Social norm nudging and preferences for household recycling

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Abstract: Previous research on pro-environmental behaviours has shown that nudges can be effective in changing behaviour in some settings. However, to be a useful policy tool, nudges should have stable, predictable impacts on targeted behaviours. In this paper, we use a randomized experiment to test one specific nudge, namely the communication of a descriptive social norm. The paper examines whether the effects of such a nudge on stated preferences for household recycling are indeed stable and predictable in terms of household willingness to pay for waste collection contracts requiring more recycling effort by households. Three aspects of the social norm are varied: its absolute level, the geographic proximity, and whether relative performance information is included. We find that while respondents generally respond positively to social norm information, the effect is not necessarily monotonic, with the highest social norm levels not necessarily being the most effective, in fact discouraging some respondents from sorting. In addition, whether and how respondents react to the social norm information strongly depends on their current engagement level, with respondents who sort a lot reacting in a negative manner.

Keywords: waste sorting, descriptive norms, social norm nudge, stated preferences, choice modelling

JEL codes: D04, D91, Q51, Q53

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Highlights:

- Preferences for household recycling in Poland are examined;
- The effect of communicated social norm is varied in terms of absolute level, geographical proximity, and relative comparison provided;
- Stated willingness to pay for more recycling varies with the level and type of the norm;
- Effects are highly dependent on an individual's current recycling effort.

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1. Introduction

Increased household recycling levels is an objective for many governments. Higher levels of household recycling can contribute to reductions in water pollution (including plastics pollution to the sea), to climate change policy, or to reducing material use and solid waste flows to landfill sites (Davies and Doble, 2004; Kinnaman, 2006; Cleary, 2009; Acuff and Kaffine, 2013). From a systems viewpoint, household-level sorting is often seen as economically efficient, relative to central sorting. It is also more effective with respect to some waste categories, which once mixed with other waste are difficult or impossible to recycle (e.g., paper, plastics, and biodegradables). The policy design problem is therefore one of encouraging citizens to voluntarily contribute to this public good by increasing their level of household sorting.

A large empirical literature in economics, dating back to the mid-1990s (Hong, Adams and Love, 1993), shows that peoples' recycling and waste disposal behaviours respond both to price incentives ("pay as you throw") for conventional waste disposal, and to changes in waste collection system which impact on the costs of effort to recycle (such as the requirement for households to source-separate wastes; or the deployment of kerb-side recycling pickups; Viscusi, Huber and Bell, 2011). Moreover, researchers including Bartelings and Sterner (1999) and Hage, Söderholm and Berglund (2009) have identified the importance of what the former refer to as "non-economic motives" for recycling behaviours: beliefs, ethical positions and a regard for the behaviour or opinion of others (Viscusi, Huber and Bell, 2011).

Indeed, a wide literature within behavioural economics tells us that economic agents respond to many more influences than just changes in relative prices and income (Chetty, 2015; Nyborg et al., 2016). For environmental public goods in particular, Croson and Treich (2014) argue that "…socio-psychological factors play an important role..." in behaviour (p. 336), and note that changes to the framing of decisions might be particularly important. One aspect of the framing of choices is what people understand or believe about the behaviour of others, that is, about a social norm. Changing the framing of people's choices over environmental goods through a policy initiative is known as a "nudge" (Thaler and Sunstein, 2008). Providing information on a social norm is a specific type of nudge. For nudges to be a useful part of the environmental policy toolkit, they need to be effective in changing behaviour, and to have reliable, predictable impacts. However, empirical evidence on the effectiveness of social norm nudges in changing pro-environmental behaviours is currently divided (see for example Richter, Thøgersen and

Klöckner, 2018, and the literature review in Section 2 for a discussion). Understanding of what determines the effect of a social norm nudge, and how sensitive the nudge is to changes in the choice context, is thus important for recycling policy design.

To address this problem, we designed and conducted a stated preference (SP) study, in which we experimentally manipulated communicated social norms (information about recycling efforts of others). We use stated willingness to pay for higher levels of recycling required by a waste collection contract as an indicator of future levels of recycling by the household. SP methods have been widely used in policy analysis with respect to a range of pro-environmental behaviours (Hanley and Czajkowski, forthcoming). SP approaches allow the preferences of the wider public to be considered in policy making in a cost-effective manner. SP studies are cheaper and easier to implement than Randomized Control Trials as a tool for predicting policy outcomes, whilst incentivised lab experiments typically draw on non-representative (e.g., student) subjects, which is an important drawback if we are trying to estimate the preferences of those who will be affected by a policy initiative. Finally, an SP approach allows for preferences to be estimated for policy options which are currently not in existence in the case study area, an important advantage over revealed preference approaches.

A potential disadvantage of SP is that the approach is based on responses in hypothetical markets rather than on actual behaviour, as so could result in "hypothetical bias". However, given the substantial progress in understanding what constitutes best practice in SP design, well-deigned studies can be a reliable and informative source of estimates of people's preferences for environmental improvements, and their willingness to undertake pro-environmental actions (Carson and Groves, 2007; Vossler, Doyon and Rondeau, 2012; Johnston et al., 2017).

This paper contributes to the literature on nudges and pro-environmental behaviours by investigating how stated willingness to pay (WTP) for higher levels of recycling within a household depends on the nature of the nudge provided. In particular, an experimental design is used which allows us to vary the absolute size of the social norm and its geographic proximity. We also investigate whether adding relative performance information increase the effect of the nudge; and whether these effects depend on the current and prior behaviours of the individual. These issues are important if governments wish to employ social norm-based

nudges alongside prices and infrastructural improvements to help achieve recycling goals (or, indeed, any environmental policy goal).

In what follows, we first of all briefly summarise the literature on the effects of social norms and social norm-bssed nudges on pro-environmental behaviours. Section 3 then discusses evidence on how such norm-based approach fits in with other likely determinants of household recycling behaviour. This leads to a set of testable hypotheses which inform a research design set out in section 4. Section 5 has results, and section 6 discussion and conclusions.

2. Social norms and pro-environmental behaviours

A social norm can comprise a typical behaviour of one's important reference group in a particular decision context (this is also known as a descriptive norm). For example, how many people in my village take empty glass bottles to the bottle bank? What is the average electricity consumption per month in my apartment block? Such descriptive social norms represent the behaviour of the majority, and can be expressed in terms of how common the behaviour is and what is the mean level of engagement in the behaviour (for discussion on the use of social norm concept in economics see Nyborg (2018) and Wallen and Romulo (2017)). Descriptive social norms can be distinguished from injunctive social norms that represent views on what one ought to do (Cialdini, Reno and Kallgren, 1990). Injunctive norms are related to commonly-held opinions in society on actions that merit social approval or disapproval. Farrow, Grolleau and Ibanez (2017) synthetize taxonomies of different types of norms, and how they interrelate with one another. In our study, social norms are communicated as prevalence of recycling behaviours within different interest groups, and are thus descriptive norms.

Research on the effectiveness of social norms in regulating human behaviour began in social psychology long before it was first applied in behavioural economics (Cialdini, Reno and Kallgren, 1990; Schultz, 1999). It is now a well-documented phenomena that people in some situations imitate the behaviours of others and try to conform to this majority behaviour (Asch, 1956; for a review see Cialdini and Goldstein, 2004). Direct experience of the actions of other people influences one's own behaviour (Nolan et al., 2008) leading to social norms become unconsciously internalised (Sherif, 1936). In economics, interventions based on social norms

have proved to be effective in changing individuals' choices in laboratory studies and field experiments (Schultz et al., 2007; Sliwka, 2007; Shang and Croson, 2009).

There is now a large body of evidence on the role and influence of social norm nudges on a wide range of environmentally-related choices and behaviours (Farrow, Grolleau and Ibanez, 2017). Much of this research has shown an effect when descriptive social norms were communicated to subjects in a written message instead of being directly observed by them (e.g., Schultz, 1999; Nolan et al., 2008). The best-known examples in the environmental area include large-scale applied microeconomic experiments, some based on hundreds of thousands of observations, which show that individuals informed or reminded about the behaviour of relevant others may reduce energy consumption (Schultz et al., 2007; Nolan et al., 2008; Allcott, 2011; Ayres, Raseman and Shih, 2013) or save water (Ferraro, Miranda and Price, 2011; Ferraro and Price, 2013). Allcott (2011) showed that information allowing for a comparison of one's own electricity use to the average level of neighbours reduced consumption by 2% relative to a control group. People with electricity use much higher than the average cut consumption by the greatest fraction, whilst those with lower-than-average consumption did not increase electricity use (i.e., a boomerang effects was avoided). Treatment effect did not fade with time (Allcott and Rogers, 2014), much of which was later attributed to investments in physical capital, i.e. acquisition of energy-efficient appliances (Brandon et al., 2017). Ferraro and Price (2013) evaluate the effects of social comparison information on demand for water by residential customers in the USA. They found that such information had a bigger effect on consumption than simply asking people to reduce water use or telling them how to do so; and that the effects of social comparison information was greatest for those consumers who had relatively high water use. Another well-known example showed increase in towel reuse in hotel rooms, when people were informed about how many guests re-use their towels (Nolan et al., 2008).

However, social norms communication is not a universally effective environmental policy tool. Recently, the Alcott experiment on the role of social comparisons in energy reduction was replicated in Germany (where energy consumption is much lower than in the USA). A much smaller effect of the norm was found (Andor et al., 2017). Non-effectiveness of social nom nudges was found in studies on sustainable seafood purchasing patterns (Richter, Thøgersen and Klöckner, 2018) and fees collection amongst students (Silva and John, 2017). Attempted

replications of the Nolan et al towel reuse programs could not reproduce the original results (Nolan et al., 2008; Schultz, Khazian and Zaleski, 2008; Bohner and Schlüter, 2014; Reese, Loew and Steffgen, 2014). This points to contextual and social dynamic effects in a population in terms of how people respond to social norm information (Nyborg et al., 2016). Schultz (2014) notes that communicated social norms effectively promote pro-environmental behaviour but only "in some contexts, for some behaviours, and for some individuals". One should therefore expect a high degree of inter-personal heterogeneity in how a specific nudge affects choices in different contexts, and also differences between countries and cultures.

According to the classic theory of normative conduct, the effectiveness of descriptive and injunctive norms depends on their saliency (Cialdini, Reno and Kallgren, 1990; Cialdini, Kallgren and Reno, 1991). The impact of social norms is determined by the degree to which the norm is in focus (Kallgren, Reno and Cialdini, 2000) and to which norms are consistent (Cialdini, 2003). Previous research has shown a great power of descriptive social norms in changing behaviours (e.g., Lewis and Neighbors, 2006), but communication of injunctive norms is more effective when socially undesirable behaviours are common and widespread (Cialdini et al., 2006; Cialdini, 2009).

A separate strand of research focuses on aspects related to identification with the reference group. Nolan et al. (2008) show that a more local norm, for guest of same room, is more influential than norm for guest of the hotel. A local social norm on tax payments was also more effective than the country level norm in increasing tax compliance (Hallsworth et al., 2017). Heterogeneity of identities within the reference groups may led to emergence of anti-conformist bias (Silva and John, 2017). In summary, the impact of social norms on behaviour may depend on factors such as an individual's self-identification with social peer group (e.g., "other rock climbers think it is important not to litter"), the implied reference group, the norm evoked and the specific environmental context (Farrow, Grolleau and Ibanez, 2017).

Broadly speaking, the motivating effect of the descriptive social norm nudge comes from comparison of one's own behaviour to the expected conduct signalled by the communicated norm and one's subsequent willingness to conform. The difference between an individual's own behaviour and the behaviour of others can enter into her utility pay-offs through different channels of motivation such as a concern for self-image, an external-image concern (Czajkowski, Hanley and Nyborg, 2015) and concern for others (for a review on conformity see

Cialdini and Goldstein, 2004). However, the exact mechanisms underlying observed changes in choices after social norm interventions, especially why of the behaviours change, are not yet well understood (Brandon et al., 2017), and nudge based interventions lack rigorous economic theoretical support (Ölander and Thøgersen, 2014). In particular, economic theories do not account well for the diversity of real-world behaviours related to social norms, and cognitive processes related to changing perceptions of a communicated norm.

According to Thaler and Sunstein (2008) social norms are part of people's choice architecture and their communication has a persuasive "nudging" impact (Ölander and Thøgersen, 2014; Richter, Thøgersen and Klöckner, 2018). Social norm interventions were shown to work through intuitive, heuristic reasoning processes, unrecognized by subjects (Cialdini, 2007; Nolan et al., 2008). From a psychological perspective, social influence-related behaviours often serve multiple goals, the most important being accuracy, affiliation, and the maintenance of a positive self-concept; whilst social influence processes are "subtle, indirect, heuristic-based, and outside of awareness" (Cialdini and Goldstein, 2004).

In empirical work studying the influence of social norms on pro-environmental behaviours such as recycling, three main approaches are taken. The first approach is observational, using revealed preference methods to see how choices shift when individuals move between surroundings and the associated reference group norms. The second approach is to ask people what they think the social norm is, or about other aspects related to social norms, such as concerns with respect to others' perceptions of one's behaviour (Armstrong et al., 2017) or views on the behaviour of their neighbours (Viscusi, Huber and Bell, 2011). The third approach is experimental, which manipulates social norms in contextual "cues" or communicates social norms in direct messages expressing a new reference point. This can take a flexible form such as feedback on the level of action taken by others (ex. neighbours), information about the number of people who take an action, about actions undertaken or approved by other people in a particular reference group.

3. Determinants of household recycling behaviour

Understanding the likely effects of using a social norm to change recycling behaviour requires an appreciation of what other factors determine a household's recycling behaviour. In

conjunction with the information on the determinants of nudge effects outlined in the previous section, this allows the development of four testable hypotheses concerning the likely impact of different forms of communicated social norm in the present study.

Recycling decisions by a household depend on a combination of economic, moral (internal) and social (external) factors (Viscusi, Huber and Bell, 2011). Economic factors include the time cost of sorting wastes and any utility gained from the act of home sorting. Moral factors include ethical views on waste and personal responsibility. Social factors include pressure from our neighbours and our views on what others more widely expect us to do, or our impressions of what others do. The strength of and balance between these three sets of factors determine how much each individual wishes to recycle, and their willingness to engage in and pay for recycling and waste collection services (Armstrong et al., 2017).

Recycling is a form of pro-environmental behaviour. It is individually costly, requiring the allocation of time, space, and effort (Bruvoll, Halvorsen and Nyborg, 2002) and results in provision of a public environmental good (Abbott, Nandeibam and O'Shea, 2013). Nevertheless, when given the opportunity to recycle, some individuals engage in it without any monetary motivation (Berglund, 2006; Briguglio, Delaney and Wood, 2016). This behaviour may reflect a range of private benefits associated with increased home recycling, such as a personal sense of satisfaction, or a belief that individuals are better at waste separation than central recycling facilities. A positive WTP for home sorting of wastes was found for a sample of Polish households by Czajkowski, Kądziela and Hanley (2014) despite no change in the level of recycling achieved in their municipality; whilst in a follow-up study, Armstrong et al. (2017) show that this positive WTP for a substantial group of respondents was motivated by belief in a social norm, namely their perception that their neighbours would judge them badly for not engaging in recycling efforts.

Using aggregate rather than individual data, Abbott, Nandeibam and O'Shea (2013) investigate the determinants of per capita recycling using data from English local authorities. They find that it is partly explained by a social norm, which they construct as the mean level of recycling in a reference group of local authorities (although it is not clear that individuals would be aware of this level: a problem we avoid in our study). Sidique, Lupi and Joshi (2010) show that a perception that family and neighbours expect one to sort is a significant driver of recycling in Michigan. Brekke, Kipperberg and Nyborg (2010) find empirical evidence from Norwegian

households which supports a model of recycling where individuals are motivated by considering the gap between the recycling actions of others and their own behaviour. Hage, Söderholm and Berglund (2009) use survey data of 2,800 Swedish households focussing on their self-reported levels of recycling for packaging waste. They find that self-reported recycling behaviour increases with perception of other's recycling behaviours ("how much of their household waste do you think that other households in your municipality recycle?") and a feeling of moral obligation, but does not change with a social norm ("important persons close to me want me to recycle"). Miliute-Plepiene et al. (2016) found that in early-stage recycling schemes (Lithuania) social norms (perceived behaviour of important persons) are important. Poland can be considered such an early-stage recycling scheme. Note, however, that the authors of abovementioned studies do not externally vary the strength of the social norm, relying instead on variation in people's agreement with statements describing the behaviour or attitudes of others. A study using communicated norms was conducted by Schultz (1999), who showed that a group feedback intervention (a descriptive norm) increased participation in a recycling programme. In contrast, the field experiment of van Soest and Vollaard (2018) shows no effect of descriptive or injunctive social norm treatments on recycling behaviours in the Netherlands.

Based on the literature reviewed above, we developed four testable hypotheses concerning the effects of a social norm-based nudge on household preferences for recycling. These then informed the design of an empirical strategy described below. Our hypotheses are tested using a study implemented in Poland (described in more detail in the following section), where the characteristics of household waste systems make construction of credible stated preference scenarios possible.

The hypotheses to be tested are as follows:

Size of the norm

In Armstrong et al. (2017), one relevant factor determining how much an individual wishes to recycle is the difference between their current behaviour and that of a relevant interest group, weighted by a utility parameter. This implies that the effect of providing a nudge should depend on the absolute size of the social norm, since for any individual this determines the

distance between their current behaviour and that norm. This takes into account both individuals with a relevant behaviour above the social norm (I recycle more than others in my town) and below this norm (I recycle less). However, there is no empirical evidence to date on this "absolute norm" effect for household recycling. We thus test:

H1: Higher levels of the absolute size of the social norm (communicated shares of others who recycle) lead to increased willingness to pay for contracts with more household-level sorting.

Geographic proximity

There is some evidence in the literature of a "geographic proximity" effect for social norms. Based on Bohner and Schlüter (2014), and Hallsworth et al 2017, we expect the nudge associated with a social norm of given absolute size to be stronger when the norm relates to behaviour in a community "closer" to the individual in some sense. Here, we test for the effect by comparing a norm based on recycling rates in the city where the respondent lives compared to the nation as a whole. A geographic proximity effect is also likely if one considers the sub-set of people conforming to a given behaviour who are likely to sanction me for breaking the norm: this subset is more likely to be composed of those living close to me than those living further away, even if the latter are members of a relevant peer group (Masclet et al., 2003). This leads to the second hypothesis to be tested:

H2: A descriptive social norm of give absolute size will have a larger nudge effect when it relates to the behaviour of a geographically-closer community than a geographically more distant community.

Relative versus absolute norms

The nudge effect of a social norm depends on people comparing their behaviour to that of "relevant others", or caring about the behaviour/opinion of relevant others. However, it may be hard for people to judge their performance compared to others when only presented with an absolute value. We thus wish to see whether providing additional information on relative performance increases the strength of the nudge. This leads to hypothesis 3:

H3: The nudge effect will be stronger when information on relative performance is provided alongside absolute performance data.

Effects of past behaviour

Finally, it is clear from work such as Ferrero and Price (2013), Viscusi, Huber and Bell (2011) and Brekke, Kipperberg and Nyborg (2010) that the effects of social norm information are mitigated by preference parameters within people's utility function (how much weight I place on my own moral views; how much weight I place on the views of others…), the prices they face in engaging in recycling activity, and their past experience or behaviours. Both prior to the nudge being implemented and once it is in place, these preferences and prices co-determine our behaviour. This implies that the effects of a specific nudge will be mediated by people's preferences and the prices they face, which in turn are reflected in their past recycling behaviours. Logically then, the effectiveness of a nudge should vary across people with different histories of recycling behaviour. This leads to a final testable hypothesis:

H4: The effective of a descriptive social norm on willingness to pay for future recycling actions will depend on an individual's past record of recycling.

4. Study design: recycling by Polish households

In this paper, a stated preference approach (Hanley and Czajkowski, 2017) was taken to estimate the effects of a nudge on WTP for higher levels of household recycling. A choice experiment based on the design earlier used by Czajkowski, Kądziela and Hanley (2014) and Armstrong et al. (2017) was employed. Polish households were the population of interest. The questionnaire consisted of five main sections: (1) an introduction, (2) questions on current method of household waste collection, and individual opinions on waste management policy, (3) description of Polish recycling regulations and attributes in the choice scenarios, (4) the choice sets measuring preferences for alternative waste collection schemes, (5) elicitation of attitudes to recycling and socio-demographic questions.

At the beginning of the survey, subjects were informed about outcome consequentiality of the survey – that the results would be communicated to policy makers and could be used for designing changes to municipal solid waste management policy which were being considered

at the time. The study was conducted during discussions regarding the revision of waste sorting and recycling policies in Poland that had been introduced a few years earlier. In this policy innovation, municipalities were required to meet recycling targets while designing and organizing a system of waste recycling and collection for all inhabitants of the municipality. Each municipality could choose different waste sorting and collection systems, characterised by the number of categories households are required to sort their waste to, and ex-post sorting in central facilities. Fees charged per household depended on the nature of the scheme offered and household size.

In practice, a campaign communicating social norms can be used to maximize support for a policy involving more sorting at household level, or establishing a stronger norm of rigorous sorting amongst households who decided to have different waste categories collected separately. Since EU recycling targets were established and are enforced at the level of the municipality, we were able to hold the overall level of recycling (the supply of the public good) constant across all choice scenarios, since central waste sorting would be required to make sure the municipality target was achieved if households choose to not recycle (ie sort) enough. The survey participants were informed about this requirement for sufficient central facility sorting to satisfy the overall recycling targets.

The choice experiment (Carson and Czajkowski, 2014) consisted of 12 choice tasks that asked respondents which waste collection contract they preferred from a range of possibilities. Possible contracts were described in terms of the following attributes:

- *SORT* – this attribute described into how many categories a household would be required to sort waste into before it was collected. The levels of this attribute (the number of sorting categories) consisted of no sorting by the household, or sorting into 2, 3, or 5 categories of waste. This attribute represents our main measure of household recycling behaviour.
- *TIME* – the frequency of waste collection. The levels ranged from daily collection, through collection thrice, twice, once a week, to once every two weeks. This attribute in included as our earlier work (cited above) showed the frequency of waste collection to be important for some households in terms of which waste management contract they would prefer.

– *PRICE* – a monthly bill sent to respondent's household, which amounted to 25, 50, 75, and 100 PLN[4].

In each choice situation, one of the alternatives represented the current method of household waste collection and recycling (the status quo). An example choice card is provided in Figure 1. In each choice situation, respondents were asked to choose their most preferred contract out of a set of four available options.

Figure 1. Example of a choice card (translation)

Situation 1.	Option 1	Option 2	Option 3	
Method of sorting in household	Sorting into 3 categories	Sorting into 2 categories	Sorting into 5 categories	Current method of waste collection
Frequency of waste collection	Once a week	Three times a week	Twice a week	
Monthly cost for your household	25 PLN	100 PLN	50 PLN	
Your choice:	□	□	□	□

4.1. Information treatments for the social norm

In the survey, we provided respondents with a descriptive social norm, defined in terms of what respondents are told about the level of recycling in their community, where "community" can mean either country (Poland) or their city of residence, depending on the treatment to which a particular participant is allocated. We avoided the unethical procedure of providing false information to subjects (that is, we avoided deception). Instead, we used factual information from a number of different reliable reports and official data sources (Central Statistical Office of Poland, Ministry of Environment website, Polish Press Agency, Public Opinion Research Centre) on different aspects of recycling and waste management at national and city levels. We used the most recent data available at the time when the study was designed and conducted. Even though the reference year differs between treatments (2011 or

[4] At the time of our study 1 PLN ≈ 0.25 EUR ≈ 0.33 USD.

2012), there were no major changes in the public opinion, political situation or Polish recycling system at the time. As a result, we expect that the year used in the intervention will not matter. This procedure allowed us to vary the figure given to each respondent across the treatments, whilst avoiding what Croson and Treich (2014) refer to as "deceptive nudges".

The figures provided for the descriptive social norm referred to either the % of households that reported sorting waste in a particular year, the % of household waste collected that is sorted, or the % of waste collected separately (that is, source-separated by households). These are not identical definitions of household recycling, but all refer to the same process of waste separation and collection in different years. That is, these alternative definitions of the level of recycling all refer to how common participation in recycling is. Whilst it is to be regretted that the way in which the social norm is described in each treatment varies somewhat, the only alternative experimental design was to deceive respondents.

Treatment groups are set out below in Figure 2, and each respondent was randomly allocated to one of the eight treatments. Each respondent was only provided with one of piece of information on recycling behaviour by others, apart from those in control group (treatment #8 below) who were not provided with any of this information. That is, each person surveyed received only one kind of social norm-based nudge, or else received no nudge. Treatments #1 to #3 included three levels of a national norm: low, medium, and high. This allows us to test hypothesis H1, where the relevant peer group is taken to be everyone living in Poland. Treatments #4, #5, #6 and #7 refer to differences in the size of norm presented in terms of the city where people live. Sampling was undertaken in 3 Polish cities (Cracow, Warsaw and Bialystok) to accomplish this. These cities were selected because they differed in the current recycling rates, offering a range of baseline situations. Comparing the effects of varying the size of the city-norm with the size of the country-norm allow us to test the *geographic proximity effect,* that is H2. Within these 4 city-group treatments, we also include variation according to whether people are told about how recycling levels in their city compare to the national figure for Poland. This allows a test of the *relative versus absolute norm effect,* H3, by comparing T4 with T5, and T6 with T7. Finally, we present below an analysis of how the effects of a given nudge vary according to peoples' self-reported past recycling behaviours, to enable a test of H4. Comparing preferences or WTP with T8 with another other treatment allows for a test of the presence of any descriptive social norm effect at all.

Figure 2: Treatment groups

- T1. "In 2011, **10%** of all municipal waste collected from households in Poland was sorted."
- T2. "In 2012, **44%** of households in Poland stated that they sort waste regularly."
- T3. "In 2012, **69%** of households in Poland declared that they sort waste."
- T4. "In 2011, **15%/11%/6%*** of all municipal waste collected from households in Cracow/Warsaw/Bialystok was collected selectively[5]."
- T5. "In 2011, **15%/11%/6%*** of all municipal waste collected from households in Cracow/Warsaw/Bialystok was collected selectively. The average for Poland is **10%**."
- T6. "In 2011, **72%/65%/58%*** of households in Cracow/Warsaw/Bialystok declared that they sort waste."
- T7. "In 2011, **72%/65%/58%*** of households in Cracow/Warsaw/Bialystok declared that they sort waste. The average for Poland is **69%**."
- T8. No information on national or local levels of sorting of waste provided.

4.2. Survey administration

The survey questionnaire was administered via a computer-assisted web interviewing (CAWI) technique to a sample of households in Cracow, Warsaw and Bialystok during February 2014. The final sample consisted of 1,853 respondents, with approximately 600 respondents per city. The sample was quota-controlled with respect to gender, age and being a resident of the respective city. The data collection was contracted to a professional public opinion company.

4.3. Econometric Approach

The discrete choice data is modelled using random utility theory (McFadden, 1974). This assumes that the utility an individual receives from an alternative depends on observed characteristics (attributes) of both the choice alternatives and the individual making those choices; and unobserved idiosyncrasies represented by a stochastic component. Individual i's utility from choosing alternative j in situation t can be expressed as:

$$V_{ijt} = \mathbf{X}_{ijt}\boldsymbol{\beta}_i + e_{ijt}\,. \tag{1}$$

This utility expression is separable in the observed choice attributes $\mathbf{X}_{ijt}$ and e_{ijt} the stochastic component representing unobservable factors that affect individuals' choices (or random aspects of choice). In the mixed logit model (MXL), the parameters $\boldsymbol{\beta}_i$ represent individual-specific taste parameters associated with marginal utilities of the choice attributes, allowing for heterogeneous preferences among the respondents. The multivariate (parametric) distribution of these parameters in the sample is $\boldsymbol{\beta}_i \sim \mathbf{f}(\mathbf{b},\boldsymbol{\Sigma})$, where $\mathbf{b}$ is a vector of sample means and $\boldsymbol{\Sigma}$ is a variance-covariance matrix. A convenient way of accounting for preference differences associated with information treatments is $\boldsymbol{\beta}_i \sim \mathbf{f}(\mathbf{b}+z_i\boldsymbol{\delta},\boldsymbol{\Sigma})$, where z is a binary indicator for treatment effects and $\boldsymbol{\delta}$ is a vector of its estimated attribute-specific effects.

To facilitate interpretation of the results we specify the model in WTP-space (Train and Weeks, 2005; Bateman et al., 2008):

$$U_{ij} = \beta_i^m\left(X_{ijt}^m + \mathbf{X}_{ijt}^{-m}\boldsymbol{\beta}_i^{-m}\right) + \varepsilon_{ij}\,, \tag{2}$$

where X_{ij}^m is the monetary attribute with respect to which all marginal rates of substitution are expressed, and $\mathbf{X}_{ij}^{-m}$ are all other, non-monetary attributes. In this specification, parameter estimates $\left(\boldsymbol{\beta}_i^{-m}\right)$ can readily be interpreted as marginal WTP for the non-monetary attributes.

Estimation of the MXL requires calculation of the k-dimensional integral for a likelihood function of individual i:

$$L_i = \int p\left(\mathbf{y}_i \mid \mathbf{X}_{ijt}, \beta_i^m, \boldsymbol{\beta}_i^{-m}\right) f\left(\beta_i^m, \boldsymbol{\beta}_i^{-m} \mid \Omega\right) d\left(\beta_i^m, \boldsymbol{\beta}_i^{-m}\right), \tag{3}$$

where $f\left(\beta_i^m, \boldsymbol{\beta}_i^{-m} | \Omega\right)$ is a density function of random parameters, which distributions depend on parameters to be estimated, Ω, and $p\left(\mathbf{y}_i | \mathbf{X}_{ijt}, \beta_i^m, \boldsymbol{\beta}_i^{-m}\right)$ is conditional probability of making choices, $\mathbf{y}_i$, given by:

$$p\left(\mathbf{y}_i | \mathbf{X}_{ijt}, \beta_i^m, \boldsymbol{\beta}_i^{-m}\right) = \prod_t \left(\sum_j y_{ijt} \frac{\exp\left(\beta_i^m \left(X_{ijt}^m + \mathbf{X}_{ijt}^{-m} \boldsymbol{\beta}_i^{-m}\right)\right)}{\sum_l \exp\left(\beta_i^m \left(X_{ilt}^m + \mathbf{X}_{ilt}^{-m} \boldsymbol{\beta}_i^{-m}\right)\right)} \right). \quad (4)$$

As the analytical formula for integral in (7) is usually not known it has to be approximated. Usually, researchers employ Maximum Simulated Likelihood (MSL) method, in which R random draws from distribution described by $f\left(\beta_i^m, \boldsymbol{\beta}_i^{-m} | \Omega\right)$ has to be generated for each individual, and then (7) can be approximated as:

$$L_i \approx \frac{1}{R} \sum_r p\left(\mathbf{y}_i | \mathbf{X}_{ijt}, \beta_{ir}^m, \boldsymbol{\beta}_{ir}^{-m}\right), \quad (5)$$

where additional index r, denotes the r-th draw. To make the simulation sufficiently precise we used 10,000 scrambled Sobol draws (Czajkowski and Budziński, 2017).

In the modelling, the cost variable was specified as continuous and other attributes were dummy-coded. The parameters of alternative specific constants (ASC) and all other attributes, including the cost were modelled as random and correlated. All parameters were assumed to follow normal distributions with the exception of cost, which was assumed to be negative log-normally distributed.[6]

[6] The models were estimated using a DCE package, which among other things can be used to estimate MXL models. The package has been developed in Matlab and is available at https://github.com/czaj/DCE. The code and data for estimating the specific models presented in this study are available from http://czaj.org/research/supplementary-materials.

5. Results

Table 1 presents the choice modelling results. In the first column of data, we see parameter estimates on pooled data where we do not distinguish among treatments. Since the model is estimated in WTP-space, parameters for each attribute level are interpreted as WTP for a change in the attribute to this level relative to a baseline.

The coefficient on the status quo is negative and significant, likely implying people's dislike for the current recycling policy in Poland. For the *sort* attribute, relative to the baseline of no sorting being necessary at home, subjects have a positive WTP for sorting waste, which is lowest for sorting into 5 categories. This result that people value higher levels of home recycling (more sorting) is in line with Czajkowski, Kądziela and Hanley (2014) and Czajkowski, Hanley and Nyborg (2015). Regarding collection frequency, people are willing to pay extra to increase it above twice per month, with the highest mean WTP for collection 3 times per week. For all attributes and all levels, a significant preference heterogeneity is observed, as indicated by the standard deviation parameter estimates in column 2.

Table 1. The results of the MXL model in WTP-space (EUR) representing consumers' general preferences for the number of in-home sorting categories and the frequency of collection in future waste collection contracts

	Mean	**St. Dev.**
Status quo (ASC)	-9.85***	9.41***
	(0.10)	(0.17)
Sort in 2 categories	3.35***	5.68***
(vs. no in-home sorting)	(0.14)	(0.14)
Sort in 3 categories	3.87***	7.86***
(vs. no in-home sorting)	(0.16)	(0.17)
Sort in 5 categories	0.78***	9.63***
(vs. no in-home sorting)	(0.20)	(0.19)
Collect 1 time per week	3.23***	4.17***
(vs. 1 time every 2 weeks)	(0.18)	(0.16)
Collect 2 times per week	4.35***	5.51***
(vs. 1 time every 2 weeks)	(0.18)	(0.19)
Collect 3 times per week	4.60***	6.18***
(vs. 1 time every 2 weeks)	(0.18)	(0.15)
Collect 7 times per week	3.84***	6.67***
(vs. 1 time every 2 weeks)	(0.20)	(0.16)
- Monthly cost per household	-0.41***	1.30***
	(0.05)	(0.05)
Model diagnostics		
LL at convergence	-16,043.92	
LL at constant(s) only	-28,054.48	
McFadden's pseudo-R^2	0.4281	
Ben-Akiva-Lerman's pseudo-R^2	0.5196	
AIC/*n*	1.4479	
BIC/*n*	1.4674	
n (observations)	22,236	
r (respondents)	1,853	
k (parameters)	54	

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Parameter estimates represent WTP expressed in EUR per month per household. Standard errors provided in parentheses. All parameters were assumed to be normally distributed with the exception of the cost, which was assumed log-normally distributed (estimated coefficients of the underlying normal distribution provided). The model controls for scale (variance of the error term of utility function) differences between treatments. The scale parameters were skipped for brevity – full results are available in the online supplement to this paper.

5.1. Hypothesis tests

H1: Absolute size of the social norm

In section 3, we hypothesized that the effect of a descriptive norm on pro-environmental behaviours would depend on the absolute size of this norm (eg % of people who recycle in Poland) since, in the theoretical model provided in Czajkowski et al (2017), the utility penalty from deviating from average group behaviour is higher the bigger is the gap between what an individual currently does and this group average. Table 2 presents the results of three models in which the effects of T2 and T3 are evaluated relative to T1, the effects of T6 are relative to T4, and the effects of T7 are relative to T5. These comparisons all allow an evaluation of the effects of changing the absolute size of the descriptive social norm. Looking first at national level norm information, and thus comparing T1, T2 and T3, we see that there is a significant rise in the size of WTP for sorting into 2, 3 or 5 categories as the national-level social norm is increased. Interestingly, the effect of the highest norm (T3) seems to be consistently weaker than the effect of the moderate norm (T2), relative to the lowest norm (T1) – although T3 respondents are willing to pay more than T1 respondents, their WTP increase is not as high as that of T2 respondents. For city-level norm information, thus comparing T4 with T6, the only statistically significant effect is observed for relatively lower WTP for sorting into 2 categories. When both reference groups are used (national and city-level information; T5 relative to T7), we observe the statistically significant increase in WTP for sorting into 5 categories.

Our first conclusion is thus that we find evidence that the absolute magnitude of the descriptive social norm is important for WTP for recycling. We observe positive statistically significant effects of higher social norm levels, although they are not necessarily monotone, with the highest absolute social norm levels being less effective in increasing WTP than more moderate social norm levels.[7] In addition, we note very considerable preference heterogeneity for recycling in our data set – the standard deviation parameters for every level of the *sort* attribute are higher than the respective mean effects. We return to analysis of this heterogeneity when analysing hypothesis H4.

[7] Note that in the case of comparisons of T4 with T6 and T5 with T7 by design of the experiment we are only able to observe the effects of the lowest and the highest levels, without the effects of middle levels. The middle levels were not included because of the lack of appropriate city statistics we could have uses without lying to respondents.

Table 2. The results of the MXL models in WTP-space (EUR) representing consumers' general preferences for the number of in-home sorting categories and the frequency of collection in future waste collection contracts – the effects of increasing size of the communicated norm

	Baseline – T1 (Poland: 10%)		Interactions		Baseline – T4 (Cities: 15/11/6%)		Interactions	Baseline – T5 (Cities: 15/11/6% Poland: 10%)		Interactions
	Mean	St. Dev.	T2 (Poland: 44%)	T3 (Poland: 69%)	Mean	St. Dev.	T6 (Cities: 72/65/58%)	Mean	St. Dev.	T7 (Cities: 72/65/58% Poland: 69%)
Sort in 2 categories	2.86***	6.07***	1.85***	0.75**	2.90***	5.94***	-0.92**	3.52***	5.46***	0.23
(vs. no in-home sorting)	(0.29)	(0.25)	(0.35)	(0.32)	(0.39)	(0.25)	(0.39)	(0.30)	(0.27)	(0.40)
Sort in 3 categories	3.37***	8.06***	2.30***	1.47***	3.53***	7.80***	-0.34	4.29***	8.07***	0.56
(vs. no in-home sorting)	(0.28)	(0.28)	(0.28)	(0.34)	(0.28)	(0.25)	(0.40)	(0.25)	(0.33)	(0.34)
Sort in 5 categories	-0.40	10.29***	1.60***	0.91**	0.93**	9.51***	-0.41	0.59*	10.59***	1.23***
(vs. no in-home sorting)	(0.31)	(0.33)	(0.34)	(0.36)	(0.46)	(0.27)	(0.49)	(0.33)	(0.37)	(0.40)
Model diagnostics										
LL at convergence	-6,069.40				-3,878.43			-3,997.89		
LL at constant(s) only	-10,630.61				-6,938.19			-6,914.97		
McFadden's pseudo-R^2	0.4291				0.4410			0.4219		
Ben-Akiva-Lerman's pseudo-R^2	0.5195				0.5176			0.5219		
AIC/*n*	1.4578				1.4644			1.4600		
BIC/*n*	1.5096				1.5355			1.5291		
n (observations)	8,412				5,376			5,556		
r (respondents)	701				448			463		
k (parameters)	62				58			58		

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Parameter estimates represent WTP expressed in EUR per month per household. Standard errors provided in parentheses. All parameters were assumed to be normally distributed with the exception of the cost, which was assumed log-normally distributed (estimated coefficients of the underlying normal distribution provided). The parameters of alternative specific constant, collection frequency and monthly cost per household were not treatment-specific. The model controls for scale (variance of the error term of utility function) differences between treatments. The frequency, cost and scale parameters were skipped for brevity – full results are available in the online supplement to this paper.

H2: Geographic proximity

We hypothesised that information on the behaviour of a given percentage of others in the respondent's own city would have a stronger effect than information about the same percentage behaviours across the entire Polish nation. A precise test of this hypothesis is beyond the reach of this study, as we could not set the same % levels for the city population in T4, T5, T6, T7 and in T1, T2 and T3 without misleading respondents. However, one would expect that a comparison of the size of effect between T1 and T3, relative to respectively T4 and T6, would be revealing, as the lower and upper levels for the behaviour of "others" is rather similar. Table 3 presents these results.

We found that in the case of low absolute descriptive norms (T1 vs. T4), moving from a nation-level norm to a city-level norm did not result in significant changes of WTP. In the case of higher descriptive norms, moving from national (T3) to city-level norms (T6) resulted in statistically significant *lower* WTP for recycling. Apparently, the effect of communicating social norms that relate to more local reference group has a more nuanced effect than expected, with no significant differences in the case of low levels of social norms, and high levels of social norms leading to larger WTP decreases in the case of using city rather than the country as a reference.

Table 3. The results of the MXL models in WTP-space (EUR) representing consumers' general preferences for the number of in-home sorting categories and the frequency of collection in future waste collection contracts – the effects of using a country vs. local norm

	Baseline – T1 (Poland: 10%)		Interactions	Baseline – T3 (Poland: 69%)		Interactions
	Mean	St. Dev.	T4 (Cities: 15/11/6%)	Mean	St. Dev.	T6 (Cities: 72/65/58%)
Sort in 2 categories	3.09***	5.79***	0.08	2.68***	5.70***	-0.78**
(vs. no in-home sorting)	(0.23)	(0.15)	(0.25)	(0.25)	(0.28)	(0.40)
Sort in 3 categories	3.52***	7.80***	-0.14	4.02***	6.84***	-1.01**
(vs. no in-home sorting)	(0.19)	(0.15)	(0.23)	(0.29)	(0.25)	(0.42)
Sort in 5 categories	0.58*	10.21***	-0.23	0.88**	8.81***	-1.01**
(vs. no in-home sorting)	(0.31)	(0.19)	(0.31)	(0.42)	(0.26)	(0.50)
Model diagnostics						
LL at convergence	-4,045.78			-3,909.09		
LL at constant(s) only	-7,145.69			-6,890.32		
McFadden's pseudo-R^2	0.4338			0.4327		
Ben-Akiva-Lerman's pseudo-R^2	0.5190			0.5163		
AIC/n	1.4677			1.4726		
BIC/n	1.5365			1.5435		
n (observations)	5,592			5,388		
r (respondents)	466			449		
k (parameters)	58			58		

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Parameter estimates represent WTP expressed in EUR per month per household. Standard errors provided in parentheses. All parameters were assumed to be normally distributed with the exception of the cost, which was assumed log-normally distributed (estimated coefficients of the underlying normal distribution provided). The parameters of alternative specific constant, collection frequency and monthly cost per household were not treatment-specific. The model controls for scale (variance of the error term of utility function) differences between treatments. The frequency, cost and scale parameters were skipped for brevity – full results are available in the online supplement to this paper.

H3: Relative versus absolute norm

In this instance, we compare WTP values in T5 with those in T1 and T4; and WTP values in T7 with those in T3 and T6. From Table 4, we can see that providing information on both the nation and city-level norms is more effective than using only one of these values. In the case of lower level norms, using national norms (T1) rather than both (T5) leads to statistically significant decreases of WTP for all levels of sorting. In the case of higher levels of communicated norms, using national norms only (T3) results in significantly lower WTP for all sorting levels than using both norms (T7), while using only city-level norms (T6) leads to lower decreases in WTP that are only significant for sorting into 2 categories. Overall, we find evidence in support of our hypothesis. The social norm nudge has a greater positive impact on WTP when information on relative performance is provided alongside absolute performance information, and this result applies to social norm information at both city and national levels.[8]

[8] Admittedly, it is likely that what matters is not only the provision of relative information but also the characteristics of the information itself. Note that the recycling levels in cities could have been above or below the country-level of recycling, potentially leading to different effects. We tried to analyse this using city-specific models, however, with much fewer observations the qualitative results were not stable across different modelling approaches and hence unreliable. For this reason, we only present the aggregated results here.

Table 4. The results of the MXL models in WTP-space (EUR) representing consumers' general preferences for the number of in-home sorting categories and the frequency of collection in future waste collection contracts – the effects of using an absolute vs. relative norm

	Baseline – T5 (Cities: 15/11/6% Poland: 10%)		Interactions		Baseline – T7 (Cities: 72/65/58% Poland: 69%)		Interactions	
	Mean	St. Dev.	T1 (Poland: 10%)	T4 (Cities: 15/11/6%)	Mean	St. Dev.	T3 (Poland: 69%)	T6 (Cities: 72/65/58%)
Sort in 2 categories	3.76***	5.55***	-1.27***	-0.72*	3.72***	5.49***	-0.61*	-0.86***
(vs. no in-home sorting)	(0.26)	(0.22)	(0.31)	(0.37)	(0.29)	(0.13)	(0.37)	(0.30)
Sort in 3 categories	4.28***	7.79***	-1.52***	-0.65*	4.24***	7.93***	-0.63*	-0.45
(vs. no in-home sorting)	(0.29)	(0.24)	(0.40)	(0.35)	(0.25)	(0.20)	(0.34)	(0.32)
Sort in 5 categories	0.53	10.70***	-1.10**	0.07	1.52***	9.58***	-1.08***	-0.55
(vs. no in-home sorting)	(0.35)	(0.28)	(0.47)	(0.42)	(0.34)	(0.25)	(0.39)	(0.38)
Model diagnostics								
LL at convergence	-6,036.27				-5,956.29			
LL at constant(s) only	-10,558.15				-10,400.05			
McFadden's pseudo-R^2	0.4283				0.4273			
Ben-Akiva-Lerman's pseudo-R^2	0.5184				0.5177			
AIC/*n*	1.4688				1.4622			
BIC/*n*	1.5212				1.5150			
n (observations)	8,304				8,232			
r (respondents)	692				686			
k (parameters)	62				62			

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Parameter estimates represent WTP expressed in EUR per month per household. Standard errors provided in parentheses. All parameters were assumed to be normally distributed with the exception of the cost, which was assumed log-normally distributed (estimated coefficients of the underlying normal distribution provided). The parameters of alternative specific constant, collection frequency and monthly cost per household were not treatment-specific. The model controls for scale (variance of the error term of utility function) differences between treatments. The frequency, cost and scale parameters were skipped for brevity – full results are available in the online supplement to this paper.

H4: Impacts of past behaviour

We now look at the preferences of sub-groups of respondents, defined using their current sorting behaviour; and how this current behaviour influences the effects of providing social norm information. The results are presented in Table 5.

The first thing to notice is that people have a strong preference for maintaining current behaviours: respondents who currently sort in 2 categories prefer this kind of sorting the most, whilst those who currently sort in 3 categories are willing to pay the most for sorting into 3 categories. Respondents who currently sort into 5 categories find this kind of sorting much more appealing than any other respondents. As theory predicts, respondents' current sorting behaviour largely reflects their preferences as stated.[9]

Focusing on the provision of country-level social norm information (T1, T2 and T3) relative to no social norm information (T8), the most important result that we find is that whether respondents' react to the communicated social norm strongly depends on their current level of recycling. Starting with respondents who do not currently sort, we find that higher levels of communicated social norm information result in higher WTP for all levels of sorting, except for the highest social norm level (T3) which does not significantly increase WTP for sorting into 5 categories. In stark contrast, for respondents who currently sort into 2 categories, the highest social norm level results in significantly reduced WTP for all levels of sorting. At the same time, the lower social norm levels significantly increase these respondents' WTP for sorting into 5 categories. Providing social norm information for respondents who currently sort into 3 categories makes them WTP even more for this degree of sorting, with preferences for sorting into other number of categories largely unaffected. And finally, providing respondents who currently do the most sorting with social norm information generally *decreases* their WTP for almost all levels of sorting. Overall, while respondents who do not currently sort or sort only a little respond to the provided social norm information by increasing their WTP for higher levels of sorting, respondents who sort a lot react in a negative way, reducing their WTP for sorting into more categories. In addition, we find that

[9] In choice experiments, in which the status quo alternative is associated with particular levels of all attributes (rather than being, e.g., an opt-out alternative), respondents' preference for their status quo attribute levels get picked up by the parameter of the alternative specific constant associated with the status quo alternative. In our case, the alternative specific constant is free of this effect.

the highest social norm levels are not necessarily the most effective at changing stated preferences, in fact (by implication) discouraging some respondents from sorting.

Table 5. The results of the MXL models in WTP-space (EUR) representing consumers' general preferences for the number of in-home sorting categories and the frequency of collection in future waste collection contracts – the effects of current/past behaviours

		Baseline – T8 (Control group)		Interactions		
		Mean	St. Dev.	T1 (Poland: 10%)	T2 (Poland: 44%)	T3 (Poland: 69%)
Currently do not sort	Sort in 2 categories	-1.20*	6.60***	2.31***	4.24***	5.60***
	(vs. no in-home sorting)	(0.66)	(0.16)	(0.72)	(0.71)	(0.77)
	Sort in 3 categories	-4.76***	9.40***	4.11***	8.49***	6.51***
	(vs. no in-home sorting)	(0.31)	(0.19)	(0.33)	(0.34)	(0.48)
	Sort in 5 categories	-6.86***	11.60***	3.50***	6.00***	0.84
	(vs. no in-home sorting)	(0.68)	(0.38)	(0.66)	(0.58)	(0.84)
Currently sort in 2 categories	Sort in 2 categories	5.82***	6.82***	-0.46	0.16	-1.91***
	(vs. no in-home sorting)	(0.32)	(0.27)	(0.41)	(0.37)	(0.46)
	Sort in 3 categories	3.98***	8.65***	0.84	-0.10	-2.00***
	(vs. no in-home sorting)	(0.40)	(0.29)	(0.61)	(0.47)	(0.57)
	Sort in 5 categories	-5.28***	12.56***	5.93***	2.90***	-1.60***
	(vs. no in-home sorting)	(0.62)	(0.44)	(0.59)	(0.56)	(0.60)
Currently sort in 3 categories	Sort in 2 categories	4.54***	6.16***	0.47**	0.57*	-0.04
	(vs. no in-home sorting)	(0.30)	(0.15)	(0.23)	(0.29)	(0.31)
	Sort in 3 categories	5.10***	8.52***	1.43***	2.13***	1.23***
	(vs. no in-home sorting)	(0.29)	(0.16)	(0.20)	(0.23)	(0.25)
	Sort in 5 categories	1.95***	10.31***	-0.16	0.05	-0.03
	(vs. no in-home sorting)	(0.37)	(0.15)	(0.32)	(0.33)	(0.37)
Currently sort in 5 categories	Sort in 2 categories	4.18***	4.47***	-0.81***	-0.90**	-0.66***
	(vs. no in-home sorting)	(0.34)	(0.15)	(0.30)	(0.36)	(0.25)
	Sort in 3 categories	6.63***	5.69***	-1.05***	0.08	-1.10***
	(vs. no in-home sorting)	(0.37)	(0.14)	(0.26)	(0.35)	(0.28)
	Sort in 5 categories	5.71***	7.34***	-0.52**	0.59*	-0.81***
	(vs. no in-home sorting)	(0.32)	(0.16)	(0.25)	(0.36)	(0.28)
Model diagnostics						
LL at convergence		-7832.78				
LL at constant(s) only		-14186.69				
McFadden's pseudo-R^2		0.4479				
Ben-Akiva-Lerman's pseudo-R^2		0.5359				
AIC/*n*		1.4373				
BIC/*n*		1.6261				
n (observations)		11304				
r (respondents)		942				
k (parameters)		291				

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Parameter estimates represent WTP expressed in EUR per month per household. Standard errors provided in parentheses. All parameters were assumed to be normally distributed with the exception of the cost, which was assumed log-normally distributed (estimated coefficients of the underlying normal distribution provided). The parameters of collection frequency and monthly cost per household were not treatment-specific. The model controls for scale (variance of the error term of utility function) differences between treatments. The frequency, cost and scale parameters were skipped for brevity – full results are available in the online supplement to this paper.

6. Discussion and Conclusions

The role of social norms as part of environmental policy has become of increasing interest in the economics literature. This paper uses the choice experiment method to collect individual-level data for people living in three Polish cities to test whether the way in which norm information is presented matters in terms of its effects on WTP for increased levels of recycling at the household level. Four testable hypotheses were developed from the literature, focussing on (i) the absolute size of the norm (ii) its geographic proximity (iii) whether relative performance information is presented and (iv) the interaction of the nudge with past behaviour. The research design randomly allocated respondents into one of eight treatments which capture this variation in social norm information.

The interesting result that emerges is that while respondents generally respond to social norm information by increasing their WTP for more recycling, the effect is not necessarily monotone, whilst with the highest descriptive social norm levels are less effective than moderate social norm levels. Given that treatments were randomly assigned to respondents, we interpret these social norm effects as being causal. As discussed below, variation in personal-level existing behaviours helps co-determine response to social norm information; it may well be that as the absolute level of the norm rises, there are an increasing number of people for whom the norm greatly exceeds their current behaviours, which may explain why very high absolute levels of the norm are less effective (they seem "out of reach"). But we would also point to the high degree of heterogeneity in how people respond to each absolute size of norm as shown in Table 2.

With respect to the geographical proximity, our hypothesis that using a more local reference group of "relevant others" for the pro-environmental behaviour would lead to larger effects in terms of changes to WTP was not found universally valid. While low levels of social norms did not lead to significant preference changes, we found that if high levels of social norms were used together with city rather than a country as a reference, the resulting WTP was lower. This effect should be considered jointly with our finding of lower effectiveness of high level of norms discussed in the previous paragraph. It is possible that whatever mechanism is leading respondents who are faced with high social norm levels to decrease their WTP for sorting, it is actually more pronounced if a local reference group of "relevant others" is used, compared to a national level reference group.

Regarding using relative versus absolute norms, we find that the nudge effect is stronger when more information on relative performance is provided. In our experiment, using combined country and city references rather than only one of these leads to higher WTP for some levels of sorting. This evidence supports our hypothesis H3 that providing relative performance information (in our case, the level of recycling in your city compared to recycling in Poland as a whole) should increase the impact of the nudge. It thus appears that people not only compare their own behaviour with the descriptive norm provided, but that they also place importance on the distance between this descriptive norm and some other measure of behaviour by a wider group.

Finally, we find that whether and how strongly respondents' react to the communicated social norm information depends on their current engagement level with household recycling. While respondents who do not currently sort or sort only a little respond to the provided social norm information by increasing their WTP for higher levels of sorting, respondents who currently recycle a lot react in a negative way to the nudge, reducing their WTP for sorting into a higher number of categories. In addition, we find that the highest social norm levels are not necessarily the most effective in increasing recycling behaviour, in fact discouraging some respondents from sorting. This suggests that if responses to a nudge depend on an easy-to-observe characteristic of households or individuals, then there is a case for targeting the provision of social norm information to identified sub-sets of households. But we realise that those aspects of current behaviour which most influence the effects of a nudge may be costly to observe.

An important point to note in thinking about these results is that the outcome variable we focus on – WTP for different levels of household recycling as required by a waste management contract – is rather more complex than the simpler outcome measures which others have studied, such as electricity use, water consumption or hotel towel re-use. However, the choice experiment method allowed us to explore the extent to which a given nudge had consistent effects across multiple attributes and levels associated with an environmental activity at the level of an individual. We would also highlight that the choices people made in our experiment were for waste management contracts which combine prices with environmental performance levels (waste sorting). WTP effects come about through impacts on both the dis-utility of higher prices and the positive or negative utility of higher levels of sorting and collection frequency.

Acknowledging limitations of our study, it should also be born in mind that, due to a desire to avoid misleading or lying to respondents, somewhat different definitions of "recycling" were employed in developing the descriptive norms. In T1-T3 (national level) this varied from "% of waste sorted" to "households who sort waste regularly" to "% who declared they sort waste". Even though the information contained in each message relates to the same underlying pro-environmental behaviour (levels of household recycling) which the nudge is targeting, these definitions are not quite the same. This difference could have led to lower than expected sensitivity to national level norms. However, the only alternative design would have been to mislead respondents. We also acknowledge that perceived social norms might be important: if I think that around 60% of Polish households recycle, and then I am told by an interviewer that the actual figure is 40%, then the effects on my behaviour and/or WTP for more recycling could be different than if I imagined, ex ante, that only 20% of households in Poland recycle. We do not observe such variation in perceived levels of collective behaviour across respondents in our sample, and so cannot control for it.

It is also important to point out that in the context of our stated preference experiments, the extent to which an individual's behaviour differs from a social norm is not subject to a public sanction, since choice cards were completed in confidence. Such public sanctions (e.g., reputation effects; shame) have been argued to be important for the effectiveness of a social norm on behaviour, whether the norm is descriptive or injunctive. On the other hand, deviating from the social norm can be thought of as imposing a utility penalty on individuals as per the conceptual model of Czajkowski, Hanley and Nyborg (2015). This self-sanction is not equivalent to a public sanction, and does not depend on observability. It is also true that the ability of individuals to monitor the recycling behaviour of others is limited (you can watch me walk to the recycling bank with empty wine bottles, but you are unlikely to go through my recycling bin to see how full it is, or whether it is contaminated with non-recyclable material). If agents' behaviour is only imperfectly observed, then the ability to sanction behaviour which violates a social norm is compromised. However, this is only one mechanism through which a social norm can change behaviour.

The stated choice method is presented here as a useful tool to predict the consequences of potential behavioural policies before they are introduced (Hanley and Czajkowski, 2017). This could potentially allow policy makers to avoid costly mistakes or failures to deliver policy

targets from introducing the wrong nudge. Of course, lab experiments can also be used to pre-test new policy instruments, but this typically comes at the cost of a much less diverse and representative sample of respondents than is the case with stated choice models. Stated choice approaches offer a low cost and highly adaptable tool for pre-testing behavioural nudges as a component of environmental policy before such nudges are implemented in practice.

In conclusion, although social norm campaigns are very tempting as a solution to environmental problems due to their low cost and appeal to liberal paternalism, their effects often cannot be generalised and thus are hard to predict for specific policy cases and specific targeted populations. Our results show that the effects of a descriptive norm-based nudge on willingness to pay for enhanced recycling depend on the nature of the nudge (absolute size, geographic proximity, inclusion of relative performance information) as well as on the observable existing behaviours of those exposed to the nudge. We therefore recommend careful pretesting norm-based nudges before introducing them as a "routine" part of the policy tool-kit. As shown here, stated choice models are a useful way of carrying out such pre-tests.

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