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Augusto Cerqua Nadia Fiorino Emma Galli

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SAPIENZA - UNIVERSITY OF ROME
P.le Aldo Moro n.5 – 00185 Roma T(+39) 0649910563
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Do Green Parties Affect Local Environmental Outcomes?

Augusto Cerqua†*, Nadia Fiorino§, Emma Galli†

Abstract: We explore whether mayors supported by pro-environmental parties enhance local environmental outcomes compared to their non-environmental counterparts. We study close elections within a regression discontinuity design and find a notable rise in recycling rates in Italian municipalities governed by pro-environmental coalitions. This uptick becomes far less pronounced when adopting broader criteria to define green mayoral candidates. Crucially, the enhanced recycling rates are not realized through augmented budgets for environmental initiatives or waste collection, but rather are primarily attributed to the implementation of local policies, such as on-call waste collection and the establishment of waste collection centers.

Keywords: Politicians; Green parties; Partisan politics; Environmental policies; Political economy; Regression discontinuity design.
JEL-Codes: H7; Q2; C21.

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† Department of Social Sciences and Economics, Sapienza University of Rome, Italy.
§ Department of Industrial and Information Engineering and Economics, University of L'Aquila, Italy.
* Corresponding author. Email: augusto.cerqua@uniroma1.it

1. Introduction

In recent decades, economic growth and progress have contributed to a worldwide increase in the quantity of waste generated, leading to issues related to land use, health problems, global warming, and concerns about environmental quality. At supra-national, national, and local government levels, it is vital to address the growing environmental damage caused by waste and its management (Paavola, 2007; Nordhaus, 2019). In recent years, European countries have made substantial progress toward more sustainable management of solid waste. These developments have been supported by EU policies and regulations, which set binding waste targets and rules to reduce waste generation, providing Member States with the tools they need to transition from linear production-consumption models to circular patterns (a key example being the 2008 EU Waste Framework Directive). However, while effective waste management requires coordinated international action, policy implementation occurs at the local level with regard to resources, production processes, technologies, and monitoring, which are closely related to territorial specifics. Consequently, waste management emerges as a critical issue in local policy-making. Our paper sheds light on the drivers of local waste management policies by investigating the link between pro-environment parties and environmental outcomes at the municipal level in Italy. We aim to verify whether mayors supported by pro-environment parties lead to an increase in the share of recycled waste and spending on waste collection and other environmental items.

This paper falls within a wide debate that has long revolved around the connection between parties' electoral platforms and government policies (*program-to-policy linkages*). The literature in the field develops along slightly different approaches—the mandate, partisan, agenda-setting, and saliency theories. According to the mandate theory (e.g., McDonald and Budge, 2005), voters give a mandate to political parties based on the platforms they present during election campaigns. Representatives know that they are expected to fulfill their promises during their term if they do not want to be punished by voters in subsequent elections. In this perspective, the resulting expectation involves a high degree of congruence between the platforms of parties in power and the content of their decisions. The tradition of partisan theory (or the *parties-do-matter* view), introduced by Hibbs in 1977 (see Potrafke, 2017, for a survey), highlights how the ideology of politicians shapes economic policy-

making. The central idea is that political candidates (parties) win elections to implement policies that are broadly consistent with the preferences and interests of their core constituencies. The saliency theory examines the congruence between the emphasis that parties place on different policy issues and the related government spending patterns (Klingemann et al., 1994; Thomson, 2001). Finally, studies in agenda setting (e.g., Jones and Baumgartner, 2005; Baumgartner and Jones, 2015) also acknowledge the relevance of electoral platforms. Nevertheless, they point out that the transposition of electoral priorities in policy results may be constrained by several factors. These include the cognitive limits of policymakers to deal simultaneously with abundant policy problems, institutional friction (Baumgartner and Jones, 2005), and complex interactions between majority and opposition parties, which may lead ruling parties to accept the issues emphasized in the opposition's platform to maximize their reelection chances (Green-Pedersen and Mortensen, 2010). Our paper connects with all these approaches with a focus on environmental policies.

Empirical research almost exclusively analyzes national policy-making (Neumayer 2003, 2004; Dalton 2009; Carter 2013; Bäck et al. 2015; Schulze 2014; Jahn 2016; Facchini et al. 2017; Schulze 2021; Boly et al. 2023), typically related to climate, energy, and pollution policies. The evidence is inconclusive. Some studies have associated left-wing governments with more climate policies and better climate performance (Garmann 2014; Neumayer 2003; Tobin 2017), while others have failed to identify significant ideological differences regarding environmental policy (Bayer and Urpelainen 2016; Jensen and Spoon 2011; Ward and Cao 2012). Hage et al. (2018) found evidence that the presence of the Green Party in government weakly affected waste recycling policies in Sweden. Likewise, Folke (2014) showed that under proportional representation systems, small parties focusing on specific policies, such as environmental policy, affect the specific policy outcomes. Recent studies have focused on the effect of upcoming elections on environmental policies and on various local government behaviors regarding waste management in Europe. Benito et al. (2017) showed that in Spain, incumbents exhibit opportunistic tendencies, increasing waste spending in the year leading up to an election and then reducing it during and after the election. In contrast, Cerqueira and Soukiazis (2022) discovered that in Portugal, recycling practices are not swayed by the political ideology of the local government. Additionally, Ferraresi et al. (2023) found that

Italian provinces tend to mirror the waste recycling collection practices of neighboring provinces.

To the best of our knowledge, our paper presents the first study that investigates the link between parties expressly supporting environmental protection in their political platforms and environmental policy outcomes at the local level. Moreover, we adopt an alternative approach to the existing literature by applying a counterfactual method: the non-parametric robust bias-corrected regression discontinuity design (RDD) with covariate adjustment (Calonico et al., 2019). We focus on local elections held between 2011 and 2019 (although we use data from 2010 to 2021) decided by a narrow margin of victory, since the characteristics of candidates who win or lose close elections are likely comparable on average. As an important innovation, we develop several definitions of green mayoral candidates based on the support received by "green parties" or "green local lists," which guards against potential distortions due to an arbitrary selection of pro-environmental mayors.

We observe evidence of an increase in the proportion of waste recycling only when adopting the strictest definition of a green coalition. We also detect no impact on municipal budget items. We then delve into the crucial question: how did pro-environmental mayors achieve this? Our findings suggest that the surge in recycling rates predominantly occurs during the mayor's first term and that it is largely due to the initiation of local policies such as on-call waste collection and the establishment of waste collection centers. These results support the hypothesis that a high degree of congruence exists between the platforms of ruling parties and their decision-making at the local level, as posited by mandate theory. The findings further corroborate the viewpoint that political parties significantly influence local environmental governance. This influence, however, does not necessarily translate into increased government expenditure on environmental policy matters.

The remainder of the paper is organized as follows. Section 2 illustrates the institutional background. Section 3 describes the data sources and outlines the empirical methodology. Section 4 focuses on the results, while the investigation of potential mechanisms is discussed in Section 5. The final section concludes.

2. Institutional background

Public governance in Italy is multilevel. Below the central government, there are 20 regions, 93 provinces, 14 metropolitan districts, and 7,904 municipalities as of 2021. Municipal administrations feature a deliberative branch—the municipal council (*consiglio comunale*), which also approves the municipal budget—and an executive branch—the executive committee (*giunta comunale*) chaired by the mayor (*sindaco*). In terms of political representation, the municipal council and the mayor are directly elected by the voters, while the executive committee is appointed by the mayor.

Municipal elections take place every five years, although the timing of electoral cycles is not aligned for all municipalities, since a large subset of municipalities hold elections each year. Since 1993 (Italian Law no. 81/1993), the electoral system for municipalities has included direct elections for the mayor. In small municipalities (less than 15,000 inhabitants) mayors are elected in a single ballot, while in larger municipalities (those with more than 15,000 inhabitants) there is a runoff stage among the two candidates with the most votes if no one wins more than 50% of votes in the first stage. The reform law of 1993 also introduced a limit of two consecutive terms for mayors.[1]

Municipal councils are elected through an open-list proportional representation system. Each mayoral candidate is tied to a single list for municipalities with less than 15,000 inhabitants and to several lists in larger municipalities. This implies that mayoral candidates in larger municipalities are often supported by visible multi-party coalitions, while coalitions tend to be grouped into ad hoc unitary lists in smaller municipalities. It is worth noting that this process occurs before the elections, and is reported during the election campaign and on the ballot; coalition reconfigurations are not possible after the elections. The majority of seats on the council are automatically assigned to the list(s) tied to the winning mayor: 60% for large municipalities and two-thirds for small municipalities.

Municipal expenditures are financed through grants from the central state, regions, and provinces. Municipalities can also levy taxes and tariffs. The main sources of municipal revenues are: *a)* local property taxes (IMU and TASI); *b)* TARI, a tariff that fully covers the

[1] In the period under analysis, three consecutive terms were allowed only in the smallest municipalities, namely those with up to 3,000 inhabitants.

costs of waste collection and disposal;[2] and *c)* a surcharge on the national personal income tax.

Municipalities are responsible for the local police, the provision of public housing, transportation, nursery schools, assistance for elderly people, and a number of public services (such as road maintenance, waste collection, and sewage) that have a significant impact on citizens' daily lives. Waste management, which is a crucial issue at the international and national levels, is increasingly becoming a key aspect of the municipal political agenda as well. In accordance with the waste management strategy established by the EU through waste reduction targets and rules to decrease waste generation (see the Waste Framework Directive 2008/98/EC revised in 2018), municipalities play a crucial role in shifting towards the circular economy.

Along with specific rules introduced by the EU, the main law on waste management is the Environmental Consolidation Act (the so-called Environmental Code, i.e., Italian Legislative Decree 152/2006). This code divides areas of competence regarding environmental matters between the regions, provinces, and municipalities. The regions are responsible for preparing, adopting, and updating the waste plan and for regulating waste management activities (Article 196). They also set the general rules and main goals for waste management by the municipalities. The provinces supervise the waste management process, as well as brokerage and trade activities (Article 197). Finally, the municipalities implement the operational strategies. In fact, they choose the management system and all policies to address the targets set by the highest level of authorities (Article 198) (Bonelli et al., 2016). To support this activity, the municipalities allocate part of their budgets to specific expenditures for waste, included in the function "Sustainable development and protection of the territory and the environment." This item includes the collection, transport, and disposal of waste, as well as the cleaning of streets, squares, and avenues. In addition, expenditures for service and program contracts with environmental hygiene companies are

[2] Municipalities possess a certain degree of discretion concerning this specific form of environmental taxation. However this discretion is somewhat limited because it depends on parameters standardized at the national level, such as the land registry income of the property.

included. The municipal waste collection and disposal service is financed through a local taxation system and is usually entrusted to a private, public, or mixed company.

2.1 Green Parties in Italy

In the 1980s, the severity of the environmental crisis and its repercussions, shifts in societal values, and the growing inadequacy of party systems to address emerging political needs spurred the emergence of green parties in several European countries (Biorcio, 2016). In Italy, the inaugural national assembly to establish the Green Lists took place in December 1984. By the 1985 regional elections, the Green Lists had representation in 12 regions, garnering over 600,000 votes. By November 1986, the *Federazione delle Liste Verdi* (Federation of Green Lists) was formed, with participation from 70 local lists. This Federation, recognized institutionally as a party, secured 2.5% and 3.8% of the votes in the 1987 (national) and 1989 (European) elections, respectively. This surge in backing was largely a reflection of voter disillusionment with conventional parties with respect to environmental policies. However, owing to the Federation's challenges in political and organizational stability, coupled with growing concerns over other pressing issues such as corruption, the fiscal crisis, and institutional reforms, the electoral support for green parties dipped to 2.8% in 1992. The introduction of a predominantly majoritarian electoral system in 1993 for both national and local elections prompted the Greens to align with the center-left coalition. This alliance led them to secure governmental roles at the national, regional, and local tiers in 1996 and 1998. However, their electoral traction waned in the 1999 European elections, dropping to 1.8%. This decline was attributed to the electoral rivalry posed by the Radical Party and Democrats, who were backed by *Legambiente*, Italy's leading environmental organization. This drop in votes was perceived as a repercussion of the policies endorsed by the Federation while in government (Biorcio, 2016).

After the decline of the Greens in more recent years, the *Sinistra Ecologia Libertà* (Left Ecology Freedom) and the *Movimento Cinque Stelle* (Five Star Movement) have dedicated a considerable portion of their political platforms to the green economy and sustainable development (see Section 3). Furthermore, the *Liste Civiche* (commonly referred to as Local

Lists) play a significant role in Italian local elections.[3] These lists are not anchored to a particular political orientation but rather operate as ad hoc parties with a focus on local objectives, such as addressing local environmental issues. In light of their specific focus, local lists with an environmental orientation have the potential to enhance the efficacy of municipal waste collection practices. One example of a green local list is *Civica AmbientaLista*, a list composed of "*citizens who, in the committees and active citizenship of Milan, have been fighting for years to defend the soil, greenery, nature, and history of their neighborhoods.*" The list collected 0.6% of the votes in the 2021 elections in Milan.

3. Data and Method

3.1 Data

We collected data from the historical electoral archive of the Ministry of the Interior on all municipal elections held between 2011 and 2019 in the fifteen ordinary statute regions, plus Sardinia.[4] For each election, we have data on several covariates, including the number of votes garnered by each party, local list, or coalition, as well as the total number of votes received by each mayoral candidate. In our empirical analysis, a mayor is classified as "green" if they are supported by at least one green party or green local list. However, recognizing that any definition of "green mayoral candidate" can be viewed as somewhat arbitrary, we introduce three alternative definitions of green political entities ranging from narrow to inclusive interpretations. This approach is a significant departure from the existing literature, since most studies use less nuanced definitions of environmental parties. For instance, some research categorizes all left-wing parties as green (e.g., Bivand and Szimanski, 2000; Ferraresi et al., 2023).

Definition 1: This includes all local lists that explicitly reference the words "Green," "Ecology," or "Environment" in their names (identified via text-mining). In addition,

[3] Over 50% of candidates, particularly in small municipalities, are solely backed by a local list.

[4] There are five Italian regions with special status (Aosta Valley, Trentino-South Tyrol, Friuli-Venezia Giulia, Sicily, and Sardinia) that have particular forms and conditions of autonomy. This also applies to the management of electoral data, except for Sardinia. For this reason, the historical electoral archive by the Ministry of the Interior includes no municipal elections information for the period under analysis on Aosta Valley, Trentino-South Tyrol, Friuli-Venezia Giulia, and Sicily.

two political parties with an overtly green designation in their names are considered: the Federation of the Green Lists and Left Ecology Freedom.

Definition 2: This incorporates all entities from Definition 1 and adds two more parties—*Italia dei Valori* (Italy of Values) and the Five Star Movement (where one of the stars represents the environment). Both of these parties dedicate over 10% of their political manifestos to green issues. The Manifesto Project provides this data, assessing party preferences on specific policies by examining the focus and space allocated to certain topics within electoral manifestos.

Definition 3: This expands on Definition 2 by incorporating parties that scored between 0 and 3 on the 0-to-10 scale of the Chapel Hill Expert Survey (CHES). A score of 0 signifies "*strong emphasis on environmental protection even at the cost of economic growth*" (see Table 1). The CHES dataset hinges on expert opinions regarding the ideological and policy stances of major European political parties. Based on the CHES findings, pro-environmental parties predominantly align with the left-wing. For instance, in 2014, the Left Ecology Freedom party received a pro-environmental score of 1.6. Similarly, the anti-elite party, the Five Star Movement, secured an environmental score of 1.8 that year. The CHES classification accounts for shifts in party stances on the anti-/pro-environmental spectrum and is updated periodically. In our analysis, we consider updates from 2010, 2014, and 2019. Parties are assigned scores that are closest in time.

|TABLE 1 HERE|

In relation to our research question, we only consider elections where a candidate backed by a pro-environmental coalition either won or secured the second position. Furthermore, we exclude municipalities affected by earthquakes that occurred within the study period, as it would be challenging to distinguish the specific policy effects on environmental outcomes from the measures implemented in response to a natural disaster.[5] Of the 11,878

[5] In particular, we consider the earthquakes that hit L'Aquila in 2009, Emilia in 2012, and Central Italy in 2016, and we drop all municipalities affected by the earthquake with an intensity greater than 5 according to the Modified Mercalli Intensity scale (see Belloc et al., 2016). It is important to note that only a dozen of these municipalities had a candidate supported by a pro-environmental coalition who won or came in second.

elections in our database, 418, 648, and 811 elections meet the previously mentioned criteria according to Definitions 1, 2, and 3, respectively. We subsequently structure our database with respect to municipality and year. This implies that the causal effect we are interested in is the average annual impact of electing a mayor backed by a pro-environmental coalition on environmental outcomes throughout the electoral cycle. However, we also investigate how this impact changes over the electoral cycle.

|TABLE 2 HERE|

We gather and process data from multiple sources. Initially, we use individuals' observed behavior in waste disposal as a proxy for residents' environmental preferences. Recycling is regarded as pivotal in mitigating global environmental harm: waste sent to landfills elevates methane emissions, leads noise and odor pollution, and can contaminate groundwater (Abbott et al., 2011). To gauge household participation in waste management, we concentrate on recycling rates. Specifically, we consider the proportion of recycled waste to total waste generation, which is the most common indicator in the literature (Briguglio, 2016). Data on recycling rates is sourced from regional environmental protection agencies and subsequently provided by the Italian National Institute for Environmental Protection and Research (ISPRA) for the period between 2010 and 2021. ISPRA also publishes data on waste generation separated by type of recycled material, information that is instrumental in further exploring our research question. In addition, data provided by the database OpenCivitas, an initiative promoted by the Ministry of Economy and Finance, allows us to assess whether municipalities changed their waste collection policies—e.g., by implementing door-to-door collection—and the overall performance of waste collection.[6] Second, to measure the environmental policy of the mayors, we collect several environmentally-related variables from municipalities' accounts: i) the share of environmental expenditure (expenditure on environmental measures and maintenance of

[6] OpenCivitas is a project instituted with Italian Law 42/2009 and Italian Legislative Decree 216/2010. The aim is to define the standard expenditure needs for Italian municipalities in relation to territorial features and sociodemographic characteristics of the resident population. Data are collected through a detailed questionnaire administered to municipalities (excluding those in regions with special status) in different waves. In the last two waves—i.e., 2018 and 2019—the questionnaire was enriched with questions on waste collection methods, which allowed waste collection performance indexes to be computed based on the costs and quality of the services.

common areas); ii) the share of expenditure for waste management (expenditure for the waste collection service and to maintain the facilities required for waste collection and disposal); iii) the share of revenue collected through the waste disposal tax (TARI). These data come from the financial statements of Italian municipalities made available by the State General Accounting Department of the Italian Ministry of Economy and Finance and concern the years 2010–2021.

Table 2 presents the descriptive statistics for all elections, as well as for each election subset delineated by the three definitions of green mayoral candidates. The table indicates that at the time of the election, the average percentage of recycled waste hovered around 50%. Furthermore, green mayoral candidates tend to emerge in larger municipalities. For instance, under Definition 1, the average municipality size stands at 69,000 inhabitants, which is eight times the size of the typical Italian municipality. This suggests that our analysis includes only a limited portion of small municipalities (e.g., less than 10% as per Definition 1).

3.2 Empirical Strategy

Through electoral selection, political parties/coalitions may choose mayoral candidates based on the specific electoral setting and quality of local politicians. This means that elected mayors have, on average, a greater ability and appeal than their competitors. Failing to control for these differences can lead to biased estimates of the causal effect of interest. Therefore, to properly isolate the causal impact of green mayors on environmental outcomes, we focus on elections decided by a narrow margin of victory, since it can be shown that candidates who win and lose close elections are, on average, comparable in all observable and unobservable characteristics. In this setting, identification, estimation, and inference proceed by comparing environmental outcomes in municipalities with candidates supported by one or more pro-environmental parties that won by a close margin (treatment group). The municipalities where candidates with the same characteristics lost by a close margin are used as the comparison group. For this type of design, the most suitable estimator is the regression discontinuity design (RDD), while the parameter of interest is β, the local average treatment effect (LATE), which reflects the causal impact of pro-

environmental parties on environmental outcomes (Y_i) in close municipal elections. We use the following RDD specification:

$$Y_i = \alpha + \beta D_i + f(x_i) + \gamma Z_i + \varepsilon_i, \forall x_i \in (-h, +h),$$

where D_i represents the treatment dummy (equal to 1 if the pro-environmental candidate wins the election), x_i the forcing variable—i.e., the pro-environmental party margin of victory—Z_i the control covariates, h the bandwidth, and ε_i the error term. Following Lee (2008), we define the forcing variable as the majority margin for the coalition receiving the most votes with respect to the runner-up in the first round or second round (for municipalities with > 15,000 inhabitants in which none of the candidates received > 50% in the first round). The pro-environmental coalition wins the election when the variable "pro-environmental party vote share margin of victory" crosses the 0 threshold ($x_i > 0$), otherwise it loses the election ($x_i < 0$).

This study employs the non-parametric robust bias-corrected estimator with covariate adjustment proposed by Calonico et al. (2019). Hyytinen et al. (2018) show that bias-corrected RDD estimates that apply robust inference approximate experimental estimates in the context of close elections. In addition, this approach does not rely on parametric assumptions, and it offers a good compromise between flexibility and simplicity when approximating the unknown regression function (Cattaneo et al., 2020a). Key aspects of the non-parametric RDD are the choice of the bandwidth and the kernel function that is used to weigh the observations. For each non-parametric local linear regression, the bandwidth h is selected using the mean squared error (MSE)-optimal bandwidth selector, while observations within h are weighted according to the triangular kernel. This implies that only observations within h receive a positive weight in the estimation, with a larger weight given to closer elections. Moreover, the inclusion of the covariates Z_i in the RDD analysis brings about substantial gains in efficiency relative to the unadjusted RDD estimator, leading to shorter confidence intervals for the RDD treatment effect (Cattaneo et al., 2020a). In particular, we control for pre-electoral values of the dependent variables and a dummy variable for the second round, population, turnout in the last European elections, share of votes for Green parties in the last national elections (according to the CHES classification reported in Table 1), income per capita, share of workers in accommodation activities,

financial accounts (expenditure rigidity index and degree of spending autonomy), and mayoral traits (gender, age and education).[7] We also add regional fixed effects and year fixed effects to control for potential time-varying differences in regional waste plans. By controlling for pre-electoral values of the dependent variables, we basically implement a difference-in-discontinuities design (see Grembi et al., 2016), which increases accuracy and ensures that our estimates also remain valid in situations of pre-treatment imbalance of the dependent variable. All regressions are estimated with errors clustered at the municipality level.

3.3 Validity of the RDD Assumptions

The RDD estimator relies on two key assumptions:

i) Only mayoral candidates receiving the most votes will become mayors;
ii) Parties and candidates do not have complete control over the share of votes they receive, so their victory can be considered almost random in close elections.

While the first assumption is automatically verified in a democratic country like Italy, it is important to test the validity of the second RDD assumption in our context. First, we verify the absence of pre-treatment discontinuities at the margin of victory threshold with respect to the covariates described in Section 3.1 for Definition 1. Figure 1 shows the differences at the threshold of the standardized coefficients alongside 90%, 95%, and 99% confidence intervals obtained using the Calonico et al. (2014) optimal bandwidth selector. As expected, there are no significant discontinuities at the threshold. We then test for the presence of sorting—i.e., we investigate the smoothness of the forcing variable around the threshold when a pro-environmental mayor ranks first or second. If mayoral candidates do not have precise control over the forcing variable around the cut-off point, the density distribution of the forcing variable should not exhibit any sharp changes around that point. Figure 2 shows the density of elections using the robust test of Cattaneo et al. (2020b). The evidence in Figure 2 is reassuring, since there is no sign of discontinuity at the threshold. Moreover, the

[7] We control for the proportion of workers in accommodation activities to account for the specific challenges touristic municipalities face during peak months, attributable to the surge in waste generated by tourists. Furthermore, we account for financial indicators and income per capita, since municipalities with well-managed finances and populated by high-income individuals are in a stronger position to tackle the challenges associated with waste management.

p-value (0.70) indicates that, as expected, there is no statistical evidence of sorting, i.e., mayoral candidates are unable to manipulate the electoral outcome.

Figures A.1 to A.4 in Appendix A show that the second RDD assumption also holds for the less restrictive definitions of green mayoral candidates.

|FIGURES 1 AND 2 HERE|

4. Results

As is usual with RDD, we begin with a graphical representation of our estimates. Figure 3 illustrates the impact of a winning pro-environmental coalition on the percentage of waste recycled for each category of green mayoral candidate. Each grey circle represents the average value of the dependent variable, binned at intervals of 0.01 vote margins. Candidates on the left side of the plots represent those endorsed by a pro-environmental coalition that did not secure an election win, whereas those on the right side were elected. These graphs suggest that the victory of a pro-environmental coalition is associated with an increase in recycling rates, which decreases with more inclusive definitions. However, none of the graphs show a clear jump at the threshold. To determine the size and statistical significance of these gaps, we use the rigorous non-parametric RDD method detailed in Section 3.2.

|FIGURE 3 HERE|

Estimates of the percentage of recycling rates derived from the non-parametric robust bias-corrected RDD estimator with covariate adjustment (Calonico et al., 2019) are reported in Table 3. Column (1) reports the estimates when using Definition 1, Column (2) when using Definition 2, and Column (3) when using Definition 3. The estimates show a sizable and statistically significant increase in the share of recycling rates (+ 10 percentage points) in municipalities led by a pro-environmental coalition when considering the most restrictive definition. However, the other columns in Table 3 show that this positive impact vanishes when considering less-restrictive definitions of green mayoral candidates.

|TABLE 3 HERE|

Thanks to the availability of disaggregated information on recycled items, we report the estimates by type of recycled item: glass, paper, organic, WEEE, bulky waste, plastic, textiles, and green waste (Figure 4). Each recycled item is calculated as a percentage of the total amount of waste. With respect to Definition 1, the figure shows that the extent of the impact is nonuniform across recycled items, with a sizable increase statistically significant at the 10% level in the percentage of organic waste (+ 4.89 percentage points). With regard to the other items, we observe a statistically significant increase at the 1% level in paper (+ 1.87 percentage points) and at the 5% level in bulky waste (+ 0.98 percentage points). With respect to Definition 2, the increase in the percentage of organic waste is still sizable (+ 4.01 percentage points) and statistically significant at the 5% level, while we observe no statistically significant increases in paper (+ 0.36 percentage points) or bulky waste (+ 0.57 percentage points). Finally, with the third definition, we find no statistically significant changes in the percentage of recycled waste over the total amount of waste.

|FIGURE 4 HERE|

Thanks to the availability of data from municipal accounts, we now investigate whether this increase in recycling rates was due to an increase in spending on environmentally-related balance sheet items. The estimates reported in Table 4 show that the positive results in terms of recycling rates obtained by pro-environmental local governments were obtained without a corresponding increase in costs. In particular, there is no evidence of differences with respect to the share of expenditure on the environment or waste management. Furthermore, the last rows in Table 4 show that pro-environmental local governments did not increase local waste collection taxes. However, because these balance sheet measures are analyzed as shares, it is still possible that green local governments modified their inflows and outflows in absolute terms. This is why we have added analyses on overall expenditures and revenues in Table 4, although we find no relevant changes in this respect.[8]

|TABLE 4 HERE|

[8] The only exception concerns Definition 3, with a statistically significant decrease at the 10% level in both expenditure and revenues associated with green local governments.

Given the relevance of these findings, we provide an in-depth analysis of their robustness in Appendix B. This appendix reports several robustness and sensitivity checks concerning the RDD specification, falsification tests, the weight assigned to observations of different sizes, the timing of the impact, and potential bias due to the possibility that some municipal unions might be in charge of waste management. Overall, these checks reaffirm that by adopting the strictest definition of a green coalition, we consistently observe a notable increase in the proportion of waste recycling without incurring additional costs. Concurrently, these evaluations reveal that even when employing Definition 2, the recycling rate estimates become statistically significant in several instances. Having confirmed the robustness of our results, we now delve into the interpretation of our findings.

5. Mechanisms

How did green mayors manage to increase the percentage of recycled waste without increasing budget expenditures? To address this pivotal question, we focus on the strictest definition of green local government, as it is the only one in which we find substantial evidence of enhanced recycling rates.

For a more in-depth understanding of the strategies employed by green mayors to increase the share of waste recycling, we scrutinized the OpenCivitas data related to waste collection services. This includes aspects such as the establishment of door-to-door collection and overall performance in waste collection. Unfortunately, the data for these variables is confined to the years 2018 and 2019. This limitation means that we cannot evaluate the 2019 elections due to the insufficient post-election time frame. Furthermore, the unavailability of pre-treatment values for these variables poses another challenge. However, considering the inherent properties of the RDD estimator, the absence of pre-treatment data should primarily result in reduced accuracy and efficiency rather than in biased estimates. The estimates corresponding to Definition 1 are detailed in Table 5.

This table offers valuable insights into the strategies green mayors employed to increase the percentage of recycled waste. As illustrated in Panel A, they attained this objective by enacting policies conducive to higher recycling rates. Specifically, there is statistical evidence suggesting that they were more inclined to initiate on-call waste collection services or establish waste collection centers. The latter finding might explain the increase in bulky

waste recycling seen in Figure 4. However, no significant data indicates a greater propensity for introducing door-to-door collection—likely because over 90% of the municipalities in our sample had already adopted this method by 2019. Concurrently, the estimates in Panel B underscore their success in significantly enhancing waste collection performance. It is worth noting, however, that these estimates are only marginally statistically significant, given the restricted number of observations.

|TABLE 5 HERE|

The actions taken by green local governments may vary based on their reelection incentives. When we narrow our sample to elections where green mayoral candidates are running for the first time, we observe that the recycling rate estimate remains statistically significant at the 1% level. Additionally, it increases slightly (+ 12.18 percentage points) compared to the estimate presented in Table 3. In contrast, for green mayoral candidates in their final term, the estimate is modest (+2.17 percentage points) and lacks statistical significance. Such a result could arise from an inability to further enhance local environmental outcomes in their second and final term or from a political strategy where local politicians prioritize environmental improvements primarily to bolster their reelection prospects.

Finally, municipalities have the capacity to initiate and promote awareness campaigns and educational projects to enhance environmental consciousness among their citizens. It is therefore possible that green local governments might have been more active than their non-environmental counterparts in running such campaigns, and this may have contributed to the increase in recycling rates. Unfortunately, it was not possible to test this hypothesis due to the unavailability of data on awareness campaigns for most of the municipalities under analysis.

6. Conclusion

Is there any congruence between partisan electoral programs and policy outcomes? Our paper investigated such *program-to-policy linkages* in environmental policies at the municipal level, analyzing the degree of congruence between the political platforms of parties that expressly support environmental protection and the environmental policy outcomes. Because waste management is a salient issue in local policies, we test whether mayors

supported by pro-environmental parties/local lists managed to increase the percentage of recycled waste and whether they spent a larger share of the municipal budget on separate waste collection and other environmental items compared to their non-environmental counterparts in Italy in the period 2010–2021. Implementing a recently developed RDD estimator, we compared the environmental policy outcomes in municipalities where the pro-environment candidate won or lost by small margins of victory. Our results show that municipalities led by a pro-environmental coalitions managed to increase recycling rates.

Another relevant finding is that the positive impact on recycling waste is observed only when considering municipalities led by mayors supported by "strictly" environmental parties or local lists. In other words, only when environmental protection is the key issue in the electoral platform do parties effectively translate their primary policy concerns into environmental outcomes. This finding supports the hypothesis that a high degree of congruence exists between the platforms of ruling parties and decision-making at the local level. At the same time, the absence of increased expenditure on environmental protection contradicts the main hypothesis posited by the saliency theory. It is also worth noting that only green mayors elected for the first time managed to boost recycling rates. This result suggests that the incumbent's engagement in environmental protection predominantly occurs during the first mandate.

Finally, we investigate how mayors managed to increase the percentage of recycled waste with constant budgetary expenditure. In this respect, we provide evidence that green mayors achieved their goals by implementing on-call waste collection services and the opening of waste collection centers. This result, far from being conclusive, suggests that the adoption of pro-environmental practices by enhancing citizens' civic engagement represents a relevant channel for improving recycling percentages without a significant increase in costs.

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Tables and Figures

Table 1 – Parties having a positive position towards environmental sustainability according to the CHES classification (score ≤3)

Party name (Italian)	**Party name (English)**	2010	2014	2019
Partito della Rifondazione Comunista	Newly Founded Communists	1.625	2	
Partito dei Comunisti Italiani	Italian Communist Party	1.4		
Italia dei Valori	Italy of Values	3		
Sinistra e Libertà; Sinistra Ecologia Libertà	Left Ecology Freedom; Left Freedom	1.17	1.6	
Sinistra Democratica	Democratic Left	1.67		
Federazione dei Verdi	Federation of Green Lists	0.29		
MoVimento Cinque Stelle	Five Star Movement		1.8	2.44
Sinistra Italiana	Italian Left			2.125

Notes: CHES classifies only the most representative parties in a given year. Considering the numerous changes in the Italian political landscape during the period analyzed, many parties are classified only in specific years.

Table 2 – Descriptive statistics

	All elections		Definition 1		Definition 2		Definition 3	
Variable name	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Percentage of recycled waste	53.204	23.252	47.139	21.484	49.055	21.138	49.312	21.271
Population	8,565.2	46,801.4	69,123.7	220,405.9	50,484.1	151,376.3	44,477.8	134,502.8
Share of second round elections	0.074	0.261	0.593	0.492	0.497	0.500	0.470	0.499
Turnout (%)	67.827	10.983	65.021	13.014	65.232	12.514	65.454	12.555
Votes for Green parties at the latest national elections* (%)	24.827	11.962	20.247	13.303	22.925	13.780	23.197	13.386
Income per capita (€)	17,860.3	4,164.0	19,574.8	3,956.8	19,525.6	3,732.8	19,448.1	3,813.4
Share of workers in accommodation activities	0.021	0.053	0.014	0.032	0.017	0.043	0.016	0.040
Share of environmental expenditure	0.221	0.098	0.248	0.093	0.244	0.094	0.246	0.090
Share of waste management expenditure	0.160	0.078	0.185	0.091	0.186	0.090	0.188	0.086
Share of waste disposal tax revenues	0.118	0.068	0.130	0.073	0.134	0.073	0.136	0.070
Elections held in the North (%)	52.95		46.89		41.36		39.46	
Elections held in the South (%)	31.88		38.28		42.90		42.17	
Number of elections	11,878		418		648		811	

Notes: All values refer to the year of the election. * Green parties are defined according to the CHES classification reported in Table 1.

Table 3 – Percentage of recycling rate estimates

	Definition 1	**Definition 2**	**Definition 3**
Coefficient	10.10***	4.32	-1.39
Standard Error	(3.74)	(2.81)	(2.61)
N^-/N^+	337/432	529/657	643/807

Notes: All estimates are non-parametric robust bias-corrected. The bandwidths for each non-parametric local linear regression are selected using the optimal data-driven method as per Calonico et al. (2019). In each regression we control for regional and yearly dummies, a dummy for second round and the pre-treatment values of: population, income per capita, share of recycled waste, share of workers in accommodation activities, share of environmental expenditure, share of waste management expenditure, share of waste disposal tax revenues, turnout and share of votes for Green parties at the latest national elections, financial accounts (expenditure rigidity index and degree of spending autonomy) and mayoral traits (gender, age and education). N− and N+ denote the number of municipality-year cases within the bandwidth below and above the threshold, respectively. ***p<0.01, **p<0.05, *p<0.1.

Table 4 – Environmentally-related balance sheet items from municipal accounts

	Definition 1	Definition 2	Definition 3
Dependent variable: Share of environmental expenditure			
Coefficient	0.0137	-0.0193*	-0.0028
Standard Error	(0.0174)	(0.0111)	(0.0099)
N^-/N^+	253/294	543/694	711/883
Dependent variable: Share of expenditure coming from waste management			
Coefficient	0.0066	-0.0051	0.0083
Standard Error	(0.0202)	(0.0118)	(0.0111)
N^-/N^+	273/332	524/647	677/817
Dependent variable: Change in the log of overall expenditure			
Coefficient	0.0466	-0.0229	-0.0605*
Standard Error	0.0446	0.0403	0.0311
N^-/N^+	229/281	398/505	677/817
Dependent variable: Share of revenues coming from the waste disposal tax (TARI)			
Coefficient	-0.0019	-0.0083	0.0019
Standard Error	(0.0131)	(0.0116)	(0.0098)
N^-/N^+	257/320	440/559	625/785
Dependent variable: Change in the log of overall revenues			
Coefficient	-0.0164	-0.0497	-0.0451*
Standard Error	(0.0459)	0.399	0.0267
N^-/N^+	200/239	365/435	563/710

Notes: See notes of Table 3. We have also used the absolute values of these variables instead of the shares but none of the estimates turns statistically significant. ***p < 0.01, **p < 0.05, *p < 0.1.

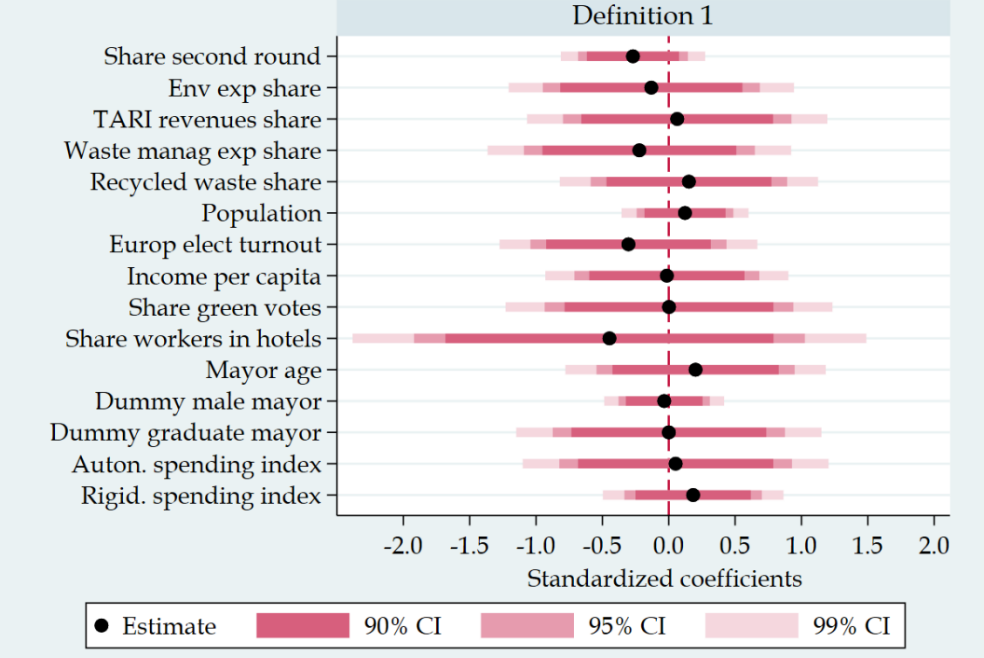
Table 5 – Waste collection services, costs and performance (Definition 1)

Panel A – Services				
	Door-to-door collection (dummy)	**Waste collection centre (dummy)**	**On-call waste collection (dummy)**	**Pay as you throw policy (dummy)**
Coefficient	-0.18	22.74**	15.19**	-11.70
Standard Error	(5.45)	(9.58)	(7.25)	(15.68)
N^-/N^+	37/40	40/48	37/39	51/56

Panel B – Costs and performance				
	Ranking costs	**Ranking performance**	**Performance by population size**	**More waste collection services (dummy)**
Coefficient	1.26	1.52	18.26	37.00*
Standard Error	(0.77)	(1.16)	(12.37)	(21.78)
N^-/N^+	46/48	49/51	57/55	42/48

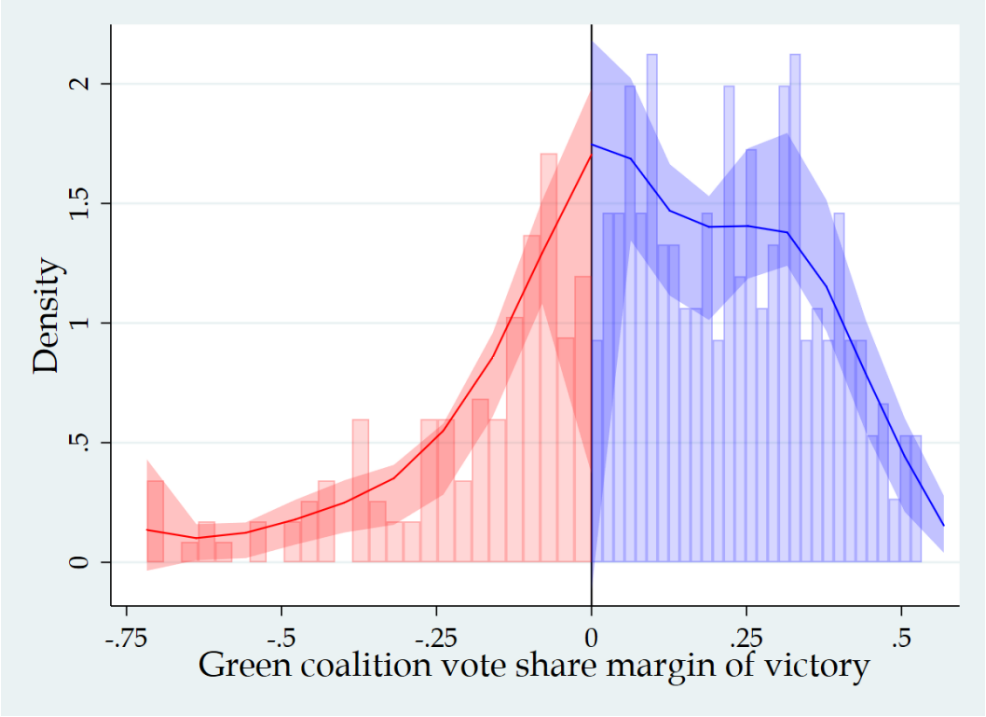
Notes: The range of variation of the ranking costs and performance variables goes from 0 to 10, while the variable performance by population size ranges from -100 to 100.

Figure 1 – Balance test of covariates at the margin (Definition 1)



Notes: The figure reports non-parametric standardized estimates of the discontinuity in covariates at the cut-off point with 90, 95 and 99 percent confidence intervals. The estimates are obtained using the Calonico et al. (2014) optimal bandwidth selector.

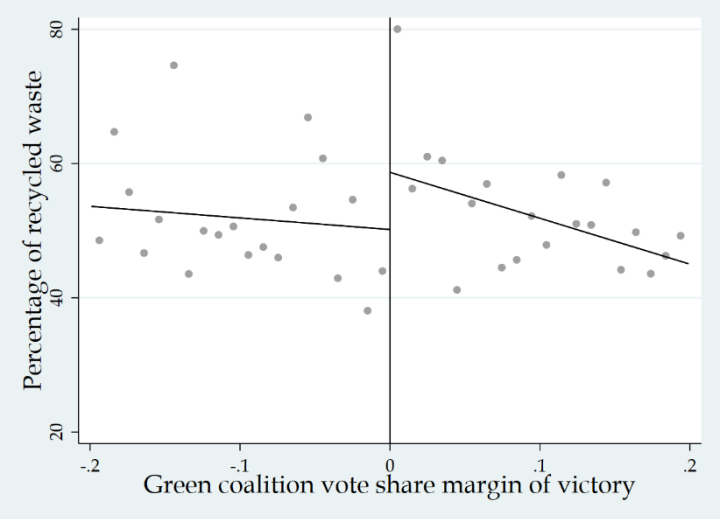
Figure 2 – Manipulation testing plot (Definition 1)



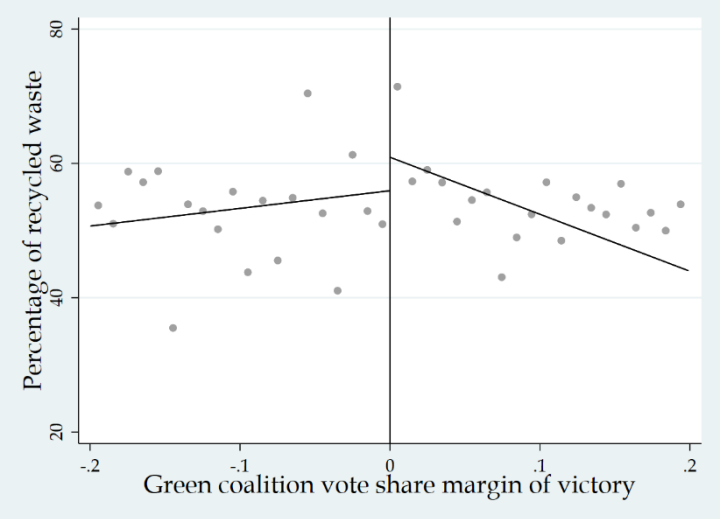
Notes: The test considers the 418 elections examined in the main analysis (Definition 1).

Figure 3 – Percentage of recycled waste around the threshold: RDD plots

Definition 1



Definition 2



Definition 3

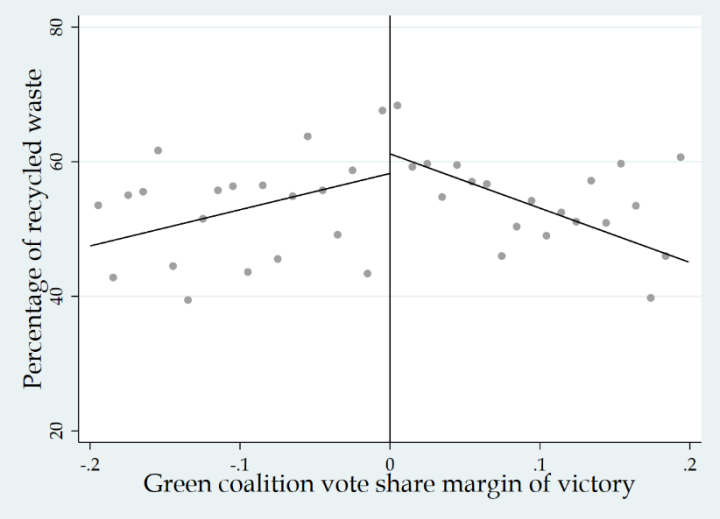
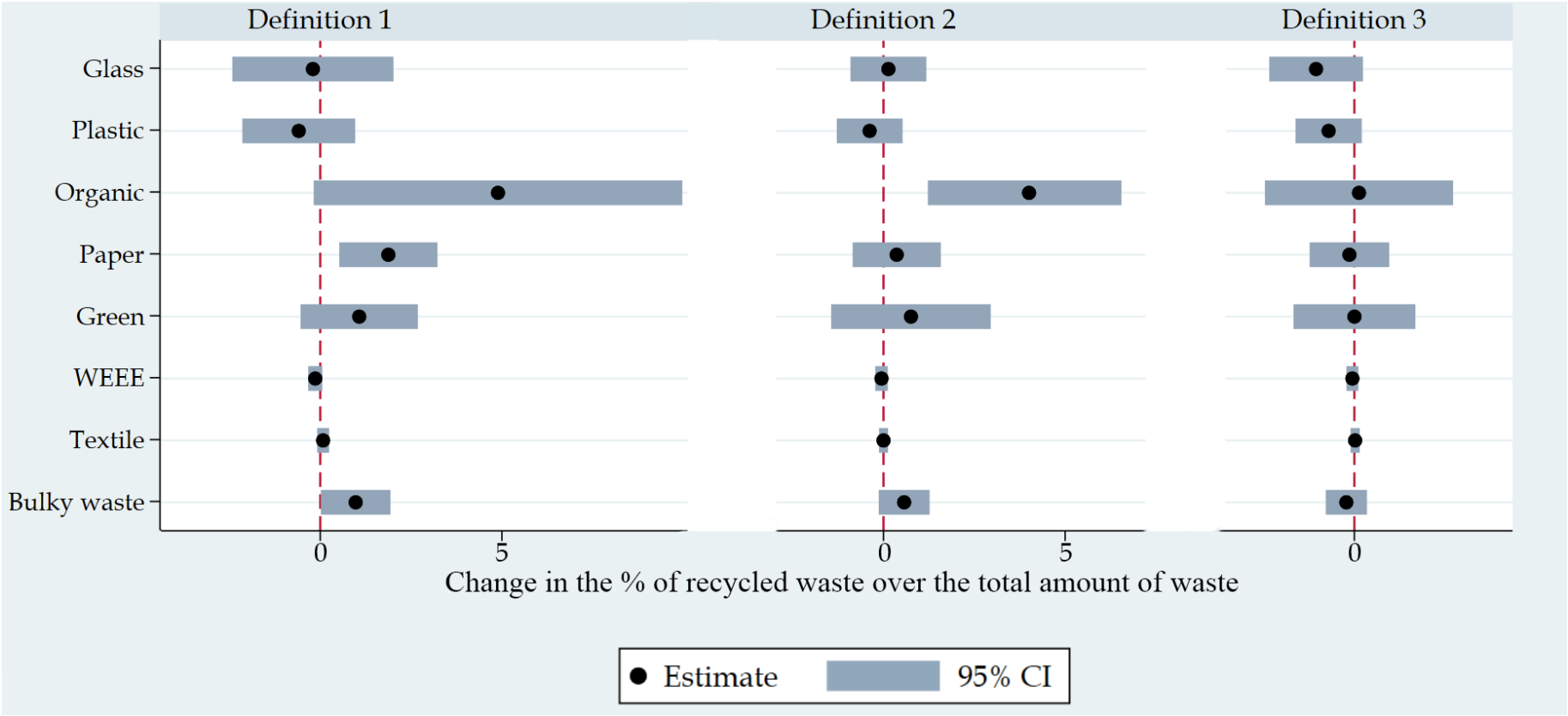


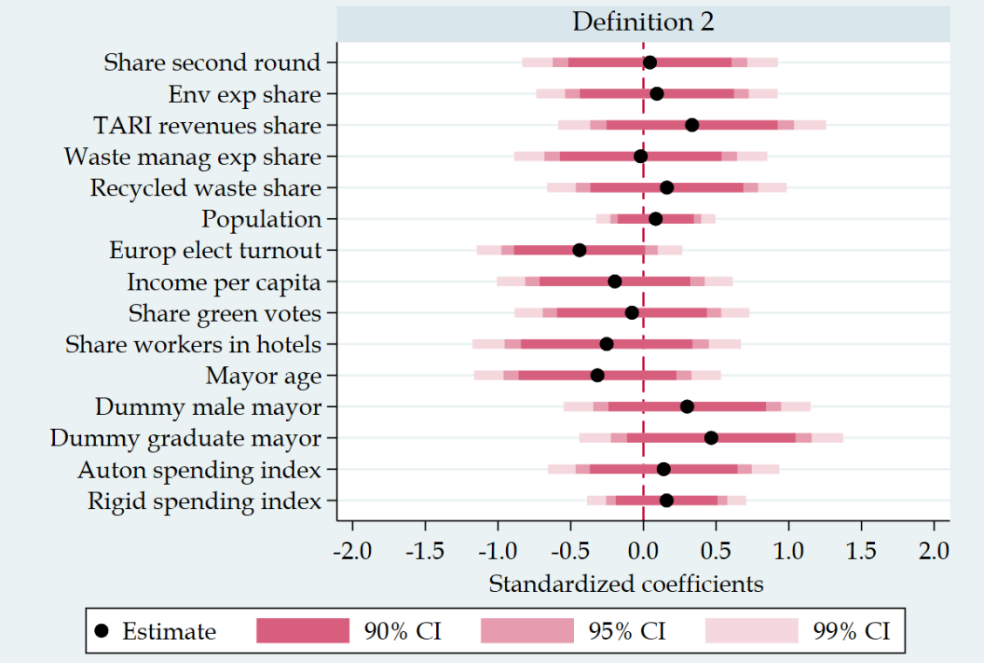
Figure 4 – Percentage of recycling rate by type of waste



Notes: WEEE stands for 'Waste from Electrical and Electronic Equipment'. All non-parametric estimates are robust bias-corrected. The bandwidths for each non-parametric local linear regression are selected using the optimal data-driven method as per Calonico et al. (2019). In each regression we control for regional and yearly dummies, a dummy for second round and the pre-treatment values of: population, income per capita, share of recycled waste, share of workers in accommodation activities, share of environmental expenditure, share of waste management expenditure, share of waste disposal tax revenues, turnout and share of votes for Green parties at the latest national elections. The figure reports point estimates with 95% confidence intervals.

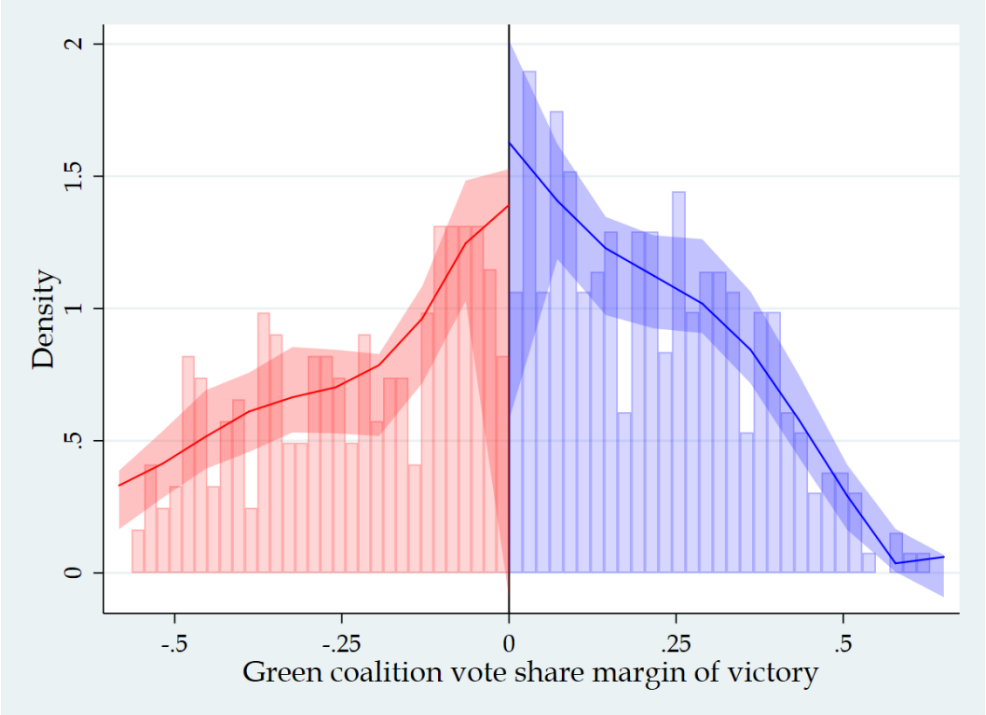
Appendix A – Validity of the RDD assumptions

Figure A.1 – Balance test of covariates at the margin (Definition 2)



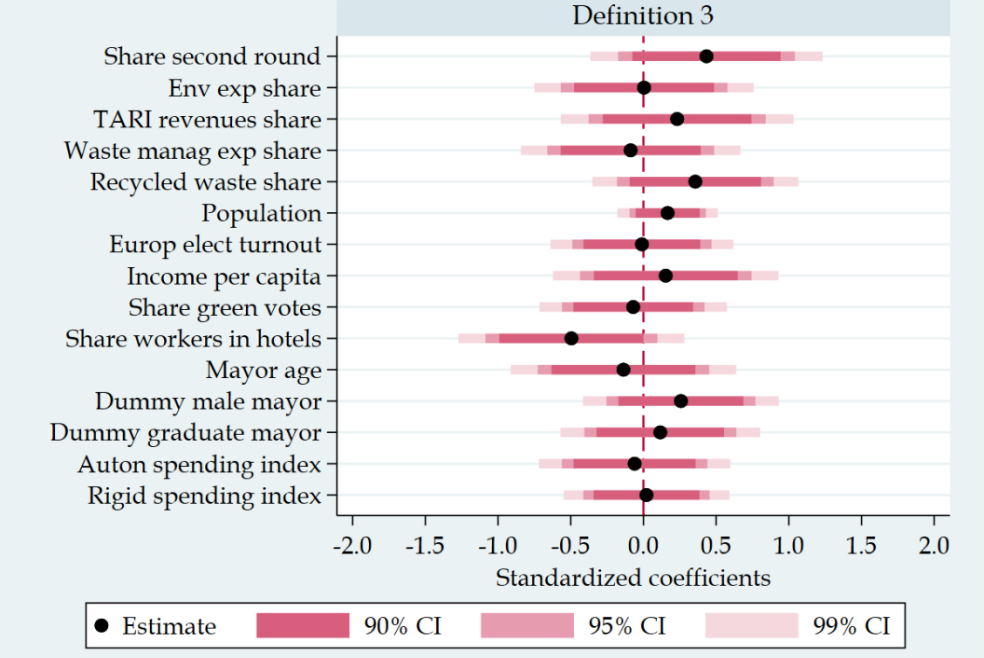
Notes: See notes of Figure 1

Figure A.2 – Manipulation testing plot (Definition 2)



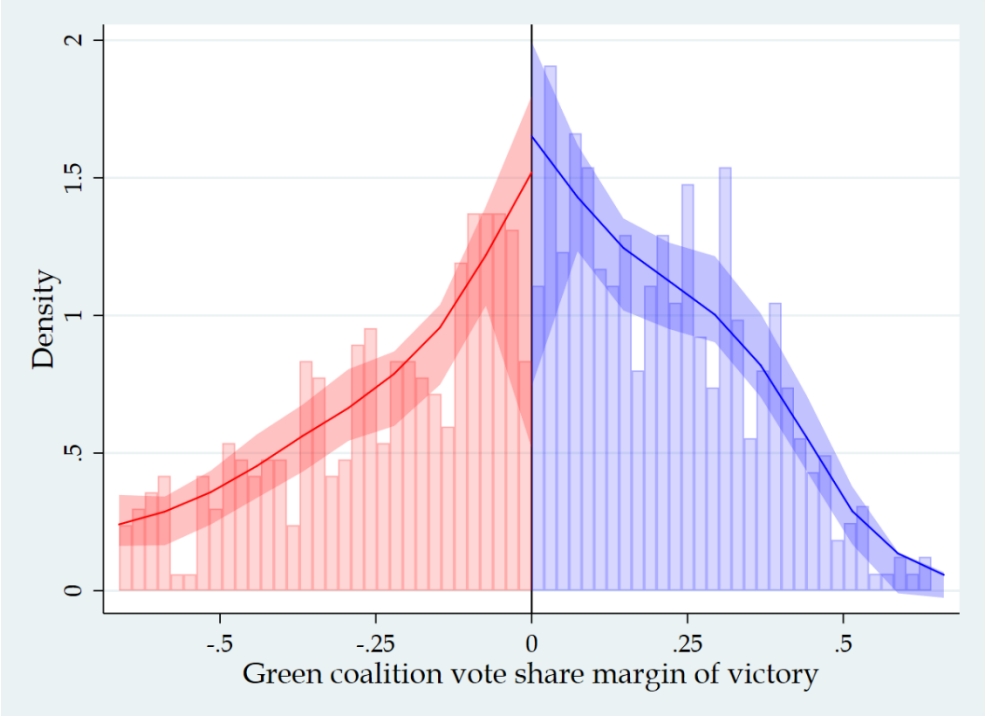
Notes: The test considers the 648 elections examined in the main analysis (Definition 2).

Figure A.3 – Balance test of covariates at the margin (Definition 3)



Notes: See notes of Figure 1

Figure A.4 – Manipulation testing plot (Definition 3)



Notes: The test considers the 811 elections examined in the main analysis (Definition 3).

Appendix B - Robustness

In this section, we present results derived from a comprehensive series of robustness and sensitivity checks. Detailed estimates are provided in Table B.1. This table encompasses all definitions under consideration and the two primary dependent variables analyzed: namely, the recycling rate percentage and the share of expenditure allocated to waste management. Table B.1 is organized into three vertical blocks of results, labeled (I)-(III). The first two columns provide estimates related to Definition 1. Columns (3) and (4) offer estimates based on Definition 2, while the final two columns present estimates corresponding to Definition 3.

Block (I) reports seven sensitivity checks related to the RDD specification. We first examine if our results hinge on the choice of bandwidth selection. Instead of using the Mean Squared Error (MSE) as the bandwidth selector, we employ the Coverage Error Rate (CER). Next, we assess the sensitivity of our estimates to the kernel function by opting for the Epanechnikov kernel in place of the triangular kernel. In the subsequent row, we investigate if our findings are sensitive to the order of the local polynomial. This is done by conducting the analysis using a local quadratic regression. Moreover, as control variables in an RDD should ideally play a secondary role, we anticipate potential discontinuities to still be evident even in an RDD specification without covariates. We present this no-covariate RDD specification in the fourth row of Block (I). Finally, as the non-parametric robust bias-corrected estimator uses a data-driven approach to select the 'optimal' bandwidth in each analysis, this means that each estimation includes a different number of units close to the threshold. Therefore, to make sure that this misalignment is not driving the differences across definitions, we repeat all the analyses using the 'optimal' bandwidth of each definition to the other definitions. These estimates are reported at the bottom of Block (I). Remarkably, all the estimates are closely aligned with those from our baseline specifications. However, it is noteworthy that the estimates concerning recycling rates—both from the local quadratic regression and the no-covariate specification—are more pronounced in magnitude for Definitions 1 and 2.

In Block (II), we conduct two falsification tests by adjusting the values of the forcing variable to create two arbitrary discontinuity thresholds that are not related to becoming mayor. Specifically, we shift the threshold by 0.05 points on either side, simulating a threshold for an anti-immigration candidate achieving a vote share of either 45% or 55%. Since these

thresholds are 'artificial', we would not anticipate observing any effects from these 'fake' treatments on the dependent variables, especially considering that the actual treatment status remains unchanged. Consistent with our expectations, none of these estimates prove statistically significant at the 5% level, reinforcing the credibility of our empirical methodology.

In Block (III), we perform three additional robustness checks:

i) Our first test involves a non-parametric RDD regression weighted by population size. This yields larger estimates for Definitions 1 and 2, which are statistically significant at the 1% and 10% levels, respectively. The increase in the recycling rate coefficients suggest that environmentally-conscious local governments promote recycling more effectively in larger municipalities.

ii) Recognizing that local governments might require time to influence environmental outcomes, we exclude the election year from our analysis. This exclusion reveals a more pronounced impact on recycling rates for Definitions 1 and 2, supporting our earlier hypothesis. To delve deeper into the timing of this impact, Figure B.1 in Appendix B breaks down the estimates by the number of years post-election for Definition 1. The figure indicates that the surge in recycling rates becomes noteworthy and statistically significant at the 5% level from the second year of the electoral term and remains relatively stable through the final years of the mandate. This result is in line with Cerqueira and Soukiazis (2022), who find that the process of adjusting current recycling behavior to its desired level is extremely fast.

iii) We also exclude municipalities that are members of a union of municipalities. It is plausible that such municipalities might delegate waste management responsibilities to their respective unions, potentially diminishing the role of individual local governments in enhancing environmental outcomes.[1] For Definition 1, the recycling rate's estimated coefficient is marginally smaller than that reported in Table 3 (+8.22 percentage points), yet it remains statistically

[1] Waste collection is managed by unions of municipalities when the latter are very small in size (Camera dei Deputati, 2022, available in Italian at https://www.camera.it/temiap/documentazione/temi/pdf/1105809.pdf?_1693398039963).

significant at the 5% level. Given that unions of municipalities are prevalent in areas with many small municipalities, this outcome aligns with our earlier observation of a more substantial impact in larger municipalities. This result was somewhat expected as inter-municipal government cooperation is in place in a minority of cities only and its impact on waste collection and sorting is usually limited to the use of shared assets for waste transfer, disposal, and city cleaning (Kaza et al., 2018).

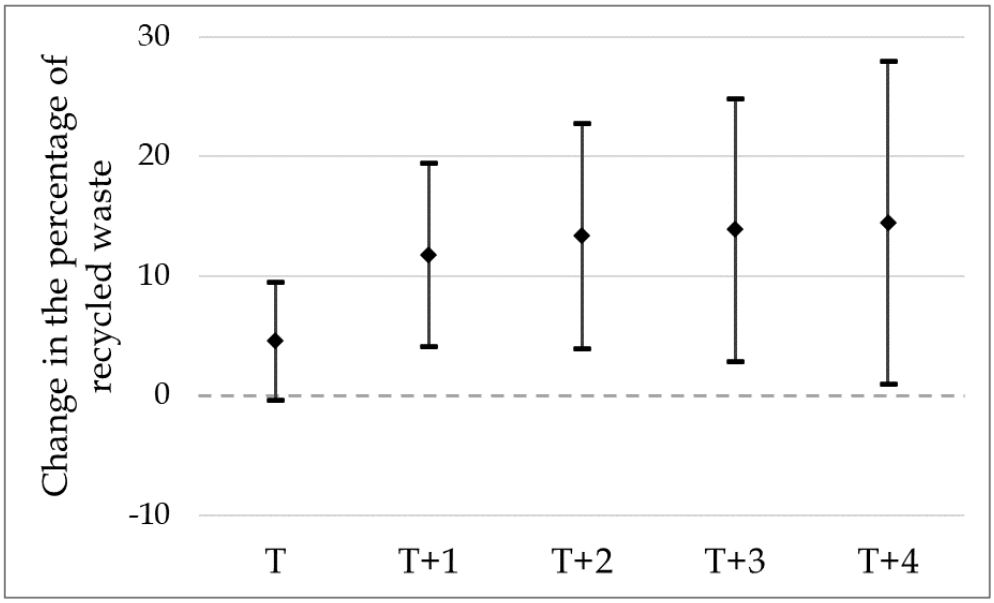
Overall, these checks reaffirm that, by adopting the strictest definition of a green coalition, we consistently observe a notable increase in waste recycling proportions without incurring additional costs. Concurrently, these evaluations reveal that even when employing Definition 2, the recycling rate estimates become statistically significant in several instances.

Table B.1 – Robustness and sensitivity checks

	Definition 1		Definition 2		Definition 3	
Type of sensitivity/robustness check	Recycling rates (%)	Share of expenditure for waste management	Recycling rates (%)	Share of expenditure for waste management	Recycling rates (%)	Share of expenditure for waste management
Main estimates	10.10*** (3.74)	0.0066 (0.0202)	4.32 (2.81)	-0.0051 (0.0118)	-1.39 (2.61)	0.0083 (0.0111)
(I) RDD features						
- Alternative bandwidth selector (CER)	9.38** (3.77)	0.0034 (0.0211)	5.23* (2.90)	0.0033 (0.0119)	-0.53 (2.63)	0.0101 (0.0114)
- Alternative kernel (Epanechnikov)	10.13*** (3.69)	0.0080 (0.0208)	3.81 (2.77)	-0.0073 (0.0121)	-1.64 (2.63)	0.0079 (0.0113)
- Squared functional form	12.15** (4.75)	0.0327 (0.0265)	6.41* (3.70)	-0.0005 (0.0143)	-0.30 (3.15)	0.0112 (0.0134)
- No control variables	14.82*** (4.55)	-0.0114 (0.0254)	9.92** (4.04)	-0.0076 (0.0179)	3.85 (3.47)	0.0028 (0.0146)
- Bandwidth selected for Def. 1	10.10*** (3.74)	0.0066 (0.0202)	5.02* (2.92)	0.0028 (0.0129)	-1.18 (2.65)	0.0112 (0.0123)
- Bandwidth selected for Def. 2	9.72*** (3.60)	-0.0014 (0.0168)	4.32 (2.81)	-0.0051 (0.0118)	-1.64 (2.57)	0.0086 (0.0111)
- Bandwidth selected for Def. 3	9.92*** (3.66)	-0.0015 (0.0170)	4.72 (2.86)	-0.0056 (0.0118)	-1.39 (2.61)	0.0083 (0.0111)
(II) Placebo thresholds						
- 0.05 point to the left	-5.44 (4.60)	-0.0157 (0.0200)	-4.88 (4.18)	-0.0306* (0.0172)	-2.84 (3.35)	-0.0233* (0.0139)
- 0.05 point to the right	-0.18 (4.65)	-0.0012 (0.0192)	-1.03 (3.76)	0.0079 (0.0177)	1.78 (3.07)	0.0094 (0.0158)
(III) Others						
- Weighted RDD (population)	11.08*** (3.29)	-0.0255 (0.0211)	8.89*** (2.71)	-0.0176 (0.0140)	2.06 (2.28)	-0.0162 (0.0126)
- No t0	12.02*** (4.53)	0.0002 (0.0233)	5.26* (3.06)	-0.0056 (0.0132)	-1.32 (2.81)	0.0125 (0.0120)
- No municipal unions	8.22** (3.81)	0.0061 (0.0208)	5.28* (2.90)	-0.0125 (0.0119)	-0.09 (2.78)	-0.0020 (0.0108)

Notes: For Definition 1, the main bandwidth is 0.1636240578876653, while the bias bandwidth is 0.2830919199139982. For Definition 2, the main bandwidth is 0.183461260121619, while the bias bandwidth is 0.3010116993390359. For Definition 3, the main bandwidth is 0.1701217080263646, while the bias bandwidth is 0.2968969896052176.

Figure B.1 – Splitting the recycling rate estimates by the number of years after the election (Definition 1)



Notes: For each year, the point estimate and the 95% confidence intervals are displayed.