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Law Enforcement and Illegal Trafficking of Waste: Evidence from Italy

Anna Rita Germani
University of Rome "La Sapienza"

Antonio Pergolizzi
University of Camerino

Filippo Reganati
University of Rome "La Sapienza"

Abstract

The illegal trafficking of waste has become one of the fastest growing areas of crime and one of the most lucrative industries among organized criminal activities, which has infiltrated both the Italian urban and hazardous waste management cycle. In this study, we aim to investigate the determinants of the organized activities for the illegal trafficking of waste (art. 260 of the Environmental Code) using waste, economic, and enforcement data in a panel analysis over the period 2002-2013. Our main findings reveal that in most of the Italian regions enforcement activities do not exert significant deterrence on criminal behaviors; a negative relationship between enforcement and illegal trafficking of waste can be identified only for very high levels of enforcement efforts. Moreover, we find that the major determinants of the illegal trafficking of waste rate differ between northern-central and southern regions, confirming the existence of a regional dualism. In particular, while in the North-Centre area the crime rate is positively related to level of education and negatively to the adoption of environmentally sound policies, in southern regions the organized activities for the illegal trafficking are negatively related to the education attainment and positively to the endowment of waste management plants.

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Contact: Anna Rita Germani - annarita.germani@uniroma1.it, Antonio Pergolizzi - antoniopergolizzi@gmail.com, Filippo Reganati - filippo.reganati@uniroma1.it.

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1. Introduction¹

Illegal trafficking of waste arises when higher profits are expected compared to legal options of recycling or disposal, combined with regulatory or enforcement failure. From an economic point of view, this environmental crime is mainly motivated by cost-saving decisions driven by the attempt: i) to reduce the relatively high costs of treatment and disposal of waste and ii) to take advantage of regional differences in environmental taxation (i.e., landfill and incineration taxes). A recent work by D'Amato et al. (2014) found that, in Italy, a stricter environmental taxation exerted a positive effect on illegal disposal and trafficking. Using a panel dataset at the Italian provincial level that integrates waste, economic, policy and enforcement data, they aim to analyze the deterrence effect of enforcement actions focusing on the role played by waste policies. Their main results are twofold and show, on one side, that enforcement actions are effective in improving deterrence reducing waste crimes only if they are implemented at a relatively high level and, on the other side, that a more diffuse incentive-based waste management policies increase illegal disposal. Also the work by Mazzanti and Montini (2014), still devoted to Italy and to waste disposal, finds evidence in support of higher environmental taxes; their findings show that more diffuse incentive-based policy instruments, such as waste tariffs, might positively correlate to better waste management providing an economic incentive to maximize the recycling rate. With regard to the work by D'Amato et al. (2014), while our analysis focuses on a very specific type of crime, namely on organized activities of illegal trafficking of waste according to art. 260 of the Italian Environmental Code, they consider different typologies of waste disposal related crime (including those linked to the violation of Directives 91/689/CEE on packaging and 91/156/CEE on waste). Moreover, while our analysis deals with all types of waste, they take into consideration the management of municipal waste (that in Italy represents the 15-20% of the total generated waste).

Another economic factor that can induce the illegal shipment of waste is the potential economic returns of waste as an export. In fact, several waste streams are shipped to countries outside the EU as 'second-hand goods' (i.e., primarily waste electrical and electronic equipment, end-of-life vehicles, but also car tires and other types of waste). The wide difference in prices between used and new products in these countries is one of the most important factors encouraging illegal shipments.

The illegal trafficking of waste may also be driven by other factors that have an institutional nature and are concerned with regulatory or enforcement failures. Firstly, in Italy, waste treatment and disposal plants are insufficient and are somewhat unevenly distributed at regional level. In Italy, every year the total production of waste amounts to almost 164 million tons with a treatment capacity of just over 150 million tons: specifically, there are 32.5 tons of municipal waste produced, 79.4 tons of nonhazardous waste, 41.9 tons of construction and demolition waste, and 9.6 tons of hazardous waste (Fise Assoambiente, 2009).² The geographical distribution of the waste treatment and disposal plants is concentrated in some areas of the country (mainly in the northern regions) with the consequence that there are territories (in the southern regions) where mafia clans and criminal organizations are the only actors able to manage waste disposal. For example, if we take into consideration the composting sector, there are 146 plants in the north, 52 plants in the south and only 42 plants in the center. Such a situation encourages the legal (and illegal) trafficking of waste often making the international transport less expensive than a long-distance treatment at home and paving the way for eco-criminal infiltrations³.

¹ This work is a specific development of a wider research on environmental crimes, namely of the research project titled "European Union Action to Fight Environmental Crimes" (www.efficacy.eu) which has been funded (for the period 2012-2016) by the European Commission within the Seventh Framework Programme.

² Overall, there are 6 404 waste recycling plants with a treatment capacity of 150 800 tons and 403 waste disposal plants with a capacity of 20 500 tons. To these numbers, must be added 686 landfills with a residual total disposal capacity of approximately 122 600 tons.

³ By "eco-criminal infiltrations" we refer to the control of strategic economic sectors or to the management of essential public services, such as urban waste disposal, implemented by a company that operates both in the legal and/or illegal market without

Second, a national waste reduction policy as well as a systemic vision concerning both urban and hazardous waste are still missing in Italy. The urban waste management is under public local municipalities, which follow their own policies, however hazardous waste management is completely left to free market rules.

Finally, the implementation of an effective system of control in Italy is sometimes quite difficult for several reasons. First, the waste management cycle is characterized by many steps whose traceability is ensured by self-certifications (the so-called formulary Fir), and so it is easily eluded and counterfeited.⁴ Second, since monitoring and inspection activities are officially delegated to some regional environmental agencies (ARPA) without a sufficient financial budget and often lacking the necessary technical equipment, the challenge is therefore entirely left to the police force that, however, may investigate only when in possession of a *notitia criminis*. In addition, multiple police forces enact law enforcement at, both, national (Arma dei Carabinieri, Polizia di Stato, Guardia di Finanza, Corpo Forestale dello Stato) and local levels (Polizia Provinciale and Polizie Municipali), which quite often do not communicate and cooperate among each other. There is no doubt that the cooperation among all law enforcement authorities and prosecutors is the best weapon to fight illegal waste trafficking; the challenge that Italian enforcers and prosecutors have to undertake is frustrated by complex and ever-changing laws and wrong (or absent) political enactments.

In the Italian legal system, the criminal protection of the environment is almost entirely limited to a series of misdemeanors, which fall outside the Penal Code.⁵ As far as the illegal trafficking of waste is concerned, it was firstly introduced in Article 259 of the Environmental Code (D.Lgs. 152/2006) on the “Illegal shipment of waste”, which punishes “*whoever carries out a shipment of waste constituting illicit traffic according to Article 26 of the Regulation (European Economic Community) 1 February 1993, no. 259 or carries out a shipment of waste listed in the Annex II of the above-mentioned Regulation in violation of article 1, par. 3, a), b), c) and d), of the Regulation itself shall be punished with a fine from €1550 to €26000 and with arrest of up to two years. The penalty is increased in case of shipment of dangerous waste*”.

Amongst the few cases that do include the felony, there is the case of organized activities for the illegal trafficking of waste⁶. Firstly introduced in 2001 when art. 22 of the Law 93/2001 implemented the art. 53-bis of the D.Lgs. 22/1997 (the so-called decreto Ronchi), in 2006 organized activities for the illegal trafficking of waste became a definitive part of the Environmental Code. In particular, art. 260 of the Environmental Code punishes by imprisonment from one to six years *any person who, in order to gain unfair profit through operations and preparation of means and organized continuing activities, sells, receives, transports, exports, imports or otherwise improperly handles large quantities of waste. If the waste is highly radioactive, the sanction is harsher, punishing violators with imprisonment from three to eight years*. It should be noted that before the approval of this law, nobody had been seriously punished for the crime of illegal trafficking of waste. Since then, criminal enforcement has made an important step forward and has enabled disbanding some of the most active national and transnational criminal organizations. The first big enquire against waste traffickers was conducted just few months after the approval of a new

necessarily violating the environmental law.

⁴ Illegal shipment may take many forms such as: i) the transport without notifying the authorities of source and destination when such a notification is necessary; ii) the falsification of any documentation regarding waste loads or the not declaration of waste; iii) the mixing of certain types of waste; iv) the classification of hazardous waste as nonhazardous ('green-listed'); v) the shipping whilst falsely claiming that it comprises second-hand goods and it is therefore not subject to waste regulations.

⁵ For example, art. 256 of the Environmental Code punishes “whoever carries out an activity of collection, transport, recovery, disposal, trade and brokerage of waste without the permit, registration or communication based on Articles 208, 209, 210, 211, 212, 214, 215 and 216 shall be punished by: a) arrest from three months to one year or fined from 2 600 to 26 000 Euro for non-dangerous waste; b) arrest from six months to two years and a fine from 2 600 to 26 000 Euro for dangerous waste”. It is an abstract endangerment offence punishing the exercise of activity out of the preventive control of the public administration. In particular, it is a misdemeanor and can be committed intentionally or negligently.

⁶ A recent law (Law 6/ 2014) was introduced into the Environmental Code Article 256 bis on the “Illegal burning of waste,” which punishes with imprisonment from two to five years whoever sets fire to waste abandoned or deposited in an uncontrolled manner in unauthorized areas.

criminal law, on February 2002. This investigation dismantled a big trans-regional criminal organization with its headquarter in Umbria, one of the richest Italian regions characterized by a low environmental crime rate. Before the enactment of this environmental criminal law, no one had been arrested for any illegal traffic of waste, not even the fearsome mafia's clan of "Casalesi" (the main responsible of the environmental disaster in the Campania region named "Land of Fires"⁷) that, until then, had been prosecuted just for minor environmental offences punished by simple fines.

In this work, thus, using a set of explanatory variables (enforcement variables, waste market-related and socioeconomic variables) we aim to investigate the determinants of the illegal trafficking of waste in Italy, over the period 2002-2013, driven by the two following research questions: i) what were the main determinants of organized illegal trafficking of waste in Italy over the period 2002-2013 and ii) to what extent is the existing enforcement system effective in deterring it? The present paper contributes to the existing literature on environmental crime in several ways. First, it explicitly analyzes a specific type of environmental crime, which presents the higher degree of sanctioning regime in the Italian environmental legislation. Second, Italy represents a quite important country study because of the strong presence of *mafia clans* and *organized crime systems* (Scarpinato, 2008) in the illegal market. Finally, our analysis is based on a unique dataset that covers the total number of reported investigations related to the organized activities for the illegal trafficking of waste (art. 260 of the Environmental Code) over the considered period.

2. Theoretical background and hypotheses

To develop the testable hypotheses that guide the empirical analysis, a range of determinants have been considered. This includes socio-economic, environmental and policy variables that might influence illegal behavior in general (Ehrlich 1973; Cornwell and Trumbull, 1994) and environmental offences in particular (Hamilton 1996; Helland 1998; Stafford 2002; Eckert 2004). Assuming that potential criminals are cynical profit-maximizers who base their decisions on whether to commit a crime or not on an expected utility calculation, then they will comply with the law as long as their benefits outweigh their costs of compliance. As such, polluters are expected to comply with environmental regulations if the probability of being apprehended and sanctioned, coupled with the penalty imposed, is sufficiently high. We derived the following research hypotheses to be tested empirically:

Hypothesis 1: An increase in the enforcement effort results in, ceteris paribus, a lower number of violations; in other words, enforcement improves deterrence.

This hypothesis postulates that increasing enforcement efforts (i.e., judicial investigations, arrests) will lead to increased deterrence. Empirical studies (Cohen, 2000) have showed that generally a high level of enforcement implies a high level of deterrence.

Hypothesis 2: An increase in economic activity leads, ceteris paribus, to a higher number of violations of illegal trafficking of waste.

The level of economic activity might influence illegal trafficking of waste in two ways (Almer and Goeschl, 2010): a scale effect and an income effect. Both mechanisms predict a higher number of violations for higher levels of economic activity.

Hypothesis 3: An increase in the legal income of the population leads, ceteris paribus, to less (more) violations of illegal trafficking of waste.

⁷ The Land of Fires indicates an area in the Campania region (South of Italy) where, systematically, since the end of the '80s, toxic wastes have been illegally burnt and buried.

The literature on the economics of crime has largely stressed the role of the legal income opportunities in affecting the benefits and costs of crime. Theoretically, the relationship between the level and growth of income and crime is ambiguous. On the one hand, higher income opportunities may increase the chances for employment in the legal sector and, therefore, reduce the crime rate; on the other hand, higher income opportunities that improve the level of transferable assets in the community may potentially raise the revenues from crime.

Hypothesis 4: An increase in the education level leads, ceteris paribus, to less (more) violations of illegal trafficking of waste.

Another economic factor that may affect the decision to engage in criminal activities is education. Primarily, higher levels of educational attainment, being associated with higher returns in the labor market, may increase the opportunity cost of criminal behavior. In addition, education may alter personal preferences in a way that affects decisions to engage in crime, bringing about a sort of “civilization” effect.

Hypothesis 5: An increase in the costs of treatment and disposal of waste lead, ceteris paribus, to more violations of illegal trafficking of waste.

Illegal trafficking of waste arises when higher profits are expected compared to legal options of recycling or disposal, combined with regulatory or enforcement failure (Sigman, 1998). The criminal behavior is driven, therefore, by an attempt to reduce the relatively high costs of legal treatment of waste, of legal disposal (i.e., landfill tax) and of transportation costs.

Hypothesis 6: A more environmentally sound policy and an integrated system of waste management and disposal reduces, ceteris paribus, the incentive to illegally traffic waste.

The lack of adequate (and effectively enforced) waste management policies generates institutional and regulatory uncertainty, which fosters the illegal trafficking of waste. Mazzanti and Montini (2014) have shown that the heterogeneous waste management and disposal performances in Italy depend not only on the existence of a north-south divide, but also on the quality of waste policy and idiosyncratic socio-economic factors.

3. Data description and empirical strategy

Data on the organized illegal trafficking of waste were provided by the Osservatorio Ambiente e Legalità of Legambiente. The dependent variable is the rate of crime, which is measured by the number of investigations related to organized illegal waste trafficking activities (art. 260 of the Environmental Code) per 100 000 resident population in each region-year. In our empirical analysis, we use a set of explanatory variables divided into three groups: deterrence variables, waste market-related and socioeconomic variables. To address the deterrent effect on criminal behavior, we use two variables such as the charge rate and the arrest rate. The former is measured by the ratio of the number of offenders charged to the total number of offenders recorded and reflects the portion of offenders that are identified by legal authorities. The latter is defined as the ratio of the total number of offenders arrested to the total number of offenders recorded. These variables indicate the portion of offenders who have already received some kind of punishment, but do not reveal the certainty of their conviction. For both the deterrence variables, we have also considered their squared terms in order to control for a possible non-monotonic relation.

To account for waste related variables, we use the number of waste treatment plants in each region and the per capita recycling (or recovery) rate. The first variable is a proxy for the cost of treatment and disposal of waste, while the second proxies the adoption of environmentally sound management policies at regional level.

Finally, we complete our dataset by including a set of socioeconomic variables that reflect the legal income opportunities of potential criminals. In particular, we insert into our model the Gross Domestic Product per capita at 2005 constant prices, the rate of growth of the real GDP at 2005

constant prices, the male unemployment rate and the share of population that has enrolled in secondary school.⁸ Table 1 provides some descriptive statistics of our sample.

3.1 Econometric methodology

Following the modern literature (Rickman and Witt 2007; Machin and Meghir 2004), in this section we implement a simple model of environmental crime, which posits a relationship between annual reported crime in each region and region-level enforcement variables, plus some other control variables. The estimation equation takes the following form:

$$\ln crime_{it} = \alpha_0 + \beta \ln crime_{it-1} + X'_{it} \gamma + \mu_i + year_t + \varepsilon_{it}$$

where the subscripts i and t represent region and time period, respectively. The dependent variable ($\ln crime$) is the crime rate, while the explanatory variables are the lagged crime rate and a set (X) of socioeconomic and waste specific variables characterizing the crime. The lagged crime rate in the previous year was inserted into the model in order to identify a possible dynamics in crime. As a matter of fact, the economic crime literature has identified the possibility of criminal hysteresis or inertia (Sah, 1991; Glaeser et al., 1996; Fajnzylber et al., 2002); in other words, higher crime today is associated with higher crime tomorrow. Past crime may affect current criminal behavior for several reasons. First, criminals can learn by doing, acquiring some level of adequate criminal know-how, which allows them to reduce their expected cost of carrying out criminal acts (Case and Katz, 1991). Moreover, convicted criminals are likely to have less legal job opportunities, thus reducing their personal cost of participating in criminal activity and making the commission of crime more attractive. Variable μ_i is a region fixed effect to control for some time-invariant regional characteristics that were omitted in the model but had an impact on crime rates over years; $year_t$ is a time effect that captures the common variations in crime rates across regions and removes the correlation amongst regions; Finally, ε_{it} stands for a well-behaved error term distributed IID $(0, \sigma^2)$.

The dependent variables and all explanatory variables, except for the number of incinerators, were natural logged to alleviate the problem caused by the skewed distributions of some variables. Another advantage of doing this was to simplify the calculation of the percentage change of crime rates for a one percent change in each explanatory variable (elasticity). The number of incinerators was not logged as the time series contained a substantial amount of zeros.

We estimate our model using the first-differenced GMM procedure (Arellano and Bond, 1991; Arellano and Bover, 1995). This estimator allows controlling for (weak) endogeneity by using the instrumental variables, which consist of appropriate lagged values of the explanatory variables. The consistency of the GMM estimator crucially depends on the validity of the instruments. We address this issue by considering two specification tests suggested by Arellano and Bond (1991). The first is the Sargan test of over identifying restrictions, which tests the null hypothesis of the overall validity of the instruments used. Failure to reject this null hypothesis gives support to the model. The second test examines the hypothesis that the error term is not serially correlated. We test the null hypothesis that the differenced error term is first and second order serially correlated. Failure to reject the null hypothesis of no second-order serial correlation implies that the original error term is serially uncorrelated and the moment conditions are correctly specified.

3.2. Results

Table 2 provides the GMM estimates obtained using the Arellano–Bond methodology. Three statistics test are reported: (i) Sargan test of over-identifying restrictions; (ii) and (iii) first and second order serial correlation test.

⁸ As there is great support in the general crime literature that different socioeconomic variables play an important role in explaining the amount of crime, we additionally tested the following list of variables: population density, value added of manufacturing sector, number of manufacturing firms, rate of irregular workers and income inequality. However, none of these seem to have a significant influence on environmental crime.

In Columns (i) and (iv) of Table 2, the reported results do not control for socioeconomic and waste-specific variables. In particular, estimates show that there is no crime persistence, with the coefficient of the lagged dependent variable being negatively and statistically insignificant. Both charge and arrest rates are positive and statistically significant. This result is quite unexpected and different with respect to the majority of the existing literature, because the cost of breaking the law, as measured by the charge to arrest ratio, should reduce the crime rate. This result might imply that deterrence is still not effective from preventing crime occurrence: if deterrence would be stronger, then one would expect to see reduction in the organized activities of illegal trafficking of waste violations. It may be that arrests are not the best measure of deterrence and the positive significant relationship might reflect this fact; this supports the suggestion by previous authors (Wilson and Herrnstein, 1985) that criminals do not consider the likelihood of the negative consequences of committing a crime. This result could also mean that criminal sanctions may not be the most effective solution, given that the illegal waste traffickers are usually companies (with their own industrial plants and logistical resources) that dislike administrative sanctions and interdiction measures, such as the suspension or revocation of licenses and concessions (i.e., administrative sanctions or measures that interrupt a company's business tend to have a stronger deterrent effect than criminal sanctions).

However, the negative and significant coefficients of both squared terms reveal the existence of a hump shaped relation between organized illegal trafficking of waste and law enforcement efforts. In line with D'Amato et al. (2014), our result indicates that the influence of law enforcement on the organized illegal trafficking of waste can only affect criminal activities up to a certain threshold and a deterrence effect on criminal behavior can only be achieved to such a level. Columns (ii) and (v) report the results obtained when the economic-specific covariates are inserted into the model. Now, we find that the lagged crime rate is negative and significant, meaning that there isn't a persistence of this type of crime over time in Italian regions. Also, the share of population that has enrolled in secondary school appears to be significantly and positively correlated with the crime rate. Similar to the results of other previous studies (Buonanno, 2006), the positive effect of this variable may be attributed to the fact that a higher level of education may reduce the cost of committing a crime or may raise the revenues of crime. However, in this specific case, the positive relationship between levels of education and illegal trafficking of waste can be explained by the nature of the crime. Being a typical economic crime, it seems to be a prerogative of subjects with higher levels of education, since the covert illegal mechanisms require high skills and resourcefulness. One of the most recent and important inquiries on illegal trafficking of waste has seen the involvement of the Italian region Emilia Romagna. As a matter of fact, Emilia Romagna registers the highest percentages of both per-capita income and children's schooling and is also one of the regions with the stronger level of fight against eco-criminals. This is not surprising, since high percentages of per-capita income and children's schooling push the economy to high productive performances, and high productive performances can imply more opportunities for the illegal traffickers of waste, especially in the recycling waste sector. In fact, to operate in this sector specific professional skills are needed: first of all, it is important to know and understand not only the prescription of the law and its vulnerability but also the supply and demand mechanisms in the waste management market. This business requires also a dynamic economy able to support the demand for the illegal traffic of waste and to facilitate the hiding of the illegal flow into the legal one.

The coefficients on GDP per capita, GDP growth rate and male unemployment rate are not statistically significant.

Finally, columns (iii) and (vi) of Table 2 present regressions that include two different indicators of waste management activities. As we can see, results are qualitatively similar to those presented above and, once again, suggest that the only significant determinants of the organized illegal trafficking of waste are the deterrence variables, the degree of educational attainment, and the lagged crime rate

With regard to the GMM specification tests, all regression models are supported by the Sargan test, which confirms the validity of the instruments used (i.e. the instruments are not correlated with the error terms). As expected, there is evidence for first-order serial correlation, while there is no evidence of second-order serial correlation.

3.3. Territorial heterogeneity

In order to account for the structural and relevant differences between the north-center and the south of Italy we estimate the crime equation for each of these territorial aggregations. Namely, we estimate a crime equation using a panel dataset for the 12 regions belonging to the north-center and a crime equation using a panel dataset for the remaining 8 regions belonging to the south of Italy. Table 3 displays coefficient estimates for northern regions.

With the exception of the model in column (iv), the lagged crime rate has a significantly negative effect in all models, indicating the absence of any persistence in crime, but past crime seems to reduce current criminal behavior. Furthermore, the results for both the charge rate and the arrest rate are uniformly positive and significant: an increase in both law deterrence variables would increase crime rate. Only the squared term of the arrest rate is negative and significant. Our findings indicate that law enforcement variables do not, in general, affect a significant deterrence on criminal behavior. Education attainment exhibits a positive and a significant effect on crime rate, indicating that, as previously found, the incidence of crime is greater, the greater the share of population that has enrolled in secondary school. It is worth noting that our findings show that an average income exhibits a negative and significant coefficient (columns v and vi). This means that, in the north-center, improvements in the overall economic condition increase the chances for employment in the legal sector and, thus reduce crime rates.

Finally, our results show that the crime rate in the north-center area is also driven by the per-capita recycling and recovery rate. In the northern regions, recycling and recovery policies seem to be the best instruments to prevent crime, because they drastically reduce the use of both landfills and extensive commutes around the country; two action areas conducive to enabling organized crime. Empirical evidence shows that in those regions where waste management policy is more virtuous (i.e., Trentino, Friuli Venezia Giulia and Marche), the propensity to commit this type of crime is much lower. For example, in 2013 the above-quoted regions registered the lowest number of reported environmental crimes (Legambiente, 2014).

The picture slightly changes when we consider empirical results for southern regions, as displayed in Table 4. First, lagged crime rate is not always statistically significant. In addition, as for the deterrence variables, we find that in the southern regions of Italy law enforcement measures related to the organized trafficking of waste do not exert significant deterrence on the criminal behavior. In particular, both the charge rate and the arrest rate are always positive and significant while their squared terms exert a negative and statistically significant effect on crime rates. In addition, in models (v) and (vi) the coefficient for education attainment is negative and significant indicating that more educated people have a higher moral stance or less time available to participate in illegal criminal activities, thus resulting in fewer perpetrated crimes.

Finally, our proxy for the cost of waste disposal exhibits a positive and significant effect on crime rate, indicating that the incidence of crime rises, the higher the plant endowment in the region is. In those regions where the presence of organized crime is higher and where waste management policy is much more influenced by corruption, waste treatment plants are used to intercept waste demand and to channel it mainly towards illegal outlets. As is also often shown by police investigations, landfills and waste treatment plants are means used to mask illegal operations of waste management.

4. Conclusions

The present paper contributes to a better understanding of the possible determinants relative to a still empirically unexplored type of environmental crime, i.e. the organized activities for the

illegal trafficking of waste (art. 260, D.Lgs. 152/2006). The obtained results reveal that, in most Italian regions, enforcement activities do not exert significant deterrence on criminal behaviors. A negative relationship between enforcement and illegal trafficking of waste can be identified only for very high levels of enforcement efforts. Moreover, the outcomes show that the major determinants of illegal trafficking of waste rate differ between northern-central and southern regions, confirming the existence of a regional dualism. In particular, while in the north-center area the crime rate is positively related to level of education and negatively to the adoption of environmentally sound policies, in southern regions the organized activities for illegal trafficking are negatively related to the education attainment and positively to the endowment of waste management plants.

If in the north of Italy, the best plant equipment is linked to a better management of the entire waste cycle, as shown by the higher standards of recycling rate, in the south, the stubborn presence of various mafias and organized crime systems are able to move the waste management plants more towards personal interests and illegal practices. Therefore, we can argue that the presence of an adequate plant facility is important but not sufficient without both an effective policy aimed to prevent and contrast organized crime and strong social control processes at local level.

Also, in the north the positive relationship between levels of education and illegal trafficking of waste can be easily explained by the nature of the crime. Being a typical economic crime, it seems to attract subjects with higher levels of education, since the covert illegal mechanisms require high skills and resourcefulness. Unlike other forms of illegal trafficking, in order to operate effectively, operators must know the legal market and its dynamics, the complex legislation, and the weaknesses of the control systems. Almost all the investigations completed so far (since 2002) show that the falsification of, both, documentation (the so-called *formulari*) and chemical-physical analysis is a constant practice. In addition, other sophisticated types of crimes, such as, corruption in the public procurement system, fraud in public procurements, and money laundering activities are emerging, supporting the fact that these are all crimes that require high skills and well-defined professional abilities. Overall, our pilot study enriches our understanding on the determinants of the illegal trafficking of waste and highlights the presence of heterogeneity across regions in Italy. From a policy perspective, the evidence obtained allows us to support the hypothesis that, in Italy, a better-integrated system of waste management and disposal in coordination with a long-term industrial strategy at national level, should be urgently implemented in order to restrict the flows of illegal trafficking of waste. Moreover, the enforcement approach could be changed: even though organised crime plays a significant role in the waste management industry, particularly in the area of illegal dumping and international illegal trafficking of hazardous waste, organised mafia-like criminals are not the only players. Indeed, although a simplistic view often prevails in the public domain according to which waste dumping is attributable only to mafia clans, a more substantial explanation of the phenomenon is articulated around the interplay of mafia-like groups, businessmen, firms and administrative officers (D'Alisa et al., 2015). Such a linkage between environmental crime and corporate crime should be taken into account in developing an effective deterrence strategy. Although these results are only preliminary, they are encouraging and indicate that we are looking at the right determinants of this kind of environmental crime. Further analysis should be conducted along these lines of enquiry, increasing the number of covariates (i.e., costs of treatment and disposal, criminal sentences, etc.) and checking for result robustness. Also, it should be useful to undertake our analysis at the province-level in order to control for the presence of finer forms of geographical heterogeneity. We believe that this pilot work sets the agenda for our future research.

Table 1. Basic descriptive statistics

	Obs	Mean	St.Dev.	Min	Max
Crime rate	240	0.36	0.056	0	0.346
Charge rate	240	0.350	0.405	0	1
Arrest rate	240	0.153	0.256	0	1
GDP growth rate	220	0.011	0.023	-0.057	0.067
Average income	240	25014.31	6483.097	14063.45	35469.01
Education attainment	200	95.201	5.880	73	106.3
Male unemployment rate	240	7.132	4.261	1.6	21.4
Recycling rate	240	27.9	-16.794	2.8	64.6
Number of plants	240	1.229	2.651	0	13

Table 2. The determinants of the organized illegal trafficking of wastes in Italy

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Crime rate lagged	-0.0685 (-1.57)	-0.184*** (-7.13)	-0.170*** (-6.15)	-0.0600 (-1.58)	-0.164*** (-4.63)	-0.152*** (-3.96)
Charge rate	0.873*** (4.42)	0.654*** (4.41)	0.680*** (4.76)			
Charge rate^2	-2.138** (-2.90)	-1.511* (-2.44)	-1.585** (-2.69)			
Arrest rate				1.015*** (4.21)	1.042*** (3.83)	1.072*** (3.83)
Arrest rate^2				-2.232** (-3.22)	-3.119** (-3.14)	-3.236** (-3.20)
GDP growth rate		-4.787 (-0.67)	-5.511 (-0.69)		-4.584 (-0.69)	-5.421 (-0.72)
Average income		-0.0400 (-0.40)	-0.0169 (-0.15)		-0.0394 (-0.37)	-0.0316 (-0.27)
Education attainment		0.540*** (5.67)	0.533*** (5.10)		0.400*** (4.06)	0.412*** (3.56)
Male unemployment rate		-0.00557 (-0.32)	0.00278 (0.13)		0.00829 (0.50)	0.0154 (0.72)
Recycling rate			-0.0359 (-1.51)			-0.0377 (-1.57)
Number of plants			-0.00154 (-0.70)			0.000225 (0.09)
Constant	0.0000272 (0.04)	0.00203 (0.84)	0.00329 (0.57)	0.00263*** (3.96)	0.00361 (1.41)	0.00295 (0.52)
Observations	200	160	160	200	160	160
Specification tests(p-values)						
i) Sargan test	0.452	0.433	0.682	0.398	0.722	0.591
ii) Serial correlation						
First order	0.0086	0.0396	0.0380	0.0017	0.0209	0.0192
Second order	0.1079	0.1043	0.0904	0.3784	0.3071	0.2890

Note: Time dummies have been included but omitted here. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 3. The determinants of the organized illegal trafficking of wastes in the North-Centre of Italy

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Crime rate lagged	-0.157* (-2.21)	-0.236*** (-3.34)	-0.242** (-2.61)	-0.124 (-1.73)	-0.144** (-2.59)	-0.152** (-2.61)
Charge rate	0.467** (2.76)	0.360* (2.33)	0.426** (3.27)			
Charge rate^2	-0.607 (-0.77)	-0.295 (-0.34)	-0.437 (-0.64)			
Arrest rate				0.821** (2.74)	1.152** (3.12)	1.109** (3.12)
Arrest rate^2				-2.180 (-1.56)	-4.666** (-2.82)	-4.432** (-2.83)
GDP growth rate		1.461 (0.32)	1.420 (0.24)		1.605 (0.24)	1.437 (0.22)
Average income		-0.0931 (-1.80)	-0.0244 (-0.36)		-0.125** (-3.22)	-0.100* (-2.54)
Education attainment		0.561*** (8.97)	0.460*** (5.69)		0.375*** (4.60)	0.352*** (4.05)
Male unemployment rate		-0.00386 (-0.26)	0.0165 (1.02)		0.0116 (1.10)	0.0156 (1.02)
Recycling rate			-0.138** (-2.77)			-0.0418 (-0.82)
Number of plants			-0.00457 (-1.69)			-0.00139 (-0.74)
Constant	-0.000904 (-1.00)	0.00203 (1.36)	0.0167 (1.76)	0.00138** (2.75)	0.00118 (0.79)	0.00710 (1.08)
Observations	120	96	96	120	96	96
Specification tests(p-values)						
i) Sargan test	0.46	0.541	0.323	0.291	0.244	0.32
ii) Serial correlation						
First order	0.0126	0.0342	0.0580	0.0085	0.0134	0.0124
Second order	0.1334	0.1604	0.1366	0.6157	0.2107	0.1676

Note: Time dummies have been included but omitted here. Robust standard errors in brackets. *** p<0.01, ** p<0.05, *p<0.1

Table 4. The determinants of the organized illegal trafficking of wastes in the South of Italy

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	D.L. CR	D.L. CR	D.L. CR	D.L. CR	D.L. CR	D.L. CR
Crime rate lagged	-0.0839*** (-3.65)	-0.0943*** (-3.98)	-0.195* (-2.10)	-0.194* (-2.18)	-0.138 (-1.81)	-0.117 (-1.92)
Charge rate	1.205** (3.19)		0.822** (2.80)	0.782** (2.87)		
Charge rate^2	-3.347* (-2.48)		-2.054* (-2.05)	-1.782* (-2.32)		
Arrest rate		1.460*** (3.71)			1.350*** (3.50)	1.348** (3.23)
Arrest rate^2		-3.041*** (-3.36)			-3.308*** (-3.57)	-3.347*** (-3.43)
GDP growth rate			11.99 (1.43)	13.80 (1.59)	8.038 (0.97)	8.177 (1.05)
Average income			-0.696 (-0.83)	-0.831 (-1.06)	-0.204 (-0.27)	-0.204 (-0.32)
Education attainment			-0.525 (-0.66)	-0.403 (-0.57)	-1.111** (-2.60)	-1.101* (-2.46)
Male unemployment rate			0.00247 (0.09)	0.00378 (0.13)	-0.00728 (-0.27)	-0.000636 (-0.02)
Recycling rate				-0.0317 (-1.33)		-0.0326 (-0.85)
Number of plants				0.0146* (2.10)		0.00564 (0.79)
Constant	0.000688 (0.90)	0.00430*** (3.35)	0.0176 (1.44)	0.00685 (0.56)	0.0163 (1.55)	0.0166 (1.02)
Observations	80	80	64	64	64	64
Specification tests(p-values)						
i) Sargan test	0.137	0.061	0.327	0.205	0.188	0.267
ii) Serial correlation						
First order	0.0455	0.0812	0.0772	0.0258	0.0897	0.0772
Second order	0.1609	0.2274	0.2119	0.1439	0.1093	0.2119

Note: Time dummies have been included but omitted here. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

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