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Pro-Environmental Determinants of Waste Separation: Does the Interaction of Human and Social Capital Matter? Evidence from Italian Provinces

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Abstract: Sustainable practices should include proper incentives and involve a large part of the population to achieve a significant environmental impact. Human capital is considered one of the factors that affect pro-environmental behaviours: more educated people tend to be more aware of waste management processes. Another factor is social capital, as far as the feeling of belonging to a society might involve people in adopting sustainable practices. However, these two concepts are strictly related and deserve to be studied as complementary to each other. Thus, this article investigates whether social capital might support waste recycling when interacting with the accumulation of human capital at a provincial level. Our analysis relies on a unique dataset of 103 Italian provinces for the period 2004–2017. Results suggest that while human and social capital has a negative effect on waste separation, their interaction turns out to be positive and even stronger when we consider Southern provinces with respect to the whole country. This finding might be of interest not only from an academic viewpoint, but also from a policymaker's perspective to alleviate the pledge of waste separation, which has affected the South of Italy in recent decades.

Keywords: human capital; waste separation; waste management; social capital; Italian provincial data

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1. Introduction

Waste separation practices are increasingly common worldwide [1,2], and the goal of waste separation is considered an integral part of sustainable processes included in the policies of many countries [3]. Well-known macroeconomic phenomena, such as the growing world population, its progressive urbanisation, and problems related to the search for a virtuous economy, highlight the necessary contribution of waste management in improving life well-being up to the processes of sustainable development [4,5].

Thanks to appropriate waste management, it is possible to observe a plethora of economic and environmental benefits, while being aware of the different costs for consumers who are involved in the separation processes [6]. The need to bear these costs implies that the necessary attention to waste separation is not automatic and requires the collaboration and adaptation of various agents involved in the cycle [7,8]. Moreover, there is a need for updated technologies to correctly process the increasing amount of produced waste [9]. Among these, it is worth mentioning the conversion of waste to energy [10], sanitary landfills, thermal treatment, and biological treatment methods [11]. All these technologies require high investments and people with high-skill capabilities to operate according to the circular economy paradigm of reuse and recovery [12]. However, education is not only important for the practitioner of a waste management process, but it turns out to be a fundamental factor as it stimulates the overall population to be fully involved and aware of the importance of correct waste management [13]. Another aspect to consider

is the role of social capital (SC), as far as the diffusion of norms concerning reciprocity and trust help to promote pro-environmental behaviours and good practices related to waste management [14–16]. Such behaviours would be triggered when a society offers the opportunity to develop relations between its members, who should be mobilised for greater participation and also tested on recycling practices. Therefore, societies where education, embedded in the accumulation of human capital (HC), is accompanied by higher levels of SC, are those that might develop better waste management practices and sustainable development initiatives [17].

This article aims to test whether endowments of HC and SC influence separate waste management, particularly domestic waste. Starting from the idea developed by Dale et al. [17], we hypothesise that, on the one hand, HC per se is not sufficient to trigger positive effects in the absence of plausible support from local SC. On the other hand, more educated individuals have more knowledge about the environmental repercussions of their behaviours; they know their responsibilities and the effects, and indeed this affects the SC [18], making the two intangible capitals connected [19].

Our empirical analysis is conducted on a unique database of 103 Italian provinces (NUTS 3 level) for the period 2004–2017. Italy can be considered an interesting environmental setting, as both the endowments of HC and SC are lower in many areas of the peninsula with respect to other developed economies. HC has low historical relevance in the Italian socioeconomic context when compared with other advanced economies [8], and this is confirmed in recent studies [20,21]. The research on the Italian case is driven by the fact that the HC and SC weakness may explain why the recent EU Eurobarometer surveys on member countries highlight that Italians who consider the responsibility for protecting the environment "very important" are approximately 10% fewer than the European average, and the 60% of Italians separating most of their waste for recycling purposes is 6% less than the European average [22].

The Italian context is also known for its high heterogeneity. Considering the well-known North–South dualism, we propose the comparison of two areas with deep social, economic, and cultural gaps, e.g., [23,24]. We study Center-North and South Italy separately for at least two reasons. First, despite periods of partial convergence from the unification of the country (in 1861) to recent years [25], provinces in the South are characterised by low levels of GDP per capita, higher unemployment rates, and higher crime rates, which in turns affect the accumulation of HC and SC [26]. Second, waste treatment in Italy is rapidly evolving. Over time, an increasing number of municipalities are implementing separate collection programs across the country [27]. However, even where waste separation is mandatory, scepticism from families [28], opportunistic behaviours, and poor civic sense [29] can induce lower levels and inefficiencies, mainly in the South. For example, the ISPRA (*Istituto superiore per la protezione e la ricerca ambientale—Higher Institute for Environmental Protection and Research*) 2019 report shows that separate collection is 67.7% of the total for the North, 54.1% for the Center, and 46.1% for the South. For these reasons, we focus on provinces as territorial units of investigation [30], and we control for potential spatial effects in the waste and HC and SC relationship.

The contribution of our article to the literature is twofold: firstly, we investigate whether the complementarity of both social and HC is relevant for waste separation practices. Knowledge per se and school education are the bases on which individuals build their behaviours and eventually achieve an "environmental consciousness" [31]. However, having more knowledge or information would not be enough to trigger environmentally conscious behaviours if social awareness does not grow [32]. The potential of our research lies in the hypothesis that the interaction of HC and SC (which would normally lead to pro-environmental behaviours) boost economic sustainability. Our study can pave the way for a new interpretation of the two interconnected intangible capitals. Furthermore, our work helps to demonstrate that even where HC and SC are of a (relatively) low level, it is possible to find alternative ways to "exploit" them, starting from a pro-environmental

attitude. The interaction effect could be a strength for economies that have already tested the role of the two capitals individually (e.g., [16]).

Secondly, our article provides a contribution to the field of circular economy, supporting the explanation of one of the practices (waste separation) that represent a pillar for waste management development [33]. In this sense, research in recent years incorporates SC and HC among the factors which support resilience in a turbulent historical period as sources of environmental consciousness (e.g., [34,35]). Our research on the "interaction effect" on waste management can therefore suggest a new way of investigating one of the fundamental practices—efficient waste management—that can be considered the basis of the circular economy [36–38].

The article is organised as follows: Section 2 briefly exposes the known factors influencing separate collection, including HC and SC. Section 3 illustrates the data and explains our econometric approach. Results and their discussion are presented in Sections 4 and 5, respectively, while we propose some policy recommendations in Section 6.

2. Theoretical Background

2.1. The Effect of Education on Pro-Environmental Behaviours

Education is considered a fundamental aspect of initiatives and development strategies for encouraging pro-environmental practices and those related to waste management [39]. The socioeconomic literature considers various types of education with respect to their role in fostering the aforementioned behaviours, and we observe at least two main types, i.e., specific training (e.g., on the relevance of environmental sustainability issues) and general training (e.g., achieving a high level of education that also contributes to environmental awareness).

More specifically, the first one (which is not treated in this article) is related to specific education programs that concern awareness of the natural environment, the waste cycle, and the importance of individual contributions to waste management, often starting from the first school levels [40,41].

The second strand of literature concerns more the general role of education. This broader definition constitutes the theoretical basis of our article. In this sense, education contributes to understanding and developing the necessary knowledge of environmental aspects. In particular, advanced education should act on the awareness of the importance of waste separation and recycling, and this should positively influence recycling attitudes and environmental behaviours (see the literature review by Aini et al. [42]). The influence of education on waste activities and environmental conduct is tested in specific surveys, in addition to social norms, perceived controls, and moral obligations [43]. Educated individuals are more conscious of sustainable development and tend to modify their behaviours to protect the environment [44]. This aspect is fundamental because it affects the involvement of consumer households in recycling processes and is strengthened by specific (public) interventions that highlight the seriousness of the problem of waste growth [45].

The role of education has been verified in recent studies, since educated people are a key point at which institutions are aiming for the future of sustainability [46]. For example, Ahmed and Wang [13] found a direct relationship between education and the improvement of the environment through the effective contribution of HC in reducing the ecological footprint in India, as similarly observed by Zafar et al. [47] for the US, which considered HC useful for a sustainable economic turnaround. Ponce et al. [48] found that HC plays a positive role in environmental behaviours and preserving the environment in Ecuador. The HC stimulus toward environmental quality finds confirmation in cross-country analysis and over long time periods, as verified by Ahmed et al. [49] for the G7 countries during 1971–2014.

However, we must consider that, although information dissemination and knowledge derived from education affect individual conduct [50], a specific pro-environmental attitude is not always relevant in studies on education and effective behaviours [51].

2.2. SC and Pro-Environmental Behaviours

In addition to the awareness of environmental issues and general knowledge, SC is a major source for inducing pro-environmental and green protection behaviours [52]. De facto, SC would act as a kind of guarantee for the members of a community (e.g., investing in collective activities, such as the management of common resources), knowing that others would tend to act similarly [53].

Among the many prosocial behaviours, internal social motivators can induce triggering effects, as well as a social influence (from family, friends, and neighbours), and these are linked, for example, to recycling behaviours [54]. In fact, social interaction (or "social pressure"), when environmental compliance standards exist, can contribute to normalising them, leading to further practices related to sustainability [18]. In this sense, SC can be considered a resource of the society that makes itself more sustainable and environmentally resilient when other resources (such as public ones) are weak [55].

Many contributions in the literature endorse the role of SC. Collins et al. [56] observe that those who give to charity or who undertake charitable work show a much greater tendency to recycle. Fiorillo and Senatore [57] found a positive relationship between prosocial behaviours, waste concern, and propensity for recycling in the time preceding environmental policies, rewards, or sanctions. Torgler and García-Valiñas [58] found that SC and trust generally indicate high environmental preferences; nevertheless, these preferences can vary over time (e.g., willingness to pay specific taxes) and among areas of a country. Fiorillo [59] demonstrates that social behaviours (e.g., membership in non-profit associations, talking politics, and church attendance) strongly predict the tendency to recycle always or often. Hua et al. [60] observe that trust plays a major role in encouraging, guiding, and controlling behaviours related to recycling among the members of social communities. Owen and Videras [61] demonstrate a strong cross-country valid relationship between civic cooperation (limiting free-riding behaviours) and pro-environment attitudes and intentions to pay higher taxes to protect the environment.

In observing the particular effect of social attitude, SC is not a constant source of sustainable behaviours [62]. For this reason, it is important to identify which among the social behaviours effectively play a role in waste management practices. First, we should consider the importance of knowledge, awareness, but also the change in shared values that the social institutions (as the whole society, school, and family, among others) disseminate [63]. Zhou et al. [64] have recently shown that the mechanisms by which this occurs are to be sought from the influence of social networks, social trusts, and social participation in promoting waste-separation actions. SC can effectively do so by providing knowledge on pro-environmental behaviours "by providing opportunities for individuals' social learning and strengthening the reputation effect to encourage residents' waste-separation behaviours" [64] (pp. 13–14). De facto, SC acts with the presence of in-group norms and interpersonal trust, when present in social networks, and these sort of "social norms" affect precisely pro-environmental behaviours intentions, among which waste sorting, which in turn reward individuals and groups [65].

2.3. Waste Separation in Italy

The study of waste management in Italy has taken on relevance since policymakers and public opinion began to increasingly consider the problem of excessive waste production during the 1990s, suggesting growing attention toward recycling. In this context, the awareness of Italians grew with the first practices of waste separation at the household level [66,67]. The model of waste management in Italy concerns different levels of peripheral administrations, which also apply EU directives, with the aim, e.g., of generating less waste, obtaining materials for reuse, and, indeed, reducing pollution [68]. Administrations, such as municipalities, do not always carry out virtuous practices, and the Italian problem of excessive landfilling is known, compared to other high-income European countries [69].

The first period of "change in behaviours" related to waste management was on a voluntary basis, without incentives or punishments. In this context, facilitations in

recycling waste were decisive, as well as the greater propensity of subjects already active in the social field or capable of prosocial behaviors [59]. Since then, the Italian model has changed, and an increasing number of Italians are committed to producing less waste, differentiating more, and obtaining more services (door-to-door waste collection), even in small municipalities [28]. Italy has implemented numerous other measures (reducing landfilling and emissions, improving waste management and wastewater treatment) aimed at sustainability and the development of the circular economy in recent years, accompanied by efforts for environmental protection and by combating environmental crime [70].

However, these good practices are not present in all areas. Evident gaps between the wealthy Center-North and the relatively "poor" South are also present in waste management, in the provision of related infrastructures, and in the levels of waste separation [71,72]. The delay in the development of waste management in the southern regions "*is certainly due to several environmental, social, technological and financial constraints affecting waste management (e.g., poor collection service capacity, a lack of disposal infrastructures, scarcity of waste valorisation investments)*" [73]. Substantial differences in economic development must be considered, even if the role of high income seems to have a virtuous effect only for the richest provinces, shifting the focus to the need to implement other policies that limit the creation of waste at the source [74]. Agovino et al. [75], by studying homogeneous groups of municipalities, observed that the role of institutions is preponderant in addressing separate collection practices, but the best results occur when they work in coordination with citizens, and despite the confirmation of North–South dualism, some positive cases are also present in the South.

3. Materials and Methods

3.1. Data and Variables' Description

Our goal is to investigate the effect of HC, SC, and other controls on waste separation behaviours in Italian NUTS3 provinces. To test this relation, we rely on panel data from 2004 to 2017. Data for waste separation were not available for the year 2018, and we prefer to avoid COVID biases, including the year 2020 in the analysis. For what concerns the other variables in the sample, due to the level of analysis, i.e., Italian provinces, more recent data are characterised by many missing values. Thus, we choose the period 2004–2017 to keep our sample robust and reliable. Data are collected from three main data sources: the Italian National Statistical Institute (ISTAT) for the majority of our variables, EUROSTAT for the GDP per capita and population density, and the index built by Nifo and Vecchione [76] for what concerns the SC measure.

The dependent variable (*Sepwaste*) is the percentage of separate collection of urban waste on the total amount of household waste (elaborated by ISTAT on ISPRA data). This measure is widely used as a proxy for waste separation behaviours in the Italian context [77,78]. We rely on this indicator because increasing waste separation at the household level is one of the objectives for improving and developing waste management and sustainable practices [19].

Our variable for HC is represented by the percentage of people from 25 to 64 years with at least secondary education (ISCED 3–8). The measure of school education is considered a good proxy to analyse increasing awareness of environmental issues in relation to waste management [79]. Moreover, the uneven presence of educated people is a typical feature of the Italian North–South dualism, where Southern provinces are those lagging behind more [26,80].

Our proxy for SC is the *Voice and accountability* index elaborated by Nifo and Vecchione [76]. Among the five pillars that constitute the institutional quality index, *Voice and accountability* represents the level of SC in each province as it mainly relies on association activities, cultural liveliness, electoral participation, and the presence of cooperatives. At the level of our analysis, this is the best proxy for SC, and no other data were available to distinguish separately between bridging and bonding SC. Thus, SC should influence pro-environmental attitudes by affecting behaviours toward environmental protection among

consumers, persuaded by the social context of residence [81]. SC shapes the recycling performance of a community, which is influenced by the whole community's involvement [44]. This sense of belonging and civic responsibility enhances environmental management and boosts the implementation of environmental policies [82].

Among the control variables, we consider GDP per capita (*GDP_PC*) as a measure of local economic well-being. Wealth has an important effect on pro-environmental behaviours, as documented by the EU Special Eurobarometer 501 survey: concerns for environmental issues are decreasing among the less well-off social classes and, in particular, for those who have economic problems, while those better off are more conscious about the status of the environment. This dualism holds true also for the Italian case, where it is documented that the poorer ones are also those careless toward separate waste behaviours [26]. Regarding waste management issues, tourism plays a significant role. Highly touristic areas are facing the problem of a greater amount of garbage produced [83] and, at the same time, the need to minimise the impact on sustainable practices [84]. The areas that are most at risk are those that have seen a recent and rapid growth in touristic flows, certainly present in the countries of Mediterranean Europe, thus increasing the pressure on environmental sustainability [85]. We consider the ISTAT "tourist rate" indicator (*tourism*) measured by days of presence, Italian and foreign, in the total of accommodation establishments per inhabitant. We must also consider that the presence of crime negatively affects waste management and recycling. This aspect is crucial in Italy for the presence of criminal organisations often based in the South but operating throughout the country [86]. As a proxy for the crime level, we consider the ISTAT indicator "other violent crimes reported by province" per 10,000 inhabitants (*crime*). These crimes do not include homicides or mafia organisations, and they can be a good proxy for minor crimes in a province [87]. Finally, we control for demographic variables that are known aspects influencing recycling rates [88,89]. Population density is represented by the population per square kilometre (*dens*). The continuous increasing trend of population density represents an obstacle to the collection mechanism and an indicator of urbanisation, with negative consequences on the goal of increasing separation [19]. Thus, overcrowded places are becoming a critical point to be observed for pro-environmental improvements [69]. When considering separation behaviours at the household level, we expect that older people are more careful about recycling, and women tend to be more involved than men in waste separation processes (see the extensive literature review by Matsumoto [90]). For these reasons, we introduced two additional variables, such as the mean age of the population (*elderly*) and the gender composition (*female*), to control for the presence of elderly people and the percentage of women in a province. We expect that the higher the presence of these two categories, the higher the percentage of waste separation in each province.

All the variables, their definitions, and the related sources are reported in Table 1, while Table 2 presents the summary statistics. It is possible to note from Table 2 the evident differences among the Center-North and South provinces, which also confirms in our sample the ongoing debate on the North–South divide [91].

Table 1. Variables' description.

Variable	Definition	Source
Sepwaste	Percentage of separate collection of urban waste	ISTAT
HC	Percentage of people with at least a diploma	ISTAT
SC	"Voice and accountability captures the participation in public elections, the phenomenon of associations, the number of social cooperatives and cultural liveliness measured in terms of books published and purchased in bookshops." (Nifo and Vecchione 2014, p. 1633) [76]	Nifo and Vecchione (2014) [76]

Table 1. *Cont.*

Variable	Definition	Source
GDP_PC	Per capita gross domestic product	EUROSTAT
tourism	Days of presence in the total of Accommodation establishments per inhabitant	ISTAT
crime	Other violent crimes reported by province per 10,000 inhabitants	ISTAT
dens	Population per squared kilometre	EUROSTAT
elderly	Mean age of the population	ISTAT
female	Percentage of female population	ISTAT

Table 2. Summary statistics.

	(1)	(2)	(3)	(4)	(5)
Variables	**N**	**Mean**	**sd**	**Min**	**Max**
Sepwaste	1442	0.372	0.204	0.017	0.879
Sepwaste—Center-North	938	0.449	0.171	0.034	0.879
Sepwaste—South	504	0.226	0.179	0.017	0.753
HC	1442	0.546	0.078	0.309	0.757
SC	1442	0.573	0.215	0	1
GDP_PC	1442	24,368.65	6482.86	13,000	54,000
tourism	1442	7.380	9.520	0.278	61.60
crime	1442	16.51	5.163	7.700	56.80
dens	1442	254.2	334.8	37.70	2687
elderly	1442	21.652	2.849	13	28.90
female	1442	51.49	0.490	49.92	53.13

Note: Column 1 reports the number of observations in the sample (N); columns 2 to 5 are the mean values (mean), the standard deviation (sd), the minimum (min), and maximum (max) values of each variable in the sample.

3.2. Methodology

Our econometric strategy is developed in two steps. In the first step, we test the direct effect of HC and SC on separate waste collection by performing a series of panel fixed effects models, as follows:

$$Sepwaste_{it} = \beta_1 HC_{it} + \beta_2 coop_{it} + \beta_4 HC * coop_{it} + X'_{it}\beta_4 + \theta_t + \partial_i + \varepsilon_{it} \quad (1)$$

where i is the NUTS-3 region, we considered 103 provinces which allow us to deal with consistent time series data without gaps for the period under investigation; t is the time; and, X is the vector including our control variables (tourism, crime, elderly, female, and GDP per capita). θ_t is a vector of year dummies to control for the business cycle and possible macroeconomic shocks (such as those related to the 2008 economic crisis), and ∂_i is a vector of regional dummies that we include to control for province-fixed effects. Finally, ε_{it} is the stochastic error term.

Being aware of the possible spatial effects that might emerge in the process of waste separation [91], in the second part of our analysis, we control for potential spatial correlation, testing whether an increase in separate waste collection in a province depends on the increase in waste collection and/or HC/SC in neighboring provinces [92]. The spatial analysis is a step-by-step procedure that begins running three tests that detect the presence of spatial correlation in the model: the global Moran's I, the global Geary, and the Getis–Ord tests [93]. The global Moran's I captures the presence of possible spatial dependency among the dependent variable of neighboring provinces; in our case, the waste separation process of a province might be influenced by the behaviors of the neighboring provinces [94]. Similar to the global Moran's I, the global Geary captures the spatial autocorrelation among clusters of provinces. Thus, the global Geary should be applied if the global Moran's I

do not detect the presence of spatial effects in the neighboring provinces, and there is the need to verify if this correlation is present in groups (or clusters) of provinces [95]. Finally, the Getis–Ord test is a refinement of the previous two tests as it detects local clusters that exist despite negative tests for global spatial autocorrelation [96]. If all three tests reveal the presence of possible spatial autocorrelation, in the second step, we proceed by estimating Equation (2) for the panel spatial autoregression model (SAR):

$$\begin{aligned} y_{nt} &= \lambda W y_{nt} + X_{nt}\beta + c_n + u_{nt}, \\ u_{nt} &= \rho M u_{nt} + v_{nt} \end{aligned} \tag{2}$$

where W and M are spatial weighting matrices computed as a (row standardised) binary contiguity matrix in our full panel of provinces and years to identify contiguous provinces. X_{nt} is the matrix of time-varying regressors. c_n is a vector of panel-level effects, u_{nt} is the spatially lagged error term, and v_{nt} is a vector of disturbances and is independent and identically distributed (i.i.d.) across panels and time. If the lag parameter ρ is not statistically significant, it means that the level of separate waste collection in a province is not influenced by the level of separate waste collection in the neighborhood. Conversely, a statistically significant ρ would be the sign of the presence of spatial autocorrelation in separate waste collection. In this latter case, we proceed with the following estimation procedure: first, we run the spatial Durbin model (SDM) to detect the presence of possible spatial effects in the regressors [97]. Again, if the parameter ρ is significant, the spatial error model (SEM) is useful to test for possible spatial correlation in the error component. The SEM can be considered a generalisation of the SDM with a particular focus on the correlation of the error component [98,99] to control for all the possible spatial effects in our analysis. The final model used to investigate the remaining presence of spatial autocorrelation is a particular version of the SAR model combined with spatially autocorrelated errors (Spatial Autoregressive Combined—SAC). This last model estimates an endogenous correlation that is low and not significant compared to the residual autocorrelation. The SAC model is computed when the spatial λ error is still significant after the estimation of the SEM model and detects the presence of fixed effects in the regression. If the final spatial λ error is no more significant, this model accounts for all the residual spatial correlation presented in the error term [97,100] and is able to capture all the spatial correlation among our variables.

4. Results

Table 3 highlights the main results of the panel fixed effects in Columns 1 to 3 for Italy (all provinces), while Columns 4 and 5 report the estimates for the Center-North and South, respectively. Column 1 includes only the HC and SC variables, while Column 2 also reports the other factors that might affect separate waste collection. Finally, in Column 3, we interact HC and SC to test not only for the presence of these two variables as separate constructs, but also their interaction effects.

Table 3. Regression results with panel fixed effects.

Variables	(1) Italy	(2) Italy	(3) Italy	(4) Center-North	(5) South
HC	0.117	0.132	−0.334	−0.246	−0.720 *
	[0.145]	[0.137]	[0.281]	[0.374]	[0.388]
SC	0.182 ***	0.175 ***	−0.243	−0.091	−0.886 ***
	[0.048]	[0.047]	[0.230]	[0.315]	[0.287]
HC × SC			0.724 *	0.486	2.047 ***
			[0.399]	[0.505]	[0.610]
tourism		−0.008 **	−0.007 **	−0.010 **	−0.005
		[0.003]	[0.003]	[0.004]	[0.004]
crime		−0.005 ***	−0.005 ***	−0.002	−0.007 ***
		[0.002]	[0.002]	[0.002]	[0.002]

Table 3. *Cont.*

Variables	(1) Italy	(2) Italy	(3) Italy	(4) Center-North	(5) South
elderly		0.015	0.023	−0.012	0.083 **
		[0.014]	[0.014]	[0.018]	[0.036]
female		0.036	0.026	0.017	0.034
		[0.032]	[0.030]	[0.040]	[0.047]
ln_GDP_PC		0.063	0.033	−0.073	0.149
		[0.085]	[0.086]	[0.098]	[0.132]
ln_dens		−0.068	−0.128	−0.133	0.200
		[0.189]	[0.185]	[0.175]	[0.485]
Constant	0.078	−2.584	−1.521	1.520	−7.084
	[0.070]	[2.053]	[2.052]	[2.282]	[4.310]
Observations	1442	1442	1442	938	504
R-squared	0.758	0.772	0.775	0.805	0.774
Number of Provinces	103	103	103	67	36
Year FE	YES	YES	YES	YES	YES

Notes: Columns 1–3 represent the sample of the overall 103 Italian provinces; column 4 reports the results for regions in the Center-North, while column 5 reports for the South regions. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors are clustered at NUTS3 regional level.

Columns 1 and 2 show that the effect of higher education does not induce any pro-environmental behaviours; on the contrary, our proxy of social cohesion (SC) has a positive and significant effect in both columns. When we introduce the interaction term ($HC \times SC$) in Column 3, the results are substantially different: we observe that the two intangible capitals, taken separately, have no desired effects (the low average level of the two intangible capitals probably does not reach a sufficient level to trigger positive effects. The low level of average education in Italy is a known issue and observable in international comparisons [101]. The proxy of social capital should involve related aspects regarding: acquiring information, participating in public activities, and reinforcing moral norms [52]. Widespread behaviours such as "amoral familism", or a predominant effect of bonding social capital, could play a greater role (especially in some southern areas, see Banfield [102])), while their interaction turns out positive. As we expected, they reinforce one another [103]. The control variables in Columns 2 and 3 reveal that the congestion effect due to the presence of tourism and the incidence of widespread crime support the negative effects related to separate waste collection behaviours. Indeed, tourism has the consequence of generating a large amount of waste, causing risks of environmental degradation [83], while the presence of criminal organisations, with relevance for organised crime in Italy, is a recognised aspect worsening environmental practices and waste performance [87]. For what concerns demographic controls, the general aging of the population does not seem to influence the behaviours analysed, probably influenced by an average age that is already higher in Italy than that in other countries. Higher female involvement in waste-related activities, despite an effect found in the literature [104], is not observed in our findings. We find no significance for population density, in line with the previous literature [71,105], as well as for GDP per capita, which could result in a mixed effect between the increase in municipal solid waste connected to urbanisation [106] and the greater resources to devote to environmental issues [88].

The final two columns in Table 1 report the estimates for the Center-North and South regions. Results show that the North–South divide is also confirmed in waste management practices. In the richest provinces of the country, mainly in the Center and North of Italy, none of our variables appear to affect separate collection, except for the tourism level. The effects in the northern area could suggest that the most virtuous area in waste management, those more willing to make major investments, already enjoys good results both for the will and behaviours of citizens and the work of local public administrators [71]. For the South, the negative effects of the proxies of HC and SC indeed confirm the important

deficiencies due to the socioeconomic development path of this area. In the South, however, the interaction effect is much stronger and statistically significant (with respect to the whole country in Column 3). This may be the turning point sought, that is, the appropriate interaction effect above HC and SC. The sign of the interaction effect is opposite that of the two components and, if properly exploited, may be a primary force on which to design environmental sustainability paths. In the South, even the role of crime, unlike tourism, which has a greater effect in the Center-North, shows a stronger impact than in the analysis of the overall Italian provinces, effectively reinforcing the well-known Italian weaknesses (e.g., the many inefficiencies and the strong presence of organised crime, see Pasotti [107]).

Given the evident role of the geographical feature in our analysis, we run several tests to detect the presence of possible spatial correlation. We report the global Moran's, the LM error, and the LM Lag Anselin [108] tests in Table 4. All three coefficients are positive and highly statistically significant, which is consistent with the presence of possible spatial effects in our baseline model. Thus, we proceeded with ad hoc spatial analysis to consider these spatially related issues.

Table 4. Tests on spatial autocorrelation.

GLOBAL Moran MI	0.232 ***
LM Error	165.717 ***
LM Lag Anselin	170.540 ***

Note: *** $p < 0.01$.

Table 5 reports the results when all the provinces in the sample are considered. None of the model specifications in Table 5 have a significant ρ or λ; thus, the spatial effects detected in Table 4 are related only to a specific group of provinces belonging to the division between North and Central Italy or South Italy.

Table 5. Spatial regression for the overall Italian 103 provinces.

Dep. Var. Sepwaste **Model**	**(1)** **SAR**	**(2)** **SDM**	**(3)** **SEM**
HC	−0.201	−0.170	−0.202
	[0.278]	[0.266]	[0.278]
SC	−0.094	−0.092	−0.096
	[0.221]	[0.215]	[0.221]
HC × SC	0.477	0.440	0.480
	[0.380]	[0.372]	[0.380]
tourism	−0.007 **	−0.007 **	−0.007 **
	[0.003]	[0.003]	[0.003]
crime	−0.005 ***	−0.005 ***	−0.005 ***
	[0.002]	[0.001]	[0.002]
elderly	0.032	0.032	0.031
	[0.030]	[0.031]	[0.030]
female	0.006	0.004	0.006
	[0.012]	[0.012]	[0.012]
ln_GDP_PC	0.018	0.009	0.018
	[0.087]	[0.084]	[0.087]
ln_dens	−0.253	−0.240	−0.252
	[0.200]	[0.192]	[0.200]
Spatial autocorrelation			
W_HC		0.212	
		[0.394]	
W_SC		−0.219	
		[0.326]	
W_HC × SC		0.265	
		[0.546]	

Table 5. *Cont.*

Dep. Var. Sepwaste **Model**	**(1)** **SAR**	**(2)** **SDM**	**(3)** **SEM**
W_tourism		−0.009	
		[0.008]	
W_crime		−0.004	
		[0.003]	
W_female		−0.070	
		[0.076]	
W_elderly		−0.016	
		[0.018]	
W_ln_GDP_PC		−0.051	
		[0.197]	
W_ln_dens		0.078	
		[0.374]	
Observations	1442	1442	1442
R-squared (within)	0.772	0.777	0.772
Number of NUTS-3	103	103	103
Year FE	YES	YES	YES
NUTS-3 FE	YES	YES	YES
ρ	−0.009	−0.043	
Spatial λ error			−0.014

Notes: Column 1 reports the results of the Spatial AutoRegression model (SAR), Column 2 for the Spatial Durbin (SDM), and Column 3 for the Spatial Error Model (SEM). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors are clustered at NUTS3 regional level.

To better understand why the spatial effects detected in Table 4 are not confirmed in Table 5 by looking at the entire sample, we repeat the spatial analysis for the Center-North (67 provinces) and South (36 provinces) to see if there are some macro-regional peculiarities that drive our estimations. Results from the Center-North and South are reported in Tables 6 and 7, respectively. The contiguity matrix was recomputed with respect to the two subsamples of the analysis.

Table 6. Spatial regression for the Center-North.

Dep. Var. Sepwaste **Model**	**(1)** **SAR**	**(2)** **SDM**	**(3)** **SEM**
HC	−0.283	−0.234	−0.295
	[0.353]	[0.330]	[0.354]
SC	−0.142	−0.138	−0.160
	[0.293]	[0.281]	[0.298]
HC × SC	0.560	0.545	0.584
	[0.475]	[0.457]	[0.480]
tourism	−0.010 **	−0.010 **	−0.010 **
	[0.004]	[0.004]	[0.004]
crime	−0.002	−0.003	−0.002
	[0.002]	[0.002]	[0.002]
elderly	0.015	0.011	0.015
	[0.038]	[0.037]	[0.038]
female	−0.013	−0.015	−0.012
	[0.012]	[0.012]	[0.012]
ln_GDP_PC	−0.084	−0.049	−0.079
	[0.100]	[0.094]	[0.101]
ln_dens	−0.166	−0.194	−0.162
	[0.183]	[0.165]	[0.185]

Table 6. *Cont.*

Dep. Var. Sepwaste **Model**	**(1)** **SAR**	**(2)** **SDM**	**(3)** **SEM**
Spatial autocorrelation			
W_HC		−0.995	
		[0.778]	
W_SC		−1.241 **	
		[0.613]	
W_HC × SC		1.775 *	
		[1.015]	
W_tourism		−0.013 *	
		[0.006]	
W_crime		−0.003	
		[0.004]	
W_female		−0.034	
		[0.092]	
W_elderly		0.004	
		[0.030]	
W_ln_GDP_PC		0.199	
		[0.179]	
W_ln_dens		0.200	
		[0.342]	
Observations	938	938	938
R-squared (within)	0.806	0.814	0.806
Number of NUTS-3	67	67	67
Year FE	YES	YES	YES
NUTS-3 FE	YES	YES	YES
ρ	−0.070	−0.059	
Spatial λ error			−0.068

Notes: Column 1 reports the results of the Spatial AutoRegression model (SAR), Column 2 for the Spatial Durbin (SDM), and Column 3 for the Spatial Error Model (SEM). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors are clustered at NUTS3 regional level.

While we detect no presence of spatial effects in Table 6 for the North and Center provinces, both ρ or λ are not significant, these effects emerge for the South as reported in Table 7. The presence of spatial spillovers is more related to the HC variable, meaning that pro-environmental behaviours in a province are influenced not only by the HC of that province but also by the level of education of neighbouring NUTS-3 regions. Thus, provinces in southern Italy are influenced by the behaviours of contiguous provinces when separate waste collection is considered (Table 7).

Table 7. Spatial regression for the South.

Dep. Var. Sepwaste **Model**	**(1)** **SAR**	**(2)** **SDM**	**(3)** **SEM**	**(4)** **SAC**
HC	−0.571	−0.424	−0.440	−0.550
	[0.356]	[0.398]	[0.371]	[0.487]
SC	−0.773 ***	−0.455	−0.709 **	−0.764 **
	[0.273]	[0.405]	[0.292]	[0.303]
HC × SC	1.863 ***	1.254	1.752 ***	1.851 ***
	[0.574]	[0.772]	[0.610]	[0.611]
tourism	−0.004	−0.005	−0.004	−0.004
	[0.003]	[0.004]	[0.003]	[0.004]
crime	−0.008 ***	−0.007 ***	−0.008 ***	−0.008 ***
	[0.002]	[0.002]	[0.002]	[0.002]
elderly	0.039	0.060	0.050	0.039
	[0.048]	[0.053]	[0.049]	[0.060]

Table 7. *Cont.*

Dep. Var. Sepwaste **Model**	**(1)** **SAR**	**(2)** **SDM**	**(3)** **SEM**	**(4)** **SAC**
female	0.027	0.028	0.027	0.028
	[0.020]	[0.018]	[0.021]	[0.020]
ln_GDP_PC	0.133	0.104	0.097	0.131
	[0.130]	[0.113]	[0.146]	[0.158]
ln_dens	−0.365	−0.493	−0.398	−0.370
	[0.436]	[0.475]	[0.502]	[0.453]
Spatial autocorrelation				
W_HC		1.900 ***		
		[0.471]		
W_SC		0.987 *		
		[0.515]		
W_HC × SC		−1.686 *		
		[0.948]		
W_tourism		−0.015 *		
		[0.008]		
W_crime		−0.001		
		[0.004]		
W_female		0.109		
		[0.099]		
W_elderly		−0.035		
		[0.035]		
W_ln_GDP_PC		−0.315		
		[0.453]		
W_ln_dens		−1.032		
		[1.282]		
Observations	504	504	504	504
R-squared (within)	0.773	0.791	0.771	0.772
Number of NUTS-3	36	36	36	36
Year FE	YES	YES	YES	YES
NUTS-3 FE	YES	YES	YES	YES
ρ	−0.231 **	−0.299 ***		−0.197
Spatial λ error			−0.251 **	−0.031

Notes: Column 1 reports the results of the Spatial AutoRegression model (SAR), Column 2 for the Spatial Durbin (SDM), Column 3 for the Spatial Error Model (SEM), and Column 4 for the Spatial Autoregressive Combined (SAC) model. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors are clustered at NUTS3 regional level.

5. Discussions

The first important aspect to highlight among our results concerns the interaction between HC and SC and its possible meanings. Such a result confirms that the two forms of capital are not independent of each other. An example might be the relationship between a high level of education and the position of individuals in higher social groups with different social values [109]. Thus, it is necessary that more educated people act in the community of reference, thanks to their level of SC, to boost social responsibilities, such as those related to waste separation practices [110]. The discussed mechanism seems plausible in the context of a common good, such as environmental quality, due to conscious individual behaviours. Furthermore, our results confirm that interventions in waste separation- and recycling-related behaviours need specific knowledge of the results to be obtained (e.g., the number of participants or collected materials), the specific context (e.g., the target society) and the related motivations/incentives (internal or external) to pursue it [111].

The second aspect regards the spatial effects. Our results, even if limited to the South, are in line with Agovino et al. [71], according to which the pro-environmental behaviours of neighbouring provinces influence the attitude of others, starting with the contribution of citizens who observe "neighbours" in recycling. The detection of positive effects among the southern provinces could indicate that the lack of resources in this area implies the general cooperation of several provinces to obtain something similar to the

efficient optimal territorial areas [112]. In this sense, positive effects could be reachable by greater investments in composting and incineration activities that serve the so-called optimal management areas, as well as the effort for the dissemination of better waste management strategies [113].

In addition to the interaction effect, which confirms the hypothesis that knowledge is linked to social responsibility and improves awareness of waste classifications [114], it is necessary to discuss the other results in Italy, considering the more recent economic literature. An anomaly of the Italian case can be found in the role of HC (statistically significant only in the South, and with a negative sign). In fact, education and the resulting greater awareness (including of environmental practices) are, on average, observed to positively influence pro-environmental practices as well as those related to waste, and education is confirmed as a pillar on which to focus [115]. Positive effects are recorded both in advanced economies and in developing ones [13,116,117]. In this sense, our result could be influenced by waste separation practices not fully known by families, to which is added the scarce knowledge about their importance (e.g., [118]). Along the same lines, the role of SC (with an observed negative influence and only in the South) is usually observed as positively influencing the effort of pro-environmental actions (e.g., [14]). We could hypothesise an inadequate development of SC that, for example, limits cohesion and the sense of belonging which also affects recycling behaviours [60].

To explain the unexpected effects in our analysis, we must consider that at least three major types of influences (somehow involving HC and SC) affect waste separation choices: costs, legal obligations, and behaviours habits. Regarding costs, the effort that consumer households must sustain to separate waste is compared with the perceived costs and benefits [119]. Regarding legal obligations, laws related to waste generation and recycling are increasingly important in Italy, but at the same time, they must be enforced locally, and waste management enforcement remains a responsibility of local authorities [69]. Regarding behaviours habits, we expect that awareness and knowledge normally related to general education led to a greater focus on waste separation, although this is an effect that has not occurred in all countries (see Xu et al. [120]), and HC does not seem to work in this sense in some Italian regions.

The observation of the positive effects of the interaction of HC and SC in the South paves the way for different interpretations of these intangible capitals. We refer to the revisions of the well-known research by Banfield and Putnam [121,122]. Such reviews suggest, for example, the presence of social (kinship) networks that can trigger positive effects, even if it is a different SC than the generally accepted definition. In addition, this territorial difference confirms that some resources tend to be more useful where they are scarcer (as happens in the average level of education), but in our case, only when scarce resources work together for the same goal. The positive effect could tend to run out where the considered capitals have developed faster or earlier. In fact, this effect would not have been automatic in the case of waste separation.

Regarding our control variables, the significant ones are the incidence of tourism, crime, and the elderly population. On the effect of tourism (we observe a greater negative effect in the Centre-North), it is known that excessive tourism can worsen the collection of waste, increasing its production in the face of often inadequate infrastructures (as in small municipalities and in the peak tourism season [123]). The problem is present in many European cities, and induces active policies to involve tourists in pro-environmental practices and, at the same time, improve the image of the cities involved [124]. Our result seems compatible with the ISTAT surveys that place five central-northern regions (Trentino-Alto Adige/Südtirol, Veneto, Emilia Romagna, Tuscany, Lombardy) among those with the most tourist presence in Italy for 2020, and eight in the top ten. On the effect of crime, which is relevant for Italy and particularly for the South, our findings confirm that, where organised crime is present, all waste management is penalised [77]. In fact, the presence of crime also afflicts separate collection processes [87], and in light of our results, this could affect the opportunities and endowments for recycling for families. Finally, the

growth of waste separation with the increase in the elderly population (only in the South) confirms the positive contribution of this population group known in the literature [125]. The statistical significance in the South could derive from the improvements in services (therefore, also for the benefit of people with reduced mobility) in some areas imposed by the increasingly stringent legislation, since the elderly consider more, for example, the distance to the kerbside bins [126].

6. Conclusions and Future Perspectives

In this article, the waste collection behaviours of households have been explored by looking at the endowments of HC and SC for Italian provinces. While on an intuitive level, one could assume a positive relationship between HC and SC as single factors relates to separate collection, our work shows that only the interaction of the two forms of capital can result in positive results.

This gives a first clear signal for policy actions that need to be tailor-made to support the interaction between the two forms of capital. This means seeking pro-environmental solutions through education and socialisation by creating a prosocial education environment to foster the role of education in creating advantages for society and the environment [127,128]. This result opens the possibility of new educational paths, which are not necessarily linked to pro-environmental courses but integrate prosocial notions, rules, and ideas into normal lessons, with the spontaneous goal of improving the common good [129]. As demonstrated by Bhattacharya [130], this mechanism could be triggered by offering social support to students, which would affect their prosocial attitude, and this would influence pro-environmental behaviours. Investing in specific education programmes is already in place in some European cities, as in the case of Graz (Austria) implementing the Zero Waste education [131]. The development of education toward this path through public investment in the South, which is the area most at risk of school dropout, would therefore have a threefold advantage by strengthening HC, SC, and increasing pro-environmental practices.

Future research might consider not only the role of waste separation, but also the propensity of each province/region to develop those practices related to the circular economy guidelines [132,133]. One example is represented by more energy-intensive sectors with a high environmental footprint (such as the construction industry): both academics and practitioners are investigating new ways to minimise waste and increase the reuse of resources through the application of digital technologies, following buildings' and materials' life cycles [134,135].

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