



Recycling, Norms, and Convenience: A Bivariate Probit Analysis of Household Data From a Swedish City

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The purpose of this article is to investigate the role of norms and convenience for households' packaging waste sorting activities. The theoretical point of departure is a simple economic model that integrates norm-motivated behavior into neoclassical utility theory by assuming that the individual has a preference for maintaining a self-image as a morally responsible (norm-compliant) person. The empirical analysis rests on survey responses from 398 households in the city of Eskilstuna, Sweden. Self-reported information on recycling contributions and personal norms is analyzed in a bivariate probit model, which estimates the probability of pursuing high-performing recycling efforts as an endogenously determined decision to the activation of a personal norm for waste sorting. The results suggest that norm activation is an important driver for households' recycling contributions, as is convenience in the form of access to property-close collection schemes. Personal norms are in turn primarily activated by the presence of social, legal, and descriptive norms. One important implication is that policy needs to build on well-aligned policy instrument mixes that combine references to the moral significance of households' recycling contributions with various infrastructural measures that facilitate such contributions.

Keywords: household recycling, waste sorting, packaging waste, moral norms, waste collection infrastructure, bivariate probit model, Sweden

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INTRODUCTION

Many household activities contribute to the fulfillment of environmental policy goals. One of the most prominent examples of such an activity is the sorting of household waste. Even though it is frequently emphasized that households' source separation implies sacrifices (e.g., Bruvold et al., 2002; Abbott et al., 2013)—not least in terms of time—recycling appears to assume a prominent role in the environmental consciousness of many households (e.g., Skill, 2008; Miafodzyeva and Brandt, 2013). This can—at least in part—be explained by the fact that waste recycling typically is a well-integrated activity in various types of household chores such as family meals. Moreover, household members often find it relatively easy to perform waste sorting activities in everyday life, e.g., if drop-off recycling stations are located close to home.

Still, from an economic point of view, such essentially voluntary recycling contributions represent somewhat of a paradox. Household recycling activities contribute to the production of public goods in the form of improved environmental quality, i.e., goods characterized by non-rivalry and non-excludability in consumption. Economic theory predicts that such voluntary contributions will be scarce. The payoff to everyone of not contributing to the public good is higher

than the payoff for voluntary public good provision, yet all individuals receive a lower payoff if all choose to defect than if all contribute. Andreoni (1988) also shows that even in the presence of pure altruism, the voluntary contribution to public goods—including the outcomes of households' recycling efforts—would likely be small in large economies. This article addresses the question why many households nevertheless appear keen to undertake substantial waste sorting activities. The analysis departs from the notion that the presence of norms—i.e., informal rules requiring that one should act in a certain way in a given situation—could provide an important reason for a departure from the social dilemma outcome (Biel and Thøgersen, 2007).

The purpose of this article is to investigate the role of norms and convenience for households' waste sorting activities. The analysis rests on a simple model that integrates norm-motivated behavior into neoclassical utility theory by assuming that the individual has a preference for maintaining a self-image as a morally responsible—and thus norm-compliant—person. This model also recognizes that norms need to be *activated*, and the decision to engage in waste sorting is endogenous to the choice of internalizing strong personal norms for recycling. The empirical investigation is based on a bivariate probit model employing data on packaging waste recycling from a survey to 798 households in the city of Eskilstuna, Sweden.

The Swedish case is interesting for several reasons. Swedish legislation mandates that households sort out packaging waste from other waste, clean the waste, make use of the collection systems that producers provide, and finally sort different packaging materials—plastic, metal, paper, and glass—in different recycling bins. Household participation is thus mandatory, but in practice, the efforts of households are almost never monitored and enforced. Nevertheless, the official statistics show that households in Sweden recycle considerable amounts of packaging waste (Avfall Sverige, 2018), and Eskilstuna has over the years performed well—compared to the Swedish average, e.g., in terms of the amount of household packaging waste (kg/person) dropped off for material recycling (Hage et al., 2018). There are also differences across households in terms of convenience, e.g., due to various collection schemes, and likely norms. This case therefore provides an opportunity to study the underlying reasons for differing waste sorting outcomes across households.

The article proceeds as follows. In the next section, we provide a brief overview of the literature on the determinants of recycling activities at the household level, while section Theoretical Framework presents the theoretical model. The methodological approach is outlined in section Survey Design, Variable Definitions, and Responses (survey design and variable definitions) and in section Data Sample and Empirical Model (final data sample and econometric model). Section Results presents the empirical results, which are discussed in Section Discussion and Implications. The article ends in section Conclusion and Avenues for Future Research by providing some concluding remarks and avenues for future research.

LITERATURE OVERVIEW

There is a rich empirical literature on the determinants on households' contribution to recycling of waste. Material recycling represents one way of managing the household waste. Before any waste can be recycled it must be separated and sorted, and here the efforts undertaken by households are essential. The economics literature has devoted a lot of attention to the impacts of weight-based fees on household waste collection. This research typically shows that such variable fees can have a clear positive effect on households' waste sorting efforts (e.g., Huang et al., 2011), but they could also lead to an increase in the illegal disposal of waste (e.g., Fullerton and Kinnaman, 1996). Still, there are many households that allocate time to recycling efforts also in the absence of economic incentives, and it is therefore useful to address other influences on households' waste sorting behavior. Below, we identify three broad categories of such influences.

An important influence involves norms in the form of collective values, customs and traditions that shape the behavior of individuals. In practice, it is useful to distinguish between two broad categories of norms: personal (or moral) norms and social norms. Personal norms involve a person's felt moral obligation (e.g., to sort waste), and it is self-sanctioned. Social norms involve expectations from others, and it is thus enforced through the approval or disapproval of others (e.g., friends, relatives, colleagues). Previous work shows that norms are typically a strong motivator of household recycling and that personal norms tend to be more important than social norms (e.g., Hornik et al., 1995; Bruvold et al., 2002; Halvorsen, 2008; Hage et al., 2009; Czajkowski et al., 2014, 2017).

The literature recognizes, though, that it can often be difficult to distinguish between these types of norms, and the social psychology research field emphasizes that the influences of social norms often are mediated through personal norms (Schwartz, 1977). This notion of norm activation has been recognized in more recent economics research on households' recycling behavior (Bruvold and Nyborg, 2004; Hage et al., 2009; Brekke et al., 2010; Miliute-Plepiene et al., 2016; Czajkowski et al., 2017). Some studies also address the importance of so-called descriptive norms, i.e., that beliefs about the recycling contributions by others guide an individual's decision as to whether to assume a personal responsibility or not. Nevertheless, many of these studies do not model the process of personal norm activation explicitly.

The second category of household recycling determinants includes factors that are connected to the convenience of waste sorting activity, i.e., factors that influence the time, space, and effort that need to be allocated by households to sort waste. Previous research shows that infrastructural measures that facilitate recycling, e.g., curbside waste collection schemes, increase the waste sorting activity among households (Jenkins et al., 2003; Kipperberg, 2007; Abbott et al., 2013; Starr and Nicholson, 2015). Such measures increase the proximity to the collection points, and thereby facilitate recycling in terms of time and effort. The space that needs to be allocated by households is also an important factor. In general, single-family dwellings have more space to store used products and packaging materials,

and this increases the convenience of waste sorting compared to multi-family dwellings (e.g., Jenkins et al., 2003; Hage and Söderholm, 2008; Miliute-Plepiene et al., 2016).

Third, and finally, previous research has frequently studied the importance of various socio-economic characteristic of households, but the results for individual variables are overall quite mixed. There is some evidence that households' recycling efforts tend to be positively correlated with the education level (e.g., Callan and Thomas, 1997; Jenkins et al., 2003). The results concerning the role of gender are ambiguous; quite a few studies suggest that there is no clear gender effect (e.g., Schultz et al., 1995; Hage et al., 2009; Miafodzyeva and Brandt, 2013). The age of household members can also play a role, and a few studies show that recycling efforts tend to increase with age. See, for instance, Hage et al. (2009) who argue that this may be explained by the fact that older people generally have a lower opportunity cost of time (e.g., some are retired).

Still, just as in the case of social and descriptive norms, the impact of variables such as the education level and age on recycling efforts may be mediated through personal norms. Even if there are some exceptions (e.g., Brekke et al., 2010)¹, most of the previous studies employ reduced-form econometric approaches and assume that the above variables are exogenous. This is despite the lessons drawn from the social psychology literature arguing that household recycling should be characterized as moral behavior (Thøgersen, 1996), and that personal norms therefore need to be activated (Schwartz, 1977). In principle, social norms can have a direct impact on waste sorting behavior, but this is not likely unless such behavior is clearly visible to others (e.g., Tucker, 1999; Barr et al., 2003). An important contribution of this paper is therefore to move beyond the reduced-form approach, and instead implement an empirical approach that estimates the probability of pursuing a high-performing recycling contribution as an *endogenously* determined decision to the activation of a strong personal norm for waste sorting. This approach provides an opportunity to shed new light on the underlying motivators of household's recycling contributions. Specifically, it permits us to test which factors—not least social and descriptive norms but also variables such as age and education level—tend to have direct impacts on these contributions and those that instead tend to be mediated through personal norms.

THEORETICAL FRAMEWORK

Bruvoll and Nyborg (2004) present a model of a utility-maximizing households, and it addresses the relationship between norms and economic motivation in the context of waste sorting efforts. In this article, their model serves as an important theoretical point of departure, but we also draw on further insights from the social psychology literature on pro-environmental behavior (Schwartz, 1970). The latter recognizes

that while a personal norm for recycling constitutes an important determinant of waste sorting behavior, such a norm also needs to be *activated*.

The Bruvoll/Nyborg model assumes that the preferences of a given household (i.e., its household members) can be represented by the following general utility function:

$$U = f(c, l, G, S) \quad (1)$$

where c is the household's consumption of private goods, l is leisure time, and G represents a pure public good in the form of environmental quality. The model also rests on the important assumption that the household members have a preference for maintaining a self-image as responsible persons, which is defined as persons who conform to certain norms of responsible behavior (see also Czajkowski et al., 2017). S represents the link between norm-compliance and the utility, U , of the households (see also below). The utility function is increasing and quasi-concave in c , l , G , and S . For our purposes, it is useful to treat labor supply and total income as exogenous variables, thus allowing us to focus on the effort (time) devoted to waste sorting activities and leisure, respectively. The household therefore faces the following time constraint:

$$l + e = T \quad (2)$$

where T is the total amount of time available for either leisure, l , or waste sorting activities, e . The latter includes both in-house time in the form of sorting and cleaning the waste as well as the time spent on transporting the waste to a drop-off station.

The utility derived from environmental quality, G , stems from two sources, one component that is exogenously supplied by others and the other represented by the increase in G arising from the household's own recycling efforts, g . In the model, the latter is solely determined by the time effort of the individual household, e . We have:

$$g = g(e) \quad (3)$$

This contribution g increases with the time effort e and will be zero if no waste sorting effort is undertaken. While g represents the household's contribution to the public good of environmental quality, we nevertheless assume that the impact on G , and thus on total household utility, remains negligible. In other words, the main incentive for household recycling is channeled through the inclusion of self-image in the utility function.

Self-image, S , is connected to the household's compliance to a specific norm, g^* . If the household's contribution falls short of this norm, there will be a loss in self-image. An important assumption is that this contribution is *de facto* voluntary. Even if, as noted above, Swedish households are required to sort their packaging waste, legal monitoring, and enforcement at the household level is essentially lacking, in turn making non-compliance easy in practice. For this reason, the waste sorting norm is assumed

¹Arbués and Villanúa (2016) also adopt a related approach, but these authors focus on environmental concern rather than personal norms as an endogenous determinant of, in their case, households' recycling of batteries. Omotayo et al. (2020) consider the endogenous relationship between household recycling and the payment for waste disposal.

to be a *personal norm*, i.e., it is internalized in the sense that household members sanction themselves if they do not comply with it. Specifically, S is a function of the difference between the actual contribution of the household and the norm requirement so that:

$$S = S(g - g^*) \quad (4)$$

Bruvold and Nyborg (2004) assume that $S' > 0$ if $g < g^*$, and $S' = 0$ if $g \geq g^*$. This suggests that over-compliance cannot give rise to any self-image improvements above those generated by perfect norm compliance, i.e., at $g = g^*$, S reaches a maximum. This model specification thus differs from Andreoni (1990) so-called impure altruism model, in which $S = S(g)$ and $S' > 0$ for all g .

The above therefore implies that if g^* equals zero, increases in g will not give rise to any self-image improvements (since $S' = 0$ if $g \geq g^*$), and there will be no incentive for the household to contribute to the public good. This is an important notion, not the least since “no-one is capable (cognitively or economically) to contribute to every public good in every possible way,” (Nyborg et al., 2006, p. 354). To influence behavior, the personal norm, g^* , needs to be *activated*. It is therefore meaningful to extend the Bruvold-Nyborg model by treating the activation of a personal norm as an endogenous and a deliberate decision.

Schwartz (1977) emphasizes that ascription of responsibility is a key to the activation of a personal norm. In the specific case of household recycling, individuals need to feel a personal responsibility to sort waste; they ought not to believe that it is (solely) some others actors' responsibility to solve the waste management challenges. Of course, in a situation where households have lot of discretion in terms of how much to contribute (due to a lack of strict monitoring and enforcement), people may be genuinely uncertain about whether they ought to take this responsibility. In such a situation, it makes sense to hypothesize that they may be influenced by expectations from other actors—not least people who are close as well as public authorities—but also by the extent to which others appear to be carrying this responsibility in practice (Nyborg et al., 2006).

In line with this, previous research confirms that a personal norm tends to be activated by other types of norms. First, in contrast to a personal norm, a *social norm* is enforced by the explicit approval from others, and an influence of social norms will, it is argued, often be mediated through personal norms (Schwartz, 1977). In other words, personal norms are activated through social interaction². Second, the Swedish producer responsibility ordinance mandates households to sort their packaging waste although this is not regularly monitored, and violations seldom enforced. This nevertheless indicates the presence of a *legal norm*, i.e., expectations from public authorities. Third, and finally, beliefs about the contributions of other households, so-called descriptive norms, may influence

²It is also possible that social norms affect waste sorting behavior directly, but such direct impacts may be more evident in the case of other types of behaviors that are more visible, e.g., such as smoking in public spaces (Barr et al., 2003).

the decision to take on a personal responsibility (Schultz, 2002; Nyborg et al., 2006). In other words, if household members observe that it is common for people like them to sort waste, it is more likely that they will conclude that they also have some responsibility to do the same. The above implies that the activation of a strong personal norm g^* is influenced by three other types of norms.

$$g^* = g^* (\text{social norm, legal norm, descriptive norm}) \quad (5)$$

In brief, social, legal, and descriptive norms regarding moral behavior could be adopted by each of us on a personal level, and thereby become personal norms. When such norms are internalized and activated, no external sanctions are necessary since the personal norm will be self-enforced. Household members are then driven to sort waste by their “inner voice,” not least if the recycling infrastructure that facilitate such activities is in place.

SURVEY DESIGN, VARIABLE DEFINITIONS, AND RESPONSES

The empirical analysis in the article builds on data collected through a questionnaire sent out by regular mail to 798 randomly drawn household members in the city of Eskilstuna, Sweden³. The first category of data collected concerns the extent to which the households engage in source separation of four different categories of packaging waste material: paper, plastic, glass, and metal⁴. In the survey, respondents were asked—for each waste category—the extent to which they sort out packaging waste and drop this off it at assigned recycling stations. They had five alternatives to choose between, ranging from “nothing” (1) to “everything” (5). We refer to this dependent variable as the recycling contribution of the household.

The second data category concerns the presence of norms for contributing to waste recycling, both personal (internalized) norms, descriptive norms as well as norms that involve expectations from others, i.e., other people and public authorities. To capture the presence of a personal norm for waste sorting, the respondents were asked to what extent they agreed with the following statement: “I feel a personal responsibility to sort packaging waste.” The responses were measured on a seven-point scale with the endpoints “disagree entirely” (1) and “agree entirely” (7), respectively.

³This survey investigation was based on a collaboration between the Swedish Environmental Protection Agency, the municipality of Eskilstuna and Luleå University of Technology, and the data were collected in August 2008. The main objective of the collaboration was to investigate households' view on two different types of collection schemes, one based on waste being sorted by material type and one on sorting by packaging type. However, the data collected also provide an excellent opportunity to shed additional light on the role of norms and convenience for household recycling.

⁴Our investigation does not address the recycling of products that form part of deposit-refund schemes. In the Swedish case, these products include, for instance, PET-bottles, aluminum cans and glass bottles containing soft drinks or beer.

Information about the presence of descriptive norms was based on the responses to the following question: “How much of their packaging waste do you think that other households sort out for recycling?” Just as in the question about their own recycling efforts, the respondents could also here choose between five alternatives, thus ranging from “nothing” (1) to “everything” (5). To address the presence of legal norms and social norms, respectively, the respondents were confronted with the following two statements: “The local government in my municipality expects me to sort out waste” and “Important persons close to me expect me to sort out packaging waste.” In both cases, the responses were measured on a seven-point scale with the end points “disagree entirely” (1) and “agree entirely” (7).

The third data category includes variables that address the convenience of waste sorting activities, i.e., essentially factors that can be assumed to be correlated with the opportunity cost of engaging in such activities. The survey first included a question about the approximate distance (in meters) to the closest drop-off station. Moreover, our sample includes households in both single-family dwellings (villas) and multi-family dwellings (apartments), and in the latter case some households have access to so-called property-close collection implying that they can drop off their sorted packaging waste within the borders of the building in which they live (typically in the basement). Our survey therefore included a question asking households in multi-family dwellings whether they had access to such a collection scheme (yes/no).

In quite a few Swedish municipalities, single-family dwellings can benefit from kerbside recycling, but this is not the case for the sample of households analyzed in this article. It is, however, important to recognize that single- and multi-family dwellings may also differ in other relevant ways apart from the distance to drop-off bins and stations. For instance, waste storage could prove more difficult for households in multi-family dwellings due to less room and space (e.g., in a garage). For this reason, the survey also collected information about whether the respondents lived in single- or multi-family dwellings.

Finally, the fourth data category includes socio-economic characteristics of the respondents. The survey collected information about the gender (male/female), age (in years), and education level (university degree or not) of the responding household member. One question also asked about whether any children (i.e., persons younger than 18 years) formed part of the household.

We received responses from 520 households, thus implying a 65 percent response rate. The socio-economic characteristics of the respondents show that the responses are overall reasonably representative for the population of Eskilstuna. The age structure is very similar, while the share of women and people with a university degree are slightly underrepresented. Above all, as elaborated below, our sample shows a lot of variation and therefore provides an interesting opportunity to shed light on the underlying motives for households' engagement in waste sorting activities.

DATA SAMPLE AND EMPIRICAL MODEL

Sample

Quite a few surveys were incomplete and did not provide answers to all the questions needed for the econometric analysis. These surveys were therefore left out of the investigation, and this left us with a sample of 398 households.

It should be noted that our endogenous variables—recycling contribution and personal norm—are measured along an ordinal scale in the survey, but to permit a so-called bivariate probit analysis we transformed these variables into binary (1/0) variables. Specifically, in the recycling effort case, households responding 4 and 5 were classified as high-performing recyclers (1) with the remaining households (responses 1–3), classified as low-performing recyclers (0). Furthermore, in the personal norm case, the survey responses were measured on a seven-point scale, and we also transformed these into a binary (dichotomous) variable. Thus, households responding 5, 6 and 7 were classified as having a strong personal norm for waste sorting (1) with the remaining households (responses 1–4) classified as having a weak personal norm. The remaining variables enter the empirical estimations in the way they are defined above in section Survey Design, Variable Definitions, and Responses.

The reason why we transform the likert scale used in the survey to a binary scale has to do with the fact that we wish to employ a model that estimates the probability of pursuing high-performing recycling efforts as an endogenously determined decisions to the activation of a personal norm for such efforts. This can be done with the bivariate probit model, from which it is also possible to estimate the marginal effects (see section Econometric Specification). In principle, we could have used a bivariate ordered probit model. However, while it is straightforward to estimate the marginal effects based on the univariate ordered probit model, there is no known way of doing the same based on the bivariate ordered probit model.

Table 1 summarizes the definitions of the variables included in the econometric analysis, and present descriptive statistics. The data show that many of the households in the sample are high-performing recyclers (63–76 percent), and a clear majority (77 percent) of the respondents express a strong personal norm for recycling. There is, though, also variation in the sample across households, not least when it comes to variables affecting the convenience of waste sorting activities, such as distance and access to property-close collection.

The data reveal moderate correlation rates between the independent norm variables. Specifically, in the cases of legal norm, social norm and descriptive norm, the Spearman correlation coefficients range between 0.49 and 0.58, and where the highest value refers to the correlation rate between the social norm and legal norm variables.

Econometric Specification

An important point of departure for the econometric analysis is the endogeneity between personal norm activation on the one hand and the household's recycling contribution on the other. In other words, both observable and unobservable factors that determine the activation of a personal norm also influence

TABLE 1 | Variables included in the econometric analysis: descriptive statistics.

Variables	Definition	Mean	Std. dev	Min	Max
Endogenous variables					
Recycling contribution (Paper packaging waste)	Binary variable distinguishing between high-performing (score 4–5) and low-performing waste sorters (score 1–3).	0.76	0.43	0	1
Recycling contribution (Plastic packaging waste)	Binary variable distinguishing between high-performing (score 4–5) and low-performing waste sorters (score 1–3).	0.65	0.48	0	1
Recycling contribution (Glass packaging waste)	Binary variable distinguishing between high-performing (score 4–5) and low-performing waste sorters (score 1–3).	0.75	0.43	0	1
Recycling contribution (Metal packaging waste)	Binary variable distinguishing between high-performing (score 4–5) and low-performing waste sorters (score 1–3).	0.63	0.48	0	1
Personal norm	Binary variable distinguishing between respondents with a strong personal norm (score 5–7), and respondents with a weak personal norm (score 1–4).	0.77	0.42	0	1
Independent variables					
Property-close collection	Equals one (1) if the household has access to property-close collection, and zero (0) otherwise.	0.26	0.44	0	1
Distance to drop-off bins	Distance in meters to assigned drop-off bins for packaging waste materials	518	1,121	1	2,000
Multi-family dwelling	Binary variable, which equals one (1) if multi-family dwelling, and zero (0) if single-family dwelling.	0.58	0.49	0	1
Descriptive norm	The extent to which the respondent believes that other households sort their waste, five-point scale from one (1) (nothing) to four (5) (everything)	3.08	1.89	1	5
Legal norm	The extent to which the respondent agrees with the statement “the public authorities expect me to sort waste,” one (1) for disagree entirely and seven (7) for agree entirely.	5.71	1.69	1	7
Social norm	The extent to which the respondent agrees with the statement “people who are close expect me to sort waste,” one (1) for disagree entirely and seven (7) for agree entirely.	3.69	2.30	1	7
Gender of respondent	One (1) if male, and zero (0) if female.	0.59	0.49	0	1
Children in household	One (1) if children in the household, and zero (0) otherwise.	0.38	0.36	0	1
Age of respondent	Age of respondent in number of years.	54	15	18	96
Education level	One (1) if the respondent has university degree, and zero (0) otherwise.	0.25	0.43	0	1

the household’s decision to contribute to waste recycling. The seemingly unrelated bivariate probit model is suitable for addressing this possible endogeneity (Greene, 2003), and account for the effect of norm activation on recycling contribution. In the bivariate probit model, Y_1^* represents the recycling contribution and Y_2^* personal norm activation as unobserved latent variables with a different set of covariates. We have:

$$Y_1^* = \alpha_1 X_1 + \gamma Y_2 + \varepsilon_1 \quad Y_1 = 1 \text{ if } Y_1^* > 0, \text{ and zero} \\ (0) \text{ otherwise} \tag{6}$$

$$Y_2^* = \alpha_2 X_2 + \varepsilon_2 \quad Y_2 = 1 \text{ if } Y_2^* > 0, \text{ and zero} \\ (0) \text{ otherwise} \tag{7}$$

The first equation shows how Y_1 is determined by Y_2 , and where the term γY_2 tests the joint probability between a

specification with endogeneity and without endogeneity. If the error terms, ε_1 and ε_2 , are correlated, then the outcomes are endogenously determined. The statistical significance of the correlation parameter ρ is a test of the exogeneity between recycling contribution and personal norm activation. Specifically, a statistically significant ρ indicates the existence of correlation between unobserved factors affecting the decision to engage in packaging waste recycling and activate a personal norm for such activities. X_1 and X_2 represent the vectors of explanatory variables; these vectors share some elements but differ in others, e.g., the legal, social, and descriptive norms are not included in X_2 but not in X_1 (see further section Results).

The coefficients in the bivariate probit model have been estimated using the NLOGIT 5.0 software, but these coefficients do not represent the marginal effects. A natural next step is therefore to calculate the marginal effects so that an

TABLE 2 | Parameter estimates for the bivariate probit model.

Variables	Plastic	Metal	Paper	Glass
Recycling contribution (high/low)				
Constant	-1.328***	-1.884***	-0.284	-0.557
Gender of respondent	0.014	0.278*	-0.013	0.001
Age of respondent	0.001	0.005	-0.007	0.001
Children in the household	-0.056	-0.034	-0.058	-0.069
Education level	-0.232	-0.016	-0.241	0.071
Multi-family dwelling	-0.244	-0.076	-0.431**	-0.496**
Property-close collection	0.388**	0.377**	0.118	0.236
Distance to drop-off bins	0.000	0.000	0.000	0.000
Personal norm	2.206***	2.117***	2.137***	1.912***
Personal norm (strong/weak)				
Constant	-1.704***	-1.667***	-1.809***	-1.724***
Gender of respondent	-0.014	0.031	0.027	-0.014
Age of respondent	0.015**	0.014**	0.015**	0.015**
Children in the household	0.045	0.026	0.010	0.030
Education level	0.422**	0.426**	0.326	0.390*
Multi-family dwellings	0.043	0.059	0.134	0.094
Property-close collection	0.133	0.075	0.078	0.115
Legal norm	0.141***	0.169***	0.167***	0.172***
Social norm	0.082**	0.075*	0.090**	0.087**
Descriptive norm	0.349***	0.262***	0.251**	0.208**
Rho (ρ)	-0.694***	-0.766***	-0.732***	-0.599***
Log likelihood	-376	-383	-344	-340
N	398	398	398	398

t-statistics are given in brackets. *, **, and *** indicate statistical significance at the ten, five, and one percent levels, respectively. The coefficients for the variable distance to drop-off bins have been rounded off, and the values are 0.00000535 (plastic), 0.0000372 (metal), 0.0000369 (paper), and -0.0000230 (glass).

interpretation can be given about how a one unit change in the independent variables influences the probability of the dependent variables. In our specification, the marginal effects in the norm activation equation (Y_2) are the same as those normally computed for the univariate probit model, i.e., dY_2/dX_2 at the mean value of the explanatory variables. However, in the recycling contribution equation (Y_1), the marginal effect of a change in a variable is the sum of two separate terms. First, there is the *direct* effect of such a change on the probability that $Y_1 = 1$, while the second term represents the corresponding *indirect* effect on the probability that $Y_2 = 1$ (which in turn influences the probability that $Y_1 = 1$). Greene (1996) illustrates how to compute the marginal effects emanating from the bivariate probit model, and the reader is directed to this reference for more details.

RESULTS

The estimated coefficients from the bivariate probit models, one for each packaging waste category, are displayed in **Table 2**. Since the estimate for Rho (ρ) is statistically significant at the one percent level, we can reject the null hypothesis that the model consists of two independent probit equations that can be estimated separately. Thus, the data-generating process supports our choice of the bivariate probit model.

The results show that recycling contribution is positively correlated with convenience in the form of access to property-close waste collection, at least in the case of plastic and metal packaging waste. In addition, households living in multi-family dwellings are, *ceteris paribus*, less likely to sort out paper and glass packaging waste compared to those in single-family dwellings. Overall, socio-economic variables, i.e., gender, age, education level, and children in the household, are not correlated (neither positively nor negatively) with the waste sorting effort.

Households' recycling contributions are also correlated with the presence of strong personal norms for recycling; respondents that express a strong personal responsibility to sort out waste are more inclined to do that. This is expected, and **Table 2** also displays the variables that tend to influence the activation of such a norm. The results show that for all four packaging waste categories, there are positive correlations between the presence of strong personal norms and other types of norms. This suggests, thus, that personal norms tend to be activated by perceptions that: (a) other households sort their packaging waste (descriptive norm); (b) the public authorities expect high household packaging waste recycling rates (legal norm); and (c) people close expect the household members to sort their waste (social norm). It is important to note that when we include these norm variables directly in the recycling contribution equation, they were all statistically insignificant. Moreover, the coefficients

TABLE 3 | Statistically significant marginal effects in the bivariate probit model.

Variable	Direct	Indirect	Total	Standard errors
Plastic packaging waste				
Property-close collection	0.1622	0.0121	0.1743**	0.0747
Personal norm	0.9219		0.9219***	0.1949
Metal packaging waste				
Gender of respondent	0.1205	0.0033	0.1238**	0.0568
Age of respondent	0.0023	0.0015	0.0038*	0.0023
Property-close collection	0.1633	0.0081	0.1714**	0.0742
Personal norm	0.9162		0.9162***	0.1788
Paper packaging waste				
Multi-family dwelling	-0.1488	0.0089	-0.1399**	0.0569
Personal norm	0.7372		0.7372***	0.1494
Glass packaging waste				
Multi-family dwelling	-0.1620	0.0052	-0.1569**	0.0612
Personal norm	0.6241		0.6241***	0.1786

*, **, and *** indicate statistical significance at the ten, five, and one percent levels, respectively. The table only shows the statistically significant marginal effects (at the 10 percent level or lower). The estimated marginal effects for social norm, legal norm, and descriptive norm were all statistically significant. However, since these three variables are measured according to an ordinal scale, these marginal effects do not lend themselves to any meaningful interpretations.

for all the norm variables are statistically significant, a result that is line with the moderate correlation rates between these. The low statistical significance for the social norm coefficient could perhaps in part be attributed to the correlation (0.58) between the legal norm and social norm.

Furthermore, the results also show that overall, the probability for the activation of a personal norm for recycling increases with age as well as with the education level. In contrast, gender and the presence of children in the household do not appear to influence norm activation, and this also goes for differences in the recycling infrastructure, e.g., access to property-close collection.

As noted above, the coefficients in **Table 2** only indicate the signs of the statistical correlations, i.e., whether increases in any of the independent variables increase or decrease the probabilities of a higher waste sorting effort and the activation of personal norms, respectively. For this reason, we need to also consult the estimated marginal effects. **Table 3** reports the total marginal effects that were found to be statistically significant at the ten percent level or lower.

The estimated marginal effects reinforce the observation that the activation of a personal norm plays a key role in encouraging packaging waste sorting. Specifically, in the cases of plastic and metal packing, the presence of a strong personal norm increases the probability of high-performing waste sorting contribution by roughly 90% points. The corresponding probabilities in the paper and glass packaging cases are somewhat lower, 74 and 62 percent, respectively.

While convenience also matters for positive waste sorting outcomes, the magnitudes of the relevant marginal effects are not as high. For instance, households that have access to property-close waste collection have a 17% points higher probability of

being high- rather than low-performing sorters of plastic and metal packaging waste. In the cases of paper and glass packaging waste, we instead find that multi-family dwellings are roughly 14–16% points less likely to be represented in the high-performing waste sorting category.

DISCUSSION AND IMPLICATIONS

One contribution of this article has been to move away from the estimation of reduced-form statistical models in studies on households' recycling efforts. Many previous studies find that the presence of a personal norm typically is a strong motivator of households' waste sorting efforts (e.g., Hornik et al., 1995; Bruvold et al., 2002; Tonglet et al., 2004; Hage et al., 2009; Miliute-Plepiene et al., 2016). Still, much of this work does not address the question why such norms are activated in the first place. Our results suggest that both social and legal norms activate personal norms. This supports seminal work in the social psychology literature (e.g., Schwartz, 1977), which suggests that personal norms start with social interaction and/or legal requirements. Over time these social and legal norms become internalized, i.e., self-sanctioned.

There is also a strong correlation between households' perceptions about the behavior of other households, and the willingness to acknowledge a personal responsibility for waste sorting. In other words, others' behavior appears to function as a moral compass, and here we see little differences across the various packaging waste materials. An important implication of the above is that positive news (e.g., in media) about increases in material recycling levels could stimulate households to feel an even stronger moral obligation or at least maintain a high perceived personal responsibility⁵. Previous studies (e.g., Schultz, 2002; Hage et al., 2009) have shown a positive relationship between households' recycling efforts and the beliefs about the contributions of other households. Still, this work ignores that, in the recycling context, descriptive norms are often mediated through personal norms. Brekke et al. (2010), who study glass recycling in Norway, is an exception. They find that the feeling of personal responsibility is increasing in how common people thought recycling to be amongst friends and family. With a higher perceived responsibility, glass recycling was more likely.

Our results also show that even in the presence of strong personal norms, convenience in the form of close and easy access to drop-off bins matters. This is of course well in line with many earlier studies (e.g., Kipperberg and Larson, 2012; Abbott et al., 2013). It also supports the notion that the waste sorting efforts of households are associated with opportunity costs, not least in the form of the time spent on this. The availability of storage space may play a key role in explaining the negative effect of multi-family dwellings on sorting of paper and glass packaging waste. In households in multi-family dwellings there is generally a greater likelihood of a scarcity of space for waste storage (e.g., no garage

⁵ Along the same lines, previous research on household recycling outcomes at the community level has shown the occurrence of spatial spillover effects in the sense that if one community has a high household waste collection rate, the same tends to hold true also for neighboring communities [e.g., see Hage et al. (2018) for an application to municipalities in Sweden].

and/or other storage rooms). Moreover, the paper and glass waste fractions are generally more voluminous than in the cases of plastic and metal packaging waste. This could explain why we do not see a corresponding negative effect for multi-family dwellings in the latter cases.

The results for the socio-economic variables reveal interesting things. There appears to be no strong gender effect—neither for norm activation, nor for recycling efforts—and this is in line with many future studies (e.g., Schultz et al., 1995; Hage et al., 2009; Miafodzyeva and Brandt, 2013). Our results suggest that higher education levels marginally stimulate waste sorting activities, at least in the case of metal packaging waste, and this has also been detected in earlier work (e.g., Callan and Thomas, 1997; Jenkins et al., 2003). Still, our findings shed additional light on this by showing that the education level only influences the waste sorting efforts indirectly through the perceived personal obligation to engage in such activities.

We observe something similar in the case of the age of the respondent. Previous research applying a reduced-form approach has shown that households' recycling efforts often increase with age (Hage et al., 2009; Miliute-Plepiene et al., 2016). One common explanation for this outcome has been that older people are more likely to be retired, and they then face a lower opportunity cost of time for waste sorting. However, our results do not support this interpretation. Instead, the probability to assume a personal responsibility (moral obligation) for waste sorting tends to increase with age, but this variable has no direct effect on the sorting efforts. Thus, the recycling of retired people appears to be more driven by a sense of moral obligation than a low opportunity cost of time.

Our results show the importance of both moral motivation and convenience for successful household recycling outcomes, and it is useful to highlight a few implications for policy making in the waste management field. One important implication is that policy could preferably build on “packages” (e.g., well-aligned policy instrument mixes) emphasizing both the moral obligations of households' recycling efforts and the measures introduced to facilitate these efforts. For instance, with the implementation of weight-based waste collection fees (that were not present in the Eskilstuna case), supplementary information should stress the environmental importance of increased material recycling and thus not only direct attention toward the economic incentive aspects of the policy instrument. If this is done successfully, the policy will provide both financial and moral signals, and thus stimulate waste sorting activities through both these channels.

Another policy lesson is that positive recycling contributions could have spill-over effects. If one municipality recycles frequently, neighboring municipalities tend to do the same (Hage et al., 2018), and if households believe that others in the same municipality recycle frequently, they tend to copy that. This can be used in information campaigns that, for instance, showcase neighborhoods where the recycling rates for household waste have been particularly high.

Finally, it is also important to stress that the case of household waste recycling represents a good example of how public authorities can facilitate the activation of personal norms and, at the same time, establish the infrastructure that makes

households want to act according to these norms and take active responsibility for the environment in their daily lives. However, we need to be careful about drawing too far-reaching parallels to other pro-environmental behaviors in which the sacrifices are often more extensive. Recycling is generally perceived as easy to integrate in daily life, while other activities (such as reduced car use) impose much greater demands for changes in the way households lead and organize their lives (see also Söderholm, 2010).

There may even exist a “motivational inertia” making it difficult for policy makers to activate new personal norms in replacement of existing ones. Households' efforts to promote the provision of public goods without compensation is in the end a limited resource. If efforts are largely devoted to the waste recycling domain, the preparedness to work toward other public goods—perhaps with a potentially even greater value to society—could be reduced.

CONCLUSION AND AVENUES FOR FUTURE RESEARCH

The purpose of this article was to investigate the role of norms and convenience for households' contribution to packaging waste sorting. This was achieved by employing data on a total of 398 Swedish households in a medium-sized city. The theoretical point of departure was a model that integrates norm-motivated behavior into utility theory by assuming that individuals have preferences for maintaining a self-image as a morally responsible—and thus norm-compliant—person. It also recognizes that norms need to be activated, and the decision to contribute to recycling is endogenous to the choice to internalize a strong personal norm for recycling. Self-reported information on recycling contributions and personal norms was analyzed in a bivariate probit model. The results suggest that norm activation is an important driver for households' waste sorting contribution as is convenience in the form of, for instance, access to property-close collection schemes. Personal norms are in turn primarily activated by the presence of social, legal, and descriptive norms.

Clearly, though, our investigation has important limitations, which could be further addressed in future studies. One important avenue for future research concerns the inter-relationship between norms and convenience. Specifically, the importance of personal norms could differ depending on the supporting infrastructure that is in place, e.g., it may decrease as highly facilitating property-close collection is introduced. If true, this also implies that the effectiveness of information campaigns could become weaker if the policy and the external conditions make it much easier for households to recycle. Another interesting avenue for future studies would be to apply the bivariate model used in this article in different empirical contexts, not least cities, and regions in which yet other set of policy instruments, e.g., kerbside recycling and/or weight-based waste collection fees, are used. Future research could also address the interaction between the different packaging waste materials, i.e., acknowledging that error terms could be correlated across the various waste categories.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

CB, PS, and OH: conceptualization, literature review, methodology, and data collection. CB and PS: writing

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