ReCycling: Creating Markets from Waste

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PRELIMINARY

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Abstract

Many public services in low-income settings remain underprovided not because of a lack of demand or supply, but because markets for these services do not exist. I conduct a randomized field experiment in Mozambique establishing a price-based exchange for recyclable waste. By assigning value to non-traded goods and coordinating local labor, the intervention increases waste separation by 12–43 percentage points and raises worker earnings. Social visibility further amplifies engagement, suggesting that beliefs and local interactions drive market diffusion. Results demonstrate that coordination failures, rather than preferences or infrastructure, constrain service provision, allowing market creation through underutilized local resources.

Keywords: market creation, public service delivery, informal labour, urbanisation, behaviour, recycling, Mozambique, Africa.

JEL Codes: D72, O18, J61, O12, O55.

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1 Introduction

Many socially valuable activities fail to emerge in low-income settings not because demand or supply are absent, but because markets that would enable exchange do not exist. Households may value services such as waste collection, sanitation, or water delivery, and workers may be available to provide them, yet no mechanism coordinates exchange between the two sides. In the absence of prices, contracts, or reliable intermediaries, mutually beneficial transactions fail to take place, resulting in persistent underprovision despite latent gains from trade.

This paper studies how markets for public services can be created in environments where no exchange currently takes place. I focus on urban waste management, a setting where households face high costs from waste accumulation but recycling activity remains negligible. In most low-income cities, households do not separate waste, not necessarily because they do not value cleaner environments, but because separation yields no return in the absence of reliable collection. At the same time, large informal labour forces operate below capacity, lacking access to stable demand despite having the flexibility and local reach required for last-mile service provision. These features point to a missing market: households are willing to supply recyclable material, and workers are able to collect it, but no institution exists to facilitate exchange.

Recent work documents the existence of informal recycling markets in low-income cities and highlights the frictions that limit their efficiency (Banares-Sanchez & Wiskamp (2025)). In contrast, I study a setting in which such a market is entirely absent, and ask whether a simple institutional intervention can create it. While existing work focuses on improving the functioning of active markets, I study the extensive margin of market creation.

I introduce a randomized field experiment in Quelimane, Mozambique, that creates a decentralized market for recyclable waste. The intervention establishes a simple price-based exchange mechanism linking households and informal workers. First, a buyback center sets a price per kilogram of recyclable material, assigning value to waste that was previously discarded. Second, bicycle taxi drivers - who form a dense, underutilized urban transport network - are repurposed as collectors who transport recyclables from households to the center in exchange for payment. Third, households receive information on how to separate waste and how to access collection.

Together, these components create a market in which households can sell recyclable material and workers can supply collection services, enabling transactions that were previously infeasible.

The paper then studies how such a market diffuses once created. While introducing prices and supply may be sufficient to initiate exchange, equilibrium participation may remain limited if returns depend on others' engagement or if households are uncertain about service reliability. In such environments, social visibility may shift beliefs and help coordinate behaviour. To study these forces, I introduce a second treatment arm that adds a visible, non-monetary incentive: a household-level thermometer that publicly records recycling activity. This feature allows me to test whether social visibility amplifies participation and accelerates market diffusion by making contributions observable within neighbourhoods.

Preliminary results show that creating this market generates significant behavioural change. In a setting where neither household recycling nor organized collection previously existed, treated households increase waste separation by 12 to 43 percentage points, and a majority engage with collectors at least once. These effects are accompanied by increased earnings for participating workers and improvements in perceived service quality. The results suggest that the primary constraint was not preferences, but the absence of a mechanism to coordinate exchange. By assigning value to previously non-traded goods and leveraging underutilized local labour and transport capacity, the intervention activates a market that sustains mutually beneficial transactions.

This paper makes three contributions. First, it provides experimental evidence that simple institutional interventions can create markets for public services in settings where no exchange previously existed. Second, it tests whether social visibility can accelerate the diffusion of such markets, highlighting the role of beliefs and local interactions in sustaining participation. Third, it documents how activating new demand reallocates labour supply within informal markets, generating income gains for underutilized workers. Together, the results show that market creation can be achieved by leveraging existing, underutilized local capacity, rather than through large-scale centralized investments in infrastructure.

More broadly, the findings highlight a mechanism that may apply to a wide class of urban

services in low-income settings. When households value a service and workers are available to provide it, the binding constraint may be the absence of a mechanism to coordinate exchange. Creating such mechanisms, by assigning value, enabling transactions, and leveraging existing informal networks, may offer a scalable alternative to centralized provision.

Ongoing data collection will allow me to examine persistence, spatial spillovers, labour reallocation, and the cost-effectiveness of the intervention as the market expands.

This paper relates to a growing literature on market design and service provision in low-income settings. While a large body of work studies how to improve the functioning of existing markets, less attention has been paid to settings in which markets are entirely absent and must be created. I contribute to this literature by providing experimental evidence that simple institutional changes can generate new markets by levering the value to previously non-traded goods and coordinating decentralized, underutilized resources.

The paper is closely related to recent work on informal recycling markets in developing cities. Banares-Sanchez & Wiskamp (2025) document the presence of decentralized recycling markets and highlight the frictions that limit their efficiency. In contrast, I study a setting in which such a market does not exist, and show that introducing a price-based exchange mechanism can activate both supply and demand. This distinction corresponds to the difference between improving the intensive margin of existing markets and generating the extensive margin of market creation.

More broadly, the paper contributes to the literature on public service provision in low-capacity environments. A large body of work studies interventions that increase take-up of existing services, including through information provision (Miguel & Kremer (2004)), behavioural nudges (Duflo et al. (2011)), or incentives (Ashraf et al. (2010)). These approaches typically operate in contexts where supply is already in place. In contrast, I study a setting in which the service itself is missing, and show that creating a mechanism for exchange can be a precondition for behavioural responses.

Finally, the paper relates to work on coordination failures and decentralized service delivery. Guiteras et al. (2015) show that take-up of sanitation investments depends on expectations about others' behaviour, highlighting the role of strategic complementarities. A related literature

studies the role of non-state actors in delivering public services in environments with weak state capacity (Ashraf et al. (2012); Nyqvist et al. (2019)). I contribute to these literatures by showing that coordinating existing, underutilized local resources can substitute for centralized provision, enabling market-based delivery of services that would otherwise remain unavailable.

The remainder of the paper is structured as follows. Section 2 describes the context. Section 3 presents the experimental design and data. Section 4 outlines the estimation strategy. Section 5 discusses the results, and Section 6 concludes.

2 Context

The world is increasingly urban, with cities now housing 45% of the global population (United Nations & Social Affairs (2025)). Quelimane is a recent urban centre with a rapidly growing population (approximately 4% per year (UN-Habitat (2022))), and it is currently the sixth largest city in Mozambique. While urbanisation offers potential economic gains, it also generates important challenges, particularly in vulnerable residential areas where services struggle to keep pace with population growth (Bryan et al. (2020)).

Solid waste management is one such challenge, and its projected expansion has drawn increasing policy attention. A recent United Nations report (UNEP (2024)) estimates that waste generation in Sub-Saharan Africa will grow by nearly forty percent between 2020 and 2050 as economies develop. Waste accumulation produces soil and water contamination, and open burning contributes to greenhouse gas emissions, with well-documented environmental and health consequences. In Quelimane, this problem is compounded by high flood vulnerability (World Bank (2019)), since accumulated waste frequently blocks drainage canals. This combination underscores the need for urgent action.

In Quelimane, the municipal entity EMUSA (*Empresa Municipal de Saneamento*) has been responsible for solid waste management since 2005. However, frequent collection is hindered by chronic underfunding and limited infrastructure, and the city's spatial expansion has further complicated access for large collection vehicles. As a result, waste accumulates visibly across many neighbourhoods. Recent estimates suggest that only 45% of the city's waste is currently

(Villa et al. (2022)). Yet a substantial fraction is recyclable. The United Nations suggest that slightly over 30% of waste in Sub-Saharan Africa is recyclable, while less than 5% is treated (UNEP (2024)).

Recyclable materials have positive market value, and this value has already been leveraged in related contexts (Banares-Sanchez & Wiskamp (2025)). In Quelimane, a few private entities engage in collecting and selling recyclables, but their activities remain limited, with most recovered materials originating from commercial establishments rather than households. Households face no private incentive to separate waste, and the absence of functioning collection infrastructure renders any isolated efforts ineffective. Nevertheless, households express dissatisfaction with current waste conditions: only 16% of respondents at baseline believe that collection occurs in a timely manner. A credible and reliable collection mechanism might therefore be sufficient to induce households not to dispose of all waste jointly.

These limitations raise the question of why no such credible collection device currently exists. One possibility is that access to households and common bins is costly due to the city's urban layout. Another is the chronic lack of funding for hiring and maintaining additional waste collectors. This motivates the consideration of alternative delivery mechanisms.

The cyclists are indeed the most common transportation mode in Quelimane, accounting for around 35% of all daily trips (Mendiate et al. (2022)).[1] They are environmentally friendly and particularly well suited to Quelimane's flat terrain. Their size and manoeuvrability allow them to access locations unreachable by larger vehicles and to avoid road obstacles. Yet their supply is sufficiently abundant that equilibrium prices are low: the average passenger trip costs approximately 15 MTS (US $0.23), and cyclists report earning roughly 110 MTS (US $1.70) per day, below the international poverty line of US $2.15 (World Bank (2025)). Moreover, as with any transport service, demand is concentrated in peak hours, leaving substantial periods of underutilisation. At the same time, cyclists know the city well and maintain frequent interactions with households.

With this in mind, there seems to be potential efficiency gains from repurposing part of the

[1] These bicycles include an additional seat behind the driver to accommodate a passenger.

cyclist workforce as waste collectors. Cyclists are numerous and earn very low incomes, suggesting that supplementing their earnings through waste collection could be privately valuable in a setting with limited formal employment opportunities. In addition, cyclists maintain daily proximity to households. Baseline evidence shows that most cyclists have at least one household with whom they interact regularly and maintain direct contact. This dense, decentralised network of household-level ties creates a low-cost channel through which information, collection requests, and recyclable waste could be transferred efficiently.

In this project, I test whether providing households with a credible collection device, by repurposing this underutilised but well-connected labour force, can initiate household-level waste separation and ultimately contribute to a cleaner urban environment.

3 Experimental design

3.1 The intervention

I conduct a field experiment (RCT) in which an information-based recycling intervention was delivered to randomly selected households in the city of Quelimane, Mozambique. The project was implemented in partnership with the municipal government under the name *"ReCiclar com Quelimane"* (ReCycling with Quelimane). The intervention ran from July to November 2025 and consisted of a household-level information campaign on recycling, delivered through door-to-door visits, combined with free collection of recyclable waste.

Recyclable waste collection was carried out by bicycle taxi drivers ("cyclists"), who constitute the city's main transport network. Cyclists were engaged as waste collectors in a manner that complemented their regular work as bicycle taxis. During the intervention period, cyclists received the same informational content as households, via targeted videos shown during structured visits. I now describe the design of the information campaign.

3.1.1 The information campaign

The information campaign consisted of three scripted visits to sampled households and cyclists. The first visit took place in July 2025, the second in August 2025, and the third in November 2025. The November visit took place after the midline survey and was used as a final booster session to reinforce the earlier messages. At each visit, participants watched a short video combining basic information on recycling with targeted behavioural encouragement. Videos for households and cyclists differed in focus: household videos emphasised waste separation, whereas cyclist videos emphasised waste collection and reinforcement of the programme among their client base.

All videos introduced the concept of recycling and its benefits, but each of the three rounds focused on a distinct thematic component. The first video defined recycling, highlighted its environmental benefits, and placed particular emphasis on neighbourhood cleanliness and improvements to community wellbeing. It then focused on plastic waste, explaining why plastics impose environmental harm and concluding with a list of plastic items accepted for recycling.

The second video revisited the general problem of waste accumulation before turning to metal and glass. It explained the hazards associated with these materials and provided examples of recyclable items in each category. The third video summarised the content of the first two sessions, reiterated the full list of recyclable plastic, metal, and glass items, and stressed the importance of broader community engagement to reduce visible waste accumulation in neighbourhoods.

The household video in the third round encouraged participants to share both the information received and the contact details of their "everyday cyclist" (the specific cyclist assigned to their household[2]) with close neighbours. Cyclists, by contrast, were encouraged to reinforce the informational messages with all passengers they transported and to collect separated waste bags when contacted.

In all household videos, participants were encouraged to reuse existing rice or flour sacks available in their homes as storage for separated recyclables, and to contact their everyday cyclist once the bag was full. Cyclist videos, in turn, instructed them to deliver collected recyclables to a storage point established by the municipality in the city centre. At this point, recyclables were

[2]See Section 3.2 for a detailed description of household–cyclist assignment.

weighed by material type (plastic, glass, metal), and cyclists received a pre-specified payment per kilogram, with posted prices visible at the centre. All videos incorporated visual illustrations to facilitate comprehension. Video scripts, links, and example images are provided in Appendix A.

3.1.2 The nudge treatment

To examine the role of social visibility in household engagement with waste separation, I introduced an additional treatment arm featuring a conspicuous signalling device in the form of a thermometer poster. During the baseline survey, households assigned to this group received a postcard displaying a thermometer with five uncoloured bars. The instructional videos explained that each time recyclables were collected from the household, the cyclist would colour in one bar.[3] Field administrators were instructed to write the household's ID in the top corner to enable accurate tracking over time.

The videos further informed households that the most engaged participants, measured by the number of fully completed thermometers and the total kilograms of recyclables delivered to the storage centre, would have their names and photographs displayed on a public poster in the city centre. To sustain engagement, the midline visit included a small incentive. Households that had completed at least one thermometer received a project logo sticker and a new thermometer card. In January 2026, a poster featuring the names and photographs of all households with fully completed thermometers was displayed at the entrance of the buyback centre. The poster can be seen in Figure A2 in Appendix Section A.

Field administrators photographed the thermometer display and recorded the number of coloured bars during each visit and survey wave. These photographs and counts serve as administrative measures of adherence to the nudge treatment and of household engagement throughout the intervention. An example of a fully completed thermometer poster is provided in Figure A1 in Appendix Section A.

[3] See Figure A1 in Appendix Section A for an example of the thermometer poster.

3.2 Sampling and randomisation

The baseline sample of cyclists sets the stage for the sampling in this project. It is representative of all cyclists working in the city of Quelimane as taxi drivers for at least one year, with the intent to stay for at least one more and that have at least one "everyday client". These were described as households with whom the cyclists engaged on a weekly basis and for whom the cyclist had contact details. For compliance reasons, field administrators were also instructed to use literacy as an eligibility criteria.[4] Because bicycle taxi stops in Quelimane are entirely informal, we first canvassed the city to construct a comprehensive listing of all stopping points. This exercise identified 62 stops across the city. Figure B3 in Appendix Section B provides an illustration of one such stop.

Field administrators were then assigned one stop each sampling day. To sample cyclists, they approached any group present and recorded all eligible individuals. The survey platform than randomly selected one cyclist per group to conduct the baseline interview. The enumerators repeated this protocol until up to nine cyclists had been found in each stop. We sampled nine cyclists in 58 stops and eight cyclists in four stops, and therefore the study sample consists of 554 cyclists interviewed at baseline.

The household sample was assembled in two stages. During the baseline survey, cyclists were asked to refer up to three everyday clients. In practice, we observed reluctance to provide multiple contacts.[5] During this phase, we recruited 739 households. These constituted the sampling frame for the randomisation into treatment groups (described below). To expand the household sample, during the first intervention round we revisited all cyclists in both treatment and control groups. Prior to starting treatment, field administrators emphasised the importance of having more participants in the study and requested additional contacts.[6] This effort yielded an additional 259 households. The full household sample therefore comprises 998 households.

Following the first measurement wave,[7] we revisited each sampled household. Using a de-

[4]Reports from field work indicate that most encountered cyclists were literate.

[5]Ninety percent of cyclists at baseline provided only one contact.

[6]Field administrators were instructed to contact households immediately to obtain consent when cyclists were reluctant to share contact information.

[7]See Section 3.3 for a full description of the measurement procedures.

terministic protocol, field administrators selected one closest neighbour for each household. The closest neighbour was defined as a household residing in the immediate vicinity of the originally sampled one. This step aimed to capture potential spillover effects from the intervention, particularly in the nudge treatment group.[8] We sampled one neighbour per household, resulting in 998 closest neighbours.

Cyclists and their corresponding households were randomly allocated to three comparison groups: a simple treatment group receiving the video intervention and access to the buyback centre; a nudge treatment group one receiving the same intervention plus the thermometer incentive device; and a pure control group receiving no intervention. Randomisation was stratified within blocks of three cyclists, constructed by sorting cyclists within stops by their living neighbourhood and the number of days per week working as a cyclist.[9] The 554 cyclists in the sample were allocated into the simple treatment (184), the nudge treatment (185) and to pure control (185).

3.3 Measurement and Data

3.3.1 Data sources and timeline

The analysis combines survey data from households and cyclists with administrative records from the municipal buyback centre. Appendix Figure C4 presents the full study timeline. Baseline data were collected from cyclists in June 2025 and from households in July 2025, prior to treatment implementation. A midline survey of households and cyclists was conducted in October 2025. At midline, I also surveyed neighbouring households to measure spatial spillovers. A final survey of cyclists, treated households, and neighbouring households will be conducted in February/March 2026.

Administrative records from the buyback centre provide transaction-level data on all deliveries of recyclable materials, including quantities and cyclist identifiers. These records allow precise measurement of service uptake and labour supply responses.

[8] See Section 3.1 for a detailed description of the intervention groups.
[9] Some strata have only two cyclists because we only sampled eight cyclists.

During the final survey wave, I will implement four incentivised behavioural exercises to measure pro-social preferences, private valuation of the service, political support for municipal provision, and knowledge acquisition.

3.3.2 Survey measures

Survey instruments measure four outcome categories. First, recycling behaviour and disposal practices, including learning, self-reported separation, frequency of collection, burning and dumping practices, and time devoted to waste management.

Second, perceptions of service reliability and governance, including satisfaction with municipal waste management, perceived responsiveness, and trust in the municipality.

Third, labour market and consumption outcomes for cyclists, including weekly earnings, hours worked, time allocation between passenger transport and waste collection, and income volatility. I will also measure whether contact frequency with households and neighbours has increased.

Fourth, social norms and expectations, including beliefs about neighbours' recycling behaviour and expectations regarding community engagement with the program.

3.3.3 Behavioural measures

To measure community-oriented pro-social behaviour, households participate in an incentivised contribution task. Each household receives a monetary endowment and chooses how much, if any, to allocate to a neighbourhood recycling fund. Contributions are real and earmarked for supporting local recycling activities.

To distinguish intrinsic pro-sociality from social image concerns, contribution visibility is randomised. In the private condition, households are informed that their decision will remain confidential. In the public condition, households are informed that their contribution amount will be disclosed within the neighbourhood. The comparison identifies the extent to which contributions respond to social observability, and whether treatment exposure - specifically, the visible nudge arm - amplifies image-motivated giving.

I elicit private valuation of the recycling service using a Becker–DeGroot–Marschak (BDM) mechanism. Households state their maximum willingness to pay for immediate collection of recyclable waste currently present in their home. Cyclists state their minimum willingness to accept to provide the collection service. A randomly drawn price determines whether the transaction occurs, ensuring incentive compatibility. This exercise yields behavioural measures of household demand and cyclist supply under market-like conditions.

To measure political reward for public service delivery, households are given the opportunity to make a voluntary monetary contribution to the municipal entity responsible for solid waste management. Contributions are framed explicitly as support for sustaining the buyback centre and associated recycling activities. Unlike the community fund described above, this contribution is directed to the municipality and framed as support for continued government provision. This measure captures willingness to financially reward the state for improved service delivery.

Finally, in order to assess learning, households complete an incentivised sorting task. Enumerators present a sequence of cards displaying common waste items. Participants are asked to sort each item into either a recyclable or non-recyclable bin. Correct classifications are rewarded. This behavioural task provides a direct measure of knowledge acquisition regarding recycling categories, complementing survey-based measures of awareness.

3.3.4 Measuring Sensitive Behaviours

Self-reports of environmentally harmful practices may suffer from social desirability bias. To address this concern, I implement a list experiment.

Households are randomly assigned to a direct or veiled response group. The direct group is shown three non-sensitive behaviours and reports how many (not which) they engage in. The veiled group is shown the same three behaviours plus one sensitive behaviour. Sensitive behaviours include burning waste, dumping waste on the street, and dumping waste into drainage canals. The difference in average reported counts identifies the prevalence of sensitive practices while preserving respondent anonymity.

4 Estimation strategy

I estimate treatment effects of the simple and nudge treatments using the following linear regression:

$$Y_{sci} = \alpha + \beta_1 T1_c + \beta_2 T2_c + \lambda_s + \omega \mathbf{Z}_c + \gamma \mathbf{X}_i + \epsilon_{sci} \tag{1}$$

where Y_{sci} is an outcome variable for stratum s, cyclist c, and individual i, $T1_c$ and $T2_c$ are indicator variables for an individual or cyclist assigned to simple or nudge treatment, respectively, λ_s are strata fixed effects, $\mathbf{Z}_c$ is a vector of cyclist characteristics, and $\mathbf{X}_i$ is a set of household characteristics. ϵ_{sci} is an individual-specific error term. When baseline data are available, I employ an ANCOVA specification by including the dependent variable at baseline as a control variable. controlling for the baseline outcome when available. Standard errors are robust for both individual and cyclist specifications.

4.1 Hypothesis

The project is designed to evaluate the impact of providing households with information on recycling, combined with repurposing bicycle taxi drivers as waste collectors. The main hypotheses guiding this study are as follows:

Hypothesis 1: Household separation of recyclable waste

The intervention induces households to separate recyclable waste. I expect that households comply with the intervention by placing recyclables in a separate bag, as suggested in the video. This should lead to reductions in disposal in the common bin and lower rates of waste burning.

Hypothesis 2: Increased household contact with cyclists

Households increase contact with their assigned cyclists for waste collection. I anticipate that households will use their everyday cyclist more frequently, primarily for the new purpose of waste collection. Spillover effects to other forms of contact with cyclists are also possible.

Hypothesis 3: Increased earnings for cyclists

Cyclists augment their weekly earnings by incorporating waste collection as a complementary

source of income alongside their regular taxi service. I expect that earnings from taxi driving remain stable initially, while revenues from waste collection increase. As households begin sharing the intervention content with neighbours, some substitution may occur, altering the demand for cyclist services across households.

Hypothesis 4: Increased household satisfaction with municipal waste management

Framing the intervention as a municipal policy is expected to increase household satisfaction with solid waste management. I anticipate that households will recognise and positively evaluate the efforts made by the local government to improve waste services.

Hypothesis 5: Spillover effects to neighbouring households

Neighbours of treated households may also engage in recycling behaviour and contact cyclists for collection. As households share the video content and the contact information of their cyclists, neighbouring households are expected to begin separating recyclables and utilising the cyclist service.

Hypothesis 6: Enhanced engagement under the nudge treatment

Households in the nudge treatment arm, which includes a conspicuous thermometer poster, are expected to demonstrate higher engagement than those in the simple treatment. I anticipate more frequent contact with cyclists, larger volumes of waste delivered, and increased sharing of information with neighbours. These visual and social cues are predicted to amplify spillover effects within the community.

5 Results

5.1 Descriptive statistics

Appendix Section B reports baseline characteristics for the cyclist and household samples. Cyclists in the control group are on average 28 years old and all male.[10] The vast majority originate from Zambézia (98 percent), although only 19 percent are from Quelimane itself.[11] Educational attainment is low: 75 percent have completed primary school and only 17 percent have completed

[10] To date, there is only one known case of a woman working as a bicycle taxi driver in Quelimane.

[11] Bicycle taxi driving is typically undertaken by recent rural migrants.

secondary school. Seventy per cent are married or cohabiting. Their average weekly income is 760.70 meticais (US $11.9).

Cyclists report frequent client interaction. Seventy-four percent state that they enjoy speaking with clients during trips, and they report interacting regularly with an average of 1.3 clients. They work approximately six days per week for around ten hours per day. These statistics are summarised in Table B1.

Appendix Table B2 presents baseline characteristics for the household sample. Household respondents are slightly older than cyclists, with a mean age of 29. I observe minor imbalances across treatment arms: respondents in the simple-treatment group are, on average, 1.6 years older. Fifty-three percent of respondents are male. Educational attainment is markedly higher than among cyclists: 28 percent have completed primary school and 68 percent have completed secondary school. Households assigned to the simple treatment appear marginally more educated, with a 9 percentage-point shift from primary to secondary completion relative to the control group.

Marriage rates are lower among households: 48 percent are married or cohabiting, and households in the simple-treatment group are roughly 10 percentage points more likely to be married. Income levels are substantially higher than those of cyclists: the control group reports an average weekly income of 1,509.44 meticais (US $23.62).

Self-reported waste practices also differ notably across domains. Seventeen per cent of households report burning waste, and 61 percent report having some form of waste collection service near their home. Only 14 per cent report separating waste at baseline, with a small imbalance towards the simple-treatment group. Awareness of recycling is high: 92 percent of households correctly describe what recycling entails.

In all empirical specifications, I control for baseline characteristics exhibiting imbalance.[12]

[12]These imbalances arise because the household baseline survey was administered contemporaneously with the first round of the intervention (see Section 3.2). Household characteristics therefore could not be used to stratify or adjust the allocation of cyclists to treatment. Because the households were sampled prior to the onset of treatment activities, these differences are unlikely to be a consequence of treatment assignment.

5.2 Treatment adherence

I begin by examining treatment adherence. Figure 1 reports outcomes related to programme awareness. Households and cyclists were asked whether they had heard of the programme "ReCycling with Quelimane" and whether they believed they had participated in it. Conditional on reporting participation, respondents were asked an open-ended question about how they considered themselves to have participated. The figure codes whether respondents mentioned being interviewed, having watched the videos, having received a thermometer poster, and having gathered (households) or collected (cyclists) recyclable waste.

I find very limited effects on programme awareness for both households and cyclists. This result is unsurprising given the high baseline means in the control group (96.7% and 96.2% for households and cyclists, respectively)[13], as programme participants are mechanically familiar with the programme name. Control-group means are also high (88% for households and 90% for cyclists)[14] for self-reported programme participation. Somewhat unusually, the nudge treatment induces large and statistically significant increases in perceived participation: 23 percentage points among households and 18 percentage points among cyclists, both significantly larger than the corresponding effects of the simple treatment. 4

When respondents describe why they believe they participated, households in both treatment groups are slightly less likely to cite the baseline interview (–2 and –6 percentage points). Cyclists show similar reductions (–2 and –4 percentage points). By contrast, households in the simple and nudge treatments are more likely to report having watched the videos (by 7.5 and 9 percentage points), and cyclists similarly report increases of 8 and 9 percentage points. These effects are significant at the 1% level. Only households in the nudge treatment report receiving the thermometer (9%, 1% significance), consistent with the design. Finally, 24% of households in the simple treatment and 59% in the nudge treatment mention having gathered recyclable waste; among cyclists, 34% (simple) and 64% (nudge) report having collected recyclables from households. These effects are significant at the 1% level and suggest meaningful behavioural

[13]See Appendix Tables F3 and F4 for the table version of the Figure 1.
[14]See Appendix Tables F3 and F4 for the table version of the Figure 1.

engagement.

5.3 Self-reported household waste practices

Table 1 presents treatment effects on household-level waste-management behaviours. Columns (1)–(3) report disposal methods; column (4) indicates whether households separate any waste; conditional on separation, columns (5) and (6) document subsequent disposal of separated waste. Column (7) measures whether respondents correctly define recycling, and column (8) provides a standardised index of correctly classified recyclable items, normalised using the control-group mean and standard deviation. Both treatments generate sizeable changes in self-reported waste practices. First, 37% of treated households report contacting their regular cyclist for waste collection. Both interventions increase the likelihood of waste separation, though the magnitude differs considerably: the nudge treatment raises separation by 43 percentage points, compared with 12 percentage points in the simple treatment (both significant at the 1% level). Conditional on separating waste, both treatment arms reduce the likelihood of depositing recyclable materials in the common bin (by 14.5 and 13 percentage points) and substantially increase the likelihood of requesting cyclist collection (by 64 and 70 percentage points). General familiarity with the concept of recycling is already high, but both treatments increase correct identification of recyclable items by 0.3 standard deviations.

5.4 Engagement with the buyback centre

Figures 2 to 5 present objective measures of engagement with the buyback centre. Table 2 complements these figures with survey data from cyclists. Figure 2 shows the total waste delivered at the centre (in kilograms) by operational week for each treatment. Figure 3 reports the average weight delivered per visit, by treatment. Figure 4 depicts the number of visits per cyclist, and Figure 5 shows the mean payment received per visit. Columns (1)–(3) of Table 2 report counts of cyclist deliveries; column (4) indicates whether cyclists report household-initiated collection requests; columns (5) and (6) record whether households appear in centre records and the number of entries; and column (7) reports the mean kilograms delivered per entry.

Over the 21-week follow-up period, cyclists in the simple and nudge treatments made approximately 2.2 and 3 deliveries, respectively, with average delivery weights of around 3.5 kg and 3 kg. Differences in both delivery frequency and weight are statistically significant. Payments averaged 30 MTS (approximately US$0.47) per delivery, roughly equivalent to two to three taxi trips.

With respect to household engagement, 52% of cyclists in the simple treatment and 54% in the nudge treatment reported being contacted for waste collection. Administrative records indicate that 73% (simple) and 70% (nudge) of households had at least one recorded delivery, with an average of 1.5 and 1.7 deliveries among those with non-zero activity. Households in the simple treatment accumulated roughly 6.4kg of waste before requesting collection, compared with 5.9kg under the nudge treatment. These differences are not statistically significant, though they suggest more frequent but smaller collection events in the nudge arm, consistent with the intended "conspicuous" nudge. All other effects are statistically significant at the 1% level.

5.5 Cyclists' labour supply and earnings

Table 3 examines whether the intervention affects cyclists' labour allocation. Column (1) records days worked per week as a taxi driver. Columns (2) and (3) capture, for the previous 24 hours, hours spent taxi driving and collecting waste. Columns (4) and (5) report self-reported weekly earnings from taxi driving and from waste collection, and column (6) aggregates total reported weekly earnings. The intervention induces a modest reduction in days worked as a taxi driver (significant at the 5% level), concentrated in the simple treatment. Reductions in hours spent taxi driving are directionally similar but not statistically significant. Cyclists report spending approximately five minutes per day collecting recyclable waste, significant at the 5% level in the simple treatment and at the 10% level in the nudge treatment. There is no detectable effect on taxi-driving earnings. By contrast, waste-collection earnings rise by 67 MTS (US $1.05) (simple) and 79 MTS (US $1.24) (nudge), both significant at the 1% level. These increases yield a modest rise in total weekly earnings—approximately 45 MTS—driven by the simple treatment (10% significance).

5.6 Satisfaction

Table 4 examines subjective perceptions of waste management. Columns (1) and (2) capture the prevalence of bad smells and accumulated waste in respondents' neighbourhoods; columns (3) and (4) measure whether households and cyclists believe that waste collection occurs at an appropriate frequency. Columns (5) to (8) present treatment effects on perceived municipal government performance across job creation, and solid-waste management. Household responses are shown in odd-numbered columns; cyclists' responses in even-numbered columns.

The intervention does not meaningfully shift perceptions of neighbourhood cleanliness or odour. Reports of frequent bad smells (3.6%) and accumulated waste (18.5%) are low across all groups. Perceptions of the adequacy of collection frequency show no systematic changes, apart from a small increase among cyclists in the simple treatment (10% significance).

Moving to municipal performance, households in the simple treatment exhibit a 4–percentage-point increase in approval of job-creation performance (5% significance), though this effect is not observed among cyclists. The most consistent pattern arises for solid-waste management: approval rises by 6 percentage points in the simple treatment (10% significance) and by 8 percentage points in the nudge treatment (1% significance). Cyclists' approval also increases by 11 percentage points (5% significance), again driven primarily by the simple treatment.

6 Discussion

This study examines whether low-cost institutional arrangements can overcome coordination failures in last-mile public service provision by jointly activating household behaviour and informal labour supply. Despite the empirical application to municipal solid waste, the underlying mechanism described here is more general. In the short run, the evidence is encouraging. Across both treatment arms, approximately seventy percent of treated households separated recyclable waste at least once during the four-month intervention period, and more than forty percent did so repeatedly. These patterns suggest that, when credible and easily accessible collection channels exist, households are willing to change behaviour even in the absence of strong intrinsic

environmental preferences.

The results further indicate that social visibility affects the intensity and organisation of engagement without necessarily increasing the output. Households exposed to the conspicuous signalling device request collection more frequently but deliver smaller quantities of waste per pickup. While this pattern is consistent with heightened salience or monitoring on the household side, it also has implications for collectors' returns. Cyclists in the simple treatment experience a significant increase in weekly earnings from waste collection, whereas earnings gains in the nudge treatment are smaller and not statistically significant in the short run. This divergence suggests that more frequent, lower-volume pickups may raise opportunity costs for cyclists by displacing passenger trips, thereby dampening net income gains. The finding highlights a potential trade-off in the design of behavioural incentives: interventions that successfully increase participation and visibility may also alter the organisation of activity in ways that reduce efficiency for service providers. Whether these patterns persist or adjust over time as households and cyclists learn to coordinate remains an open question that the endline survey is designed to address.

A central implication of the findings is that the recycling system in Quelimane appears to be characterised by a low-level equilibrium. When households do not separate waste, collection is unprofitable. When collection services are absent, separation yields no private returns. The intervention seeks to relax both constraints simultaneously by increasing household supply through information and increasing demand through the introduction of a buyback centre supported by an informal collection network. The nudge treatment is designed to move the system towards a higher equilibrium by shaping social perceptions and reinforcing expectations of participation. If beliefs about others' behaviour adjust accordingly, these complementarities may stabilise higher participation even after direct programme support is withdrawn.

While the empirical application focuses on recycling, the mechanism studied here is not sector-specific. The intervention operates by activating latent household demand and repurposing underutilised informal labour in a setting characterised by limited municipal capacity and high last-mile delivery costs. Similar conditions arise in a range of urban services, including wa-

ter delivery, sanitation maintenance, drainage clearing, and community health outreach. In such contexts, existing informal workers often possess local knowledge, trust relationships, and idle capacity, but lack institutional channels that connect them to households in a coordinated way. Repurposing these workers may therefore offer a scalable complement to formal public provision, particularly where fiscal constraints limit the feasibility of large infrastructure investments.

The next stage of the project focuses on testing key implications of this mechanism. The final intervention round introduced a video emphasising collective action and encouraging households to mobilise neighbours. Because neighbours of sampled households were enrolled during the midline survey, their outcomes will be measured alongside those of treated households in the endline survey. The analysis will assess whether untreated neighbours increase waste separation or collection requests when residing near treated households, and will examine the channels through which any spillovers operate. Three mechanisms are of particular interest: interpersonal knowledge transmission, shifts in perceived social norms, and visible cues that signal participation. Understanding whether light-touch interventions can generate community-wide effects without extensive direct outreach is central to assessing scalability in fiscally constrained environments.

A second dimension concerns neighbourhood-level externalities. Building on the literature documenting the social costs of environmental externalities in low-income settings, including Jayachandran et al. (2019), the project will assess whether household-level behavioural change translates into improvements in local environmental conditions. Photographic audits conducted around participating households will be used to measure changes in neighbourhood cleanliness, complemented by survey-based indicators of perceived environmental quality and self-reported health outcomes. Establishing whether private behavioural responses generate broader public benefits is essential for evaluating the social returns to the intervention.

A third question relates to persistence. The final survey, conducted several months after the intervention concludes, will distinguish between short-lived novelty effects and more durable behavioural change. Evidence that households maintain recycling practices after programme withdrawal would be consistent with habit formation or sustained shifts in social norms, and

would strengthen the case for scaling similar institutional arrangements.

The project also aims to clarify the cost structure underpinning the recycling value chain. Site visits to processing facilities will document transportation costs, sorting expenses, and intermediary margins. As these costs are currently absorbed by the partnering agent, understanding their magnitude is essential for evaluating long-run viability and for explaining why a decentralised recycling market has not emerged organically. This analysis will inform a cost-effectiveness assessment that compares programme costs per household served, per kilogram recycled, and per unit of earnings generated for collectors. Such metrics are critical for assessing scalability within existing municipal budget constraints.

Potential threats to validity are addressed directly. Cyclists record the origin of collected waste, and although payments do not depend on these reports, survey checks and direct observations provide cross-validation. Attrition is limited through sustained engagement with households and cyclists. External validity is supported by embedding the intervention within an existing municipal collaboration, which strengthens the relevance of the findings for policy.

Overall, the project advances understanding of how coordination failures in public service provision can be addressed through low-cost institutional design in low-capacity urban settings. By demonstrating how modest behavioural tools can be combined with the repurposing of informal labour networks, the study contributes to broader debates on state capacity, informality, and scalable service delivery. While the empirical focus is recycling, the insights extend to a wider class of urban services where formal provision remains limited and collective action problems persist.

References

Ashraf, N., Bandiera, O., & Jack, K. (2012). No margin, no mission?: a field experiment on incentives for pro-social tasks.

Ashraf, N., Berry, J., & Shapiro, J. M. (2010). Can higher prices stimulate product use? evidence from a field experiment in zambia. *American Economic Review*, *100*(5), 2383–2413.

Banares-Sanchez, I., & Wiskamp, Y. (2025). Trading trash on tricycles.

Bank, G. W. (2019). Disaster risk profile: Mozambique (english).

Bryan, G., Glaeser, E., & Tsivanidis, N. (2020). Cities in the developing world. *Annual Review of Economics*, *12*(1), 273–297.

Duflo, E., Kremer, M., & Robinson, J. (2011). Nudging farmers to use fertilizer: Theory and experimental evidence from kenya. *American economic review*, *101*(6), 2350–2390.

Guiteras, R., Levinsohn, J., & Mobarak, A. M. (2015). Encouraging sanitation investment in the developing world: A cluster-randomized trial. *Science*, *348*(6237), 903–906.

Jayachandran, S., Jack, B. K., & Rao, S. (2019). Environmental externalities and free-riding in the household.

Mendiate, C. J., Nkurunziza, A., Soria-Lara, J. A., & Monzon, A. (2022). Exploring users' perceptions of factors influencing cycling route choice: A perspective from quelimane, mozambique. *Transportation planning and technology*, *45*(2), 119–137.

Miguel, E., & Kremer, M. (2004). Worms: identifying impacts on education and health in the presence of treatment externalities. *Econometrica*, *72*(1), 159–217.

Nyqvist, M. B., Guariso, A., Svensson, J., & Yanagizawa-Drott, D. (2019). Reducing child mortality in the last mile: experimental evidence on community health promoters in uganda. *American Economic Journal: Applied Economics*, *11*(3), 155–192.

UN-Habitat. (2022). *Quelimane, mozambique: Green cities profile.* Retrieved from https://unhabitat.org/sites/default/files/2022/07/quelimane_en.pdf (Accessed: 24 November 2025)

UNEP. (2024). Global waste management outlook 2024: Beyond an age of waste: Turning rubbish into a resource.

United Nations, D. o. E., & Social Affairs, P. D. (2025). *World urbanization prospects 2025: Summary of results* (Report Nos. Statistical Papers – Ser. A, Population and Vital Statistics Report). Retrieved from https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2025_wup2025_summary_of_results.pdf doi: 10.18356/9789211576788

Villa, F., Vinti, G., & Vaccari, M. (2022). Appropriate solid waste management system in quelimane (mozambique): study and design of a small-scale center for plastic sorting with wastewater treatment. *Waste disposal & sustainable energy*, *4*(1), 49–62.

World Bank. (2025, October). *Mozambique poverty & equity brief.* https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099723104212527558. (Poverty & Equity Brief, World Bank)

7 Figures

Figure 1: Did you participate?

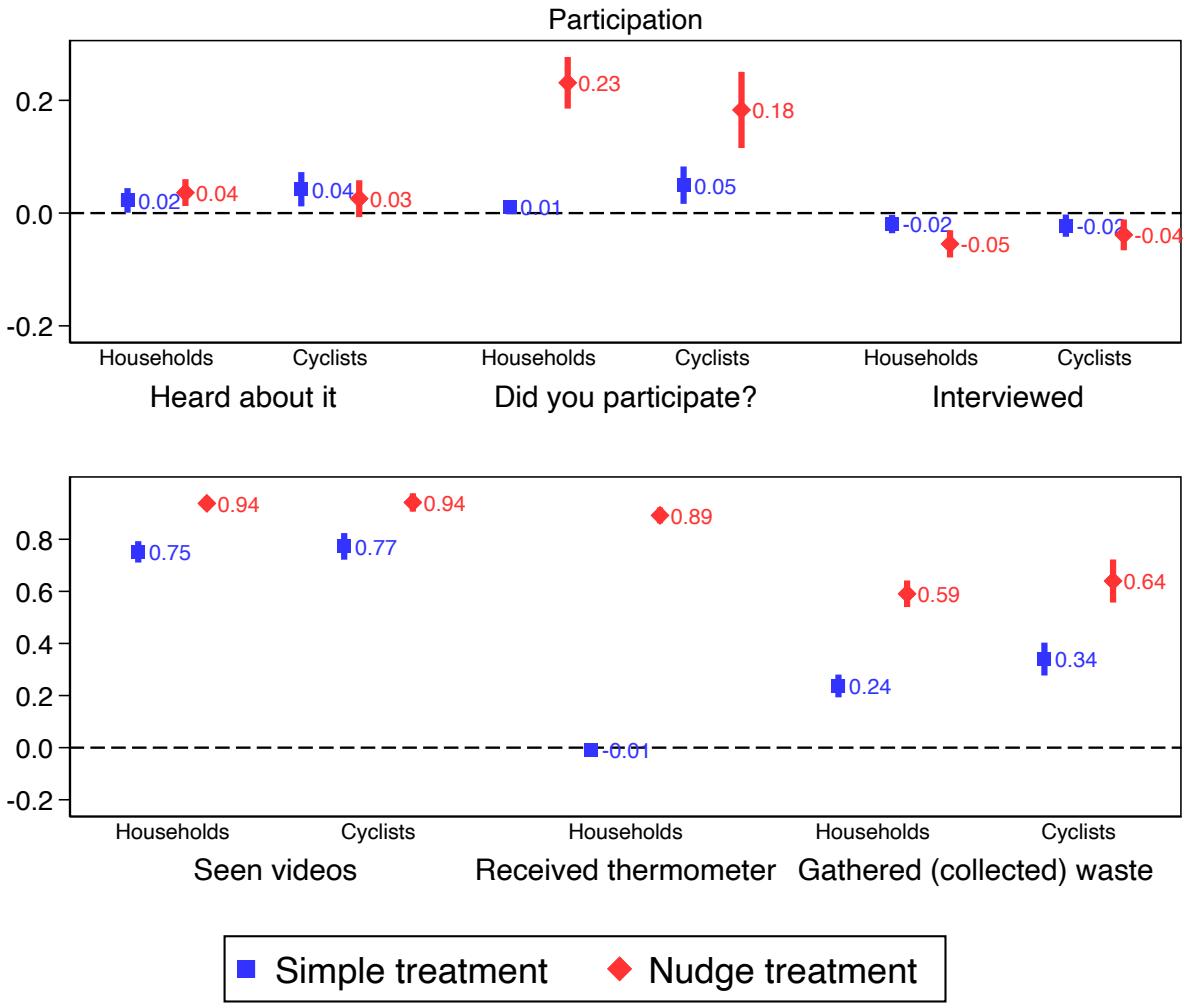


Figure 2: Deliveries by treatment

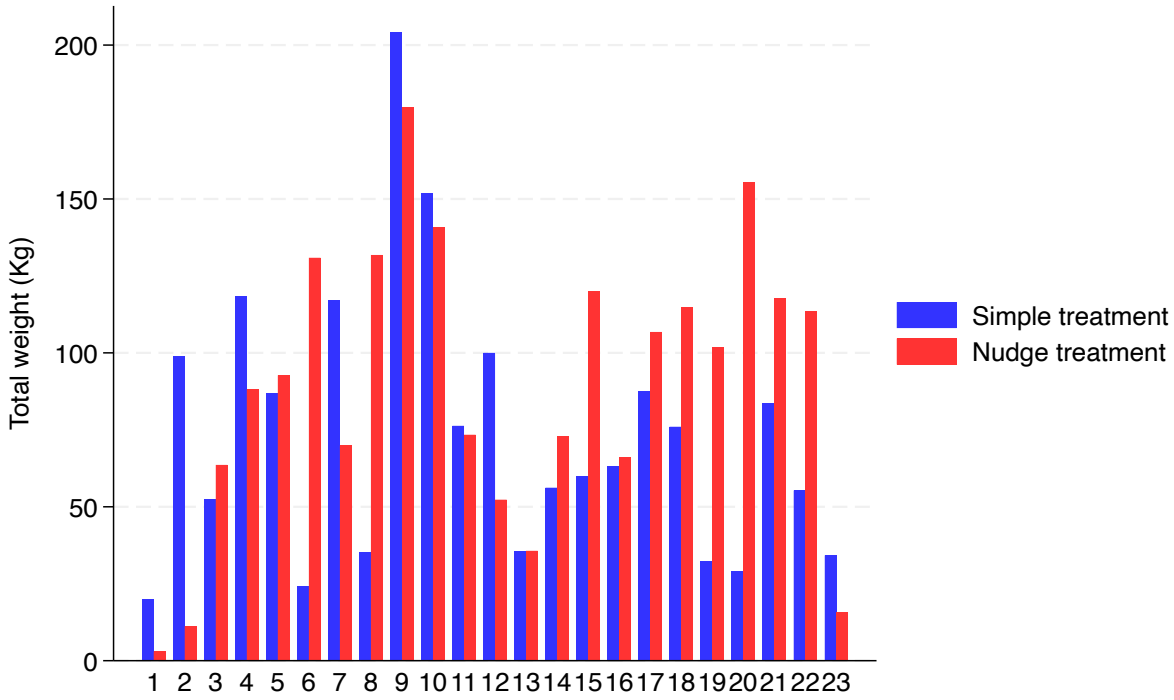


Figure 3: Delivery distribution by treatment

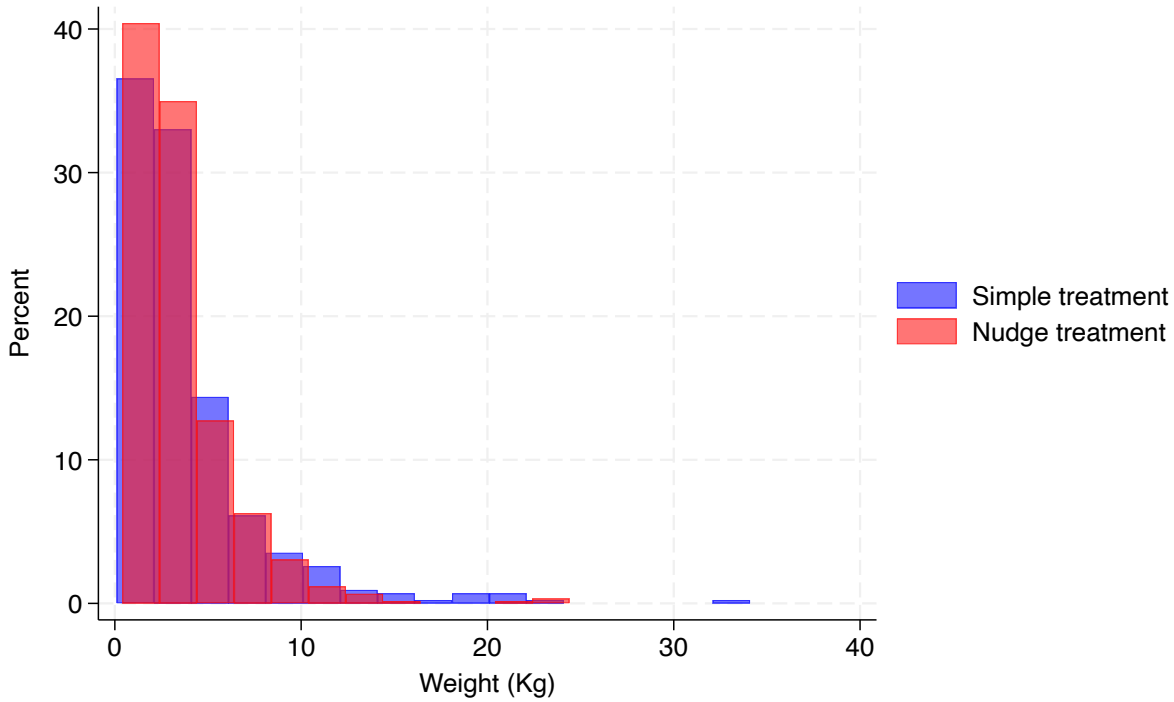


Figure 4: # deliveries at BBC - cyclist

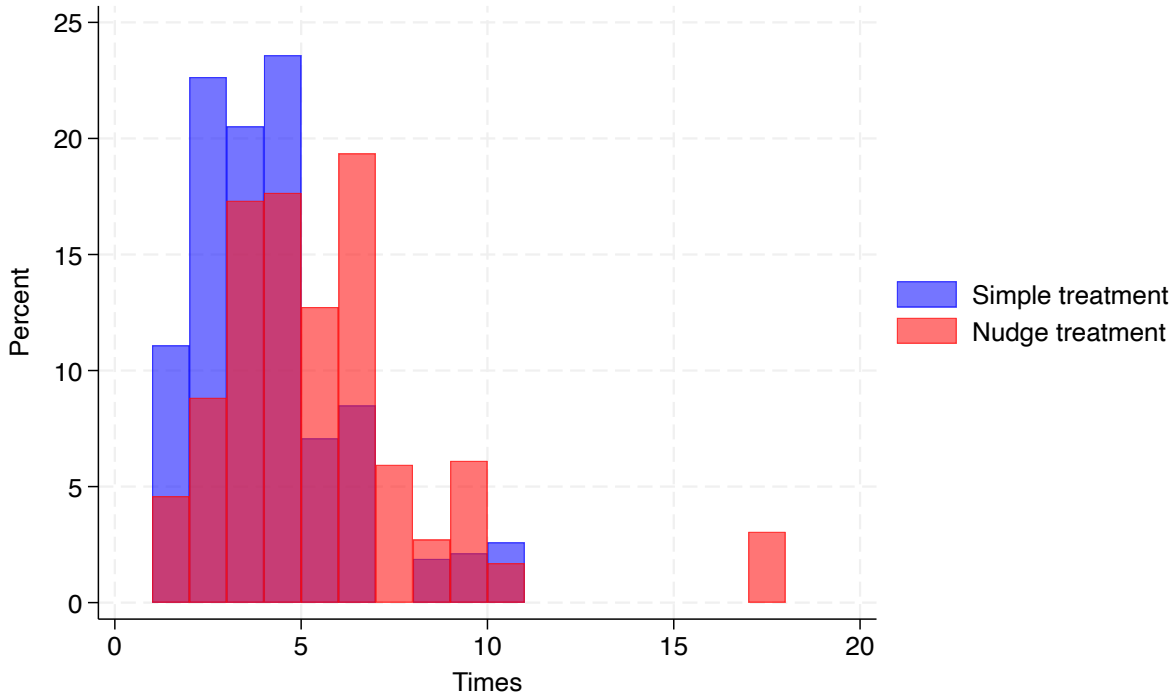
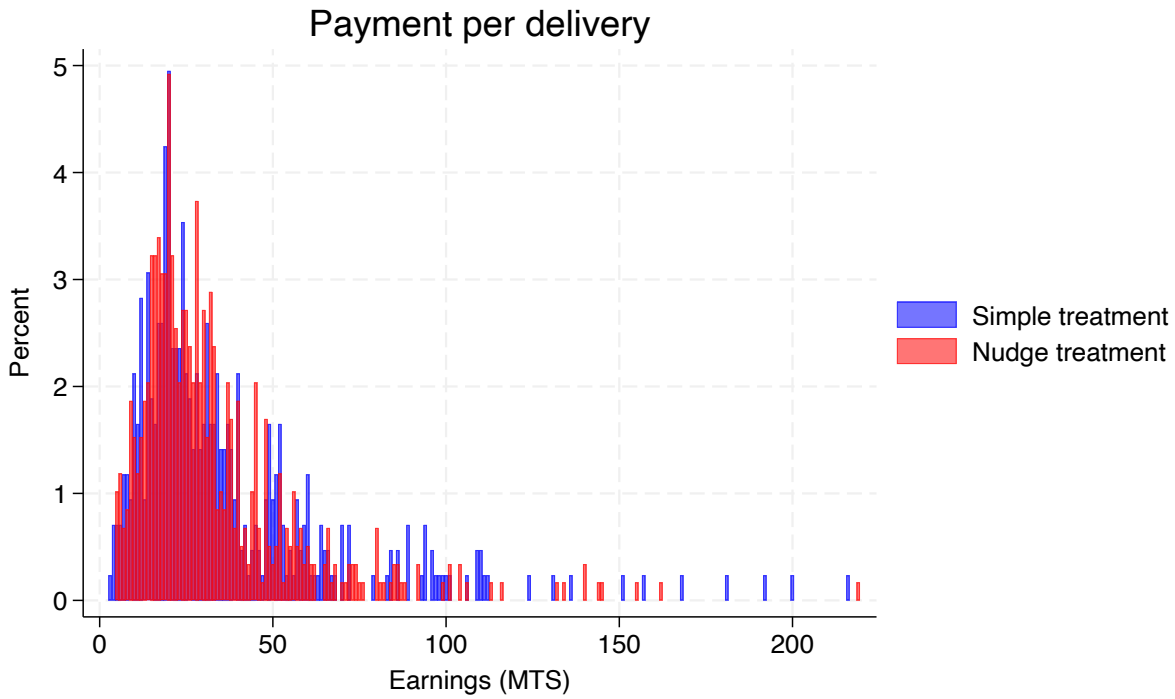


Figure 5: Mean payments



8 Tables

Table 1: Self-reported practices

	Residuals destination			Do you separate any waste?	Separated waste destination		Knows recycling	Correct answers (STD)
	Burned	Own landfill	Contacts cyclist f/ pickup		Dumps in common bin	Calls cyclist		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(T1) Simple treatment	-0.021	-0.026	0.368***	0.115***	-0.147***	0.628***	-0.004	0.326***
	(0.029)	(0.039)	(0.029)	(0.025)	(0.036)	(0.032)	(0.004)	(0.076)
(T2) Nudge treatment	-0.075*	-0.002	0.369***	0.428***	-0.134***	0.701***	-0.001	0.301***
	(0.039)	(0.036)	(0.028)	(0.035)	(0.036)	(0.036)	(0.001)	(0.065)
Observations	998	998	998	998	818	818	997	998
R^2	0.396	0.423	0.447	0.454	0.627	0.555	0.050	0.525
Mean (control group)	0.296	0.640	0.000	0.668	0.669	0.000	1.000	-0.166
T1 = T2 (p-value)	0.250	0.638	0.974	0.000	0.804	0.126	0.341	0.792
Lagged dep. value	Yes	Yes	No	Yes	No	No	Yes	No

Note. Estimates based on OLS regressions. All specifications include individual and cyclist controls, and strata fixed effects. Standard errors, reported in parentheses, are clustered at the cyclist level. *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Engagement with buyback centre

	Cyclist			Client			
	Mean times delivered	Mean quantity delivered	Mean payment p/ delivery (BBC)	Cyclist reports being contacted	Any record at BBC	# times recorded	Total waste recorded
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(T1) Simple treatment	2.154***	3.516***	31.830***	0.517***	0.725***	1.542***	6.377***
	(0.137)	(0.220)	(1.854)	(0.032)	(0.028)	(0.098)	(0.518)
(T2) Nudge treatment	3.029***	3.059***	29.040***	0.540***	0.699***	1.695***	5.966***
	(0.191)	(0.169)	(1.561)	(0.028)	(0.027)	(0.100)	(0.446)
Observations	548	548	548	989	998	998	998
R^2	0.425	0.461	0.452	0.397	0.521	0.356	0.250
Mean (control group)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
T1 = T2 (p-value)	0.000	0.096	0.258	0.566	0.480	0.236	0.534

Note. Estimates based on OLS regressions. All specifications include individual and cyclist controls, and strata fixed effects. Standard errors, reported in parentheses, are clustered at the cyclist level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Cyclists' earnings

	# days p/ week as taxi	# hours p/ day as taxi	# hours p/ day as waste collector	Weekly earnings f/ taxi	Weekly earnings f/ WC	Self-reported weekly income
	(1)	(2)	(3)	(4)	(5)	(6)
(T1) Simple treatment	-0.137**	-0.227	0.074**	17.772	66.828***	43.202*
	(0.060)	(0.275)	(0.031)	(17.391)	(5.647)	(24.337)
(T2) Nudge treatment	-0.091	-0.182	0.042**	-29.584	78.907***	25.355
	(0.084)	(0.259)	(0.021)	(18.330)	(10.354)	(23.104)
Observations	548	548	548	517	517	548
R^2	0.327	0.468	0.283	0.289	0.432	0.231
Mean (control group)	6.154	9.835	0.000	579.549	0.000	686.264
T1 = T2 (p-value)	0.651	0.902	0.403	0.066	0.303	0.597
Lagged dep. value	Yes	Yes	No	No	No	No

Note. Estimates based on OLS regressions. All specifications include individual controls, and strata fixed effects. Standard errors, reported in parentheses, are clustered at the cyclist level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Satisfaction with waste collection

	Feels bad smells frequently	Sees waste accumulated frequently	People are satisfied with WC		Gov. is creating jobs		Gov. is well managing waste	
			Household	Cyclist	Household	Cyclist	Household	Cyclist
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(T1) Simple treatment	0.006	0.018	0.013	0.053*	0.039**	0.006	0.058**	0.110**
	(0.011)	(0.029)	(0.022)	(0.029)	(0.018)	(0.029)	(0.030)	(0.044)
(T2) Nudge treatment	-0.004	-0.008	0.003	0.025	-0.009	0.015	0.082***	-0.013
	(0.023)	(0.034)	(0.015)	(0.029)	(0.018)	(0.033)	(0.025)	(0.028)
Observations	998	997	984	524	991	533	996	542
R^2	0.153	0.298	0.116	0.156	0.200	0.296	0.483	0.556
Mean (control group)	0.036	0.185	0.037	0.034	0.034	0.051	0.123	0.159
T1 = T2 (p-value)	0.678	0.549	0.700	0.477	0.060	0.844	0.547	0.027
Lagged dep. value	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note. Estimates based on OLS regressions. All specifications include individual and cyclist controls, and strata fixed effects. Standard errors, reported in parentheses, are clustered at the cyclist level. *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX
Supplementary material to
Introducing ReCycling in a Mozambican city

Frederica Mendonça

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A Treatment contents

A.1 Round 1

A.2 Round 2

A.3 Round 3

A.4 The nudge treatment



(a) Initial thermometer



(b) Filled thermometer

Figure A1: Thermometer poster



Figure A2: Banner hung at buyback centre

B Sampling and randomization

Table B1: Balance - cyclists

	Mean control (1)	Any treat (2)	T1 (3)	T2 (4)	p-value (5)	N (6)
Age	28.35	0.05	-0.01	0.10	0.99	554
	[7.12]	(0.67)	(0.79)	(0.75)		
From Zambézia	0.98	0.01	0.01	0.01	0.75	554
	[0.15]	(0.01)	(0.01)	(0.01)		
From Quelimane	0.19	0.04	0.02	0.05	0.49	554
	[0.40]	(0.04)	(0.04)	(0.04)		
Primary schooling	0.75	-0.05	-0.09*	-0.00	0.10	554
	[0.43]	(0.04)	(0.05)	(0.05)		
Secondary education	0.17	0.01	0.04	-0.01	0.48	554
	[0.38]	(0.04)	(0.04)	(0.04)		
Married/cohabiting	0.70	-0.04	-0.04	-0.04	0.68	554
	[0.46]	(0.04)	(0.05)	(0.05)		
Income	760.70	14.92	-2.73	31.80	0.61	554
	[320.68]	(31.74)	(36.68)	(37.70)		
Likes to talk during trips	0.74	-0.01	0.01	-0.04	0.54	554
	[0.44]	(0.04)	(0.05)	(0.05)		
# frequent clients	1.33	0.02	0.00	0.03	0.91	554
	[0.62]	(0.06)	(0.07)	(0.07)		
Days a week as cyclist	6.16	-0.04	-0.09	0.00	0.40	554
	[0.65]	(0.06)	(0.07)	(0.07)		
Hours a day as cyclist	10.43	-0.04	-0.01	-0.06	0.95	554
	[2.06]	(0.19)	(0.20)	(0.21)		



Figure B3: Example of mapped cyclist stop

Table B2: Balance - clients

	Mean control (1)	Any treat (2)	T1 (3)	T2 (4)	p-value (5)	N (6)
Age	29.56	1.30**	1.61**	1.04	0.11	998
	[9.40]	(0.65)	(0.79)	(0.76)		
Male	0.53	-0.00	-0.04	0.03	0.19	998
	[0.50]	(0.04)	(0.04)	(0.04)		
Primary schooling	0.28	-0.06*	-0.09**	-0.04	0.06	998
	[0.45]	(0.03)	(0.04)	(0.03)		
Secondary education	0.68	0.06*	0.06	0.05	0.22	998
	[0.47]	(0.03)	(0.04)	(0.04)		
Married/cohabiting	0.48	0.05	0.11***	0.00	0.01	998
	[0.50]	(0.03)	(0.04)	(0.04)		
Income	1509.44	35.48	-182.46*	216.03*	0.00	998
	[1107.70]	(92.34)	(94.87)	(110.09)		
Burns waste	0.17	0.03	-0.00	0.06*	0.20	998
	[0.38]	(0.03)	(0.03)	(0.03)		
Some collection around living place	0.61	-0.01	0.06	-0.07	0.03	986
	[0.49]	(0.04)	(0.04)	(0.04)		
HH does any separation	0.14	0.05*	0.06*	0.04	0.19	998
	[0.35]	(0.03)	(0.03)	(0.03)		
Heard of recycling	0.92	0.02	-0.02	0.05**	0.00	997
	[0.27]	(0.02)	(0.02)	(0.02)		

C Timeline

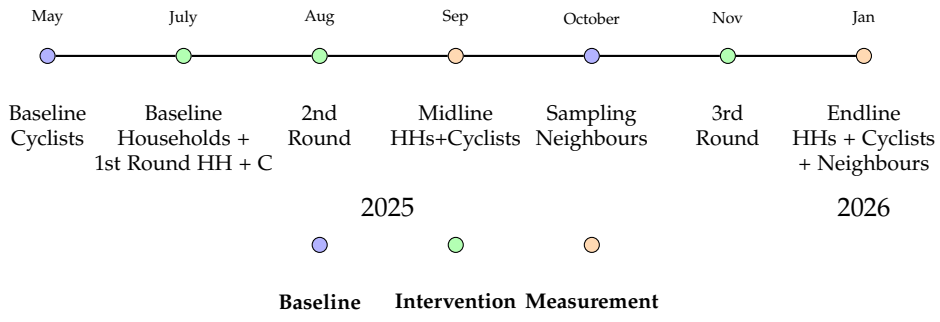


Figure C4: Project timeline

D Measurement

E Outcome variables

F More results

Table F3: Participated in the program

	Heard about the program		Participated		Was interviewed	
	Households (1)	Cyclists (2)	Households (3)	Cyclists (4)	Households (5)	Cyclists (6)
(T1) Simple treatment	0.023*	0.042**	0.011*	0.050**	-0.020**	-0.022*
	(0.013)	(0.018)	(0.006)	(0.020)	(0.010)	(0.012)
(T2) Nudge treatment	0.036**	0.026	0.231***	0.183***	-0.055***	-0.039**
	(0.014)	(0.020)	(0.028)	(0.041)	(0.015)	(0.017)
Observations	998	548	983	540	938	523
R^2	0.078	0.145	0.383	0.330	0.146	0.106
Mean (control group)	0.967	0.962	0.880	0.903	1.000	1.000
T1 = T2 (p-value)	0.502	0.528	0.000	0.002	0.039	0.393

Note. Estimates based on OLS regressions. All specifications include individual controls, and strata fixed effects. Standard errors, reported in parentheses, are clustered at the cyclist level. *** p<0.01, ** p<0.05, * p<0.1.

Table F4: Participated in the program

	Seen the videos		Received thermometer	Gathered/collected waste	
	Households	Cyclists	Households	Households	Cyclists
	(1)	(2)	(3)	(4)	(5)
(T1) Simple treatment	0.752***	0.773***	-0.009	0.237***	0.340***
	(0.025)	(0.031)	(0.007)	(0.027)	(0.038)
(T2) Nudge treatment	0.938***	0.941***	0.892***	0.591***	0.640***
	(0.016)	(0.021)	(0.019)	(0.031)	(0.050)
Observations	938	523	938	938	523
R^2	0.837	0.849	0.863	0.522	0.607
Mean (control group)	0.012	0.006	0.000	0.000	0.000
T1 = T2 (p-value)	0.000	0.000	0.000	0.000	0.000

Note. Estimates based on OLS regressions. All specifications include individual controls, and strata fixed effects. Standard errors, reported in parentheses, are clustered at the cyclist level. *** p<0.01, ** p<0.05, * p<0.1.