Environmental Crime and Shadow Economy: Evidence from Italy

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ABSTRACT

This study investigates the role of the shadow economy on environmental crimes in Italy, using a regional panel dataset over the period 2006-2016. Our main findings, after controlling for socioeconomic and judicial inefficiency characteristics, support the existence of a positive relationship between shadow economy and environmental crime, suggesting that increases in the shadow economy will increase environmental crime, adversely affecting the protection of the environment. The results are robust to model specifications and endogeneity. Moreover, we find that regions in which there are higher levels of corruption are more likely to experience higher levels of environmental crime; the intuition behind this result is that corruption could grease the wheels of environmental crimes. In terms of policy implications, our findings highlight that there is a wide room for efficiency gains in the fight against environmental crime implementing policies aimed to address the main drivers of the shadow economy.

Keywords: environmental crime, shadow economy, Italian regions. *JEL classifications:* Q56, K32.

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1. INTRODUCTION

Crimes against the environment are one of the most profitable illegal sectors with low risks and high profits, in Italy, where every year the eco-mafia invests between 13 and 20 billion \in in illegal environmental activities (Legambiente, 2018); these numbers are emblematic in that they witness the strength and the growth of the volume of illegal environmental markets. In 2022, more than 30.000 environmental crimes were ascertained in Italy with an average of around 84 crimes per day (Legambiente, 2023); the Southern regions of Campania, Sicily, Apulia, and Calabria still

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suffer the greatest impact of eco-criminality with a concentration of nearly 44% of the total crimes recorded. Italy is a compelling case study, given that organized crime is involved in many economic activities ranging from illegal trafficking of waste to illegal trade of wildlife and cultural heritage, from counterfeiting in the agri-food sector to forest fires and illegal constructions. Environmental crime, often, goes hand in hand with white collar type of crimes throughout the criminal chain (Nelleman *et al.*, 2016), and is usually linked more often to other crimes, such as the exploitation of disadvantaged communities, the violation of human rights, tax fraud, money laundering and corruption (Pergolizzi, 2019; UNEP, 2013).

However, despite the public's opinion simplistic and prevailing view that organized crime is the major responsible of environmental crime in Italy, more recently, Italian authorities (i.e., National Anti-Mafia Directorate) have emphasized that corporations with no mafia relations very often commit environmental crimes (Roberti, 2014; de Falco, 2014), advocating a widening in their classification towards a broader corporate crime definition rather than exclusively mafia-type of crimes. Notwithstanding the increasing attention, in recent years, at both political, institutional, and social level, environmental crime in Italy is still an under-investigated issue in the economic empirical literature. This study attempts to fill this gap by exploring whether the shadow economy may have a role in explaining environmental crime. Besides ecomafia,¹ in Italy, one of the most serious socio-economic problems is the growing concern on the unobserved economy, which includes both the shadow² economy and the illegal³ economy. According to the Italian Institute of Statistics,⁴ in 2022, the non-observed economy in Italy was worth 175 billion \in , 11% of the GDP, with an underground economy estimated around 157 billion \in , and an illegal economy estimated around 17 billion \in . The proceeds of criminal organizations in the Italian economy have been estimated in a range from 1 to 2 per cent of GDP (Transcrime, 2015). Illicit markets in Italy are huge in scale due to several factors (Transcrime, 2015), including i) the relative size of the legitimate economy (third-largest GDP in the EU after Germany and France), ii) the country's strategic position on illicit trafficking routes (i.e., illicit drugs, counterfeiting, trafficked persons, illicit trafficking of waste), and iii) the historical presence of well-rooted organized criminal groups.

In this work, we aim to investigate if, and to what extent, the shadow economy can affect environmental crimes, while controlling for socio-economic, enforcement and judicial regional heterogeneity. Therefore, we seek to advance the empirical research on the understanding of the determinants of environmental crime which, in Italy, has only recently begun to be investigated (Castaldo *et al.*, 2021; Germani *et al.*, 2020) and, as far as we know, the role of the shadow economy has not received any attention yet. Our empirical findings could be in line with the idea that we can

¹ Legambiente, one of the most well-known environmental NGOs in Italy, coined the term "ecomafia" to define all business activities (waste trafficking, unauthorized construction, illegal mining, forest fires, trafficking of wildlife, etc.) that apply disruptive use of environmental resources, and in which organized mafia-like groups have a prominent role.

² "For shadow economy - or "unofficial" economy, as opposed to the legitimate economy, which can be measured using wages, Gross Domestic Product (GDP), unemployment, etc. - are intended all the legal transactions concealed from the tax authorities; the main components of underground economy are under-reporting of added value and added value produced by undeclared work.

³ For illegal economy are intended all those activities of production of goods and services whose sale/distribution/possession is prohibited by law, and those activities which, although legal, are carried out by unauthorized individuals or organizations. The main illegal activities refer to drug trafficking, prostitution, and tobacco smuggling.

⁴ See the Report on non-observed economy at: <u>https://www.istat.it/it/archivio/275914</u>

make environmental crimes less worthwhile by fighting both shadow and illegal economies; it is hoped that they will be translated into practical applications to fight environmental crime in Italy. The remainder of this chapter is organized as follows. In section 2, we frame our contribution within the related relevant literature. Section 3 introduces the data and presents our econometric methodology. Estimation results are presented and discussed in section 4. Section 5 considers some relevant policy implications and provides some concluding remarks.

2. RELATED RELEVANT LITERATURE

Since Becker's (1968) pioneering work based on the rational decision of a utility-maximizing individual who decides whether or not to commit a crime, taking into account the probability of being arrested and punished and the magnitude of the sanction, the economics of crime has shifted toward a more flexible approach (Argentiero *et al.*, 2020) in which several socio-economic and demographic variables can play a role in explaining criminal offences (e.g., Glaeser and Sacerdote, 1999; Fajnzylber *et al.*, 2002; Buonanno, 2003; Buonanno and Leonida, 2009; Draca *et al.*, 2011). Economists have been interested to estimate the relationship between the economy and criminal behavior suggesting that when the legitimate (official) economy is healthy (i.e., when wages and employment are high), crime is low. Similarly, when the economy downturns, rational beings could move to alternatives illegal opportunities (i.e., criminal activities) to address their needs (Rocque *et al.*, 2019; Agnew, 2006). However, following the competing theoretical linkage of the opportunity perspective (Britt, 1994; Cantor and Land, 1985), a strong/weak economy will increase/decrease crime because there are more/less potential targets for offenders (more/less resources in society, accessible goods, etc.). Therefore, this relationship is, *a priori*, ambiguous,

given that the net effect of the economy conditions on criminal behavior may reduce crime, but may also result in an increase of criminal activity.

The main motivation behind this study is to explore, thus, whether shadow economy, which is found to be relevant in the economic literature on "classical" crime (Schneider and Enste, 2000), could be also pertinent to the study of environmental crime in Italy. The empirical literature on environmental crime in Italy focuses mainly on both its determinants and vulnerabilities, especially with regard to waste mismanagement, illicit trafficking of waste, and to wildfire crimes (Andreatta *et al.* 2022; Canepa and Drogo, 2021; Castaldo *et al.*, 2021; Dell'Anno *et al.*, 2020; Germani *et al.*, 2020; Morganti *et al.*, 2020; Germani *et al.*, 2018; D'Amato *et al.*, 2015; Germani *et al.* 2015; Massari and Monzini, 2004). Despite these important advancements, it remains the case that the interrelationship between environmental crime and the shadow economy has been unexplored in the economic literature; one consequence of this omission is that whether and how the shadow economy influences environmental crime is poorly understood so far.

3. DATA SECTION AND METHODOLOGY

3.1. DATA DESCRIPTION

The panel consists of annual data for the 20 Italian regions (NUTS-2) over the 11-year period 2006 to 2016. The data was obtained by the Italian Statistical Agency (ISTAT)^{5,} Legambiente, and EUROSTAT. Table 1 presents a summary of the variables that we used in our estimations.

| Variable | Description | Source |
|----------|-------------|--------|
| | | |

⁵ <u>https://www.istat.it</u>

Dependent variable(s)

| Environmental crime | number of criminal proceedings on waste-related and wastewater violations | ISTAT years 2006-2016 |
|---------------------------|---|--|
| Waste-related crimes | number of criminal proceedings on waste-related violations | ISTAT years 2006-2016 |
| Economic explanatory va | uriables | |
| Shadow economy | rate of irregular work, measured as 'standard units' (annual working units) of full-time equivalent employment | ISTAT years 2006-2016 |
| GDP (per capita) | per-capita regional GDP at current prices | EUROSTAT years 2006-2016 |
| Unemployment rate | unemployment rate relative to a time period of work inactivity longer than 12 months | ISTAT years 2006-2016 |
| Poverty | regional poverty index (households) | ISTAT years 2006-2016 |
| Other socio-economic co | ntrols | |
| Education | population aged 30-34 who achieved a level of tertiary education and bachelor's (or equivalent) level as a percentage of the population in the same age group (total) | ISTAT years 2006-2016 |
| School abandonment | percentage of the population aged 18- 24 years, with at least the middle school diploma, who has not completed/attended any school or educational activities for more than 2 years | ISTAT years 2006-2016 |
| Population density | inhabitants/km ² | ISTAT |
| Enforcement/judicial-rela | ated explanatory variables (sticks) | |
| Trial length | criminal trials length (expressed in number of days) | Italian Ministry of Justice years 2006-2016 |
| Corruption | number of convicted offenders | ISTAT years 2006-2016 |

for corruption

| Amosta | number of arrested | Legambiente years |
|---------|-------------------------|-------------------|
| Arrests | environmental offenders | 2006-2016 |
| | | |

Dependent Variables

We use the number of criminal environmental proceedings under the provisions of the Environmental Code (L.D. 152/2006), ⁶ as a proxy of environmental crimes. More specifically, our dependent variable is presented in two specifications, namely i) as the aggregation of waste-related and wastewater violations (such as mixing of waste, unauthorized waste management, illegal traffic of waste, discharges of wastewater from industrial plants or non-compliant behaviors with regard to maximum pollution thresholds), and ii) as waste-related crimes only. All the relative values are expressed in per capita for one million inhabitants for each region. Figures 1 and 2 depict the geographical distribution of both specifications of the dependent variable in terms of average values (2006-2016) of environmental criminal proceedings. According to the last Legambiente report (2023), ecomafía activities are primarily concentrated in the Southern regions (Apulia, Campania, Calabria, and Sicily) where organized crime has its historical roots although, for some decades now, the Central and Northern regions have shown themselves to be an area of interest to

⁶ The Environmental Code (Law Decree 152/2006) regulates several issues: environmental impact assessment, protection of soil and water, regulation of the waste and wastewater sectors, and decontamination of polluted sites. It consists of seven parts: i) Environmental general principles, ii) Environmental impact assessment and integrated pollution prevention and control (IPPC) permit, iii) Water resources management and soil protection, iv) Waste and packaging management, v) Remediation of contaminated sites, vi) Air protection and air emissions, vii) Environmental Damage. Only recently, Law 68/2015 has introduced a new chapter (VI bis) to the Italian Penal Code defining the crimes against the environment: environmental disaster, intentional crimes against the environment, fatal injuries as a result of the crime of environmental pollution, traffic, and abandonment of high radioactivity material (and related consequential side effects). In terms of severity of the applicable penalty, the most significant crimes are: i) "environmental pollution" (article 452a), punished with imprisonment from two to six years and a fine from €10,000 to €100,000 (if it causes deaths or bodily harm, sentences are harsher - article 452b); and ii) "environmental disaster" (article 452c), punished with imprisonment from five to fifteen years.

new businesses and financial aspects (Lavorgna and Sergi, 2014) connected to the greater possibilities of inclusion in the markets of the legal economy (Corte dei Conti, 2009).

FIGURE 1. GEOGRAPHICAL (REGION-LEVEL) DISTRIBUTION OF CRIMINAL PROCEEDINGS FOR CRIMES AGAINST THE ENVIRONMENT (2006 - 2016, average values) - per 100,000 inhabitants



Source: authors' elaboration on data released by the Italian National Institute of Statistics (ISTAT)

The regions with a darker colour exhibit higher average numbers of criminal proceedings for environmental crimes: Abruzzo, Basilicata, Molise and Sardinia in the South along with the northern regions of Piemonte, Liguria and Valle d'Aosta report the highest numbers of criminal proceedings for unlawful behavior falling under the provision of the Environmental Code. As it is possible to observe, the two specifications of the dependent variable follow a similar (averaged)

geographic distribution over the years considered.

FIGURE 2. GEOGRAPHICAL (REGION-LEVEL) DISTRIBUTION OF CRIMINAL PROCEEDINGS FOR WASTE CRIMES (2006 - 2016, average values) - per 100,000 inhabitants



Source: authors' elaboration on data released by the Italian National Institute of Statistics (ISTAT)

In Figure 3, throughout the support of some box plots, it is offered a visual representation over time of both the dependent variables considered.⁷ As said, our two specifications follow a similar time

⁷ Box plot is another way to assess the normality of the data; it shows the median as a horizontal line inside the box. It shows the median as a horizontal line inside the box and the interquartile range (IQR - range between the first and third quartile) as the length of the box. The whiskers (line extending from the top and bottom of the box) represent the minimum and maximum values when they are within 1.5 times the IQR from either end of the box. A box plot that is symmetric with the median line at approximately the center of the box and with symmetric whiskers indicate that the data come from a normal distribution.

trend reaching a plateau in 2014: the statical data are generally normally distributed even though the range (the width between the minimum and the maximum values of the variables) tend to first decrease and then increase after 2014. Thus, data dispersion is quite limited over the time-period considered.

FIGURE 3. BOX PLOTS OF THE DISTRIBUTIONS IN THE YEARS CONSIDERED (2006-2016) OF CRIMINAL PROCEEDINGS FOR BOTH ENVIRONMENTAL VIOLATIONS, AND FOR WASTE-RELATED VIOLATION



Independent Variables

The primary sources for the chosen socio-economic and enforcement/judicial variables are the Italian Statistical Agency (ISTAT), Legambiente, and Eurostat. As we noted earlier, we aim to estimate whether shadow economy, whose size in Italy is estimated to be very substantial,⁸ has an effect on environmental criminal activities, controlling for socio-economic and enforcement characteristics. A range of determinants has been considered, according to those most commonly used in the economics of crime literature (Buonanno, 2003) that might influence illegal behavior in general (Ehrlich, 1973; Cornwell and Trumbull, 1994; Baltagi, 2006) and environmental

⁸ Eurispes (https://eurispes.eu/rapporti/), a private Italian research institute, already in 2016 noted that the Italian official GDP would need to be raised by around one third to account for a shadow economy GDP. In the conclusions of the report, the research institute talks about tax evasion and the underground economy as a mass phenomenon in Italy.

offences in particular (Helland, 1998; Stafford, 2002; Eckert, 2004; Almer and Goeschl, 2010). In addition to shadow economy, several socio-economic control variables are selected to enter the estimation equation, such as regional GDP,⁹ level of education, and unemployment rate. The existence of a causal link between all these explanatory variables and common crimes has been widely investigated in the literature (Argentiero *et al.*, 2020); here, we use them to specify a model of environmental crime determinants in which shadow economy plays a role.

Even though there is not a unified definition of the shadow economy, it is referred to as the unofficial, hidden, or black economy that is not reported in official financial statements (Schneider and Enste, 2000).¹⁰ Several types of economic activity can be considered as measures of the shadow economy (Schneider and Enste, 2013), such as economic work that is conducted off the books (informal activities), and other economic transactions that involve illegal actions (illegal activities, such as tax evasion). Following Schneider and Enste (2013),¹¹ and in line with Chiarini and Marzano (2004), the measure of the shadow economy used in the present study is the rate of irregular work, measured as 'standard units' of full-time equivalent employment. Theoretically, the relationship between environmental crime and shadow economy can be, *a priori*, ambiguous, given that the shadow economy may either lead to a decrease of environmental crime due to a structural shift from the formal sector to the informal/illegal sector in the economic system (the reality is of course that environmental crime does not reduce, it is just no longer detected or reported), or to an increase of environmental crime due to the fact that they both are, in a sense, alternatives to the legitimate economy and, thus, a larger underground sector may correlate with

⁹ The effect of income is normally analyzed in the literature and its effects on crime are often ambiguous, finding both positive and negative relationship (i.e., Soares, 2004).

¹⁰ Dell'Anno (2007) suggests that the shadow economy involves informal production, underground production, and illegal production. Alternatively, Schneider (2010) argues that the shadow economy is related to production activities intentionally hidden from public agencies.

¹¹ Schneider and Enste (2013) discuss twelve distinct techniques for estimating the shadow economy in the literature.

higher environmental criminal activities (capturing illegal activities for purposes of financial gains). Figure 4 illustrates the geographical distribution of our main independent variable of interest, measured in terms of irregular labour. As it is possible to observe, the regions with a darker colour (i.e., Abruzzo, Apulia, Campania, Calabria, and Sicily), exhibit the highest concentration of irregular labour (followed by Basilicata, Lazio, Molise, Umbria, and Sardinia regions) implying that the irregular sector/unofficial economy is a relevant phenomenon in these territorial areas.

FIGURE 4. GEOGRAPHICAL (REGION-LEVEL) DISTRIBUTION OF SHADOW ECONOMY PROXIED BY IRREGULAR LABOUR (2006 - 2016, average values) - per 100,000 inhabitants.



Source: authors' elaboration of data released by the Italian National Institute of Statistics (ISTAT)

From Figure 5, we can observe an initial decreasing trend (up to 2010) of the shadow economy, proxied by the number of irregular workers, followed by an increasing pattern in the following years of the time span considered. Also in this case, data dispersion is stable over time, while the data range diminishes. The economic crisis immediately following the global financial crisis of 2007-08 seems to have increased the size of the Italian underground economy; in 2008, the rate of irregular work, measured as "standard units"¹² of full-time equivalent employment, was 11.8 % of total employment (Talani, 2019). After 2010, the rate of irregular labour increased to 12.3 %; in the years following the 2010/11 eurozone crisis, the rate of irregular work kept on increasing, reaching almost the 16% of the labour force in the 2015.¹³

FIGURE 5. BOX PLOT OF THE DISTRIBUTION IN THE YEARS CONSIDERED (2006-2016) OF THE SHADOW ECONOMY PROXIED BY IRREGULAR WORKERS.



With regard to the other socio-economic explanatory variables, we use regional *GDP*, *unemployment* rate, and *poverty* as measures of economic conditions in the Italian regions. The

¹² ULA (unità lavorative annue) – annual working units.

¹³ ISTAT (2015) indicates that the highest irregularity rate was registered in the sector of personal and domestic services (45% in 2013), followed by the agricultural sector (17.6%), commercial activities such as transport, hotels, and catering (15.6%), and construction (15.4%).

level of *GDP* might have, a priori, an ambiguous effect on environmental crime; Germani *et al.* (2020) found evidence of a non-linear relationship between environmental crime and per-capita income, in Italy. The existence of a causal link between *unemployment* and crime has been widely investigated in the literature, although the strength of this relationship remains ambiguous both in its nature and in its robustness (Chalfin and McCrary, 2017).

In addition to the above economic variables, with regard to the other socio-economic control variables, Castaldo *et al.* (2021) found the existence of a U-inverted relationship between education and environmental crime, in Italy, showing that environmental crime with respect to the level of education increases at a decreasing rate. The interpretation of this result is related to the nature of environmental crimes as white-collar type of crimes; nevertheless, as education levels increase, awareness and self-perception of the risks and costs associated to environmental degradation increase, too. *Education* is measured in terms of population (aged 30-34) who achieved a level of tertiary education and bachelor's (or equivalent) level as a percentage of the population in the same age group. *School abandonment* is measured in terms of percentage of the population (aged 18-24 years), with at least the middle school diploma, who has not completed or attended any school or educational activities for 2 more years. Moreover, geographers consistently found differences in the spatial distribution of crime (Hudson, 2014); for instance, crime is typically higher in urban areas (Glaeser and Sacerdote, 1999), or in neighborhoods with high *population density* (Hoch, 1973).

Corruption is also included in our estimation model, since it might facilitate shadow activities, while shadow operators might need grease money (bribes) to successfully continue their operations; this coexistence between corruption and shadow economy might exacerbate the commission of environmental criminal activities. Finally, we also include enforcement and judicial characteristics. As it is well known (Gray and Deily, 1996; Cohen, 2000; Polinsky and Shavell,

2000) increasing enforcement efforts (*arrests*) and more efficient judicial courts (*trial length*) should lead to increased deterrence. *Trial length* is defined in terms of average length (expressed in the number of days) of all criminal trial proceedings (at the prosecutorial office level)¹⁴ and is considered as a measure of the inefficiency of the judicial system at regional level.^{15,16} Arguably, environmental crime will be lower in regions with higher enforcement rates and with more efficient courts (those able to handle a high number of proceedings). Lower enforcement efforts and/or longer trials are likely to postpone the timing of punishment (Becker, 1968), and this could be an important factor in inducing individuals and firms to undertake illegal activities. By merging the above environmental crime, socio-economic and enforcement data, we produce a dataset that can contribute to the extremely exiguous economic literature on environmental crime studies in Italy.

Table 2 provides an overview of the selected variables and their summary statistics. An overall look illustrates significant heterogeneity in our variables, in the time span under consideration, especially for a within country panel covering a rather short time-period.

| Variables | Obs | Mean | Std. Dev. | Min. | Max. |
|---------------------|-----|-----------|-----------|--------|---------|
| | | | | | |
| Environmental crime | 220 | 11.983 | 7.409 | 0.234 | 63.686 |
| Waste crime | 220 | 10.226 | 6.9 | 0.234 | 62.54 |
| Shadow economy | 220 | 12.814 | 4.331 | 6.874 | 23.6 |
| GDP | 220 | 26,090.46 | 6,583.293 | 16,200 | 38,700 |
| Unemployment | 220 | 5.177 | 3.64 | 0.54 | 15.902 |
| Poverty | 220 | 74.664 | 39.458 | 2.50 | 34.90 |
| Education | 220 | 21.656 | 4.647 | 12.571 | 32.639 |
| School abandonment | 220 | 16.251 | 4.766 | 6.729 | 28.717 |
| Population density | 220 | 183.492 | 117.987 | 38.227 | 736.406 |

TABLE 2. DESCRIPTIVE STATISTICS

¹⁴ The calculated average length indicates the average period of permanence of a proceeding occurring in a judicial office and is calculated as the ratio between the value obtained by adding the initial pending (IP) to the final pending (FP) and the value of the sum of the registered (I) with the defined (D). This is an indicator already used by ISTAT to calculate the average duration of the proceedings: Average length in days = $[(IP+FP)/(I+D)]^*365$.

¹⁵ Note that trial and appeal delays are one of the major problems associated with the inefficiency of justice in Italy. ¹⁶ To deal with endogeneity, we use trial length not only of environmental crime proceedings but of all criminal proceedings.

| Trial length | 220 | 334.983 | 92.923 | 158.005 | 563.19 |
|--------------|-----|---------|--------|---------|--------|
| Corruption | 220 | 19.964 | 25.005 | 0 | 121 |
| Arrests | 220 | 9.955 | 15.269 | 0 | 104 |

3.2. IDENTIFICATION STRATEGY

We wish to model the relationship between environmental crime and shadow economy for the Italian regions and since, to our knowledge, no previous studies have examined whether the shadow economy can influence environmental crime, our study is necessarily exploratory. Our data is comprised of 20 regions over an eleven-year period. Pooled OLS panel models are commonly used in this empirical setting because they are able to capture unobserved heterogeneity (Wooldridge, 2010). Specifically, we consider the following log-log panel model:

$$EnvCrime_{it} = \beta_0 + \beta_1 Shadow Economy_{it} + \beta_2 X_{it} + \varepsilon_{it}$$

where, the subscripts i and t represent respectively the region and the time period, *EnvCrime* is the number of criminal proceedings for environmental crimes, *ShadowEconomy* is measured in terms of rate of irregular work, and *X* is a set of socio-economic and institutional variables characterizing the type of crimes considered, ε is the time-varying error term which stands for a well-behaved error term distributed IID (0, σ^2). The orthogonality assumption that is required for the validity of the estimates is that shocks to environmental crime are uncorrelated with shocks to shadow economy and other socio-economic controls. We believe this condition to be satisfied and to be coherent with a plausible assumption.

This first approach provides the OLS pooled but, due to heteroskedasticity issues, we also estimate fixed (FE) and random (RE) effects models. However, fixed and random estimation models could suffer from cross-sectional dependence in the errors. This problem could be caused by several common unobserved factors (i.e., social norms, neighborhood effects, etc.), thus, both the FE and RE estimators could be consistent, but inefficient, and the standard errors could be biased (De Hoyos and Sarafidis, 2006). Indeed, the Pesaran (2004) test reveals the existence of cross-sectional dependence across regions. To deal with serial correlation, given that the number of regions (20) is greater than the number of time periods (11), we improve our approach, by relying on the Panel Corrected Standard Error – PCSE (Beck and Katz, 1995). This method, with a two-step modified version of the OLS estimation, assumes that the error terms are heteroskedastic and correlated through the regions, allowing for unbiased results in the presence of cross-sectional dependence. In particular, in the first stage, throughout a Prais-Winsten (1954) transformation, the data are treated to remove serial correlation; in the second stage, the transformed data is used for the OLS estimation and standard errors are corrected for cross-sectional correlation.

4. RESULTS AND DISCUSSION

The results of the pooled OLS estimates and both panel fixed (FE) and random (RE) effects are presented in Table 3.

| Variables | (1) OLS Pooled | (2) Panel-FE | (3) Panel-RE | (4) Panel-CSE | | |
|--------------------------------|-------------------------------------|---------------------------------|-------------------------------------|-------------------------------------|--|--|
| Economic explanatory variables | | | | | | |
| Shadow_Economy | 1.080^{**} | 0.953^{**} (0.447) | 1.113^{**} (0.444) | 1.072^{**} (0.453) | | |
| GDP | -81.724*** (17.476) | -73.903** (27.702) | -80.596*** (19.393) | -65.528*** (13.734) | | |
| GDP^2 | 821.913 ^{***} (176.106) | 722.785** (280.686) | 806.406 ^{***} (197.703) | 659.803 ^{***} (140.536) | | |
| Unemployment | 0.217 ^{***} (0.060) | 0.366 ^{***} (0.096) | 0.306*** (0.066) | 0.271*** (0.075) | | |
| Poverty | 0.075* (0.042) | 0.056** (0.024) | 0.079** (0.033) | 0.056 | | |
| Other socio-economic contr | ols | | | | | |
| Education | 0.711*** (0.240) | 0.251 (0.292) | 0.533 [*] (0.278) | 0.611 ^{***} (0.215) | | |
| School_abandonment | 0.379** (0.163) | 0.512 ^{**} (0.228) | 0.444 ^{****} (0.172) | 0.430**** (0.122) | | |
| Pop_Density | -0.550*** (0.119) | -1.085**** (0.119) | -0.772*** (0.154) | -0.692*** (0.078) | | |

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|-----------------------------|----|-----------|-------------|------------------|-----|
|-----------------------------|----|-----------|-------------|------------------|-----|

Enforcement/judicial related explanatory variables

| Trial length | 0.239** | 0.407^{**} | 0.392*** | 0.461*** |
|--|---|---|---|--|
| e | (0.110) | (0.178) | (0.135) | (0.155) |
| Corruption | 0.107^{*} | 0.008 | 0.113* | 0.098^{**} |
| 1 | (0.062) | (0.068) | (0.063) | (0.041) |
| Arrests | 0.042 | 0.032 | 0.039 | 0.035^{*} |
| | (0.028) | (0.032) | (0.030) | (0.019) |
| Fixed effects | | | | |
| Geographic FE | Yes | - | Yes | Yes |
| | | | | |
| | | | | |
| Cons | -1075.193*** | -922.183** | -1050.098*** | -864.358*** |
| Cons. | -1075.193*** (230.911) | -922.183** (368.858) | -1050.098*** (260.533) | -864.358*** (186.719) |
| Cons. Obs. | -1075.193*** (230.911) 200 | -922.183** (368.858) 200 | -1050.098*** (260.533) 200 | -864.358*** (186.719) 200 |
| Cons. Obs. Regions | -1075.193*** (230.911) 200 20 | -922.183** (368.858) 200 20 | -1050.098*** (260.533) 200 20 | -864.358*** (186.719) 200 20 |
| Cons. Obs. Regions <i>F-stat.</i> | -1075.193*** (230.911) 200 20 11.462*** | -922.183** (368.858) 200 20 29.499*** | -1050.098*** (260.533) 200 20 - | -864.358*** (186.719) 200 20 - |
| Cons. Obs. Regions <i>F-stat.</i> <i>Wald</i> c ² | -1075.193*** (230.911) 200 20 11.462*** | -922.183** (368.858) 200 20 29.499*** | -1050.098*** (260.533) 200 20 - 639.430*** | -864.358*** (186.719) 200 20 - 279.767*** |

Robust standard errors in parentheses: p < 0.10, p < 0.05, p < 0.01

Overall evidence, at this first stage of analysis, confirms the consistent effect exerted by the shadow economy as a pull factor of environmental crimes, across all the estimates obtained. The positive and highly statistically significant relationship supports the argument that higher levels of shadow economy create a fertile ground to raise illicit environmental activities. The estimation results of the Panel Corrected Standard Error - PCSE (Beck and Katz, 1995) - are overall consistent with the findings previously obtained confirming that both the magnitude and significance of the estimated parameters remain substantially unchanged, highlighting a higher statistical significance for *shadow economy* (we have a very good fit with an R² of 0.92). This finding confirms the hypothesis that both environmental crime and the shadow economy are, in some sense, alternatives to the legitimate economy and, thus, may emerge simultaneously. The shadow economy itself is characterized by a lack of environmental regulation; this makes the underlying irregular/illegal activities becoming a major source of environmental criminality.

Consistently with recent evidence by Germani *et al.* (2020), the relationship with *GDP* is confirmed to be nonlinear with an initial decreasing pattern that prevails with respect to the subsequent increasing part; environmental crime initially decreases, while at higher levels of

income this result is averted (possibly due to a lack of environmental/public policy). Also, in line with previous literature (Germani and Castaldo, 2022), the positive and statistically significant relationship supports the argument that higher levels of both *unemployment* rates and *poverty* create a fertile ground to raise environmental crimes. The positive and statistically significant relationship with *education* is also in line with the most recent literature (Castaldo *et al.*, 2021) showing that environmental crime is a corporate type of crime which requires both high skills and resources (i.e., white collar) in order to address the complexity of such offenses. We find that *density* of population is negative and statistically significant; thus, we expect densely populated areas to be associated with lower environmental crime, implying that informal neighborhood surveillance prevents environmental crimes from occurring (Jacobs, 1961).

When looking at *trial length* as a measure of judicial inefficiency, we find a positive and highly significant relationship: this result is very interesting in that the propensity for environmental crime increases with expected judicial inefficiency as measured by judicial delay. The intuition is that the judicial inefficiency increases the expectation that no sanction may follow at all. Discounting of sanctions that may be imposed after a lengthy trial to their present value could also reduce deterrence.

Moreover, we find the sign of *corruption* positive and statistically significant in all model specifications, except for the fixed effect model: regions in which there are higher levels of corruption are more likely to experience higher environmental crimes. The intuition behind this result is that corruption could precisely be geared towards the implementation of environmental crimes. Lastly, the obtained results reveal that in most of the Italian regions enforcement activities proxied by *arrests* do not exert significant deterrence on environmental criminal behaviors.

As a robustness check, using a different environmental crime specification – i.e., wasterelated crimes – we find that the signs and statistical significance of our strategic independent variable (i.e., *shadow economy*) remain substantially unchanged and, generally, the results are all confirmed (we have a very good fit with an R^2 of 0.89). The positive relationship between environmental crimes and shadow economy is still confirmed, and this corroborates the efficiency of the estimation strategy adopted.

| | (1) | (2) | (3) | (4) | | | |
|--------------------------------|---------------------|-------------|--------------|---------------|--|--|--|
| Variables | OLS Pooled | Panel-FE | Panel-RE | Panel-CSE | | | |
| | | | | | | | |
| Economic explanatory variables | | | | | | | |
| Shadow Economy | 1.107^{**} | 1.043** | 1.152** | 1.284^{***} | | | |
| | (0.529) | (0.461) | (0.449) | (0.450) | | | |
| GDP | -89.452*** | -78.011** | -83.633*** | -68.606*** | | | |
| | (16.698) | (29.247) | (20.548) | (14.254) | | | |
| GDP^2 | 900.911*** | 764.923** | 836.455*** | 690.002*** | | | |
| | (168.576) | (295.355) | (210.729) | (146.543) | | | |
| Unemployment | 0.286^{***} | 0.383*** | 0.361*** | 0.352*** | | | |
| | (0.063) | (0.105) | (0.074) | (0.080) | | | |
| Poverty | 0.060 | 0.053^{*} | 0.070^{**} | 0.038^{*} | | | |
| | (0.038) | (0.027) | (0.033) | (0.023) | | | |
| Other socio-economic cor | ntrols | | | | | | |
| Education | 0.654*** | 0.372 | 0.556^{*} | 0.573** | | | |
| | (0.238) | (0.337) | (0.303) | (0.224) | | | |
| School_abandonment | 0.455*** | 0.469* | 0.469** | 0.441*** | | | |
| — | (0.167) | (0.226) | (0.184) | (0.130) | | | |
| Population density | -0.569*** | -1.057*** | -0.797*** | -0.728*** | | | |
| | (0.113) | (0.116) | (0.150) | (0.072) | | | |
| Enforcement/judicial rela | ted explanatory var | riables | | | | | |
| Trial length | 0.225** | 0.294 | 0.341** | 0.365** | | | |
| C | (0.113) | (0.203) | (0.153) | (0.154) | | | |
| Corruption | 0.088 | -0.000 | 0.092 | 0.081** | | | |
| Ĩ | (0.060) | (0.071) | (0.065) | (0.040) | | | |
| Arrests | 0.023 | 0.020 | 0.025 | 0.031 | | | |
| | (0.030) | (0.036) | (0.034) | (0.021) | | | |
| Fixed effects | | | | | | | |
| Geographic FE | Yes | - | Yes | Yes | | | |
| | | | | | | | |
| Cons | -1179.761*** | -978.022** | -1088.699*** | -902.350*** | | | |
| | (221.382) | (387.151) | (279.114) | (195.485) | | | |
| Obs. | 200 | 200 | 200 | 200 | | | |

TABLE 4. ROBUSTNESS CHECK: SHADOW ECONOMY AND WASTE-RELATED

 CRIMES

| Regions | 20 | 20 | 20 | 20 |
|------------|---------------------------------|-----------------------------|---------------------------|------------|
| F-stat. | 13.538*** | 31.482*** | - | - |
| Wald c^2 | - | - | 825.527*** | 484.430*** |
| R^2 | 0.56 | 0.60 | 0.54 | 0.89 |
| | Dobust standard smore in payout | $1000000^{*} m < 0.10^{**}$ | $m < 0.05^{***} m < 0.01$ | 1 |

Robust standard errors in parentheses: p < 0.10, p < 0.05, p < 0.01

In summary, we find robust empirical evidence of a positive and statistically significant relationship between environmental crime and shadow economy, indicating that shadow economy, in Italy, is expected to act as a facilitator factor of environmental illegal activities.

5. CONCLUSIONS

The present study takes a first step in investigating the link between environmental crime and the shadow economy in Italy; it provides a significant contribution to both the empirical literature and policymakers, showing that the shadow economy leads to higher rates of environmental crime, controlling for socio-economic, enforcement and judicial territorial characteristics. A second important policy finding is that we find a positive correlation between corruption and environmental crime; we find that regions in which there are higher levels of corruption are more likely to experience higher levels of environmental crime. The intuition behind this result is that corruption could grease the wheels of environmental crimes not only by facilitating illegal activities that may have environmental impacts, but also by serving entrepreneurial criminal networks. Moreover, our results support the evidence that criminal environmental conducts are influenced by the inefficiency of judicial courts, measured in terms of criminal proceedings' delays; when looking at our judicial inefficiency measure, we find a positive and significant result implying that the propensity to commit environmental crimes increases with proceedings' delay. As it is well known (Cohen, 2000; Polinsky and Shavell, 2000), increasing enforcement efforts and judicial efficiency of courts generates deterrence improvements.

For policymakers, these findings could be relevant for designing policies to reduce illegal environmental misconducts based on regional heterogeneity; by lowering the level of shadow economy and corruption might be possible to significantly reduce environmental crimes. Our study was based on data concerning Italian regions. There may be particular specificities in Italy that create greater space for shadow economy and corruption, thus potentially weakening the system of prevention and enforcement. Our findings may, however, also have importance beyond the confines of Italy. They point to the fact that, generally, the fight against environmental crimes cannot be dissociated from the relationship to shadow economy and corruption; a pragmatic way to deal with the fight against environmental crime is to tackle both shadow economy and corruption simultaneously. Therefore, this creates the need for stronger coordination between anti-shadow economy, anti-corruption policies and environmental law enforcement efforts, to generate more integrated strategies, certainly across Italy, but potentially in other countries where similar problems might arise as well.

REFERENCES

- Agnew, R. (2006). *Pressured into crime: An overview of general strain theory*. New York, NY: Oxford University Press.
- Almer, C., T. Goeschl (2010). Environmental crime and punishment: Empirical evidence from the German penal code, *Land Economics*, 86: 707–26.
- Andreatta D., S. Favarin, M. Lisciandra, E. Millemaci (2023). Digging into waste: an analysis of waste crime in the Italian provinces, *Regional Studies*, 57(7):1367-1379.
- Argentiero A., B. Chiarini, E. Marzano (2020). Does tax evasion affect economic crime? *Fiscal Studies*, 41(2): 441-482.
- Baltagi B. (2006). Estimating an Economic Model of Crime Using Panel Data from North Carolina, *Journal of Applied Econometrics*, 21: 543-547.
- Beck N., J. N. Katz (1995). What To Do (and Not To Do) With Time Series Cross-Section Data, *American Political Science Review*, vol. 89(3): 634- 647.
- Becker G. (1968). Crime and Punishment: An Economic Approach, *The Journal of Political Economy*, 76 (2): 169-217.

- Britt C. L. (1994). Crime and unemployment among youths in the United States, 1958–1990. *American Journal of Economics and Sociology*, 53: 99-109.
- Buonanno P., L. Leonida (2009). Non-market effects of education on crime: Evidence from Italian regions, *Economics of Education Review*, 28: 11-27.
- Buonanno P. (2003). The Socioeconomic Determinants of Crime: A Review of the Literature, Working Paper series n. 63, Università Milano Bicocca.
- Canepa A., F. Drogo (2021). Wildfire crime, apprehension and social vulnerability in Italy, *Forest Policy and Economics*, 122: 102330.
- Cantor, D., K.C. Land (1985). Unemployment and crime rates in the post-World War II United States: A theoretical and empirical analysis, *American Sociological Review*, 50: 317-332.
- Castaldo A., A.R. Germani, A. Pergolizzi (2021), Does education affect environmental crime? A dynamic panel data approach at provincial level in Italy, *International Criminal Justice Review*: 1-18, https://doi.org/10.1177/10575677211020812.
- Chalfin A., J. McCrary (2017). Criminal Deterrence: A Review of the Literature, *Journal of Economic Literature*, 55(1): 5-48.
- Chiarini B., E. Marzano (2004.) Dimensione e dinamica dell'economia sommersa: un approfondimento del" currency demand approach", *Politica Economica*, 20(3): 303-334.
- Cohen M.A. (2000). Empirical research on the deterrent effect of environmental monitoring and enforcement, *Environmental Law Reporter* 30:10245-52.
- Cornwell C., W. Trumbull (1994). Estimating the economic model of crime with panel data, *The Review of Economics and Statistics*, 76(2): 360-366.
- Corte dei Conti (2009). Relazione sull'attività svolta nell'anno 2009, http://www.lexitalia.it/articoli/corteconti 2009.pdf.
- D'Amato, A., M. Mazzanti, F. Nicolli (2015). Waste and organized crime in regional environments: How waste tariffs and the mafia affect waste management and disposal, *Resource and Energy Economics*, 41: 185-201.
- De Falco G. (2014). Traffico illecito dei rifiuti: un approccio giudiziario, in *Gazzetta Ambiente* 4: 71-75.
- De Hoyos R.E, V. Sarafidis (2006). Testing for cross-sectional dependence in panel-data models, *The Stata Journal*, 6(4): 482–496.
- Dell'Anno R., A. Pergolizzi, R. Pittiglio, F. Reganati (2020). Waste crime in Italian regions: A structural equation approach, *Socio-Economic Planning Sciences*, 71: 100751.
- Dell'Anno, R. (2007). The shadow economy in Portugal: An analysis with the MIMIC approach, *Journal of Applied Economics*, 10(2): 253–277.
- Draca M., S. Machin, R. Witt (2011). Panic on the Streets of London: Police, Crime and the July 2005 Terror Attacks, *American Economic Review*, 101: 2157-2181.
- Eckert H. (2004). Inspections, warnings and compliance: The case of petroleum storage regulation, Journal of Environmental Economics and Management, 47: 232-259.
- Ehrlich I. (1973). Participation in illegitimate activities: A theoretical and empirical investigation, *Journal of Political Economy*, 81: 521-565.
- Fajnzylber P., D. Lederman, N. Loayza (2002). Inequality and violent crime, *Journal of Law and Economics*, 45: 1-39.
- Germani A.R., A. Castaldo (2022). Income inequality and environmental crime in Italy: an empirical analysis at regional level, in A. Antonelli (ed.), *Inequalities, welfare policies and macroeconomic sustainability of public finances*, McGraw Hill: Milano.

- Germani A.R., A. Ker, A. Castaldo (2020). On the existence and shape of an environmental crime Kuznets Curve: A case study of Italian provinces, *Ecological Indicators*, <u>https://doi.org/10.1016/j.ecolind.2019.105685</u>
- Germani A.R., A. Pergolizzi, F. Reganati (2018). Eco-Mafia and Environmental Crime in Italy: Evidence from the Organised Trafficking of Waste, in: Spapens T., R. White, D. van Uhm, W. Huisman, (eds.), *Green Crimes and Dirty Money, London*: Routledge, Taylor and Francis Group.
- Germani A.R., A. Pergolizzi, F. Reganati (2015). Illegal trafficking and unsustainable waste management in Italy: evidence at the regional level, *Journal of Security and Sustainability Issues*, 4(4): 369-389.
- Glaeser E. L., B. Sacerdote (1999). Why is there more crime in cities? *The Journal of Political Economy*, 107 (6/2): 225-258.
- Gray W., M. Deily (1996). Compliance and enforcement: air pollution regulation in the U.S. steel industry, *Journal of Environmental Economics and Management*, 31: 96-111.
- Helland E. (1998). The Revealed Preferences of State EPAs: Stringency, Enforcement, and Substitution, Journal of Environmental Economics and Management, 35:242-261.
- Hoch I. (1973). Factors in urban crime, Journal of Urban Economics, 1:184-229.
- Hudson R. (2014). Thinking through the relationships between legal and illegal activities and economies: Spaces, flows and pathways, *Journal of Economic Geography*, 14 (4):775-795.
- ISTAT (2015). L'Economia non osservata nei conti nazionali (2011-2013), https://www.istat.it/it/archivio/175791
- Jacobs J. (1961). The life and death of great American cities. New York: Random House.
- Lavorgna A., A. Sergi (2014). Types of organized crime in Italy. The multifaceted spectrum of Italian criminal associations and their different attitudes in the financial crisis an in the use of Internet technologies, *International Journal of Law, Crime and Justice*, 42(1):16-32.
- Legambiente (2018, 2023). Ecomafia 2018, 2023, Edizioni Ambiente, Milan, Italy.
- Massari M., P. Monzini (2004). Dirty Businesses in Italy: A Case-study of Illegal Trafficking in Hazardous Waste, *Global Crime*, 6(3-4): 285-304.
- Morganti M., S. Favarin, S., D. Andreatta (2020). Illicit waste trafficking and loopholes in the European and Italian legislation, *European Journal on Criminal Policy and Research*, 26: 105-133.
- Nellemann C., R. Henriksen, A. Kreilhuber, D. Stewart, M. Kotsovou, P. Raxter, E. Mrema, S. Barrat, (eds) (2016). *The Rise of Environmental Crime A Growing Threat to Natural Resources Peace, Development and Security*, A UNEP-INTERPOL Rapid Response Assessment, United Nations Environment Programme and RHIPTO Rapid Response-Norwegian Center for Global Analyses.
- Pergolizzi A. (2019). *Emergenza Green corruption. Come la corruzione divora l'ambiente*, Andrea Pacilli ed., Manfredonia (Foggia).
- Pesaran M.H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels, Faculty of Economics, https://www.repository.cam.ac.uk/handle/1810/446
- Polinsky A., M. S. Shavell (2000). The Economic Theory of Public Enforcement of Law, *Journal* of Economic Literature, 38(1): 45-76.
- Prais, S.J., C.B. Winsten (1954). Trend Estimators and Serial Correlation, Cowles Commission Discussion Paper, 383.

- Roberti F. (2014) Audizione del Procuratore Nazionale Antimafia. Commissione parlamentare d'inchiesta sulle attività illecite connesse al ciclo dei rifiuti. XVII Legislatura, available at http://www.camera.it/leg17/210?commissione=39&annomese=201411&view=filtered.
- Rocque M., J. W. Saunoris, E. C. Marshall (2019). Revisiting the Relationship Between the Economy and Crime: The Role of the Shadow Economy, *Justice Quarterly*, 36(4): 620-655.
- Schneider F., D.H. Enste (2013). *The shadow economy: An international survey*, Cambridge: Cambridge University Press.
- Schneider F. (2010). The influence of public institutions on the shadow economy: An empirical investigation for OECD countries, *Review of Law & Economics*, 6(3): 441-468.
- Schneider F., D.H. Enste (2000). Informal Economies: Size, Causes and Consequences, *The Journal of Economic Literature* 38(1): 77-114.
- Stafford S. (2002). The effect of punishment on firm compliance with hazardous waste regulations, Journal of Environmental Economics and Management, 44(2): 290-308.
- Talani S. L. (2019). Assessing the relation between the underground economy and irregular migration in Italy, *The International Spectator*, 54(2): 102-122.
- Transcrime (2015). From illegal markets to legitimate businesses: the portfolio of organised crime in Europe, *Final Report of Project OCP – Organised Crime Portfolio*, Savona E. U. and M. Riccardi (eds.), Transcrime - Università degli Studi di Trento.
- UNEP (2013). UNEP and INTERPOL Assess Impacts of Environmental Crime on Security and Development, <u>https://www.unep.org/news-and-stories/press-release/unep-and-interpol-</u> <u>assess-impacts-environmental-crime-security-and</u>