Siep
Società italiana di economia pubblica

WORKING PAPER
No 759
agosto 2020

POLITICAL CYCLES AND YARDSTICK COMPETITION IN THE RECYCLING OF WASTE. EVIDENCE FROM ITALIAN PROVINCES

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JEL Classification: H20, H71, H77

Keywords: spatial interactions, political budget cycle, waste management, recycling, yardstick competition

Political cycles and yardstick competition in the recycling of waste. Evidence from Italian provinces[1]

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Abstract

Recycling and the recovery of waste are crucial waste management strategies. In light of the new EU circular economy approach, these strategies remain core pillars of a competitive and sustainable waste value chain. Local governments have an important role in controlling and checking the implementation of waste management policies. We study the spatial determinants of waste recovery by using a dataset of 102 Italian provinces from the years 2001-2014. We exploit the political cycle of the provinces to isolate the effects of waste recovery in one province on neighboring provinces. We find that provinces mimic their own neighbors' in the separate collection of waste aimed at recycling and recovery, with this effect being fully guided by provinces where the president can run for re-election (consistent with the yardstick competition hypothesis) but only when waste management policies become politically salient, that is, after the transposition of the 2008 EU Waste Framework Directive.

Keywords: spatial interactions, political budget cycle, waste management, recycling, yardstick competition

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Introduction

The new Circular Economy Action Plan (EC, 2020), which is part of the European Green Deal strategy, describes the challenges surrounding and the necessary actions for achieving its ultimate objective regarding waste and material flow management, namely, reducing waste generation. The plan recognizes that 'despite efforts at the EU and national levels, the amount of waste generated is not going down'. Annual waste generation from all economic activities in the EU amounts to 2.5 billion tons, or 5 tons per capita a year, and each citizen produces on average nearly half a ton of municipal waste. 'The decoupling of waste generation from economic growth will require considerable effort across the whole value chain'. It also highlights that 'EU waste laws have driven major improvements in waste management since the 1970s', though 'additional efforts are necessary to support the Member States in waste management. Half of them are at risk of noncompliance with the 2020 target to recycle 50% of municipal waste'.

Thus, while the overall strategy is coherently moving towards waste reduction, for economic, social, and environmental motivations, the performance of recycling and recovery of waste (Kinnaman et al. 2014) is far from fully desirable. Part of the difficulty in homogenously reaching waste management targets is the intrinsic decentralization of policies in this realm, a typical element of 'environmental federalism', which also gives rise to spillovers between nearby areas. Along these lines, it is therefore relevant to study the spatial dimension of waste management performance and policies (Kinnaman, 2003, 2014; Kinnaman and Fullerton, 2000), especially because they constitute the 'transmission chain' for waste reduction and circular economy developments. This is the issue that this paper addresses. More specifically, the objective of this paper is to seek answers to two questions. First, are local policy decisions regarding waste management spatially related, and second, if they are, are they determined by political interests, such as re-election concerns?

There is a growing body of literature seeking to explain the determinants of waste management performance. Among others, D'Amato et al. (2015) examine the relationship between waste management and disposal performance and local crime diffusion in Italy. Mazzanti et al. (2011, 2012) explore the economic and policy determinants of waste disposal and waste generation, looking at the recycling performance among the relevant factors. Managi et al. (2014) focus on the role of subsidies to municipalities in Japan to support waste-related technologies. Dijkgraaf and Gradus (2009) point out the role of environmental political activism as a driver of waste policies at the local level. In a similar vein, there is a wide body of research addressing spatial interactions in fiscal policy decisions at the local level. On the one hand, empirical works including Bartolini and Santolin, 2012; Baicker, 2005; Case et al., 1993; Costa et al., 2015; Figlio et al., 1999; Foucalut et al., 2008; Revelli, 2002 and 2003, among others, aim to investigate the presence of strategic interactions in local expenditure. On the other hand, spatial effects in local taxes have been detected by Agrawal, 2015; Baskaran, 2020; Delgado et al., 2015; Edmark and Agren, 2008; Parchet, 2019, Revelli, 2005; Rizzo, 2008; and 2010.[7]

[7] The existence of strategic interactions between local governments is theoretically explained by several models, e.g., yardstick competition, tax and welfare competition, spillover effects, political trends and, more recently, knowledge diffusion and social learning. The most common explanations are based on the yardstick competition hypothesis or beneficial spillovers. In the yardstick competition model, voters without complete information on the cost of public goods and services compare expenditures and taxes in their jurisdiction with those of nearby jurisdictions (Salomon, 1987), and hence, voters punish the incumbent politician if her tax rate decisions are not in line with those of their neighbors. As for spillovers, the expenditures and taxes in a given local jurisdiction may have positive or negative effects beyond the jurisdiction's own boundary, thus affecting the welfare of

While these works shed light on the determinants of waste management in the public policy setting, there are only a few works that have analyzed the geographical aspects, potential spillovers and political determinants of waste management performance all together (Costa, 2016; Fu et al., 2018).

We thus complement the existing literature on spatial interactions and environmental policies by employing a novel identification strategy and explicitly focusing on waste management. In particular, we use information on all Italian provinces over the period of 2001–2014 and exploit the exogenous variation in policy decisions on waste management due to the political cycle.[8] Italian provinces are characterized by staggered election times, so from the province perspective, being surrounded by jurisdictions in different years of a political term can be considered as good as randomly assigned. We take advantage of this unique setting to show that provincial waste recycling is affected by the political cycle; then, we use the political cycles of neighboring provinces to induce exogenous variation in the neighbors' recycling of waste. Following this approach, we document positive and sizable spatial effects; that is, we find evidence of positive horizontal interdependence in waste recovery across Italian provinces. We further investigate whether these results are affected by political determinants, and we show that spatial interactions are significant only when the incumbent president of the province can be re-elected, which is a finding that indicates that waste recycling performance is used in the electoral campaign to buy voters and thus supports the yardstick competition hypothesis. Moreover, it is very relevant to note that spatial interactions hold only after the implementation of the Waste Framework Directive (EC, 2008), which represents a very important milestone in the policy adoption decisions of provinces. Finally, when combining these two pieces of evidence, we find that political motivations explain these strategic interactions, but only when waste recycling policies have become more visible to citizens and therefore are at the heart of the policy agenda.

The remainder of the paper is organized as follows. Section 2 describes the institutional and policy settings and outlines the research hypotheses. Section 3 presents the data and the identification strategy of the model. Section 4 comments on the set of empirical analyses and main outcomes, including robustness tests and heterogeneous effects. Section 5 concludes.

2. Institutional setting and research hypotheses

The Italian Constitution provides four layers of territorial governments: regions, provinces, metropolitan cities and municipalities. In our work, we focus on provinces, which are ordinary administrative entities corresponding to the European NUTS-3 level.

Having specified this, and with reference to the waste management sector, Legislative Decree 152/2006 (Environmental Consolidation Act) splits the competencies between regions and provinces. Regions are responsible for the preparation, adoption and updating of the waste plan and waste management regulatory activities (art. 196), as well as for the development, approval and updating of plans for the remediation of polluted areas (art. 197). Provinces and

residents in neighboring municipalities. See Ferraresi et al., (2018) for a comprehensive discussion of these models.

[8] The ultimate goal of EU policies is to decrease waste generation. The implementation of waste prevention strategies strongly relies on the performance of the crucial waste management strategies of separate collection of waste, recovery and recycling.

municipalities also participate in the definition of these plans. However, the specific task of provinces is the periodic control over all waste management, brokerage and trade activities (art. 197), and the control and verification of remedial interventions and the consequent monitoring thereof. Regions, moreover, often delegate to the provinces the task of developing provincial waste management plans relating to the management of urban and special waste, such as defining the objectives for the containment of waste production, waste recovery and the reduction of landfilling; defining a program for the reuse and recovery of urban waste; planning the separate collection of urban waste according to specific local situations; identifying the offer of recovery and disposal by the industrial system for urban and special waste; and identifying areas unsuitable for the location of urban and special waste recovery and disposal plants. Therefore, provinces can put effort into monitoring actions affecting the level of waste recycling when implementing regional waste plans and waste management regulatory activities. This has been especially true after the Waste Framework Directive (EC, 2008), which, on the one hand, set new recycling and recovery targets and, on the other, required that EU Member States adopt waste prevention programs, namely, programs aimed at a reduction in the amount of waste generated. After this directive, waste recycling became much more important for policy programs, and politicians used the directive as a way to improve their visibility.

Regarding the electoral systems, during the period from 2001-2014, citizens directly elected the president of the province, who is in charge of the executive branch together with a government body (Giunta). Voters are also entitled to vote for the Provincial Council (Consiglio Provinciale), which enjoys legislative power. Provincial elections are normally held every 5 years, but the timing is not the same for all provinces. The staggering of electoral dates is the result of local government officials resigning before the end of their term because they could not form a majority in the city council to support the local government or because of political scandals or judicial impeachment. It then follows that the large degree of discretion enjoyed by provinces in the control over all waste management, combined with the unique institutional and electoral setting within which these local governments operate, provides a suitable framework to test how – and to what extent – the strategic choice of waste management and recovery is spatially and politically affected.

More specifically, the following hypotheses are empirically tested:

Hypothesis 1: Given the geographical proximity and observability of waste management performance at the provincial level, public policy actions might present relevant spatial correlations/interactions due to mimicking behavior.

Hypothesis 2: Some relevant institutional and policy factors might explain the existence of spatial interactions. In detail, given the different incentives for politicians who run for re-election and politicians who do not, mimicking behavior is enhanced when politicians run for re-election. Such an effect is expected to have become more marked after the introduction of the 2008 EU Waste Framework Directive, which has increased citizens' attention to and awareness of waste recycling practices. In other words, since the adoption of the directive, politicians might have had an incentive to observe what their neighboring municipalities do to increase (or to not lose) political consensus and thus be re-elected (consistent with the yardstick competition hypothesis).

3. Empirical analysis

3.1 Data

Our dataset combines information from several sources. First, on the waste management side, provincial data on the separate collection of waste for recycling and recovery are used. These data, produced every year by the Italian Institute for Environmental Protection and Research (ISPRA), allowed us to build our main dependent variable: the (log) per capita waste recovery at the provincial level (*per capita waste recovery*), which measures separated collected waste performance, which is behind waste recovery, reuse and recycling.

We also include, for robustness, a set of time-varying variables that characterize the province's demographic and economic situation from the Italian Statistical Office (ISTAT). We include the (log) population of the province (*population*) and the ratio between the population and the province's area (*population density*) to control for possible agglomeration and scale effects (Mazzanti *et al*., 2008). Territories with greater economic well-being are more likely to apply more efficient, sustainable policies, including waste management policies (Grossman and Krueger, 1995). Hence, we control for some economic provincial characteristics (Johnstone and Labonne, 2004): the (log) gross domestic product (GDP) at current market prices per capita (*per capita GDP*), the difference between the value of output and the value of intermediate costs (*value added*) and the (log) ratio of the employed to the working age population (*employment rate*). Finally, tourists may have a lower propensity to separate waste, as they are not directly interested in the local environmental impact (Mateu-Sbert *et al*., 2013); hence, we include the (log) *per capita presence of tourism*.

As was already mentioned, provincial elections are normally held every 5 years, but the timing is not the same for all provinces. For the period 2001-2014, electoral data are were collected from the Italian Ministry of the Interior. Table A1 of the Online Appendix shows that provinces follow different election schedules. Specifically, more than half of the provinces in the sample had elections in 2004 (and subsequently in 2009). Of the remaining provinces, 19 voted in 2008, 14 in 2003, 12 in 2013 and 11 voted in 2011. In the remaining years, we register 10 or fewer provincial elections. Since the Italian provincial electoral system establishes a limit of no more than two consecutive terms for the office of president, we build a dummy variable, *termlimit*, that is equal to 1 if the president of the province cannot be re-elected and 0 otherwise.

Finally, we obtain a balanced panel sample of 102 provinces, including 1,428 observations spanning from 2001–2014. The summary statistics for all of the variables used in the analysis are reported in Table A2 of the Online Appendix.

3.2 Identification Strategy

The classical model of spatial interactions can be written as follows:

$$R_{pt} = \gamma' W R_{pt} + \beta' X_{pt} + \mu_p + \tau_t + \varepsilon_{pt} \qquad (1)$$

where R_{pt} is the log of per capita waste recovery (kg) in province p at time t, and $WR_{pt} = \sum_{j \neq p} \omega_{pj} R_{jt}$ is the weighted (log of) per capita average waste recovery in the neighboring provinces j at time t; ω_{pj} are all equal weights that aggregate the per capita waste recovery of

neighboring provinces into a single variable WR_{it} and are normalized so that $\sum_{j \neq p} \omega_{pj} = 1$.[9] The vector X_{pt} includes the control variables described in Section 3.1, while μ_p and τ_t are provincial and year fixed effects, respectively. Robust standard errors are clustered at the provincial level.

The simultaneous determination of waste recovery makes the variable WR_{pt} endogenous. To address this issue, we exploit the change in waste recovery due to the political cycle, motivated by the fact that the staggered timing of provincial elections generates a sort of random assignment of the political cycle of provinces, that is to say that the position in the term of a single province in a given year can be considered as good as randomly assigned (Ferraresi, 2020). It follows that if a strategic incentive to manipulate policy decisions, including the choice of promoting a waste recovery attitude, close to the time of elections held at the local level (i.e., a political budget cycle) is present, the timing of neighboring elections can be used as a way to induce exogenous variation in neighbors' attitudes towards recycling.

The key question is then whether the attitude of Italian provinces towards waste recovery is affected by the political budget cycle. The empirical evidence seems to support this hypothesis but limits the analysis to fiscal outcomes, as shown by Benito *et al*., 2017, who found the presence of an electoral budget cycle on waste collection expenditures in Spanish municipalities.

Therefore, we estimate a model where we use the log of per capita waste recovery as the dependent variable and use five dummy variables, one for each year of the term, as regressors, while controlling for both provincial- and year-fixed effects. Figure 1 depicts the estimated coefficients. The year-in-term indicators capture any fluctuations in the provincial attitude towards waste recovery due to the political cycle and vary cross-sectionally by province, as provinces are at different points in the electoral cycle. Moreover, given that in each year, there are provinces that hold elections and provinces that do not hold elections, it is possible to control for common shocks to all provinces (such as changes in macroeconomic conditions) by including time dummies.

Taking one year after the election as the baseline (and thus omitting it from the regression), the figure, although descriptive, suggests that the propensity of waste recovery increases as elections approach and then decreases just after elections before continuing to rise again. In terms of point estimates, it is worth noting that per capita waste recovery reaches its peak during the electoral year, when it is found to be approximately 4% higher with respect to the year after the election. Taken together, these results corroborate the presence of the political budget cycle for Italian provinces.

INSERT FIGURE 1 HERE

The presence of the political budget cycle among Italian provinces allows province attributes, X, to be replaced with a variable that induces a continuous exogenous change in the average value of the waste recovery of neighbors. Hence, we use five dummy variables, one for each year of the term, and then we construct averages for these dummies across neighbors to

[9] The approach used here is that of only considering neighbors that are contiguous municipalities as this is a neutral and simple definition which captures the idea that interactions are more likely to take place between adjoining jurisdictions.

instrument for WR_{pt}. Note that the indicator for one year after an election, $d_{pt}^{\tau+1}$, and its corresponding neighbor value, $Wd_{pt}^{\tau+1}$, are excluded from the estimation to avoid multicollinearity and thus act as a reference group. It follows that the first stage is:

$$WR_{pt} = \lambda^{-3}Wd_{pt}^{\tau-3} + \lambda^{-2}Wd_{pt}^{\tau-2} + \lambda^{-1}Wd_{pt}^{\tau-1} + \lambda^{0}Wd_{pt}^{\tau} + \beta' X_{pt} + \mu_p + \tau_t + \epsilon_{pt} \quad (2)$$

where $Wd_{pt}^{\tau-3}, Wd_{pt}^{\tau-2}, Wd_{pt}^{\tau-1}$ and Wd_{pt}^{τ} are four average dummies across neighbors for each year of the term indicating neighbors 3 years before an election, neighbors 2 years before an election, neighbors 1 year before an election and neighbors during an election year, respectively.

The rationale behind this instrument is that the variation in the neighbors' per capita waste recovery can be explained by the position of each neighboring province in its own political term, the intuition being that higher levels of waste recovery are likely to occur when provinces draw closer to election years. The validity of the instrument is based on the assumption that the neighbors' political cycle is uncorrelated with the error term in Eq. (1). While this assumption is not directly testable, we argue that it is likely to hold since the instrument is based on the timing of elections of neighboring provinces, which, from the province perspective, can be reasonably considered exogenous (Coviello and Gagliarducci, 2017). After all, it is unlikely that a province deliberately manipulates the timing of its elections in view of the waste recovery of its neighbors.

4. Results

4.1 Baseline evidence

Table A3 of the Online Appendix presents the (first-stage) results based on Equation (2). The first column shows the specification without control variables, whereas in Column 2, provincial controls are included. The neighbors' per capita waste recovery is found to be larger during the electoral year than during other years of the term. In particular, following the Column 1 estimates, the year 3 years after an election is associated with an increase in the neighbors' waste recovery, as the estimated coefficient is positive (0.05) and statistically significant at the 5% level. In contrast, the coefficient of neighbors' expenditures 2 years before elections is not statistically significant at the conventional level. One year before the election, the cycle seems to begin again. In fact, the coefficient related to neighbors' expenditures one year before an election is positive, although imprecisely estimated, while the coefficient associated with the election year is positive (0.05) and statistically significant at the 10% level. Regarding the diagnostic test, the Hansen J-test for overidentifying restrictions reported at the bottom of the table does not reject the validity of the instruments (p-value=0.872). This last evidence, together with the strong statistical significance of the instruments, indicates that the instruments are valid. The results are consistent when provincial controls are included (Column 2).

For the second stage (Table 1), central to the issues at hand is the coefficient on neighbors' waste recovery, which is positive (0.79) and statistically significant at the 5% level in the specification that does not include control variables (Column 1), and it is very similar (0.76) and significant at the 5% level when provincial controls are included (Column 2).

These findings obtained by employing a pure, genuinely exogenous instrument point to the existence of a positive horizontal interdependence in waste recovery among Italian provinces. Specifically, we find that a one percent increase in the average per capita waste recovery of neighbors generates, ceteris paribus, an increase of 0.79% in the waste recovery of province *p*. In practice, this reveals that provinces strategically mimic each other in their waste recovering practices (Hypothesis 1).

INSERT TABLE 1 HERE

4.2 Robustness tests

In this section, we assess the validity of the previous results by performing a set of robustness checks. These checks are intended to address possible issues related to the validity of the instruments, which could bias the baseline estimates. First, we use a different definition of the political budget cycle as an external instrument. After controlling for province and year fixed effects, we test for the potential presence of remaining sources of bias by performing balancing regressions. Finally, we conduct a battery of falsification tests.

4.2.1 Alternative measures of the political budget cycle as instrumental variables

Council resignations and/or dismissals among provinces might create concerns about identification, as the resignation/dismissal could be endogenous to local area circumstances. To account for this, and in the spirit of the test conducted by Repetto (2018) and Ferraresi (2020), we construct an artificial political cycle for all provinces by using "predicted" years relative to the election, regardless of commissioner status. More precisely, we fix the election cycle timing to that at the beginning of the study period, and we assume that each province votes again every 5 years. That is, if a province is in its pre-electoral year in 2002, it is automatically assumed to vote again in 2008 and thus be in its pre-electoral year in 2007. We repeat the same procedure according to the specific year of the term that provinces are in during 2001. Using these theoretical schedules, we build the predicted pre-electoral year dummy variable and then construct averages for this dummy across neighbors to instrument the per capita waste recovery of neighboring municipalities. Column 1 of Table 2 reports the results of this analysis and shows that the coefficient is statistically significant and very similar to, although slightly larger in magnitude than, those obtained in the baseline specification, thus suggesting that endogenous resignation is not a serious concern.

4.2.2 Falsification test

Another possible concern is related to the timing of the effect. Since the political cycle of neighboring provinces at time *t* impacts per capita waste recovery, which affects the waste recovery behavior of a given province at time *t*, it is very unlikely that the waste recovery decisions of neighboring provinces in year *t* shape a given province's own waste recovery attitude at time *t-1*. Hence, we conduct a timing falsification test by replacing the dependent variable with a one-year lag. The results are shown in Table 2. As seen in Column 2, the coefficient of *neighbors' waste recovery* at time *t* does not have any impact on the level of a given province's own waste recovery decisions at time *t-1*.

INSERT TABLE 2 HERE

4.2.3 Balancing test

While we control for time-invariant unobserved determinants of provincial waste recovering capacity in the estimates by including province fixed effects, there still might potentially be some remaining sources of bias due to unobserved confounders. The usual way to overcome this issue is to add variables as controls on the right-hand side of the regression. Were the presence of unobserved effects detected, the coefficient of interest would be sensitive to the inclusion of these controls. As the comparison of the estimates in Columns (1) and (2) of Table 3 shows, including controls to the baseline specification hardly changes any of the results. However, these demographic, institutional and socio-economic variables might be poorly measured proxies for the confounders. In this respect, as recently shown by Pei *et al*. (2018), a more suitable test consists of including provincial controls as dependent variables on the left-hand side of the regression equation. Table 3 shows the results of these balancing regressions for various provincial characteristics, and none of these regressions yields significant effects. These results help to rule out the possibility that a correlation between the neighboring waste-recovery attitude variable and other time-varying characteristics of provinces are driving the results.

INSERT TABLE 3 HERE

All this evidence seems to indicate that the analyses conducted in this section have helped to reinforce the existence of a positive relationship between waste recovery at the provincial level and the waste recovery of neighboring provinces. In addition, the results indicate that it is very likely that the change in waste recovery is indeed caused by the change in the neighbors' waste-recovery attitudes via the neighboring political cycle, as no other plausible explanation that holds as an argument against a causal interpretation of this relationship was found.

4.3 Yardstick competition hypothesis and regulatory effects

The baseline results show the presence of spatial interactions among local government decisions on waste recovery. However, there might be several reasons behind this choice, and, in particular, one of the most common explanations is based on the yardstick competition hypothesis. Politicians might have an incentive to observe what their neighboring provinces do to increase (or to not lose) political consensus and thus be re-elected (Salmon, 1987). Therefore, were this the case, a different behavior would be expected from politicians who run for re-election and politicians who do not (Besley and Case, 1995; Bordignon *et al*., 2003). To test this assumption, we take advantage of several features of the Italian local political system, as well as of other institutional (and exogenous) breaks.

4.3.1 Term limit

The Italian provincial electoral system establishes a limit of no more than two consecutive terms for the office of the president of the province. This feature can be used to investigate whether spatial interactions differ according to the status of the president (i.e., first or second term in office) and thus test for the yardstick competition hypothesis. Hence, we use the split-sample idea to divide the sample into two according to presidents in their first or second term. Provinces guided by presidents facing a term limit are expected to be less concerned about

competing with their neighbors; that is, the neighbors' recycling coefficient should be less marked for provinces governed by second-term presidents. Shown in Columns 1 and 2 of Table 4 – Panel A, the coefficient accounting for spatial interactions in provinces governed by first-term presidents is positive (1.02) and statistically significant at the 1% level, while the same coefficient turns out to be statistically indistinguishable from zero for the sample of provinces led by presidents in their second term of office. Strikingly, what is therefore found is that spatial interactions hold only in provinces governed by first-term presidents, which is consistent with the yardstick competition hypothesis.

4.3.2 Waste Framework Directive

A key milestone in the European regulation on waste disposal has been established by the Waste Framework Directive (Directive 2008/98/EC), which was introduced in 2008; this directive provides a general framework of waste management requirements and sets the basic waste management definitions for the EU. Hence, the introduction of the directive might have generated stronger incentives for Italian provinces to foster positive attitudes towards the management of waste recovery. Therefore, spatial interactions should be more pronounced after 2008. To test this hypothesis, we follow the same strategy as before, and we divide the sample into two periods: one before and one after 2008.

Shown in Columns 3 and 4 of Table 4 – Panel A, the coefficient accounting for spatial interactions before the introduction of the Waste Framework Directive (WFD) is statistically indistinguishable from zero. In contrast, after 2008, the same coefficient is found to be positive (0.60) and statistically significant at the 1% level. These findings suggest that the need to mimic neighboring expenditure emerged once the Waste Directive was in place, as its approval made waste recovery very salient politically.

4.3.3 Term limit and regulatory effects

However, the transposition of the Waste Directive had the benefit of increasing citizens' awareness of waste recovery, and it also had the drawback of making waste recovery policies and their management very politically salient. As a consequence, if politicians compare policies carried out in their provinces with those of nearby provinces, we would expect yardstick competition to be more pronounced after the approval of the Waste Directive. To test for this hypothesis (Hypothesis 2), we divide provinces according to whether the president was in his or her first or second term and whether waste management strategies were implemented before and after the adoption of the Waste Directive. We then estimate Equations (1) and (2) for the four samples. The results of this analysis are reported in Panel B of Table 3 and support the prediction that strategic interactions do exist but are limited to provinces guided by second-term presidents and in which waste management strategies were implemented after the adoption of the directive. Indeed, in Columns 1 and 2, which present the results for the sample of provinces before the transposition of the directive, the coefficient associated with neighbors' waste recovery is not statistically significant for either first-term presidents or second-term presidents. In contrast, after the adoption of the directive, in the group of provinces guided by non-term limited presidents (Column 3), the coefficient of neighbors' waste recovery is positive (0.84) and statistically significant at the 1% level, while the same coefficient is statistically indistinguishable from zero for the sample of provinces led by presidents in their second term of office (Column 4). These findings suggest that electoral motivations guide waste management strategies only when these become very salient in the political agenda.

INSERT TABLE 4 HERE

5. Conclusion

The paper has shown that waste management strategies, which are often implemented at the local level due to policy decentralization in the natural resources realm, became very salient after the approval of the Waste Framework Directive (Directive 2008/98/EC). The directive is a policy milestone that pointed towards more ambitious waste management actions as pillars of waste prevention and circular economy strategies. In Italy, for example, waste is primarily managed at the regional and provincial levels. Regions are responsible for the preparation, adoption and updating of waste plans and waste management regulatory activities but often delegate periodic control over all waste management, brokerage and trade activities to provinces. Therefore, provinces have an important role in determining and controlling the amount of waste recovery. We explored the existence of spatial interactions between provinces for the management of waste recovery, and we found a statistically significant positive effect. We also documented a more marked effect for provinces guided by non-lame duck presidents, which is a finding consistent with the yardstick competition hypothesis. Interestingly, we have shown that these interactions hold only after the approval of the Waste Framework Directive, thus pointing to the key role played by the regulation in making waste recovery a salient political issue. Finally, we documented that the incentive for presidents to observe what their neighboring provinces do to increase (or to not lose) political consensus is effective when presidents can run for re-election, but only after the transposition of the waste directive, namely, after waste management policies became politically salient. What all of this seems to suggest is that the provinces, in regard to controlling and planning waste management policies, act as rent seekers, thereby indicating that a more centralized decision-making system, either nationally or regionally centered depending on the institutional setting, could mitigate such a distortion.

References

Agrawal, D. R. (2015), The tax gradient: spatial aspects of fiscal competition, *American Economic Journal: Economic Policy*, 7, 1–29.

Baicker, K. (2005), The spillover effects of state spending, *Journal of Public Economics*, 89, 529–544.

Bartolini, D., Santolini, R. (2012), Political yardstick competition among Italian municipalities on spending decisions. *Annals of Regional Science*, 49, 213–235.

Baskaran, T. (2020), Fiscal interactions in the short and the long run: evidence from German reunification, *Journal of Economic Geography*, 20, 711-732.

Benito, B., Guillamón, M. D., Ríos, A. M. (2017), The electoral budget cycle on municipal waste collection expenditure, *Applied Economics*, 49, 41, 4161-4179.

Besley, T., Case A. (1995), Does electoral accountability affect economic policy choices? Evidence from gubernatorial term limits, *The Quarterly Journal of Economics*, 110, 769–798.

Bordignon, M., Cerniglia, F., Revelli, F. (2003), In search of yardstick competition: a spatial analysis of Italian municipality property tax setting, *Journal of Urban Economics*, 54, 199-217.

Case, A. C., Hines, J. R. J., Rosen, H. S. (1993), Budget spillovers and fiscal policy interdependence. Evidence from the states, *Journal of Public Economics*, 52, 285-307.

Costa, H., Veiga, G.,Portela, M. (2015), Interactions in local gov- ernments' spending decisions: Evidence from Portugal. *Regional Studies*, 49(9), 1441–1456.

Costa, H. (2016), *Pork barrel as a signaling tool: the case of US environmental policy*, GRI Working Papers 225, Grantham Research Institute on Climate Change and the Environment.

Coviello, D., Gagliarducci S. (2017), Tenure in office and public procurement, *American Economic Journal: Economic Policy*, 9, 59–105.

D'Amato, A., Mazzanti, M., Nicolli, F. (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.

Delgado, F. J., Lago-Penas, S., and Mayor, M. (2015). On the determinants of local tax rates: New evidence from Spain. *Contemporary Economic* Policy, 33, 351–368.

Dijkgraaf, E., Gradus, R. (2009), Environmental activism and dynamics of unit-based pricing systems, *Resource and Energy Economics*, 31, 1, 13-23.

EC (2008), Directive 2008/98/EC on waste (Waste Framework Directive), EC, Bruxelles.

EC (2020), Communication: A new Circular Economy Action Plan for a Cleaner and More Competitive Europe, Bruxelles, March, https://ec.europa.eu/environment/circular-economy/

Edmark, K., Agren, H. (2008), Identifying strategic interactions in Swedish local income tax policies. *Journal of Urban Economics*, 63: 849–857.

Ferraresi, M., Migali, G., Rizzo, L. (2018), Spillover effects in local public spending, *Regional Studies*, 52, 1570–1584.

Ferraresi, M., (2020). Political cycles, spatial interactions, and yardstick competition: evidence from Italian cities, *Journal of Economic Geography*, Vol. 20, 1093-1115.

Figlio, D. K., Kolpin, V. W., Reid, W. E. (1999), Do state play welfare games? *Journal of Urban Economics*, 46, 437–454.

Foucault, M., Madies, T., Paty, S. (2008), Public spending interactions and local politics. Empirical evidence from French municipalities, *Public Choice*, 137, 57–80.

Fu, W., Li, C., Ondrich, J., Popp, D. (2018), *Technological Spillover Effects of State Renewable Energy Policy: Evidence from Patent Counts*, National Bureau of Economic Research Working Paper Series, 25390.

Grossman, G., Krueger, A. (1995), Economic growth and the environment, *Quart. J. Econ*, 110 (2), 353–377.

Kinnaman, T. (2003), *The Economics of Residential Solid Waste Management*, Aldershot, Ashgate Publishing.

Kinnaman, T. (2014), Understanding the Economic of Waste: Drivers, Policies and External Costs, *International Review of Environmental and Resource Economics*, 8, 281-320.

Kinnaman, T., Fullerton, D. (2000), Garbage and Recycling with Endogenous Local Policy, *Journal of Urban Economics*, 48(3), 419-442.

Kinnaman, T., Yamamoto, M., Shinkuma, T. (2014), The Socially Optimal Recycling Rate, *Journal of Environmental Economics and Management*, 68(1), 54-70.

Johnstone, N., Labonne, J. (2004), Generation of household solid waste in OECD countries: an empirical analysis using macroeconomic data, *Land Economics*, 80, 529–538.

Managi, S., Hibiki, A., Shimane, T. (2014), Efficiency or technology adoption: A case study in waste-treatment technology, *Resource and Energy Economics*, 36, 2, 586-600.

Mateu-Sbert, J., Ricci-Cabello, I., Villalonga-Olives, E., Cabeza-Irigoyen, E. (2013), The impact of tourism on municipal solid waste generation: The case of Menorca Island (Spain), *Waste Management*, 33, 12, 2589-2593.

Mazzanti, M., Montini, A., Zoboli, R. (2008), Municipal waste generation and socio economic drivers, Evidence from comparing Northern and Southern Italy, *J. Environ. Dev.*, 17, 51–69..

Mazzanti, M., Montini A., Nicolli F. (2011), Embedding Landfill Diversion in Economic, Geographical and Policy Settings, *Applied Economics*, 43.

Mazzanti, M., Montini, A., Nicolli, F. (2012), Waste dynamics in economic and policy transitions: decoupling, convergence and spatial effects, *Journal of environmental planning and management, 55, 63-81.*

Parchet, R. (2019), Are local tax rates strategic complements or strategic substitutes?, *American Economic Journal: Economic Policy*, 11, 189–224.

Pei, Z., Pischke, J. S., Schwandt, H. (2018), Poorly measured confounders are more useful on the left than on the right, *Journal of Business & Economic Statistics*, 37, 205–216.

Repetto, L. (2018), Political budget cycles with informed voters: evidence from Italy, *The Economic Journal*, 128, 3320-3353.

Revelli, F. (2002), Testing the tax mimicking versus expenditure spillover hypotheses using English data, *Applied Economics*, 34, 1723–1731.

Revelli, F. (2003), Reaction or interaction? Spatial process identification in multi-tiered government structures, *Journal of Urban Economics*, 53, 29–53.

Rizzo, L. (2008), Local Government Responsiveness to Federal Transfers: Theory and Evidence, *International Tax and Public Finance*, 15, 316-337.

Rizzo, L. (2010), Interaction between federal taxation and horizontal tax competition: theory and evidence from Canada, *Public Choice*, 144, 369-387.

Salmon, P. (1987), Decentralisation as an incentive scheme, *Oxford Review of Economic Policy*, 3, 24–43.

Table 1: Waste recovery and spatial interactions – Second stage regressions

Dependent Variable: Per-capita waste recovery (log)		
	(1)	(2)
Neighbors' waste recovery	0.79**	0.76**
	(0.36)	(0.36)
1 year before election	-0.01	0.00
	(0.02)	(0.02)
2 years before election	-0.01	-0.00
	(0.02)	(0.02)
3 years before election	0.00	0.01
	(0.01)	(0.01)
Election	0.01	0.02
	(0.02)	(0.02)
Kleibergen-Paap F	3.970	4.284
Hansen Test (p-value)	0.872	0.902
Year Effects	Yes	Yes
Province Effects	Yes	Yes
Province Controls	No	Yes
Observations	1,428	1,428
R-squared	0.79	0.81
Number of Provinces	102	102

Notes: period 2001-2014. *Neighbors' waste recovery* is the average value across neighbors' of the (log) of per capita waste recovery. The variable *neighbors' waste recovery* is instrumented by using the following variables: neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. Provincial controls are: population, employment rate, per capita presence of tourism, per capita GDP, population density and value added. The corresponding first stage is reported in Table A3 of the Online Appendix. Robust standard errors clustered at provincial level are shown in parenthesis. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Table 2: Waste recovery and spatial interactions – Falsification tests (second stage)

Dependent Variable:	Per-capita waste recovery (log)	Per-capita waste recovery $(log)_{t-1}$
	(1)	(2)
Neighbors' waste recovery	0.87***	1.08
	(0.25)	(0.69)
1 year predicted before election	0.00	
	(0.02)	
2 years predicted before election	-0.01	
	(0.02)	
3 years predicted before election	0.01	
	(0.02)	
1 year predicted Election	0.02	
	(0.02)	
1 year before election		-0.04**
		(0.02)
2 years before election		-0.02
		(0.02)
3 years before election		-0.00
		(0.02)
Election		-0.03
		(0.02)
Kleibergen-Paap F	4.094	1.291
Hansen Test (p-value)	0.755	0.807
Year Effects	Yes	Yes
Province Effects	Yes	Yes
Province Controls	Yes	Yes
Observations	1,428	1,326
R-squared	0.81	0.76
Number of Provinces	102	102

Notes: period 2001-2014. Neighbors' waste recovery is the average value across neighbors' of the (log) of per capita waste recovery. The variable neighbors' waste recovery is instrumented by using the following variables: neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. The variable neighbors' waste recovery in col. (1) is instrumented by using the following variables: neighbours' 1 year before predicted election, neighbours' 2 years before predicted election , neighbours' 3 years before preecited election, neighbours' predicted election. The variable neighbors' waste recovery at time *t-1* of column 2 is instrumented by using the following variable: neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. The corresponding first stage is reported in Table A4 of the Online Appendix. Provincial controls are: population, employment rate, per capita presence of tourism, per capita GDP, population density and value added. Robust standard errors clustered at provincial level are shown in parenthesis. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Table 3: Balancing regressions

Dependent variable	Population	Employment	Tourism	GDP	Density	Value Added
	(1)	(2)	(3)	(4)	(5)	(6)
Neighbors' waste recovery	0.02	-0.38	-0.01	0.02	-26.09	-0.03
	(0.02)	(0.36)	(0.18)	(0.04)	(22.86)	(0.03)
Kleibergen-Paap F	4.454	4.402	4.873	4.554	4.464	4.636
Hansen Test (p-value)	0.212	0.447	0.282	0.134	0.855	0.460
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Province Effects	Yes	Yes	Yes	Yes	Yes	Yes
Province Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,428	1,428	1,428	1,428	1,428	1,428
R-squared	0.74	0.26	0.57	0.97	0.64	0.96
Number of Provinces	102	102	102	102	102	102

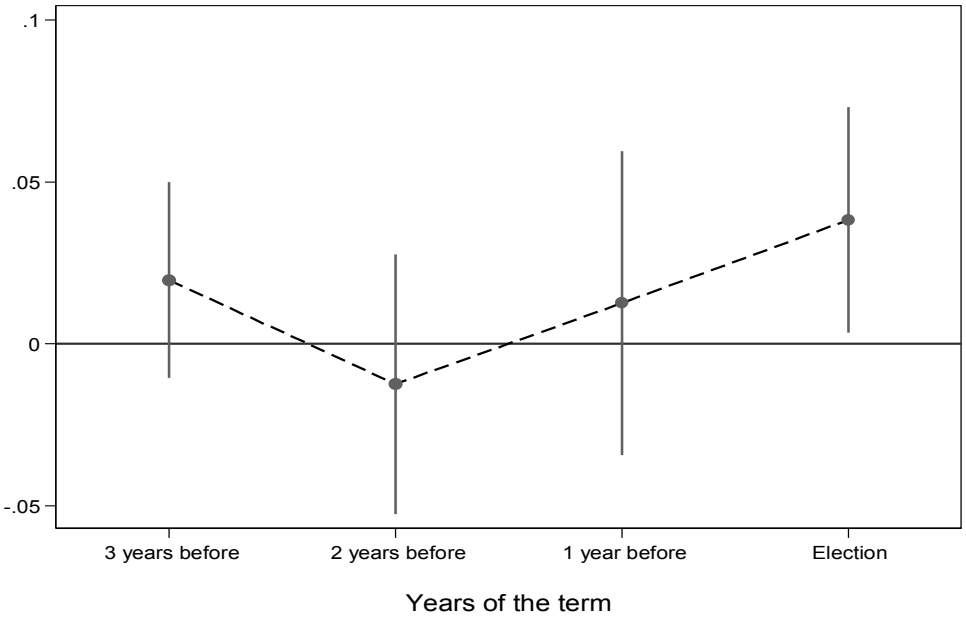
Notes: period 2001-2014. Provincial control varibales are population, employment rate, per capita presence of tourism, per capita GDP, population density and value added, and exclude the dependent variable. Neighbors' waste recovery is the average value across neighbors' of the (log) of per capita waste recovery. Robust standard errors clustered at the provincial level are shown in parentheses. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Table 4: Yardstick competition and regulatory effects – Second stage results

Panel A	No term-limit	Term-limit	No WFD	WFD
Dependent variable: per-capita waste recovery (log)				
	(1)	(2)	(3)	(4)
Neighbors' waste recovery	1.02***	-0.49	0.30	0.60***
	(0.39)	(1.53)	(0.76)	(0.21)
Kleibergen-Paap F	2.503	0.24	0.732	7.036
Hansen Test (p-value)	0.740	0.911	0.868	0.733
Year Effects	Yes	Yes	Yes	Yes
Province Effects	Yes	Yes	Yes	Yes
Province Controls	Yes	Yes	Yes	Yes
Observations	1,018	407	714	714
R-squared	0.79	0.61	0.64	0.63
Number of Provinces	101	82	102	102
	No WFD		WFD	
Panel B	No term-limit	Term-limit	No term-limit	Term-limit
Dependent variable: per-capita waste recovery (log)				
	(1)	(2)	(3)	(4)
Neighbors' waste recovery	0.05	1.13	0.84***	-0.03
	(0.67)	(1.39)	(0.25)	(0.42)
Kleibergen-Paap F	1.079	0.615	6.200	2.668
Hansen Test (p-value)	0.472	0.736	0.957	0.109
Year Effects	Yes	Yes	Yes	Yes
Province Effects	Yes	Yes	Yes	Yes
Province Controls	Yes	Yes	Yes	Yes
Observations	457	251	558	138
R-squared	0.57	0.39	0.67	0.77
Number of Provinces	101	71	98	33

Notes: period 2001-2014. Neighbors' waste recovery is the average value across neighbors' of the (log) of per capita waste recovery. The variable neighbors' waste recovery is instrumented by using the following variables: neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. Provincial controls are: population, employment rate, per capita presence of tourism, per capita GDP, population density and value added. The corresponding first stage is reported in Table A5 and A6 of the Online Appendix.Robust standard errors clustered at provnical level are shown in parenthesis. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Figure 1: Waste recovery and the political budget cycle



Notes: This graph is based on the estimates where we use per-capita waste recovery (log) as the dependent variable and four dummy variables indicating each year of the electoral term, controlling for province fixed effects and time dummies. Dots represent point estimates taking the year after the election as the baseline, while lines denote 95% confidence intervals.

Online Appendix

Table A1: Timing of local elections in Italy

Year	# province holding elections	% provinces holding elections on the total
2001	9	8.74
2002	10	9.71
2003	14	13.59
2004	63	61.17
2005	6	5.83
2006	10	9.71
2007	8	7.77
2008	19	18.45
2009	59	57.28
2010	8	7.77
2011	11	10.68
2012	1	0.97
2013	12	11.65
2014	10	9.71

Table A2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Per-capita waste recovery	1,428	-2.17	0.95	-5.43	-0.77
Neighbors' waste recovery	1,442	-2.13	0.86	-5.99	-1.08
1 year before election	1,442	0.20	0.40	0.00	1.00
2 years before election	1,442	0.22	0.42	0.00	1.00
3 years before elections	1,442	0.23	0.42	0.00	1.00
Election	1,442	0.17	0.37	0.00	1.00
Neighbors' 1 year before election	1,442	0.20	0.31	0.00	1.00
Neighbors' 2 years before election	1,442	0.23	0.32	0.00	1.00
Neighbors' 3 years before elections	1,442	0.23	0.32	0.00	1.00
Neighbors' election	1,442	0.17	0.28	0.00	1.00
Population (log)	1,442	12.95	0.71	11.37	15.28
Employment rate (log)	1,442	-0.95	0.27	-4.29	-0.30
Per capita tourism (log)	1,442	0.42	1.00	-3.97	3.50
Per capita GDP (log)	1,442	-3.78	0.36	-5.87	0.00
Population density	1,442	256.60	360.04	28.88	2,652.58
Added value	1,442	23.01	0.75	21.21	25.41
Vote-turnout	1,442	0.72	0.07	0.54	0.83
Termlimit	1,442	0.28	0.45	0.00	1.00
Waste Framework Directive (WFD)	1,442	0.50	0.50	0.00	1.00

Table A3: Waste recovery and spatial interactions – First stage regressions of Table 1

Dependent Variable: Neighbors' waste recovery		
	(1)	(2)
Neighbors 1 year before election	0.04	0.06
	(0.04)	(0.04)
Neighbors 2 years before election	-0.00	0.00
	(0.03)	(0.03)
Neighbors 3 years before election	0.04**	0.04*
	(0.02)	(0.02)
Neighbors Election	0.05*	0.07**
	(0.03)	(0.03)
Kleibergen-Paap F	3.97	4.284
Hansen Test (p-value)	0.872	0.902
Year Effects	Yes	Yes
Province Effects	Yes	Yes
Province Controls	No	Yes
Observations	1,428	1,428
Number of Provinces	102	102

Notes: period 2001-2014. *Neighbors' waste recovery* is the average value across neighbors' of the (log) of per capita waste recovery. Provincial controls are: population, employment rate, per capita presence of tourism, per capita GDP, population density and value added. Robust standard errors clustered at provincial level are shown in parenthesis. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Table A4: Waste recovery and spatial interactions – Falsification tests (first stage result of Table 2)

Dependent Variable: Neighbors' waste recovery		
	(1)	(2)
Neighbors 1 year predicted before election	0.13***	
	(0.04)	
Neighbors 2 years predicted before election	0.09**	
	(0.04)	
Neighbors 3 years predicted before election	0.07***	
	(0.03)	
Neighbors Election	0.10***	
	(0.03)	
Neighbors 1 year before election		0.00
		(0.03)
Neighbors 2 years before election		-0.03
		(0.02)
Neighbors 3 years before election		-0.04
		(0.03)
Neighbors Election		0.01
		(0.02)
Kleibergen-Paap F	4.094	1.291
Hansen Test (p-value)	0.755	0.807
Year Effects	Yes	Yes
Province Effects	Yes	Yes
Province Controls	Yes	Yes
Observations	1,428	1,326
Number of provinces	102	102

Notes: period 2001-2014. Neighbors' waste recovery is the average value across neighbors' of the (log) of per capita waste recovery. The variable neighbors' waste recovery is instrumented by using the following variables: neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. The variable neighbors' waste recovery in col. (1) and (2) is instrumented by using the following variables: neighbours' 1 year before predicted election, neighbours' 2 years before predicted election , neighbours' 3 years before preecited election, neighbours' predicted election. The variable neighbors' waste recovery in col. (3) to (6) is instrumented by using the following variable: neighbours' 1 year before election. Robust standard errors clustered at municipal level are shown in parenthesis neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. Provincial controls are: population, employemnt rate, per capita presence of tourism, per capita GDP, poplation density and value added. Robust standard errors clustered at provnical level are shown in parenthesis. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Table A5: Yardstick competition and regulatory effects – First stage results of Table 4 - Panel A

Dependent variable: Neighbors' waste recovery				
	(1)	(2)	(3)	(4)
Neighbors 1 year before election	0.09	0.03	0.00	0.04
	(0.06)	(0.05)	(0.05)	(0.03)
Neighbors 2 years before election	0.04	0.03	0.00	-0.04
	(0.06)	(0.05)	(0.03)	(0.03)
Neighbors 3 years before election	0.07*	0.03	0.03	0.04*
	(0.04)	(0.04)	(0.03)	(0.02)
Neighbors Election	0.06*	-0.00	0.05	0.02
	(0.04)	(0.03)	(0.05)	(0.02)
Kleibergen-Paap F	2.503	0.24	0.732	7.036
Hansen Test (p-value)	0.740	0.911	0.868	0.733
Year Effects	Yes	Yes	Yes	Yes
Province Effects	Yes	Yes	Yes	Yes
Province Controls	Yes	Yes	Yes	Yes
Observations	1,018	407	714	714
Number of Provinces	101	82	102	102

Notes: period 2001-2014. Neighbors' waste recovery is the average value across neighbors' of the (log) of per capita waste recovery. The variable neighbors' waste recovery is instrumented by using the following variables: neighbours' 1 year before election, neighbours' 2 years before election, neighbours' 3 years before election, neighbours' election. Provincial controls are: population, employemnt rate, per capita presence of tourism, per capita GDP, poplation density and value added. Robust standard errors clustered at provincial level are shown in parenthesis. Significance at 10% level is represented by *, at the 5% level by **, and at 1% level by ***.

Table A6: Yardstick competition and regulatory effects – First stage results of Table 4 - Panel B

Dependent variable: Neighbors' waste recovery				
	(1)	(2)	(3)	(4)
Neighbors 1 year before election	-0.01	0.05	0.01	0.09*
	(0.08)	(0.06)	(0.04)	(0.05)
Neighbors 2 years before election	-0.00	0.02	-0.04	0.10
	(0.05)	(0.05)	(0.04)	(0.07)
Neighbors 3 years before election	0.04	-0.02	0.04	0.07
	(0.04)	(0.03)	(0.03)	(0.04)
Neighbors Election	0.07	-0.01	0.03	0.01
	(0.07)	(0.03)	(0.03)	(0.04)
Kleibergen-Paap F	1.079	0.615	6.2	2.668
Hansen Test (p-value)	0.472	0.736	0.957	0.109
Year Effects	Yes	Yes	Yes	Yes
Province Effects	Yes	Yes	Yes	Yes
Province Controls	Yes	Yes	Yes	Yes
Observations	457	251	558	138
Number of Provinces	101	71	98	33

Notes: See Table A3.