Willingness to Pay for Improved Water Service: Evidence from Urban Peru

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WILLINGNESS TO PAY FOR IMPROVED WATER SERVICE: EVIDENCE FROM URBAN PERU*

Francisco B. Galarza / Max Carbajal / Julio Aguirre

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Abstract

We study the willingness to pay (WTP) for a large set of improvements in water service related to water quality, continuity, and securing access for people with no house piped water during the COVID-19 pandemic. Using data from urban Peru, and the contingent valuation method, we estimate a mean WTP of around PEN 4.3 (USD 1.05), 3.7 and 1.8, respectively, for the aforementioned sets of improvements, with the combined WTP representing a 23% increase in the households' water service monthly bill. We find that the WTP for all sets of improvements is influenced by the expenditure in bottled water (which acts as a substitute for tap water) and a proxy variable for household assets. The influence of the individual characteristics typically scrutinized by the literature (e.g. sex, age, and education) varies with the type of improvement examined. We find a significant heterogeneity in WTP across providers and calculate the users' contribution to a water fund that could crowd-in the public investment in water infrastructure.

Key words: Access to tap water, Contingent valuation method, Continuity, COVID-19, Households, Quality, Safe water, Willingness to pay.

JEL Codes: C25, D12, I10, L95, Q25, Q51.

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1. Introduction

Access to water and sanitation is essential for the fulfillment of all human rights (UN, 2010). However, despite the significant increase in access to water and sanitation services recorded worldwide in the last two decades, 26% of the world's population (or 2 billion people) did not have access to safely managed drinking-water service in 2020.[1] While many developed countries have universal access, the least developed ones have the lowest coverage, with most of them reaching at most 50% of their population with safely managed water services (WHO/UNICEF, 2021). The consequences of this deficit are more critical in the developing world, where a large share of illnesses is related to inadequate water and sanitation,[2] and where improvements in those services can be associated with the reduction of diarrheal disease, a significant cause of child morbidity (Wolf et al., 2018).[3]

Reaching the United Nations' Sustainable Development Goal 6, targets 6.1 and 6.2, aimed at achieving universal access to safe water and sanitation, in low- and middle-income countries (United Nations Statistical Commission, 2016) would cost USD 114 billion per year from 2016 to 2030, an investment that has been shown to yield a positive benefit-cost ratio in most regions (WHO/UNICEF, 2021). In contexts in which there is still room for improvement in service for people with connection to a public water network, which portrays the case of several developing countries, a valuation exercise (valuing water service) would tell us the extent of users' welfare gains, had there been smaller costs of implementing the improvements, compared to their willingness to pay. In the other scenario, in which the costs exceed the willingness to pay, such exercise will inform us about the scope of the government's intervention needed to close the gap in service and internalizing a positive externality.

Although the literature reports important work on the extent of the willingness to pay (WTP) for improved water service (see Van Houtven et al. (2017) for a recent survey), as well as the factors influencing such monetary value (e.g., Amoah and Moffat, 2021; Makwinja et al., 2019; Chatterjee et al., 2017; Rodríguez-Tapia et al., 2017; Vasquez and Espaillat, 2016; Khan et al., 2014; Tanellari et al., 2015; Tussupova et al., 2015; Vásquez et al., 2009; Venkatachalam, 2004), most of those studies focus on a reduced number of components of water quality, and typically have a limited geographic scope (mainly local or regional, at best), those two limitations widely apply to studies for both developed and developing countries.[4]

We address this issue of valuing water service for the case of Peru, an emerging economy whose water utility network has significantly grown in the last decades, but where still 10.6% of its population lack access to tap potable water and 33% do not have access to sanitation services (2017 Census data). Although the nationwide access to water (89.4%) would seem fairly high, such figure masks a substantial regional heterogeneity, with some regions reaching only 63.6% (e.g., Loreto in the Jungle) and 76.5% (e.g., Puno in the Highlands) of their populations, a disparity that is exacerbated by the significant regional variation in the quality of water service they receive (MVCS, 2021).

In urban Peru, the management, operation, maintenance and delivery of water and sanitation services are

1 This figure was 39% in 2000 (WHO/UNICEF, 2019) and 29% in 2017 (HDR, 2019).

2 The 2003 United Nations press release (by the UN Secretary General), which claimed that 80% of illnesses, deaths in the developing world are related to inadequate water and sanitation (https://www.un.org/press/en/2003/sgsm8707.doc.htm). Visited: March 13, 2022.

3 Wolf et al. (2018)'s meta-analysis shows that safe drinking water, hygiene, and sanitation services are associated with the reduction of the risk of diarrheal morbidity. In particular, point-of-use filter interventions with safe storage decreased diarrheal risk by 61%, while piped water to premises of higher quality and continuous availability did it by 75% and 36%, respectively, compared to a baseline of unimproved drinking water. Lastly, sanitation interventions reduced such risk by 25%; and interventions that promoted handwashing with soap reduced it by 30%, compared with no intervention.

4 In terms of the limited geographic scope, a few notable exceptions include Amoah and Moffat (2021), Dendup and Tshering (2018), and Beaumais et al. (2014), which use representative data for urban Ghana, a nationwide representative survey for Bhutan, and a sample of about 10,000 observations to study ten OECD countries, respectively. For developing countries, some examples of the limited study areas include: Comilla, Munshiganj and Pabna Districts in Bangladesh (Khan et al., 2014); Sucre in Bolivia (Saz-Salazar et al., 2014); San Lorenzo City in San Marcos region, Guatemala (Vásquez and Espaillat, 2016); Tamil Nadu (Venkatachalam, 2005), and Kerala (Griffin et al., 1995) in India; the Chia Lagoon (Nkhotakota) in Malawi (Makwinja et al., 2019); El Parral in Chihuahua (Vásquez et al., 2009), and Mexico City (Rodríguez-Tapia et al., 2017 and Soto Montes de Oca & Bateman, 2006) in Mexico; Puno (Tudela-Mamani et al., 2018) and Loreto region (Fujita et al., 2005) in Peru; and Lusaka in Zambia (Tidwell, 2020). For developed countries, some limited study areas include: Jacksonville City in Florida (Chaterjee et al., 2017), and North Virginia, Maryland and Washington, DC (Tanellari et al., 2015) in the U.S. All those studies show a limited geographic scope.

provided by either Service Providing Enterprises, hereafter *EPS*[5] (in small, medium-sized and large cities), or municipalities (in small towns). According to the diagnosis of the National Sanitation Plan 2022-2026, conducted by the Peruvian Ministry of Housing, Construction, and Sanitation (MVCS, for its acronym in Spanish), the widespread perception of the providers' service is markedly negative regardless of their size, location or ownership status. Thus, while water service providers claim they need to increase the bills to cover the cost of implementing the improvements in service that users request, they assert to already pay an adequate amount for the service they receive. In this setting, we assess the extent of the increase in water service bill that could be supported by consumers.

In particular, after examining the users' perception of several characteristics of water quality and water continuity, we estimate the magnitude of their WTP for the related investments to improve the service. We also study the users' WTP for securing access to potable water (for non-connected users) in the context of the COVID-19 pandemic. We find that users are willing to pay an aggregate amount equivalent to around 23% above their current monthly water and sanitation service bill. In terms of the factors influencing their WTP, while we see some variation in the importance of sex, age, education, and satisfaction with the service across the three groups of improvements examined, only the expenditure in bottled water and a proxy indicator for assets do affect the WTP for all groups under scrutiny. We further take advantage of the variation in the number of providers across the country, to examine the heterogeneity in their users' WTP for the same set of improvements.

Our contribution to the literature is two-fold. First, unlike most of studies for developing countries and even developed countries, we have survey data representative of urban areas in Peru, where 81.5% of the population resides (INEI, 2021a).[6] The representativeness of our data allows us to calculate a water fund based on the users' valuation that could crowd-in public investments aiming to close the country's gap in access to quality water and sanitation infrastructure. Second, we adopt a rather comprehensive outlook and analyze a broader set of improvements in water service than those examined by most of the literature; thus, we study three groups of improvements: (i) water quality (related to color, turbidity, presence of particles, smell, flavor, and perceived safety); (ii) water continuity, no interruptions in service, and adequate pressure; and (iii) ensuring access via water trucks, for poor people with no house piped water in the context of the COVID-19 pandemic.

The remainder of the paper proceeds as follows. Section 2 presents background information about the providers of water and sanitation services in Peru, as well as the tariff structure and several providers' management indicators. Section 3 describes the data. Section 4 introduces our methodology, Section 5 presents the main results, and Section 6 concludes.

2. Background Information

We study the case of Peru, where 3 million people (10.6% of its population) lack access to tap drinking water and 8 million (or 33% of its population) do not have access to sanitation services (2017 Census data). The lack of access to water and sanitation services (WSS) is more critical in rural areas, where 28% and 73% of population do not have access to public water and sewerage networks, respectively. In the case of the urban areas of the country, though the access to water and sewerage is substantially higher than the national average (95% and 90% of population, respectively), users consistently report complaints about water availability and several other components of quality–such as continuity, water pressure, water network breaks, and blockages in sewage network–across the country.[7]

The provision of WSS in Peru is based on several modes of organization and operation. In urban areas with a population larger than 15,000 inhabitants, the *EPS* are responsible for small, medium-sized and large cities, which

5 For its acronym in Spanish (Entidades Prestadoras de Servicios).

6 For instance, the sample sizes were 600 in Khan et al. (2014) for Bangladesh; 206 in Venkatachalam (2005), and 1,150 in Griffin et al. (1995), for India; 1,424 in Soto Montes de Oca & Bateman (2006), 398 in Vásquez et al. (2009), and 689 in Rodríguez-Tapia et al. (2017), for Mexico; 324 in Saz-Salazar et al. (2015), for Bolivia; 322 in Tudela-Mamani et al. (2018) and 1,000 in Fujita et al. (2005), for Peru; and 618 in Chatterjee et al. (2014), for the USA.

7 As of 2020. the density of complaints, per 1000 connections, went from 1 to 299, with an average of 103 and a standard deviation of 73. The average density of complaints has only been worse in the previous five years.

account for more than 62% of the population, or 85% of the urban population (World Bank, 2018; OECD, 2021). All 50 existing *EPS* are publicly owned, 49 by local municipalities and one by the national state (Figure C1 in the Appendix shows the geographic distribution of the *EPS*). The Peruvian National Superintendence of Sanitation Services (SUNASS, for its acronym in Spanish) classifies the *EPS* according to the number of connections they manage. We thus have: SEDAPAL, the largest provider, 4 very large *EPS*, 14 large *EPS*, 15 medium-sized EPS, and 16 small *EPS*.[8] On the other hand, small towns located out of the *EPS* scope, with a population of between 2,000 and 15,000 inhabitants, are serviced by approximately 450 Municipal Management Units (*UGM*, for its acronym in Spanish) and Special Operators. In rural areas, with fewer than 2,000 inhabitants, WSS are provided by more than 25,000 Sanitation Services Administrative Boards (JASS, for its acronym in Spanish) and other providers.

A significant issue related to the negative perception of *EPS* is their limited financial sustainability, which only allows them to operate with a low budget and an abridged team, leading, not only to large network losses and low quality of the network, but also to a limited investment in the sector (OECD, 2021). In terms of the *EPS* management indicators, a 2020 report released by SUNASS indicates that the average continuity of the service was 18.5 hours per day, the average pressure reached 20.5 meters of water column (mH2O), the micro measurement coverage (the ratio of the number of connections with water consumption meter to the total number of connections) was 72.4% (which places us below the 78.9% average level for Latin America and the Caribbean), an average operating margin of 0.52%, and a mean return on equity of -0.29%. These and other indicators suggest that the provision of WSS presents some deficits in terms of *EPS* management, situation that may be affecting the consumers' perception of the quality of the service received from the *EPS* (see page foot 8).

In order to deal with compelling financial and other problems, an *EPS* can be placed in a Transitory Support Regime (RAT, for its acronym in Spanish), as a temporary regime to improve their operations, while the Technical Agency for the Administration of the Sanitation Services (OTASS, for its acronym in Spanish), a state agency attached to the MVCS, manages these companies (e.g., elects their board and managers) (OECD, 2021). So far, 20 *EPS* are placed under OTASS administration.10[9] Once placed under RAT, an *EPS* is assessed by SUNASS every three years, to determine whether it should continue under this regime or not.

SUNASS also approves the Tariff Studies for each *EPS* and *UGM*. Tariffs should reflect the total long-run economic cost of water and sanitation services, including costs of investment, operation, and maintenance (Rogers et al., 2002; Olmstead and Stavins, 2009). For this purpose, based on an Optimized Master Plan (PMO, for its acronym in Spanish),[10] SUNASS applies a hybrid regulatory scheme, which combines efficient-firm regulation, cost regulation and yardstick competition. The regulatory scheme allows tariff increments in order to adjust for inflation; but additional tariff increments are made, conditional on the achievement of certain management goals, such as the improvement of network coverage (Felgendreher and Lehmann, 2015).

A number of consumer categories (social, domestic, commercial, industrial, and public) are identified for the tariff setting. Consumers pay a fixed charge, as well as a variable tariff based on actual consumption (increasing block rate). In urban areas with more than 15,000 inhabitants, tariffs are set for periods of 3 to 5 years. Tariffs can increase during that period, but conditional on the achievement of certain performance goals by the *EPS*. Tariff setting considers additional payments such as: (i) for the Ecosystem Services Compensation Mechanism fund, to contribute to the conservation, recovery and sustainable use of ecosystem services; (ii) for the Disaster Risk Management fund, and (iii) for the Adaptation to Climate Change fund (OECD, 2021).

On the other hand, poor households can benefit from subsidized tariffs, funded through the tariffs on other users in the system (cross-subsidization). In addition, according to Legislative Decree No 1280, SUNASS is also responsible for determining the tariffs for service provision through municipal management units (*UGM*), in the case of small towns (OECD, 2021).

8 In terms of the number of connections managed, SEDAPAL manages more than 1 million, each very large EPS manages between 100,000 and 1 million, each large EPS manages between 40,000 and 100,000, each medium- sized EPS manages between 15,000 and 40,000, and each small EPS manages fewer than 15,000. As of 2020, the total number of connections managed by SEDAPAL was 1.54 million; while such figures for very large EPS, large EPS, medium-sized EPS, and small EPS were: 0.85 million, 0.84 million, 0.35 million and 0.10 million, respectively.

9 Including Tumbes. Available at https://www.sunass.gob.pe/prestadores/empresas-prestadoras/regimen-de-apoyo-transitorio. Visited on June 1, 2022.

10 The PMO includes a plan of investments describing which projects should be carried out, and how they will be financed. The time horizon of the PMO is up to 30 years (SUNASS, 2020).

Furthermore, it is important to highlight that most investments in water and sanitation in Peru comes from direct subsidies made annually by the MVCS, the regional governments, and the local municipalities (MVCS, 2021). In this context, from a policy perspective, identifying the characteristics of the water service received by users will provide information about the room for improvements and the factors underlying the users' valuation of water service (MVCS, 2021). In addition to achieving those goals, we aim to estimate the WTP for the improvements that are valued by users (Carbajal and Lucich, 2016). These estimates could, in turn, set the ground for any subsequent change in tariffs or a public intervention via subsidization on investments or cost of service.

3. Data Collection and Study Area

We focus on urban Peru, where 81.5% of the country's population resides[11] (2017 Census data). We use data from an extensive survey conducted by telephone, between August and October, 2021,[12] with a sample of 13,700 users of water and sanitation services, from 296 districts, which belong to 108 provinces, spread across all 25 Peruvian regions.[13] This sample is representative at the level of provider groups and urban areas (see Figure C2, in the Appendix, for the surveyed sample).[14] That sample contains all respondents that received the Contingent Valuation (CV) questions for any three out of the six groups of improvements in water service we examined. For this paper, we restrict the analysis to the sub-sample that received CV questions on the following three sets of improvements: in water quality, continuity, and to secure access for non-connected users, which is composed of 2121 respondents.[15]

The survey's questionnaire is divided into three sections containing: (i) the main features of the WSS received|: type of connection, provider, use of water meter, use of water tanks or reservoirs, monthly service bill, knowledge of water source, treatment of waste water, satisfaction with service, filing of service complaints, practices of water treatment before consumption, expenditure in bottled water, and characteristics of the water received (quality and continuity); (ii) the Contingent Valuation (CV) questions, using a close-ended approach. As mentioned earlier, three groups of CV questions were chosen per respondent (section 4 contains the details about this selection); and (iii) the respondent's demographics and household's characteristics: age, sex, education, main economic activity, income, house ownership, household size (younger than 5, older than 18), number of floors, rooms, and bathrooms, type of house wall (whether the house wall was made of brick and mortar,[16] our proxy for assets), having a backyard, and tenancy of durable goods (personal computer, cell phone, washing machine, automobiles, TV, microwave, refrigerator).

Our survey respondents are household heads (57.8%), their partners (22.1%), or any other adult responsible for

11 An urban population center (*Centro poblado urbano*) is defined by the official statistics as one having at least two thousand inhabitants.

12 While we did not have a choice about the mode of survey, since this was conducted in times when a strict physical distancing was mandatory in Peru, due to the COVID-19 pandemic, it is worth mentioning that there is a widespread use of cell phones in the country: 94.5% of households have at least one member with a cell phone, a figure that is 96.4% in Lima (the capital city of Peru), 97.1% in the rest of urban areas, and 86.2% in rural areas (INEI, 2021b). Thus, we should not expect the phone survey to yield significantly different results from those that could have been obtained by in-person interviews.

13 The geopolitical division of Peru includes 25 regions (akin to a US State), 196 provinces, and 1874 districts, as of December 2019. Another important distinction made when analyzing the data is among the three natural regions in Peru: the Coastal area (Costa), bordering the Pacific Ocean; the Highlands (Sierra), which is a section of the Andes; and the Jungle (Selva), the Peruvian section of the Amazon.

14 The data collection was in charge of an experienced company conducting socioeconomic surveys in Peru. Our research team trained all the pollsters. During the training, we paid special attention to explain the rationale behind the contingent valuation single-bounded and double-bounded questions, so that they could appropriately collect that information. A set of pilot surveys was conducted to test the software, procedures, and clarity of the instructions, as well as to time the length of the questionnaire. Excluding outliers, the average survey time was 20 minutes. The response rate was 60%. From the calls that were accepted, 98.4% were made to cell phones, and the remaining 1.6% were made to land line numbers.

15 Around 53% of our full sample is composed of users who reported any flaw in water quality and continuity (and thus received CV questions for a third group of improvements), and 40% includes users with flaws in either water quality or continuity.

16 One could claim that this variable could not properly capture the tenancy of assets in the *Sierra* and the *Selva*. However, the percent of households reporting their houses wall to be made with brick and mortar is fairly high in all three natural regions: 89% on the Coastal region, 74% in the *Sierra*, and 70% in the *Selva*.

the household's expenses (20.1%). Table 1 reports the main descriptive statistics for our sample, split by type of provider; the last column reports the number of observations for any given feature (row). In our sample, 93% of the respondents' households have a connection to water and sanitation services, while 7% has only water service; 97.5% of water users have house connection to piped water (and this share is similar across providers). The use of water meter is more common among users from medium-sized and larger *EPS* (75% or more have metered water use), in clear contrast with those from small *EPS* (45.7%) and *UGM* (18.9%). In terms of in-house water storage mechanisms, though on average, a small share of households has water reservoir (or water tank) (between 4% and 9%), about 26% of households have upstairs water tank. In general, users from the largest *EPS* show the highest use of upstairs water tanks.

In terms of the overall satisfaction with the service, we see a modest average level: 2.7 (in a 1-to-5 Likert scale), with a minimum of 2.2 (for small *EPS*) and a maximum of 3.2 (for SEDAPAL, the largest provider). In terms of the consumption of water, the average amount of the WSS bill in our sample decreases with the size of the provider, with the highest amount (PEN 76.9 or USD 18.8) being paid by SEDAPAL users, equivalent to more than six times the average amount paid by water users from *UGM* (PEN 12.3); these differences largely reflect the households' dissimilar purchasing power across cities. Furthermore, users spend a non- negligible portion of their monthly WSS bill in bottled water; such percentage goes from 15.2% (SEDAPAL users) to 83.7% (*UGM* users), with an average of 28% for all sample. These figures suggest a complementary between piped and bottled water for households in our sample, a connection we will explore in our regression analysis.

In terms of the quality of the piped water received, we see a substantial heterogeneity in all six conditions examined (color, turbidity, presence of particles, smell, flavor, and safety). On average, between 11.7% and 26.4% of the sample mentioned that the tap water they receive was not crystal clear, or has particles, or is turbid, or has foul smell, or has foul flavor (in all cases, we see a substantial heterogeneity across providers), while a resounding 83.2% perceived the tap water as unsafe. As a result, on average, 1.8 out of six of those problems were reported, with SEDAPAL users reporting a smaller number of problems (1.4) than the rest of providers (1.9-2.4). For most of those characteristics, the *UGM* serving small towns have more positive indicators than small *EPS*. All those six characteristics were used to examine the WTP for improvements in water quality. For the CV questions, the rate of positive responses to the random bids the respondents received to implement the related improvements go from 32% (SEDAPAL) to about 50% (*UGM* and large *EPS*), with an average of 43.1%.

In terms of the second group of water attributes (weekly availability, daily availability, water pressure and service interruptions) scrutinized, we observe a greater report of problems, especially in terms of inadequate pressure and service interruptions. Thus, households receive water 15.3 hours daily on average; this figure is the highest for SEDAPAL users (21.7 hours daily) and the lowest for *UGM* and small *EPS* users (about 11 hours daily). As a result, the percent of users unsatisfied with the daily hours of service goes from 17.3% (SEDAPAL) to 61.8% (*UGM*), with an average of 44.3%. We see higher levels of dissatisfaction across all providers in the case of water pressure (63.5% respondents report inadequate levels: 26.1% due to an excessive pressure, and 37.4%, to a low pressure) and a slightly lower dissatisfaction with interruptions in water service (60.3% of respondents reported service interruptions during the six months prior to the survey). Thus, on average, 1.5 problems (out of 4 possible ones) were reported for SEDAPAL and 2.3 for small *EPS*, and about 2 for the remaining providers, with an overall average of 1.9. The rate of positive responses to the random bids received by the respondents fluctuates between 30.2% (SEDAPAL) and 57.2% (large *EPS*), with an average of 46.8%. Except for SEDAPAL, the rate of positive responses is higher for all providers than that recorded for improvements in water quality.

In the case of securing water access for those with no house piped water, we used a double-bound approach, the rate of positive responses to the initial bid are the same, on average, as those for water quality, but lower than those for water quantity (continuity, interruption in service and pressure). Including the second bid, the average rate of positive responses (to either the first bid, the second bid, or both) is 56.9%. This figure could be reflecting both a concern for helping the poor (those non-connected users) to secure access to water in times of the COVID-19 pandemic (altruism), and an attempt to reduce the extent of a negative externality (the spread of the COVID-19), among other reasons.

In terms of the demographic characteristics of our sample, our average respondent is 43.9 years old, with relatively older users from SEDAPAL (47.2 years old) and younger users from very large *EPS* (around 41.3 years old). Also, 53.6% of respondents are women, with averages going from 49% (*UGM*) to 61.5% (very large *EPS*). Respondents have similar average education levels across all *EPS* (around 7, indicating some post-secondary technical education), while users from *UGM* have lower average levels, 5.5 (indicating some secondary education), in a 1 (Illiterate)-to-11 (graduate studies) scale. These figures, however, mask a significant heterogeneity observed at higher levels of education, especially university education.[17]

We further gathered information on income and assets (proxied by an indicator for a house wall made of brick and mortar). In the former case, considering 11 income brackets, we see that, in general, smaller *EPS* serve lower-income households. We see a similar pattern in the latter indicator (93.3% for households served by SEDAPAL, and 58% for those served by *UGM*). Finally, the figures for house ownership and the share of children under five years of age in the household tend to be larger for smaller providers, with averages of 56.1 and 5.3%, respectively.

Table 1. Basic descriptive statistics, by provider (Averages)

	SEDAPAL	***EPS***				***UGM***	**TOTAL**	
		Very large	**Large**	**Medium-sized**	**Small**		**Mean**	**N**
Water and sanitation service								
Household has only water service (%)	0.4	2.7	5.7	8.5	5.2	15.0	7.0	2,121
Household has water and sewage service (%)	99.6	97.3	94.3	91.5	94.8	85.0	93.0	2,121
Household has a piped connection inside the house (%)	97.5	98.3	97.7	97.5	100.0	96.7	97.5	2,121
Household has water meter (%)	94.7	88.1	75.0	75.7	45.7	18.9	63.7	2,121
Has water reservoir (downstairs) (%)	8.1	13.8	9.8	6.1	13.0	6.8	8.9	2,121
Has water tank (%)	4.9	6.9	4.6	3.1	3.8	2.7	4.2	2,121
Has upstairs water tank (%)	29.0	35.2	30.8	18.0	23.6	17.5	25.7	2,121
Satisfaction with the service (1 to 5) [a/]	3.2	2.6	2.7	2.8	2.2	2.4	2.7	2,121
Expenditure in bottled water, last month (PEN)	11.7	14.0	13.9	14.3	8.0	10.3	12.1	2,121
Monthly water and sanitation service bill (PEN) [b/]	76.9	51.7	43.8	32.0	21.8	12.3	43.0	2,121
Water quality (color, turbidity, presence of particles, smell, flavor, and safety)								
Tap water has color [c/] (%)	9.5	12.1	25.0	21.9	30.1	15.1	16.1	2,121
Tap water is turbid [d/] (%)	12.0	23.2	24.0	22.0	22.1	23.6	20.6	2,121
Tap water has particles (%)	8.1	6.2	14.1	12.3	14.7	15.3	11.7	2,121
Tap water has foul smell (%)	11.4	26.9	25.0	27.4	42.3	27.7	23.4	2,121
Tap water has foul flavor (%)	14.8	34.6	23.9	28.1	40.6	31.6	26.4	2,121
Tap water feels unsafe [e/] (%)	81.9	84.7	80.1	81.0	87.3	85.5	83.2	2,121
Number of problems reported for water quality (0/6)	1.4	1.9	1.9	1.9	2.4	2.0	1.8	2,121
Positive responses for bid (0=No; 1=Yes) (%)	32.0	39.5	49.3	43.9	40.6	50.2	43.1	2,121
Water continuity, no interruptions in service and adequate pressure								
Daily continuity (hours)	21.7	15.1	14.2	16.9	10.7	10.8	15.3	2,110
Unsatisfied with daily continuity (%)	17.3	45.2	49.8	41.7	55.0	61.8	44.3	2,110
Receives water fewer than 7 days a week (%)	5.3	20.7	15.0	13.6	35.8	24.8	17.0	2,110
Pressure of water is inadequate (%) [f/]	61.7	62.4	62.4	63.2	75.0	65.0	63.5	2,110
Experienced water service interruptions last 6 months (%)	69.2	71.7	54.9	57.6	59.6	51.7	60.3	2,110
Number of service interruptions (last 6 months)	3.4	3.6	2.7	2.3	2.5	2.6	2.9	2,110
Number of problems reported for water continuity, no interruptions and adequate pressure (0/4)	1.5	2.0	1.8	1.8	2.3	2.0	1.9	2,110
Positive responses for bid (0=No; 1=Yes) (%)	30.2	43.2	57.2	54.5	55.6	52.8	46.8	2,110
Water access for 3 million people with no house piped water in times of the COVID-19 pandemic								
Positive responses for first bid (0=No; 1=Yes) (%)	37.2	44.6	49.4	40.7	38.1	44.4	43.1	2,121
Positive responses for second bid (0=No; 1=Yes) (%)	34.4	38.5	38.5	33.9	33.3	34.7	35.8	2,121
Positive responses for some bid (0=No; 1=Yes) (%) [g/]	49.1	58.7	63.8	54.7	60.7	58.3	56.9	2,121
Individual and household characteristics								
Age of respondent (years)	47.2	41.3	42.8	44.2	43.8	43.2	43.9	2,057

17 In the entire sample, 55% of respondents either completed post-secondary technical or higher education. Those figures are 60.3% for users from SEDAPAL, 75.8% for users from very large EPS, 66.2% for users from large EPS, 56.9% for users from medium-sized EPS, 48.6% for users from small EPS, and 33.9% for users from UGM.

Respondent is women (=1) (%)	54.2	61.5	53.4	54.0	58.0	49.0	53.6	2,121
Education level of respondent (1 to 11) [h/]	6.7	7.1	7.0	6.5	6.0	5.5	6.4	2,121
Respondent has Primary education or lower (%)	2.2	6.2	4.4	6.1	10.3	13.6	7.3	2,121
Respondent has Secondary education (%)	37.5	18.0	29.4	37.0	41.1	52.5	37.7	2,121
Respondent has post-secondary technical college education (%)	23.4	27.7	19.5	21.5	21.0	19.2	21.8	2,121
Respondent has university education or higher (%)	37.0	48.1	46.7	35.4	27.6	14.8	33.2	2,121
Household income brackets in PEN (1 to 11)[i/]	7.7	8.1	7.8	8.4	9.4	9.8	8.5	2,121
House wall made of bricks and mortar (1=Yes; 0=No) (%)	93.3	89.4	87.1	68.3	72.9	58.0	78.2	2,121
Respondent owns the house (1=Yes; 0=No) (%)	48.5	46.4	53.6	58.9	64.0	67.1	56.1	2,121
Share of children younger than 5 in household (%)	3.5	5.4	5.9	4.9	6.4	6.4	5.3	2,121
Observations	311	405	654	200	97	454	n.a.	2,121

Note: The number of observations smaller than 2,121 is due to non-responses. We used the expansion factor to produce these statistics. [a/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [b/] From the 110 respondents with missing information, 29 do not know the amount paid, 47 do not pay for water and sanitation service, and 34 have such cost included in the rental cost. [c/] Water has color of tea, is white-ish, or has any other color. [d/] Water is turbid, during the first minutes after opening the faucet, or all the time. [e/] For this question, we first defined "safe water" as not containing germs or toxic substances that could affect peoples' health. [f/] Meaning that water pressure is low, very low, high, or excessively high, in regards to an "adequate" pressure. [g/] This indicator is equal to 1, if the respondent accepted either the first bid or the second bid, or both. [h/] Education levels: 1: Illiterate; 2: Kindergarten; 3: Some Primary; 4: Primary; 5: Some Secondary; 6: Secondary; 7: Some post- secondary technical education; 8: Post-secondary technical education; 9: Some university; 10: University; 11: Graduate. [i/] Income levels (PEN): 1: More than 13,000; 2: [6,701, 13,000); 3: [5,001, 6,700); 4: [4,001, 5,000); 5: [3,401, 4,000); 6: [2,801, 3,400); 7: [2,301, 2,800); 8: [1,901, 2,300); 9: [1,401, 1900); 10: [801, 1,400); 11: Less than 800. Source: SECOSAN Survey for Urban Peru (2021).

4. Methodology

We employed the contingent valuation (CV) method, which is a commonly used tool to estimate the willingness to pay for improvements in several elements of water quality, both in developed and developing countries.[18] In particular, we implemented the referendum (also called a dichotomous choice) approach, which asks for a "Yes/No" answer to a specific bid, randomly drawn from a discrete set of prices. This format in intended to overcome the "zero" answers that may affect open question formats and the starting point bias that affects the bidding design.

In our research design, we used a comprehensive survey to elicit the WTP for six groups of improvements in water service, related to investments: (1) to ensure the quality of water service (related to color, turbidity, presence of particles, smell, flavor, and safety); (2) to increase water continuity (days of week and hours per day), avoid service interruptions, and provide an adequate pressure; (3) to improve the treatment of wastewater to avoid the contamination of rivers, lakes and the sea; (4) to mitigate the impact of a natural disaster (e.g. an earthquake or "*El Niño*" Phenomenon) on water service availability; (5) to improve the conservation and recovery of natural sources of water (e.g., rivers, lagoons or natural springs), to guarantee the water supply for the next 10 years; and (6) to secure the supply of potable water via water trucks for 3 million people with no house piped water, to ensure cleanliness and hygiene practices, such as hand washing, to prevent the spread of the COVID-19. In this paper, we focus on the first, second and sixth groups.[19]

We asked for the marginal WTP using a single-bound dichotomous choice for groups 1 and 2 (with a 'Yes/No' answer), and a double-bound approach for groups 3 to 6. In the double-bound questions, an affirmative answer to an initial randomly selected bidding price expressed in PEN (say b_1 was followed by a dichotomous choice question about a second price ($b_2 > b_1$), while a negative answer was followed either by a price equal to ($b_2 < b_1$) (if $b_1 > 1$) or (if $b_2 = 0.5$) (if $b_1 = 1$). The initial bids ranged from PEN 1 to 11 (or USD 2.7) to properly reflect a sensible

18 Two alternative methods of non-market goods valuation include choice experiments and travel cost. Carson et al. (1996) conducts a meta-analysis comparing CV values with those from travel cost values. In general, the author finds lower CV values, which we can take as a lower bound, at least compared to the travel cost method.

19 An interesting question to examine would be whether the WTP for water quality and continuity remains when the third group is not water access for the poor but any other improvement. We defer this to further research.

bids' distribution.[20] More details about the set of bids for each group (which varies) under study are presented in section 5 (see Table 2).

In our design, each respondent was asked about only three out of the six groups of improvements in water service. For each respondent, if she reported any problem related to water quality (group 1) or continuity, interruptions in service, and adequate pressure (group 2), they received CV questions on these groups. And, if the respondent had access to sewage network (93% of our sample does), the third group was randomly selected from the four remaining groups.[21] Thus, we have three random components in our research design: The group of improvements over which to express a marginal WTP (at least one of these groups was randomly chosen), the order in which the groups were presented for the CV exercise, and the bids (an ad hoc software, designed for our project, automatically randomized those conditions for each respondent). Since the three sets of WTP questions were not made independently, we can aggregate the WTP.[22]

As mentioned earlier, for Groups 1 and 2, our questionnaire identified the existence of deficiencies in service in regards to the aforementioned features, before asking the CV questions. In particular, for the case of water quality, the four related questions were: Q1: "¿Is the tap water in your household clear, or has a color, is turbid, or comes with particles?" (multiple choice answers in closed format), Q2: "¿Does the tap water in your household have a foul smell?" (Yes/No answer), Q3: "¿Does the tap water in your household have a foul flavor?" (Yes/No), Q4: "'Safe' water is defined as water that, because of its condition and treatment, does not have germs or toxic substances that may affect peoples' health. ¿Do you think that the tap water in your household is safe?" (Yes/No). Appendix A presents the questions used for the case of water quality.[23]

4.1 Empirical Strategy

We model the WTP for improvements in each group examined as follows. Under the double- bounded dichotomous choice approach, individual i is asked about an initial bid or price (b_1), and then about a second price (b_2), which will be higher than b_1, after a positive answer; and lower than b_1, otherwise. Thus, since we assume that the underlying WTP differs for both responses, we estimate the WTP for the first (WTP_{1i}) and second questions (WTP_{2i}) using binary choice models, as follows:

$$\begin{cases} WTP_{1i} = X'_{1i}\beta_1 + \varepsilon_{1i} \\ WTP_{2i} = X'_{2i}\beta_2 + \varepsilon_{2i} \end{cases}, \qquad (1)$$

where X_{1i} and X_{2i} are vectors of independent variables that include the bids that were offered (b_1 and b_2, respectively), individual i's characteristics and her household's characteristics, potentially correlated with the WTP. Our survey collected information about these correlates.

If we let Y_{1i} and Y_{2i} denote the individual i's answers to the first and second bids, respectively, the typical latent utility framework is used to link those answers to the WTP equation, as follows:

$$\begin{cases} Y_{1i} = 1, \text{if } X'_{1i}\beta_1 + \varepsilon_{1i} > b_{1i}; \text{otherwise}, Y_{1i} = 0 \\ Y_{2i} = 1, \text{if } X'_{2i}\beta_2 + \varepsilon_{2i} > b_{2i}; \text{ otherwise}, Y_{2i} = 0 \end{cases} \qquad (2)$$

20 As part of our research project, we conducted 42 focus groups with about 336 WSS users from all types of providers. The bids used in our survey roughly respond to the values stated by those users; in particular, the maximum amount (PEN 11).

21 The 3-group sequence generated for each respondent took this form: "xyz", where the values 123, 231, and 312, which reflect the order of each group, were equally likely. For instance, a respondent with the sequence 3,1,_,_,_,2 received CV questions for group 2, group 6, and group 1, in that order. The blanks mean this subject did not receive questions for groups 3, 4, and 5.

22 In each of the three groups of WTP questions, the respondents were told that they will be asked three times (i.e., for three groups of improvements), so that, when answering, they should consider that the implementation of those improvements would reduce their disposable income by the aggregate amount they stated. See Appendix A.

23 The questionnaires used for the other groups of improvements in water service are available from the authors upon request.

Thus, respondent i's answer is 'yes' to the first bid (i.e., accepts the bid), if her WTP is greater than its bid value; and similarly, for the answer to the second bid. When we examine the single bounded cases (for water quality and water continuity, no interruptions and adequate pressure), only the first part of equations (1) and (2) will be estimated. And when we estimate the double bounded case (water access for non-connected people), we use both parts of those equations in the estimation. We proceed in two ways for this last case: we estimate a bivariate *Probit* specification (where two separate sets of estimates are obtained), and a joint specification, where only one set is estimated are obtained (we use the Lopez-Feldman (2010) *doubleb* Stata module). We compute the Krinsky and Robb (1986) confidence intervals for the mean WTP from the estimations of binary choice models, using 5000 draws.

From the estimation of equation (1), we calculate the mean WTP for both the first and the second bids, as follows:

$$E(WTP) = -\frac{X'\hat{\beta}}{\hat{\beta}_{price}}$$

Next, we examine the acceptance rates (positive responses) for each of the bid used, and the marginal WTP for the three groups of improvements in service under scrutiny, as well as the correlates of the related WTP.

5. Results

The response rates for the initial bids for our sample are within expectations, as shown in Table 2: 44.1% for improved water quality, 49.3% for improved water continuity, no interruptions and adequate pressure, and 44.2% to secure water access for non-connected people. As expected, the average acceptance rates of the initial bid are decreasing with the bid amount (this provides some assurance for the construct validity of the study design: the law of demand holds). Note that the average acceptance rates are similar across these groups of improvements, although the frequency of the initial bids somewhat differs, especially between water quality and water access.

Table 2: Response rate by initial amounts of bid

Initial bid (PEN)	Water quality (color, turbidity, presence of particles, smell, flavor, & perceived safety)			Water continuity, no interruptions in service & adequate pressure			Water access for 3 million people with no house piped water during the COVID-19 pandemic		
	No	Yes	Total	No	Yes	Total	No	Yes	Total
1	63 (26.6)	174 (73.4)	237 (100.0)	61 (29.8)	144 (70.2)	205 (100.0)	170 (39.2)	264 (60.8)	434 (100.0)
2							400 (51.2)	382 (48.8)	782 (100.0)
3	150 (43.6)	194 (56.4)	344 (100.0)	306 (43.7)	394 (56.3)	700 (100.0)			
4				261 (49.2)	269 (50.8)	530 (100.0)	395 (66.8)	196 (33.2)	591 (100.0)
5	282	240	522	231	154	385	144	62	206
	(54.0)	(46.0)	(100.0)	(60.0)	(40.0)	(100.0)	(69.9)	(30.1)	(100.0)
6	268 (63.2)	156 (36.8)	424 (100.0)						
7				129 (70.5)	54 (29.5)	183 (100.0)	75 (69.4)	33 (30.6)	108 (100.0)
8	255 (69.9)	110 (30.1)	365 (100.0)						
9	92 (67.6)	44 (32.4)	136 (100.0)	88 (74.6)	30 (25.4)	118 (100.0)			

11	75 (80.6)	18 (19.4)	93 (100.0)						
Total	**1,185 (55.9)**	**936 (44.1)**	**2,121 (100.0)**	**1,076 (50.7)**	**1,045 (49.3)**	**2,121 (100.0)**	**1,184 (55.8)**	**937 (44.2)**	**2,121 (100.0)**

Note: Row percentages in parentheses. The average overall positive responses reported in this table differ from those reported in Table 1 because back then, we used the population expansion factor. For this table, we did not weight the observations.

In terms of the estimation of WTP, and its correlates, our base equation includes individual characteristics (age, sex and education), household-level features (percent that children under age of 5 represent in the household, an indicator for the house wall made with brick and mortar (our proxy variable for assets), ownership of the house, and expenditure in bottled water), in addition to the satisfaction level with the service received, as well as indicator variables for the order in which the WTP for the improvement under scrutiny was asked to the respondent (in first or second place, with the third place as the omitted category), to control for a potential sequencing effect.

We estimate a logit regression for water quality; continuity of service, no interruptions and adequate pressure; and water access for people with no house piped water (first part of equations 1 and 2);[24] and a double-bound and a bivariate *Probit* regressions (equations 1 and 2) for the last group of improvements. In all cases, in addition to the correlates of the WTP for improved water service, we are interested in estimating the marginal WTP amount. As mentioned earlier, we restrict our sample to those respondents who reported any problem with water quality *and* with continuity, interruptions of service, or pressure, *and* were randomly selected to get questions about contributing to secure water access for non-connected users.

Table 3 reports the results for improvements in water quality. We first show the unconditional WTP (column 1), and then we add some respondent's characteristics (column 2), and household-level variables (column 3). As seen in column 3, the WTP is positively and significantly correlated with education and expenditure in bottled water, which acts a substitute for tap water.[25] Those coefficient estimates are robust to the inclusion of controls for the order in which this particular improvement in service (hereafter, *regular* controls) was introduced to respondents (column 4) (this will be our preferred specification), and provider fixed effects (column 5).[26] Age, sex and the share of children under five in the household do not appear to be significantly correlated with the WTP in any of the five specifications used.[27] Finally, respondents with house walls made of brick and mortar (our indicator of household's assets) are willing to pay a smaller amount for improved water; this is consistent higher-income richer households being less willing to pay for improvements in water service.[28] Also, while the level of service satisfaction has a positive coefficient, it is not statistically significant; house ownership is also non-significant.

The other important information from these estimations is the mean/median WTP, which lies between PEN 4.0 and 4.5 (around USD 1.3), as shown at the bottom of the table, where we also report the Krinsky and Robb (1986) confidence intervals. Those amounts are equivalent to 9.3%- 10.5% of the WSS average monthly bill.

Table 3: Logit regressions on the WTP for improved water quality (color, turbidity, presence of particles, smell, flavor, and perceived safety)

	(1)	(2)	(3)	(4)	(5)
Bid	-0.234*** (0.021)	-0.246*** (0.022)	-0.247*** (0.023)	-0.255*** (0.023)	-0.247*** (0.023)
Age (years)		-0.003 (0.004)	0.001 (0.004)	-0.000 (0.004)	0.003 (0.005)

24 The results are similar when we estimate *Probit* models.

25 93% percent of respondents make some treatment of tap water before drinking it. This figure is 97.2% for SEDAPAL users, 94.2% for very large *EPS* users, 88.5% for large *EPS* users, 92.9% for medium-sized *EPS* users, 93.8% for small *EPS* users, and 94.2% for *UGM* users. The most common treatment made is boiling water, which was done by 94.9% of those who treat it.

26 Though the specification in column 5 yields greater WTP figures for all improvements in service, we prefer to be a bit conservative by using the specification in column 4.

27 The coefficient on sex is negative (women are willing to pay less), while that on children under five is positive (households with a larger share of children under five are willing to pay more). This latter result is commonly found by previous studies (e.g., Chaterjee et al., 2017 and Tanellari et al. 2015).

28 If we included income in the specification, besides losing a significant number of observations (due to non- responses), we would see that this variable negatively affects the WTP. Results are available upon request.

Women (=1)		-0.075 (0.105)	-0.081 (0.106)	-0.091 (0.108)	-0.075 (0.109)
Education levels (1 to 11)[a/]		0.113*** (0.026)	0.130*** (0.029)	0.123*** (0.029)	0.138*** (0.030)
Children under five (%)[b/]			0.426 (0.539)	0.430 (0.552)	0.280 (0.558)
House wall[c/]			-0.526*** (0.131)	-0.520*** (0.136)	-0.399*** (0.141)
Respondent owns the house (=1)			-0.091 (0.112)	-0.130 (0.115)	-0.214* (0.116)
Expenditure in bottled water[d/]			0.016*** (0.003)	0.016*** (0.003)	0.017*** (0.003)
Satisfaction with service (1 to 5)[e/]				0.012 (0.051)	0.066 (0.053)
Constant	0.942*** (0.123)	0.505* (0.296)	0.480 (0.318)	0.150 (0.355)	-0.087 (0.356)
Order-of-the-group fixed effects[f/]	No	No	No	Yes	Yes
Provider fixed effects	No	No	No	No	Yes
Observations	2121	2057	2057	2057	2057
Pseudo R^2	0.057	0.071	0.091	0.120	0.132
Mean/Median WTP (PEN)	4.03	4.37	4.36	4.34	4.52
Krinsky and Robb 95% CIs[g/]	[3.51, 4.48]	[3.88, 4.78]	[3.87, 4.78]	[3.87, 4.76]	[4.06, 4.92]

Note: [a/] Education levels: 1: Illiterate; 2: Kindergarten; 3: Some Primary; 4: Primary; 5: Some Secondary; 6: Secondary; 7: Some post-secondary technical education; 8: Post-secondary technical education; 9: Some university; 10: University; 11: Graduate. [b/] Share of children under five in the household. [c/] House wall made of brick and mortar (=1). [d/] Monthly expenditure in bottled water, in PEN. [e/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [f/] Indicators for the WTP for water access through water trucks appearing in the first or second order. [g/] We used 5,000 replications. Robust standard errors in parenthesis. * p < 0.10, ** p<0.05,*** p<0.01.

In the case of the improvement in water continuity, no interruptions in service, and adequate pressure (see Table 4), we find two sets of differences with respect to the case of water quality. First, in terms of the correlates of the WTP, the sex of the respondent is negatively and significantly correlated with the WTP, with women being less prone to pay more for this type of improved water than men. Similarly, education is not significant in any specification. The rest of covariates have similar significance levels as in the case of water quality.[29] Second, the point estimates of the mean/median WTP are smaller (by approximately 11% to 12%) in each specification, and go from PEN 3.55 to 4.04.[30] This smaller mean WTP at the margin might be due to a smaller number of improvements considered in this case or to the intrinsically higher valuation of water availability (and adequate pressure) with respect to the quality of water, conditional on having it.

Table 4: Logit regressions on the WTP for improved water continuity, no interruptions in service and adequate pressure

	(1)	(2)	(3)	(4)	(5)
Bid	-0.283*** (0.030)	-0.290*** (0.030)	0.302*** (0.031)	-0.299*** (0.031)	-0.300*** (0.032)
Age (years)		-0.007* (0.004)	-0.003 (0.004)	-0.003 (0.004)	0.000 (0.004)
Women (=1)		-0.331*** (0.102)	-0.332*** (0.103)	-0.335*** (0.104)	-0.331*** (0.106)
Education levels (1 to 11)[a/]		-0.017 (0.025)	0.004 (0.027)	0.010 (0.027)	0.014 (0.028)
Children under five (%)[b/]			0.980* (0.538)	0.979* (0.541)	0.849 (0.544)
House wall[c/]			-0.555*** (0.132)	-0.562*** (0.133)	-0.454*** (0.139)
Respondent owns the house (=1)			0.063 (0.110)	0.060 (0.110)	-0.027 (0.113)

29 Though we use the same base specification for all sets of improvements in water service, our results are robust to alternative (more complete) specifications, as we will show in section 5.1.

30 We should be cautious with this interpretation, as the WTP figures across groups of improvements are not strictly comparable: the former measures improvements in quality (e.g., going from water with particles to crystal clear), while the latter asks for improvements in quantity (continuity), no interruptions in service and adequate pressure.

Expenditure in bottled water[d/]			0.016*** (0.003)	0.015*** (0.003)	0.015*** (0.003)
Satisfaction with service (1 to 5)[e/]				-0.070 (0.048)	-0.011 (0.049)
Constant	1.006*** (0.128)	1.650*** (0.297)	1.574*** (0.321)	1.510*** (0.348)	1.237*** (0.358)
Order-of-the-group fixed effects[f/]	No	No	No	Yes	Yes
Provider fixed effects	No	No	No	No	Yes
Observations	2121	2057	2057	2057	2057
Pseudo R^2	0.044	0.051	0.073	0.081	0.101
Mean/Median WTP (PEN)	3.55	3.68	3.70	3.71	4.04
Krinsky and Robb 95% CIs[g/]	[3.17, 3.90]	[3.31, 4.02]	[3.35, 4.03]	[3.35, 4.05]	[3.70, 4.36]

Note: [a/] Education levels: 1: Illiterate; 2: Kindergarten; 3: Some Primary; 4: Primary; 5: Some Secondary; 6: Secondary; 7: Some post-secondary technical education; 8: Post-secondary technical education; 9: Some university; 10: University; 11: Graduate. [b/] Share of children under five in the household. [c/] House wall made of brick and mortar (=1). [d/] Monthly expenditure in bottled water, in PEN. [e/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [f/] Indicators for the improvement in water continuity, interruptions and adequate pressure appearing in the first or second order. [g/] We used 5,000 replications. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Lastly, Table 5 reports the estimates of the correlates of WTP and the mean WTP for securing water access for people with no house piped water, via water trucks, using a simple logit regression. We report two sets of results. First, unlike the case of water quality and continuity (quantity), age and satisfaction with the service appear correlated with the WTP: older people are more willing to accept the bid offered, and so do users more satisfied with the service. Moreover, WTP is also positively influenced by users' education levels. And, the coefficients on our proxy variable for assets and the expenditure in bottled water show the same signs and similar magnitudes than those observed for the prior water service improvements.

Second, we continue to see smaller WTP estimates than those obtained for improvements in water that the respondents would actually receive (quality and continuity). The point estimates of the mean WTP go from PEN 1.64 to 2.03, amounts equivalent to less than half those found for improvements in water quality. In a way, unlike WTP estimates for water quality and quantity, these figures may reflect the concern for others, in times where access to water was particularly important to stop the spread of the COVID-19. The statistical significance of those reveals certain level of altruism among water users.

In sum, we see that the while there are common factors influencing the WTP for all three types of improvements examined, some of the factors are particular to the specific improvements studied. Thus, had we examined fewer categories of improvements in service, we would have captured a partial picture of the factors influencing the WTP.

Table 5: Logit regressions on the WTP for securing water access for 3 million people with no house piped water, in times of the COVID-19 pandemic

	(1)	(2)	(3)	(4)	(5)
Bid (first bid)	-0.240*** (0.033)	-0.241*** (0.034)	-0.241*** (0.033)	-0.248*** (0.034)	-0.248*** (0.035)
Age (years)		-0.010*** (0.004)	-0.008* (0.004)	-0.009** (0.004)	-0.007* (0.004)
Women (=1)		-0.022 (0.102)	-0.030 (0.103)	-0.027 (0.104)	-0.025 (0.105)
Education levels (1 to 11)[a/]		0.058** (0.026)	0.066** (0.027)	0.065** (0.027)	0.063** (0.028)
Children under five (%)[b/]			-0.242 (0.526)	-0.143 (0.530)	-0.214 (0.533)
House wall[c/]			-0.389*** (0.128)	-0.420*** (0.129)	-0.420*** (0.133)
Respondent owns the house (=1)			-0.124 (0.110)	-0.098 (0.112)	-0.117 (0.114)
Expenditure in bottled water[d/]			0.010*** (0.003)	0.012*** (0.003)	0.012*** (0.003)
Satisfaction with service (1 to 5)[e/]				0.123*** (0.048)	0.145*** (0.050)

Constant	0.394*** (0.103)	0.534* (0.285)	0.642** (0.305)	0.177 (0.335)	0.117 (0.344)
Order-of-the-group fixed effects[f/]	No	No	No	Yes	Yes
Provider fixed effects	No	No	No	No	Yes
Observations	2121	2057	2057	2057	2057
Pseudo R^2	0.044	0.031	0.041	0.051	0.055
Mean/Median WTP (PEN)	3.55	1.87	1.86	1.86	2.03
Krinsky and Robb 95% CIs[g/]	[3.17, 3.90]	[1.30, 2.30]	[1.29, 2.29]	[1.32, 2.30]	[1.52, 2.42]

Note: [a/] Education levels: 1: Illiterate; 2: Kindergarten; 3: Some Primary; 4: Primary; 5: Some Secondary; 6: Secondary; 7: Some post-secondary technical education; 8: Post-secondary technical education; 9: Some university; 10: University; 11: Graduate. [b/] Share of children under five in the household. [c/] House wall made of brick and mortar (=1). [d/] Monthly expenditure in bottled water, in PEN. [e/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [f/] Indicators for the WTP for water access through water trucks appearing in the first or second order. [g/] We used 5,000 replications. Robust standard errors in parenthesis. * p < 0.10, ** p<0.05,*** p<0.01.

As mentioned in Section 4.1, since we used a double-bounded approach for this improvement in service, we can estimate a bivariate *Probit* model and a double bound regression. In the former case (whose results are reported in Table 6), for the first bid, we see similar results (in significance and magnitude) than those reported from the estimation of a logit model (age, education, our proxy for assets, expenditure in bottled water, and satisfaction with the service are significantly correlated with WTP), while in the latter (see Table B1 in the Appendix), we also see similar qualitative results. The mean WTP from the double-bound regressions is around PEN 2.10- 2.17 in all specifications (Table B1), while the mean WTP for the second bid in the bivariate *Probit* regressions is substantially lower, and in all specifications, we cannot reject the null hypothesis of the coefficients taking the value of 0 (Table 6).

Table 6: Bivariate Probit regression on the WTP for securing water access for 3 million people with no house piped water, in times of the COVID-19 pandemic

	(1)	(2)	(3)	(4)	(5)
First bid	-0.153*** (0.020)	-0.153*** (0.020)	-0.153*** (0.021)	-0.156*** (0.021)	-0.156*** (0.021)
Age (years)		-0.006*** (0.002)	-0.005** (0.003)	-0.005** (0.003)	-0.005* (0.003)
Women (=1)		-0.012 (0.063)	-0.013 (0.064)	-0.013 (0.064)	-0.012 (0.064)
Education levels (1 to 11)[a/]		0.035** (0.016)	0.038** (0.017)	0.040** (0.017)	0.039** (0.017)
Children under five (%)[b/]			-0.081 (0.323)	-0.097 (0.323)	-0.139 (0.325)
House wall[c/]			-0.256*** (0.079)	-0.261*** (0.079)	-0.261*** (0.081)
Respondent owns the house (=1)			-0.063 (0.068)	-0.056 (0.069)	-0.069 (0.070)
Expenditure in bottled water[d/]			0.007*** (0.002)	0.007*** (0.002)	0.007*** (0.002)
Satisfaction with service (1 to 5)[e/]			0.074** (0.030)	0.077*** (0.030)	0.090*** (0.031)
Constant	0.253*** (0.063)	0.342* (0.177)	0.236 (0.199)	0.115 (0.206)	0.078 (0.211)
Second bid	-0.119*** (0.023)	-0.125*** (0.023)	-0.123*** (0.023)	-0.123*** (0.023)	-0.126*** (0.024)
Age (years)		-0.005** (0.002)	-0.003 (0.003)	-0.003 (0.003)	-0.003 (0.003)
Women (=1)		-0.051 (0.062)	-0.056 (0.063)	-0.055 (0.063)	-0.059 (0.063)
Education levels (1 to 11)[a/]		0.066*** (0.016)	0.072*** (0.016)	0.073*** (0.016)	0.070*** (0.017)
Children under five (%)[b/]			0.323 (0.319)	0.327 (0.320)	0.311 (0.321)
House wall[c/]			-0.271*** (0.077)	-0.273*** (0.077)	-0.289*** (0.081)
Respondent owns the house (=1)			-0.066 (0.067)	-0.064 (0.067)	-0.064 (0.068)

Expenditure in bottled water[d/]			0.004** (0.002)	0.004** (0.002)	0.004** (0.002)
Satisfaction with service (1 to 5)[e/]			0.097*** (0.029)	0.098*** (0.029)	0.105*** (0.030)
Constant	-0.018 (0.074)	-0.167 (0.179)	-0.367* (0.200)	-0.406** (0.203)	-0.421** (0.206)
Order-of-the-group fixed effects[f/]	No	No	No	Yes	Yes
Provider fixed effects	No	No	No	No	Yes
Observations	2121	2057	2057	2057	2057
AIC	2081198.7	2003320.7	1982751.0	1974230.6	1969522.7
Mean WTP for initial bid (PEN)	1.65	1.88	1.86	1.87	2.03
95% CIs	[1.08, 2.08]	[1.33, 2.29]	[1.29, 2.29]	[1.35, 2.30]	[1.54, 2.41]
Mean/Median WTP (PEN)	-0.15	0.23	0.13	0.14	0.32
95% CIs	[-2.09, 0.79]	[-1.47, 1.05]	[-1.67, 1.01]	[-1.59, 1.02]	[-1.31, 1.12]

Note: [a/] Education levels: 1: Illiterate; 2: Kindergarten; 3: Some Primary; 4: Primary; 5: Some Secondary; 6: Secondary; 7: Some post-secondary technical education; 8: Post-secondary technical education; 9: Some university; 10: University; 11: Graduate. [b/] Share of children under five in the household. [c/] House wall made of brick and mortar (=1). [d/] Monthly expenditure in bottled water, in PEN. [e/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [f/] Indicators for the WTP for water access though water trucks appearing in the first or second order. Robust standard errors in parenthesis. * p < 0.10, ** p < 0.05, *** p < 0.01

An important advantage of using representative data is that we can use our estimates to make inferences for the entire population, urban Peru, in our case. We thus exploit our estimates to calculate the amount of a water fund for an improved water supply system (the "project"), which can be generated annually by the urban households (h) in Peru, using the following formula:

$$Water\ Fund\ (WF) = WTP_h \left(1 + \frac{r}{100}\right)^t \text{ x } HH_t$$
$$\text{x } Probability\ to\ contribute \text{ x } 12\ months,$$

Where WTP_h is the mean monthly WTP per household h,r is the annual adjustment rate on water tariff, HH_t is the total number of households in urban Peru in year t (where $HH_t = (\frac{total\ urban\ population}{household\ size})\text{x}(1 + \text{urban } pop.growht\ rate)^t$), and $Probability\ to\ contribute$ is the percent of households willing to pay for an improved service. We compute the WF for each group of improvement in service under scrutiny, as well as the aggregate WF.[31] Using the official statistics for the population growth and household size in urban Peru, we project the income streams from the water fund, using (arbitrary) 5% and 10% interest adjustments in water tariff, which could help crowd-in the public investment. Table 7 shows the results from that calculation.

Table 7: Additional revenue for improved service from our WTP estimates

	WTP per month (PEN)[a/]		Future value of annual Water Fund b/				Present value of cumulative Water Fund (million USD)	
			(Million PEN)		(Million USD)			
			Interest rate (r)				Discount rate	
	5%	10%	5%	10%	5%	10%	5%	10%
2021	9.91	9.91	431.52	431.52	106.55	106.55	106.55	106.55
2026	12.65	15.96	600.42	757.66	148.25	187.08	641.86	709.17
2031	16.14	25.70	766.31	1,220.22	189.21	301.29	819.19	1,142.12
2036	20.60	41.40	978.03	1,965.17	241.49	485.23	1,045.52	1,839.40
2041	26.29	66.67	1,248.24	3,164.93	308.21	781.47	1,334.37	2,962.37
2046	33.56	107.37	1,593.10	5,097.16	393.36	1,258.56	1,703.04	4,770.92
Total			**20,595.19**	**42,438.70**	**5,085.23**	**10,478.69**	**5,650.52**	**11,530.52**

Note: We compute figures for each group of improvements in water service, separately, using the respective mean probability to contribute (0.441, 0.489 and 0.449, respectively); the figures reported in the table are the sum of those separate calculations. [a/] We consider annual adjustments (r)

31 Soto Montes de Oca & Bateman (2006) and Ahsan et al. (2021) perform a similar exercise for Mexico and Bangladesh, respectively. The former authors also conduct a cost-benefit analysis, and the latter authors use a choice experiment (with a sample of 161 respondents) instead of a survey.

of 5% and 10%, in water tariffs. Future WTP (at year t) is computed using the formula: $Initial\ WTP\text{x}(1+\frac{r}{100})^{t}$. [b/] As of 2021, the urban population in Peru was 26,914,893, the urban household size was 3.49, and the 2007-2017 average urban population growth was 2.18 (INEI, 2021b). The number of households in each year is computed as follows: $HH_t\ =(\frac{total\ urban\ population}{household\ size})\text{x}(1+pop.growht\ rate)^{t}$.

As shown in the table above, considering a 5% and 10% interest rate over the next 25 years for the project, the income stream would make a cumulative revenue worth PEN 20.60 billion (USD 5.08 billion) and PEN 42.44 billion (USD 10.48 billion), respectively.[32] Thze present value of this project's cumulative revenue generation is USD 5.65 billion and USD 11.53 billion, using a discount rate of 5% and 10%, respectively. If we utilize the 8% social discount rate (MEF, 2021), used to discount the present value of social projects in Peru, the present value of the project's cumulative revenue generation will be USD 5.22 billion, which represents almost 15% of the country's gap in access to quality water and sanitation infrastructure (estimated in around USD 36.04 billion[33]) (Bonifaz et al., 2020).

5.1 Robustness Analysis

In this section, we examine the extent to which the WTP figures we estimated above remain qualitatively and quantitatively unaltered, when we include the attributes related to the WTP exercise in the regression. Table 8 reports those results (at the bottom of each panel), as well as the coefficient estimates for the additional variables (the specifications used are the same as in the previous regressions). As shown in the table, the WTP figures remain largely unaltered when we control for those attributes for all three groups of improvements in water service examined. This is also true, in general, for the magnitude of the coefficient estimates. Full results are available from the authors.

Table 8: Logit regressions on WTP, including controls for water attributes

	(1)	(2)	(3)	(4)	(5)
A. Water quality (color, turbidity, presence of particles, smell, flavor, and perceived safety)					
Bid	-0.233*** (0.021)	-0.245*** (0.022)	-0.245*** (0.023)	-0.255*** (0.023)	-0.247*** (0.023)
Water has color (=1)	0.083 (0.140)	0.025 (0.144)	0.009 (0.145)	0.038 (0.150)	-0.041 (0.153)
Water is turbid (=1)	0.141 (0.122)	0.159 (0.126)	0.117 (0.127)	0.181 (0.133)	0.128 (0.131)
Water has particles (=1)	0.662*** (0.155)	0.662*** (0.156)	0.613*** (0.158)	0.620*** (0.167)	0.552*** (0.166)
Water has foul smell (=1)	0.129 (0.129)	0.118 (0.133)	0.069 (0.135)	0.077 (0.140)	0.044 (0.141)
Water has foul taste (=1)	0.089 (0.128)	0.127 (0.132)	0.045 (0.135)	0.073 (0.138)	0.054 (0.140)
Water is unsafe (=1)	0.030 (0.141)	0.104 (0.147)	0.072 (0.149)	0.184 (0.159)	0.185 (0.160)
Mean/Median WTP (PEN)	4.04	4.37	4.36	4.34	4.51
Krinsky and Robb 95% CIs[a/]	[3.51, 4.48]	[3.87, 4.79]	[3.86, 4.79]	[3.87, 4.77]	[4.03, 4.92]
P-seudo R^2	0.067	0.081	0.098	0.127	0.138
B. Water continuity, no interruptions in service and adequate pressure					
Bid	-0.283*** (0.030)	-0.290*** (0.031)	-0.302*** (0.031)	-0.300*** (0.031)	-0.302*** (0.032)
Receives water fewer than 7 days a week (=1)	0.385*** (0.133)	0.374*** (0.137)	0.338** (0.140)	0.356** (0.142)	0.337** (0.142)
Unsatisfied with no. of daily hours that receives water (=1)	0.560*** (0.105)	0.554*** (0.108)	0.512*** (0.109)	0.564*** (0.117)	0.471*** (0.118)

32 The aforementioned figures assume a vertical growth in water access (i.e., no new connections).

33 Since the quality in the provision of the service considers different attributes (e.g. water continuity, pressure, density of breaks in the water network, density of blockages in the sewage network, among others), this figure represents only a portion of the quality gap. Thus, the indicators considered were: the percentage of the population with access to a safe water service and percentage of the population with access to a safe sanitation service (from the World Bank database's World Development Indicators). 'Safe water' is defined as accessible water, available when needed (i.e., access 24 hours a day), and free of any contaminant. 'Safe sanitation' is defined as access to sanitation facilities not shared with other households, by which excreta are safely disposed of, on-site or transported, and subsequently treated.

Has suffered water interruptions, last 6 months (=1)	0.123 (0.104)	0.096 (0.107)	0.088 (0.108)	0.088 (0.110)	0.172 (0.112)
Water has inadequate pressure (=1)	-0.001 (0.106)	0.026 (0.108)	0.009 (0.109)	0.031 (0.112)	0.038 (0.113)
Mean/Median WTP (PEN)	3.57	3.72	3.73	3.72	4.03
Krinsky and Robb 95% CIs[a/]	[3.18, 3.92]	[3.35, 4.06]	[3.37, 4.06]	[3.37, 4.06]	[3.70, 4.35]
P-seudo R^2	0.064	0.069	0.087	0.095	0.112
C. Water access for 3 million people with no house piped water in times of the COVID-19 pandemic					
First bid	-0.240*** (0.033)	-0.241*** (0.034)	-0.241*** (0.034)	-0.248*** (0.034)	-0.248*** (0.035)
Water is very important to prevent the spread of COVID-19 [b/]	0.188 (0.154)	0.104 (0.157)	0.121 (0.156)	0.089 (0.156)	0.143 (0.156)
Mean/Median WTP, first bid (PEN)	1.63	1.86	1.85	1.86	2.02
Krinsky and Robb 95% CIs[a/]	[0.99, 2.07]	[1.28, 2.30]	[1.26, 2.29]	[1.29, 2.29]	[1.53, 2.42]
P-seudo R^2	0.026	0.031	0.041	0.051	0.055
Order-of-the-group fixed effects	No	No	No	Yes	Yes
Provider fixed effects	No	No	No	No	Yes
Observations	2121	2057	2057	2057	2057

Note: The specifications in this table are the same as those in Table 6 (except for the attributes, whose coefficients are reported in all specifications). [a/] We used 5,000 replications. [b/] The question was: "In a 1-to-5 scale, where 1 means 'not important at all' and 5 means 'very important', How important do you think the water service was to combat the contagion of COVID-19?" The variable used here is an indicator for ratings 4 and 5. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Furthermore, in the case of improvements in water quality, when we add a large set of controls, including indicators for households that have a backyard, households that filed a complaint last year, households that suffered from blockades in sewerage in last six months, households making any type of water treatment before drinking (boiling, use of chlorine, use of water filter, or any other treatment), knowledge of the source of water, perception that water will be scarce in next ten years, and certainty level in the answer to the WTP question, in addition to provider fixed effects, the main results remain unaltered and the WTP estimates are essentially the same (see Appendix Table B2). This is also the case for water continuity, where the new specification includes indicators for the house having water reservoir, upstairs tank, and water tank, instead of the water treatment indicators used for water quality above (see Appendix Table B3).

We next examine the extent to which the observed differences in WTP across providers for improvements in water quality and quantity are due to differences in the attributes over which the contingent valuation exercise is being expressed (quality and continuity, no service interruptions and adequate pressure). Though we also estimate the WTP for securing water access via water trucks, we do not expect to see big differences in this case, since this is not asking about the water they will receive, but rather the water that the 3 million people with no house piped water will receive. As shown in Appendix Table B4, panels A and B, we continue to see different mean WTP for water quality and quantity across providers, which suggests that other factors, such as the reliability on the provider to implement those improvements, may be playing an important role. In the case of water access via water trucks (for the first bid), indeed, we see a smaller variation in mean WTP.

Earlier, we mentioned that *EPS* facing financial and management difficulties are placed under a Transitory Support Regime (RAT). We proceed to examine whether our results differ between those 20 *EPS* placed under RAT (21.3 % of our sample) and the *EPS* with a more solid performance (78.7% of our sample). We use the specification with the "regular" controls (the same as that from column 4 in the initial regressions–see Tables 4, 5, or 6). For the sake of space, we only report the coefficients on bids and the WTP figures (with the corresponding CIs) for all groups. Table 9, columns 1 (with no controls) and 2 (with regular controls) report the results for the entire sample, for reference.

A priori, we should expect the water user's WTP for improvements in water service that will directly benefit them (e.g., piped water quality and continuity) to be more correlated with the *EPS* management indicators than that for improvements that will benefit others (e.g., providxing water access through water trucks for poor people with no connection to piped water). Examining the specification with regular controls (column 4 for *EPS* placed under RAT and column 6 for more financially sound EPS), Table 9 shows that the WTP for EPS under RAT is significantly larger than the WTP for *EPS* with better management indicators for the case of water quality and continuity, but a similar WTP for both groups of *EPS*. Specifically, the related ratios of mean WTP is 1.54 (water quality), 2.15 (water continuity/quantity) and 1.07 (water access via water trucks). These results are in line with our expectations and are consistent with users believing that *EPS* under RAT could actually implement those improvements.

Table 9: Logit regressions on WTP: EPS placed under RAT vs more financially sound EPS

	(1)	(2)	(3)	(4)	(5)	(6)
	All		*EPS* with more solid management		*EPS* placed under RAT	
	No controls	Regular controls[a/]	No controls	Regular controls [a/]	No controls	Regular controls [a/]
A. Water quality (color, turbidity, presence of particles, smell, flavor, and perceived safety)						
Bid	-0.234*** (0.021)	-0.255*** (0.023)	-0.252*** (0.024)	-0.277*** (0.027)	-0.169*** (0.040)	-0.177*** (0.044)
Mean WTP (PEN)	4.03	4.34	3.80	4.11	6.17	6.33
Krinsky & Robb 95% CIs[b/]	[3.51, 4.48]	[3.87, 4.76]	[3.23, 4.28]	[3.58, 4.55]	[4.97, 7.75]	[5.02, 8.09]
Pseudo R^2	0.057	0.120	0.065	0.133	0.033	0.086
B. Water continuity, no interruptions in service and adequate pressure						
Bid	-0.283*** (0.030)	-0.299*** (0.031)	-0.307*** (0.035)	-0.324*** (0.036)	-0.206*** (0.056)	-0.208*** (0.057)
Mean WTP (PEN)	3.55	3.71	3.18	3.31	7.00	7.10
Krinsky & Robb 95% CIs[b/]	[3.17, 3.90]	[3.35, 4.05]	[2.75, 3.55]	[2.93, 3.69]	[5.71, 10.56]	[5.55, 10.25]
Pseudo R^2	0.044	0.081	0.050	0.093	0.026	0.056
C. Water access for 3 million people with no house piped water in times of the COVID-19 pandemic						
Bid (first bid)	-0.240*** (0.033)	-0.248*** (0.034)	-0.231*** (0.037)	-0.238*** (0.038)	-0.300*** (0.072)	-0.329*** (0.072)
Mean WTP, first bid (PEN)	1.64	1.86	1.58	1.87	1.91	2.01
Krinsky & Robb 95% CIs[b/]	[1.04, 2.08]	[1.32, 2.30]	[0.84, 2.09]	[1.17, 2.34]	[0.83, 2.60]	[1.27, 2.86]
Pseudo R^2	0.025	0.051	0.023	0.052	0.040	0.068
Observations	2121	2057	1669	1608	452	449

Note: [a/] Regular controls include age, sex, education, share of children under 5 in the household, an indicator for the house wall made of brick and mortar, house ownership, expenditure in bottled water, satisfaction with service, and order of groups in the CV questions. [b/] We used 5,000 replications. Robust standard errors in parenthesis. * p < 0.10, ** p <0.05,*** p <0.01.

5.2 Heterogeneity Analysis

In this section, we examine the heterogeneity in the WTP figures for three selected subsamples. In particular, we aim to know whether users have higher WTP for improvements in service implemented by different types of providers, or if users highly satisfied with their water service are distinguishably less (or more) willing to pay for further improvements in service; or if users who are very certain about their responses to the WTP question during the CV exercise have markedly different WTP from users uncertain about those responses.[34]

We use the specifications that include the regular controls in our estimations, in addition to controls related to the attributes being examined (similar to those in Table 6). The results are reported in Table B4 (panel A, for improvements in water quality, and panel B, for improvements in water continuity/quantity), and Table B5 (for securing water access for the poor through water trucks), in Appendix B. Both tables report the WTP figures for the entire sample (in columns 1), for reference. For the sake of space, we only report the WTP figures (full results are available from the authors).

First, we analyze whether users from different providers (SEDAPAL, the largest WSS provider in the country, the other *EPS*, and the municipal management units–*UGM* in charge of the water service in small towns) have different average WTP for the same improvement in service. In principle, a higher WTP could be related to the users' expectations about the improvement in service, conditional on having achieved certain minimum level of satisfaction. But, on the other hand, users who are "moderately" satisfied with the current service, may not see the need to pay more for additional improvements in the service.

34 In the previous analysis, the provider fixed effects were significant, and satisfaction (measured in a 1/5 Likert scale) with WSS was significant only in the case of water access in COVID-19 times. For this analysis, we compare the highly satisfied and highly certain users with the other users.

We find that the WTP amounts for SEDAPAL are significantly smaller than those for the other providers, for the three groups examined. In particular, the ratio of mean WTP among SEDAPAL users vis-à-vis among users from the other providers goes between 0.56 and 0.77 in the case of water quality (Table B4, panel A, columns 2 to 7), between 0.34 and 0.59 for water continuity, no interruptions and adequate pressure (Table B4, panel B, columns 2 to 7), and is particularly stark in the case of water access via water trucks (except for the comparison with small *EPS*, the WTP for SEDAPAL with respect to the other providers lies between 0.05 and 0.09), as can be inferred from Table B5, columns 2 to 7, panel A (for the logistic regression on the first bid).[35] Considering that SEDAPAL has the highest report on users' service satisfaction in our sample,[36] these results are likely driven by the relatively high valuation of SEDAPAL's current service.

Second, we examine whether highly satisfied users (defined as those who reported the highest satisfactions levels, 4 and 5, on a Likert scale) are actually less willing to pay for additional improvements than the rest of not-highly-satisfied users (those reporting levels of 1, 2, and 3). Looking at columns 8 and 9 from Table B4, panels A and B, we do not see significant differences in WTP for these two groups of respondents.

Lastly, we split the sample by the degree of certainty about the answer to the WTP question. We compare those that reported levels 4 or 5 ("highly certain") with those who reported levels 1 to 3. For all three groups of improvements, we do not a clear pattern between the level of certainty in the responses and the WTP across sets of improvements in water service, as shown in columns 10 and 11 from panels A and B in Table B4, and Table B5.

6. Conclusion

Access to safely managed drinking water service is still far from universal. We study the case of urban areas in Peru, which hosts 81.5% of the population, and where we observe a significant heterogeneity in the characteristics of the water service they receive, as well as in the corresponding satisfaction levels, across the country. As in other developing countries, most of the investments in water and sanitation in Peru targeted to implement improvements in coverage and service, come from direct subsidies made at the national, regional, or local levels.

We study the willingness to pay (WTP) for improved water in urban Peru, considering a large set of characteristics of the service. Looking at our point estimates, we find a positive WTP for three sets of improvements in water service; namely: in water quality (related to color, turbidity, presence of particles, flavor, smell, and safety); in water continuity, absence of interruptions in the service, and adequate pressure; and to secure the water supply for non-connected users in times of the COVID-19 pandemic. We find a positive average WTP for those improvements in water service, which amounts to 23% above the households' current monthly water service bill. The income flow generated by these amounts suggests that water users are willing to contribute a sizeable amount that may help crowd-in the public investment. Our findings identify a cumulative income flow equivalent to around 15% of the amount needed to close the country's gap in access to quality water and sanitation infrastructure, over the next 25 years.

In 2020, the Peruvian government passed an Emergency Decree (No. 036-2020), enabling water service providers to distribute drinking water through water trucks to those with no access to piped water service, in the context of the COVID-19 pandemic. This water supply is financed through direct subsidies, which puts its sustainability at risk. Our WTP estimates show that a cross- subsidization policy, from the users of water service to those with no access to piped drinking water, could help ensure this water supply's financial sustainability.

Our results could help guide policy interventions in urban Peru. In particular, they can be used to estimate the welfare gains from the investment in improving the water service, in a scenario in which the marginal cost of the related improvements in service is lower than the user's declared WTP. Relatedly, if the marginal cost exceeds the users' WTP, one way to increase welfare would be to subsidize the cost of the investment, given the positive externalities from enhancing water service. The policy prescription would depend on a case-by-case analysis,

35 On the other hand, considering that the WSS monthly bill paid by users in our sample decreases with the provider size, the share of the aggregate WTP with respect to the monthly bills increases with the provider size: it represents 6.7% for SEDAPAL users, 18.5% for very large EPS users, and goes as high as 91% for UGM users.

36 On a 1-to-5 Likert scale, SEDAPAL users report an average satisfaction level of 3.23, which is higher than those from very large *EPS*, large *EPS*, medium-sized *EPS*, small *EPS*, and *UGM*: 2.64, 2.67, 2.80, 2.28, and 2.39, respectively. The average satisfaction level for the entire sample is 2.68.

and our analysis of heterogeneous effects by type of provider, which is not typically addressed by the literature, could help guide such endeavor.

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Appendices

Appendix A: Contingent valuation questions for improved water quality (color, turbidity, presence of particles, smell, flavor, and perceived safety)

The CV questions were stated as follows:

"Q1. Considering the service you currently receive, if there is an investment in new water treatment plants, reservoirs, and technology oriented to **ensure the quality of water**; all of which will allow that the tap water you receive:[1]

- Will be crystal clear (if reported that water was not crystal clear)
- Will not be turbid (if reported that water was turbid)
- Will not have any particles (if reported that water had particles)
- Will be odorless (if reported that water had foul smell)
- Will be flavor less (if reported that water had foul flavor)
- Is guaranteed to be safe (if reported that water was not safe)

Would you be willing to pay PEN **[Random amount drawn from {1, 3, 5, 6, 8, 9, 11}]** every month, above the amount you currently pay for your water service?"

1. Yes
2. No

"Q2. In a 1-to-5 scale, where 1 means 'not certain at all' and 5 means 'Totally certain', how certain are you with your decision?:"

1. Not certain at all
2. A bit certain
3. Somewhat certain
4. Certain
5. Totally certain

"Q3. Why would you (not) be willing to pay PEN (**Use random amount drawn from {1, 3, 5, 6, 8, 9, 11}: question 1**), monthly, above the amount you currently pay in your water bill? (Spontaneous answer)."

Practical Example:

Since the choices available for question 1 above depended on the problems previously reported by the respondent, the WTP question was adapted accordingly. Thus, for instance, for someone who said that her tap water was clear, has particles, is odorless, has an unpleasant flavor, and does not look safe, the WTP question 1 was phrased as follows:

"Considering the service, you currently receive, if there were an investment in new water treatment plants, reservoirs, and technology oriented to ensure the quality of water; all of which will allow that the tap water you receive:

- Will not have any particles
- Will not have a foul flavor
- Is guaranteed to be safe

Will you be willing to pay PEN **[Random amount drawn from {1, 3, 5, 6, 8, 9, 11}]** every month, above the amount you currently pay for your water service?"

1 The question was asked in the following way: "The Ministry of Housing, Construction and Sanitation will subsidize investments in infrastructure to improve the water and sanitation services. These investments will require to incur in greater operating and maintenance costs to make it sustainable. We will ask next, three questions about your willingness to pay for those improvements. Keep in mind that, if the majority of users are willing to pay, it will be highly likely to implement those investments. For that to happen, you should consider your monthly budget before answering."

Appendix B: Tables

Table B1: Double bound regression: WTP for securing water access for 3 million people with no house piped water, in times of the COVID-19 pandemic

	(1)	(2)	(3)	(4)	(5)
Age (years)		-0.025*** (0.006)	0.021*** (0.007)	-0.022*** (0.007)	-0.021*** (0.007)
Women (=1)		-0.060 (0.161)	-0.060 (0.161)	-0.049 (0.160)	-0.065 (0.159)
Education levels (1 to 11)[a/]		0.159*** (0.040)	0.164*** (0.042)	0.156*** (0.042)	0.135*** (0.043)
Children under five (%)[b/]			-0.503 (0.824)	-0.292 (0.816)	-0.305 (0.813)
House wall [c/]			-0.442** (0.207)	-0.505** (0.205)	-0.625*** (0.211)
Respondent owns the house (=1)			-0.233 (0.171)	-0.163 (0.169)	-0.143 (0.170)
Expenditure in bottled water [d/]			0.011*** (0.004)	0.014*** (0.004)	0.014*** (0.004)
Satisfaction with service (1 to 5)[e/]				0.355*** (0.074)	0.366*** (0.076)
Constant	2.097*** (0.082)	2.232*** (0.439)	2.429*** (0.465)	1.219** (0.510)	1.124** (0.514)
Sigma Constant	3.259*** (0.093)	3.201*** (0.092)	3.191*** (0.092)	3.151*** (0.091)	3.133*** (0.090)
Order-of-group fixed effects [f/]	No	No	No	Yes	Yes
Provider fixed effects	No	No	No	No	Yes
Observations	2121	2057	2057	2057	2057
AIC	5622.46	5459.78	5454.59	5420.52	5418.35
Mean/Median WTP (PEN)	2.10	2.17	2.17	2.17	2.17
95% CIs	[1.93, 2.26]	[2.01, 2.33]	[2.01, 2.33]	[2.01, 2.33]	[2.01, 2.33]

Note: [a/] Education levels: 1: Illiterate; 2: Kindergarten; 3: Some Primary; 4: Primary; 5: Some Secondary; 6: Secondary; 7: Some post-secondary technical education; 8: Post-secondary technical education; 9: Some university; 10: University; 11: Graduate. [b/] Share of children under five in the household. [c/] House wall made of brick and mortar (=1). [d/] Monthly expenditure in bottled water, in PEN. [e/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [f/] Indicators for the improvement in water service examined appearing in the first or second order. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B2: Logistic regression: WTP for improved water quality, with full controls

	(1)	(2)	(3)	(4)
Bid	-0.255*** (0.023)	-0.262*** (0.024)	-0.256*** (0.024)	-0.254*** (0.027)
Age (years)	-0.000 (0.004)	-0.006 (0.005)	-0.003 (0.005)	-0.003 (0.006)
Respondent is women (=1)	-0.091 (0.108)	-0.047 (0.110)	-0.038 (0.111)	0.080 (0.128)
Education levels (1.Illiterate,...,11.Graduate)	0.123*** (0.029)	0.086*** (0.030)	0.099*** (0.031)	0.062 (0.039)
Children younger than 5 in household (%)	0.430 (0.552)	0.293 (0.552)	0.134 (0.556)	-0.068 (0.655)
House wall made of brick and mortar (=1)	-0.520*** (0.136)	-0.408*** (0.136)	-0.302** (0.141)	-0.408** (0.161)
Respondent owns the house (=1)	-0.130 (0.115)	-0.092 (0.116)	-0.169 (0.117)	-0.169 (0.134)
Expenditure in bottled water, monthly (PEN)	0.016*** (0.003)	0.016*** (0.003)	0.016*** (0.003)	0.013*** (0.004)
Satisfaction level with service (1 to 5)[a/]	0.012 (0.051)	0.035 (0.053)	0.091* (0.055)	0.020 (0.066)
CV questions for water quality were shown first[b/]	0.934*** (0.133)	0.977*** (0.134)	0.991*** (0.136)	0.952*** (0.157)
CV questions for water quality were shown second[b/]	0.126 (0.140)	0.161 (0.141)	0.142 (0.141)	0.104 (0.159)
Household has garden/backyard (=1)		-0.292** (0.129)	-0.314** (0.131)	-0.198 (0.145)
Filed complaint to service provider last year (=1)		0.183 (0.118)	0.241** (0.119)	0.123 (0.136)
Suffered from blockades in sewerage, last 6 mos. (=1)		0.129 (0.133)	0.155 (0.134)	0.191 (0.156)
Boils water before drinking (=1)		0.054 (0.195)	0.128 (0.192)	0.186 (0.215)
Adds chlorine to water before drinking (=1)		0.148 (0.238)	0.120 (0.235)	0.069 (0.258)
Filters water before drinking (=1)		0.047 (0.229)	0.112 (0.219)	-0.038 (0.290)
Makes any other treatment before drinking (=1)		0.169 (0.541)	0.171 (0.491)	1.119** (0.517)
Does know the source of water in her town (=1)		0.621*** (0.113)	0.587*** (0.115)	0.560*** (0.133)
Think that water will be scarce in next 10 years (=1)		0.139 (0.152)	0.091 (0.153)	0.133 (0.183)
Certain or very certain of answer to WTP question (=1)		0.110 (0.142)	0.099 (0.144)	0.227 (0.169)
SEDAPAL (=1)[c/]			-0.711*** (0.196)	-0.764*** (0.231)
Very Large EPS (=1)[c/]			-0.366** (0.172)	-0.400** (0.203)
Large EPS (=1)[c/]			0.094 (0.154)	-0.133 (0.179)
Medium-size EPS (=1)[c/]			-0.247 (0.202)	-0.450* (0.231)
Small EPS (=1)[c/]			-0.203 (0.266)	-0.498* (0.295)
Household income, in levels (1 to 11)[d/]				-0.110*** (0.033)
Constant	0.150 (0.355)	0.046 (0.456)	-0.189 (0.460)	1.261* (0.704)
Observations	2057	2057	2057	1574
Pseudo R^2	0.120	0.139	0.150	0.155
AIC	948425.40	927786.69	915392.87	696780.97
Mean/Median WTP	4.34	4.34	4.54	5.08
Krinsky & Robb 95% CIs[e/]	[3.87, 4.76]	[3.86, 4.76]	[4.61, 5.53]	[4.61, 5.53]

Note: [a/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [b/] The omitted category is "CV for this group was shown third". [c/] The omitted provider is UGM (from small towns). [d/] Income levels expressed in PEN: 1. More than 4000, ..., 11. Less than 800. [e/] We used 5,000 replications. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B3: Logistic regression: WTP for improved water continuity, with full controls

	(1)	(2)	(3)	(4)
Bid	-0.299*** (0.031)	-0.298*** (0.031)	-0.300*** (0.032)	-0.307*** (0.037)
Age (years)	-0.003 (0.004)	-0.005 (0.004)	-0.001 (0.005)	-0.003 (0.005)
Respondent is women (=1)	-0.335*** (0.104)	-0.318*** (0.106)	-0.322*** (0.108)	-0.226* (0.124)
Education levels (1.Illiterate,…,11.Graduate)	0.010 (0.027)	-0.007 (0.028)	-0.002 (0.029)	-0.035 (0.036)
Children younger than 5 in household (%)	0.979* (0.541)	0.933* (0.547)	0.789 (0.547)	0.767 (0.623)
House wall made of brick and mortar (=1)	-0.562*** (0.133)	-0.505*** (0.136)	-0.401*** (0.142)	-0.448*** (0.163)
Respondent owns the house (=1)	0.060 (0.110)	0.088 (0.112)	-0.003 (0.115)	-0.016 (0.130)
Expenditure in bottled water, monthly (PEN)	0.015*** (0.003)	0.014*** (0.003)	0.014*** (0.003)	0.012*** (0.003)
Satisfaction level with service (1 to 5)[a/]	-0.070 (0.048)	-0.045 (0.050)	0.026 (0.052)	-0.023 (0.061)
CV questions for water continuity were shown first[b/]	0.521*** (0.134)	0.504*** (0.135)	0.539*** (0.136)	0.532*** (0.157)
CV questions for water continuity were shown second[b/]	0.127 (0.120)	0.120 (0.121)	0.148 (0.122)	0.110 (0.140)
Household has garden/backyard (=1)		-0.186 (0.128)	-0.199 (0.131)	-0.015 (0.145)
Filed complaint to service provider last year (=1)		0.106 (0.113)	0.149 (0.114)	0.069 (0.131)
Suffered from blockades in sewerage, last 6 mos. (=1)		0.165 (0.123)	0.211* (0.126)	0.225 (0.145)
N° of water service interruptions, last 6 mos.		0.005 (0.011)	0.012 (0.011)	0.016 (0.013)
House has water reservoir (=1)		0.361** (0.173)	0.388** (0.176)	0.782*** (0.209)
House has upstairs tank (=1)		-0.197 (0.122)	-0.191 (0.125)	-0.159 (0.142)
House has water tank (=1)		0.213 (0.246)	0.215 (0.242)	0.186 (0.267)
Does know the source of water in their locality (=1)		0.252** (0.109)	0.211* (0.112)	0.253** (0.129)
Think that water will be scarce in next 10 years (=1)		0.202 (0.144)	0.125 (0.147)	0.185 (0.165)
Certain or very certain of answer to WTP question (=1)		0.016 (0.142)	0.076 (0.148)	0.113 (0.164)
SEDAPAL (=1)c/			-0.754*** (0.189)	-0.719*** (0.223)
Very Large EPS (=1)c/			-0.288* (0.162)	-0.313 (0.192)
Large EPS (=1)c/			0.337** (0.148)	0.272 (0.174)
Medium-size EPS (=1)c/			0.136 (0.192)	0.026 (0.219)
Small EPS (=1)c/			0.161 (0.245)	0.186 (0.271)
Household income, in levels (1 to 11)d/				-0.069** (0.032)
Constant	1.510*** (0.348)	1.351*** (0.417)	1.048** (0.425)	1.983*** (0.667)
Observations	2057	2057	2057	1574
Pseudo R^2	0.081	0.089	0.110	0.115
AIC	998374.91	988906.67	966437.81	731659.39
Mean/Median	3.71	3.70	4.04	4.42
Krinsky & Robb 95% CIs[e/]	[3.35, 4.05]	[3.34, 4.05]	[3.71, 4.35]	[4.07, 4.83]

Note: [a/] Satisfaction level with WSS provider: 1: Very unsatisfied; 2: Unsatisfied; 3: Neutral; 4: Satisfied; 5: Very satisfied. [b/] The omitted category is "CV for this group was shown in third place". [c/] The omitted provider is UGM (from small towns). [d/] Income levels expressed in PEN: 1. More than 4000, …, 11. Less than 800. [e/] We used 5,000 replications. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B4: WTP for improved water quality and continuity (no interruptions and adequate pressure): Selected sub-samples (Estimated after logistic regressions)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	All	Provider						Satisfaction with water service		Certainty with answer to the WTP question	
			EPS								
		SEDAPAL[a/]	Very Large	Large	Medium-Sized	Small	*UGM*	Highly Satisfied [b/]	Not Highly Satisfied [c/]	Highly Certain [d/]	Not Highly Certain [e/]
A. **Water quality (color, turbidity, presence of particles, smell, flavor, and perceived safety)**											
Mean WTP	4.34	3.14	4.08	5.60	4.26	4.33	4.99	4.69	4.22	4.41	3.96
Krinsky & Robb CIs[f/]	[3.87, 4.76]	[1.32, 4.17]	[2.79, 4.94]	[4.93, 6.33]	[0.39, 6.22]	[2.45, 5.49]	[3.88, 6.89]	[3.64, 5.51]	[3.65, 4.72]	[3.90, 4.87]	[2.34, 5.02]
Observations	2057	291	395	650	198	96	427	476	1581	1663	394
Pseudo R^2	0.132	0.222	0.151	0.124	0.118	0.260	0.121	0.149	0.116	0.128	0.103
AIC	935583.6	190017.30	137053.74	184995.25	72809.30	24636.87	287903.22	222834.28	721127.66	763229.92	180408.47
B. Water continuity, no interruptions in service and adequate pressure											
Mean WTP	3.71	1.83	3.09	5.35	4.98	4.19	4.48	3.03	3.90	3.71	3.69
Krinsky & Robb CIs[f/]	[3.35, 4.05]	[-0.17, 2.72]	[1.94, 3.86]	[4.66, 6.58]	[4.04, 6.60]	[3.25, 5.15]	[3.68, 6.07]	[1.92, 3.79]	[3.51, 4.29]	[3.33, 4.09]	[2.51, 4.56]
Observations	2057	291	395	650	198	96	427	476	1581	1698	359
Pseudo R^2	0.087	0.133	0.120	0.055	0.124	0.236	0.062	0.111	0.083	0.081	0.094
AIC	998374.90	207105.39	144418.51	196576.07	72554.05	25947.087	306071.45	232279.90	755165.11	827672.04	167649.81

Notes: All specifications include a constant term, individual controls (age, sex, education), household-level controls (type of wall, expenditure in bottled water), and satisfaction with WSS (except for columns 8 & 9), and indicators for the order in which this group was presented to each respondent. [a/] Since SEDAPAL offers service in Lima (the country's capital), this is equivalent to estimating the results for Lima. [b/] Indicator for satisfaction levels 4 ("Satisfied") & 5 ("Highly satisfied") in a 1-to-5 scale. [c/] Indicator for satisfaction levels 1 ("Highly unsatisfied"), 2 ("Unsatisfied") and 3 ("Neutral" in a 1-to-5 scale"). [d/] Indicator for certainty levels 4 ("Certain with my response to the WTP question") and 5 ("Very certain with my response") in a 1-to-5 scale. [e/] Indicator for certainty levels 1 ("Very uncertain with my response to the WTP question"), 2 ("Uncertain with my response"), and 3 ("Neither certain nor uncertain with my response") in a 1-to-5 scale. [f/] 95% CIs computed with 5,000 replications. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B5: WTP for securing water access for 3 million people with no house piped water, in times of the COVID-19 pandemic: selected sub-samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	All	Provider						Satisfaction with water service		Certainty with answer to the WTP question	
			EPS								
		SEDAPAL[a/]	Very Large	Large	Medium-Sized	Small	*UGM*	Highly Satisfied [b/]	Not Highly Satisfied [c/]	Highly Certain [d/]	Not Highly Certain [e/]
A. After a logistic regression											
Mean WTP (1st bid)	1.86	0.15	2.38	2.85	1.85	0.25	1.73	2.83	1.53	1.67	2.91
Krinsky & Robb CIs[f/]	[1.32, 2.30]	[-16.57, 14.02]	[1.34, 3.12]	[2.18, 3.55]	[0.53, 2.57]	[-17.41, 17.41]	[0.22, 2.63]	[2.03, 3.64]	[0.76, 2.06]	[1.02, 2.14]	[1.56, 4.49]
Pseudo R^2	0.051	0.068	0.059	0.102	0.154	0.062	0.097	0.080	0.047	0.055	0.059
B. After a bivariate Probit regression											
Mean WTP (1st bid)	1.87	0.16	2.33	2.84	1.87	0.33	1.72	2.83	1.57	1.64	2.89
Krinsky & Robb CIs[f/]	[1.35, 2.30]	[-16.20, 13.73]	[1.27, 3.10]	[2.21, 3.52]	[0.61, 2.58]	[-15.08, 13.93]	[0.32, 2.58]	[2.01, 3.74]	[0.84, 2.08]	[0.99, 2.11]	[1.66, 4.31]
Mean WTP (2nd bid)	0.14	-0.36	1.07	0.55	-0.43	18.89	-0.08	1.78	-0.46	-0.65	1.84
Krinsky & Robb CIs[f/]	[-1.59, 1.02]	[-22.81, 12.15]	[-3.17, 2.25]	[-4.41, 1.82]	[-25.32, 24.81]	[-76.59, 56.62]	[-5.73, 1.21]	[-0.26, 2.61]	[-3.24, 0.71]	[-4.01, 0.66]	[0.32, 2.57]
C. After a double-bound regression											
Mean WTP	2.17	1.76	2.46	2.50	1.85	1.97	1.82	2.65	2.04	1.98	2.73
Krinsky & Robb CIs[f/]	[2.01, 2.33]	[1.19, 2.32]	[2.06, 2.86]	[2.24, 2.76]	[1.37, 2.33]	[1.42, 2.52]	[1.51, 2.12]	[2.28, 3.01]	[1.87, 2.22]	[1.78, 2.17]	[2.47, 3.00]
Observations	2057	291	395	650	198	96	427	476	1581	1628	429

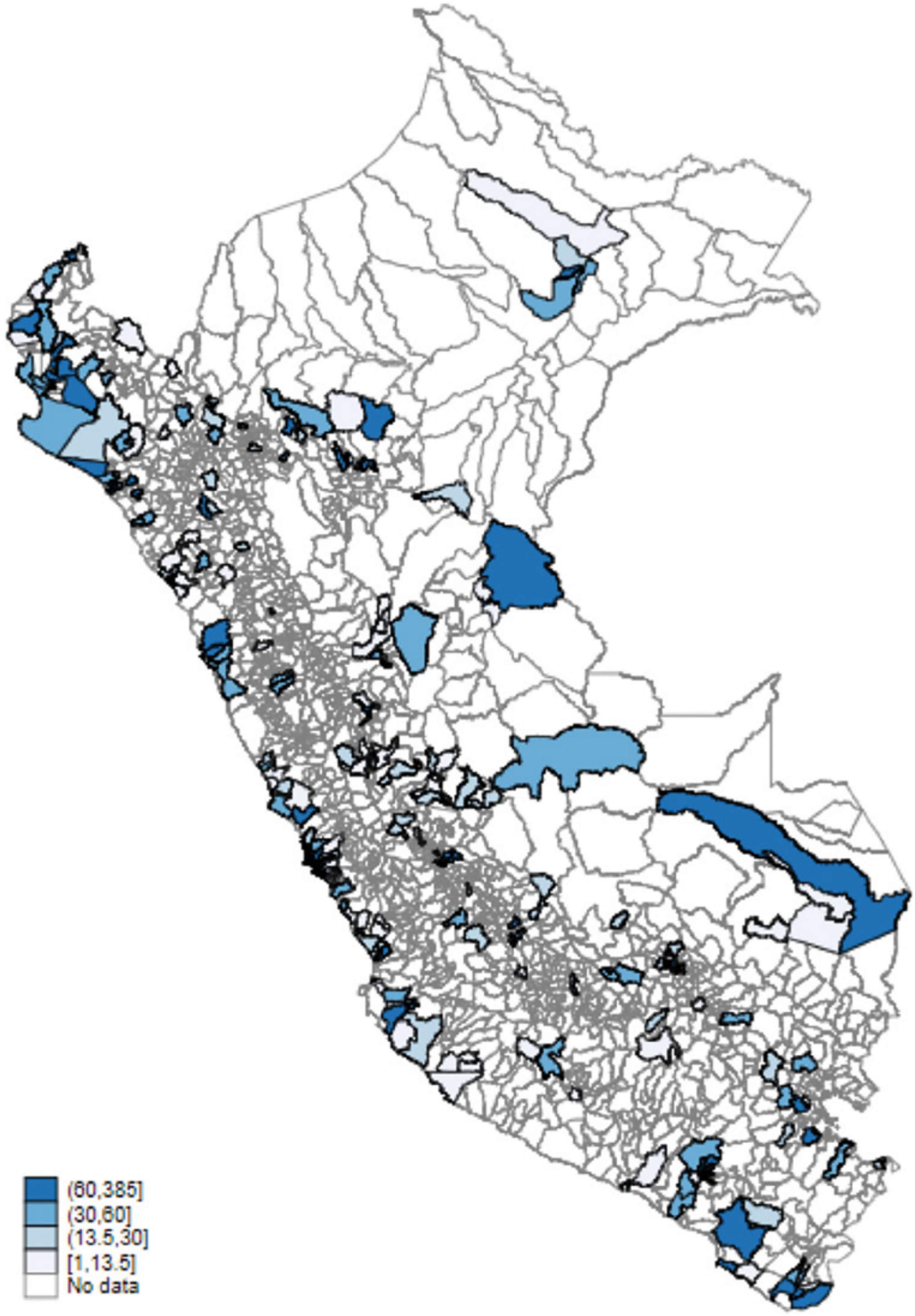
Notes: All specifications include a constant term, individual controls (age, sex, education), household-level controls (type of wall, expenditure in bottled water), and satisfaction with WSS (except for columns 9 and 10), and indicators for the order in which this group was presented to each respondent. [a/] Since SEDAPAL offers service in Lima, this is equivalent to estimating the results for Lima. [b/] Indicator for satisfaction levels 4 ("Satisfied") and 5 ("Highly satisfied") in a 1-to-5 scale. [c/] Indicator for satisfaction levels 1 ("Highly unsatisfied"), 2 ("Unsatisfied") and 3 ("Neutral in a 1-to-5 scale"). [d/] Indicator for certainty levels 4 ("Certain with my response to the WTP question") and 5 ("Very certain with my response") in a 1-to-5 scale. [e/] Indicator for certainty levels 1 ("Very uncertain with my response to the WTP question"), 2 ("Uncertain with my response"), and 3 ("Neither certain nor uncertain with my response") in a 1-to-5 scale. [f/] 95% CIs computed with 5,000 replications. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix C: Figures

Figure C1: Water service providers in urban Peru by size, 2020

Fuente: Dirección de Fiscalización de la Sunass

Figure C2: Municipalities sampled (Number of surveys per quintiles)



Total municipalities: 296; total provinces: 108; total regions: 25.
SECOSAN Survey for Urban Peru.