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Out of sight out of mind:

Household perceptions of "fair" water prices in Nairobi, Kenya

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Abstract

Providing piped water and sewer services is extremely capital intensive, yet most of this infrastructure is buried, hidden from citizens and ratepayers. Roman emperors built elaborate public fountains to increase the salience of massive infrastructure investments to the public, yet modern households give scarce thought to the water network that serves them. At the same time, tariffs are often too low to recover operations and maintenance costs, let alone capital replacement and system expansion. We use a field experiment to investigate whether providing 353 households in Nairobi, Kenya with information about the water infrastructure that serves them changes their perceptions of water and sewer bills. Compared to a control group, we find that providing households verbal and visual information (in person) about the capital intensity of water service delivery in Nairobi increased their perceptions of "fair" water bills by 15% to 24% above the control mean of 404 KSH/mo.

Keywords:

JEL Codes:

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Key Points:

- Water supply is capital intensive but the infrastructure is out of public view
- The public's lack of knowledge about infrastructure may undermine support for price increases
- People who were provided information about local water infrastructure reported 15-24% higher "fair" price for water

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Abstract

Providing piped water and sewer services is extremely capital intensive, yet most of this infrastructure is buried, hidden from citizens and ratepayers. Roman emperors built elaborate public fountains to increase the salience of massive infrastructure investments to the public, yet modern households give scarce thought to the water network that serves them. At the same time, tariffs are often too low to recover operations and maintenance costs, let alone capital replacement and system expansion. We use a field experiment to investigate whether providing 353 households in Nairobi, Kenya with information about the water infrastructure that serves them changes their perceptions of water and sewer bills. Compared to a control group, we find that providing households verbal and visual information (in person) about the capital intensity of water service delivery in Nairobi increased their perceptions of "fair" water bills by 15% to 24% above the control mean of 404 KSH/mo.

1.0 Introduction

The World Bank estimated that it will cost approximately USD 100 billion per year to meet the Sustainable Development Goals' aspirations of ensuring safe and affordable water and sanitation for all by 2030 (Hutton & Varughese, 2016). This estimate did not include the cost to replace existing infrastructure as it ages or ensuring that water and sanitation infrastructure is resilient to climate change. Donor funds are not sufficient to meet this funding gap, which means funds will need to be secured through tax revenue or user fees (i.e., tariffs). Utilities in low- and middle-income countries charge customers far below the full cost of providing water and sanitation services. According to Andres et al. (2019), 35% of utilities listed in the International Benchmarking Network (IBNET) database charge tariffs sufficient to cover operations and maintenance costs. Only 14% charge tariffs sufficient to cover the full cost of water and sanitation service delivery. As a result, very few utilities in low- and middle-income countries generate enough revenue to replace capital as it ages or invest in system expansion and improvement. Many of these utilities risk falling into – or are already in – a low-level equilibrium trap of insufficient revenue, declining service quality, and decreasing customer willingness to pay for poor quality services (Savedoff & Spiller, 1999; Singh et al., 1993).

Even if governments show the political will to raise taxes to finance water and sanitation infrastructure investments, the vast majority of utilities in low- and middle-income countries will need to increase tariffs to improve service quality for existing customers and expand access to households that currently lack access to piped water and sanitation services. However, there are many barriers to utilities increasing tariffs for water and sanitation services. Raising prices is politically unpopular, and local politicians may not be willing to advocate increasing prices during their term. Regulators may be unwilling to approve tariff increases for utilities that are not run efficiently (e.g., high staff ratios, high levels of non-revenue water, or low bill collection rates) and deliver low-quality services. Politicians, regulators, and utility managers might be hesitant to raise prices due to concerns about affordability or a desire to protect the poor. This low willingness to charge among various stakeholders might also be influenced by public perceptions of a "fair" price for water and sanitation services.

Although there is a large stated preference literature estimating households' average total willingness to pay for improved water and sanitation services (see Van Houtven et al. (2017) for a review), there has been relatively little research on what households perceive as "fair" prices (Suwal et al., 2019; Thuy et al., 2020). While households' willingness to pay for water service and their perceptions of a fair price for water may be related, the two measures are conceptually distinct. Willingness to pay is a strictly economic concept and represents the economic welfare the household enjoys as a result of accessing the service. It is bounded in theory and in practice by a households' income and ability to pay. Fair price perceptions are more complex. A price may be "affordable" to someone (i.e., a very small percentage of her income) but perceived by her as unfair for several reasons. For instance, perceptions of fair water prices might be influenced by an individual's beliefs about who bears responsibility for providing – and paying for – water and sanitation services. While some individuals might believe that users bear the sole responsibility for paying for water and sanitation services, others might believe that water is a merit good and that the government should cover a portion, or all, of the costs of providing services. Perceptions of fair water prices might also be influenced by perceived service quality, or individuals' trust in the government or service provider.

In this study, we use a small field experiment in Nairobi, Kenya to examine whether providing information about the cost and capital intensity of water service delivery influences individuals' perceptions of what constitutes a fair price for water service. This study builds upon a substantial

literature on information treatments in the energy and water sectors and a small, but growing literature on the perception of fair water prices. To our knowledge, this is the first study to examine the impact of information on the capital intensity of water service delivery on individuals' willingness to pay for utility services or their perceptions of fair prices. We find that providing customers information about Nairobi's water supply infrastructure increased their perception of a fair price to pay for water service. This has potentially important implications for the role of customer communication in building public support for the tariff increases that are required to get utilities on the path to financial sustainability.

2.0 Background and Literature

Water service delivery is highly capital-intensive compared to other industries and public utilities. According to Hanemann (2005), in the United States, "the ratio of capital investment to revenue in the water sector is double that in natural gas and 70% higher than in electricity or telecommunications" (74). Unlike other services, however, the vast majority of the infrastructure involved in providing municipal water and sewer services is out of the public eye. Surface water supplies are typically located on the periphery of cities, and wells are underground. Even in systems that rely on surface water, above-ground pipelines that carry raw or finished water to cities are typically outside of public view. Although water and wastewater treatment plants have a large physical footprint, they are often located outside cities or shielded from public view and access due to security and aesthetic concerns. Unlike transmission lines for electricity, which are often above ground, the piped network that delivers water to households is buried underground and largely invisible to the end-user. Only in the relatively rare instances of a water main break might a citizen be aware of the vast underground piped network that delivers water to their home. For households with access to piped water service, one simply turns on the tap and water flows out (when services are available). Very few individuals have a detailed sense of where their water comes from or the infrastructure involved in bringing water from the source to the tap (Attari et al., 2017).

The cost and capital intensity of water service delivery, combined with the largely out-of-sight nature of the infrastructure, poses a special challenge for the water sector. How do policymakers mobilize public support for large investments in water infrastructure when much of this infrastructure is invisible to the public? This challenge is not new and was well-recognized by Roman emperors, who funded and

oversaw the development of ancient Rome's pioneering water supply infrastructure. Ancient Rome's water supply invokes images of ornate bridges and viaducts. However, these structures made up a small fraction of ancient Rome's water supply system, which consisted primarily of underground pipes and canals (Sedlak, 2015). Though impressive, the viaducts that brought water to ancient Rome were outside the city, largely out of public view. Rome's leaders built ornate fountains in public squares to make the water supply investment and engineering marvel visible to the public. These fountains provided public access to water for domestic use and a poignant visual reminder of the state's engineering accomplishments (Salzman, 2005; Sedlak, 2015). Unlike ancient Rome, cities today largely lack visual, public reminders of the vast infrastructure required to provide municipal drinking water service. This study seeks, in part, to determine if providing individuals with information about the capital intensity of water service delivery can influence their perceptions of fair water prices.

There is a substantial literature on the impact of information treatments on tax compliance (Alm, 2019; Hallsworth et al., 2017; John & Blume, 2018), energy use (Allcott, 2011; Allcott & Kessler, 2015; Taylor et al., 2018), and water use (Brent et al., 2015; Carlsson, Gravert, et al., 2021; Carlsson, Jaime, et al., 2021; Ferraro & Price, 2013). Other studies examine the impact of information on customer demand for health-improving technologies or services (Brown et al., 2017; Hamoudi et al., 2012; Jalan & Somanathan, 2008; Pattanayak et al., 2009; Tidwell et al., 2019). More closely related to this study, Hassan et al. (2021) examined the impact of information on the costs households incur to cope with unreliable water supply (coping costs) on households' willingness to pay for improvements in service reliability and drinking water quality in Lahore, Pakistan. The study used a "counting the costs" information treatment in which enumerators worked with respondents in the treatment group to complete a detailed worksheet to estimate the costs households incur to cope with irregular water supply. They found that treated households were 20 percentage points more likely to agree to increased tariffs for improved service quality. In the context of the United States, Teodoro (2022) recently examined the impact of different framings on respondents' willingness to accept a "modest" water rate increase. He found that customers were 11% more willing to accept a modest water rate increase framed as providing "safer drinking water" than when the rate increase was framed as providing better tasting water, reducing pollution, or improving low-income affordability.

In addition to this information treatment literature, a limited number of studies have explicitly examined customer perceptions of fair water prices or reasonable bills for water service. Suwal et al. (2019)

assessed household preferences for tariff structures in Kathmandu, Nepal by asking households what they thought was a fair water bill for an exogenously assigned quantity of water. They found evidence that households preferred a water tariff in which a household's water bill increased with the quantity used but did not find evidence of household support for an increasing, non-linear tariff like an increasing block tariff used by many utilities in low- and middle-income countries. Thuy et al. (2020) examined household perceptions of "reasonable" bills for municipal water service in Ho Chi Minh City, Vietnam. In addition to findings related to tariff structure preferences, they found that respondents thought some bills were too low and that 25% of respondents felt a "reasonable" bill should ensure the bill was sufficient to cover the cost of service provision.

This study is conceptually different from the studies described above in four important ways. First, studies that test the impact of information about service quality (e.g., water quality) on demand for quality-improving products (e.g., water treatment technologies or vended water) provide information on aspects of service quality that are difficult for customers to observe. This information is household-specific and focuses on private behavioral responses. Our study focuses on providing information on the vast public infrastructure involved in service delivery rather than service quality. We also focus on perceptions of a fair price for service, which has both a private and public dimension. Second, social norm information treatment studies typically provide users with information on how their usage compares to others (Allcott, 2011; Ferraro & Price, 2013). The information treatments in these studies are endogenous to households' baseline consumption (Brown et al., 2017); high water users are by definition more likely to receive an unfavorable social comparison. Most studies find that high users are more sensitive to receiving the information treatment, but this endogeneity makes it difficult to know whether the effect is driven by these households having low-cost conservation opportunities or by the higher "moral tax" they received (Brent et al., 2020). The information treatment used here is exogenous to households' perceptions of fair water prices, the outcome variable of interest, as well as their reported baseline water bills. Third, unlike social norms and comparison information treatments (Allcott & Kessler, 2019), there is likely no disutility associated with providing information on the cost and capital intensity of water service delivery. Fourth, while Suwal et al. (2019) and Thuy et al. (2020) directly examine customer perceptions of fair and reasonable water bills, respectively, they do not experimentally assess factors that might influence customer perceptions of what constitutes a fair price for water.

3.0 Materials and Methods

3.1 Study Location and Sampling

Our field experiment was conducted in Mailisaba, a low-income area in the eastern part of Nairobi (Figure 1). As the economic hub of East Africa, Nairobi is a rapidly growing city with a population of approximately 4.5 million. According to WASREB, Kenya's national water regulator, Nairobi City Water and Sewer Company (NCWSC) serves 3.6 million people through private connections to the piped network, shared taps, and public kiosks (WASREB, 2021). Residential customers in Nairobi with a private connection to the piped network face an increasing block tariff for water service (Table 1). Customers pay a fixed charge of 50 KSH/mo. and a minimum charge of 204 KSH/mo. for the first six cubic meters. The volumetric price increases in the second and third consumption blocks of the tariff. Customers with sewer service pay an additional 75% surcharge on their volumetric water use.

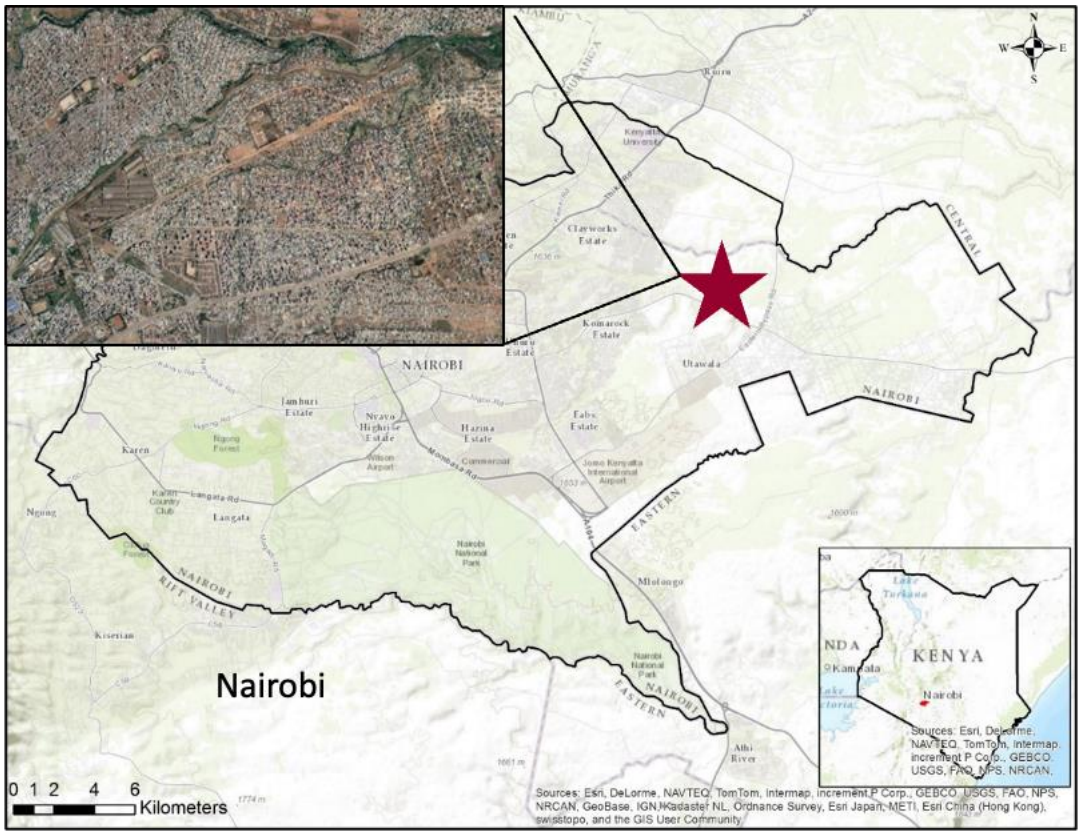

Figure 1. Location of the study area – Mailisaba in Nairobi, Kenya.

Tariff Component	Unit Charge	Unit
Meter rent (1/2")	50	KSH/mo.
0 to 6 m^3/mo.	204 flat charge	KSH/mo.
7 to 60 m^3/mo.	53	KSH/m^3
> 60 m^3/mo.	64	KSH/m^3

Note: Customers with sewer service assessed 75% surcharge on billed water volume.

Table 1. Tariff implemented by NCWSC as of June 2019.

Like many large cities, Nairobi is not terribly different from ancient Rome with respect to the challenge of sourcing water for the city's residents. Nairobi's water supply comes from a series of tunnels, reservoirs, treatment plants, and pipelines to the north of the city (Figure 2). Water is treated at two main water treatment plants located to the north-northwest of the city and transported to the city via a series of pipelines. A smaller third treatment plant is located in the northeastern part of the city. Thus, for most residents of Nairobi, the vast infrastructure that supplies water to the city and the underground piped network that brings water to homes is largely out of public view.

The survey for this study was implemented in June 2019. This study received ethical approval from the University of South Carolina's Institutional Review Board (Study No. 00089084) and Kenya's National Council for Science and Technology (Ref No. NACOSTU/P/ 13/8073/406). To select the sample for the study, the study location was divided into ten areas. Each day of the study, a team of six survey enumerators was randomly assigned to an area within Mailisaba. Enumerators surveyed every 10^{th} house in the area. If residents were not home at the time of the initial inquiry, enumerators conducted two callbacks on different days before a household was replaced. Because Mailisaba is relatively unsafe and it is not uncommon for both locals and outsiders (e.g., meter readers) to be victims of robbery and physical violence, community elders were enlisted to provide protection to the survey enumerator

team. The elders did not influence household selection and remained outside of residences during the implementation of the survey to ensure the confidentiality of the survey responses. A research associate not affiliated with the team of enumerators conducted check backs on 15% of the respondents to verify that an enumerator visited their household, the duration of time spent on the interview, and the content of the interview. The final sample for the study consisted of 353 households.

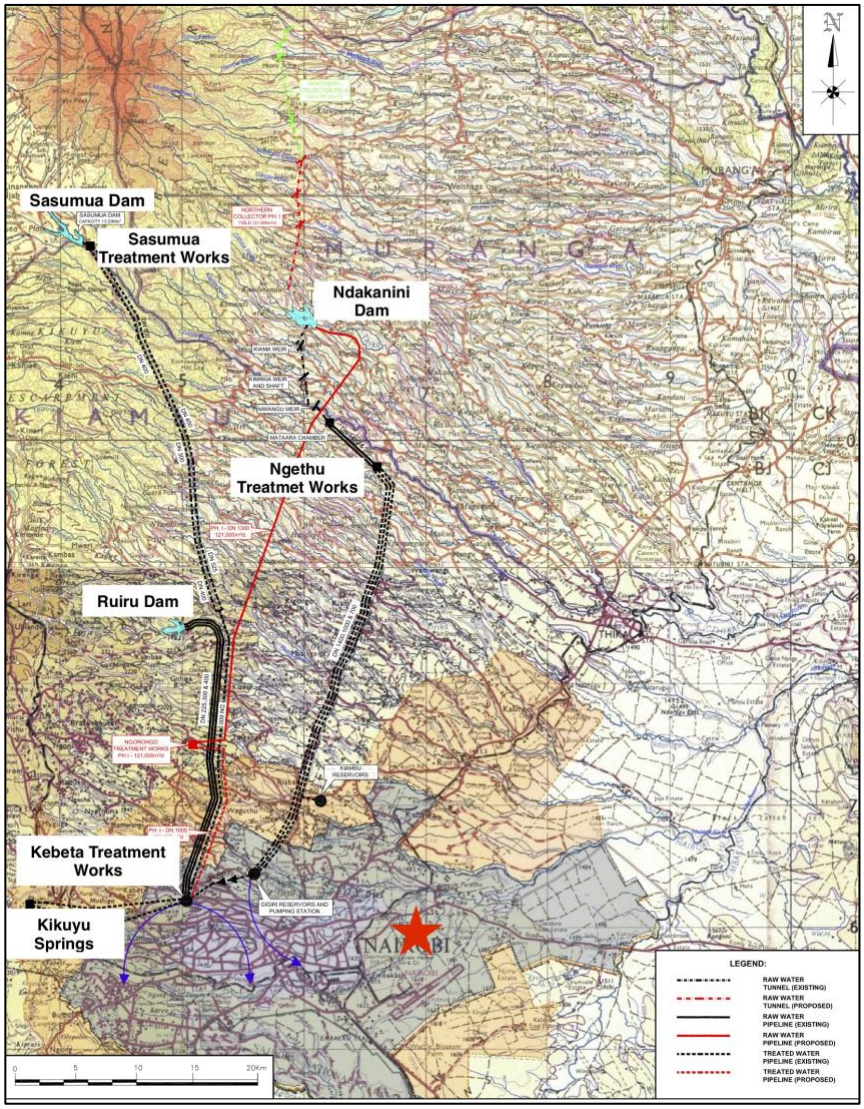

Figure 2. Map of Nairobi's water supply infrastructure. (Adapted from AWSB (2012).)

3.2 Empirical Strategy

Before conducting the survey, households were randomly assigned to treatment and control groups. Randomization was performed via a simple coin flip by the enumerator before approaching a household. Respondents did not observe the coin flip. Forty-three percent of households were shown the information treatment.

Enumerators were instructed to speak to the person in the family most familiar with the household water situation and household expenditure on water. If the person was not available, a call back was scheduled. To elicit households' perceptions of a fair price for municipal water service in Nairobi, households were first told that "[l]ike many water utilities, the price charged by Nairobi Water is not sufficient to cover the full cost of collecting, treating, and distributing water." Households randomly assigned to the treatment group were then presented with the information treatment described in more detail below. All households were then asked, "[a]ccording to Nairobi Water, households in Mailisaba use approximately 8 units per month. Knowing that it costs more per unit to provide water than you currently pay, what do you think is a fair amount to pay for this amount of water (KSH/month)?" This elicitation approach is similar to the open-ended approach used in Suwal et al. (2019). Because we did not seek to assess household preferences for a particular tariff structure (i.e., an increasing block tariff), all households were presented with the same hypothetical quantity of water rather than an exogenously assigned water quantity. Like Suwal et al. (2019) and Thuy et al. (2020), we did not seek to elicit households' maximum willingness to pay for municipal water services.

Households randomly assigned to the treatment group were read a script and showed a series of pictures to help them visualize the infrastructure used to deliver water services to the city. Respondents were first told,

> "Water for Nairobi comes from 4 main sources: Kikuyu Springs, Sasumua Dam (60 KM away), Ruiru Dam (25 km away), and Ndakanini Dam (50 km away). Once it is collected, water is treated at 3 large treatment plants and transported by a large pipeline to Nairobi. For example, the water collected at Ndakanini Dam is pumped 15 km to the Ngethu Water treatment works, then treated, and pumped 30 km to Nairobi."

As enumerators read the names of each dam and treatment plant, they pointed to the locations of the infrastructure on the map shown in Figure 2. They were also shown the images of the Ndakanini Dam intake and outfall (Figure 3 – upper panel). They were then shown the images of the Ngethu water treatment plant (Figure 3 – lower panel). Finally, households were told, "[t]here are more than 3,000 km of pipes in Nairobi that deliver water to households. As you can tell, collecting, treating, pumping, and delivering water to households in Nairobi requires a lot of infrastructure and is expensive." Households were then read the same "fair price" elicitation script (described above) presented to households in the control group.

Figure 3. Images of the Ndakanini dam intake (upper left), Ndakanini dam outfall (upper right) and Ngethu water treatment plant (lower left and lower right).

Prior to the fair price elicitation, respondents were asked several questions about their current water supply situation. In particular, respondents were asked to describe the regularity of the service they received from NCWSC (i.e., days per week and hours per day) and whether they could recall the amount

of their last bill. Respondents were also asked to report their average bill over the past six months and whether they had trouble paying their bills in the past year. After the fair price elicitation, respondents were asked questions related to a variety of socioeconomic factors (e.g., income, asset ownership, expenditure on other utilities, etc.). Respondents were also asked about their overall satisfaction with the service provided by NCWSC as well as their overall perception of different dimensions of service quality (quantity, quality, reliability, and pressure).

4.0 Results

4.1 Household characteristics

Average household size in our sample was 4.4 individuals and respondents reported an average monthly household income of approximately KSH 20,000 (Table 2). Relatively few households in our sample owned cars (15%) and motor bikes (14%), which is consistent with the relatively low incomes reported. Fifty-five percent of households in our sample had a water-sealed toilet in their home, with 6% of the respondents having a connection to the piped sewer network. The remaining households had pit latrines.

To assess balance on observable characteristics between the treatment and control groups, we examine balance across 10 variables including household socioeconomic characteristics, gender of the respondent, previous utility bills, and satisfaction with the water service provided by NCWSC. The results of the balance tests are presented in Table 2. Treatment and control groups were balanced relative to most of the observable characteristics considered. However, we observe statistically significant differences in the gender of the respondent and the reported average water bill for the past six months among the treatment and control groups. Households in the treatment group had somewhat higher average bills and were more likely to have a female respondent. We include models below to attempt to control for this imbalance that arose by chance.

317

	(1) Overall		(2) Control		(3) Treatment		T-test p-value
Variable	**N**	**Mean**	**N**	**Mean/[SE]**	**N**	**Mean/[SE]**	**(2)-(3)**
Female respondent	353	0.67	202	0.72	151	0.60	0.016**
				[0.032]		[0.040]	
Household size	353	4.3	202	4.18	151	4.38	0.344
				[0.133]		[0.169]	
Monthly income	311	20038	176	20048	135	20025	0.988
				[1130]		[1020]	
Last bill	313	669	174	647	139	697	0.470
				[47.8]		[50.8]	
Average bill (past 6 mo.)	350	568	199	534	151	613	0.068*
				[22.7]		[39.0]	
Electricity bill	351	540	201	518	150	570	0.299
				[29.0]		[42.6]	
Water sealed toilet	353	0.55	202	0.554	151	0.55	0.929
				[0.035]		[0.041]	
Car	353	0.15	202	0.14	151	0.17	0.387
				[0.024]		[0.031]	
Motor bike	353	0.14	202	0.14	151	0.15	0.955
				[0.025]		[0.029]	
Very or somewhat satisfied with water service	353	0.62	202	0.64	151	0.60	0.492
				[0.034]		[0.040]	

The value displayed for t-tests are the differences in the means across the groups.

***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

318

319 **Table 2**. Differences between the treatment and control groups.

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321

4.2 Perceptions of fair water bills

Under the tariff implemented at the time of the survey, customers without a sewer connection paid 310 KSH for eight cubic meters of water. The average fair bill for 8m^3/mo. of water reported by our sample was 446 KSH, with treatment and control group averages of 502 KSH and 404 KSH, respectively. On average, respondents' perception of a fair bill for 8 m^3/mo. of water was considerably higher (44% overall, 62% treatment, and 30% control) than the amount charged by NCWSC. However, the average fair bill for 8 m^3/mo. reported by the sample was lower than the average of household's reported last bill and their reported average bill over the past 6 months (Table 2). Approximately 75% of households reported a fair bill for 8 m^3/mo. of water that was less than or equal to their reported average bill over the past six months. This suggests that households may have used more than 8m^3/mo., had unpaid balances on their account as is common in Nairobi, or both. Since we were unable to link households to utility billing records, we do not observe monthly water use or whether households had unpaid balances on their accounts.

We estimate the impact of the information treatment as described in Equation (1):

$$(1) \qquad FB_i = \alpha + \beta T_i + \gamma \boldsymbol{X} + \kappa \boldsymbol{Z} + \varepsilon_i$$

Where, FB_i is respondent i's stated fair water bill for 8 m^3/mo., T_i indicates whether a household was treated (1) or not (0), $\boldsymbol{X}$ is a vector of observable characteristics that were unbalanced among the treatment and control groups (i.e., average water bill for the past six months and the gender of the respondent), and $\boldsymbol{Z}$ is a vector of characteristics hypothesized to affect household perceptions of fair water prices (i.e., income, satisfaction with water service, and whether households purchase water from vendors).

Specification 1 in Table 3 shows the results of a simple regression without controls. Respondents in the treatment group reported a fair bill that was ~100 KSH, or 24%, higher on average than respondents in the control group. The increase in fair prices decreases but remains significant when controlling for the lack of balance on gender and average bills (model 2). We find a statistically significant relationship between respondents' reported average water bill for the past six months, but not the gender of the respondent (specifications 2 and 3). In specification 3, we find a statistically significant relationship with

354 households' reported income. However, we do not find a relationship between respondents'
355 perceptions of a fair water bill and their overall satisfaction with the water service provided by NCWSC.
356 We also do not find a relationship between household perceptions of a fair bill for 8m^3/mo. of water and
357 whether households purchase supplemental water from vendors. Across specifications, we find that
358 providing households information about the capital intensity of water service delivery in Nairobi
359 increased their perceptions of fair water bills by 15% to 24% above the control mean of 404 KSH/mo.
360
361 We asked households about their overall satisfaction with the service provided by NCWSC and how they
362 would rate the quality of service they receive along various dimensions of service quality (quantity,
363 quality, reliability, and pressure). Households were generally satisfied with the service they receive from
364 NCWSC. Sixty-two percent of respondents were either very satisfied or somewhat satisfied with their
365 water service. Only 13 percent were very dissatisfied with the quality of service provided by NCWSC. We
366 tested whether information about the cost and capital intensity of water service delivery influenced
367 customer satisfaction. In particular, we estimated a logit model with the dependent variable equal to 1 if
368 the respondent said they were somewhat or very satisfied and treatment status and demographic
369 controls as independent variables. The average treatment effect was not statistically significant (t= -
370 0.23, p-value 0.817).
371

	Model		
Variables	**(1)**	**(2)**	**(3)**
Treatment	97.549***	62.398**	70.513**
	(32.97)	(25.43)	(27.60)
Female respondent		-15.15	-14.20
		(30.18)	(32.95)
Average bill		0.444***	0.421***
		(0.07)	(0.07)
Income			0.002**
			(0.001)
Very or somewhat satisfied			2.22
			(29.22)
Buy water from vendor			-11.79
			(33.05)

Control mean	404	404	404
Observations	353	350	308
R-squared	0.03	0.38	0.40

Robust standard errors in parenthesis;

***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 3. The impact of information provision on perceived fair bills for 8m^3/mo. (OLS).

5.0 Discussion

We find that providing customers information on the capital intensity of water service delivery increased customer perceptions of a fair bill for 8 m3/mo. of water by 15% to 24%. We did not assess customers' knowledge of Nairobi's water supply and distribution system. However, our results suggest that customers may have incomplete knowledge of the vast infrastructure involved in providing piped water service to the city and that providing customers with this information can impact their perception of what constitutes a fair price for water service.

In both the treatment and control groups, respondents' perception of a fair bill for 8 m^3/mo. of water was considerably higher than the amount charged by NCWSC. One could interpret this as a signal that, at least in low-income communities like Mailisaba, NCWSC could raise prices substantially and still charge a price that was perceived as fair by customers. However, the average of perceived fair bills masks heterogeneity in our sample. Only half of the respondents reported a fair bill that was greater than the KSH 310 charged by NCWSC for 8 cubic meters of water at the time of the survey. Thus, it is not clear that increasing prices would be widely supported or tolerated by customers in Mailisaba. Indeed, forty-three percent of our sample reported having problems paying their water bill in the previous year.

While the average fair bill for 8 m^3/mo. of water service reported by customers was greater than the amount charged by NCWSC, customer perceptions of a fair bill were far below the full cost of service. The full cost of providing water service in Nairobi is estimated to be approximately 150 KSH/m^3 (Fuente et al., 2016). At this price, the bill for 8 m^3/mo. of water service would be KSH 1200. This is considerably higher than the average fair bill reported by households in the treatment group (502 KSH, or 42% of full

cost recovery). However, respondents were not provided information about the full cost of water service delivery before the fair bill elicitation. Given the relatively low prices charged by NCWSC, it is not surprising that customers' perceptions of fair bills were far below the full cost of service delivery.

This study had several limitations that warrant mention. First, the study has a relatively small sample size and the experiment was conducted in a relatively unique context – i.e., a low-income community with nearly universal access to piped water service. Residents of Mailisaba are, however, precisely the type of a customer policy makers might be concerned about when deciding whether to raise prices for water service. Although we find no association between households purchasing water from vendors and their perceptions of a fair bill in our sample, it is possible that households in Mailisaba have more recent or direct experience obtaining water from non-piped sources (e.g., vendors) and may value piped water more than the general population. We did not collect information on respondent's level of education. However, more educated households might have had more baseline knowledge of the water supply system which might diminish the effect of the information treatment used in this study. Further work is needed to determine whether our findings are reflective of the broader customer population in Nairobi. Although the gender of the respondent is not statistically significant in our models, future work could systematically examine intrahousehold differences in preferences related to what constitutes a fair price for water service. Finally, we do not attempt to estimate the maximum willingness to pay for piped water service and do not consider customers' perceptions of fair bills for different quantities of water. Future studies with larger sample sizes could examine customer perceptions of fair water prices by exogenously varying the quantities of water considered or implement a stated preference willingness to pay study (Van Houtven et al., 2017).

6.0 Conclusion

The Sustainable Development Goals have focused attention on the tripartite challenge of increasing access to water and sanitation services, improving service quality, and ensuring that services remain affordable for low-income households. These aspirations are unlikely to be met if utilities continue to price water below the full cost of service delivery. Utilities will need to raise prices while implementing targeted means of ensuring water is affordable for low-income households. Much like the leaders of ancient Rome, policymakers today face the challenge of building and maintaining public support for the

provision of water and sanitation services. While there has been considerable research on the willingness to pay for municipal water and sanitation services in low- and middle-income countries, less attention has been paid to customers' perceptions of fair prices for these services. Public perceptions of fairness are likely to play an important role in determining the political acceptability of higher prices for water and sanitation services. Because the prices charged by most utilities in the Global South are far below the full cost of service delivery, prices will need to be increased significantly to provide utilities with the resources necessary to expand access to services and improve service quality. This will be politically difficult, and more work is needed to better understand how customers conceptualize fairness in the context of water pricing and the various factors that influence these perceptions.

Ancient Romans understood the challenge of making the largely out-of-sight engineering marvel of public water supply visible to the public. This study provides initial evidence that providing customers information on the capital intensity of water service delivery can influence their perception of what constitutes a fair price to pay for water. While additional work is needed to assess the external validity of this finding, our findings suggest that there may be valuable lessons to learn from the experience of ancient Rome. Ornate fountains are no longer the most effective way to build public support for investing in water infrastructure. Utilities and policymakers would be well served to experiment with novel ways of effectively communicating the vast infrastructure – and financial resources – required to provide high-quality municipal water and sanitation services to the public.

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