

# Boosting Recycling Behaviour Among Urban Households in Peru – A Field Experiment on the Role of Social Norms and Beliefs

## Pre-analysis Plan

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January 22, 2021

### Abstract

The aim of our study is to understand the role of social norms and individual beliefs about social norms for people's decision to recycle. In cooperation with a local municipality in Lima, Peru, we will conduct a field experiment using phone surveys to increase sign-up rates to the municipality's recycling programme. We will make use of different types of social norm information to motivate sign-ups of households, focussing on injunctive and dynamic norm information. We will do so in a 2x2 design, with injunctive norm information on the one side (no/yes) and dynamic norm information on the other side (no/yes), testing both the individual and the combined effect of the two distinct norm messages. Moreover, we will investigate the role of individual pre-treatment beliefs about injunctive and dynamic norms for the response to our information treatments that directly aim at correcting those beliefs. Our primary outcomes of interest will be i) people's sign-up decision during the phone survey and ii) people's actual sign-up through the official registration link that they will receive from the municipality shortly after the survey. We are interested in the average treatment effects of our social norm treatment messages as well as heterogeneous treatment effects as a result of individual level belief updating about dynamic and/or injunctive norms, depending on the treatment.

## 1 Introduction

Environmental pollution is one of the main challenges we are facing these days. Global waste accumulation is posing a serious threat to people and ecosystems, with the waste sector contributing significantly to global climate change. As a consequence, sustainable waste and resource management has become crucial for countries' climate change mitigation efforts (UNEP, 2015). Recycling is one of the key steps in this process to tackle the immense challenge of reducing global waste accumulation. Waste separation in the household is essential in this regard, as without the effort of individual consumers to separate materials appropriately, the whole process would not function (Dai et al., 2015; Varotto and Spagnolli, 2017). Thus, changing policies alone is not enough, but behavioural change at the individual consumer level is necessary as well for the recycling sector to work.

While countries in the Global North used to account for the largest part in global waste generation, low- and middle-income countries are expected to overtake this position soon, with rising populations, migration to cities and changing consumption patterns leading to rapidly growing waste accumulation (UNEP, 2015). At the same time, the infrastructure for waste management is often worse than in developed countries, with large amounts of waste ending up in local dumpsites, threatening both people's health and the environment. This also holds in the case of Peru. The country is facing a serious waste problem, while it is estimated that only 4% of all waste generated in the country's capital city, Lima, is recycled (WWF, 2018). At the same time, a large proportion of waste generated can be

attributed to households, underlining the important role of the individual consumer. It is therefore essential to understand the motivational drivers and barriers for individuals to recycle, especially in those regions where waste generation is growing fast and where the consequences of improper waste management are most severe.

Municipalities are the ones responsible for coordinating recycling activities at the household level in Peru. Some municipalities in Lima have established their own recycling programmes over the last years as an effort to improve their local waste management. However, the uptake and active participation of households in these programmes is still rather low. For our study, we have teamed up with the municipality of Miraflores, an upper middle- to high-income neighbourhood in Lima. The municipality has established a recycling programme, in which households can participate voluntarily and free of charge. Households separate their recyclable materials at home and collect them in a separate bag, which is then placed outside their house on the street on a specific day per week and collected by formal recyclers. So far, only 12% of the households in Miraflores are participating in the municipality's recycling programme. With our study, we aim to increase this number by motivating households to sign up to the programme.

Inducing behavioural change in the context of recycling is, however, not that easy. As many other sustainable behaviours, recycling constitutes a collective action problem, where people have to invest individual costs for collective benefit (Harring et al., 2019; Sparkman et al., 2020). Individual costs can for example refer to the time and effort needed to separate materials and fill in recycling bags, collective benefit can be seen as reduced waste accumulation and better environmental quality. This creates the incentive for individuals to free-ride, meaning to not contribute to the public good themselves (i.e. not to recycle) while still gaining the collective benefit at the cost of others (i.e. better environmental quality). In such a social dilemma situation, it is in everybody's personal best interest not to cooperate regardless of what the other people in society do, while all individuals would be better off if everybody in society cooperated (Dawes, 1980), which is also known as the "tragedy of the commons" (Hardin, 1968). Research has shown that social norms can help to overcome such collective action problems (Bicchieri and Dimant, 2019; Ostrom, 2000; Sparkman et al., 2020).

A prominent theory in the economics literature for why people respond favourably to social norm information is that people experience moral costs when deviating from the norm, which can be an important mechanism to induce behavioural change (Levitt and List, 2007).<sup>1</sup> Despite its growing importance in the theoretical literature, however, Hallsworth et al. (2017) point out that so far only few experimental studies exist of its efficacy. Similarly to the approach of Hallsworth et al. (2017), our study aims to motivate behavioural change by increasing the moral costs of participants through different treatment messages based on social norms.<sup>2</sup>

While the concept of social norms has been studied extensively in the literature, its definitions vary between and within disciplines (see Farrow et al., 2017, for an overview). For our research purposes, it is important to distinguish between two types of norms, *descriptive norms* and *injunctive norms*.<sup>3</sup> Descriptive norms say what other people do; injunctive norms refer to what other people think should be done, or approve of doing. As Hallsworth et al. (2017) point out, the two are conceptually different and should be treated as such. Moreover, a more recent stream of literature has introduced the concept of *dynamic norms*, which indicate how the behaviour of others has developed over time

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<sup>1</sup> As applied for example in Allcott (2011), Byrne et al. (2018), Ferraro and Price (2013) and Hallsworth et al. (2017).

<sup>2</sup> While Hallsworth et al. (2017) do so in the context of tax compliance.

<sup>3</sup> As commonly done in the economics literature, such as in Krupka and Weber (2013) or Hallsworth et al. (2017), based on the origins of Cialdini et al. (1991).

(Sparkman and Walton, 2017). In principle, dynamic norms could apply to both descriptive and injunctive norms (the latter would then describe how the social approval of others has developed over time), while so far the concept has only been used in the context of descriptive norms, which will also be the understanding of dynamic norms in our research.

A key challenge with many pro-environmental behaviours is that they are often not normative (yet). Accordingly, motivating behavioural change by pointing towards a descriptive majority of others that is already engaging in the behaviour is often not possible as it does not exist. However, even though still far from representing a descriptive norm, many pro-environmental behaviours are increasing in popularity, meaning that more and more people start to engage in them. In the case of the recycling programme in Lima we are working with, current participation rates are still rather low (12%) while the number of households participating in the programme has doubled over the last three years, from 6% to 12%, indicating a clear positive trend in recycling behaviour of households. Based on the evidence available from the dynamic norms literature (Loschelder et al., 2019; Mortensen et al., 2019; Sparkman and Walton, 2017 and 2019; Sparkman et al., 2020), highlighting the positive trend in the behaviour of others can successfully encourage people to engage in the behaviour as well, even if there is no descriptive majority yet. We will test whether informing people about the dynamic norm in participation rates can increase the moral cost of not recycling, thereby motivating people to sign up to the recycling programme. To our knowledge, we are the first to test the effect of dynamic norms in a field experiment outside a high-income country context, adding an important new lens to the so far very limited evidence on the dynamic aspect of norms.

Despite the positive evidence on the effect of dynamic norms found in previous studies, we ask ourselves whether this positive trend will be motivating enough for people to recycle in our context if the current prevalence of other people engaging in the behaviour is still at such a low level.<sup>4</sup> The question is whether the moral cost of not belonging to the growing group of people that has started to recycle will be large enough to induce behavioural change. Since it is not only morally costly to deviate from what other people do, but also from what other people approve of doing (Hallsworth et al., 2017), we therefore conducted a pre-survey with 100 households in Miraflores to elicit people's injunctive norm beliefs, i.e. their sense of importance and social approval for recycling. We found that of the 100 people we asked, 97% think that recycling is important for protecting the environment, indicating a strong injunctive norm. Thus, we face a situation with a low current prevalence (12%), considerable increase over the last years (doubled from 6% to 12%) and high social approval (97%).

The question that then arises is why so many people privately support the behaviour but only few people actually recycle themselves. We hypothesize that biased beliefs about both the positive trend and the high social approval could be a reason. If someone privately thinks recycling is important but at the same time believes that hardly anyone around him/her has started to recycle, he/she might not be willing to make the effort him-/herself. Also, the person might believe that other people think recycling is not important since hardly anyone else seems to engage in the behaviour. Given the

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<sup>4</sup> It should be noted that the way dynamic norms have so far been used in the literature differs between studies. Loschelder et al. (2019) only give information about the fact that "more and more" people are engaging in the behaviour without linking it to any descriptive numbers. Sparkman and Walton (2017) give information about the fact that a certain percentage of people (in their case 30%) has started to engage in the behaviour, simply representing the descriptive number of people that is already engaging in the behaviour in a dynamic way (30% have started to do so vs. 30% are doing so). Our approach is similar to the one of Mortensen et al. (2019), where people are informed about the current prevalence in the behaviour of others, in addition to how this number has developed over time. In the case of Mortensen et al. (2019), however, the descriptive number of people engaging in the target behaviour was already at 48%, thus considerably closer to being a descriptive norm than in our case.

collective action nature of recycling, the positive effects of someone's own actions would be minimal if hardly anyone else recycled. Thus, biased beliefs about the positive trend and the high social approval might be in line with low efficacy beliefs of recycling, which might hinder people from engaging in the behaviour themselves. The findings of Jachimowicz et al. (2018) on the role of second-order normative beliefs for pro-environmental behaviour support the hypothesis that beliefs about what other people regard as important matter, and further show that they can be even more important than people's individual first-order beliefs about the importance.<sup>5</sup>

In our study, we will test whether informing people about the positive trend in recycling behaviour and the high social approval by other people can increase the moral cost of not recycling and thereby encourage people to sign up to the recycling programme of the municipality. To our knowledge, we are the first to contrast the effect of dynamic and injunctive norms for behavioural change in a field experimental context. We will do so in a 2x2 design, with injunctive norm information on the one side (no/yes) and dynamic norm information on the other side (no/yes), analysing both the individual and the combined effect of dynamic and injunctive norm information on people's sign-up decision. We will further investigate whether there are systematic biases in beliefs about the positive trend and the social approval, and whether such biased beliefs can explain people's response to our treatment messages that directly aim at correcting those beliefs. To our knowledge, Byrne et al. (2018) and Bursztyn et al. (2020) are the only studies so far that combine measuring people's pre-treatment beliefs with intervention treatments that directly aim at correcting those beliefs.<sup>6</sup> Both studies show that pre-treatment beliefs matter, and that they can explain variations in people's response to information treatments, resulting in heterogeneous treatment effects. In particular, both studies show that providing people with information is particularly effective to encourage behavioural change among those people who previously underestimated the information they receive. To our knowledge, the importance of pre-treatment beliefs in the context of dynamic norms has not been investigated yet.

Moreover, we will observe whether receiving information about dynamic and injunctive norms in recycling behaviour will alter people's beliefs about recycling behaviour in the future (as suggested by Sparkman and Walton, 2017) as well as beliefs about their own and their collective actions as a group being effective (personal and collective response efficacy, as suggested by Doherty and Webler, 2016). The two are interlinked, as only with a large enough number of people engaging in recycling behaviour the own as well as the collective actions as a group will be effective. Previous research has shown that efficacy beliefs are important for motivating pro-environmental behaviour (Bostrom et al., 2019; Doherty and Webler, 2016; Hart and Feldman, 2016). As outlined above, biased beliefs about dynamic and injunctive norms might be accompanied by low efficacy beliefs, which could be changed by correcting those beliefs with our information treatments.

Our experiment will be conducted via phone surveys in cooperation with a local survey company. We aim for a sample size of around 1,600 participants in total for our study. Participants will be recruited from the official data base of the municipality of Miraflores that contains all households with respective phone numbers and addresses. Enumerators will call households based on a randomly generated order. The survey was programmed using the software SurveyCTO. The software will allow us to directly monitor incoming data and apply quality checks when needed. The randomization of treatments has been programmed within the software as well based on a random draw that will

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<sup>5</sup> The study of Jachimowicz et al. (2018) analyses the role of second-order normative beliefs for energy saving behaviour.

<sup>6</sup> In contrast to previous studies that either document biases in beliefs without correcting them, provide information without measuring baseline beliefs, or measure only beliefs with post-treatment surveys, while still interpreting treatment effects as a result of pre-treatment errors in beliefs, as Byrne et al. (2018) point out.

randomly assign people to one of the four treatment groups. Our first dependent variable of interest will be people's sign-up decision during the phone survey (binary variable – yes/no). While this first sign-up decision can be seen as people's sign-up intention, our second dependent variable will be people's actual sign-up to the programme through the official registration link that they will receive from the municipality shortly after the survey (binary variable – yes/no).

We aim to contribute to the literature in the following areas in particular. Firstly, we aim to expand evidence on the literature that uses messages based on social influence to encourage pro-environmental behaviour, such as energy conservation (Allcott, 2011; Ayres et al., 2013; Nolan et al., 2008; Schultz et al., 2007), water conservation (Datta et al., 2015; Ferraro et al., 2011; Ferraro and Price, 2013; Lede et al., 2019; Schultz et al., 2016), recycling (Schultz, 1999) or the reuse of towels in hotels (Goldstein et al., 2008). Secondly, we aim to contribute to the recent literature that investigates the effect of dynamics norms for behavioural change (Loschelder et al., 2019; Mortensen et al., 2019; Sparkman and Walton, 2017 and 2019; Sparkman et al., 2020), which is so far underrepresented in economics. Thirdly, we aim to contribute to the few papers existing so far that combine measuring people's individual pre-treatment beliefs with information treatments that directly aim at correcting those beliefs (Byrne et al., 2018; Bursztyrn et al., 2020). In this context, we also relate to the paper of Jachimowicz et al. (2018), which outlines the importance of second-order normative beliefs for encouraging pro-environmental behaviour. Fourthly, we link up to the paper of Hallsworth et al. (2017) that uses different norm messages to motivate behavioural change by increasing the moral costs of participants, applying the theory of Levitt and List (2007) in a field experimental context.

The experimental design, including the experimental procedure, research hypotheses and measurement of variables, is described in detail in the subsequent section, followed by the empirical strategy.

## 2 Experimental Design

### 2.1 Experimental procedure

Our experiment will be conducted via phone surveys through a local survey company. The protocol for the survey is as follows. Enumerators will start by explaining who they are and that they are conducting a short survey in line with the municipality's recycling programme. As a first check, enumerators will ask whether the household is already enrolled in the programme, and if so, thank the respondent and end the survey, as we are interested in the households that are not yet part of the programme. If a household is not enrolled yet, enumerators will inform respondents about how the data will be used and that all their answers will be treated confidentially and analysed anonymously. Respondents will then be asked to give their verbal consent to participate in the study.<sup>7</sup> Moreover, respondents will be informed that the survey will take less than 10 minutes and that they can win a prize (one of 15 Falabella gift cards of 50 Soles each)<sup>8</sup> when participating in the study. If the respondent agrees to take part in the study, enumerators will start with the actual survey.

In the first step of the survey, we will elicit people's pre-treatment beliefs about dynamic and injunctive norms regarding recycling in Miraflores as well as their personal first-order beliefs about the importance of recycling. The beliefs questions are incentivized in the sense that people will be able to win another Falabella gift card of 10 Soles each for each question where their belief will be accurate,

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<sup>7</sup> The study has been approved by the International Development Research Ethics Committee at the University of East Anglia (date of approval 03.03.2020).

<sup>8</sup> Falabella is a well-known company in Peru. The incentives have been chosen based on discussions with local partners in Peru.

in addition to the 50 Soles Falabella gift card they can win for their general participation. Afterwards, we will collect demographic information about the respondent and the household in general as well as control questions. These general questions also aim to serve as buffer questions between the beliefs questions and the treatment messages, which both focus on the same information.<sup>9</sup> In the next step, the treatment messages will be conveyed, for which participants will be randomly assigned to one of the four treatment groups based on the following 2x2 design. The randomization has been programmed within the survey based on a random draw from 0 to 1, with an equal probability for each treatment.

		Injunctive norm (% think recycling is important)	
		No	Yes
Dynamic norm (Δ recycling)	No	A	B
	Yes	C	D

Table 1: Treatment groups within 2x2 design.

The treatment messages for the respective treatment groups are as follows (here presented in English, while the survey will be conducted in Spanish):

- **A (control group):** no message
- **B (injunctive norm):** Of the 100 households in Miraflores we asked, **97%** think that it is important for the environment that households participate in the municipality’s recycling programme!
- **C (dynamic norm):** The number of households in Miraflores that are participating in the municipality’s recycling programme **has doubled, from 6% to 12%**, over the last three years!
- **D (dynamic + injunctive norm):** The number of households in Miraflores that are participating in the municipality’s recycling programme **has doubled, from 6% to 12%**, over the last three years! Of the 100 households in Miraflores we asked, **97%** think that it is important for the environment that households participate in the municipality’s recycling programme!

The treatment messages will be directly followed by the question whether the household would like to sign up to the recycling programme. The sign-up decision during the survey will be measured as a binary variable (yes/no) and will be our first outcome variable. After that, we will elicit people’s post-treatment beliefs about future norms in recycling behaviour as well as personal and collective response efficacy. Moreover, we will collect additional control variables that are related to recycling and will therefore be asked after the sign-up decision to not influence the respondents’ decisions and reduce potential experimenter demand effects. Finally, we will collect the contact details for the household (in case the household wants to sign up to the programme) and inform respondents that they will receive an official registration link from the municipality within the following days. All participants will further be informed that they will be notified whether they won the Falabella gift cards after completion of the data collection.

<sup>9</sup> For example, we aim to reduce the potential effect that respondents might still be thinking about the injunctive norm (as they were asked to make a guess about it) when receiving the dynamic norm information in the treatment message (or vice versa).

Over the subsequent weeks following our initial survey, we will then observe whether a household actually signs up to the recycling programme through the official link of the municipality, which will be our second outcome variable (again measured as a binary variable). The official registration link will be sent via email or WhatsApp (depending on the participant’s preference) and will contain the treatment message again to reinforce its strength. Figure 1 summarizes the experimental procedure.

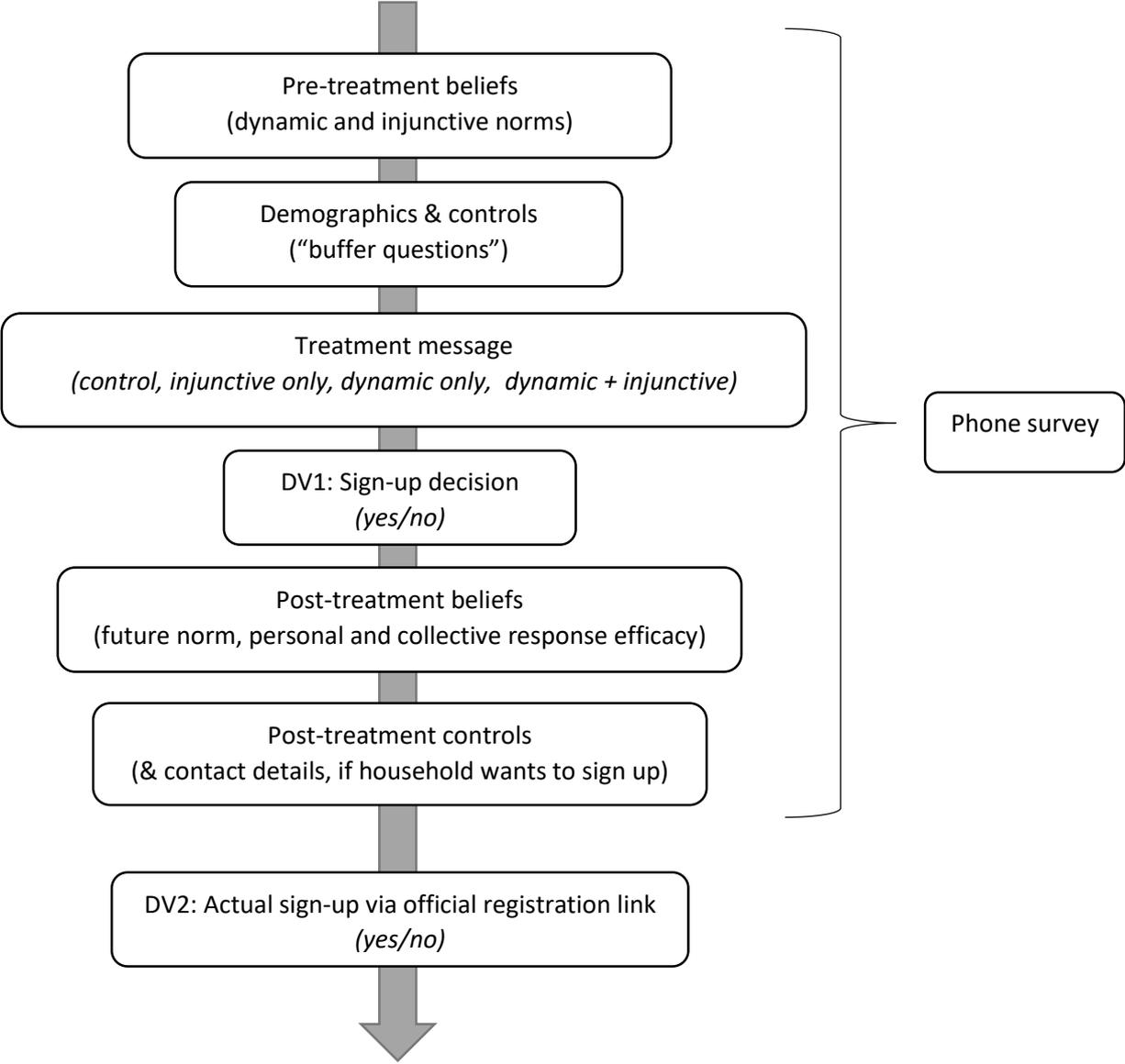


Figure 1: Experimental procedure.

### 2.2 Hypotheses

Our hypotheses are as follows, separated for average and heterogeneous treatment effects. The letters (A to D) refer to the respective cells/treatments in table 1. We use the word recycling here as a synonym for our two dependent variables – the sign-up decision during the survey and the actual sign-up through the official registration link. We expect these hypotheses to hold for both dependent variables, while we expect the effect to be stronger for the sign-up decision during the survey as it requires less effort from the participants and the treatment manipulation might be more salient.

### **Average treatment effects:**

Regarding which treatment will be most effective, on average, we hypothesize that it will depend on the distribution of individual pre-treatment beliefs about dynamic and injunctive norms. If, on average, people underestimate both the dynamic and the injunctive norm, the combined treatment should be most effective, as it would lead to belief updating on both types of information. If, however, people overestimate one type of information, on average, that specific element (dynamic or injunctive information) might reduce the effect of the combined treatment compared to the individual treatment that only contains the other part of information (i.e. dynamic or injunctive information only).

We expect all treatments to have a positive effect on sign-ups compared to the control group, on average, based on the following reasoning.

- **H1 (injunctive norm effect):** Not recycling has a moral cost. Learning that more other people than expected think recycling is important increases the moral cost. When the moral cost increases, people are more likely to recycle (compare B and A).
- **H2 (dynamic norm effect):** Not recycling has a moral cost. Learning that the number of other people that recycle is increasing more than expected increases the moral cost. As the moral cost increases, people are more likely to recycle (compare C and A).
- **H3 (dynamic + injunctive norm effect):** Learning that the number of other people that recycle is increasing more than expected and also that more other people than expected think recycling is important increases the moral cost. As a consequence, people are more likely to recycle (compare D and A).

### **Heterogeneous treatment effects:**

We expect to find heterogeneous treatment effects based on individual level belief updating as described above, which leads to the following hypotheses.

- **H4 (belief updating on injunctive norm):** We expect the message in treatment B to be particularly effective among those people that previously underestimate the injunctive norm.
- **H5 (belief updating on dynamic norm):** We expect the message in treatment C to be particularly effective among those people that previously underestimate the dynamic norm.
- **H6 (belief updating on dynamic + injunctive norm):** We expect the message in treatment D to be particularly effective among those people that previously underestimate the dynamic and the injunctive norm.
- **H7 (belief updating on current prevalence):** The dynamic norm treatment (C) as well as the combined treatment (D) also convey information about the low current prevalence in participation rates (12%). We therefore expect the effect of the message in treatment C and treatment D to be less effective among those people that previously overestimate the current participation rate.

## 2.3 Measurement of variables

The following variables will be collected during the phone survey (again presented in English, while the survey will be conducted in Spanish).

## Pre-treatment beliefs

I am now going to ask you about your beliefs about recycling in Miraflores. For every belief that is accurate, you can win an extra 10 Soles Falabella gift card, in addition to the 50 Soles Falabella gift card that you can win for your participation.

- **Dynamic norm belief:**

*Note: People's dynamic norm belief is calculated as the difference between people's belief about participation in the recycling programme today and participation three years ago.*

- Belief participation today: Out of every 100 households in Miraflores, how many do you think are currently participating in the municipality's recycling programme? All numbers between 0 and 100 are allowed.

*(integer 0-100)*

- Belief participation three years ago: Compared to your answer before, how many out of every 100 households in Miraflores do you think have been participating in the programme three years ago? Again, all numbers between 0 and 100 are allowed.

*(integer 0-100)*

- **First-order belief about importance:** Do you think that it is important for the environment that households in Miraflores participate in the municipality's recycling programme?

*(yes/no/don't know)*

- **Second-order belief about injunctive norm:**<sup>10</sup> We asked 100 households in Miraflores to answer the same question we just asked you, so whether it is important for the environment that households in Miraflores participate in the municipality's recycling programme. How many of those 100 do you think said yes?

*(integer 0-100)*

## Demographics and controls

- **Time preferences:** Please answer the following question on a scale from 0 to 10, where 0 means you are "completely unwilling to do so" and a 10 means you are "very willing to do so". How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future? *(Likert-scale from 0 to 10)*
- **Relation to household head:** What is your relation to the head of the household? *(choose from list)*
- **Gender:** *male/female/diverse*
- **Age:** *integer*
- **Number of household members:** *integer*
- **Number of children in household:** *integer*
- **Level of education:** What is your level of education? *(choose from list)*

## Treatment message

**Treatment A:** *(no message)*

**Treatments B-D:** I am now going to share a piece of information about the recycling programme of the municipality with you: *(one of B, C or D, as presented above)*

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<sup>10</sup> The question is inspired by the elicitation in Bursztyn et al. (2020).

### Sign-up decision

If you like, you now have the chance to sign up to the recycling programme of the municipality. Would you like to sign up to the recycling programme? *(yes/no)*

### Post-treatment beliefs

On a scale from 1 to 7, please choose to what extent you agree or disagree with the following statements. 1 means strongly disagree; 4 means neither agree nor disagree; 7 means strongly agree. *(7-point Likert-scale)*

- **Belief about future participation:** The number of households in Miraflores that are participating in the recycling programme is going to increase in the future.
- **Personal response efficacy belief:** By participating in the recycling programme myself, I can make an important contribution to environmental protection.
- **Collective response efficacy belief:** If many households in Miraflores participate in the recycling programme, together they can make an important contribution to environmental protection.

### Post-treatment controls

- **Personal effort of recycling:** Recycling means a lot of personal effort for me. *(7-point Likert-scale on dis-/agreement as above)*
- **Responsibility for recycling within household:** Who is responsible for recycling within this household? *(choose from list)*
- **Already recycling through other ways:** Do you or does your household already recycle through other ways than the municipality's recycling programme? *(yes/no – if yes, how)*

The following variable will be collected after the phone survey.

### Actual sign-up through official registration link

Following our initial survey, we will observe whether households actually sign up to the recycling programme through the official registration link that they will receive from the municipality shortly after the survey. The actual sign-up will be measured as a binary variable. *(yes/no)*

## 3 Empirical Strategy

### 3.1 Outcome variables

#### Primary outcomes:

- Sign-up decision during phone survey (binary variable)
- Actual sign-up through official registration link (binary variable)

#### Secondary outcomes:

- Belief about future participation in the recycling programme (7-point Likert-scale)
- Belief about personal response efficacy (7-point Likert-scale)
- Belief about collective response efficacy (7-point Likert-scale)

## 3.2 Planned specifications

### **Average treatment effects**

We will first test whether our treatments have an average effect on the sign-up decision of households during the survey and their actual sign-up through the official registration link afterwards (H1-H3). To do so, we will use regression analyses with the different treatments as dummy variables. The analysis will be run separately for the two dependent variables. To test hypothesis 1, we will use treatment B as dummy variable in the regression; to test hypothesis 2, treatment C will be used; and to test hypothesis 3, treatment D will be used. Additional specifications will include demographic and control variables.

### **Heterogeneous treatment effects**

For our heterogeneity analysis (H4-H6), we will first analyse whether there are systematic biases in individual pre-treatment beliefs about dynamic and injunctive norms regarding recycling in Miraflores. We will then interact our treatments with individual pre-treatment beliefs to analyse whether individual differences in pre-treatment beliefs can explain heterogeneous treatment effects. We will use beliefs dummies to indicate whether households overestimate, are correct about, or underestimate the dynamic and/or injunctive norm in the respective treatments, respectively. In particular, to test hypothesis 4, we will test whether the effect of treatment B is stronger for those people who underestimate the injunctive norm; for hypothesis 5, we will test whether the effect of treatment C is stronger for people who underestimate the dynamic norm; and for hypothesis 6, we will test whether the effect of treatment D is stronger for people who underestimate both the dynamic and the injunctive norm. We will further test whether the effect of treatment C and D is weaker for people who overestimate the current prevalence (H7). Moreover, we will calculate the sign and wedge between people's individual beliefs about dynamic and injunctive norms and the true information, with the aim to compute a continuous measure of belief updating to be interacted with the respective treatments in the regression. Again, the analysis will be performed separately for the two dependent variables, and additional specifications will include demographics and control variables.

## 3.3 Power calculations

Different power calculations have been performed using the two proportions command (chi-squared test, two-sided) in Stata, assuming a power of 0.8 and a significance level of 0.05, to detect the required sample size for the study. Different effect sizes depending on different base values have been considered based on pilot data and similar studies, leading to the decision to aim for around 400 subjects per group, hence around 1,600 subjects in total.<sup>11</sup>

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<sup>11</sup> This sample size would, for example, allow us to detect an increase in sign-up rates from 0.75 to 0.83, from 0.70 to 0.79, from 0.65 to 0.74, from 0.60 to 0.70, from 0.55 to 0.65, or from 0.50 to 0.60 percentage points. We consider these to be conservative estimations, since regression analysis will allow us to estimate treatment effects more efficiently.

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