Enforcing Payment for Water and Sanitation Services in Nairobi's Slums

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Abstract: Most of the recent focus in the delivery of public utility services has been on last mile connections to water, sewerage and electricity grids. However, the high frequency of nonpayment for services associated with this expansion has created a fiscal crisis for public utilities and has forced utilities to ration services. Public utilities afraid that service disconnections will have political consequences are reluctant to enforce payment with service cutoff. We test this hypothesis using a field experiment in the slums of Nairobi with two interventions intended to improve repayment for water and sewage services: a soft encouragement that informs tenants about landlord's payment delinquency and, second, a hard threat of disconnection for nonpayment with enforcement if landlords do not pay. While we find no effect of the soft encouragement intervention, we find very large effects of the disconnection intervention on repayment. Moreover, there seems to be no effect on landlord and tenant perceptions of utility fairness or quality of service delivery, on community activism, on the relationships of tenants with their landlords, or on child health. To counterbalance the effective increase in utility fees paid, landlords increase their rental income by both renting out additional space in their compounds and by marginally increasing tenant rents. These results suggest that strict enforcement through disconnections increases payment and the financial position of the utility without incurring political costs.

Human Subjects and Study Registration: The study received local and international ethical clearance from Maseno University and Innovations for Poverty Action International Review Board before commencement. The overall design, interventions, primary and secondary outcomes, and power calculations were published in the American Economic Association RCT registry on November 13 2018 at the time of rollout of the interventions and before data analysis (AEARCTR-0003556)

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1. INTRODUCTION

In many cities in low- and middle-income countries, public utility infrastructure such as electricity, water, and sanitation services are stressed. Household connections to water and sanitation infrastructure are especially low with modern sanitation facilities being used by less than 50% of the urban population in poor countries (WaterAid, 2007). In order to rectify this situation, much of the recent policy focus has been on last mile connection costs as a major constraint to service delivery. Significant progress has been made on this front as credit and subsidies are proving to be transformative tools for expanding connections to basic services (Lee et al, 2019; Devoto et al, 2012).

However, just because a household is connected to utility infrastructure does not mean that they pay the fees for the service. In fact, utilities lose an estimated $39 billion of billable water and $96 billion in electricity each year due to non-payment (Liemberger et al, 2019; Northeast Group, 2017). A culture of non-payment for services can lower effective prices below marginal cost, making each new customer a financial liability to the utility. This may ultimately lead to rationing services to existing customers and reluctance to expand services further (Burgess et al, 2020). Water rationing in particular is not only inconvenient, but has negative impacts on health (Galiani et al., 2015; Asraf et al., 2018). This nonpayment problem is exacerbated by weak institutions, where increasing enforcement may be difficult to implement and susceptible to extortion (Ashraf et al. 2016). In fact, politicians may be reluctant to cut services due to nonpayment for fear of losing public support.

In this study we explore possible solutions within the context of a large-scale expansion of water and sewerage service connections to households living in the slums of Nairobi, Kenya. Most households in these slums live in compounds with multiple rented dwellings with a single piped water and sewer connection available to all compound residents. The government invested USD 427 million in water and sewer infrastructure, and then used USD 7 million to finance a combination of subsidies and credit to reduce compound connection costs that successfully expanded connections to near universal levels between 2013 – 2018. However, after three months of being connected, 57% of the customers had yet to make any payment and the share of bills paid continued to fall over time (Figure 1).

In this case, while the subsidies and credit significantly increased water and sanitation coverage, they effectively shifted the financial burden of supplying services onto the utility to the extent that households failed to pay their bills. Service quality subsequently deteriorated. Based on data from a representative panel survey of 587 households from Kayole Soweto, the proportion of compounds that received water from their water point in the past week fell from 95% to 40% between 2014 and 2018.

To address this challenge, we worked with the Nairobi City Water and Sewerage Company (NCWSC) to test two approaches designed to increase payment rates using field

experiments. The first is a face-to-face meeting with tenants to explain the financial status of the water and sewer bill, the consequences for the utility, and discuss what they could do to encourage landlords to make payment. The other intervention serves official disconnection notices to delinquent customers and follows through with disconnections in the case of non-payment.[1]

We find that the disconnection intervention significantly increased both the likelihood of customers making a payment, and the overall amount paid. In contrast, the face-to-face intervention had a precisely estimated null effect. Using data from a survey conducted 9 months after the disconnection intervention, we find that water and sanitation service connections and quality were not meaningfully different between treatment and control compounds despite the disconnections that took place. Moreover, we do not find evidence of negative impacts of the increased enforcement on landlord and tenant perceptions of fairness and quality of service delivery, on community activism, on the relationships of tenants with their landlords, or on child health. To counterbalance the effective increase in utility fees paid, landlords increased their rental income predominantly by renting out additional space in their compounds and by marginally increasing tenant rents. These results suggest that strict enforcement through disconnections increases payment and the financial position of the utility without incurring political costs.

The study provides a unique opportunity to explore and contrast high-stakes enforcement with more typical community engagement approaches to improving compliance. There is a dearth of evidence on high-stakes enforcement, especially when compared to lighter-touch information/engagement interventions. The existing evidence on enforcement is mostly limited to developed country settings, most prominently in the tax evasion literature (e.g. Slemrod et al., 2001; Kleven et al., 2011), and to a lesser extent in environmental protection (e.g. Telle, 2013; Duflo et al., 2018). The small number of studies exploring high-stakes enforcement in developing countries find significant impacts. In Brazil, Bruhn and Mckenzie (2013) randomize inspections and fine firms if they are found to be operating without a business license and that increases business registrations. In Costa Rica, Brockmeyer et al. (2019) find significant increases in tax payments from credible enforcement emails. In Kenya, Bedoya et al. (2020) randomize inspections of health clinics and ultimately close facilities if they are found to be non-compliant with patient safety rules. These inspections successfully increase compliance rates and patient safety. Our findings show that increased high-stakes enforcement is both possible and effective in developing,

[1] While NCWSC has always had the legal authority to disconnect compounds, they rarely used that authority in slums. The rationale for not disconnecting customers was that the failure to pay was based on an inability to pay. While a formal disconnection policy was in place, it was only applied to middle- and high-income neighborhoods and rarely then.

informal settings, while engaging in low-stakes, bottom-up accountability efforts in the same setting are found to have no effect.

2. INTERVENTIONS

To ensure basic information constraints were not to blame for low repayment rates, an initial awareness campaign was rolled out by NCWSC to all customers in the 8 targeted Nairobi slums in August 2018. NCWSC delivered the following activities in sequence: (i) A phone call to the landlord / owner to collect up-to-date contact information, provide basic information on how to read meters and pay bills, and share their latest account balance on record; (ii) an on-site meter reading; and (iii) an SMS to landlords/owners providing the account balance based on the meter reading.

Two additional interventions to encourage payment were rolled out experimentally. The first was an engagement intervention in which compounds in payment arrears received a face-to-face visit from NCWSC informing tenants about the current balance, how payments could be made, and the importance of ensuring the landlord makes payment for the utility to be able to provide quality service and avoid disconnection. NCWSC staff followed a specific script loaded onto a tablet during each visit to ensure uniformity in intervention delivery (see Appendix). This intervention took place during September and October of 2018 after the initial awareness campaign described above.

The second intervention increased enforcement through creditable threats of disconnection for nonpayment. Compounds in payment arrears were given official notification that they had to make payment, or their services would be disconnected[2]. Official communication included in order: (i) a notice posted to the compound door and next to the water point (when possible) warning customers of disconnection if payment is not made by a specified deadline, and providing a contact number for coordinating a payment arrangement or disputing bill; (ii) an SMS providing a second warning; and (iii) a third and final warning provided through a phone call made to landlords alerting them to pay within 48 hours or be disconnected. Compounds that did not make payment after the warnings were then disconnected after the deadline passed. In these cases, reconnection would be at the landlord/owner's expense, and only after paying their outstanding service charges. In practice NCWSC would allow customers to avoid disconnection or reconnect if they made some payment and expressed an interest to be more compliant, even if they were unable to pay the full outstanding balance. The disconnection notices were delivered from 29 October

[2] Disconnection eligibility was determined by the number of months a customer had not paid, and the outstanding balance. This differed slightly by settlement. All customers needed to have an outstanding balance of more than KES 2,500 (USD 25). In addition, customers in Kayole Soweto and Matopeni needed to have missed at least three months of payments, while customers in Mowlem and River Bank needed to have missed at least one month of payment.

to 7 November of 2018, with follow ups and disconnections taking place during November and December of the same year.

3. EXPERIMENTAL DESIGN

All informal settlement customers in Nairobi Water's utility database were first called to confirm contact details and receive the base intervention. Eligibility criteria into the study included: (i) customers were able to be contacted and their contact details could be updated; (ii) their payment accounts were in arrears and (iii) customers did not hold multiple accounts (multiple property owners). All eligible customers then received the basic information intervention and contact details were updated.

Figure 2 describes the experimental design and sample selection. Half of the compounds with tenants were individually randomly assigned to receive the engagement treatment. Starting from the group of 5,091 account customers that completed the landlord phone survey in August 2018, just over 50% of these accounts (2,584) indicated that they had tenants residing in the property. These 2,584 accounts were randomly assigned into a group of 1,292 who received the engagement treatment and an equally sized control. The engagement intervention was successfully implemented in 885 (69%) of the 1,292 accounts assigned to the treatment group. Reasons for non-compliance included not being able to find the property, tenants being unavailable at the time of visit, and incorrect recording of the compound as having tenants when this was not the case.

Figure 3 illustrates how the two-stage randomization was applied for the enforcement intervention. We first listed and mapped eligible compounds into clusters, i.e. living on the same street block. Clusters were then randomly assigned into treatment or control clusters. Within treatment clusters, half of all eligible compounds were randomly assigned to receive disconnection notices. The two-stage randomization design allows us to test for direct and spillover effects associated with the enforcement intervention.

For the enforcement intervention, we started with the same 5,091 accounts used for the engagement intervention and removed two informal settlements (Kibera and Makongeni) because these settlements are characterized by multi-story apartment blocks where individual disconnections pose a technical challenge. The remaining sample of 3,253 accounts from 4 settlements were then clustered by street using GPS and address data. This generated 147 distinct street clusters. We then randomized 73 clusters consisting of 1,584 accounts into the treatment group, while the remaining 74 clusters (1,669 accounts) were left as controls. There were 649 accounts eligible for disconnection in the disconnection treatment clusters and 674 compounds eligible in the control clusters. Within disconnection clusters, the individual accounts were randomized to either receive disconnection notices (327) or not (322). The disconnection notices were delivered to 299 compounds (91.4%).

In the remaining cases (28), compounds were found to have already disconnected their services in which case no notice was delivered. From the 299 compounds that received notices, 97 were eventually disconnected for failure to pay.

The two interventions were implemented sequentially. The engagement intervention was implemented in September and October, while the enforcement intervention was implemented in November and December.

4. Empirical Strategy

The engagement intervention was individually randomized, and we estimate the intention to treat (ITT) effect using the sample analog of:

$$ITT = E(Y_{it} \,|T_i = 1) \; - E(Y_{it} \,|T_i = 0) \qquad [1]$$

where Y_{it} is the outcome of interest for compound i at month $t\{t=1,9\}$ after the intervention was completed; and T_i is equal to 1 if compound i is assigned to receive treatment and 0 otherwise. Note that treatment status does not change over time. We condition the analysis on settlement fixed effects and estimate robust standard errors.

The enforcement intervention was rolled out as a clustered randomization. In this case we estimate the ITT using the sample analog of:

$$ITT = E\big(Y_{ijt} \,\big|T_{ij} = 1, C_j = 1\big) \; - E\big(Y_{ijt} \,\big|C_j = 0\big) \qquad [2]$$

where C_j is the cluster j indicator which is equal to 1 if the cluster was assigned to treatment and 0 otherwise. The sample in both treatment and control clusters includes only disconnection-eligible compounds.

Finally, to measure spillovers to the non-treated units (SNT) for the enforcement intervention, we estimate the sample analog of:

$$SNT = E\big(Y_{ijt} \,\big|T_{ij} = 0, C_j = 1\big) \; - E\big(Y_{ijt} \,\big|C_j = 0\big) \qquad [3]$$

In the estimation of the sample analogs of equations [2] and [3] we condition on settlement fixed effects given that the randomization was stratified at that level. Standard errors are clustered at the street level, which was the level of cluster randomization.

5. DATA

We use high-frequency administrative billing and payment data from NCWSC to measure our primary repayment outcomes. Jisomee Mita is a web-based ICT platform that enabled customers to use a mobile phone to self-read meters, receive and pay water bills, and check their current balance at any time. We use billing data from Jisomee Mita, which contains water consumption, invoice amounts, payment history, current balance, and contact information of the customer for merging with survey and treatment assignment data. When payments or balance checks are submitted, the Jisomee Mita data are updated automatically. However, monthly standing charges are applied to each account independent of whether a customer made a payment or billing enquiry which means that each customer's balance is updated at least once a month.

The billing data is complemented with tenant and landlord survey data. A short baseline listing phone survey of landlords was conducted in August 2018. This captured ownership and water/sanitation connection status, landlord residency and number of paying tenants in the compound.

From August to October 2019 a follow up survey of both landlords and tenants included in the enforcement intervention captured data on rent, service-level satisfaction, political engagement, and general demographic measures of one randomly selected tenant and the corresponding landlord from each compound in the sample.

We use NCWSC billing data to generate our primary outcomes. This includes: (1) the proportion of customers making a payment for water/sewer charges since the intervention, (2) the total amount (in Kenyan Shillings) paid by customers' post-intervention and (3) the proportion of outstanding service charges paid post-intervention. The data spans the entire period from when the first customers were connected in 2014 up to nine months after the interventions were implemented (September 2019).

For our secondary outcomes we rely on the follow up tenant and landlord survey which captures a range of outcomes to assess the possible welfare effects of the enforcement intervention. To reduce the potential for false positives from multiple hypothesis testing, we combine like outcomes into weighted, standardized indices following Anderson (2008). We generate the following indices: (1) *Tenant-Landlord relationship*: For the landlord index this includes landlord perceptions on whether tenants complain about the water and sewer facilities or about the general conditions of the compound, and whether tenants keep the compound in a good condition. For tenants, we simply ask how they would rate their

relationship with the landlord from 1 (very poor) to 10 (excellent). (2) *Perception of service quality*: Tenant / Landlord agrees or strongly agrees that they are satisfied with NCWSC services, NCWSC services improve people's lives and provides clear communication, the government is trying to improve their lives, and (reverse coded) the government is not interested in helping the community. (3) *Perception of service fairness*: Tenant / Landlord agrees or strongly agrees that NCWSC enforcement mechanisms are fair and bills are accurate and fair. (4) *Activism*: Whether the compound has a committee, tenants have reached out to community leaders, participated in community meetings, or are members of community committees. (5) *Child health*: Oldest child under 5 has had diarrhea or a fever in the past 2 weeks. In addition to these indices, we measure rent and rental income, migration and general socioeconomic measures of landlords and tenants to explore possible effects on rent and associated gentrification.

6. Results

a. Baseline Balance

We present descriptive statistics and baseline comparisons between treatment and control groups for our primary outcome measures using the administrative payment data on 6 August 2018 and 28 October 2018 to coincide with the download dates for the data sets used for the randomized assignment of the *engagement* and *enforcement* interventions respectively. Table 1 presents comparisons for each group and we find balance on the majority of key measures covered.[3]

b. Repayment Behavior

We find a precisely estimated null effect of the engagement intervention for all primary repayment outcomes and time periods measured

Table 2). The control group payments increase steadily over the nine-month period from 30.1% of customers having made payments one month after the intervention to 55.8% having made at least one payment by nine months. However, compounds being exposed to the engagement intervention track almost the exact same trajectory as their control comparison. The total amount paid and proportion of balance paid off are similarly indistinguishable across treatment and control group.

In contrast to the engagement intervention, we find a sharp increase in repayment behavior among compounds exposed to the disconnection notices. The likelihood of

[3] Regressions used to estimate the treatment effects reported below are replicated including variables that are not balanced at as covariates and do not change the sign or significance of any of the results presented in the paper.

repayment within one month increases by 30 percentage points from 11 percentage points. This difference in payment likelihood sustains through the nine-month period, although with a slight decline relative to the control group. A similar pattern is found for the total payments after one month, which increases by KES 878 (USD 8.8; p-value < 0.0005) from a base of KES 502 (USD 5.02). After this sharp initial increase, the difference remains roughly constant between treatment and control groups while both increase over time. Treatment compounds have paid off 11.3 percentage points more than control compounds after the first month of intervention. Control compounds begin to catch up gradually over the nine months, closing this gap to 7.8 percentage points. Results are presented in

Table 3.

Exploiting the full time series data available from the daily payment information extracted from the NCWSC billing database presents a more nuanced set of result through visual inspection. Figure 4 visually describes the dynamics for the proportion of people making a payment at least once over time by plotting the cumulative distribution functions. We begin at 7 November 2018, immediately after the disconnection notices were delivered. The visual assessment confirms the results found in the more formal regression analysis. We find very similar trajectories of control and treatment customers provided with the engagement treatment. We also find clear evidence of a sharp jump in payments in the first months of the enforcement intervention which dissipates over time and follows a similar trajectory to the control group thereafter.

Figure 5 presents the same comparisons as shown in Figure 4, but now exploring total payments made rather than whether customers made a payment. Measuring total per capita payments over time we again find high congruence between treatment and control customers over the 5 years where data are available in both pre- and post-treatment periods for the engagement treatment. We find a stark contrast in the enforcement intervention where, again we find highly consistent payment trajectories during the four-year pre-treatment period, but also find a sharp increase in payments at the point when the enforcement intervention was implemented.

c. SPILLOVERS

To test for spillovers onto the repayment behavior of disconnection-eligible customers we compare control compounds in treatment clusters to the equivalent disconnection-eligible customers in control clusters and find no significant difference between the groups, suggesting no discernible spillover effects from the program using our originally specified empirical strategy for estimating spillovers (Table 4, Panel A). In Table 4 Panel B we report

similar results for disconnection-ineligible customers suggesting that there are no spillovers on paying customers either as a result of the enforcement intervention.

d. Service Connection and Political Costs

The enforcement intervention had little effect on compound connections to water and sanitation services. NCWSC reported that most of the 97 disconnected compounds were reconnected after paying a portion of their balance. We also find little evidence of illegal connections based on enumerator observation (3 cases across the sample). These results are reflected in the survey data collected nine months after the intervention as reported in in Table 5. While there is no effect of enforcement on connections to the sanitation system, treatment landlords report being 3.6 percentage points less likely to have a piped water connection in the disconnection group compared to the control group. While statistically significant, the effect is small as 97% of the control group is connected and becomes insignificant when adjusting for multiple hypothesis testing.

Finally, we find no evidence of meaningful changes across the set of indices described in Section 5 including landlord-tenant relationships, perceptions of service quality, perceptions of service fairness, child health and community activism (see Table 5). These are all insignificant, and small, with the largest (statistically insignificant) difference being a 0.1 standard deviation increase in perceptions of service delivery fairness. This is driven up mostly by an 11-percentage point improved perception that "water bills are accurate" which is the only statistically significant sub-component in any of the indices reported.

e. Rental market

We find that landlord rental income increases significantly from KSh 6,258 by KSh 2,388 (Table 6). Interestingly, this does not appear to be driven entirely by increases in tenant rental prices. While landlords in treatment areas are significantly more likely to have increased rent in the past 6 months, this is only 3.6 percentage points higher in the treatment group which cannot explain the significant increases in rental income. However, we find a significant increase in the proportion of landlords renting out at least part of their compound, which increases from 58.9% by 13 percentage points.

The results suggest that landlords responded to an increase in effective water and sanitation service charges from increased enforcement by becoming more likely to rent out parts of their compound, which is the main driver of increased rental income to cover the increased costs. Rent increases presents another possible channel for increasing rental income reported by landlords that are consistent with the data but seem to play at best a small part.

7. CONCLUSION

While disconnecting public utility services from those that may need them the most may appear to be antipoor and regressive, the alternative of treating basic services as a "right" may erode incentives for utilities to provide those services in the first place. Despite taking place in a relatively weak institutional setting, we show that increasing enforcement is both possible and able to significantly improve repayment behavior. But it is useful to reflect on the associated costs of the increased enforcement to assess its viability in the long run.

A first concern is the sheer number of disconnections. The treatment resulted in 97 disconnections out of 327 eligible compounds (29%) with no obvious positive spillovers of repayment behavior into control clusters. If disconnections permanently excluded customers from the service, this would quickly become self-defeating if this was repeated regularly. However, in this case the disconnection is low-cost and easily reversible by NCWSC and we find that many of the originally disconnected households have reconnected nine months later. There is a balance between ensuring that the disconnection is credible and economically meaningful to the customer, while also being flexible enough to allow for reasonable opportunities for remedial action. NCWSC opted for more flexible arrangements with customers, requiring them to make a payment and some commitment to address the outstanding balance, rather than paying the full balance at once, which is a significant barrier. In this way our results are consistent with the theoretical prediction in Ashraf et al (2016) who show that in a setting like the one we studied, the optimal fine is often not a draconian penalty, but a mild charge that is small enough to avoid extortion.

Second, there is a concern that increased enforcement may increase the rate of illegal connections as an informal workaround, exacerbating the non-revenue water challenges NCWSC faces. Enumerators were trained to identify illegal water connections and conducted site inspections as part of their visits. In total, only 3 illegal connections were identified across the sample, suggesting that this is not a significant problem in this setting.

Third, the returns to increasing enforcement are a function of how sustainable the repayment behavior change is. NCWSC billing data clearly show a large spike in repayments in the month of the disconnection notices, but after this point, the flow of payments in the treatment group resembles that of the control group for the next 8 months. This means that customers seem to be induced to make a significant one-off payment that is not repeated in later months, but they also do not substitute out of making payments later on, suggesting that this is a real net gain. Customers may have perceived that disconnection threat to be one time and not ongoing. NCWSC may need to use the threat in an ongoing basis to fully change payment behavior. We also see that the intervention induced payment increases on the extensive margin, bringing more paying customers into the fold that would not have been making any payments otherwise.

Finally, a major reason for why governments and utilities are hesitant to implement disconnections, particularly in low-income settings, is because of the political and social costs involved. Since a primary objective of connecting low income households in the first place is to improve development outcomes, there is a fear that removing these services may then have the opposite effect and negatively impact the poor. The potential backlash from communities may also be costly to service providers in various ways, from reduced political support to increased tensions in already volatile settings and counter-responses from communities that could damage both the relationships between providers and communities and the costly physical infrastructure. We find little evidence of negative impacts from the increased enforcement across all measures, suggesting that this may be less of a concern than anticipated.

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Figures and Tables

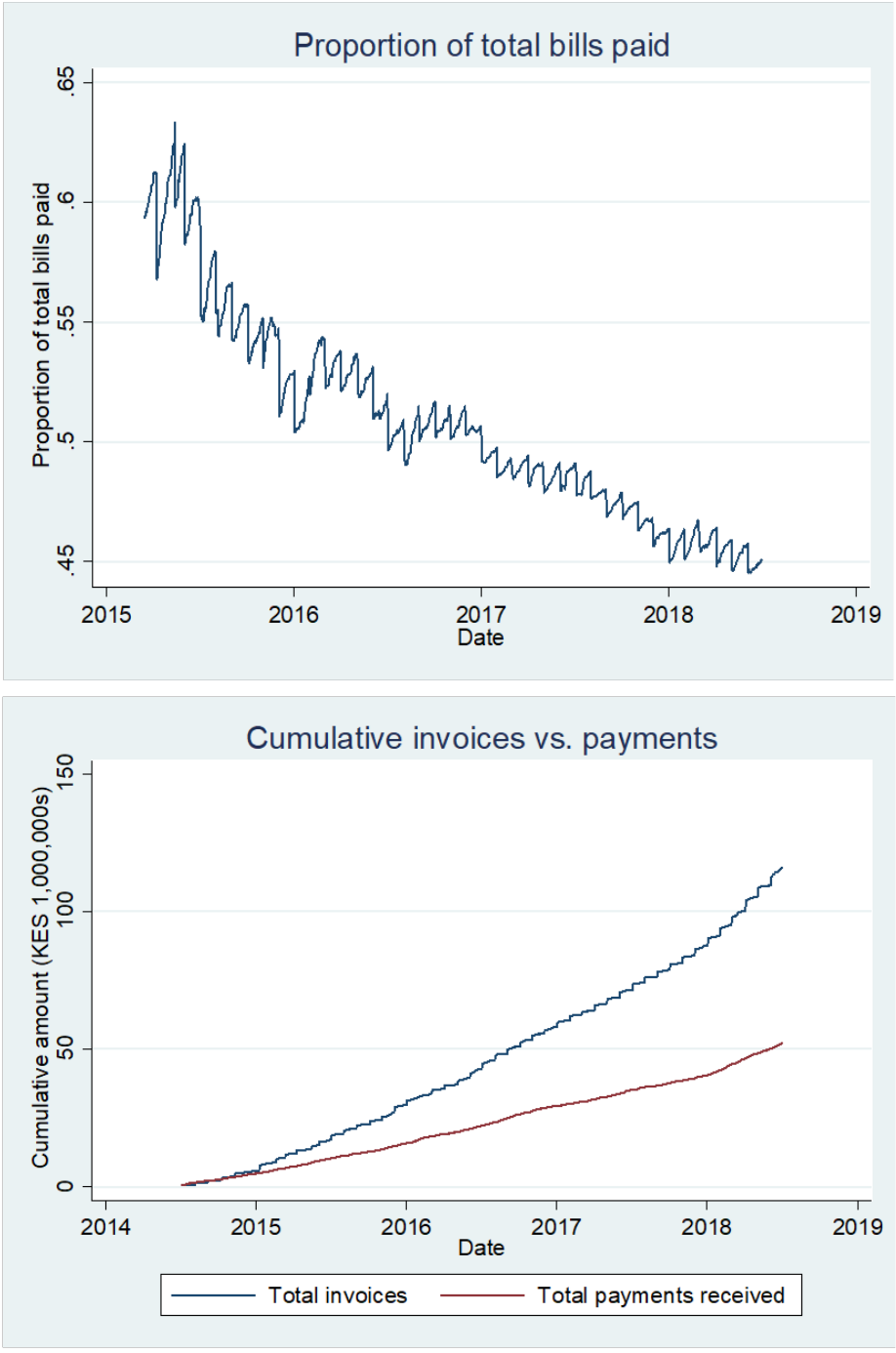
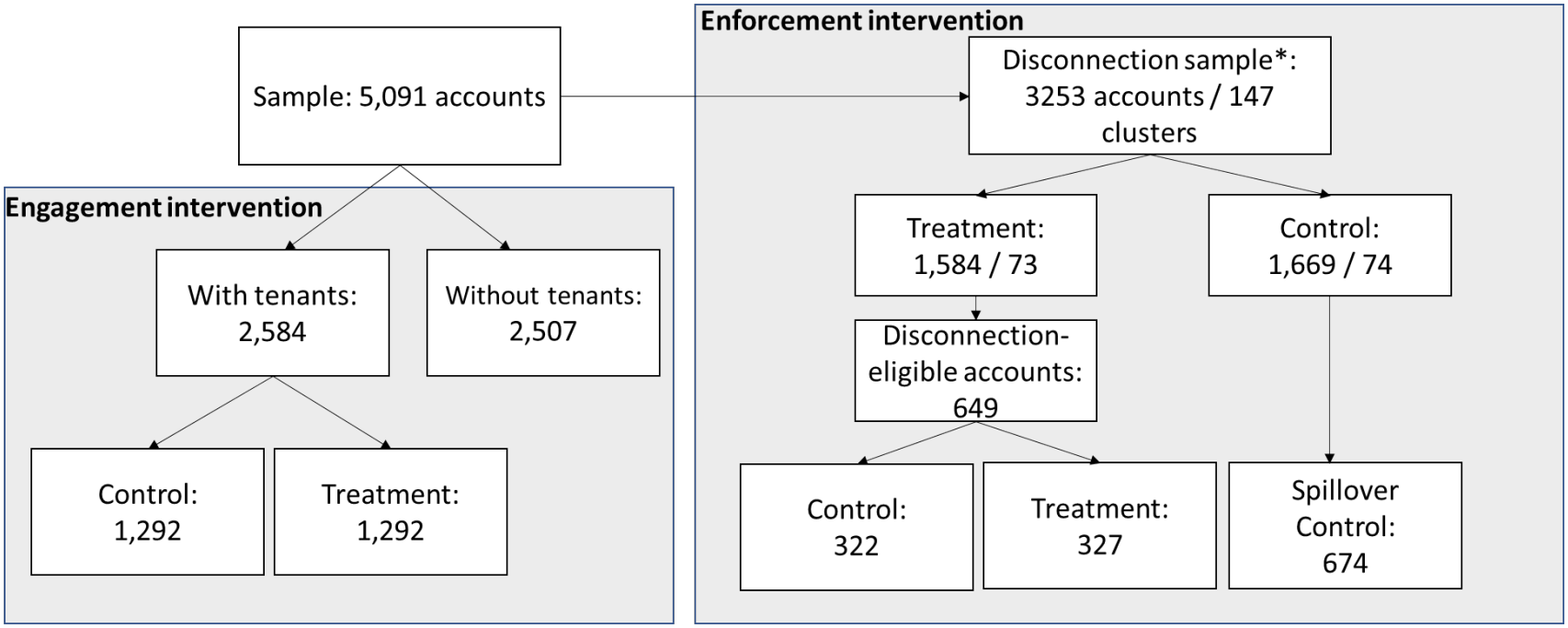


Figure 1: Billing and payments of NCWSC customers in informal settlements



*2 settlements excluded from enforcement intervention because of housing density and compound design

Figure 2: Experimental Design and Sample Selection

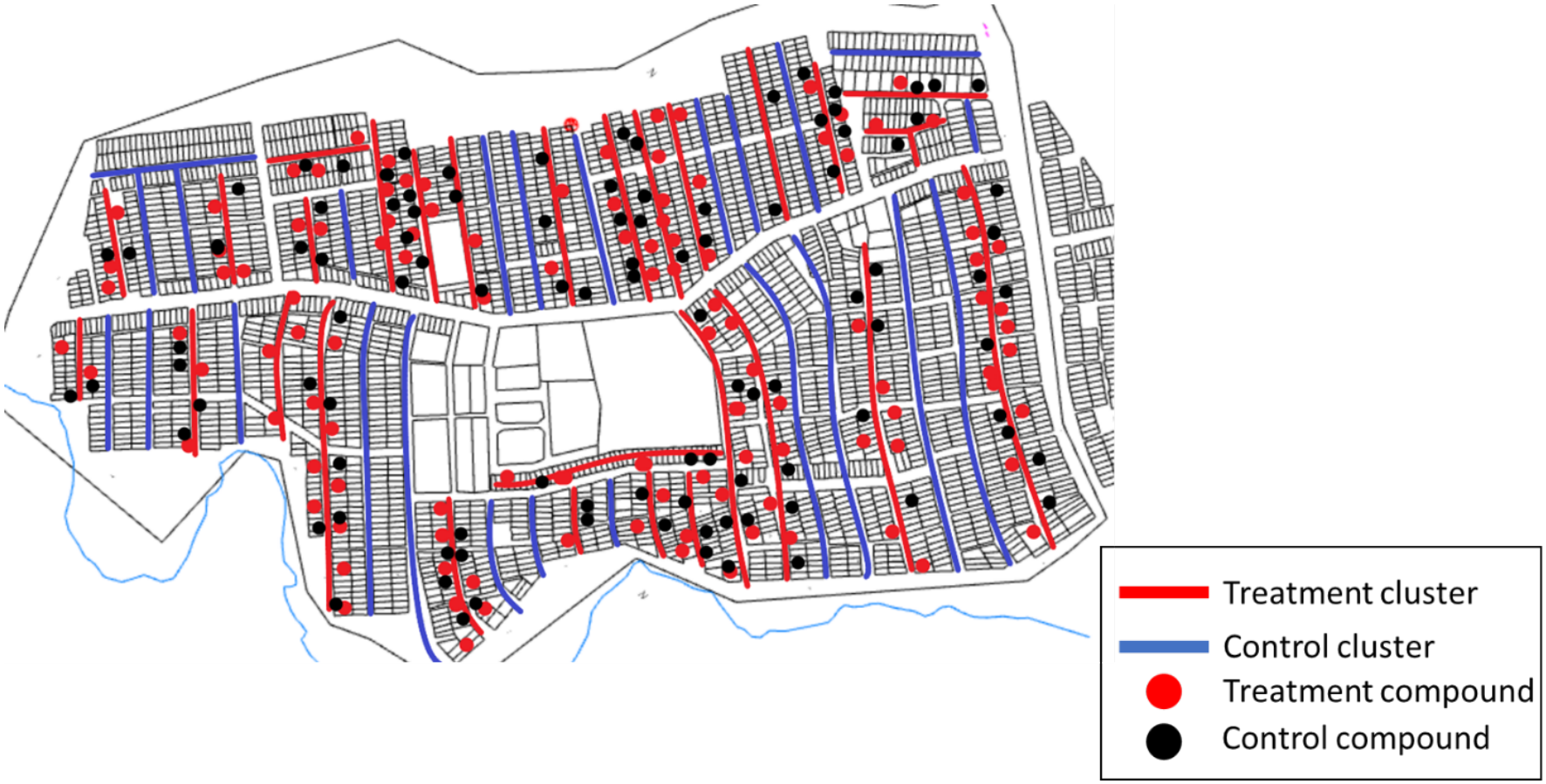


Figure 3: Illustration of two-stage randomization for disconnection notices in Kayole Soweto

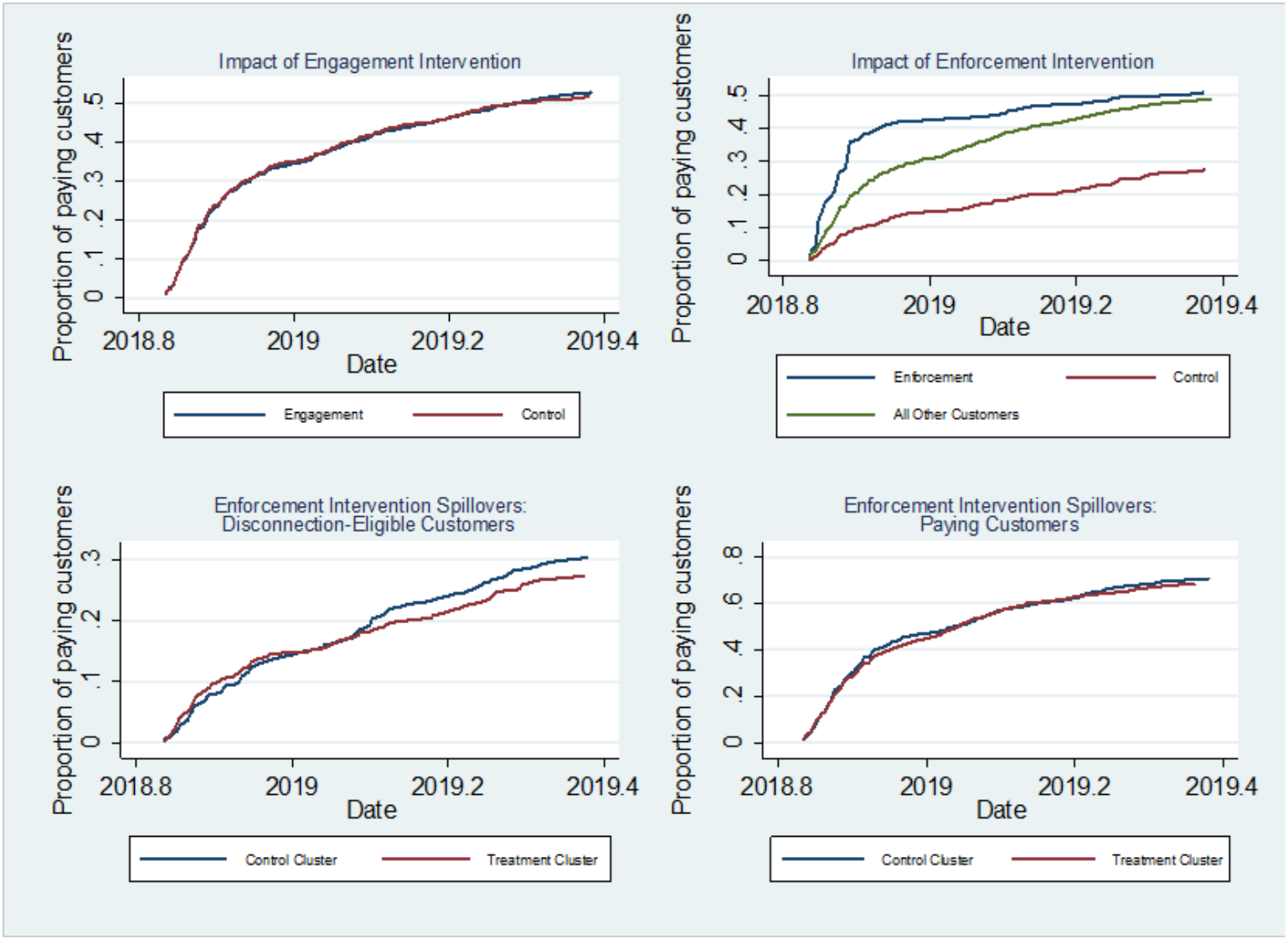


Figure 4: Cumulative distribution function of customers making at least one payment

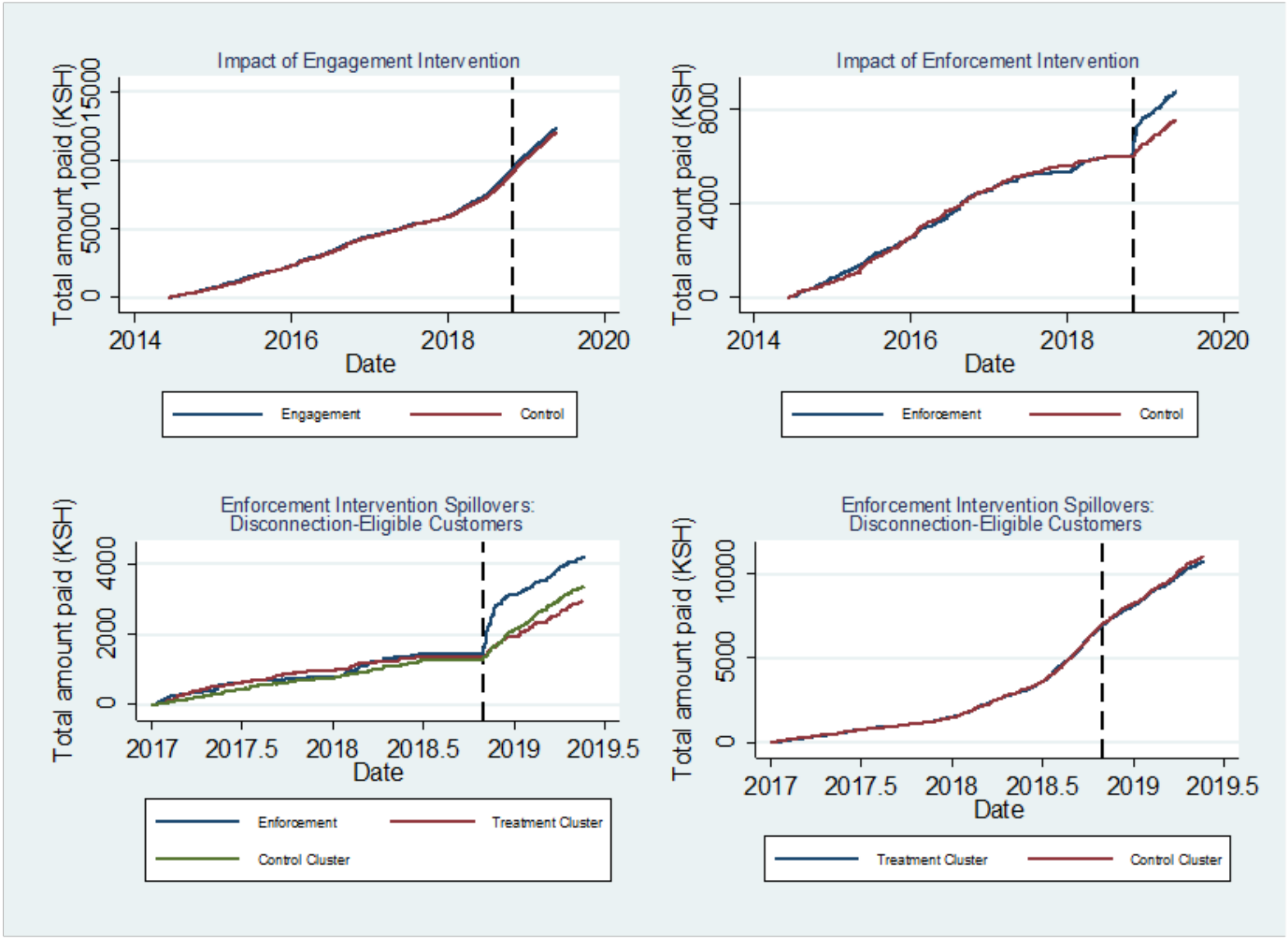


Figure 5: Cumulative payments in KES by treatment group

Table 1: Baseline Balance

Variable	Engagement					Enforcement							
	(1) Control		(2) Treatment		(3) t-test p-value: (2) - (1)	(4) Control		(5) Spillover control		(6) Treatment		(7) t-test p-value: (6) - (4)	(8) t-test p-value: (6) - (5)
	N	Mean	N	Mean		N	Mean	N	Mean	N	Mean		
Payment data													
Ever made a payment	1292	0.604	1292	0.618	0.468	322	0.494	674	0.509	327	0.502	0.844	0.827
Years as a NCWSC customer	1292	2.139	1292	2.163	0.688	322	2.488	674	2.536	327	2.499	0.926	0.721
Number of unique payments made	1292	5.819	1292	5.384	0.208	322	3.531	674	3.010	327	3.477	0.905	0.176
Total amount paid (KES)	1292	6302.43	1292	6468.47	0.662	322	4914.16	674	4081.94	327	4869.76	0.950	0.127
Current outstanding balance	1292	4202.04	1289	4137.04	0.751	322	7659.22	674	7502.05	327	7085.37	0.243	0.282
Months until first payment	780	8.413	798	8.214	0.596	159	7.725	343	8.216	164	8.064	0.693	0.835
Compound data													
Compound has a water connection	1290	0.988	1285	0.991	0.436	316	0.994	658	0.992	319	1.000	0.155	0.020**
Compound has a sewer connection	1282	0.973	1279	0.978	0.377	315	0.959	655	0.979	320	0.966	0.649	0.306
Compound received water last week	1292	0.843	1292	0.836	0.630	322	0.817	674	0.829	327	0.817	0.993	0.612
Landlord is responsible for paying water and sewer bills	1096	0.476	1074	0.443	0.122	269	0.349	561	0.335	278	0.338	0.781	0.954
Landlord is a resident of the compound	1287	0.553	1287	0.554	0.968	316	0.506	658	0.530	318	0.500	0.874	0.376
Compound has paying tenants	1292	1.000	1292	1.000	-	322	0.627	674	0.623	327	0.697	0.060*	0.038**
Number of paying tenant households	1292	4.255	1292	4.602	0.313	172	4.814	362	4.771	194	4.887	0.866	0.762
Bill has never been paid for the following reason:													
lack of money	475	0.147	458	0.114	0.126	144	0.201	304	0.191	151	0.185	0.730	0.895
landlord doesn't know how to make payment	475	0.116	458	0.094	0.276	144	0.146	304	0.092	151	0.126	0.617	0.297
compound didn't receive water	475	0.491	458	0.520	0.374	144	0.493	304	0.520	151	0.477	0.781	0.469

Note: ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Payment outcomes are derived from the billing data and compound outcomes come from the landlord survey in August 2018. Baseline balance comparisons for the engagement intervention use administrative billing data from 6 August 2018 - the data used to draw the original sample for the landlord updating survey. Balance tests for the enforcement intervention use 28 October 2018 administrative billing data - the dataset on which the enforcement randomization was conducted. P-values for t-test comparisons between the engagement group treatment and control are presented in column (3). Comparison tests between the enforcement treatment group and controls within treatment clusters are presented in column (7). Comparisons between the enforcement treatment group and controls in control clusters are presented in column (8).

Table 2: Impacts of engagement intervention on repayment

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Made at least one payment within…		Total amount paid within…		Proportion of balance paid within…	
	1 month	9 months	1 month	9 months	1 month	9 months
Engagement	-0.005	-0.002	4.943	-57.519	0.013	0.008
	(0.018)	(0.019)	(64.229)	(201.073)	(0.017)	(0.015)
	[0.776]	[0.928]	[0.939]	[0.775]	[0.432]	[0.613]
Observations	2,584	2,584	2,584	2,584	2,584	2,584
Control Mean	0.301	0.558	695.8	3834	0.496	0.484

Note: Standard errors in parentheses; P-value in brackets. *** p<0.01, ** p<0.05, * p<0.1. Sample includes all compounds that were included in the randomization procedure to assign the tenant-level accountability intervention. Time periods are based on the end date of the intervention (7 November 2018) and use data downloaded from the Nairobi Water billing data for 7 December 2018, and 7 September 2019 to estimate impacts 1 and 9 months after the intervention respectively.

Table 3: Impacts of enforcement intervention

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Made at least one payment within…		Total amount paid within…		Proportion of balance paid within…	
	1 month	9 months	1 month	9 months	1 month	9 months
Enforcement	0.300***	0.195***	878.3***	907.8**	0.113***	0.078***
	(0.039)	(0.043)	(171.37)	(415.41)	(0.025)	(0.027)
	[0.000]	[0.000]	[0.000]	[0.031]	[0.000]	[0.005]
Control Mean	0.110	0.334	502.6	2472	0.268	0.300
Observations	1,001	1,001	1,001	1,001	1,001	1,001
Number of Clusters	142	142	142	142	142	142

Note: Standard errors in parentheses; P-value in brackets. *** p<0.01, ** p<0.05, * p<0.1. Sample includes all compounds that were included in the randomization procedure to assign the disconnection notices (enforcement) intervention. Time periods are based on the end date of the intervention (7 November 2018) and use data downloaded from the Nairobi Water billing data for 7 December 2018, and 7 September 2019 to estimate impacts 1 and 9 months after the intervention respectively.

Table 4: Spillovers from enforcement intervention

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Made at least one payment within…		Total amount paid within…		Proportion of balance paid within…	
	1 month	9 months	1 month	9 months	1 month	9 months
Panel A: Spillovers on compounds eligible for disconnection						
Enforcement	0.010	-0.020	-42.43	-172.1	0.019	0.008
	(0.023)	(0.039)	(135.30)	(392.44)	(0.025)	(0.027)
	[0.681]	[0.610]	[0.754]	[0.662]	[0.449]	[0.760]
Control Mean	0.110	0.334	502.6	2472	0.268	0.300
Observations	996	996	996	996	996	996
Number of Clusters	144	144	144	144	144	144
Panel B: Spillovers on compounds not eligible for disconnection						
Enforcement	-0.015	-0.009	-33.96	30.30	-0.003	0.005
	(0.023)	(0.029)	(72.260)	(361.71)	(0.025)	(0.026)
	[0.507]	[0.752]	[0.639]	[0.933]	[0.914]	[0.822]
Control Mean	0.409	0.734	854.4	5116	0.721	0.655
Observations	1,930	1,930	1,930	1,930	1,930	1,930
Number of Clusters	143	143	143	143	143	143

*Note: R*obust clustered standard errors based on the level of randomization (street) in parentheses and associated p-value in brackets. *** p<0.01, ** p<0.05, * p<0.1.Panel A includes all compounds that were eligible for the disconnection intervention. The comparison is between compounds assigned to the control group in treatment clusters with all disconnection-eligible compounds residing in control clusters. Panel B includes all compounds that were not eligible for the disconnection intervention. The comparison is between disconnection-ineligible compounds in treatment clusters with all disconnection-ineligible compounds residing in control clusters. Time periods are benchmarked on the end date of the intervention (7 November 2018) and use data downloaded from the Nairobi Water billing data for 7 December 2018 and 7 Sep 2019 to estimate impacts 1 and 9 months after the intervention respectively.

Table 5: Costs of enforcement

VARIABLES	(1) Observations	(2) Control Mean	(3) Treatment coefficient	(4) Standard error	(5) p-value
Compound has a piped water connection	538	0.978	-0.036**	0.017	0.033
Main toilet is a flush/pour system	609	0.947	-0.021	0.020	0.280
Landlord					
Index: Perceptions of service delivery fairness	570	0	0.098	0.083	0.240
Index: Perceptions of service delivery quality	589	0	-0.043	0.084	0.606
Index: Relationship with tenants	371	0	-0.097	0.113	0.391
Tenant					
Index: Perceptions of service delivery fairness	358	0	0.010	0.113	0.930
Index: Perceptions of service delivery quality	402	0	0.056	0.105	0.594
Index: Child health	183	0	-0.158	0.163	0.333
Index: Community activism	403	0	-0.031	0.109	0.776
Relationship with landlord (scale of 1 to 10)	403	8.266	0.199	0.241	0.409

Note: *** p<0.01, ** p<0.05, * p<0.1. Sample includes all compounds that were included in the follow up survey: control and treatment compounds in disconnection-treatment clusters. Landlord and compound water outcomes are from the landlord survey. Tenant outcomes are from the tenant survey. Indices are computed following Anderson (2011), normalized by the control group.

Table 6: Rental income and market

VARIABLES	(1) N	(2) Control Mean	(3) Treatment coefficient	(4) Standard error	(5) p-value
Compound Rental Income Last Month (KSh)	525	6258	2,388**	1,012	0.019
Does compound have rental dwellings?	568	0.589	0.135***	0.038	< 0.0005
Number of rental units in compound?	566	3.29	0.381	0.377	0.312
Increased rents in the last 6 months?	371	0.018	0.036*	0.021	0.091
Paying tenants moved out in last 6 months?	371	0.704	-0.064	0.052	0.218

Note: *** p<0.01, ** p<0.05, * p<0.1. Sample includes all compounds that were included in the follow up survey: control and treatment compounds in disconnection-treatment clusters. "Have you increased rents", "Paying tenants have moved out" is estimated only on the sub-sample of compound landlords that report having tenants.

APPENDIX

Script for engagement intervention:

"Firstly, we'd like to make you aware of the importance of paying for water/sewer service charges and help you take the necessary steps to avoid being disconnected. You may not be responsible for making water payments, but you can still make a difference by helping your landlord or caretaker remember when and how to take action. Today we'd like to explain to you how you can help ensure payments are made and how to avoid being disconnected.

Now I'd like to give you some information about the outstanding bill for this compound and understand if there has been any trouble with making payments.

From our records as of ${balance date}, the outstanding balance on this compound was ${balance}. This is your balance for water and sewer fees only, not the outstanding balance for your loan.

Now I'd like to give you some information on your water meter and answer any questions you might have about how to use it.

Now we I'll explain how to read the meter

Now I'll explain how to check the balance"