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*Illegal Waste Disposal, Territorial Enforcement and Policy.
Evidence from regional data.*

by

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ILLEGAL WASTE DISPOSAL, TERRITORIAL ENFORCEMENT AND POLICY

EVIDENCE FROM REGIONAL DATA

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Abstract

This paper investigates if and how illegal disposal of waste is affected by the decentralized waste management commitment of local governments and by enforcement policies. On the basis of a panel dataset at the Italian provincial level that originally integrates waste, economic, policy and enforcement data, our empirical analysis presents two main insights. First, a more diffuse commitment towards incentive based waste policy tends to increase illegal disposal. Second, a non-linear bell shaped relationship exists between enforcement and illegal disposal, namely deterrence only results after a (relatively high) level of controls is implemented.

JEL: Q53, K42, D73.

Keywords: waste management, illegal disposal, forestry corps, enforcement, regional settings, waste tariffs, ecological-economic data.

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1. Introduction

Waste is one of the most problematic challenges to sustainability. Though various improvements have occurred in waste management and disposal over the recent decades in most advanced countries, an effective absolute delinking between waste generation and economic growth/consumption has not been achieved for all relevant streams of waste, from urban waste to packaging to construction and demolition waste (Shinkuma and Managi, 2011; Mazzanti and Montini, 2009; Mazzanti and Zoboli, 2009; EEA, 2009). In addition, average national figures often hide rather heterogeneous regional performances (D'Amato et al., 2013) that might characterize 'hot spots', that is to say, failure of the economic, institutional and technological systems in finding a proper waste management and disposal equilibrium (D'Alisa et al., 2010). Starting from seminal papers that outlined the general theoretical considerations on waste disposal issues (Pearce and Brisson, 1995), these observations have stimulated recent research on the 'regional features' of waste performance, especially in those economic systems that witness high levels of policy decentralization. Among others, we note that recent key works have concentrated on waste generation and disposal drivers, focusing on the analysis of regional frameworks in the EU and other OECD countries (Hage and Soderholm, 2008; De Jaeger and Eyckmans, 2008, Dijkgraaf and Gradus, 2009; Yamamoto et al. 2011) building up on the more consolidated literature on the determinants of waste performances at EU (Mazzanti and Zoboli, 2009, EEA, 2009) and OECD levels (Johnstone and Labonne, 2004). Very recent works have also emphasized that waste management systems and performance develop 'by clustering' (i.e. regions and provinces agglomerate within a given country), leading to virtuous high performance in some cases and to critical hot spots in others (Mazzanti and Montini, 2013). Divergences and agglomerations can be found also when the costs of waste disposal and recycling services are considered, confirming the existence of differences at regional as well as municipality level (Abrate et al., 2012).

In this respect, Italy is a compelling case study given its high heterogeneity in terms of economic, environmental and institutional characteristics (Costantini et al., 2013; Mazzanti et al., 2008, 2012), as well as for the well-known activity of organized crime in conditioning waste related performances (D'Amato et al., 2013).

An important role in determining the emergence of 'waste crises'--that is, idiosyncratic hot spots in a circumscribed territory--is indeed played by illegal practices of waste disposal and trafficking, an overwhelmingly lucrative phenomenon worldwide¹, but especially relevant in Italy. In this country, the illegal waste business has grown significantly in last decades (Pasotti, 2010), reaching a turnover of approximately 7 billion Euros in 2009 (Legambiente, 2010), while 20,000 tons of hazardous waste simply disappear every year, either dumped (on the land or in the sea) or illegally exported to other countries. Despite the complex legal and institutional framework implemented and enforced by the Italian government, several critical "hot spots" still persist, casting some doubt on the effectiveness of criminal enforcement in terms of deterrence. The magnitude of illegal waste activity in Italy as well as the harm it causes to human well-being and the environment, suggest the need to empirically investigate the determinants of waste crime and the effectiveness of enforcement in this area.

The illegal disposal of waste is in fact determined by a variegated set of economic, institutional and policy factors: among others, the development of the region, its institutional 'quality', which relates to factors such as social capital, policy commitment, and the presence of organized crime willing to

obtain profit off of illegal markets. These factors present strong idiosyncratic features that shape each territory in a specific manner. They all contribute to determining the quantitative and qualitative impacts of waste disposal along economic and ecological dimensions.

A flavour of the relevance of regional specificities related to waste performances in a country such as Italy is provided by Figures 1-3, which are illustrative for waste generation, separated collection, and landfilled waste, respectively. Similar heterogeneity can be found in other countries. What is of interest in Italy is, as we will later comment on, its high waste management and policy decentralization, theoretically based upon the rationale of decentralised public good provision (for conceptual insights see Mazzanti and Zoboli, 2013).

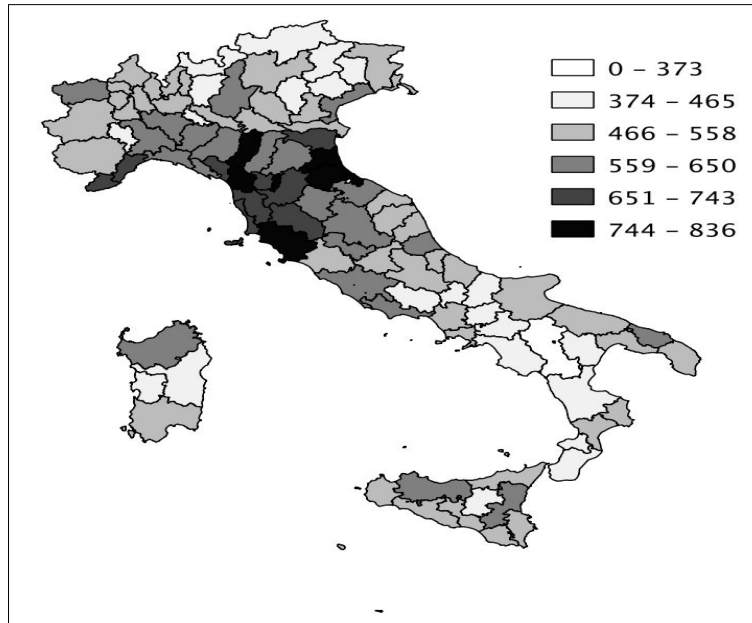


Figure 1 - Municipal Waste Generation. kg per capita (average 2005-2010)

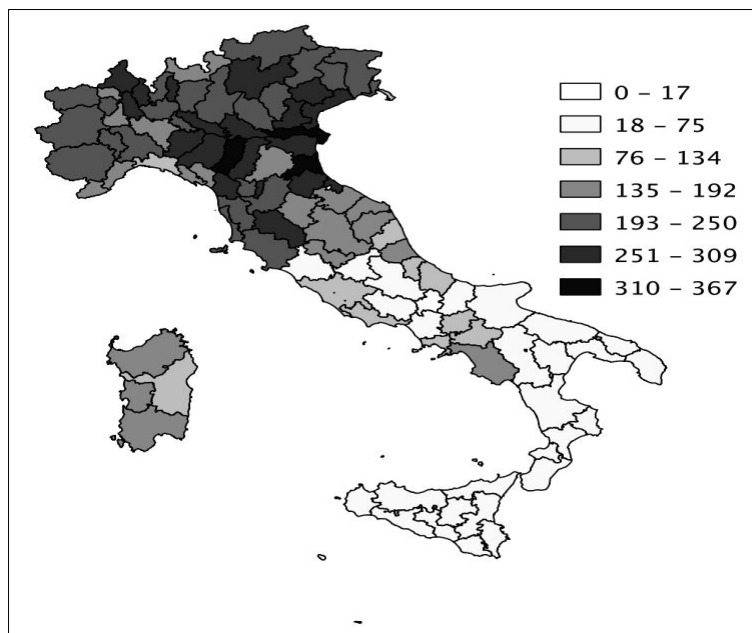


Figure 2 - Separated collection of waste - kg per capita (average 2005-2010)

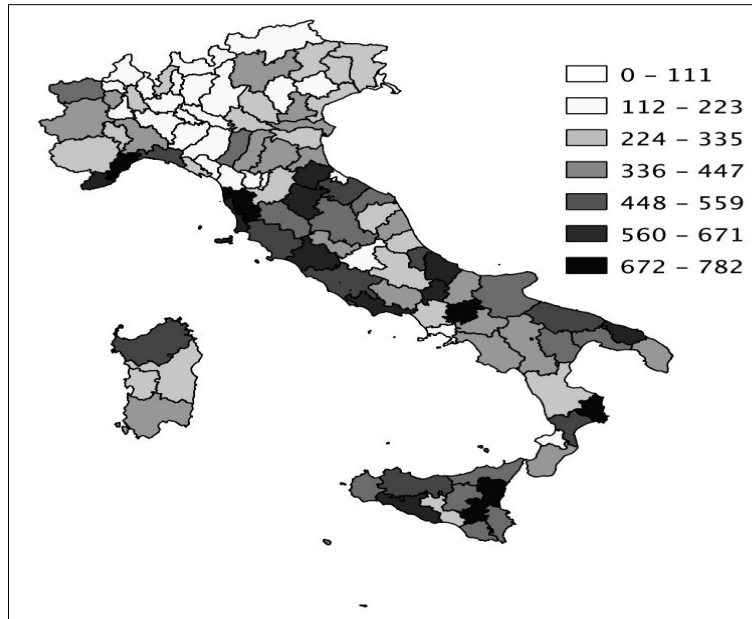


Figure 3 - Landfilled waste - kg per capita (average 2005-2010)

Indeed, with the exception of waste separated collection, a necessary but not sufficient pre condition for recycling and recovering waste, no clear territorial pattern emerges, suggesting that driving forces of waste related performances are more complex than the well-known “north south” divide. A proper identification of local waste performances and, for our purposes, of waste crime determinants has therefore to be searched by looking at idiosyncratic regional and provincial features.

Several studies in the literature empirically test the impact of enforcement policies on the degree of compliance with environmental policy². Among others, Gray and Deily (1996) focus on a subset of forty-one large steel mills in the US during the 1976-1989 period, concluding that enforcement actions significantly affect the degree of firms’ compliance with air pollution regulations. Similar results are obtained in subsequent works by Deily and Gray (2007), focused on the same industry and period, and Gray and Shadbegian (2005), where pulp and paper mills in the 1979–1990 period are scrutinized in order to assess air pollution compliance responses to EPA and state law enforcement actions.

Other works still devoted to the US and addressing water pollution (Magat and Viscusi, 1990; Shimshack and Ward, 2005 and 2008) as well as toxic waste disposal (Alberini and Austin, 2002; Sigman, 2009) find further evidence in support of a deterrence effect of enforcement actions and stricter liability rules.

Most of the existing studies, however, focus on the effectiveness of environmental regulations in the US, with very few exceptions devoted to other countries. This is an important shortcoming in the literature, as it can be expected that countries’ specificities might significantly affect the impact of enforcement efforts (Gray and Shimshack, 2011). Exceptions cover Canadian pulp and paper industry (Doonan et al., 2005), manufacturing facilities in China (Dasgupta et al., 2001) and the impact of criminal sanctions on environmental crimes in Germany (Almer and Goeschl, 2010). In general, however, empirical assessments of the monitoring and enforcement impact of environmental law are particularly scant for European countries (Tosun, 2012). Also, with few

exceptions, most of the works seem to focus on water and air pollutants, leaving solid waste as a minor topic.

Our contribution draws on this still substantially underdeveloped current of literature. We aim at analyzing the deterrence effect of enforcement actions with specific reference to the illegal disposal of waste in Italy and with an eye explicitly focused on the role played by waste policy.

As mentioned above, the Italian case appears to be particularly relevant, due to the extent of illegal practices in waste management and the influential role performed by Mafia-type organizations. The study is further justified by the availability of an originally constructed panel dataset based on two official sources we merge:

- the dataset on waste management performances of Italian provinces and waste policy provided by ISPRA (The Institute for Environmental Protection and Research);
- the dataset on several types of offences related to illegal disposal and enforcement activities constructed by the Forestry Guard, the public entity that is in charge of managing territorial control over illegal waste disposal³.

This original dataset allows us to test the set of hypotheses related to the potential relationships between waste crimes, waste policy and enforcement efforts.

The paper is structured as follows. Section 2 presents the main research hypotheses. Section 3 presents the data and the empirical model. Section 4 comments on the main econometric evidence. Section 5 concludes.

2. Theoretical background and research hypotheses

Under a theoretical point of view, our paper mainly links to the literature on public law enforcement, starting from the seminal papers by Becker (1968) and Stigler (1970), followed by several contributions focused on specific issues and extensions, including the possibility of corruption, of mistakes in the enforcement process as well as of the use of imprisonment as a sanction for illegal behaviour (Polinsky and Shavell, 2000). Environmental economics literature has also turned to explicitly including monitoring and enforcement in the debate concerning policy design issues, starting from Russel et al. (1986).

Focusing on the specific issue of this paper, illegal waste disposal is considered by a number of papers, originating from Sullivan (1987) and Fullerton and Kinnaman (1995), where the possibility of illegal dumping is explicitly accounted for. In subsequent papers, costly enforcement (Choe and Fraser, 1999) and transaction costs (Shinkuma, 2003) are addressed.

As noted in the introduction, the empirical literature that examines the deterrence effect of criminal enforcement for environmental offences is still underdeveloped, with the relevant exception of the literature on environmental enforcement by regulators in the US. An important contribution outside the US is provided by Almer and Goeschl (2010), where the deterrence effect of criminal sanctions for environmental crimes is empirically analyzed with specific reference to 15 German states in the period from 1995 to 2005. Their main findings suggest that criminal sanctions can play a relevant role in deterring environmental offences, affecting significantly environmental crime rates, and that public trials are more effective, compared to the conviction rate and the magnitude of fines.

In this section we draw on some of the suggestions put forward by previous works, in order to explore the possibility of a deterrence effect of criminal enforcement for waste crimes in Italian provinces.

To derive the research hypotheses to be tested empirically, we primarily follow recent works by D'Amato et al. (2011) and by D'Amato and Zoli (2012). Our underlying model is a very simple public enforcement model where risk neutral agents choose their compliance strategy according to the comparison between the benefits from illegal behaviour with expected costs, as determined by the monitoring effort and related sanctions. More specifically, we assume that, coherently with the literature, regulated agents minimize expected compliance costs, given by the sum of legal disposal costs and expected sanctions for illegal behaviour. An increase in illegal behaviour implies, in this theoretical setting, both benefits in terms of the avoided costs of proper disposal, (including the payment of waste taxes, for instance landfill taxes etc.) but also an increase in the expected punishment related costs. The choice of the equilibrium level of illegal disposal will be determined by a standard 'liability' condition where marginal benefits from waste crime equal the related expected marginal costs.

As in many other works, we rely on the number of violations as a proxy of illegal waste behaviour (more details below). On the basis of the conceptual reasoning related to the exploration of the aforementioned literature, we present our key testable implications.

Testable implication H1. A stricter waste policy (e.g. a larger landfill tax, and/or a more diffused incentive based waste management tariff) implies a stronger incentive towards illegal waste disposal.

This conjecture rests on the assumption that illegal waste disposal is mainly induced by economic motivations related to the possibility of savings on legal disposal costs related to the strictness of waste policy (Sigman, 1998), specifically by avoiding tax payments on legal disposal itself. In other words, we can expect that, ceteris paribus, an increase in the tax rate paid on legal disposal (a waste charge or landfill tax, for example) can increase the benefits of illegal disposal and, therefore, lead to a larger incentive towards illegal behaviour (namely, midnight dumping). This is compatible with the standard literature on public law enforcement (Polisky and Shavell, 2000) as well as with existing works testing the role of the strictness of waste policy on legal forms of waste disposal and management (D'Amato et al., 2011), where the possibility of a trade-off between the strictness of waste policy and the criminal waste-related activities is indirectly demonstrated.

Testable implication H2. An increase in the enforcement effort, as measured by the number of controls, brings about a lower number of violations; in other words, enforcement bears a deterrence effect.

We aim at testing whether the monitoring effort is capable of achieving a reduction in illegal waste disposal. In principle, we can expect the number of controls to affect regulated entities' perception of the strictness in enforcement, so that deterrence may result. This is quite reasonable and, again, coherent with the received literature related to law enforcement: an increase in enforcement leads to an increase in the expected costs related to illegal disposal and, as a result, to a decrease in illegal waste disposal.

On the other hand, the deterrence hypothesis cannot be taken for granted in countries such as Italy. As Gray and Shimshack (2011) underline, the specific institutional features of a country, as well as its level of development, might affect how enforcement effort translates into effective deterrence.

Under the point of view of existing legislation, in Italy waste crime punishment is subject to Decree 22/97 (art. 53bis, now art. 260 of the Italian Environmental Code, d.lgs 152/2006), accounting for crimes related to waste trafficking (“Attività organizzate per il traffico illecito di rifiuti”) and including the possibility of imprisonment for up to 8 years. Of course, the overall impact of these provisions on actual waste crimes depends crucially on controls and on the local implementation of waste policy⁴.

At the same time, anecdotal evidence on Italy suggests caution. As data from Legambiente (2010) shows, in relatively homogenous areas of the country, a greater number of crimes can be associated to a greater number of controls, casting some doubt on the deterrence effect of law enforcement vigilance; for example, the region of Tuscany (central Italy, capital Florence) features more controls per square kilometre than Emilia Romagna and, at the same time, a larger (lagged) incidence of crimes per square kilometre; the same reasoning can be applied to Lazio (capital Rome) and Marche (eastern-central Region, capital Ancona)(see Tables 1 and 2 in D’Amato and Zoli, 2012).

Clearly, the investigation of the impact of enforcement choices must take into account all the caveats outlined, among others, by Gray and Shimshack (2011). We refer, in particular, to the issues of potential reverse causality and the difficulties in measuring the perception of enforcement stringency by regulated agents; the consequences of these estimation problems on our empirical results will be discussed in section 4. The next section describes, instead, the data and introduces the empirical setting.

3. The data and the empirical model

The dataset we exploit derives from the merger of two official datasets: ISPRA panel data on waste management and disposal indicators by province, and the Forestry Guard panel dataset on illegal disposal instances and enforcement activities. This merger leads to a balanced panel dataset of 86 provinces (out of 103 in Italy) observed over 6 years⁵. Data are constructed bottom up from local Forestry Guard offices, which then communicate data to central levels. As in other cases of decentralized implementation, data generation is an ancillary but important factor of the monitoring and enforcement action. We employ various econometric models to test and provide sensitivity analysis in relation to the following reduced form specification:

$$(1) \text{ crime}_{it} = \alpha_i + \text{enforcement}_{it} + \text{enforcement}_{it}^2 + \text{policy}_{it} + \text{population density}_{it} + \text{Value added}_{it} + \text{Landfill Ratio}_{it} + \varepsilon_{it}$$

On the basis of the information provided by the Forestry Guard, we consider different typologies of ‘waste disposal related crime’⁶, and use them, in turn, as a dependent variable. The main measure of crime we adopt is that of discovered criminal violations (‘reati’), which are mostly linked to illegal waste trafficking and disposal and to the violation of Directives 91/689/CEE on packaging and 91/156/CEE on waste. We also perform our analysis by adopting as dependent variable each of two other different measures of waste related crime, namely reporting / charge (‘denuncia’), and requisition (‘sequestro’)⁷. All these are related to penal crimes.

Moving on to the regressors, α_i is the provincial level fixed effect, enforcement is proxied by the

number of waste related controls performed by the Forestry Guard every year at the provincial level. Population density is used to control for different anthropic pressures on the waste system. It is a common control variable in empirical waste studies (Mazzanti and Zoboli, 2009) and can be either positively or negatively correlated with waste management performances depending on factors such as economies of scale and land opportunity costs in urban and densely inhabited areas. Provincial value added, being positively correlated with income (for which provincial level data are not available), controls for structural differences among provinces, and is again a very common control variable in empirical analysis on waste management performances (see, among others, Mazzanti et al., 2012). As a policy variable we adopt the share of population living in municipalities where the waste policy regime has moved from being based on a waste tax to the adoption of a waste tariff. In the last years Italy has undergone a transition from the old taxation system (TARSU, Tassa sui Rifiuti Solidi Urbani) to the new Italian waste tariff, TIA (Tariffa di Igiene Ambientale)⁸. The TARSU was simply related to the size of household living space, and did not follow strict cost-recovery or polluter pays principles. Instead, TIA should move waste management towards a full-cost pricing/polluter pays principle based system. The tariff is composed of two elements: a fixed element, which covers the fixed costs of waste management (such as street cleaning costs), and a variable element, which covers the variable costs of this service, such as the costs of waste collection and disposal. We can consider its adoption as the best available proxy of the overall commitment that municipalities put towards waste management issues⁹. Finally, we added the ratio between the total amount of waste disposal and the provincial level of waste generation, to control for the technological composition of local waste management. Despite the rapid transformation that the national waste system has experienced in the last decade, there are striking differences across Italian provinces, with some laggard areas still relying heavily on disposal and some richer (generally northern) provinces characterized by the absence of disposal and share of recycling close to 50% (See again Figures 2 and 3).

Table 1. Descriptive Statistics

Acronym	Variable Description	N	Mean	Min	Max
Violations	Criminal violations (Dependent Variable)	516	18.79	0	158
Charges	Reporting/Charge (Dependent Variable)	516	20.15	0	368
Requisition	Requisition (Dependent Variable)	516	8.62	0	391
Control	Controls by the Forestry Guard (Rescaled in the analysis: divided by 1000)	516	699.16	0	3799
Copcomtar	Share of municipalities that introduced waste tariff substituting the former waste tax (%)	516	12.91	0	100
Popdens	Population/surface (inhabitants/km ²)	516	276.18	48.73	2635.59
Value Added	Provincial yearly value added per capita (€2000) (Rescaled in the analysis: divided by 1000)	516	19539.04	8788.46	30479.08
Land Ratio	Share of Landfilled waste on total Waste management (Landfilled Waste / Total Waste Generated)	516	0.51	0	4.69

Table 1 presents the main descriptive statistics, including Forestry Guard controls and the share of Municipalities in the province that have shifted to the new waste tariff (the two main covariates by which we test H1 and H2).

4. Econometric evidence

In this Section we provide the main results of our empirical investigation. To account for the count nature of our dependent variables, we choose to adopt fixed effect negative binomial estimation techniques. Using a fixed effect Poisson estimator could be an alternative possible choice, but the presence of over dispersion in the data strongly supports the choice of a negative binomial model. Table 2 below presents the core results for the four dependent variables. We also performed additional analysis by developing a multidimensional indicator of environmental crimes, through principal component analysis.

Other models are then used as robustness checks (to cope with reverse causality problems). Estimates from the negative binomial model show the effect of waste tariffs (which is the empirical counterpart of testable implication H1) and enforcement efforts (to test H2) on waste related crimes. As far as H1 is concerned, we cannot reject the hypothesis that stricter environmental policy tends to favour the emergence of illegal disposal, with the exception of charges (Column 2), for which the effect is not significant. This poses a problem in the overall effectiveness of waste management: even if it is true that more diffuse incentive based policy instruments such as waste tariffs might positively correlate to better waste management and disposal performances (Mazzanti and Montini, 2013), drawbacks (in terms of greater illegal disposal practices) are possibly present. In other words, the trade-off stemming from existing literature between waste policy strictness and incentives towards illegal behaviour is highlighted by our estimates.

The most unexpected result in our setting is indeed linked to the effect of law enforcement on waste related crime: estimation results show the existence of a bell shaped relationship between waste crimes and enforcement efforts. This suggests that controls presumably catch up with criminal activities at least up to a certain level of enforcement. After the turning point, however, deterrence effects become visible and our hypothesis H2 cannot be rejected. Contrary to the bulk of the existing literature, then, we find that in most of the Italian provinces policy controls related to illegal disposal practices do not exert significant deterrence on criminal behaviours. A negative relationship between enforcement and waste crimes can be identified only for very high levels of enforcement efforts, which are reached in very few Italian provinces. This is shown in the following maps (Figures 4, 5 and 6), where red (blue) colour depicts a province featuring a number of controls (average 2005-2010) lower (larger) than the estimated turning point, and darker colours stand for a greater (absolute value of) the difference between the average number of controls and the estimated turning point. As it clearly emerges from Figures 4 to 6, the number of provinces where average controls exceed the estimated turning point is quite small, while in most of the provinces much more effort appears to be needed in order to reach a deterrence effect. These conclusions are robust across different crimes.

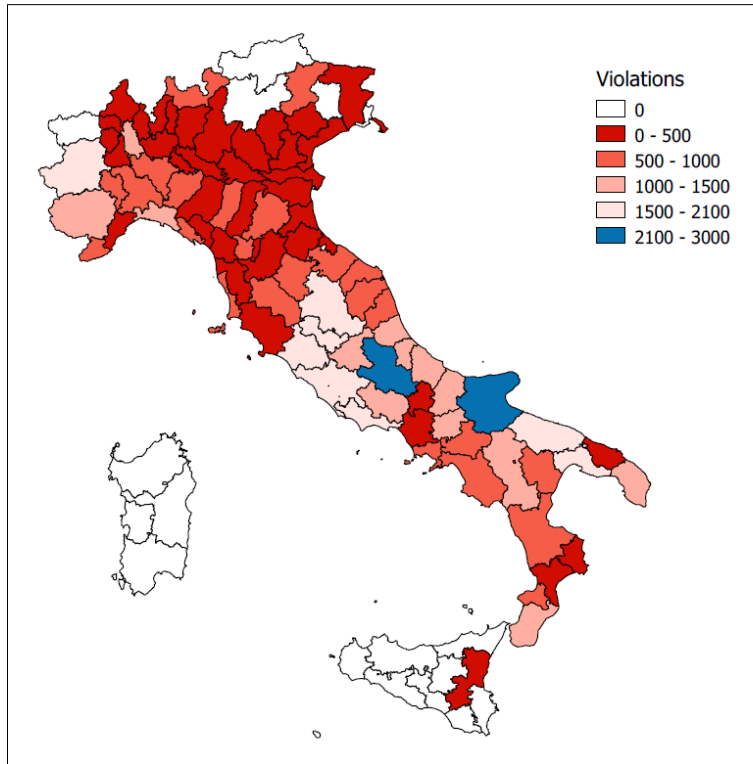


Figure 4—Provincial controls (average 2005-2010) as compared to estimated turning point – violations
Legenda: Blue – number of controls above estimated TP; Red – number of controls below estimated TP

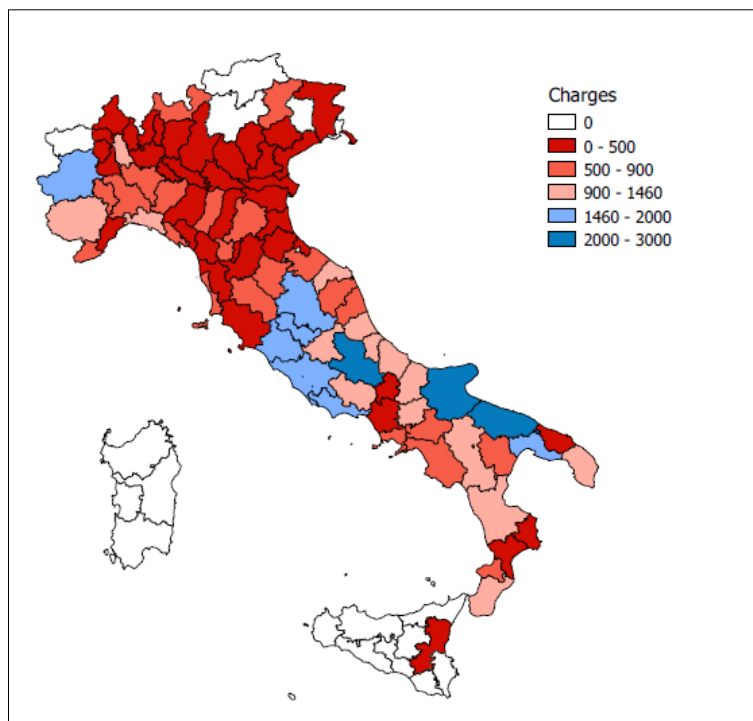


Figure 5—Provincial controls (average 2005-2010) as compared to estimated turning point – charges
Legenda: Blue – number of controls above estimated TP; Red – number of controls below estimated TP

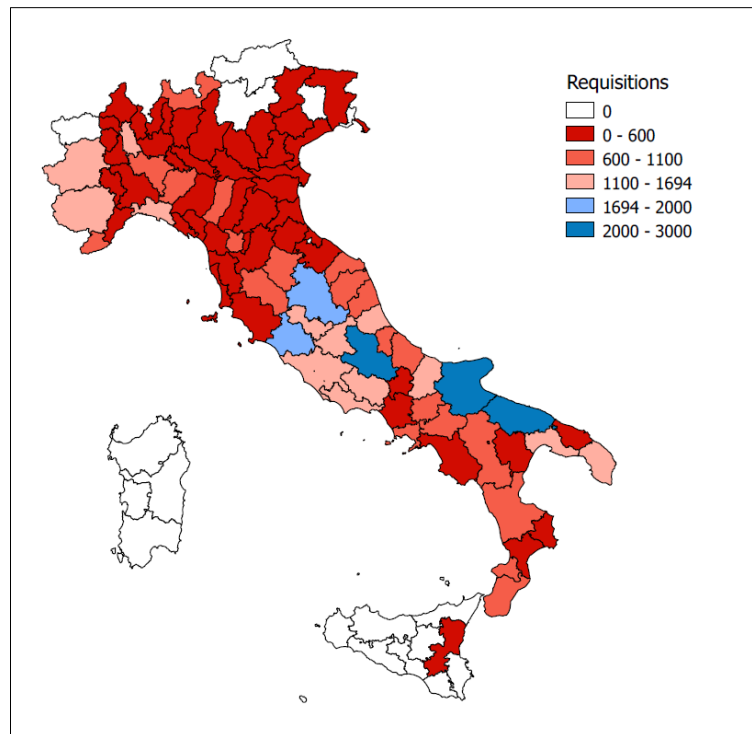


Figure 6—Provincial controls (average 2005-2010) as compared to estimated turning point – requisitions
Legenda: Blue – number of controls above estimated TP; Red – number of controls below estimated TP.

As anticipated in section 2, a possible problem in testing the existence of a deterrence effect is related to the potential presence of a reverse causality effect (from illegal behaviour to controls and not vice versa, a source of endogeneity) and the issue of measuring the perception of monitoring and enforcement efforts by regulated agents (Gray and Shimshack, 2011).

Table 2. Illegal disposal drivers – Negative Binomial estimations.

	Violations	Charges	Requisition
Control	1.1326*** (0.1893)	1.2216*** (0.2211)	1.1750*** (0.2583)
Control squared	-0.1482*** (0.0472)	-0.2183*** (0.0623)	-0.1792** (0.0753)
Copcomtar	0.0091** (0.0036)	0.0050 (0.0038)	0.0109** (0.0049)
Popdens	-0.0000 (0.0003)	0.0002 (0.0003)	0.0008** (0.0004)
Value Added	-0.0293 (0.0180)	-0.0047 (0.0189)	0.0188 (0.0196)
Land Ratio	-0.0437 (0.0645)	-0.0327 (0.0828)	0.0705 (0.0872)
Turning Point	2100	1460	1694
Country FE	Yes	Yes	Yes
N	504	504	510

Standard errors in parentheses

* $p < .1$, ** $p < .05$, *** $p < .01$

Table 3. Robustness checks– lagged control (columns 1-3, estimated via negative binomial) and composite crime index as dependent variable (Column 4, estimated via OLS).

	Violations	Charges	Requisition	Factor
Control				2.44798*** (0.6853)
Control squared				-0.1909*** (0.0627)
Copcomtar	0.0083** (0.0040)	0.0012 (0.0043)	0.0157*** (0.0055)	0.0172*** (0.0049)
Popdens	-0.0002 (0.0003)	0.0001 (0.0003)	0.0008* (0.0004)	0.0086 (0.0101)
Value Added	-0.0530** (0.0212)	-0.0470** (0.0225)	0.0101 (0.0214)	0.0615 (0.0770)
Land Ratio	-0.0663 (0.0662)	-0.0460 (0.0818)	0.0812 (0.0933)	-0.1466 (0.2546)
Lagged Control	0.9378*** (0.2164)	0.9056*** (0.2662)	0.7036** (0.3136)	
Lagged Control squared	-0.1513*** (0.0577)	-0.2143** (0.0846)	-0.1383 (0.0966)	
Turning Point	1633	1050	-	3300
Country FE	Yes	Yes	Yes	Yes
N	420	420	425	516

Standard errors in parentheses

* $p < .1$, ** $p < .05$, *** $p < .01$

To mitigate flaws depending upon simultaneity, we perform robustness checks by using lagged enforcement variables (Columns 1-3, Table 3). Also in this case results are fairly consistent with the main specifications in the cases of violations and charges. As far as requisitions are concerned, at the opposite, the quadratic relationship is not significant and deterrence never arises.

Finally, we also consider a composite indicator of waste crime derived by applying a principal component analysis (PCA) on the three variables of criminal offences.

One of the main advantages of applying a PCA is its ability to synthesize in one or more sub-indexes the variability of an original set of variables. Specifically, the application of this technique allows the researchers to reduce the multiplicity of the original variables into a smaller number of variables, called components, each of which represents a share of the variance in the original data. In particular, the first component accounts for the greatest share of variability among the original variables, the second one for the greatest share of the remaining variability, etc. For this reason, this technique is often used in all cases, like ours, in which researchers seek to synthesize in a single index the overall variability of a wider set of data. In this case the PCA produced only one component associated with an eigenvalue bigger than one (1.97) which accounts for slightly more than 65% of overall variance, as it is shown in table 4. The table also displays the factor loading values, indicating a quite satisfactory correlation of crime measures with the factor arising from the PCA, especially for violations and charges.

In the fourth column of Table 3 we present a fixed effect (FE) estimation using as dependent variable the multidimensional indicator. Consistently with the main empirical evidence reported in Table 2, both testable implications H1 and H2 are not rejected also when the multidimensional

indicator of waste crime is considered, even though in this case the turning point is significantly higher and close to the 90% of the control distribution.

Table 4. PCA Analysis

Crime measure	Factor loadings
Violations	0.9221
Charges	0.8825
Requisitions	0.5854
EigenvalueFactor 1	1.97193
Share of varianceexplained	0.6573

The overall evidence thus suggests two main relevant conclusions: a trade-off between the strictness of waste policy and enforcement effort is present in most of the estimates. This is coherent with the idea that opportunities for implementing stricter waste policies, and specifically, for authorities to commit to incentive-based policy, is bounded due to the existence of illegal behaviours and organized crime.

A second and more surprising result stems from the fact that enforcement of waste management regulation in Italian provinces does not feature a deterrence impact, contrary to the bulk of existing literature. Indeed, we get in most cases a bell shaped link between controls and illegal behaviour, suggesting that to achieve deterrence a sufficiently high level of controls has to be put in place. This comes as a support to the idea that the effectiveness of environmental enforcement might well depend on the geographical context as well as on the environmental problem at hand (Gray and Shimshack, 2011). The possibility for the monitoring effort not to be effective in reducing waste crime might also be explained by considering that Italy still lacks a structured set of laws and legal/economic instruments to cope with environmental crimes. The EU 2008 Directive (99/2008 EC) was formally adopted, but lacks concrete and sufficient implementation instruments (e.g. penalties that are proportional to the environmental damage). As a result, increases in monitoring efforts might not get the desired deterrence effect yet due to the lack of credibility of the “punishment phase”.

5. Conclusions

This paper conceptually and empirically addresses the drivers of illegal waste disposal at a decentralised level of government. This investigation is particularly relevant as far as waste disposal problems are concerned given the territorial structure of waste management policies and controls (enforcement) in many countries. Italy is a compelling example, given the rich heterogeneity it presents across provinces, which also relates and eventually leads to diverse environmental performances. Waste management policies and enforcement activities both operate at the local level, often in absence of coordination, given that different policy makers are responsible for the implementation of controls aimed at tackling illegal disposal on the one hand, and at supporting

better management and disposal performances on the other. In Italy, the Forestry Guard (a corps under the jurisdiction of the Ministry of Agriculture, divided regionally), together with other police forces, is responsible for enforcement; municipalities and provinces, are responsible of implementing waste policy to achieve waste management objectives.

We find that enforcement activities, that is the control and monitoring of the territory, and waste management policies need to be, to some extent, 'complementary'. Namely, they need to reinforce each other in a context where two goals have to be pursued: enhancing waste management practices and tackling 'midnight dumping' side effects.

In this paper we provide two important pieces of evidence in this respect. First, under a 'policy mix' point of view, we show that our theoretical hypothesis suggesting that more diffuse incentive based waste management policies do increase illegal disposal cannot in general be rejected. As a result, stricter levels of territorial enforcement by police corps are needed to compensate the negative - but somewhat unavoidable - spillovers related to waste policy choices. Second, our econometric analysis provides evidence that enforcement, though non linearly related to illegal disposal, is effective in reducing waste crimes if the strength of monitoring effort is sufficiently large (i.e. when the number of controls is sufficiently high). This means that a relatively strict enforcement is necessary to reduce illegal disposal when waste policies aim at increasing recycling and reducing legal disposal of waste. Our results also suggest that more effort will be needed in most Italian provinces in order to enhance deterrence in the waste realm. Future research might add further insights by increasing the level of detail of policy actions, and by extending the analysis of illegal waste phenomena to the explicit modelling of spatial features.

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¹As indicated by UNEP and the Green Customs Initiative, “national and international crime syndicates worldwide earn an estimated US\$ 20–30 billion dollars annually from hazardous waste dumping, smuggling proscribed hazardous materials, and exploiting and trafficking protected natural resources” (<http://www.greencustoms.org/background/>) (last accessed 22/11/2013).

² An extensive survey on this issue is provided by Gray and Shimshack (2011).

³ The Forestry Guard (CorpoForesta dello Stato) is a police corp (falling under the jurisdiction of the Ministry of Agriculture), which includes, among its main aims, that of contrasting environmental crimes, including illegal waste trafficking and disposal.

⁴Subsequent attempts have been made to introduce environmental and specific waste crimes in the Criminal Code (Book II, Section VI bis, crimes against the environment), specifically through a Government bill in April 2007 (Government ddl 24/4/2007). Various articles referred to environmental crimes including the introduction of the ‘organized environmental crime’ (eco-mafia) notion, and the related penalties. Since governmental bills need to pass a parliamentary vote, the end of the Prodi Government prevented from introducing those crimes in the criminal/penal code.

⁵We have omitted 17 provinces due to missing data in the Forestry Guard dataset.

⁶ As codified by the Forestry Guard register. More information is available upon request. All data is available for replication.

⁷ Italian terms in brackets.

⁸The new waste management tariff was introduced by Italian Law No. 22/1997, and should in theory substitute the former waste management tax. The tax, however, is still in force in many Italian municipalities because law 22/1997 allows for a transition phase that has shown to be quite gradual and slow. The tax was calculated on the size of household living spaces, while the tariff is based on principles of full-cost pricing for waste management services and delivers some market-based incentives to the system.

⁹The very recent evolution of waste policy has led to changes in the waste tax/tariff regimes. These changes are, however, not relevant for our empirical analysis, as the time horizon of our data ends up in 2011.