional dependence (Millo, 2014). The results show that the cross sectional correlation of residuals of the random and the dynamic random model can be treated as a spatial correlation. Regional tax gap shares are then spatially persistent. In

this case, a SARSAR model should be used in order to obtain consistent estimates (Elhorst, 2003). This choice is also confirmed by the Baltagi-Song-Koh test of local cross sectional dependence (Baltagi, Song, and Koh, 2003) performed on the residuals of the model [3.8]. Results suggest that the null hypothesis of no spatial correlation cannot be rejected.

Results in column 4 of table 1 allow drawing a taxonomy of the determinants of regional tax gap shares and analyzing the role of the tax authority's policies on regional tax compliance.

Variables *IRA_ss* and *IRA_enforcement* are both negative and significant. As expected, the share of non-congruous on total taxpayers who joined the '*studi di settore'* scheme is negatively correlated with regional tax gap shares. In fact, non-congruous taxpayers have a higher probability to be audited and their share positively affects the capacity of such a scheme in improving tax compliance. The coefficient of *IRA_enforcement* shows that an increase in the audit probability reduces the regional tax gap share. This result indicates a positive effect on the regional compliance rate of the IRA activities (Alm, 1999 and Yitzhaki, 1974) and it is in line with the results obtained for Italy by Marigliani and Pisani (2014)[vi]. The coefficient is higher for *IRA_enforcement* than for *IRA_ss*, indicating that when enforcement is exercised via a direct increase in audits it has a higher effect than when it translates into an indirect measure to increase compliance. Nevertheless, our results show that controlling for socio-economic characteristics of the region and geography, the IRA's action is effective in increasing tax compliance at a regional level.

The coefficient of the spatial lagged dependent variable (*Lag(TG)*[vii]), strongly significant and positive, confirms our a priori idea that tax gap is spatially persistent. This result is similar to that of Alm and Yunus (2009) for the US: the proximity to a region with high (low) *TG* share is a significant determinant of the high (low) *TG* shares of a neighboring region. The *Lag(TG)* variable also exerts a relatively high coefficient. Ceteris paribus, a one percentage point increase of regional tax gap share increases by almost half a percentage point the tax gap share of a neighboring region.

Analyzing the features of the regional production system, the higher the quota of regional value added produced by the agricultural sector the higher the tax gap share. This result confirms other descriptive analyses conducted by the Italian National Statistics Institute (ISTAT) on the sectorial composition of the underground economy (Istat, 2015). It is somewhat surprising that the value added of the industrial sector is positive in the SARSAR specification. The coefficient also changes by sign, level and significance throughout model specifications. We can relate this result to the fact that ISTAT computes the value added of the industrial sector of the region where the plant is located. This can be different from the region where the firm's headquarter is located, which is also the region where tax gap share is imputed.

As expected, the coefficient for the variable *Q_Self-employed* is positive and highly significant. As in Bordignon and Zanardi (1997), this result reflects one of the characteristics of the Italian production system with a high proportion of small firms and self-employed professionals on the total workforce. Ceteris paribus, tax evading chances are clearly higher for the self-employed than for employees (Braiotta, Carfora, Pansini and Pisani, 2015). Such evidence is observed also for the UK, where the tax gap from individuals in self-assessment is 17% (HMRC, 2015) and Denmark, where the

evasion rate for individuals with self-reported income is equal to 37% (Kleven, Knudsen, Kreiner, Pedersen, and Saez, 2010).

The firm's size (*Size*) has a negative effect on regional tax gaps. As stated by Italian fiscal law, large firms are subjected to several additional duties and obligations in comparison to smaller firms when filing their tax return forms. Moreover, due to specific features of business conduct[viii] and a higher number of IRA's controls, the bigger the firm's dimension the less the chance to evade taxes.

Electronic money (*Pos-ATM_pc*) has a significant and negative effect. There is a large debate on the positive relation between the amount of transactions in cash and the level of tax gap. This debate relates to a large quantity of evidence on the link between the use of cash and increasing opportunities to evade taxes. In fact, the use of electronic money and other traceable means of payment is often thought to be deterrent for tax evasion.

The amount of bank deposits on regional value added positively affects tax gap shares. Nevertheless, the coefficient is very low, almost close to zero. This is a unexpected result as we think that higher financial wealth leads to less tax evasion. With reference to the SARSAR model, it may be due to the information captured by the variable considered. In fact, it measures deposits in banks located in one region also for people who are resident elsewhere. Since a proportion of these deposits does not contribute to the regional tax gap, the coefficient is approximately zero.

The coefficient for *Crime* is positive and significant even though not as high as expected. This can be due to measurement errors in the crime variable or to the fact that our variable considers not only economic crimes but also other types of illegal activities. We expect that a narrower indicator could have a higher effect on tax gap. Nonetheless, the positive and significant coefficient confirms results obtained by Dell'Anno and Schneider (2006). In fact, if we link to the crime variable the double meaning of the rate of illegality and efficacy of police action, it can also have a negative effect on tax gap, due to the fact that the cost in participating in illegal activities increases (Eilat and Zinnes, 2000).

As expected, the binary variable *D_Gdp* that captures if regional GDP has increased, is negatively correlated with regional tax gap. The debate on the relationship between business cycle and tax gap is widespread and unresolved (see, among others, Giles, 1999 and Chiarini and Marzano, 2008). Two are the possible drivers behind our result: first, the reduction of demand for underground products as GDP increases; second, the fact that positive regional GDP growth can create more job opportunities in the regular economy leading to a reduction of the tax gap.

Finally, as also in Malik and Schwab (1991), the share of resources received after fiscal amnesties on regional tax revenues (*Tax_amnesties*) has a significant and positive effect on regional tax gap share. This result confirms our a priori idea that tax amnesties can implicitly represent an incentive for taxpayers to evade tax payment with the perspective of having their fiscal obligations condoned in the future.

5. Conclusions

The analysis of determinants of tax gap has always attracted large attention in theoretical and empirical research. The efficacy of any policy measure to improve tax compliance relies on the capacity to understand what factors drive tax evasion. Among these factors, the role of tax agencies is undoubtedly of great importance. In fact, assessing the effect of tax enforcement on tax evasion has implications in terms of the design of auditing rules, the optimal extent of enforcement, the level of penalties and, more broadly, an evaluation of the effectiveness of tax authority's policies.

Our paper provides additional evidence that greater enforcement increases tax compliance. The novelty of the analysis is represented by the use of an official original panel dataset of Italian regional tax gap shares and data on audits implemented by the IRA. We account for the regional structure of data and control for the effect of geography using a spatial panel model specification. Results show that the probability of targeted audits and the enforcement of additional schemes to increase the disclosure of declared income have a positive effect on tax compliance. Geography also has a significant effect due to the fact that we find that regional tax gaps are characterized by spatial persistence.

We believe that our results are relevant for both theory and empirical methods on tax evasion and for evaluating tax enforcement policy. From a theoretical point of view, we move from a traditional portfolio approach toward more recent theoretical extensions. In the former, compliance depends exclusively on individual monetary incentives to evade; in the latter, factors like tax morale, the socio-economic context and social norms together with enforcement, affect taxpayers' choice to cheat.

From an empirical point of view, we provide a general framework to study tax evasion at a sub-national level using official data on tax gap shares. In fact, we can draw up a taxonomy of the determinants of tax gap at a regional level: operational factors and the effectiveness of audits and enforcement; socio-economic and institutional factors (incidence of agriculture on regional value added, share of self-employed, firm size, crime, electronic money, tax amnesties and GDP growth); and geography.

From the point of view of compliance policy instruments, our results on the effectiveness of enforcement at a regional level can be extended to other countries other than Italy. Given differences in tax systems, tax gap estimates and audit schemes, we can expect a negative correlation between traditional full audits and tax gap shares. Similar results in fact have been obtained for Argentina, the US, Spain, the UK and Denmark (for a general review see Slemrod, 2016). Finally, an additional interesting result is the different effect stemming from the types of enforcement mechanisms, either audit-based or any alternative scheme leading taxpayers to increase declared income. This outcome is also in line with the latest recommendations of the Intra-European Organization of Tax Administrations (Martín, Pladsen, Bendiksen, Aaas, and Andersen, 2016) for identifying effective solutions for increasing tax compliance.

We acknowledge that our results need additional research. If a panel of tax gap data for Italian provinces were to be available, it would be interesting to check if our results remain robust even at a sub-regional level. Moreover, testing the relative effect of different audit schemes would be of particular interest for policy purposes by tax authorities.

References

Alm, J. (1999). Tax compliance and administration. *Public Administration and Public Policy, 72*, 741-768.

Alm, J. (2012). Measuring, explaining, and controlling tax evasion: lessons from theory, experiments, and field studies. *International Tax and Public Finance*, *19*(1), 54-77. doi:10.1007/s10797-011-9171-2.

Anselin, L. (1988). *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic Publisher.

Anselin, L. (2009). Spatial Regression. In A. Stewart Fortheringham, & P. A. Rogerson (Eds.), *The SAGE Handbook of Spatial Analysis*. Los Angeles: SAGE.

Ardizzi. G., Petragna C., Piacenza M., & Turati F. (2013). Measuring the Underground Economy with the Currency Demand Approach: A Reinterpretation of the Methodology With an Application to Italy. *The Review of Income and Wealth*, *60(*4), 747–772. doi:10.1111/roiw.12019.

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies 58*, 277-297. doi:10.2307/2297968.

Barone, B., & Mocetti, S. (2011). Tax morale and public spending inefficiency. *International Tax and Public Finance 18*(6), 724-749. doi: 10.1007/s10797-011-9174-z.

Braiotta, A., Carfora, A., Pansini, R.V., & Pisani, S. (2015). *Tax Gap and Redistributive Aspects across Italy*. (Argomenti di Discussione No. 02/2015). Rome: Italian Revenue Agency.

Baltagi, B., & Li, Q. (1995). Testing AR(1) Against MA(1) Disturbances in an Error Component Model. *Journal of Econometrics, 68*, 133-151. doi:10.1016/0304-4076(94)01646-H.

Baltagi, B.H., Song, S.H., & Koh, W. (2003). Testing panel data regression models with spatial error correlation. *Journal of Econometrics, 117*, 123–150. doi:10.1016/S0304-4076(03)00120-9.

Bordignon, M., & Zanardi, A. (1997). Tax Evasion in Italy. *Giornale degli Economisti e Annali di Economia*, *56*(3-4), 169-210.

Cannari, L., & D'Alessio, G. (2007). The Opinion of Italians on Tax Evasion. (Bank of Italy Economic Research Paper No.618). Rome: Bank of Italy.

Chiarini, B., Marzano, E., & Schneider, F. (2008). *Tax Rates and Tax Evasion: An Empirical Analysis of the Structural Aspects and Long-Run Characteristics in Italy*. (IZA Discussion Papers No. 3447). Bonn: Institute of Labor Economics (IZA).

Cliff, A.D., & Ord, J.K. (1981). *Spatial processes: models and applications*. London: Pion LTD.

Clotfelter, C.T. (1983). Tax Evasion and Tax Rates: An Analysis of Individual Returns. *Review of Economics and Statistics, 65*(3), 363-373. doi:10.2307/1924181.

Dell'Anno, R., & Schneider, F.G. (2006). *Estimating the underground economy by using MIMIC models: A response to T. Breusch's critique*. (Economics working papers 2006-07). Linz: Johannes Kepler University, Department of Economics.

Di Caro, P., & Nicotra, G. (2014). *Knowing the unknown across regions: spatial tax evasion in Italy*. Retrieved from Social Science Research Network: http://ssrn.com/abstract=2446803.

Eilat, Y., & Zinnes, C. (2000). *The Evolution of the Shadow Economy in Transition Countries: Consequences for Economic Growth and Donor Assistance*. (CAER II Discussion Paper No. 83). Cambridge, MA: Harvard Institute for International Development.

Elhorst, J.P. (2003). Specification and Estimation of Spatial Panel Data Models. *International Regional Science Review, 26*, 244-268. doi:10.1177/0160017603253791.

Giles, D.E.A. (1999). Measuring the hidden Economy: Implications for Econometric Modeling. *The Economic Journal, 109*(456), doi:370-380. 10.1111/1468-0297.00440.

Godfrey, L. (1978). Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. *Econometrica, 46*, doi:1293–1302. 10.2307/1913829.

Herwartz, H., Tafenau, E., & Schneider, F. (2015). One Share Fits All? Regional Variations in the Extent of the Shadow Economy in Europe, *Regional Studies, 49*. doi: 10.1080/00343404.2013.848034.

Marigliani, M. and S. Pisani (2014) Una stima dell'effetto deterrenza esercitato dall'Agenzia delle Entrate, mimeo.

Martín, G., J., Pladsen, T., Bendiksen, I.,G., Aaas, A.,K., & Andersen, R. (2016). Identifying Effective Solutions to Increase (Voluntary) Tax Compliance. In International Organization of Tax Authorities [IOTA] (Ed.) *Tax Tribune*, *35*. Budapest: IOTA.

Italian Ministry of Finance [MEF] (2016). *Annex to the 'Update of the Economic and Financial Document 2016*'. Retrieved from MEF website: http://www.dt.tesoro.it/en/attivita_istituzionali/analisi_programmazione_economico_finanziaria/documenti_programmatici/sezione3/def_assistenza.html.

Kapoor, M., Kelejian, H.H., & Prucha, I.R. (2007). Panel Data Model with Spatially Correlated Error Components. *Journal of Econometrics, 140*(1), 97-130. doi: 10.1016/j.jeconom.2006.09.004.

Kelejian, H.H., & Prucha, I.R. (1999). A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model. *International Economic Review, 40*(2), 509-533. doi: 10.1111/1468-2354.00027.

Kleven, H.J., Knudsen, M.B., Kreiner, C.T., Pedersen, S., & Saez, E. (2010). *Unwilling or unable to cheat? Evidence from a randomized tax audit experiment in Denmark* (NBER Working paper No.15769). Cambridge, MA: National Bureau of Economic Research (NBER).

Malik, A.S., & Schwab, R.M. (1991). The economics of tax amnesties, *Journal of Public Economics, 46*(1), 29-49. doi: 10.1016/0047-2727(91)90063-8.

Marino, M.R, & Zizza, R. (2012). Personal Income Tax Evasion in Italy: An Estimate by Taxpayer Type. In Pickhardt, M., & Prinz A. (Eds.) *Tax Evasion and the Shadow Economy*. Cheltenham: Edward Elgar.

McGee, R.W. (2012). Gender and the Ethics of Tax Evasion: An Empirical Study of 82 Countries. In McGee, R. W. (Ed.) *The Ethics of Tax Evasion* (pp 415-439). New York, NY: Springer.

Millo, G. (2014). Narrow Replication of a Spatio-temporal Model of House Prices in the USA Using R. *Journal of Applied Econometrics, 30*(4), 703-704. doi: 10.1002/jae.2424

Moran, P.A.P. (1950). Notes on Continuous Stochastic Phenomena, *Biometrika 1/2*, 17-23. doi: 10.1093/biomet/37.1-2.17.

Pesaran, M. H. (2004). *General Diagnostic Tests for Cross Section Dependence in Panels* (CESifo Working Paper No. 1229). Munich: Ifo Institute, Center for Economic Studies (CES).

Pesaran, M.H., & Tosetti E. (2011). Large Panels with Common Factors and Spatial Correlations. *Journal of Econometrics, 161*(2), 182-202. doi: 10.1016/j.jeconom.2010.12.003.

Santoro, A., & Fiorio, C.V. (2011). Taxpayer Behavior When Audit Rules Are Known: Evidence from Italy. *Public Finance Review, 39*(1), 103-123. doi:10.1177/1091142110386214.

Schneider, F., & Enste, D.H. (2000). Shadow Economies: Size, causes, and consequences. *Journal of Economic Literature, 38*, 77 -114. doi: 10.1257/jel.38.1.77.

Slemrod, J. (2007). Cheating Ourselves: The economics of tax evasion. *The Journal of Economic Perspectives, 21*(1), 25-48. doi: 10.1257/jep.21.1.25.

Slemrod, J. (2016). *Tax Compliance and Enforcement: New Research and its Policy Implications.* Paper presented at the conference "The Economics of Tax Policy", December 3-4, 2015, Washington D.C.

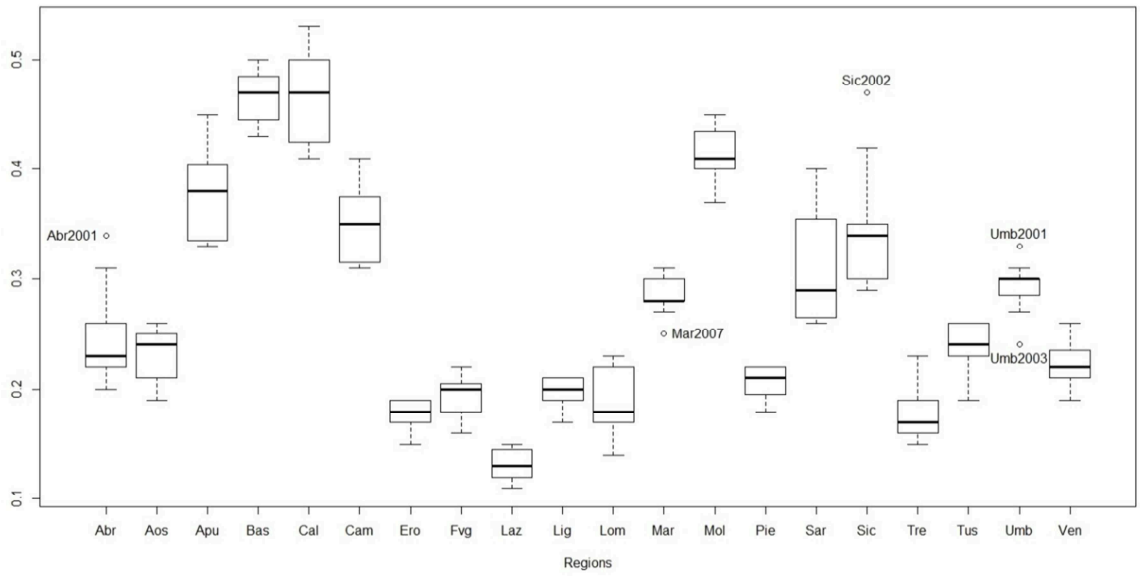
Slemrod, J., & Yitazky, S. (2002). Tax avoidance, evasion, and administration. In A. Auerbach, J., & Feldstein, M. (Eds.). *Handbook of Public Economics* (pp. 1423-1470). Amsterdam, London, and New York: Elsevier.

Torgler, B., Schneider, F., & Schaltegger, C.A. (2009). Local autonomy, tax morale, and the shadow economy. *Public Choice, 144*(1-2), 293-321. doi:10.1007/s11127-009-9520-1.

Yitzhaki, S. (1974). A note on income tax evasion: a theoretical analysis. *Journal of Public Economics, 3*(2), 201-202. doi: 10.1016/0047-2727(74)90037-1

6. Tables and Figures

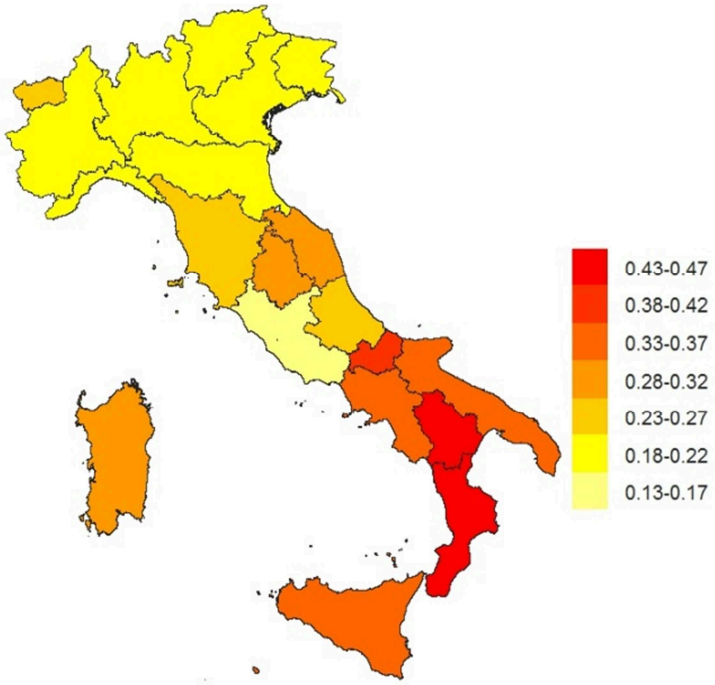
Figure 1: 2001-2011 distribution of Tax Gap shares (TG) across Italian regions



Abbreviations for regions: Abr=Abruzzo; Aos=Aosta Valley; Apu=Apulia; Bas=Basilicata; Cal=Calabria; Cam=Campania; Ero=Emilia-Romagna; Fvg=Friuli-Venezia Giulia; Laz=Lazio; Lig=Liguria; Lom=Lombardy; Mar=Marche; Mol=Molise; Pie=Piedmont; Sar=Sardinia; Sic=Sicily; Tre=Trentino-South Tyrol; Tus=Tuscany; Umb=Umbria; Ven=Veneto.

Source: authors' calculation based on IRA estimates.

Figure 2 Regional distribution of average 2001-2011 TG shares.



Source: authors' calculation based on IRA estimates.

Table 1 Dynamics of tax gap determinants

	OLS	**Random**	**Dynamic**	**SARSAR**
	(1)	(2)	(3)	(4)
Intercept	0.102	0.073		0.077
	(0.084)	(0.087)		(0.000)
Lag(y)			0.088	0.377***
			(0.092)	(0.052)
Lag(IRA_ss)	-0.082	-0.087**	-0.106***	-0.054***
	(0.044)	(0.028)	(0.024)	(0.016)
IRA_enforcement	-0.248	-0.201	-0.104	-0.228*
	(0.204)	(0.128)	(0.161)	(0.103)
Q_Agriculture	1.631***	1.038	0.363	1.163***
	(0.298)	(0.619)	(0.785)	(0.261)
Q_Industry	0.191**	-0.088	-0.424*	0.114*
	(0.069)	(0.110)	(0.203)	(0.054)
Q_Self-employed	0.471***	0.646***	0.440	0.557***
	(0.112)	(0.186)	(0.281)	(0.086)
Size (log)	-0.266***	-0.225***	-0.076	-0.202***
	(0.019	(0.033	(0.048	(0.016
POS-ATM_pc(log)	-0.086***	-0.081***	-0.088**	-0.041***
	(0.008)	(0.014)	(0.027)	(0.008)
Deposits	0.000	0.001	0.001**	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
Crime	0.000	0.001**	0.000	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
D_gdp	-0.016**	-0.014***	-0.011***	-0.013***
	(0.006)	(0.003)	(0.002)	(0.002)
Tax_Amnesties	0.005*	0.004**	0.002	0.004***
	(0.002)	(0.001)	(0.001)	(0.001)
Notes: Robust standard errors are in parenthesis. Significance levels: *** 0.001%; **0.01%; *0.05%				
Diagnostics				
Adj.R2	0.871	0.632		
θ		0.747		0.578
ρ				-0.604
Sargan (p-value)			0.999	
Unobserved effects *(H_0: No individual effects)*				
Breusch-Pagan	329.124			
	(0.000)			
Wooldridge	2.905			
	(0.004)			
Serial Correlation *(H_0: No serial correlation)*				
Baltagi and Li		36.521		
		(0.000)		
Breusch–Godfrey		52.528	17.132	5.049
		(0.000)	(0.020)	(0.830)
AR (1)			-3.109	
			(0.001)	
AR (2)			0.005	
			(0.498)	
Cross sectional correlation *(H_0: No cross sectional correlation)*				
Pesaran CD		4.996	3.899	1.8431
		(0.000)	(0.000)	(0.065)
Local cross sectional correlation *(H_0: No local cross sectional correlation)*				
Pesaran CD (p)		7.712	3.9152	1.944
		(0.000)	(0.000)	(0.052)
Baltagi Song. Koh				0.051
				(0.959)

Note: p-values are in parenthesis.

Table 2 Spatial autocorrelation of regional PTG

Year	I-statistics	Moran's test (p-value)
2001	0.642	0.000
2002	0.683	0.000
2003	0.552	0.000
2004	0.510	0.000
2005	0.502	0.000
2006	0.571	0.000
2007	0.560	0.000
2008	0.523	0.000
2009	0.487	0.000
2010	0.442	0.000
2011	0.490	0.000

APPENDIX

Table A.1: Data Description

Variables	Definition	Description	Source
		Dependent variable	
TG	Tax Gap propensity	Ratio of tax gap and potential tax revenues (sum of taxes paid and tax gap)	Authors' calculation based on IRA internal data
		Independent variables	
Lag(IRA_ss)	Strength of sectorial studies	One year lag of the number of not congruous taxpayers on total taxpayers subject to 'sectoral studies' (studi di settore) auditing scheme	Authors' calculation based on IRA internal data
IRA_enforcement	Index of audit coverage	Number of audited taxpayers on total taxpayers' population	Authors' calculation based on IRA internal data
Q_Agriculture	Agricultural sector quota of value added	Share of value added from agricultural sector on total value added per region	National Statistics Institute: National Accounts statistics
Q_Industry	Industrial sector quota of value added	Share of value added from industrial sector on total value added per region	National Statistics Institute: National Accounts statistics
Q_Self-employed	Self- employed rate	Number of self-employed professionals on total regional employees	National Statistics Institute: Statistics on Occupation
Q_Pub-employees	Public-employed rate	Share of employees in public administration on total regional empolyees	National Statistics Institute: Statistics on Occupation
Size (log)	Employees	Log of the average number of firms' employees by region	National Statistics Institute: Register of active firms
Pos-ATM_pc	Number of Points of Sales and ATM per capita	Log of number of point of sale terminals (for electronic payment) and of automatic teller machines divided by resident population.	Bank of Italy – Statistics Bulletin and National Statistics Institute
Deposits	Bank Deposits per capita	Share of bank deposits on regional value added.	Bank of Italy – Statistics Bulletin and National Statistics Institute
Crime	Crime index	Number of crimes related to organized crime per resident population (1000 inhabitants) weighted by their seriousness assigned by the Italian penal law	National Statistics Institute
D_gdp	GDP variation index	It takes value 1 if there has been a positive GDP's growth; 0 if there has been a negative GDP's growth. We consider GDP at constant price, base year 2005.	Authors' calculation based on GDP statistics from National Statistics Institute
Tax_amnesties	Amount of tax amnesties	Share of taxes paid by taxpayers that qualified for the amnesty and shelter on regional tax revenues	Ministry of Finance internal database
History	Historical legacy	Dummy variable that takes values: 1 if the region belonged to the Spanish reign; 0 for other regions	Authors' calculation
Gini	Inequality	Regional GINI index	National Statistics Institute
Export	Export on GDP	Proportion of export on regional GDP	National Statistics Institute
H_expenditure	Health expenditure per capita	Per capita regional expenditure in health services	National Statistics Institute
Unemployment	Unemployment rate	Regional Unemployment rate	National Statistics Institute

[i] Total tax gap is the sum of evasion related to VAT, personal income tax (namely, IRPEF), corporate income tax (namely, IRES) and tax on production activities (namely, IRAP), which are taxes under the duty Italian Revenue Agency. For details on the calculation of tax gap, see BRAIOTTA et al. (2015).

[ii] For each *i*-region we calculate the average TG as the ratio between the average tax gap (period 2001-2011) and the average PTR (period 2001-2011) as $\overline{\mathrm{TG_i}} = \frac{\mathrm{E(TaxGap_i)_{01-11}}}{\mathrm{E(PTR_i)_{01-11}}}$

[iii] Endogeneity issues are eluded as this variable measures the ratio between non-congruous taxpayers and total taxpayers subjected to 'studi di settore', it does not refer to any amount of collectable and evaded taxes.

[iv] Since their institution in 1993 by law n.427, 'studi di settore' require that taxpayers subject to this audit scheme must attach to their tax return file a form containing information required in order to estimate their revenues. While they are obliged to fill in the form, they are not obliged to respect the criteria of congruity and coherence. For details on the effects of 'studi di settore' audit scheme on tax compliance, see SANTORO and FIORIO (2011).

[v] The two main tax debt write-offs has been approved by Law n. 289 of December 2002 (fiscal amnesty) and law n. 102 of August 2009 (tax shelter).

[vi] They use a slightly different indicator for IRA enforcement as they calculate the ratio of the amount of taxes collected by preventing and tackling evasion and total tax gap.

[vii] For the sake of simplicity of table 1, the variable *lag(TG)* indicates alternatively the time-lagged tax gap in the dynamic panel specification and spatial-lagged tax gap in the SARSAR model.

[viii] As stated by Italian law, large firms are subject to a specific 'tutoring' activity by the IRA consisting in a detailed and long-lasting fiscal assistance. Moreover, large firms are subject to several additional rules involving the widespread use of electronic payment and invoicing in business conduct that limit the opportunities of evasion.