The influence of local waste management culture on individual recycling behavior

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Abstract
The transition towards sustainable consumption and production requires public engagement and support. In this context, understanding the determinants of individual pro-environmental behavior can assist in sustainability policy design, and contribute to explaining cross-country and regional differences in its implementation and effectiveness. This paper examines the influence of local waste management culture on individual recycling behavior. To isolate the impact of location-specific norms, habits and traditions comprising waste management culture from the confounding effect of contemporaneous local economic and social conditions, we use data from over 40 000 domestic immigrants in Greece. Estimating models relating individual recycling activity in the region of current residence to recycling practices in the region of origin, we find robust evidence that region of origin waste management practices have quantitatively and statistically significant influence on individual recycling behavior: a 10 percentage point increase in the prevalence of recycling in the region of origin, increases the probability a subject recycles by 0.9 percentage points. The results suggest that locally prevailing waste management norms and practices influence individual recycling behavior independently of local economic, social and environmental circumstances. Designing effective sustainability policy may need to account for regional variation in norms and preferences, and encourage investment in the development of sustainable waste management culture.

1. Introduction
Aiming to meet sustainable resource use policy objectives and reduce waste production, national governments and international organizations encourage household waste recycling (Aspinwall and Cain 1997, Liu 2021), through behavioral interventions (Byerly et al 2018, DiGiacomo et al 2018, Maki et al 2019, Nisa et al 2019, Akbulut-Yuksel and Boulatoff 2021), information campaigns (Abrahamse and Steg 2013, Setiawan et al 2019, Pretner et al 2021) and pecuniary incentives (Jenkins et al 2003, Gellynck and Verhelst 2007, Viscusi et al 2011, Ferrara and Missios 2012, Chong et al 2015, Dijkgraaf and Gradus 2017). Target 12.5 of the Sustainable Development Goals for example calls for reducing waste generation through recycling, while the EU’s Waste Framework Directive (2008/98/CE) aspired to increase municipal waste recycling rates among member states to 50% by 2020 (European Comission 2018). Differences in waste management practices remain across jurisdictions sharing common policy objectives, with aggregate recycling rates often varying across regions at comparable levels of development, employing similar waste management policies, and sharing similar institutions (Abbott et al 2011, London Assembly 2011, Ferrara and Missios 2012, EEA 2013, Hage et al 2018, Agovino et al 2019). Assessing the influence of location-specific norms, traditions and collective practices on individual waste management attitudes and behavior, can contribute to explaining contemporaneous differences in recycling rates across and within countries, and assist in the design of regionally relevant, effective sustainability policy (Caldas et al 2015, Zheng et al 2021).
Location-specific social norms, customary beliefs, values and practices that have evolved over time and comprise local culture can influence recycling
behavior by affecting individual preferences and attitudes for environmental quality (Halvorsen 2008, Abbott et al. 2013, Kountouris and Remoundou 2016, Czajkowski et al. 2017, Hynes et al. 2018, Chaikumbung et al. 2019, Sovacool et al. 2021), defining acceptable standards of behavior influencing decision making (Gelfand et al. 2011, Caldas et al. 2015, Carvalho 2017, Davis et al. 2018, Yokoo et al. 2018, Perry et al. 2021, Walzberg et al. 2021), and impacting on the design and effectiveness of environmental policy and institutions (Tabellini 2010, Alesina and Giuliano 2015, Zheng et al. 2021). Cross-national and regional comparisons point to differences in the effectiveness of recycling policy instruments, and the influence of socioeconomic characteristics on recycling behavior across and within countries, that may be due to variation in waste management norms and cultural traits (Kipperberg 2007, Kuo and Perrings 2010, Crociata et al. 2015, Agovino et al. 2019, Kaplan Mintz et al. 2019). Nevertheless, empirically attributing the observed variation in recycling outcomes and behavior to local waste management norms and culture is challenging; as local waste management norms are place-bound (Perry et al. 2021), their influence on behavior is confounded by the effects of contemporaneous local economic, institutional and social conditions (Luttmer and Singhal 2011, Alesina and Giuliano 2015).

This paper examines whether individual recycling behavior is influenced by local norms and culture, as they pertain to waste management practice. To isolate the influence of local waste management culture from its confounders, we use individual-level data from the 2011 Greek population and housing census. Focusing on samples of internal immigrants, we observe individual recycling behavior under contemporaneous social and economic conditions different from those prevailing in the subjects’ region of origin, and estimate models relating individual recycling behavior in the region of current residence, to prevailing waste management practices in the region of origin. While the influence of region of origin waste management culture may diminish over time as internal immigrants adapt to the norms prevailing in their region of residence, its traces may be detectable in individual behavior in the medium to long term (Bisin and Verdier 2001, Fernandez 2011, Atkin 2016). If local waste management culture determines individual recycling behavior independently of aggregate socioeconomic and environmental conditions, a relationship should exist between domestic immigrants’ recycling behavior in their region of current residence and waste management practices in their region of origin. The paper adds to the literature on the determinants of pro-environmental behavior in general and recycling in particular in the following ways: (a) it provides evidence on the presence of a waste management culture effect on individual recycling behavior, (b) it suggests that within-country regional differences in waste management norms can have important influence on individual behavior, even in the context of a country that is fairly homogeneous in terms of institutions and general cultural traits, (c) it points to the importance of accounting for local norms when designing recycling policy (Caldas et al. 2015), and (d) stresses the potential long-term significance of developing sustainable waste management culture.

2. Methods

2.1. Econometric approach and data
Assessing the relationship between local waste management culture and individual recycling behavior is challenging due to the confounding effect of locally prevailing conditions, including infrastructure availability, waste management policy, and the economic and natural environment among others. To isolate the influence of local waste management culture, we focus on the recycling behavior of internal immigrants. When moving from one location to another, people take with them the set of habits, behaviors, beliefs and ideas comprising their local culture, that were formed through their experience of life in their region of origin, or were inherited from their ancestors (Fernandez and Fogli 2006, Fernandez 2007, Luttmer and Singhal 2011, Alesina and Giuliano 2015, Ek 2021, Jergins 2021). While the region-of-origin influence will slowly decay as movers assimilate to their destination, traces of collective attitudes and habits may persist, and manifest in individual behavior (Bisin and Verdier 2001, Fernandez 2011). Focusing on domestic immigrants allows to observe individual recycling behavior detached from region of origin-specific contemporaneous circumstances that confound local waste management culture. We estimate models relating domestic immigrants’ individual recycling behavior in their region of current residence, to prevailing waste management practices in their region of origin. Should local waste management norms and culture influence individual recycling behavior, a relationship will exist between individual recycling practice in the region of residence and aggregate waste management practices in the region of origin. We also assess whether the influence of region-of-origin waste management culture diminishes as domestic immigrants assimilate to their region of residence, and test the results’ stability to modeling choices. Similar approaches have been applied to assess the influence of local and national culture on women’s employment and fertility decisions (Fernandez and Fogli 2006, 2009, Fernandez 2007), human capital accumulation (van Hoorn 2019), preferences for redistribution (Luttmer and Singhal 2011), and nutrition (Atkin 2016) among others.
Data come from the 10% sample of the 2011 Greek Population and Housing Census (Minnesota Population Center 2020) made available by the National Statistical Office of Greece, reporting socio-demographic information and housing characteristics from 1056 607 individuals and 413 460 households living in Greece in 2011. Household waste collection in Greece is in the remit of municipal authorities, with much of the infrastructure supplied by the Hellenic Recovery Recycling Corporation, a joint venture between the public and private sector. Households are asked to separate their waste and dispose recyclables in designated curbside communal bins, with collection frequency varying by municipality. In 2011, about 79% of the population had access to the Hellenic Recovery Recycling Corporation waste collection network (HERRCO 2022).

The 2011 census collected information on household waste recycling behavior. Households were asked: ‘Do you recycle your waste?’ Available responses were ‘1. Yes’ and ‘2. No’. We use the response to this question to construct a binary variable indicating households that recycle. The recycling indicator is the dependent variable in the analysis. Socio-demographic information is reported at the individual household member level, while recycling behavior is reported at the household level. To address the disparity at the reporting level, we focus on single-person households, where individual and household behavior and characteristics coincide. Census data report the municipalities of current residence and birth for each respondent. Using this information we define domestic immigrants (or movers) as those individuals born in Greece, who at the time of the census resided in a municipality other than their municipality of birth. The main independent variable is the prevalence of recycling among non-movers (locals) in single-person households in the movers’ region of origin, as reported in response to the recycling question. It is intended to capture waste management practices, norms and habits that have emerged in each region over time. We remove individuals who were under 18 at the time of the census, and individuals born abroad as the prevalence of recycling in their municipality of origin is not known. The final sample for the main analysis consists of 41 591 observations.

A limitation of the empirical approach comes from domestic immigrants self-selection. Movers decide whether to migrate from their region of origin and choose their destination. It is plausible that individuals choosing to leave their region of origin have weaker links to local norms, habits and traditions, and are weaker representatives of their regional waste management culture. In this case, the empirical approach is biased against finding a relationship between local waste management culture and recycling behavior, and the results presented here will likely underestimate the influence of local culture on individual waste management practice. A further challenge can arise from the nature of the data. Information on recycling activity employed here is self-reported, raising the possibility that social desirability bias influences individuals’ statement of recycling behavior (Larson 2019). If willingness to appear conforming to local social norms varies systematically across regions of origin, results presented here may not capture exclusively the influence of local waste management culture, but also reflect local social desirability biases.

2.2. Main analysis

To assess the relationship between region of origin waste management practices and individual recycling behavior we estimate the following equation:

\[
P(R_{iblt} = 1) = \alpha + \gamma_l + \beta_i \times R_b + C_i \beta_2 + \epsilon_{iblt},
\]

where the outcome of interest \(R_{iblt}\) is a binary variable indicating whether a domestic immigrant \(i\) born in location \(b\) and residing in location \(l\) recycles. The main independent variable \(R_b\) is the prevalence of recycling in the individual’s region of origin as described earlier. We test the null hypothesis that the prevalence of recycling in the respondents’ region of origin does not influence individual recycling behavior in the region of residence. Matrix \(C_i\) contains a set of individual-level controls that may influence pro-environmental behavior in general and recycling behavior in particular (Jenkins et al 2003, Torgler and García-Valiñas 2007, Li et al 2019, Poortinga et al 2019). Specifically, \(C_i\) includes indicators for age in 10 year bands (18–29, 30–39, 40–49, 60–69, 70–79 and 80+ years, with 50–59 the omitted category), indicators for educational attainment (less than primary, primary, and higher, with secondary educational attainment the omitted category), indicators for employment status (unemployed, housework, student, pensioner and inactive, with employed the omitted category), indicators for the subject’s main source of income (property/capital, pension, transfers, and other, with income from wages the omitted category) and a female indicator. To account for the influence of the subjects’ financial status on the probability of recycling³, matrix \(C_i\) also controls for the count of cars owned, living space in \(m^2\), and an indicator for whether \(i\) is

1 We thank an anonymous Referee for pointing this out.

2 Table A1 in the appendix describes all variables used in the analysis.

3 Census data do not report income. Empirical evidence on the impact of income on recycling is mixed (Jenkins et al 2003, Huhtala 2010, Viscusi et al 2011, Yokoo et al 2018). Income may affect behavior through its influence on the opportunity cost of time and the subject’s financial status. We use car ownership, property ownership and living space area, to approximate the subject’s financial status, while the opportunity cost of time is captured by the employment status and the main source of income controls.
the property owner. γ is a set of municipality of residence indicators, capturing characteristics specific to the region-of-residence that may influence recycling behavior, including recycling infrastructure availability and local waste management practice. Finally ε is an error term. As the analysis focuses on the influence of region-of-origin waste management practices on the probability of recycling, we report average marginal effects from Probit regressions. To facilitate interpretation of models including interaction terms and assess the sensitivity of the result to the estimation method we also show coefficient estimates from Linear Probability Models (LPM). Standard errors are clustered at the region-of-origin level (Wooldridge 2010, Cameron and Miller 2015).

2.3. The influence of local waste management practice over time and across groups

We assess whether the influence of region-of-origin waste management culture diminishes as movers adapt to the norms prevailing in their region of residence (Fernández 2011). To this end we first examine whether the influence of region-of-origin waste management practice varies with the time elapsed since migration, and with the length of tenure at the region of residence (Lubotsky 2007). To approximate time elapsed since migration and length of tenure, we use information on the respondents’ municipality of residence in 2006, 5 years before the 2011 census. We construct: (a) a ‘time since migration’ binary variable indicating respondents who in 2006 resided in their region of origin and (b) a ‘length of tenure’ binary variable indicating respondents who in 2006 resided a municipality other than their municipality of birth, and (b) a ‘length of tenure’ binary variable indicating respondents currently residing in the same municipality as in 2006. We estimate:

\[ P(R_{ibt} = 1) = \alpha + \gamma_i + \beta_1 \times \bar{R}_b + \beta_2 \times \bar{R}_b \times X_i + \beta_3 \times X_i + \gamma_{ib} + \epsilon_{ibt}, \]  

where \( R_{ibt} \) is the recycling indicator, \( \bar{R}_b \) is the prevalence of recycling in \( i \)’s region of origin and \( \gamma_{ib} \) is the set of controls as described earlier. Equation (2) is estimated when \( X_i \) is either the ‘time since migration’ or the ‘length of tenure’ indicator. For linear models, \( \beta_2 \) captures the difference in the marginal effect of \( \bar{R}_b \) between the mutually exclusive groups defined by \( X_i \). Specifically, it captures the difference in the influence of \( \bar{R}_b \): (a) between subjects that migrated more than, and less than five years before 2011, and (b) between subjects that have lived in their region of residence for at least 5 years, and for less than five years. We test the null hypothesis that the influence of \( \bar{R}_b \) is homogeneous across the groups defined by \( X_i \) (\( H_0 : \beta_2 = 0 \)). This interpretation of \( \beta_2 \) does not carry over to non-linear models (Ai and Norton 2003, Greene 2010). To assess how the influence of \( R_b \) varies with groups defined by \( X \) in the case of Probit regressions we follow Greene (2010), and diagrammatically show the marginal effect of \( R_b \) across the groups defined by \( X \), calculated at a range of values of \( R_b \).

The influence of region of origin waste management culture on individual behavior may vary with the extent of interaction with peers from different local cultures (Berry et al 2006, Kashima and Loh 2006, Leung 2014). To assess this, we approximate the extent of peer interaction with higher educational attainment and employment status. We assume that subjects with higher educational attainment had greater opportunity to engage with individuals from different local cultures during the course of their studies, relative to others. At the same time, those in employment are more likely to have repeated interactions with peers in their region of residence, relative to those out of employment. We report estimates from equation (2) when \( X_i \) is (a) an in-employment indicator, and (b) a higher educational attainment indicator. In the first case, \( \beta_2 \) captures the difference in the influence of \( \bar{R}_b \) between individuals that are currently employed and not employed. In the latter, \( \beta_2 \) captures the difference in \( \bar{R}_b \)’s influence between those with and without higher educational attainment. As earlier we test for homogeneity in the influence of \( R_b \) across the groups defined by \( X_i \). To facilitate interpretation of the results, in \( \gamma_{ib} \) we replace the full set of educational attainment indicators with a single ‘higher educational attainment’ binary variable equal to one for those with completed higher education and zero otherwise, and the set of employment status indicators with a single ‘in employment’ binary variable, equal to one for those in employment and zero otherwise. As earlier, in the case of Probit models we show diagrammatically average marginal effects of \( R_b \) across the groups of individuals with and without higher educational attainment, and individuals in and out of employment.

2.4. Robustness

We present a series of additional analyses to assess the main result’s robustness to the choice of the sample and the definition of the main independent variable. The country’s two main metropolitan areas\(^4\) contain many municipalities sharing similar characteristics, while there is significant population mobility across them. The main analysis collapses all municipalities in each of the metropolitan areas in single units. To test whether the result is sensitive to this choice, we show estimates from equation (1) when treating each municipality contained in both metropolitan areas as a separate entity.

\(^4\) All models are estimated using Stata v14.2.

\(^5\) The Athens and Thessaloniki metropolitan areas.
To assess whether the result holds in the case of international immigrants, we estimate equation (3) for the sample of international immigrants in single person households. In this case $M_{in}$ is binary, indicating whether individual $i$ originates from country $n$. Results shown in figure B1 in the appendix, suggest significant variation in recycling behavior across international immigrants.

6 To assess whether the result holds in the case of international immigrants, we estimate equation (3) for the sample of international immigrants in single person households. In this case $M_{in}$ is binary, indicating whether individual $i$ originates from country $n$. Results shown in figure B1 in the appendix, suggest significant variation in recycling behavior across international immigrants.

3. Results

3.1. Descriptive statistics

Figure 1 shows the distribution of recycling prevalence in the 104 regions of origin. The average prevalence of recycling by local single-person households is 0.3 (std. dev. 0.19, median 0.29). There is substantial variation in the prevalence of recycling behavior across municipalities: the prevalence of recycling ranges from less than 1% to 73%.

Table 1 shows averages and standard deviations for the variables used in the analysis. Approximately 51% of the sample gave an affirmative response to the recycling question. Nearly 64% of the sample are women, while 32% and 39% of the sample are in employment or retirement respectively, and 18% have completed higher education. About 50% own their residence, while the average property size is 67 m².

3.2. Main result

Table 2 shows estimates from equation (1), assessing the relationship between individual recycling behavior and region of origin waste management practices, using information from the sample of movers in single-person households. Columns 1 and 2 present Probit average marginal effects and LPM coefficient estimates respectively. Results suggest that waste management practices prevailing in domestic immigrants’ region of origin have statistically significant and quantitatively noticeable influence on their probability of recycling in their region of residence: a 10 percentage point increase in the region-of-origin prevalence of recycling is related to a 0.9 percentage point increase in the probability a subject recycles in their region of residence, controlling for individual level socio-demographic characteristics and region of residence-specific effects. This implies that locally prevailing waste management norms and culture can influence individual behavior independently of region-specific aggregate environmental or socio-economic conditions.
Table 1. Descriptive statistics.

| Variable                                      | Mean | Std. Dev. |
|-----------------------------------------------|------|-----------|
| Dependent variable                            |      |           |
| $R_{ib}$                                      | 0.51 | 0.50      |
| Independent variables                         |      |           |
| $R_b$ (Prevalence of recycling in municipality of birth $\times 10$) | 3.22 | 2.03      |
| Female                                        | 0.64 | 0.48      |
| Age 18–29                                     | 0.25 | 0.43      |
| Age 30–39                                     | 0.12 | 0.32      |
| Age 40–49                                     | 0.08 | 0.27      |
| Age 50–59                                     | 0.09 | 0.29      |
| Age 60–69                                     | 0.12 | 0.33      |
| Age 70–79                                     | 0.19 | 0.39      |
| Age 80+                                       | 0.15 | 0.36      |
| Employment status: in employment              | 0.32 | 0.47      |
| Employment status: unemployed                 | 0.04 | 0.20      |
| Employment status: houseperson                | 0.07 | 0.26      |
| Employment status: student                    | 0.15 | 0.36      |
| Employment status: retired                    | 0.39 | 0.49      |
| Employment status: inactive                   | 0.02 | 0.15      |
| Educational attainment: no primary education  | 0.11 | 0.32      |
| Educational attainment: primary education     | 0.28 | 0.45      |
| Educational attainment: secondary education   | 0.42 | 0.49      |
| Educational attainment: higher education      | 0.18 | 0.38      |
| Main income source: employment                | 0.31 | 0.46      |
| Main income source: property and capital      | 0.02 | 0.14      |
| Main income source: pensions                  | 0.38 | 0.49      |
| Main income source: transfers                 | 0.25 | 0.43      |
| Main income source: other                     | 0.04 | 0.19      |
| Cars owned                                    | 0.39 | 0.53      |
| Property size (m$^2$)                         | 67.09| 31.43     |
| Property owned                                | 0.50 | 0.50      |
| Length of tenure                              | 0.71 | 0.45      |
| Time since migration                          | 0.80 | 0.40      |
| Observations                                  | 41 595|

Note: Data from the 2011 Greek population and housing census. All variables except for $R_b$, cars owned, and property size are binary. The median, minimum and maximum for $R_b$ are 3.05, 0.095 and 7.36 respectively.

Remaining estimates point to statistically significant relationships between individual recycling participation and some socio-demographic characteristics. Females appear more likely to recycle relative to males, while the probability of recycling is lower at the extremes of the age distribution, plausibly reflecting differences in preferences across cohorts, and variation in the expected returns from pro-environmental behavior (Torgler and García-Valiñas 2007). Increasing educational attainment is positively correlated with recycling behavior: the probability of recycling is higher for subjects with tertiary education and lower for subjects with primary education, relative to those with secondary education. Finally, the probability of recycling increases with the number of cars owned, the respondent’s living space and with property ownership, suggesting a positive association between financial status and pro-environmental behavior. There is no evidence of a relationship between the probability of recycling and employment status, or the main income source.

3.3. The influence of local waste management culture over time

Figure 2(a) assesses whether the influence of region-of-origin waste management culture varies with the time elapsed since migration, showing the average marginal effect of $R_b$ from probit regressions of equation (2), for individuals who migrated from their region of origin less than, and more than 5 years before the 2011 census. The effect of $R_b$ is consistently lower for individuals that migrated from their region of origin at least 5 years ago, suggesting that the influence of local waste management culture diminishes with the time elapsed since migration. Figure 2(b) examines whether the influence of region-of-origin waste management culture varies with the length of tenure at the region of residence. The influence of $R_b$ appears consistently lower for those individuals living in their current region of residence for longer than 5 years, suggesting that the influence of region-of-origin waste management culture diminishes as individuals adapt to life in their region of residence.
Table 2. Individual recycling behavior and region of residence waste management practices.

|                      | (1)       | (2)       |
|----------------------|-----------|-----------|
| $\bar{R}_b$          | 0.009***  | 0.009***  |
|                      | (0.002)   | (0.002)   |
| Female               | 0.094***  | 0.096***  |
|                      | (0.007)   | (0.007)   |
| Age: 18–29           | −0.028**  | −0.029**  |
|                      | (0.012)   | (0.012)   |
| Age: 30–39           | −0.002    | −0.003    |
|                      | (0.013)   | (0.013)   |
| Age: 40–49           | −0.003    | −0.004    |
|                      | (0.012)   | (0.012)   |
| Age: 60–69           | 0.014     | 0.014     |
|                      | (0.010)   | (0.010)   |
| Age: 70–79           | −0.036*** | −0.039*** |
|                      | (0.012)   | (0.013)   |
| Age: 80+             | −0.146*** | −0.147*** |
|                      | (0.013)   | (0.013)   |
| Employment status: unemployed | 0.011     | 0.011     |
|                      | (0.028)   | (0.029)   |
| Employment status: housework | 0.016     | 0.014     |
|                      | (0.033)   | (0.034)   |
| Employment status: student | −0.002    | −0.006    |
|                      | (0.030)   | (0.031)   |
| Employment status: pensioner | −0.046    | −0.050    |
|                      | (0.040)   | (0.040)   |
| Employment status: inactive | −0.006    | −0.007    |
|                      | (0.036)   | (0.037)   |
| Educational attainment: less than primary | −0.201*** | −0.204*** |
|                      | (0.010)   | (0.010)   |
| Educational attainment: primary | −0.109*** | −0.115*** |
|                      | (0.007)   | (0.007)   |
| Educational attainment: higher | 0.063***  | 0.063***  |
|                      | (0.006)   | (0.006)   |
| Main income source: property/capital | −0.008    | −0.006    |
|                      | (0.033)   | (0.034)   |
| Main income source: pension | 0.027     | 0.030     |
|                      | (0.036)   | (0.038)   |
| Main income source: transfers | −0.023    | −0.023    |
|                      | (0.031)   | (0.031)   |
| Main income source: other | 0.011     | 0.012     |
|                      | (0.033)   | (0.033)   |
| Cars in household    | 0.055***  | 0.054***  |
|                      | (0.005)   | (0.005)   |
| Living space         | 0.001***  | 0.001***  |
|                      | (0.000)   | (0.000)   |
| Property owned       | 0.013**   | 0.015**   |
|                      | (0.006)   | (0.006)   |
| Method               | Probit    | LPM       |
| Observations         | 41 595    | 41 595    |

Note: Data from the 2011 Greek population and housing census. Estimates from equation (1). Column 1 shows average marginal effects from a probit regression. Column 2 shows coefficient estimates from a linear probability model. In both columns the dependent variable is binary, indicating individuals that recycle. The main independent variable $\bar{R}_b$ is the prevalence of recycling among locals in the individual's region of origin in tens. Omitted categories are: male; age 50–59; employment status: in employment; educational attainment: secondary; main income source: wages. All models control for region-of-residence indicators. Standard errors clustered at the level of municipality of birth reported in parentheses. *** $p < 0.01$, ** $p < 0.05$.

Table 3 shows the corresponding LPM estimates from equation (2). The negative and statistically significant coefficient on the interaction term in column 1 suggests that the influence of region-of-origin waste management practice is systematically lower for those who moved before 2006. Similarly, the negative and statistically significant coefficient on the interaction term in column 2 indicates that increasing the length of tenure in the region of residence lowers the influence of region-of-origin waste management norms.
Figure 2. In (a) points represent average marginal effects of $\bar{R}_b$ for those that migrated from the region of origin less than 5 years before 2011, and for those that migrated from the region of origin at least five years before 2011, calculated at the 5%–95% percentiles of the $\bar{R}_b$ distribution. In figure (b) points are average marginal effects of $\bar{R}_b$ for those with less than five years tenure in the region of residence, and for those with more than 5 years tenure in the region of residence, calculated at the 5%–95% percentiles of the $\bar{R}_b$ distribution. Bars and ticks indicate 95% and 90% confidence intervals respectively. The horizontal line marks zero.

Table 3. The influence of time elapsed since migration and length of tenure in region of residence.

|                | (1)     | (2)     |
|----------------|---------|---------|
| $\bar{R}_b$    | 0.021***| 0.016***|
|                | (0.002) | (0.002) |
| Time since migration $\times \bar{R}_b$ | $-0.015^{**}$ | $-0.010^{**}$ |
|                | (0.002) | (0.003) |
| Time since migration | $0.098^{***}$ | $0.059^{***}$ |
|                | (0.012) | (0.013) |
| Length of tenure $\times \bar{R}_b$ |               | $-0.010^{**}$ |
|                |               | (0.003) |
| Length of tenure | $0.059^{***}$ |         |
|                | (0.013) |         |
| Observations   | 41 595   | 41 595  |

Note: Data from the 2011 Greek population and housing census. Each column shows LPM coefficient estimates from equation (2). All models include the full set of controls as described in the methods section. In all cases the dependent variable is binary indicating recycling individuals. $\bar{R}_b$ is the prevalence of recycling among locals in the individual’s municipality of birth in tens. 'Time since migration' is binary, indicating those that in 2006 resided a municipality other than their municipality of birth. 'Length of tenure' is binary indicating respondents currently residing in the same municipality as in 2006. Standard errors clustered at the level of municipality of residence reported in parentheses. *** $p < 0.01$. 

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3.4. The influence of local waste management culture across groups

Figure 3(a) shows marginal effects of \( R_b \) from probit regressions of equation (2), for individuals with and without higher educational attainment, while figure 3(b) shows marginal effects for those in and out of employment. Results suggest that higher educational attainment and employment decrease the influence of region-of-origin waste management culture. Conclusions are similar when examining LPM coefficient estimates from equation (2) reported in Table 4. In column 1, the negative and statistically significant coefficient on \( R_b \times \text{Higher Ed.} \) suggests that higher educational attainment dampens the influence of region-of-birth waste management practices on the probability of recycling. Similarly, the negative coefficient on \( R_b \times \text{Employed} \) in column 2 implies that the influence of \( R_b \) is lower for individuals in employment, relative to individuals not in employment.

3.5. Robustness

Table 5 shows Probit average marginal effects and LPM coefficient estimates from various specifications of equation (1), assessing the result's sensitivity to the sample choice and the definition of the main independent variable. Column 1 reports estimates when treating each of the municipalities in the major metropolitan areas as a separate entity. Results are
Table 5. Recycling behavior and local waste management culture: robustness.

| Panel A: Probit average marginal effects |
|------------------------------------------|
| \( \bar{R}_b \) | (1) | (2) | (3) | (4) | (5) |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|                     | 0.008***            | 0.012***            | 0.006***            | 0.011***            | 0.008***            |
| Observations        | 48 211              | 13 774              | 21 556              | 34 853              | 41 595              |
|                     | (0.001)             | (0.003)             | (0.002)             | (0.001)             | (0.001)             |

Panel B: LPM coefficient estimates

| Panel B: LPM coefficient estimates |
|------------------------------------|
| \( \bar{R}_b \) | (1) | (2) | (3) | (4) | (5) |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|                     | 0.008***            | 0.012***            | 0.006***            | 0.010***            | 0.008***            |
| Observations        | 48 211              | 13 774              | 21 556              | 34 853              | 41 595              |
|                     | (0.001)             | (0.003)             | (0.002)             | (0.001)             | (0.001)             |

Note: Data from the 2011 Greek population and housing census. Each column in each panel presents results from a different estimation of equation (1). Panel A shows average marginal effects from Probit regressions. Panel B shows coefficient estimates from linear probability models. In all cases the dependent variable is binary, indicating recycling individuals. All models include the full set of controls as described in methods. Column 1 distinguishes between each individual municipality in the Athens and Thessaloniki metropolitan areas. Column 2 uses the sample of respondents that were born in and currently reside in a municipality with population over 20,000. Column 3 uses the sample of respondents residing in the Athens and Thessaloniki metropolitan areas. Column 4 uses the sample of respondents residing in a prefecture different to their prefecture of birth, while \( \bar{R}_b \) is the prevalence of recycling among locals in prefecture \( b \). In Column 5 \( \bar{R}_b \) is the prevalence of recycling across all households whose members are all local to their municipality of residence. Standard errors clustered at the level of region of origin reported in parentheses. *** \( p < 0.01 \).

![Marginal effects from Probit regressions of equation 3](image1)

(a) Marginal effects from Probit regressions of equation 3

![Coefficient estimates from OLS regressions of equation 3](image2)

(b) Coefficient estimates from OLS regressions of equation 3

Figure 4. Each point shows the estimated influence on the probability of recycling, for individuals originating from one of 103 regions, relative to the omitted region (Athens Metropolitan area). Bars and ticks are 95% and 90% confidence intervals respectively.

Similar to those reported earlier suggesting that a 10 percentage point increase in the prevalence of recycling in the region of origin, increases the probability of recycling by 0.8 percentage points. Column 2 shows estimates when focusing on the sample of domestic immigrants that were born and currently reside in municipalities with population over 20,000. The influence of waste management practices in the region of origin on the probability of recycling is statistically significant and of comparable magnitude to the main result: a 10 percentage point increase in the prevalence of recycling in the region of origin, is related to a 1.2 percentage point increase in the probability of recycling. Column 3 reports estimates restricting the sample to domestic immigrants residing in the Athens and Thessaloniki metropolitan areas. Similar to the main result, a 10 percentage point increase in the prevalence of recycling in the region of birth is related to a 0.6 percentage point increase in the probability of recycling. Column 4 shows qualitatively and quantitatively similar estimates when defining domestic immigrants as those individuals currently residing in a prefecture different to the one of their birth. Estimates in column 5 test the result’s stability to the definition of the main independent variable, defining \( \bar{R}_b \) as the prevalence of recycling among all households (single- and multi-person) that consist exclusively of local individuals, with no change to the result.

Finally, figure 4 shows estimates from equation (3), replacing the main independent variable with a set of region-of-origin indicators. Each point...
represents the difference in the probability of recycling between individuals born in municipality $i$ relative to those born in the Athens Metropolitan area. Estimates confirm that region-of-origin has significant influence on the individual recycling behavior of movers, as 92% of the coefficients are statistically significant, their magnitude is substantial, ranging from around 0.1 to −0.2, while the null of joint insignificance of parameters $\delta_n$ is rejected ($p = 0.000$).

4. Discussion and conclusion

This paper examines the influence of local waste management culture on individual recycling behavior. To isolate the influence of waste management norms and practices from the confounding effect of local infrastructure, waste management policy, and economic and social conditions, we focus on samples of internal immigrants in Greece. Results suggest a quantitatively and statistically significant relationship between local waste management culture and individual recycling behavior: individuals originating from regions with higher prevalence of recycling are more likely to engage with recycling in their region of residence, when controlling for individual-level characteristics and region of residence. The result is robust to variations in the sample choice, the definition of the main independent variable, and the estimation approach.

Findings add to the existing literature on the relationship between culture and behavior (Guiso et al 2009, Fernández 2011, Luttmer and Singhal 2011, Alesina and Giuliano 2015, Atkin 2016), suggesting that within-country differences in norms can have significant influence on individual behavior. Results also suggest that the influence of region of origin waste management practices diminishes with the time since migration, the length of tenure in the region of residence and domestic immigrants opportunity to interact with other local cultures, agreeing with research showing that the influence of culture decays over time as immigrants adapt to the practices prevailing in their region of residence (Tabellini 2010, Fernández 2011, Luttmer and Singhal 2011).

The results raise the importance of fostering local sustainability culture for encouraging pro-environmental behavior. Developing sustainable waste management norms can increase recycling rates independently of locally prevailing socioeconomic conditions. At the same time, social norms, habits and cultural traits can be inherited across generations and have persistent influence on behavior that is detectable over long horizons (Tabellini 2010, Fernández 2011). The persistence of local norms over time further points to the urgency of promoting sustainable resource management norms and practices. To this end, policy makers can employ behavioral interventions (Shearer et al 2017, Nisa et al 2019, Akbulut-Yuksel and Boulatoff 2021), waste management-related education (Vining and Ebreo 1989, De Young 1990), and pecuniary incentives (Viscusi et al 2011, Li et al 2021), that can increase recycling rates either by directly affecting individual behavior, or by establishing pro-environmental social norms propagated by peer influence (Abbott et al 2013, Ceschi et al 2021, Deng et al 2021).

The result also points to the importance of accounting for local norms and behaviors in sustainability policy design (Caldas et al 2015). The success of technical and economic interventions aiming to increase recycling rates may be contingent on local waste management norms that have been established over time and reflect regional traditions and practices. Explicitly accounting for regional variation in waste management preferences in sustainability policy design can improve its effectiveness. In this context, central government’s role in waste management should be to support regional administrations, that possess better understanding of local waste management practices (Abbott et al 2011). It is worth mentioning that the result is established in the context of a country that is largely homogeneous in terms of waste management policy, institutions and general cultural traits. While findings cannot be readily generalized in other national contexts, it is plausible that the effect of local waste management culture will be more pronounced in regions with more heterogeneous populations, further increasing the importance of accounting for local norms and traditions.

As with any empirical analysis it is worth keeping in mind some caveats. Results will likely underestimate the importance of local waste management norms, if self-selected internal immigrants are systematically weaker carriers of their region of origin’s social norms. Finally, as information on recycling activity is self-reported, if social desirability biases vary systematically across regions of origin, the result may not capture exclusively the influence of local waste management culture, but also reflect variation in local social desirability biases.

Data availability statement

The data generated and/or analysed during the current study are not publicly available for legal/ethical reasons but are available from the corresponding author on reasonable request.

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## Appendix

**Table A1. Variable description.**

| Variable | Description |
|----------|-------------|
| **Dependent variable** | Recycling: Binary, equal to 1 for individuals that recycle, zero otherwise |
| **Independent variables** | |
| Prevalence of recycling in municipality of birth ($\times 10$) | Continuous; min = 0.095, max = 7.355, median = 3.060 |
| Female | Binary, equal to 1 for females, zero otherwise |
| Age 18–29 | Binary, equal to 1 for ages 18–29, zero otherwise |
| Age 30–39 | Binary, equal to 1 for ages 30–39, zero otherwise |
| Age 40–49 | Binary, equal to 1 for ages 40–49, zero otherwise |
| Age 50–59 | Binary, equal to 1 for ages 50–59, zero otherwise |
| Age 60–69 | Binary, equal to 1 for ages 60–69, zero otherwise |
| Age 70–79 | Binary, equal to 1 for ages 70–79, zero otherwise |
| Age 80+ | Binary, equal to 1 for ages 80+, zero otherwise |
| Employment status: in employment | Binary, equal to 1 for the employed, zero otherwise |
| Employment status: unemployed | Binary, equal to 1 for the unemployed, zero otherwise |
| Employment status: houseperson | Binary, equal to 1 for housepersons, zero otherwise |
| Employment status: student | Binary, equal to 1 for students, zero otherwise |
| Employment status: retired | Binary, equal to 1 for the retired, zero otherwise |
| Employment status: inactive | Binary, equal to 1 for the inactive, zero otherwise |
| Educational attainment: no primary education | Binary, equal to 1 for those with no primary education, zero otherwise |
| Educational attainment: primary education | Binary, equal to 1 for those with primary education, zero otherwise |
| Educational attainment: secondary education | Binary, equal to 1 for those with secondary education, zero otherwise |
| Educational attainment: higher education | Binary, equal to 1 for those with higher education, zero otherwise |
| Main income source: employment | Binary, equal to 1 for those with main income from employment, zero otherwise |
| Main income source: property and capital | Binary, equal to 1 for those with main income from property or capital, zero otherwise |
| Main income source: pensions | Binary, equal to 1 for those with main income from pensions, zero otherwise |
| Main income source: transfers | Binary, equal to 1 for those with main income from transfers, zero otherwise |
| Main income source: other | Binary, equal to 1 for those with main income from other sources, zero otherwise |
| Cars owned | Count; min = 0, max = 2 |
| Property size $m^2$ | Continuous; median = 61, min = 4, max = 1370 |
| Property owned | Binary, equal to 1 if the respondent owns the property, zero otherwise |
| Time since migration | Binary, equal to 1 for those that migrated more than 5 years before the census, zero otherwise |
| Length of tenure | Binary, equal to 1 for those that live in their municipality of residence for longer than 5 years, zero otherwise |

**Note:** Data from the 2011 Greek population and housing census.
Figure B1. Each point shows the estimated influence on the probability of recycling, for the sample of 8588 international immigrants living in single-person households originating from one of 32 countries that are represented by more than 40 persons in the 2011 census, relative to the omitted country of origin (Germany). Bars and ticks are 95% and 90% confidence intervals respectively. The null of joint insignificance is rejected ($p = 0.000$). All models include the full set of controls as described in methods.

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