Fighting crime for improved recycling: evaluating an anti-mafia policy on source separation of waste.

Baraldi, Anna Laura and Cantabene, Claudia and De Iudicibus, Alessandro

University of Campania L. Vanvitelli

15 November 2023

Fighting Crime for Improved Recycling: Evaluating an Anti-Mafia Policy on Source Separation of Waste [*]

Anna Laura Baraldi[†]   Claudia Cantabene[‡]   Alessandro De Iudicibus[§]

Abstract

It is well documented that organized crime heavily affects the waste management system. This paper focuses on examining the impact of Law 164/1991, one of Italy's most stringent measures against organized crime. The law, designed to counteract suspected mafia infiltration by mandating the dissolution of city councils, is investigated for its role in reinstating a more efficient waste management system. This involves an increase in selective waste collection for recycling purposes. We exploit the staggered enforcement of Law 164/1991 to show that both the percentage and the per-capita tonnes in selective waste collection, measured for municipalities in Apulia, Calabria, Campania and Sicily, increase sharply starting from the first election after compulsory administration in dissolved municipalities compared to the control group of those never dissolved; the average treatment effect of the anti-mafia policy is measured in a 5 percentage points and 17.5 Kg increase in the percentage and in per-capita tonnes of selective waste collection, respectively. This outcome is influenced by the city council dismissal, as it severs the connections between organized crime and local politicians. The resulting refreshed pool of elected officials, characterized by lower levels of corruption, then implements policies that are unfavorable to organized crime. This leads to a more effective allocation of public funds in sectors specifically targeted by organized crime, such as waste management.

[†]Department of Economics, University of Campania L. Vanvitelli, C.so Gran Priorato di Malta 81043 Capua, Italy. E-mail: annalaura.baraldi@unicampania.it. Corresponding author.

[‡]Department of Economics, University of Campania L. Vanvitelli, C.so Gran Priorato di Malta 81043 Capua, Italy. E-mail: claudia.cantabene@unicampania.it.

[§]Department of Economics, University of Campania L. Vanvitelli, C.so Gran Priorato di Malta 81043 Capua, Italy. E-mail: alessandro.deiudicibus@unicampania.it.

1 Introduction

Waste is an inherent outcome of human existence, with all human endeavors producing varying quantities of waste. Globally, effective waste management services play a crucial role in promoting societal well-being and ensuring the environmental sustainability at both local and national levels. Often, it is inefficiently organized, in the aspect of effective collection, transport, recycling, and disposal. Inadequate waste management not only leads to widespread litter but also has adverse effects on the environment, causing air and water pollution. Thus, careless waste disposal directly contributes to climate change by releasing carbon-based particles into the air through the combustion of petroleum products. Moreover, scholars emphasize the impact of source separation of waste as a crucial factor in promoting increased reliance on recycling (Lavee, 2020).

Especially in Italy, evidences suggested that the illegal system interesting waste sector is powered by the interaction between organized crime, waste producers, corrupt local authorities and supervisory entities (Abrate et al., 2015, D'Amato et al., 2013). In particular, the "waste crisis", interesting southern Italian regions in the last decade,[1] caused severe problems in the waste management systems, with heavy consequences on human health and worsened environmental quality.[2] Such "waste crisis" offered rooms for the infiltration of mafia-type organizations[3] in the waste sector, that are considered the biggest perpetrator of environmental crimes (D'Alisa et al., 2015). Therefore, the presence of mafia in a territory may affect policy and waste management choices, interesting primarily the recycling and landfilling. As a consequence, accounting for the effect of the presence of organized crime in a area on the waste management system is a great concern for policy makers given the greater amount of unauthorized waste disposal (than sorting waste collection) overseen by mafia to collect higher rents (Abrate et al., 2018, Cesi et al., 2019).

Despite the significance of organized crime's involvement in the Italian waste management system, there is a scarcity of empirical studies examining this issue. Specifically, given that the environmental crimes ground on the insufficient allocation of economic resources to crime prevention and control, coupled with the lack of powerfully policies contrasting the significant interaction and collusion between political parties and organized crime, the exam of the effectiveness of enforcing laws represents a crucial research inquiry. In this paper we aim at filling this gap by empirically investigating the effect of the enforcement of a specific Italian anti-mafia measure, Law 164/1991, still in force, which decrees the city council dismissal

---

[1]See, for example, the waste conflict afflicting the metropolitan area of Naples (D'Alisa et al., 2010).

[2]The illegal waste business in Italy has reached a turnover of approximately 9 billion euros in 2022. In the same year, there were 5,606 crimes related to the waste cycle, and 6,087 individuals were reported. Approximately the 45% of such crimes occurred in the four southern Italian regions of Apulia, Campania, Calabria, and Sicily, characterized by the higher presence of mafia activity (Legambiente, 2023).

[3]Typically, the mafia-type organizations are the Camorra in Campania, the 'Ndrangeta in Calabria, the Sacra Corona Unita in Apulia and the Mafia in Sycily. In the paper, for simplicity, we will refer to mafia to deal with all the previous form of organized crime.

for suspected mafia infiltration, on the waste management choices and performances. The dissolution of the local government and the appointment of external commissioners to oversee the municipality for a duration of 12 to 24 months (referred to as compulsory administration) serves as an external disruption to the presence and activities of organized crime within the city. This scenario establishes circumstances that can be analyzed as a quasi-experimental framework, allowing for the categorization of municipalities into a treatment group (those that have been dissolved) and a control group (those that have never undergone dissolution).

Our empirical analysis estimates a panel data model, for Italian municipalities in the four regions of Apulia, Calabria, Campania and Sicily most plagued by organized crime (and where the 95% of city council dismissals are concentrated), of the effectiveness of the enforcement of Law 164/1991 on measures of selective waste collection in years from 2010 to 2019. By comparing the selective waste collection in municipalities subject to the anti-mafia policy (the treatment group) with those that are not affected by it (the control group), a more precise distinction can be made between the impacts of the policy and the influences of potential confounding factors.

We, firstly, employ the Difference-in-differences (DiD) estimator to calculate the average impact of the enforcement of Law 164 on selective waste collection; we exclude any effect related to trend or seasonal factors by using year fixed effects. We measure selective waste collection, at municipal level, by: 1) the percentage of selective waste collection; 2) the per-capita tonnes in selective waste collection. This first set of estimates shows that both the measures of selective waste collection increase significantly, on average, in the treatment group compared to the control group of municipalities after compulsory administration. Specifically, the increase of the percentage in selective waste collection reaches about 5 percentage points (in the full specification) while that of the per-capita tonnes in selective collection is about 0.0175 (i.e., 17.5 Kg).

Secondly, the fully dynamic model (event study) reveals that the two measures of selective waste collection increase sharply when new elections after compulsory administration are held. Moreover, the dynamic pattern of the selective waste collection in treated and control municipalities displays no-anticipatory affect of Law 164, reassuring about the validity of the parallel trend assumption.

The results are not affected by the potential treatment effect heterogeneity, as the test provided by De Chaisemartin and d'Haultfoeuille (2020) shows. Moreover, the matched diff-in-diff analysis as well as several robustness checks confirm the results.

The most likely mechanism behind these findings reflects the literature that documents that the enforcement of Law 164, by removing the allegedly corrupt politicians and replacing them with external commissioners, gives a strong signal that mafia infiltration in local government is no longer tolerated (Fenizia and Saggio, 2023). Accredited literature showed that after the dismissal, the new elected council is composed by more highly educated, younger, more female politicians (e.g., Daniele and Geys, 2015; Baraldi et al., 2022a; Baraldi and

Ronza, 2022) that are typically less inclined to be corrupted. Consequently, they are more likely to promote a more efficient allocation of public funds in sectors targeted by organised crime, as waste management sector (e.g., Di Cataldo and Mastrorocco, 2022; Ravenda et al., 2020).

Compared to the existing literature documenting the link between organized crime and waste management, this study improve in evaluating the effect of a specific anti-mafia measure on selective waste collection; moreover, it grounds the analysis at the lower level of Italian government, the municipalities, rather than at provincial or regional level, as previous studies have done. Looking instead at the specific literature on the effect of corruption on the waste collection, this research also contributes by analysing the effect on waste management of a measure that removes allegedly corrupt politician from office and substitutes them firstly, with external commissionaires, and, then, with more honest politicians.

The rest of the paper is organized as follows. Section 2 describes the prescription of Law 164/1991. In Section 3 we present the variables of the analysis. Section 4 illustrates the empirical strategy and Section 5 presents the empirical evidence on the effect of the enforcement of Law 164/1991 on the measures for selective waste collection and sets out the discussion of the results. Section 6 provides some sensitivity analysis and robustness checks. Section 7 concludes.

2 Law 164/1991

Law 164, disciplining the city council dissolution because of mafia infiltration in the local government,[4] is one of the strongest measure adopted by the Italian government to fight the widespread corruption, particularly at the local level, beginning in the 1980s.

Against this backdrop, in 1991, the Italian Parliament approved Law 164, one of its most aggressive measure for fighting organized crime. Law 164 prescribes that the national government can decree the dismissal of a city council when evidence emerges regarding direct or indirect links between members of that council and criminal organizations. Typically, the process starts when the police investigation identifies a link between officials in city council and organized crime. The *Prefetto* (an officer of the Ministry of Interior), after gathering the evidences emerged during the investigation, appoints a commission responsible to establish, within 3 months, whether the local government is likely to be liable to prosecution.[5] Finally, if the final report documented a personal connection between criminal organization and local politics, a parliamentary commission of the Ministry of Interior ("Commissione Parlamentare Antimafia") proposes the dissolution of the corrupted administration to the

---

[4]In Paragraph "Local political institutions in Italy" in Appendix we summarize the features of local political institution in Italy.

[5]The central government investigation, which is kept secret until finalized, is not linked to financial and political characteristics of municipalities.

President of the Republic, who issues the official decree of municipal dissolution. When a local government is dissolved and upon new election for the removal of the city council, a "compulsory administration" composed by three external commissioners (with full legislative and executive power) manages the municipality for the following 12–18 months, possibly extended to 24 months.[6]

The enforcement of Law 164, by providing a sharp exogenous variation in the level of mafia infiltration in local government, allows us to shed light on the causal effect of organized crime infiltration in local government on the efficiency of municipal management, of which selective waste collection belongs to.[7]

3 Data and variables

3.1 Main regressor

The main regressor in the empirical analysis is a variable for the city council dissolution. In Italy, there were 81 dissolved administrations between 2010-2019, as Table 1 shows.[8]

Table 1: City council dismissal by regions

Region	City council dismissals
Calabria	39
Campania	8
Sicily	21
Puglia	9
Piemonte, Lombardia, Liguria, Emilia Romagna	1
Rest of Italy	0
Total	81

Note. The table displays the number of dissolved administrations among those elected from 2010 to 2019 in Italy by region. Piemonte, Lombardia Liguria, Emilia Romagna experienced 1 dissolution each.

The regions of Campania, Calabria, Sicily and Puglia count 77 dismissals, corresponding to the 95% of Italian city council dismissals. 10 municipalities in our database have been dissolved more than once. In order to achieve the highest degree of homogeneity in the sample of municipalities (which helps reducing estimation bias in terms of unobservables), we concentrate the baseline analysis on these four regions.[9] However, for robustness, we will deal with the Italian municipalities as a whole.

Figure B.1 (Panel B.1a) in Appendix B shows the number of mafia-related dissolution by year.

The enforcement of Law 164 allows to identify the dissolved municipalities as the treatment group and the undissolved municipalities as the control group. Figure 1 displays the

---

[6]The commissioners are public officials that, generally, come from a different geographical area to minimize potential connections with the dismissed administration.

[7]The paragraph "Mafia and waste management" in Appendix provides details on the involvement of organized crime in the municipal waste management.

[8]Data on city council dissolution comes from the Italian Ministry of Interior.

[9]Our choice also follows that of the greatest part of the recent empirical work dealing with the city council dissolution (Baraldi et al., 2022b,c, Daniele and Geys, 2015, Di Cataldo and Mastrorocco, 2022).

geographical distribution of municipalities in both the groups.

Figure 1: Geographical Distribution of Municipalities in Treatment and Control Groups

(a) *Apulia*

(b) *Calabria*
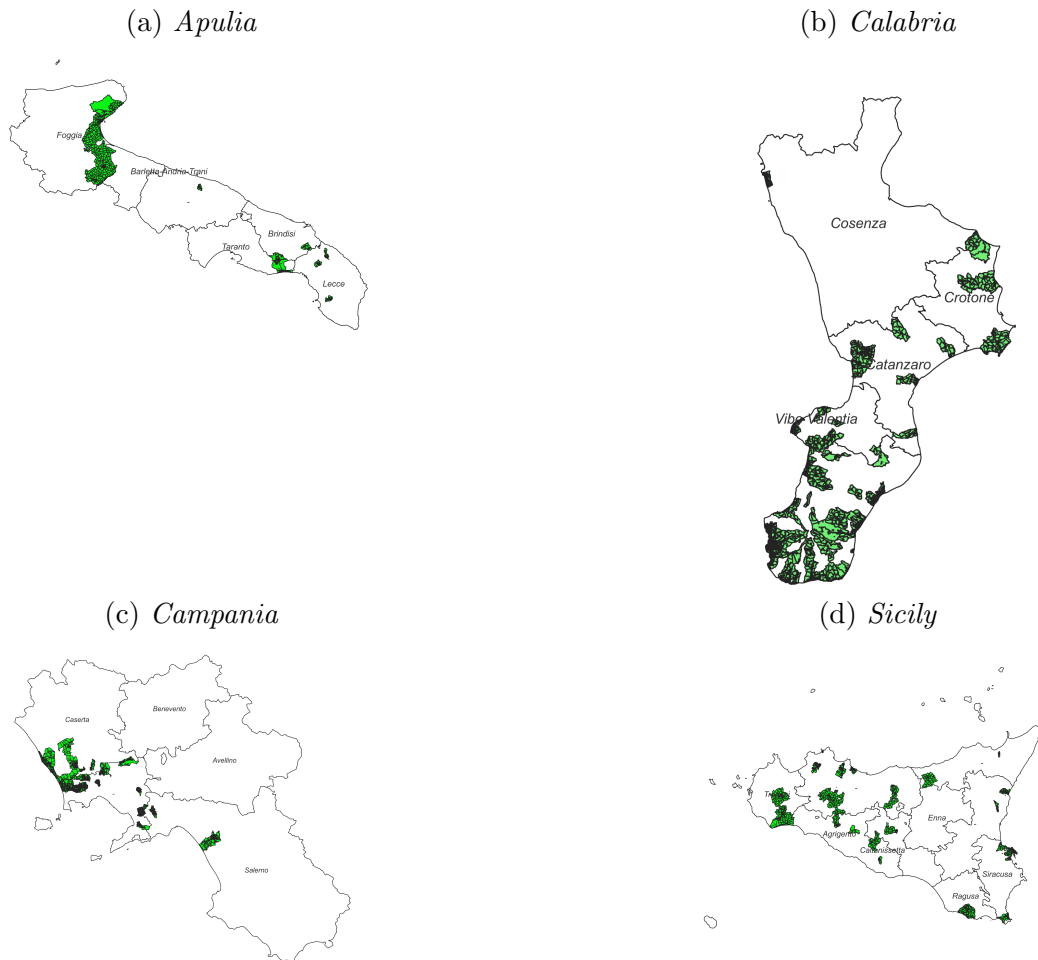
(c) *Campania*

(d) *Sicily*

Note. The Figure report the geographical distribution of municipalities in the treatment and control group in the regions of Apulia, Calabria, Campania and Sicily. The green color indicates municipalities in the treatment group; the white color indicates municipalities in the control group. Period: 2010-2019.

In the empirical analysis the regressor measuring the mean impact of the law's enforcement is *Law 164*, which equals 1 for treated municipalities in all of the years between the dissolution and the end of the time span (2019) and 0 in the period before. For never dissolved (untreated) municipalities, it is equal to 0 for the entire time span of our data set.

3.2 Dependent variables

Data on waste come from the *Istituto Superiore per la Protezione e la Ricerca Ambientale* (ISPRA), an institution under the supervision of the Minister for Environment and Energy Security ("Ministro dell'ambiente e della sicurezza energetica"). We collect yearly data on waste at the municipal level in Italy from 2010 (the first available data) to 2019.[10]

---

[10]The paragraph "Guidelines of urban waste management" in the Appendix contains details on the municipal waste management guidelines.

The dependent variables in the empirical analysis are 1) the percentage of selective waste (the ratio between the weight of selective waste and the total weight of waste collected) and 2) the tonnage of selective waste collection per-capita.

Figure 2: Trend, over years, of the percentage of selective waste and per-capita tonnes of selective waste collection in Apulia, Calabria, Campania, and Sicily. 2010-2019

(a) Percentage of selective waste

(b) Per-capita selective waste
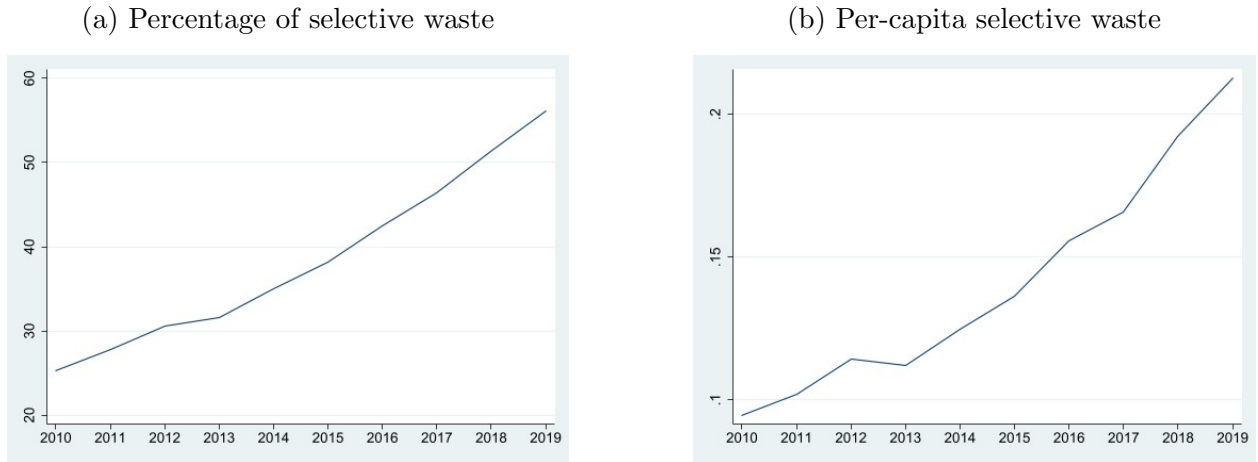
Note. The graphs report the mean, over municipalities, of the percentage of selective waste collection (Graph 2a) and of per-capita tonnes of waste collected (Graph 2b). Years 2010-2019.

Figure 2 shows the curve of the mean, for the sample municipalities, of the percentage of selective waste collection (Graph 2a) and of the per-capita tonnes of waste collected (Graph 2b). The increase in the percentage of selective waste collection is striking: from 25% in 2010 to about 55% in 2019. The same striking increase is visible for the per-capita tonnes of selective waste collection during the period of analysis. In Figure B.2 in Appendix B we show the mean curve, over all the Italian municipalities, of both the percentage and the per-capita tonnes of selective waste collection.

Figure B.3 in Appendix B shows the mean (over municipalities in the same region) percentage of selective waste collection and per-capita tonnes in selective waste collection in the four regions under analysis of Apulia, Calabria, Campania and Sicily.

Table 2 shows the descriptive statistics for the total amount of selective waste and of each type of selective waste in the sample.

Table 2: Descriptive statistics

	Obs	Mean	Std.Dev.	Min	Max
Percentage selective waste	14031	38.498	25.195	0	99.12
Per-capita selective waste	14031	0.141	0.114	0	3.746
Pop	14578	9686.714	36207.193	158	989111
Female pop	14573	0.527	0.237	0.264	14.01
Per-capita GDP	14562	13158.206	2212.483	7851.343	36004.75
Municipal education	14519	2765.318	10031.352	33	270921
Council education	14578	14.239	1.451	8	18
Council age	14578	43.487	3.976	22.838	76.447

Notes. Descriptive statistics of the variables. Period: 2010-2019. Sample of municipalities in the regions of Apulia, Calabria, Campania and Sicily.
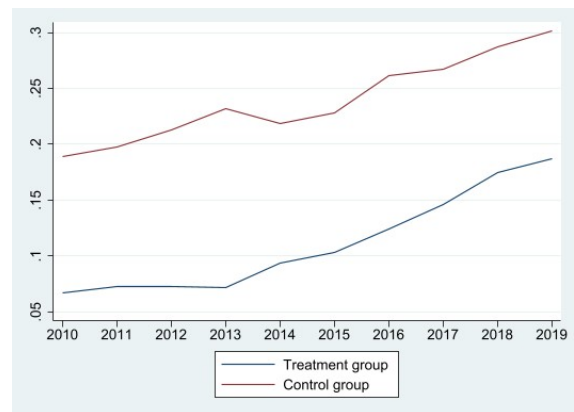
Selective waste collection in the treatment and control group. Figure 3 displays the mean percentage of selective waste collection (Graph 3a) and the per-capita tonnage of selective waste collection (Graph 3b) in the treatment and control municipalities between 2010 and 2019. The graphs show a sharper increase in selective waste collection in the treated municipalities than in control once.

Figure 3: Percentage of selective waste collection and per-capita tonnes in selective waste collection in treatment and control group

(a) Percentage of selective waste collection
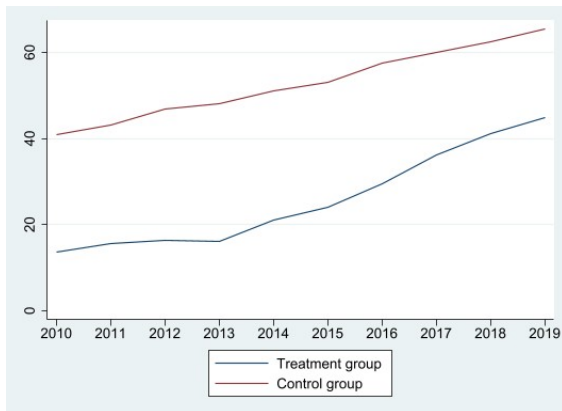
(b) Per-capita tonnes of selective waste collection

Note. Graphs 3a and 3b, respectively, report the yearly mean, over municipalities, of the percentage of selective waste collection and per-capita tonnes of selective waste collection in the treatment and control municipalities. The treatment group is municipalities dissolved because of mafia infiltration according to Law 164/1991; the control group, municipalities not affected by Law 164/1991.

3.3 Control variables

The control variables employed in the empirical analysis are the following. First, the waste management service may be influenced by the socioeconomic and demographic characteristics of a municipality. Consequently, we control for population (denoted *Pop*) that accounts for the size-related effects[11] of municipalities as well as for possible confounding effects due to local election laws.[12]

Given that women tend to be more concerned about the environment and more willing to take action on it (Brough et al., 2016), we control for the female population (*Female pop* as a share of total population). In this regard, Kallgren et al. (2000) find that men litter more than women and Kallgren et al. (2000) and Zelezny et al. (2000) also document that men recycle less.

We control for the standard of living proxied by the municipality's per capita GDP (*Per*

---

[11]In this context, Gaeta et al. (2017) conducted an analysis on municipalities in the Lombardy and observed a negative correlation between population size and the total amount of recycled municipal waste.

[12]We are dealing with the variation in the salary of the mayor at the cut-off of 5,000 inhabitants and the increase in female municipal politicians due to the gender quota measure prescribed by Law 215/2012.

capita GDP) (Abbott et al., 2011, Gaeta et al., 2017, Lakhan, 2014, Romano et al., 2019, Starr and Nicolson, 2015).

The censuses of 2001, 2011, 2018 and 2019 provides data on average educational attainment at the municipality level (i.e., the average secondary education degree holders — *Municipal education*) (Gaeta et al., 2017, Lakhan, 2014, Romano et al., 2022, Sidique et al., 2010, Starr and Nicolson, 2015).

We also control for politicians' characteristics, such as: 1) the average age of municipal council members (denoted by *Council age*) in order to take account of the personal status of politicians linked to their age; 2) the average level of education in the city council (hereafter *Council education*).

Finally, we control for the election cycle (that takes into account policies implemented in proximity of elections to increase the probability of re-election) through a set of dummy variables from election years up to three years after, for all municipalities in the sample.[13]

Table 2 gives the descriptive statistics.

4 Empirical strategy

The effectiveness of the enforcement of Law 164 in increasing the selective waste management collection is studied in two steps.

Initially, we assess the average treatment effect (ATE) of Law 164 through a difference-in-differences (DiD) analysis, leveraging the phased introduction of Law 164/1991 across various municipalities and time periods. This analysis takes advantage of the staggered implementation of Law 164/1991, which, along with other factors outlined in Paragraph "Local political institutions in Italy" in the Appendix, results in staggered municipal elections in the dataset.

We compare the variables related to selective waste collection, such as the percentage of selective waste collection and per-capita selective waste collection, in municipalities across Apulia, Calabria, Campania, and Sicily before and after the significant event – city council dissolution due to mafia infiltration. This treated group is compared with municipalities that have never experienced dissolution, serving as the control group.

The estimated equation is the following[14]

$$Y_{it} = \beta_1 Law\ 164_{it} + \alpha_i + \delta_t + \gamma X_{it} + \epsilon_{it} \tag{1}$$

where Y_{it} are the two measures of selective waste collection (the percentage of selective waste collection/per-capita selective waste collection) in municipality i at year t. The re-

---

[13]Considering that the whole electoral cycle should normally last five years, we include four dummies to avoid the dummy variable trap.

[14]The same methodology has been already employed in the papers, among others, by Baraldi et al. (2022c), Baraldi and Ronza (2022), Daniele and Geys (2015), Di Cataldo and Mastrorocco (2022).

gressor measuring the average treatment effect is $Law\ 164_{it}$ which is equal to 1 for treated municipalities in all the years from dissolution due to mafia infiltration and 2019, and to 0 in the period before; for control municipalities (never dissolved), it is equal to 0 for the entire period 2010-2019.

The term α_i denotes the set of fixed effects specific to each municipality, which accounts for time-invariant characteristics associated with the outcome variables. Additionally, δ_t represents the time fixed effects that manage time-varying variations in the level of selective waste collection measures during years that are common to all municipalities.

X_{it} is the vector of control variables listed above, namely resident population, the share of female population, the per-capita GDP, the municipal education, the council age and education. ϵ_{it} is the idiosyncratic error term.

In the second phase of the empirical analysis, we illustrate the evolving trend of selective waste collection by employing a dynamic difference-in-differences (DiD) research design. This approach allows us to compare the trajectories of both selective waste collection measures between treated and untreated municipalities in each year, both before and after the implementation of the law aimed at combating mafia infiltration. That is, we adopt an event-study model that estimates the effect of enforcement of Law 164 year-by-year (Mora and Reggio, 2019). These assessments enable the examination of both the assumption of parallel trends and the absence of anticipation effects related to the anti-mafia measure, which form the foundation of the difference-in-differences (DiD) design.

The event-study regression equation (subscript i is for municipalities, t for years) is:

$$Y_{it} = \sum_{t=-7}^{+7} \nu_t \cdot D_t + \alpha_i + \delta_t + \gamma X_{it} + \epsilon_{it} \tag{2}$$

where Y_{it} is the percentage of selective waste collection/per-capita selective waste collection at year t in municipality i and D_t is the set of event-time dummies taking the value of 1 only for dissolved municipalities if year t is k periods before/after the dissolution. The omitted category, D_{t0}, is the year of city council dissolution; the remaining ν_t coefficients measure the effects of Law 164 in the period before and after its enforcement (t_0). We include periods from 7 years before city council dismissal (to represent the anticipatory effect) to 7 years after (in order to display a dynamic impact of the measure).

To avoid bias in the composition of the control group of municipalities, we exclude from the analysis municipalities dissolved for mafia infiltration before 2010.

4.1 DiD identification assumptions

The empirical framework relies on the validity of the identification assumption, assuming the exogeneity of the anti-mafia measure concerning the outcome variables. To address potential endogeneity concerns regarding dissolution and its relation to selective waste collection,

one might question whether municipalities with a higher prevalence of mafia influence experience more dissolutions. In such instances, there may be doubt about the exogeneity of Law 164/1991, considering the possibility that increased police monitoring in "risky" municipalities could be a contributing factor. It's important to emphasize, however, that city council dissolution is strictly an administrative measure and does not involve an expansion of police forces or increased allocations for public safety during compulsory administration (Mete, 2009; Cavaliere, 2004). Furthermore, a recent study by Baraldi et al. (2023), examining incidents of threats and violence against local politicians as indicators of mafia presence in southern Italian municipalities, compellingly demonstrates that attacks against politicians do not exhibit statistical differences between dissolved (due to mafia infiltration) and undissolved municipalities *before* the dissolution.

The statistical validation of the exogeneity of the anti-mafia measure concerning the outcome variables is provided by testing the parallel trend assumption, a prerequisite for DiD to be as an unbiased estimator of the average treatment effect. The confirmation of a parallel trajectory in the outcome variables between the treated and control groups is presented in Subsection 5.2. In this section, we employ a fully dynamic model (event study) as to equation 2 to examine the year-by-year progression of selective waste collection measures in treated units compared to control units. The absence of an anticipatory effect implies no significant variation in the trend of selective waste collection before the dissolution due to mafia infiltration between the treated and untreated units.

One potential source of bias in estimations is the question of whether the central government can influence dissolution. Di Cataldo and Mastrorocco (2022) alleviates this concern by providing reassuring evidence, indicating no substantial correlation between the political affiliations of provincial or national governments and those of dissolved municipal governments. Additionally, Mete (2009) documents that the central government refrains from exploiting Law 164 against rival parties.

5 Results and discussion

5.1 ATE

We, firstly, examine the average impact of enforcement of Law 164 on the measures of selective waste collection in the period 2010-2019. The results of the DiD estimations as in eq. 1 are displayed in Table 3. Columns 1 and 2 show estimation results for the percentage of selective waste collection (% *Selective* in the table) while Columns 3 and 4 for the per-capita tonnes of selective waste collection (*Per-capita Selective* in the table). The coefficient measuring the ATE is β_1 of *Law 164* in eq 1. In all the specifications in Table 3 we control for municipality and year FE; standard errors are clustered at municipal level.

Upon initial examination, the positive and highly significant coefficient of *Law 164* sug-

gests that the enforcement of this measure against organized crime leads to an increase in both the percentage and per-capita tonnes of selective waste collection across.

Concerning the extent of the impact, Column 1 indicates that, all else being equal, the percentage of selective waste collection is, on average, only 8.14 percentage points higher in the years following the dismissal of the city council compared to what it would have been if there had been no dissolution. The analysis reveals that the implementation of Law 164 results in an increase in the percentage of selective waste collection by approximately one-third of its actual standard deviation (25.19).[15] The refinement of the model through the inclusion of controls raises the percentage of selective waste collection in the treatment group by 5 percentage points compared to the control group (Column 2).

---

[15]Refer to Table 2 in Appendix A.

Table 3: ATE

Dep. Var.:	(1) % Selective	(2) % Selective	(3) Per-capita Selective	(4) Per-capita Selective
Law 164	8.137***	5.004***	0.0296***	0.0175***
	(1.694)	(1.852)	(0.00599)	(0.00660)
Pop		-0.00104**		-4.49e-06**
		(0.000465)		(1.89e-06)
Female pop		121.6**		0.442**
		(56.37)		(0.203)
Per-capita GDP		0.00375***		1.46e-05***
		(0.00106)		(4.51e-06)
Municipal education		0.00364*		1.64e-05*
		(0.00205)		(8.97e-06)
Council education		1.961***		0.00605***
		(0.286)		(0.00115)
Council age		0.132*		0.000292
		(0.0728)		(0.000297)
Electoral cycle_1		0.233		-0.000584
		(0.336)		(0.00174)
Electoral cycle_2		-0.171		-0.000793
		(0.387)		(0.00216)
Electoral cycle_3		0.181		9.29e-06
		(0.350)		(0.00183)
Electoral cycle_4		0.129		0.00115
		(0.288)		(0.00213)
Observations	14,031	13,966	14,031	13,966
R-squared	0.203	0.271	0.123	0.163
No. Municipalities	1,468	1,457	1,468	1,457
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Note. The dependent variable is the percentage of selective waste collection in Columns $1-2$ and the per-capita tonnes in selective waste collection in Columns $3-4$. *Law 164* is a dummy taking the value of 1 for all the years from the city council dissolution and the end of the period and 0 otherwise. The sample is restricted to municipalities in the regions of Apulia, Calabria, Campania and Sicily. Coefficients of municipality FE and year FE are not reported. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 2010-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Columns $3-4$ in Table 3 utilize the per-capita tonnes in selective waste collection as the dependent variable. The baseline model in Column 3 reveals a post-dissolution increase of 0.03 in per-capita tonnes for treatment municipalities compared to untreated ones, indicating a rise of 29.6 kg per capita. Enhancing the model by incorporating municipality controls in Column 4 reduces the impact of *Law 164* to 0.0175 tonnes, equivalent to approximately one-fifth of the standard deviation in per-capita tonnes of selective waste collection.

In summary, the enforcement of the anti-mafia measure results in an average treatment effect with an increase in both metrics of selective waste collection.

The resident population appears to exert a negative influence on selective waste collection, while all other controls exhibit a significant positive effect. Dummies for the electoral cycle

are consistently not significantly different from zero.

The estimates presented in this section pertain to the subset of municipalities located in Apulia, Calabria, Campania, and Sicily. To validate the robustness of our findings concerning this sample restriction, we conduct a robustness check by estimating the relevant relationship across the entire set of Italian municipalities. The outcomes are detailed in Table A.1 in the Appendix. Notably, for both metrics of selective waste collection, the coefficients are consistent in terms of sign, significance, and magnitude.

5.2 Dynamic of selective waste collection in treated compared to control municipalities

Examining the dynamic impact of Law 164 on selective waste collection, Figure 4 illustrates the results of estimating equation 2 for both the percentage and per-capita tonnes of selective waste collection. The figure depicts the 95% confidence intervals of ν_t. Upon initial inspection of the graphs, it is evident that before the reference year t_0 (i.e., the year of mafia dissolution), the confidence intervals are consistently centered around zero. In specific terms, the estimates indicate the absence of an anticipatory effect of Law 164 on selective waste collection, supporting the validity of the assumption of a parallel trend between the treatment and control groups of municipalities, which is fundamental to the DiD approach. This observation is further substantiated statistically through the Wald test, which tests the null hypothesis that all coefficients from $t_0 - 1$ to $t_0 - 7$ in equation 2 are jointly equal to $0.$[16]

Following the implementation of Law 164, the dynamics of selective waste collection exhibit a gradual increase over time, regardless of the metric under consideration. Specifically, at $t_0 + 1$, corresponding to the period of compulsory administration (with no new elections held), the coefficients for ν_t remain insignificant, as anticipated. This lack of significance aligns with expectations, given that no new policies or contracts are typically introduced during compulsory administration. Subsequently, at $t_0 + 2$, when the new pool of politicians is elected, the discernible upward trend in both the percentage and per-capita selective waste collection becomes apparent in treated municipalities compared to the untreated ones.

---

[16]The details of the Wald test are available upon request.

Figure 4: Event study graphs
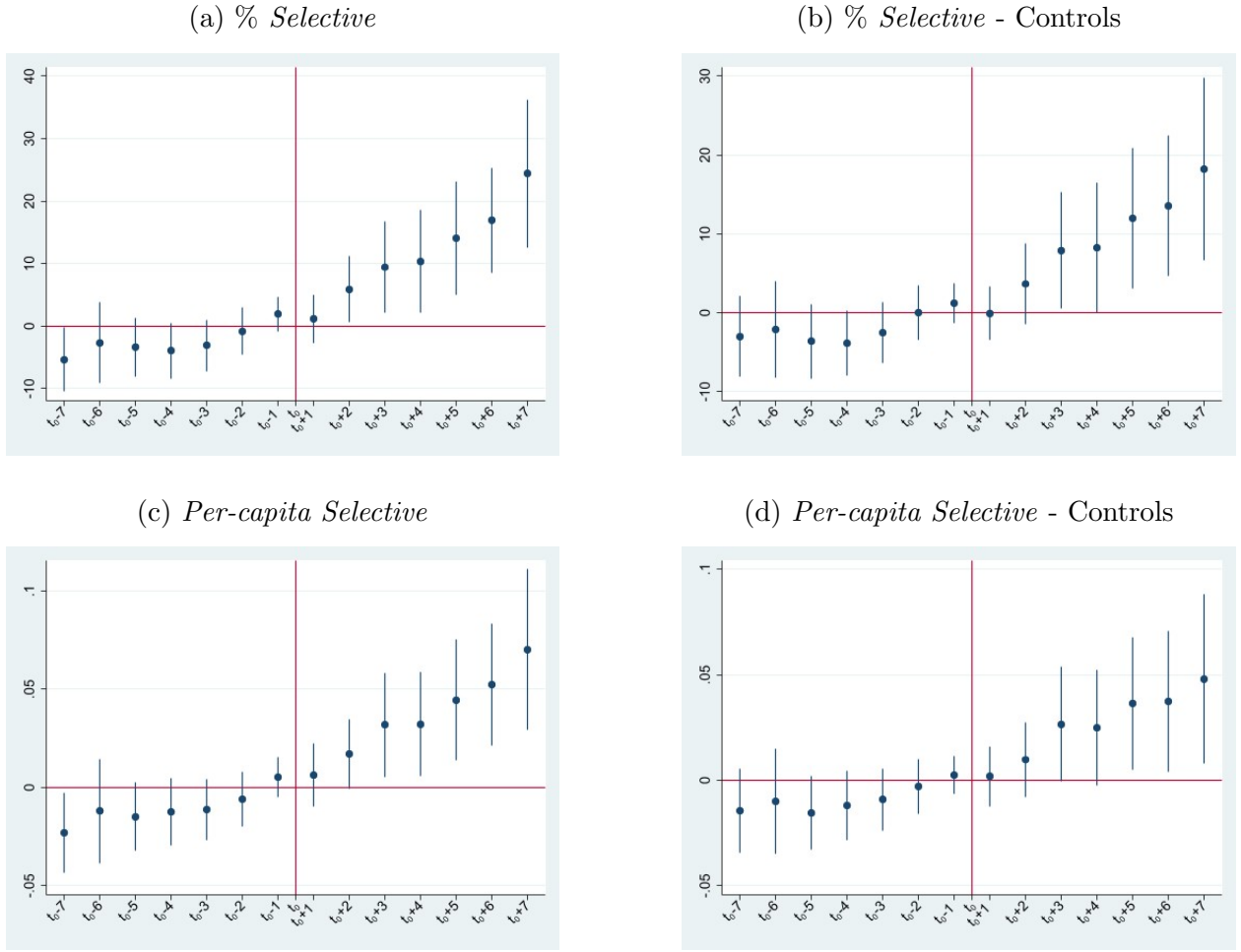
(a) % *Selective*

(b) % *Selective* - Controls

(c) *Per-capita Selective*

(d) *Per-capita Selective* - Controls

Note. The Graphs report coefficients and confidence intervals estimated according to specification as in eq. 2. Dots refer to point estimates, spikes to 95% confidence intervals. In Graphs 4a and 4b, the dependent variable is the percentage of selective waste collection; in Graphs 4c and 4d, the dependent variable is the per-capita tonnes in selective waste collection. The omitted category is the election year that appointed the dissolved administration (t_0). The sample is restricted to municipalities in the regions of Apulia, Calabria, Campania and Sicily. Standard errors are clustered at municipal level. All regressions include municipality FE and year FE. Graphs 4b and 4d include control variables as *Pop*, *Female pop*, *Per-capita GDP*, *Municipal education*, *Council education* and *Council age*. Period: 2010-2019.

For robustness, we show the event-study graphs over the full sample of Italian municipalities in Figure B.4 in Appendix B.

5.3 Discussion of results

The empirical analysis highlighted that the enforcement of Law 164/1991 has been effective in influencing the selective waste collection practice. By enhancing the selective waste collection, it is possible to reduce environmental impact through the improvement of recycling.

This study contributes to the literature documenting the link between organized crime and waste management. The theoretical framework is based on the works focusing on illegal waste disposal (Fullerton and Kinnaman, 1995, Sullivan, 1987) and on costly enforcement and

transaction costs (Shinkuma, 2003). The empirical literature finds that criminal sanctions provide deterrence effect (Almer and Goeschl, 2010) and the negative correlation between enforcement efforts and the illegal trafficking of waste is noticeable only at extremely high levels of enforcement (Germani et al., 2015). D'Amato et al. (2015), on the sample of Italian provinces, documented that sorted collection of recyclable waste and legal forms of waste disposal are lower when the mafia affects local governments actions. Moreover, Agovino et al. (2018) provide evidence that a less efficient legal system and a greater inclination toward corruption negatively impact the provinces' performance in the separate waste collection process. Among this findings, our paper is the first that test the effectiveness of a specific anti-mafia measure in restoring a fairer waste management system in terms of separate waste collection for recycling. Infact, it finds that, after dissolution, the measures of selective waste collection we used increases on average and year-by-year over the period of analysis in the treated municipalities compared to the untreated once. Additionally, it grounds the analysis at the municipal level, which are really responsible for the waste service provision.

This paper also contributes to the literature linking corruption and the provision of public service, such as the management of waste. Indeed, the waste management sector is acknowledged as one of the industries most affected by corruption and mismanagement (Commission et al., 2014). As underlined by Liddick (2010), corruption of public officials (perpetrated by organized crime to infiltrate politics (Dal Bó et al., 2006)) is important in the illegal waste traffic and management. Despite of that, few studies on corruption have looked at the waste management activity. Some valuable exceptions demonstrate that corruption negatively affects the cost efficiency (Abrate et al., 2015), and that more corrupt regions with lower level of voter information provide less cost-efficient waste management service (Abrate et al., 2018). Very recently, Romano et al. (2021) demonstrated that higher corrupted Italian provinces have higher production of per-capita urban waste. To our knowledge, this literature on corruption and waste management has neglected to analyse the impact of anti-corruption policies. In this respect, the enforcement of Law 164 can be properly considered as a measure against corruption, perpetrated by organized crime, to affect public officials. We offer an interesting contribution in terms of policy implication, providing evidence of the effectiveness of a government measure in the public waste management.

Why the enforcement of Law 164/1981 enhances selective waste practice? By removing the allegedly corrupt city council politicians and substituting them with external commissioners, the central government sends a clear message that mafia infiltration in local government is unacceptable (Fenizia and Saggio, 2023). This reflects in a number of evidences such as that after compulsory administration newly elected city councilors pool is made up of more highly educated politicians (e.g., Daniele and Geys, 2015; Baraldi et al., 2022a) and with a larger share of women (Baraldi and Ronza, 2022)[17] as well as younger politicians at their

---

[17]In a very recent work Baraldi et al. (2023) have shown that an increase in female political participation in Italian city council leads to an improvement in selective waste collection.

first term in office (Daniele and Geys, 2015). They are typically less inclined to corruption (e.g., Decarolis et al., 2023; Lochner and Moretti, 2004) and, therefore, they are more inclined to implement policies hostile to organised crime throughout a more efficient allocation of public funds in sectors targeted by organised crime, as waste management sector (e.g., Di Cataldo and Mastrorocco, 2022; Ravenda et al., 2020). This is likely to explain the increasing dynamic pattern in the selective waste collection in the treatment group of municipalities compared to the control group. Moreover, our results provide significant insights on how the renewed effectiveness in the selection of waste is an important factor contributing to explain the findings by Fenizia and Saggio (2023) of a long-run impact of city council dismissal on municipality economic performance.

6 Sensitivity and Robustness

6.1 The empirical design

In this type of empirical design, the determination of the control group holds significant importance. Firstly, as depicted in Graph B.1b within Figure B.1, there were no instances of mafia dissolutions in municipalities located in the provinces of Avellino, Barletta-Andria-Trani, Benevento, and Enna. To address potential bias stemming from the absence of sufficiently similar units between the treatment and control groups, we conduct robustness checks where these provinces are excluded. The results are presented in Table A.2 in Appendix A. Notably, for both metrics of selective waste collection, the coefficients maintain consistency in terms of sign and significance, albeit with a reduced magnitude compared to those in Table 3. Additionally, we illustrate the dynamic pattern of Law 164 on both metrics of selective waste collection within this restricted sample of municipalities in Figure B.5 in Appendix B.

Secondly, in the initial analysis, the control group comprises local governments that have never been dissolved due to mafia infiltration. However, the premature termination of a municipal council, as outlined in the paragraph on "Local political institutions in Italy" could introduce selection bias, given the various possible reasons for such early terminations. Indeed, the likelihood of an infiltrated municipality being detected and included in the control group rather than the treatment group may decrease with early termination. To address this concern, we perform a DiD estimation, excluding local governments from the control group that experienced early dissolution for reasons unrelated to mafia involvement. The results, presented in Table A.3, reaffirm the baseline findings. The dynamic pattern of selective waste collection in treated municipalities compared to untreated ones after the implementation of Law 164, as illustrated in Figure B.6, consistently exhibits an upward trajectory.

As outlined in the preceding Section 3.1, certain municipalities underwent dissolution multiple times within the period.[18] This implies that, in some cases, the implementation

---

[18]In such instances, the treatment variable *Law 164* for municipalities dissolved more than once takes on

of Law 164 might prove ineffective in preventing mafia infiltration. To mitigate potential post-treatment bias, we address this by excluding municipalities that experienced dissolution more than once. The ATE estimates are presented in Table A.4 in Appendix A, and the dynamic pattern in the event-study is depicted in Figure B.7 in Appendix B. The baseline findings are consistently upheld.

To mitigate potential concerns regarding omitted variable bias, we have implemented controls for fixed and time-varying municipal characteristics. Firstly, the empirical model incorporates municipality fixed effects (to account for distinctive municipal traits that remain constant over time) and time fixed effects (to control for time-dependent changes in outcome variables common to all municipalities). Additionally, to further test the identifying assumptions, we assess how the inclusion of supplementary controls (*Pop*, *Female pop*, *Per-capita GDP*, *Municipal education*, *Council education*, *Council age*, and dummies for the electoral cycle) alongside the baseline estimate impacts the magnitude of the coefficient of interest in equation 1. If the magnitude of β_1 remains consistent with the inclusion of additional controls, it strengthens the case for a causal interpretation of the results. To evaluate this, we conduct a t-test on the difference between the two estimated β_1 values in Columns 1 and 3 (for *% Selective*) and in Columns 2 and 4 (for *Per-capita Selective*) in Table 3, respectively. The t-test results indicate non-significant differences at the 1% level for both measures of selective waste collection.[19] This outcome substantiates the identification assumption, supporting a causal interpretation of the results.

6.2 The issue of negative weights in staggered DiD

In staggered DiD designs, where the timing of treatment varies among units, the DiD coefficient is essentially a weighted average of simple 2x2 DiDs. Recent econometric literature has highlighted that heterogeneous timing in treatment can lead to negative weights, potentially biasing DiD estimates (Goodman-Bacon, 2021).[20]

To assess the validity of this concern, we employ the test proposed by De Chaisemartin and d'Haultfoeuille (2020) to calculate the number of negative weights in our model.[21] The test results indicate that the number of negatively-weighted Average Treatment Effects on the Treated (ATTs) for both measures of selective waste collection is 0, signifying that the

---

the value of 1 after the *first* dissolution.

[19]The Stata command *lincom* is employed to estimate t-statistics and p-values for the difference between the two coefficients of interest, calculated separately for specifications in Columns 1 and 3 (for *% Selective*) and in Columns 2 and 4 (for *Per-capita Selective*) in Table 3. The parameters estimates and related variance/covariance matrices of the two separate models are combined (and stored) into a single parameter vector and a simultaneous variance/covariance matrix using the Stata post-estimation command *suest* (Seemingly Unrelated Estimations). The test details are available upon request.

[20]Negative weights arise due to variations in treatment effects over time, causing previously treated units to transition into the control group. Consequently, changes in their treatment effects over time are no longer considered in the DiD estimate.

[21]We utilize the *twowayfeweights* Stata command, developed by De Chaisemartin and d'Haultfoeuille (2020), for linear DiD.

primary and sole source of heterogeneity lies in the differences between municipalities that have received treatment and those that have never been treated. Therefore, this statistical inference supports the hypothesis that our initial estimates are not affected by negative weights.

6.3 Propensity score matching

In this section, we employ a matched DiD analysis (Borusyak and Jaravel, 2017, Goodman-Bacon, 2021) to further support the identification of the empirical research design. This approach involves a temporal comparison between municipalities that experienced treatment (i.e., city council dismissal) and counterfactual matched municipalities that never underwent treatment, utilizing nearest-neighbor propensity score matching.[22] Propensity score analysis grapples with the challenge that the potential influence of mafia infiltration may cause treated units to differ from their never-treated controls in various relevant (observable and unobservable) characteristics before the policy implementation. These differences could serve as confounding factors in policy evaluation. Simultaneously, factors influencing the susceptibility of a municipality to infiltration may contribute to the electoral responses of voters after the policy enforcement. Therefore, the propensity score matching analysis, by minimizing the disparity between the treatment and control groups, aims to render the control group an unbiased counterfactual.

The propensity score involves estimating a probit model that predicts the probability of each municipality being dissolved (i.e., the treatment status) within the entire sample of Italian municipalities from 2010 to 2019. Subsequently, the control group is selected based on the propensity score, resulting in a set of municipalities highly likely to exhibit a similar trend to the treated ones.[23] The probit model estimation incorporates the following covariates: population (in natural log), per-capita GDP, municipal employment rate, municipal tourism rate (defined as the number of tourist accommodations divided by resident population), and the average level of education in the city council. To assess the effectiveness of this matching process, we conduct t-tests for the mean differences of the covariates between matched municipalities in the treatment and control groups, as presented in Table A.5 in Appendix A. The results indicate a good balance, as the null hypothesis is not rejected for any of the covariates, affirming the similarity between the treatment and control groups.

The graphs in Figure B.8 illustrate the propensity scores for the treatment and comparison groups both before and after the matching process. Specifically, Graph B.8b demonstrates a highly favorable overlap in the distribution of propensity scores for the treatment and control groups of municipalities after the matching.

---

[22]For the calculation of nearest-neighbor propensity score matching, a one-to-five matching ratio is employed.

[23]I utilize the Stata command *psmatch2* developed by Leuven and Sianesi (2003).

The matched DiD results are presented in Table A.6 in the Appendix, indicating the average treatment effect of the anti-mafia measure on both metrics of selective waste collection. These results confirm the findings presented in the previous Table 3.

The dynamic pattern of the percentage and per-capita tonnes in selective waste collection before and after the enforcement of Law 164 is depicted in Figure B.9 in Appendix B. Once again, no anticipatory effects are observed, and selective waste starts to increase after compulsory administration, thereby affirming the baseline results.

7   Conclusions

The illegal trafficking of waste governed by organized crime is one of the most important environmental problems worldwide. This phenomenon interested primarily the southern Italian regions generating the "waste crisis", widely debated in recent years. In this scenario, the effectiveness of anti-mafia measures in restoring a more efficient waste management by local governments becomes a very relevant issue. This paper grounds on this debate and is the first that estimates the impact of the enforcement of one of the most aggressive policy aimed at fighting the organized crime infiltration in local politics (Law 164/1991) on the waste management collection and disposal for recycling. The empirical analysis, employing a DiD approach to compare waste selection measures in treated (the dissolved because of mafia infiltration municipalities) and control (the undissolved once) groups of municipalities, reveals the effectiveness of Law 164 in restoring a fairer waste management. We find that after city council dismissal the percentage of selective waste collection increases by 5 percentage points in treated compared to untreated municipalities. An increase by 17.5 Kg occurs in the per capita waste selection. Interestingly, the analysis of the dynamic pattern of the percentage in selective waste collection as well as the per-capita tonnes in selective waste collection displays an increasing trend in treated municipalities (compared to municipalities in the control group) just in the first election after compulsory administration.

From a policy-making point of view, this finding serves to enhance the efficacy of Law 164 enforcement. Notably, Law 164, apart from leading to the selection of better and younger politicians (Daniele and Geys, 2015), as well as more female politicians (Baraldi and Ronza, 2022), influences also urban waste management. This, in turn, contributes to the well-documented, long-term economic growth observed in dissolved municipalities (Fenizia and Saggio, 2023).

The limitation of the present paper lies in the availability of both a continuous measure of mafia infiltration or corruption and suitable instruments to conduct a specific analysis of the impact of corruption perpetrated by organized crime on selective waste collection. Moreover, other limitations derive from 1) the unavailability of suitable measure of mafia infiltration at national level; 2) the limited time span of analysis (10 years) because we forced to stop at 2019, the last year before the COVID pandemic; 3) the availability of suitable instrumental

variables for mafia infiltration to conduct a rigorous causal analysis. These limitations open rooms for future research.

References

Abbott, A., S. Nandeibam, and L. O'Shea (2011). Explaining the variation in household recycling rates across the uk. *Ecological Economics 70*(11), 2214–2223.

Abrate, G., F. Boffa, F. Erbetta, and D. Vannoni (2018). Voters' information, corruption, and the efficiency of local public services. *Sustainability 10*(12), 4775.

Abrate, G., F. Erbetta, G. Fraquelli, and D. Vannoni (2015). The cost of corruption in the italian solid waste industry. *Industrial and Corporate Change 24*(2), 439–465.

Agovino, M., A. Garofalo, and A. Mariani (2018). Institutional quality effects on separate waste collection: Some evidence from italian provinces. *Journal of Environmental Planning and Management 61*(9), 1487–1510.

Almer, C. and T. Goeschl (2010). Environmental crime and punishment: Empirical evidence from the german penal code. *Land Economics 86*(4), 707–726.

Baraldi, A. L., C. Cantabene, A. De Iudicibus, et al. (2023). Does gender affect environmentally virtuous behaviour? evidence from selective waste collection. *mimeo*.

Baraldi, A. L., G. Immordino, and M. Stimolo (2022a). Mafia wears out women in power: Evidence from italian municipalities. *Journal of Economic Behavior & Organization 193*, 213–236.

Baraldi, A. L., G. Immordino, and M. Stimolo (2022b). Mafia wears out women in power: Evidence from Italian municipalities. *Journal of Economic Behavior & Organization 193*, 213–236.

Baraldi, A. L., G. Immordino, and M. Stimolo (2022c). Self-selecting candidates or compelling voters: How organized crime affects political selection. *European Journal of Political Economy 71*, 102–133.

Baraldi, A. L., E. Papagni, and M. Stimolo (2023). Neutralizing the tentacles of organized crime. assessment of the impact of an anti-crime measure on mafia violence in italy. *mimeo*.

Baraldi, A. L. and C. Ronza (2022). Does corruption hinder female political participation? evidence from a measure against organized crime. *The Journal of Law, Economics, and Organization*, ewac015.

Borusyak, K. and X. Jaravel (2017). Revisiting event study designs. *Available at SSRN 2826228*.

Brough, A. R., J. E. Wilkie, J. Ma, M. S. Isaac, and D. Gal (2016). Is eco-friendly un-manly? the green-feminine stereotype and its effect on sustainable consumption. *Journal of Consumer Research 43*(4), 567–582.

Cavaliere, C. (2004). *Un vaso di coccio: dai governi locali ai governi privati: comuni sciolti per mafia e sistema politico istituzionale in Calabria.* Rubbettino Editore.

Cesi, B., A. D'Amato, and M. Zoli (2019). Corruption in environmental policy: the case of waste. *Economia Politica 36*, 65–78.

Commission, E. et al. (2014). Eu anti-corruption report. Technical report, European Commission.

Dal Bó, E., P. Dal Bó, and R. Di Tella (2006). "plata o plomo?": bribe and punishment in a theory of political influence. *American Political Science Review 100*(1), 41–53.

D'Alisa, G., D. Burgalassi, H. Healy, and M. Walter (2010). Conflict in campania: Waste emergency or crisis of democracy. *Ecological Economics 70*(2), 239–249.

D'Alisa, G., A. R. Germani, P. Falcone, P. Morone, C. Imbriani, F. Reganati, et al. (2015). Victims in the land of fires: a case study on the consequences of buried and burnt waste in campania, italy. *ELETTRONICO*, 1–53.

Daniele, G. and B. Geys (2015). Organised crime, institutions and political quality: Empirical evidence from Italian municipalities. *The Economic Journal 125*(586), F233–F255.

De Chaisemartin, C. and X. d'Haultfoeuille (2020). Two-way fixed effects estimators with heterogeneous treatment effects. *American Economic Review 110*(9), 2964–96.

Decarolis, F., R. Fisman, P. Pinotti, S. Vannutelli, and Y. Wang (2023). Gender and bureaucratic corruption: evidence from two countries. *The Journal of Law, Economics, and Organization 39*(2), 557–585.

Di Cataldo, M. and N. Mastrorocco (2022). Organized crime, captured politicians, and the allocation of public resources. *The Journal of Law, Economics, and Organization 38*(3), 774–839.

DIA (2020). Direzione investigativa antimafia - relazione semestrale. *Ministero dell'Interno*.

D'Amato, A., M. Mazzanti, and 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.

D'Amato, A., M. Zoli, et al. (2013). A note on illegal waste disposal, corruption and enforcement. *Waste Management in Spatial Environments*, 63–78.

Fenizia, A. and R. Saggio (2023). Organized crime and economic growth: Evidence from municipalities infiltrated by the mafia. Technical report, Mimeo.

Fullerton, D. and T. C. Kinnaman (1995). Garbage, recycling, and illicit burning or dumping. *Journal of Environmental Economics and Management 29*(1), 78–91.

Gaeta, G. L., S. Ghinoi, and F. Silvestri (2017). Municipal performance in waste recycling: An empirical analysis based on data from the lombardy region (italy). *Letters in Spatial and Resource Sciences 10*, 337–352.

Germani, A. R., A. Pergolizzi, F. Reganati, et al. (2015). Illegal trafficking and unsustainable waste management in italy: Evidence at the regional level. *Journal of Security and Sustainability Issues 4*(4), 369–389.

Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics 225*(2), 254–277.

Kallgren, C. A., R. R. Reno, and R. B. Cialdini (2000). A focus theory of normative conduct: When norms do and do not affect behavior. *Personality and Social Psychology Bulletin 26*(8), 1002–1012.

Lakhan, C. (2014). Exploring the relationship between municipal promotion and education investments and recycling rate performance in ontario, canada. *Resources, Conservation and Recycling 92*, 222–229.

Lavee, D. (2020). Are economic tools preferable to direct regulatory measures in achieving environmental goals? *Environmental Policy and Law 50*(3), 181–191.

Legambiente (2023). Rapporto ecomafia. *Edizioni Ambiente*.

Leuven, E. and B. Sianesi (2003). PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing. Statistical Software Components, Boston College Department of Economics.

Liddick, D. (2010). The traffic in garbage and hazardous wastes: an overview. *Trends in Organized Crime 13*(2-3), 134–146.

Lochner, L. and E. Moretti (2004). The effect of education on crime: Evidence from prison inmates, arrests, and self-reports. *American Economic Review 94*(1), 155–189.

Mete, V. (2009). *Fuori dal comune: Lo scioglimento delle amministrazioni locali per infiltrazioni mafiose*, Volume 72. Bonanno Rome.

Mora, R. and I. Reggio (2019). Alternative diff-in-diffs estimators with several pretreatment periods. *Econometric Reviews 38*(5), 465–486.

Ravenda, D., M. G. Giuranno, M. M. Valencia-Silva, J. M. Argiles-Bosch, and J. García-Blandón (2020). The effects of mafia infiltration on public procurement performance. *European Journal of Political Economy 64*, 101923.

Romano, G., G. V. Lombardi, A. Rapposelli, and M. Gastaldi (2022). The factors affecting italian provinces' separate waste-collection rates: An empirical investigation. *Waste Management 139*, 217–226.

Romano, G., L. Masserini, and G. V. Lombardi (2021). Environmental performance of waste management: Impacts of corruption and public maladministration in italy. *Journal of Cleaner Production 288*, 125521.

Romano, G., A. Rapposelli, and L. Marrucci (2019). Improving waste production and recycling through zero-waste strategy and privatization: An empirical investigation. *Resources, Conservation and Recycling 146*, 256–263.

Shinkuma, T. (2003). On the second-best policy of household's waste recycling. *Environmental and Resource Economics 24*, 77–95.

Sidique, S. F., F. Lupi, and S. V. Joshi (2010). The effects of behavior and attitudes on drop-off recycling activities. *Resources, Conservation and Recycling 54*(3), 163–170.

Starr, J. and C. Nicolson (2015). Patterns in trash: Factors driving municipal recycling in massachusetts. *Resources, Conservation and Recycling 99*, 7–18.

Sullivan, A. M. (1987). Policy options for toxics disposal: laissez-faire, subsidization, and enforcement. *Journal of Environmental Economics and Management 14*(1), 58–71.

Zelezny, L. C., P.-P. Chua, and C. Aldrich (2000). New ways of thinking about environmentalism: Elaborating on gender differences in environmentalism. *Journal of Social Issues 56*(3), 443–457.

APPENDIX

Local political institutions in Italy. The sub-national levels of government in Italy are regions (15 ordinary-statute[24] and 5 special-statute — *Regioni a Statuto Speciale*)[25]. The intermediate level of government consists of 107 provinces, the lowest of some 7,900 municipalities.[26]

Municipal government is composed by the mayor (which heads the municipality), the municipal council and the executive committee (composed of aldermen).

The number of councilors and aldermen within the city council varies depending on the municipality's population. Regularly, municipal election are held every five years, and the term of councilors coincides with that of the mayor.[27] Municipal governments cannot alter this schedule, but under specific circumstances an unscheduled termination of the local government and early elections may occur. Such circumstances include a permanent impediment, removal, lapse of appointment, or death that prevents the mayor or the majority of the council from performing their duties; a violation of the Constitution or national law; and failure to pass the budget. The enforcement of Law 164/1991 is one of the reasons leading to the legislature early termination. Such early termination of the local government causes staggered municipal elections in the data.

The mayor and the whole body of councilors have legislative power; they are supported by the executive body. Aldermen are appointed by the mayor from among members of the council in municipalities below 15,000 residents. In larger municipalities, they can also be appointed from outside the council.

Policy decisions on expenditures and revenues involve the whole city council: mayor and executive committee propose budgetary policy, the council authorizes the proposals. Therefore, policy implementation depends on the ability, to build consensus within the council.

Guidelines of urban waste management. Legislative Decree 152/2006 regulates waste management in Italy, stating that municipalities are responsible for the collection and handling of urban waste, as outlined in both national and regional guidelines. Municipalities tailor specific plans for selective waste collection based on the local socio-economic landscape. These plans are mandated to actively promote and incentivize citizens to engage in selective waste collection, with rigorous monitoring to guarantee thorough and effective

---

[24]Abruzzo, Basilicata, Calabria, Campania, Emilia Romagna, Lazio, Liguria, Lombardy, Marche, Molise, Piedmont, Puglia, Tuscany, Umbria, and Veneto.

[25]Friuli-Venezia Giulia, Sicily, Sardinia, Trentino-Alto Adige, and Valle d'Aosta. Article 116 of the Italian Constitution confers autonomy upon the five special-statute regions, endowing them with legislative, administrative, and financial authorities that differ based on their individual statutes. These regions have the option to delegate their direct administrative powers to municipalities. In contrast, ordinary-statute regions lack direct administrative competence, as the Constitution designates this authority to municipalities.

[26]Data at January 1, 2023.

[27]The term was shortened to four years between 1993 and 2000 (Law 25/3/1993, n. 81, art.2; DLgs 18/8/2000, n. 267, art.51).

implementation. The pivotal component of these plans lies in the contractual agreements for waste management services. Specifically, municipalities have jurisdiction over the following aspects: 1) overseeing the handling of urban waste and associated materials; 2) controlling the management of urban waste, encompassing methods for collection, transportation, and procedures for the disposal of selectively collected waste; 3) establishing guidelines for the secure operation of the service and for safeguarding environmental and health interests; 4) formulating regulations pertaining to the management of hazardous urban waste; and 5) defining criteria for classifying non-hazardous special waste as urban waste.

The core of any effective selective waste collection service lies within the municipal council, where councilors play a crucial role as influential advocates and promoters, contributing to heightened awareness and guiding the population toward more mindful waste differentiation. Municipal councils engage with providers of selective waste services through a multi-step process, typically involving the following phases:

1. *Planning and Programming*: The municipality formulates a *Waste Management Plan* ("Piano Rifiuti"), outlining objectives, strategies, and methods for waste management.

2. *Determination of collection phases*: The municipality specifies the type and frequency of separate waste collection (e.g., paper, plastic, glass) through a public tender process. This includes issuing tender notices, evaluating bids based on factors like price, the company's experience, service quality, and financial capacity, and ultimately awarding the contract to the most qualified provider.

Subsequently, it is the municipality's responsibility to oversee the service, ensuring adherence to contractual obligations and environmental regulations. The contract for selective waste collection may undergo renewal or modification in response to the municipality's requirements and the service's performance.

Mafia and waste management. The illegal trade of waste is one of the most dangerous and lucrative crimes committed by environmental criminals, posing serious risks to the ecosystems. The criminal behavior results in air pollution, contamination of groundwater, and the pollution of rivers and agricultural lands. Crimes occur at every stage of the waste cycle, from production to transportation, disposal, and fake recovery. Individuals are more likely to engage in waste management criminal activities when the anticipated profits from unlawful practices exceed those under legal recycling or disposal options. This practice finds support by the lack of regulation and law enforcement.

Up to 2015, the Italian Penal Code did not punish environmental crimes. Law 68/2015 introduced six new environmental crimes in the Penal Code: environmental pollution; environmental disaster; trafficking and abandonment of highly radioactive material; hindering of the control; omitted remediation; seabed inspection. However, local authorities often opt for the fastest waste disposal solution during emergencies in waste management, primarily to

manage potential social conflicts and evade administrative responsibilities; organized crime is ready to satisfy these requirements. (DIA, 2020).

The participation of organized crime to the waste management introduces an additional level of complexity and danger to these undertakings. Mafia may have an incentive to interfere with collection system operations, taking advantage of institutional weaknesses and creating social disorder within the domain of waste management. As a result, mafia operates by the landfilling of the waste, ultimately discouraging diversification in waste handling. By doing that, organized crime has the potential to enhance its territorial control capabilities and increase profits derived from land allocated for landfill establishment or expansion and waste storage (D'Alisa et al., 2010). The involvement of mafia in waste management might deal with deceptive practices, such as falsifying records, mislabeling waste, or illicit waste disposal methods. These activities are all designed to avoid detection and regulatory scrutiny. Finally, environment crimes in waste management present opportunities for money laundering, as unlawfully obtained funds can be generated through illicit waste disposal activities and subsequently incorporated into the legal economy.

A   Tables

Table A.1: ATE - Italy

Dep. Var.:	(1) % Selective	(2) % Selective	(3) Per-capita Selective	(4) Per-capita Selective
Law 164	9.577***	8.788***	0.0353***	0.0313***
	(1.596)	(1.643)	(0.00731)	(0.00766)
Pop		0.000151		1.47e-07
		(9.27e-05)		(3.24e-07)
Female pop		-0.521**		-0.00411***
		(0.257)		(0.00152)
Per-capita GDP		0.00245***		8.74e-06
		(0.000173)		(5.45e-06)
Municipal education		0.00140***		8.30e-06***
		(0.000537)		(2.96e-06)
Council education		1.285***		0.00651**
		(0.0962)		(0.00269)
Council age		0.190***		0.00118**
		(0.0283)		(0.000523)
Electoral cycle_1		2.029***		0.00592*
		(0.140)		(0.00340)
Electoral cycle_2		-2.192***		-0.0126***
		(0.147)		(0.00393)
Electoral cycle_3		0.654***		0.00765
		(0.143)		(0.0111)
Electoral cycle_4		0.485***		-0.00135
		(0.124)		(0.00449)
Observations	72,715	70,040	72,715	70,040
R-squared	0.196	0.243	0.004	0.005
No. Municipalities	7,922	7,420	7,922	7,420
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes

Note. The dependent variable is the percentage of selective waste collection in Columns $1-2$ and the per-capita tonnes in selective waste collection in Columns $3-4$. *Law 164* is a dummy taking the value of 1 for all the years from the city council dissolution and the end of the period and 0 otherwise. The sample is restricted to municipalities in the regions of Apulia, Calabria, Campania and Sicily. Coefficients of municipality FE and year FE are not reported. Standard errors adjusted for clustering at the municipal level are in brackets. Period: 2010-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.2: ATE - Dropping municipalities in provinces without city council dismissal

Dep. Var.:	% Selective	Per-capita Selective
	(1)	(2)
Law 164	4.333**	0.0152**
	(1.868)	(0.00664)
Observations	11,775	11,775
R-squared	0.293	0.165
No. Municipalities	1,235	1,235
Municipality FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes

Note. The dependent variable is the percentage of selective waste collection in Column 1 and the per-capita tonnes in selective waste collection in Column 2. *Law 164* is a dummy taking the value of 1 for all the years from the city council dissolution and the end of the period and 0 otherwise. The sample is restricted to municipalities in the regions of Apulia, Calabria, Campania, Sicily and we exclude municipalities within the provinces of Avellino, Barletta-Andria-Trani, Benevento and Emma. All regressions include municipality FE, year FE and control variables as *Pop, Female pop, Per-capita GDP, Municipal education, Council education* and *Council age*; coefficients are not reported. Standard errors are clustered at municipal level. Period: 2010-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.3: ATE - Dropping municipalities experiencing government early termination unrelated to mafia infiltration

Dep. Var.:	% Selective	Per-capita Selective
	(1)	(2)
Law 164	6.357***	0.0192**
	(2.295)	(0.00790)
Observations	10,912	10,912
R-squared	0.269	0.149
No. Municipalities	1,150	1,150
Municipality FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes

Note. The dependent variable is the percentage of selective waste collection in Column 1 and the per-capita tonnes in selective waste collection in Column 2. *Law 164* is a dummy taking the value of 1 for all the years from the city council dissolution and the end of the period and 0 otherwise. The sample is restricted to municipalities in the regions of Apulia, Calabria, Campania, Sicily and we excludes municipalities experiencing government early termination unrelated to mafia infiltration. All regressions include municipality FE, year FE and control variables as *Pop, Female pop, Per-capita GDP, Municipal education, Council education* and *Council age*; coefficients are not reported. Standard errors are clustered at municipal level. Period: 2010-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.4: ATE - Dropping municipalities dissolved for mafia infiltration more than once

Dep. Var.:	% Selective	Per-capita Selective
	(1)	(2)
Law 164	5.128***	0.0178***
	(1.927)	(0.00687)
Observations	13,920	13,920
R-squared	0.271	0.163
No. Municipalities	1,452	1,452
Municipality FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes

Note. The dependent variable is the percentage of selective waste collection in Column 1 and the per-capita tonnes in selective waste collection in Column 2. *Law 164* is a dummy taking the value of 1 for all the years from the city council dissolution and the end of the period and 0 otherwise. The sample is restricted to municipalities in the regions of Apulia, Calabria, Campania, Sicily and we excludes municipalities dissolved for mafia infiltration more than once. All regressions include municipality FE, year FE and control variables as *Pop*, *Female pop*, *Per-capita GDP*, *Municipal education*, *Council education* and *Council age*; coefficients are not reported. Standard errors are clustered at municipal level. Period: 2010-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).

Table A.5: Mean difference tests

	Mean		t-test	
Variable	Treated	Control	t	p>t
Ln(Pop)	8.844	8.710	0.64	0.526
Per-capita GDP	13634	13476	0.37	0.711
Municipal employment	0.31024	0.30539	0.59	0.557
Rate of tourism	0.00196	0.0021	-0.16	0.870
Council education	14.32	14.207	0.51	0.611

Note. The Table shows the value of the t and the p-value of the covariates used for the probit estimation of the treatment status. *Pop* is the resident population, *Per-capita GDP* is the municipality per-capita GDP, *Municipal employment* is the rate of municipal employment, *Rate of tourism* is the municipal rate of tourism, *Council education* is the the municipal average level of education. We use the Stata command *pstest*.

Table A.6: ATE - Propensity score matching

Dep. Var.:	% Selective	Per-capita Selective
	(1)	(2)
Law 164	5.277**	0.0152*
	(2.423)	(0.00885)
Observations	3,704	3,704
R-squared	0.312	0.252
Number of _id	392	392
Municipality FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes

Note. The dependent variable is the percentage of selective waste collection in Column 1 and the per-capita tonnes in selective waste collection in Column 2. *Law 164* is a dummy taking the value of 1 for all the years from the city council dissolution and the end of the period and 0 otherwise. The control group comprises municipalities selected according to the propensity score matching procedure. All regressions include municipality FE, year FE and control variables as *Pop*, *Female pop*, *Per-capita GDP*, *Municipal education*, *Council education* and *Council age*; coefficients are not reported. Standard errors are clustered at municipal level. Period: 2010-2019. Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).
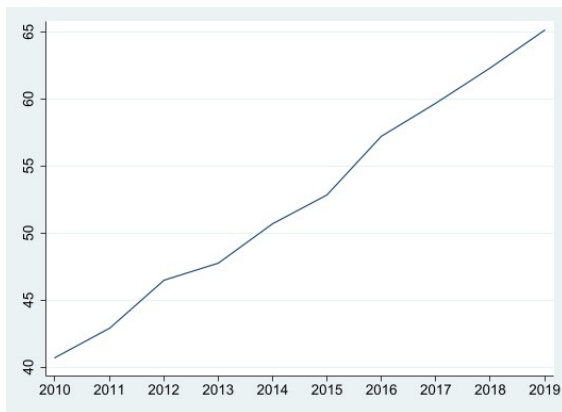
B *Figures*

Figure B.1: City council dissolution by year and province

<center>(a)</center>

<center>(b)</center>
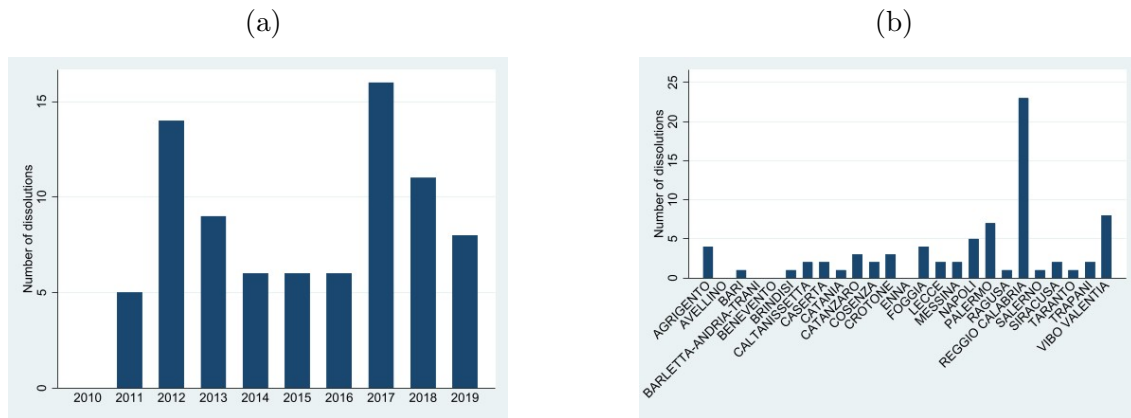
Note. Panel B.1a reports the number of city council dissolutions due to suspected mafia infiltration by year of election of the dissolved administration. Panel B.1b reports the city council dissolutions due to suspected mafia infiltration by province in the regions of Calabria, Campania, Sicily and Puglia. Time-span 2010-2019.

Figure B.2: Percentage of selective waste and per-capita tonnes in selective waste collection in Italy

(a) Percentage of selective waste collection

(b) Per-capita tonnes in selective waste collection
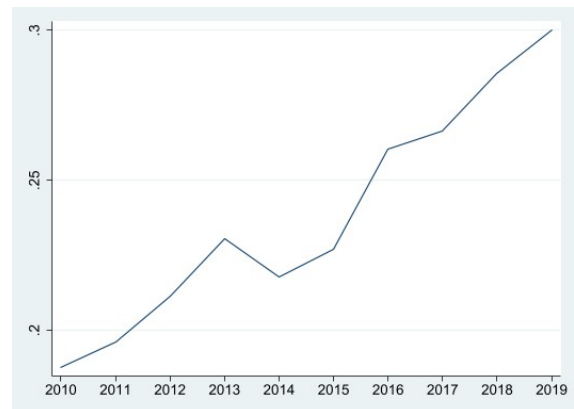
Note. The graphs report the mean, over municipalities, of the percentage of selective waste collection (B.2a) and of per-capita tonnes of selective waste collection (B.2b). Period: 2010-2019.

Figure B.3: Mean, over regions, of the percentage of selective waste and per-capita tonnes of selective waste collection in Apulia, Calabria, Campania, and Sicily. 2010-2019
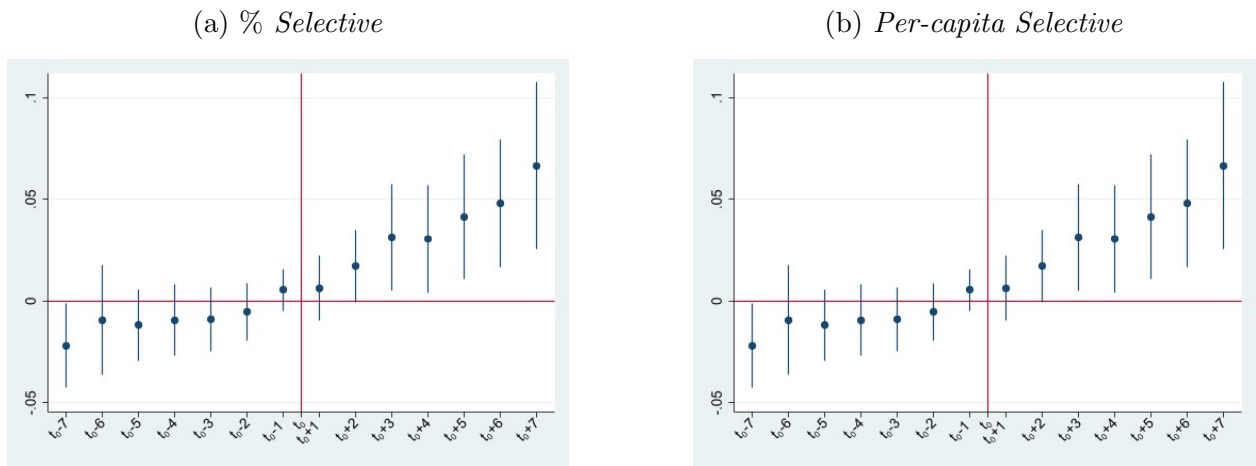
(a) Percentage of selective waste

(b) Per-capita selective waste
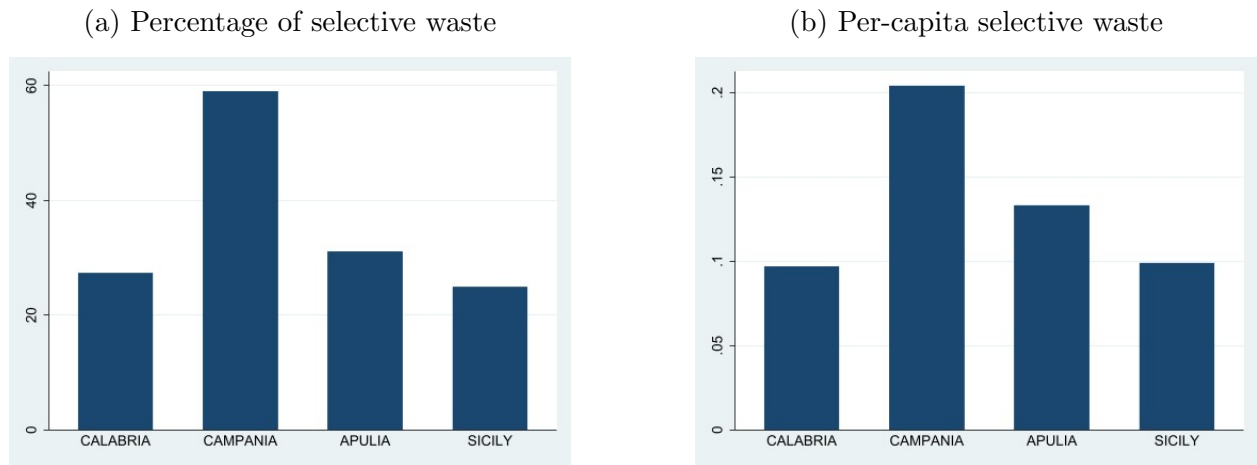
Note. The graphs report the mean, over municipalities in the same region, of the percentage of selective waste collection (Graph B.3a) and of per-capita tonnes of waste collected (Graph B.3b) in the four regions of analysis of Apulia, Calabria, Campania and Sicily. Years 2010-2019.

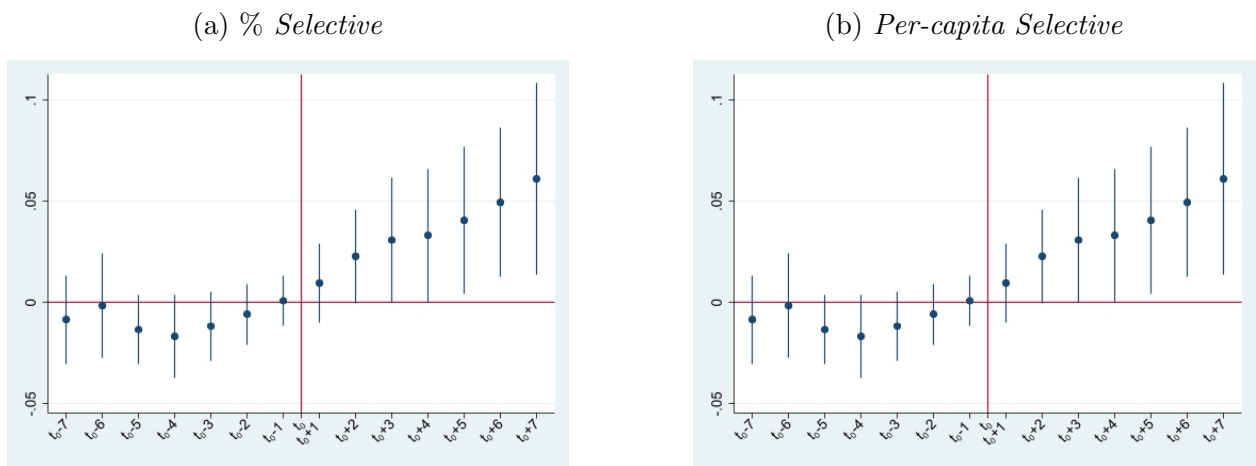Figure B.4: Event study - Italy
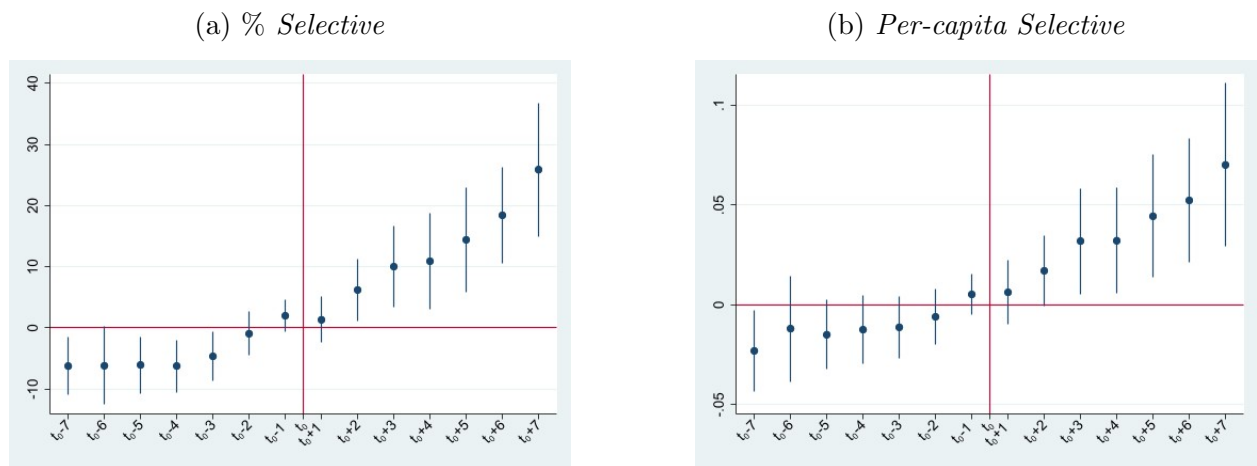
(a) *% Selective*

(b) *Per-capita Selective*

Note. The Graphs report coefficients and confidence intervals estimated according to specification as in eq. 2. Dots refer to point estimates, spikes to 95% confidence intervals. In Graph B.4a the dependent variable is the percentage of selective waste collection; in Graph B.4b the dependent variable is the per-capita tonnes in selective waste collection. The omitted category is the election year that appointed the dissolved administration (t_0). The sample comprises all the Italian municipalities. Standard errors are clustered at municipal level. All regressions include municipality FE and year FE. Period: 2010-2019.

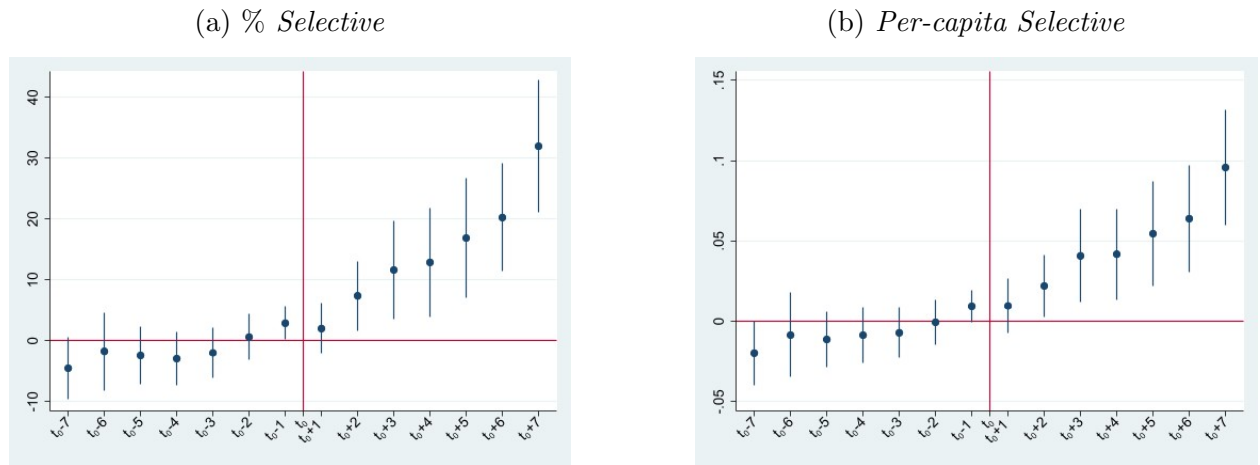Figure B.5: Event study - Dropping municipalities in provinces without city council dismissal

(a) *% Selective*

(b) *Per-capita Selective*

Note. The Graphs report coefficients and confidence intervals estimated according to specification as in eq. 2. Dots refer to point estimates, spikes to 95% confidence intervals. In Graph B.5a the dependent variable is the percentage of selective waste collection; in Graph B.5b the dependent variable is the per-capita tonnes in selective waste collection. The omitted category is the election year that appointed the dissolved administration (t_0). The sample comprises all the municipalities in the regions of Apulia, Calabria, Campania, Sicily and excludes from the control group municipalities in the provinces of Avellino, Barletta-Andria-Trani, Benevento and Enna. Standard errors are clustered at municipal level. All regressions include municipality FE and year FE. Period: 2010-2019.

Figure B.6: Event study - Dropping municipalities experiencing government early termination unrelated to mafia infiltration
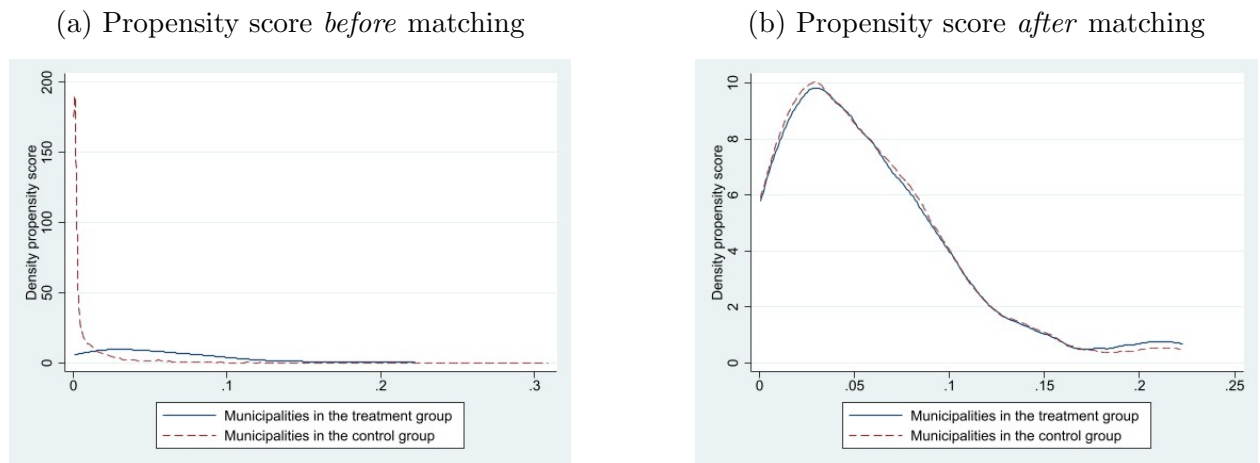
(a) *% Selective*

(b) *Per-capita Selective*

Note. The Graphs report coefficients and confidence intervals estimated according to specification as in eq. 2. Dots refer to point estimates, spikes to 95% confidence intervals. In Graph B.6a the dependent variable is the percentage of selective waste collection; in Graph B.6b the dependent variable is the per-capita tonnes in selective waste collection. The omitted category is the election year that appointed the dissolved administration (t_0). The sample comprises all the municipalities in the regions of Apulia, Calabria, Campania, Sicily and excludes from the control group municipalities experiencing government early termination for reasons unrelated to mafia infiltration. Standard errors are clustered at municipal level. All regressions include municipality FE and year FE. Period: 2010-2019.

Figure B.7: Event study - Dropping municipalities experiencing multiple government dissolution for mafia infiltration

(a) % *Selective*

(b) *Per-capita Selective*

Note. The Graphs report coefficients and confidence intervals estimated according to specification as in eq. 2. Dots refer to point estimates, spikes to 95% confidence intervals. In Graph B.6a the dependent variable is the percentage of selective waste collection; in Graph B.6b the dependent variable is the per-capita tonnes in selective waste collection. The omitted category is the election year that appointed the dissolved administration (t_0). The sample comprises all the municipalities in the regions of Apulia, Calabria, Campania, Sicily and excludes municipalities experiencing multiple government dissolution for mafia infiltration. Standard errors are clustered at municipal level. All regressions include municipality FE and year FE. Period: 2010-2019.
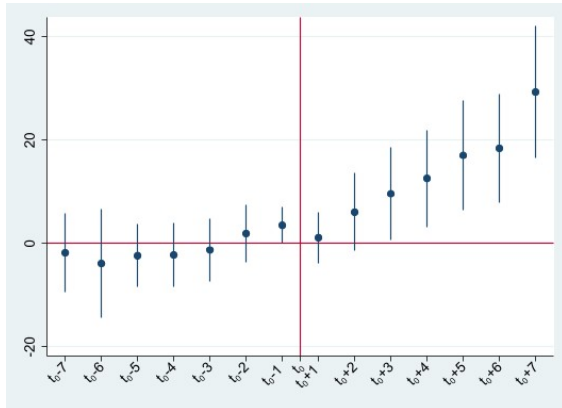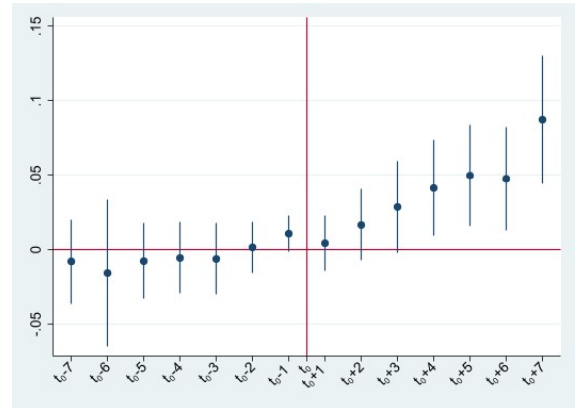
Figure B.8: Propensity score graphs

(a) Propensity score *before* matching

(b) Propensity score *after* matching

Note. Overlap in propensity scores in treated and matched samples of municipalities before and after the propensity score matching.

36

Figure B.9: Event study - Propensity score matching

(a) *% Selective* (b) *Per-capita Selective*

Note. The Graphs report coefficients and confidence intervals estimated according to specification as in eq. 2. Dots refer to point estimates, spikes to 95% confidence intervals. In Graph B.9a the dependent variable is the percentage of selective waste collection; in Graph B.9b the dependent variable is the per-capita tonnes in selective waste collection. The omitted category is the election year that appointed the dissolved administration (t_0). The control group comprises municipalities selected according to the propensity score matching procedure. Standard errors are clustered at municipal level. All regressions include municipality FE and year FE. Period: 2010-2019.