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A Global Assessment of Non-Tariff Customer Assistance Programs in Water Supply and Sanitation

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Joseph Cook, Dale Whittington, David Fuente and Michael Matichich*

Abstract

A key strategy for adapting to changing water availability and rapid urbanization is a move towards full cost recovery tariffs for water and sanitation services. Because these services are substantially underpriced in most places, this strategy implies that careful attention must be directed at programs to help the poor manage water affordability. In this paper, we systematize these "customer assistance programs" (CAPs) by defining their major elements and develop a typology that highlights the connection between CAPs and water scarcity. We then present a broad review of evaluations and case studies of CAPs from both industrialized countries and low- and middle-income countries (LMICs). Although several researchers have documented that increasing block tariffs are a poor targeting mechanism for directing subsidies to the poor, there are relatively few careful evaluations of "non-tariff" CAPs, including subsidies to connect households to the network.

Key Words: tariff, water, sanitation

JEL Codes: Q25

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1 Introduction

The issue of protecting the poor in providing water supply and sanitation services has been of interest in low-income countries for several decades. These settings are often characterized by a significant fraction of households that may have difficulty paying full cost recovery tariffs and customers who are not connected to the network services either because they cannot afford the connection, live in informal settlements without land tenure, or cannot procure a connection because of bureaucratic hassle or corruption. Unconnected households rely on public taps, water vendors or tanker trucks, or buy water from connected neighbors, in many cases paying higher volumetric prices than those with piped connections. Households unconnected to the piped sewer network rely on private pit latrines, public toilets, or open defecation. Concerns about affordability and protecting the poor were raised in relation to proposed Private Sector Participation (PSP) contracts in the 1990s. There is no shortage of discussion and policy advice on the best way to protect the poor through a tariff reform process. There are also several evaluation studies in these settings, though nearly all focus on the targeting properties of subsidy programs – whether benefits intended to reach the poor actually do — rather than how the subsidies are funded and delivered.

The issue of protecting the poor has received less attention in industrialized countries until relatively recently. There the issue goes by the "affordability challenge" label, but many of the underlying dynamics are becoming more similar to situations found in low-income countries. Water and sanitation service providers need to raise tariffs to replace aging capital stock, improve service levels, improve environmental and drinking water quality, and send an economic signal of water scarcity to consumers (if water is indeed scarce). Public support for such tariff increases can be jeopardized, however, if a portion of the population would need to pay a substantial fraction of their income for water and sewer services. Compounding this problem is regional inequality: cities and towns in parts of the United States that are economically stagnant find themselves struggling to maintain revenue and systems in the face of a dwindling customer base and flat income growth. Because of these problems, a number of utilities in industrialized countries have adopted programs to help the poor and maintain good relations with struggling customers. Throughout this paper, we will use the term by which these subsidy programs are referred to in the U.S. literature: Customer Assistance Programs (CAPs).

One widely used approach for attempting to help the poor is a tariff structure with increasing blocks – i.e. increasing block tariffs (IBTs) (Fuente and Bartram 2018). Proponents of IBTs believe that if a) poor households consume less water than rich households and b) if the

lowest block(s) of the IBT structure are set below full cost and the highest blocks are set above full cost, then rich households cross-subsidize poor households "through the tariff". In practice, however, a number of studies have shown that IBTs are a poor mechanism for redistribution, particularly in low-income countries (see Fuente et al. 2016 for a review). This is because a) all blocks of the tariff are typically set below full cost, so all households with a piped connection are being subsidized, b) poor households are less likely to be connected to the system, c) poor households are more likely to share meters and thus find themselves in the most expensive volumetric blocks and d) the empirical relationship between income and water use is much weaker than many believe. Because of this, we focus our attention on "non-tariff" CAPs, or subsidy programs that do not involve manipulating the tariff structure that *all* households face in order to help the poor.

The paper is organized as follows. We begin by defining four major elements of CAPs: subsidy administration, funding, targeting and delivery mechanism. Using these definitions, we describe a typology of subsidies that links the targeting properties of the CAP with the economic signal of water scarcity. We then review experiences with CAPs in the U.S., Europe and Australia before describing a broad overview of subsidy programs in low- and middle-income countries (LMICs) and highlighting two cases from Chile and Singapore. We next discuss the existing evaluation literature on CAPs. We conclude with four lessons from our review of the global experience with non-tariff CAPs.

2 Elements of Customer Assistance Programs

There are four facets of programs that assist the poor in the water sector: who administers subsidies, how subsidies are funded, how subsidies are targeted, and how subsidies are delivered.

2.1 Administration

First, who administers subsidies? This includes determining eligibility criteria for subsidy programs (if those programs are targeted), verifying that eligibility with information provided by customers, and deciding how subsidies will be delivered (see "CAP strategies" below). By this definition, most CAPs in LMICs are administered by the utility, though donors often play an important role in deciding how subsidies will be delivered (i.e. the Global Partnership on Output-Based Aid (GPOBA) program to subsidize connections to the piped system). Most CAPs in the U.S. are administered by utilities, though most use existing poverty criteria to determine eligibility and some partner with local social service agencies to verify eligibility criteria. For example, the U.S. government has a federally funded home heating assistance program (LIHEAP). The water utility in Cleveland, Ohio, contracts with a local nonprofit (Cleveland Housing Network) responsible for verifying LIHEAP eligibility, receiving

in turn a list of their LIHEAP-eligible customers. Coordinating CAPs and eligibility is in fact a current focus in many U.S. and European utilities to reduce the administrative burden on utilities and customers.

2.2 Funding

Second, how are subsidies funded (Table 1)? In the U.S., many CAPs are funded by the utility through a financial cross-subsidy in which some users pay slightly higher prices to generate revenue used for the subsidy programs. In many instances in low-income countries, utilities and analysts may describe their subsidy programs as being funded by cross-subsidies when in fact all users are paying prices that are lower than full cost recovery: utilities are often relying on capital or operating subsidies from higher levels of government. Furthermore, true cross-subsidy funding schemes may be infeasible in low-income countries because the percentage of customers needing support is a substantial fraction of the customer base.

In many parts of the U.S., such cross-subsidies are expressly forbidden by state law or state-level public service commissions (Berazher et al. 2017). In those cases, programs are funded with voluntary "round up your bill" options[1] or partnerships with charitable organizations. Voluntary contribution programs typically produce less revenue than would be required to support all identified needs of eligible poor customers. We also include in this voluntary category donor support programs that explicitly fund subsidies targeted to the poor (e.g. GPOBA).

A third type of financing comes from the government, either local, state or federal funding. These programs generally do not exist in the U.S. or Europe, and are rare in LMICs. There are, however, some industry associations in the U.S. that are advocating for federal funding to support customer assistance for poor customers of water and wastewater systems. Government financing support in most countries comes in the form of direct support to the water utility through capital investments, preferential lending, etc., rather than support tied directly to serving the poor.

[1] For example, if a bill is $43.11, the bill statement might ask if you would like to pay $44 and donate $0.89 to the low-income fund.

Table 1. Funding Types

Funding Types	Description
Utility-funded	No significant involvement of any other municipal, county or federal agency in providing subsidies targeted to the poor (rather than general operations subsidies to the utility as a whole). Subsidies contribute to operating deficit of utility in most places, since overall tariff structure does not reflect costs.
State-funded	Other government agency directly involved in delivery or funding of water subsidies to poor households, even if utility still interfaces with clients.
Voluntary, charities, donors	A third party is involved in subsidizing households to connect or pay their bills.

2.3 Targeting

Means-testing is by far the most common approach in industrialized-country CAPs, and typically uses earned income as reported to the federal tax agency (Table 2). A poor household may bring paperwork proving economic status either to the utility or a partner agency in order to qualify for the CAP. In areas where income varies substantially through the year, is rarely reported (large informal economies), or is difficult to verify, proxy characteristics can be used to characterize poverty. Common proxy measures include characteristics of the home, durable asset ownership, or education levels. Proxy-based poverty measures can also be prone to gaming by the households, e.g., households have moved durable assets to friends' apartments during interviews. There is also the administrative issue of how frequently eligibility must be re-checked. Geographic targeting relies on a strong spatial pattern of poverty. In the absence of centrally reported income information, it is likely to have lower administrative costs than proxy-based means-testing but typically has worse targeting properties, as discussed below.

Table 2. Targeting Types

Targeting Type	Description
Means-tested (income and/or proxy measures)	Threshold could be based solely on all-source income. Can be self-reported in an interview, often requiring documentation such as a pay stub to confirm income level; in other cases, it is based on information reported to a tax agency based on employer records. Where income data are unavailable or unreliable, may be combined with proxies such as dwelling type, durable asset ownership, number of people in the household.
Geographic targeting	The household's location determines poverty status; map areas of a city into poor and non-poor areas based on observable characteristics of areas.
Demographic targeting	Targeting by age, gender, or some other demographic characteristic
Self-targeting	Only poor households would want to use this service (usually public taps or shared connections). Sometimes referred to as "service level" targeting.

Demographic targeting uses age, disability status, or other characteristic of the individual. For example, Ukraine offers bill reductions of 15-100% for pensioners, the disabled, students, the unemployed, war veterans, and victims of Chernobyl (Smets 2008). As discussed below, senior citizens are often eligible for CAPs in the U.S. Finally, self-targeting relies on the assumption that only poor households will opt for the service being offered. In water, this often entails a service-level targeting by subsidizing public taps or shared connections. Untargeted IBTs are sometimes described as being self-targeting under the assumption that only the poor will choose to consume water within the first lifeline block, though this is not true for reasons described above.

2.4 Delivery: CAP Program Strategies

Earlier studies (Komives et al. 2005, Banerjee et al. 2008) broadly characterize subsidies in LMICs as either connection or consumption subsidies. In the United States, the EPA (2016) compendium classifies CAPs as "bill discount", "flexible terms", "temporary assistance", "water efficiency" and "lifeline rates". Since this report covers CAPs in both types of settings, we require a common typology.

Furthermore, relatively little attention has been paid to the intersection of CAPs and water scarcity. In settings where water is plentiful or the fraction of customers eligible for CAPs is relatively small, this intersection will not be important. In areas where water scarcity is a concern but where most of the poor are unconnected, the retail water price these unconnected households face at kiosks plus the associated time cost of collection (for themselves or vendors)

may approximate the right long-run marginal cost. In other words, there is probably little concern that households carrying water home are wasting it. This intersection may be more important in places (like Cape Town) where water resources planning, including demand management, is paramount; the fraction of low-income customers is substantial; and most have piped connections. In other places, like water-scarce parts of the U.S., aging infrastructure will need to be replaced with ratepayer funds. Increasing inequality and stagnating incomes could lead to a larger fraction of customers eligible for CAPs, and thus more attention on the incentive properties of CAPs. In the typology below, we have subdivided these CAPs by whether we believe the CAP preserves incentives.

In our typology (Table 3), the first strategy is a connection subsidy. This can be in the form of a free connection to the water or sewer network or partly subsidized connections. It could involve no- or low-interest financing of the connection fee. A CAP might also charge the full cost of connecting the household but spread the charges over time in the bill. If the utility passes along the full financing costs (i.e. its own borrowing costs), there would be no financial subsidy to the household per se, but the household may have an easier time affording a connection. The utility might finance these connection fees with a dedicated connection fee revolving fund, where more connections can be extended as original connection loans are paid off.

Payment flexibility programs give customers the option to make payments in ways that best suit them. Examples include programs that allow customers to pay more frequently than a monthly or bimonthly billing cycle, or payment using prepaid meters rather than post-paid bills. In the U.S. these can include programs to help customers deal with past unpaid debts to the utility.

A common CAP in the U.S. is a water efficiency/conservation program. These include partially or fully subsidized assistance in detecting and fixing leaks that are the homeowners' responsibility, installing low-flow appliances or irrigation timers, repairing appliances, home audits, and education/outreach programs.

Temporary or emergency assistance programs are tailored not to customers who are considered "poor" but to those who may have episodic difficulty paying water bills. This has also been a prominent feature of affordability discussions in the UK (OfWat 2016).

Table 3. Customer Assistance Strategies

	Customer Assistance Strategy	Description
Unlikely to affect monthly consumption	Connection	Free or subsidized cost of connection to the water or sewer network; also includes financing cost of connection through microloan or repayment through the normal bill.
	Payment Flexibility	Allows customers to pay more frequently than normal billing schedule, use prepaid meters, or pay via innovative billing mechanism. Can also include help with arrears management and repayment assistance.
	Water Efficiency/Conservation Assistance	Assists customers in reducing their bill by reducing water consumption: rebates for low-flow appliances (sometimes including installation), leak detection, etc.
	Temporary/Crisis Assistance	One-time credits for those episodically in need.
Consumption subsidies; More likely to affect consumption	Fixed Rebate	A set amount is given to the customer each payment cycle, typically through a bill credit. The rebate is unrelated to the customer's water usage.
	Fractional Price/Bill	The customer pays a certain percentage of the normal water tariff/ bill each payment cycle (i.e. customer pays 25% of bill, 75% discount), which will be tied to consumption if the tariff has a volumetric component.
	Volumetric Allowance or "Lifeline blocks"	Customers are allowed a certain amount of water free or at reduced cost each payment cycle (e.g. 5 m^3 per month); *smaller allowances less likely to affect overall consumption, larger "lifeline blocks" more likely to affect consumption.*
	Free Water	Customers are allowed unlimited water free of charge.
	Fixed Bill	The customer pays a set amount for water each payment cycle, no matter consumption. Includes bill based entirely on customer's income (e.g. Philadelphia's Tiered Assistance Program).

Consumption subsidies have the potential to influence a household's decision about how much water to consume. These can take the form of a fixed rebate, where a set amount of money is credited to the customer, regardless of water consumption. A fixed rebate policy is well suited for two-part tariffs, so that poor households could be credited for the fixed portion of the bill, thereby reducing their average cost while maintaining the marginal cost of water. The rebate

could be any fixed amount, however; a policy of charging a uniform volumetric price at marginal cost with a targeted or untargeted rebate has long been advocated in the sector (Boland and Whittington 2000). We include fixed rebates as a consumption subsidy, however, because there is now substantial evidence that consumers respond to complex non-linear price structures by implicitly calculating average price rather than identifying the relevant marginal price in the block structure (Ito 2014, Wichman 2014). Because of this, any fixed rebate that is tied in a salient way to the water bill may reduce average price in the consumer's mind and dampen marginal incentives to conserve. Although there are no empirical tests, one might expect that marginal incentives will be stronger if fixed rebates are delivered a) further away in time from the bill (i.e. pay the bill at the end of each month, but subsidy arrives in the middle) or if the subsidy is lumped with other subsidy or transfer payments (as in Singapore's USave program that includes electricity).

At the other end of the spectrum of incentives to conserve are programs that provide free water (no bill for use) or fixed bills, where the bill has no volumetric component and the customer pays the same amount each month. Both equally provide no incentive to conserve. Philadelphia's new tariff structure is a variant of the latter.[2] This program became operational only in July 2017, so there is very little discussion or evaluation of the program as implemented. The basic outline of the program is that customers whose income is between zero and 50% of the federal poverty line (FPL) will pay 2% of their monthly income, those earning between 51% - 100% will pay 2.5%, and those earning between 101-150% will pay 3%. The minimum bill was set at $12. The bill is in no way tied to water consumption. Providing free water from public taps is an example of the former (with type-of-service targeting). In both cases, the program eliminates any financial incentive for the customer to fix leaks or conserve water. In a fractional cost/bill approach, households pay a certain percentage of their bill calculated according to the normal tariff schedule. Because the size of the rebate changes with consumption, one might expect that fractional bill approaches would weaken marginal incentives to conserve compared to a fixed rebate, though this is an empirical question.

The final type of consumption subsidy is a volumetric allowance or "lifeline rate" in which customers are allotted a set amount of water free or at reduced cost each payment cycle. The size of this block may be designed to ensure that the poor receive enough water for basic hygiene, typically given as 40-100 liters per person per day (LCD) multiplied by an assumption about average household size. In the discussion below, we consider only *targeted* volumetric allowances as CAPs. Untargeted lifeline rates, or an IBT structure where the price for the first

[2] See http://www.circleofblue.org/2017/world/philadelphia-water-rate-experiment-aims-help-struggling-residents-pay-bills/ or https://beta.phila.gov/services/water-gas-utilities/water-bill-customer-assistance/

block of consumption is set low for *all* customers, is the most common approach that utilities in low-income countries use in an attempt to direct subsidies to the poor.

Finally, although necessarily a delivery mechanism for subsidies, prepaid water meters (PPMs) may have a role in ensuring a minimum level of service for poor customers while minimizing administrative non-revenue water. They empower households to monitor their consumption while protecting the utility from non-payment (Murrar 2017). PPMs may also encourage conscientious water use; the installation of PPMs in Palmas, Brazil, resulted in a 38% reduction in water consumption (Ruiters 2007). If a utility is unable to make a large investment, they could also install PPMs on public standposts instead of individual meters, as in Uganda (Berg and Mugisha 2010). However, the installation of PPMs can also be controversial, as in Cape Town (Calfucoy et al. 2009). In Nairobi, more than half of customers were qualified to be disconnected from the network due to outstanding water and sanitation debt, resulting in poor cost-recovery for the utility. In response, the utility installed PPMs with a goal of reducing non-revenue water to less than 40%. The installation of PPMs resulted in a public outcry, vandalism, and wasted investment due to technological malfunction (Heymans et al. 2014). However, Ruiters (2007) also found that PPMs can improve the public image of a utility by requiring customers to "self-disconnect" instead of being directly cut off by the utility.

2.5 A Typology of CAP Programs

We developed the typology in Table 4 to better identify the CAPs that are most effective at the intersection of helping the poor and preserving incentives to use water wisely (Table 4). Type 1, where the CAP does not attempt to target the poor and does not preserve incentives, is the worst case: all of the water the utility provides is subsidized and benefits mainly middle- and upper-income groups. Type 1 policies include free water (for all) and large volumetric allowances (more than 15 m^3 per month) for everyone. One could argue that untargeted IBTs with large first blocks are attempting to target the poor but failing.

Table 4. Types of Water CAPs

	Policy does not attempt to target poor households	**Policy attempts to target the poor**
Policy does not maintain economic scarcity signal	**Type 1** (e.g. most IBTs with large first blocks or those where all blocks are below marginal cost)	**Type 2** (e.g. Chile's subsidy policy, Philadelphia's fixed bill program)
Policy attempts to maintain economic scarcity signal	**Type 3** (e.g. IBTs not in Type 1, untargeted connection subsidies, untargeted crisis assistance)	**Type 4** (e.g. Portland targeted fixed rebate program; GPOBA targeted connection subsidies)

In our review of CAP programs below, we deliberately excluded untargeted IBTs as pro-poor policies, though we should note these policies are more common by far than any other CAP program (Fuente and Bartram 2018). According to the most recent global tariff survey conducted by Global Water Intelligence (GWI 2017), the majority (60%) of utilities that responded to the GWI survey use IBTs. They are especially popular with utilities in Latin America (94%), the Middle East and North Africa (92%), and Sub-Saharan Africa (88%).[3]

Type 2 limits allocative inefficiency to the poor's water use, as long as the targeting works. Targeted free water and fixed bills are Type 2 policies. We would also consider Chile's well-known program to be Type 2, since the program allows a relatively large discounted consumption block of 15 m^3 for eligible customers. Type 3 provides some help to poor households, but, because it is untargeted, it is an inefficient way to direct subsidies: a substantial fraction of the subsidies goes to the non-poor. IBTs with smaller volumetric allowances[4], early payment discounts, and water at reduced prices for institutions are Type 3 policies. Type 4 is the best-case scenario; subsidies are targeted to those who need them but maintain the price signal.

[3] The annual tariff survey conducted by Global Water Intelligence is the most comprehensive tariff survey conducted globally. However, the survey does not contain a representative sample of utilities across the globe, in particular regions, or in particular countries. Many utilities that use an IBT also deploy a lifeline block with free water (i.e. the price of water in the lifeline block is zero). Forty-one percent of the utilities in Latin America that use an IBT have a free lifeline block, compared with 33% in South Asia and 15% in Sub-Saharan Africa. For utilities that used an IBT, the average size of the lifeline block was typically quite large (global average of 13.6 cubic meters). However, in the Middle East and North Africa, the average size of the lifeline block was 18 cubic meters per month, equivalent to 150 liters per capita per day for a household with four members. In South Asia the average size of the lifeline block was 15 cubic meters per month (125 liters per capita per day). Only in Sub-Saharan Africa was the average size of the lifeline block significantly lower (7 cubic meters per month, or 58 liters per capita per day).

[4] We used a cutoff of 40 liters per capita per day, for 30 days in a household with 5 members, of 6 cubic meters. This is also the level of free basic water provision in South Africa.

Small volumetric allowances with a normal tariff thereafter, targeted connection subsidies, payment flexibility and/or financing, and targeted fixed rebates, fractional rebates, and fractional bills are Type 4 schemes.

3 Overview of CAPs in High-income Countries

In this section, we describe a range of CAP programs currently deployed in the United States, Europe, and Australia.

3.1 United States

The U.S. Environmental Protection Agency (EPA) published a compendium in 2016 that reviewed 795 utilities across the U.S. Of the 795, nearly 30 percent (228 utilities) were found to offer one or more CAPs, for a total of 365 active programs. Although low-income customers are most frequently the targeted customer type, some CAPs offer assistance to those experiencing a temporary hardship (divorce, death of relative, loss of employment), senior citizens, permanently disabled persons, and military veterans. The EPA review also reveals the number of utilities using each of the delivery/subsidy types. Bill discounts are the most common type (42% of active programs), followed by flexible-terms programs (27% of programs), which include payment plans, connection loans, managing arrears, moving from bimonthly to monthly billing, and allowing customers to set up a "levelized" bill that is estimated annually but gives customers the same bill amount each month. Temporary assistance programs were also common (24%), and 9% of programs were aimed at water efficiency, such as subsidized leak repair and rebates for high-efficiency appliances. Targeted volumetric allowances were found in only 5 of 365 active programs (1%).

Table 5 reports information from five city case studies we examined in more detail: Portland, Detroit, Cleveland, San Antonio, and Pittsburgh. We chose the cities purposely to broadly represent what we felt was the experience of U.S. utilities, rather than a random sample of the EPA compendium. The table shows that a) in all five cities, the utility is employing multiple CAP strategies, b) nearly all programs are funded with utility revenue, c) the percent of customers participating is small (generally <1%), d) the CAP program costs, though substantial in absolute terms, are a small percentage of utility revenue; and e) many programs are Type 4 programs in our typology because they use means-tested targeting and generally preserve economic incentives to use water efficiently.

3.2 Europe

WAREG, a network of European Water Regulators, published a study in 2017 regarding the affordability of water, in which utilities in 17 WAREG member countries were surveyed

(WAREG 2017). Fixed bills (a cap on the bill as a percentage of average annual income) are more common than in the U.S.: 10 of 17 countries have utilities that use these programs. Two of 17 countries use targeted volumetric allowances, and seven charge lower value-added taxes on water and sewer bills. Six of 17 offered either fixed rebates or bill discounts. European governments have also been more active than Americans in regulating the procedure for disconnecting customers for non-payment. Nine of 17 countries have compulsory procedures before disconnection and disconnecting is explicitly forbidden in some. The Italian Government passed a decree in October 2016 protecting economically disadvantaged households from being completely disconnected from water service. France passed the Brottes law in 2013, which prohibits any disconnection of water service. Water providers are not able to shut off water no matter the financial situation of the non-paying customer (Aqua Publica Europea 2016).

3.3 Australia

As part of a 10-year national strategy on energy and water efficiency, Australian utilities operating in areas with customer hardship policy frameworks must provide water efficiency advice and free home water audits. However, there is no national water customer policy framework or guidelines, and as such, customer assistance policies are administered by the individual water utilities. The State of Victoria also offers a utility relief grant scheme for paying overdue water bills of low-income Victoria residents experiencing unexpected hardship due to a temporary financial crisis.

Table 5 summarizes case studies from Europe and Australia. Again, because of the use of means-testing, we consider most of the cases Type 4 subsidies that preserve economic signals of scarcity. Utility revenue again predominates as the funding source, though programs in Australia, Italy, and Scotland rely on local or state-level financing. Unlike in the U.S., some of these programs enroll a larger percentage of customers: 10% in Flanders (Belgium), 16% in France, and 29% in Australia.

Table 5. Summary of Case Studies from High-income Countries

Location/ Administration	Type	Program elements	Targeting	Source of financing	Approximate % of customers served	Cost as percent of utility revenue
United States						
Portland						
Utility + local agency	4	Fixed rebate; crisis assistance; conservation assistance	Means-tested; partner w/ local social service. Single-family homes only. Re-apply every 2 years.	Utility revenue	6% (9,602/153,500)	1% ($4.9m/$498m)
Utility	3	Payment flexibility: more frequent billing; payment extension	None; all customers	Little/no revenue implication	15% (22,743/ 153,500)	Little/no revenue implication
Utility	3	Crisis assistance	Not means-tested; show temporary crisis	Utility revenue	NA	Much less than 1%
Detroit						
Utility	4	Payment flexibility (freeze arrearages; bill credit; past due bill forgiveness); conservation assistance	Means-tested	Utility revenue	NA	0.5%
Utility	3	Payment flexibility (payment plan)	Not means-tested; past-due/delinquent accounts	Little/no revenue implication	13% (25,000/200,000)	Little/no revenue implication
Cleveland						
Utility + local agency	2	Different tariff	Means-tested; elderly and disabled; annual application	Utility revenue	8% (24,000/313,000)	0.5%
Utility + local agency	4	Bill discount (fractional cost)	Means-tested; partner w/ local social service (LIHEAP)	Utility revenue	1% (2,500/313,000)	0.5%
Utility + local agency	3	Crisis assistance	Not means-tested; show temporary crisis	Utility revenue	Less than 1% (1,135/313,000)	0.5%

Table 5. Summary of Case Studies from High-income Countries

Location/ Administration	Type	Program elements	Targeting	Source of financing	Approximate % of customers served	Cost as percent of utility revenue
Pittsburgh						
Utility w/ local nonprofit	4	Fixed rebate/grant	Means-tested; partner w/ local social service	Customer, corporate, employee *donations*	Less than 1% (1,187/666,436)	Much less than 1%
Utility w/ local nonprofit	4	Fractional cost (80% discount water, 15% sewerage)	Means-tested; partner w/ local social service	Utility revenue	2% (14,629/666,436)	NA
Utility w/ local nonprofit	4	Conservation assistance	Means-tested; partner w/ local social service	Utility revenue	NA	NA
San Antonio						
Utility	4	Fixed rebate	Means-tested; cap on water consumption	Utility revenue	4% (18,000/500,000)	0.5%
Utility + local agency	4	Crisis assistance	Means-tested	Voluntary contributions	Less than 1% (2,000/500,000)	0.5%
Utility	4	Payment flexibility (late fee waiver)	Elderly; disabled on social security	Little/no revenue implication	6% (30,000/500,000)	Little/no revenue implication
Utility + local agency	4	Conservation assistance	Means-tested; water & sewer customers	Utility revenue	NA	0.5%
Belgium						
Wallonia (region)						
Utility	4	Bill discount; conservation assistance	Financially vulnerable customers	Utility revenue	0.5%	NA (€4m)
Flanders						
Utility	4	Bill discount (fractional cost); payment flexibility (payment plan); conservation assistance	Means-tested; social welfare beneficiaries	Utility revenue	10%	NA

Table 5. Summary of Case Studies from High-income Countries

Location/ Administration	Type	Program elements	Targeting	Source of financing	Approximate % of customers served	Cost as percent of utility revenue
Brussels						
Utility + local agency	4	Conservation assistance; payment flexibility (payment plan)	Financially vulnerable customers	Utility revenue	NA	NA (€2m)
France						
Utility	4	Bill discount; payment flexibility (payment plan)	Financially vulnerable customers	Utility revenue; voluntary contributions	0.25%	NA
Utility	2/4	Lifeline rate	Social welfare assistance beneficiaries	Utility revenue	16% (15,000/94,000)	NA
Italy						
Utility	4	Tariff reduction	Means-tested; physical inabilities	Government	Less than 1% (20,000/4,500,000)	Less than 1% (€1,100,000/€550,000,000)
Utility	4	Bill discount	Means-tested	Utility revenue	1% (30,000/2,300,000)	NA (€1m)
Scotland						
Local authority	4	Bill discount	Students; low-income households; disabled persons	Tax revenue	NA	NA
Spain						
Utility	4	Tariff reduction	Means-tested	Utility revenue	1.3%	NA
Utility	4	Bill discount; lifeline rate	Means-tested	Utility revenue	NA	NA
England						
Utility	2	Fixed bill	Means-tested and three or more children or medical condition	Utility revenue	Less than 1% (130,500/56,073,000)	NA
Utility	4	Debt advice; conservation assistance	Means-tested	Utility revenue	4% (199,626/4,600,000)	NA

Table 5. Summary of Case Studies from High-income Countries

Location/ Administration	Type	Program elements	Targeting	Source of financing	Approximate % of customers served	Cost as percent of utility revenue
Australia, Victoria State						
Govt agency	4	Bill discount	Means-tested	Government	29% (670,000/2,277,967)	1% (145m AUD/12,020m AUD)

Note:
AUD = Australian dollar(s)
NA = not applicable

4 Overview of Non-Tariff CAPs in Low- and Middle-Income Countries (LMICs)

In this section we review and categorize 77 water CAPs in 45 low- and middle-income countries (LMICs). These CAPs were identified through a search of the published peer-reviewed literature, gray literature and news items. We know of no global dataset tracking CAPs or affordability programs globally; Global Water Intelligence (GWI) tracks tariffs but not assistance programs. We thus caution readers that our list of CAPs may not be representative of assistance programs globally in LMICs. Also, although we attempted to determine whether the CAPs remained current and in place, it is possible some programs may have changed or been terminated since our source documents were written. The table (Appendix 1) compiles these programs according to the typology and definitions above.

Of the 77 CAPs, 27 are from sub-Saharan Africa, 20 from Latin America and the Caribbean, nine from East Asia, eight from the Middle East and North Africa, seven from South Asia and six from Eastern Europe, the Caucasus and Central Asia. The vast majority (76%) of cases are based on information in the gray literature. In 24% of cases at least one article describing the program was described in a peer-reviewed journal.

4.1 Administration

In most cases (48%), we could not find an explicit statement about application procedures or who verified eligibility, so it is unclear who administers CAPs. Most of the remaining programs (40% of the total) are administered by the utility, and decisions about how to target subsidies and the levels at which they should be funded are made by the utility. In nine percent of cases the program was administered by a city government (as in Chile) and in only 2 cases by the state or central government (as in Singapore). In some cases, like South Africa, Bangladesh, and Chile, utilities partner with government statistical agencies in verifying eligibility or using existing definitions of poverty.

4.2 Financing

Again, the most common classification was missing information: we could not find information on how programs were financed in 56% of cases. Five cases described CAPs as being funded from utility revenue, including programs in Bolivia, Peru, and China (Smets 2008, Komives 1999, Oxford Business Group 2012, Zhong et al. 2008), though it is very likely in these cases that all customers are charged prices that are below full cost recovery rates. These programs are therefore likely funded at least in part by subsidies from other levels of government or implicitly by running down the capital stock. We found state-funded subsidies programs in 12

cases, including Chile (Gomez-Lobo and Contreras 2003, Contreras et al. 2018), Singapore (Chang and Fang 2017), and Iran (Attari and van Dijk 2016). In these cases, the local or central government funds the subsidy, but relies on the utility to deliver water service. The World Bank's connection subsidy grants through the Global Output-Based Aid (GPOBA) program in Cameroon, Kenya, the Philippines, Brazil, and Indonesia are common (9%) examples of third-party donor financing (World Bank 2014, World Bank 2016, Jagannathan et al. 2009, Ehrhardt et al. 2007, Menzies and Suardi 2009). We know of no program asking for voluntary contributions from utility customers themselves, as is common in the U.S.

4.3 Targeting

Means-tested programs are common (32% of programs), including a third of these that used proxies for income. Examples include Cameroon (World Bank 2014, Banerjee and Morella 2011), South Africa (Department of Water Affairs and Forestry 2002, Brown 2005; Calfucoy et al. 2009, Tissington et al. 2008; Szabo 2015), Kazakhstan, Russia, and Ukraine (OECD 2003), Argentina (Vagliasindi 2012), Uruguay (Komives et al. 2006), and Cambodia (Berg 2013). The most common proxy measures for income found in water CAPs are assets, household size and type of residence. Another proxy measure commonly used is dwelling type, as in Bangladesh (Lahiri 2009), Singapore (Chang and Fang 2017), Indonesia (Ehrhardt et al. 2007), Mexico (Smets 2008), Paraguay (Foster and Yepes 2006), Mongolia (Smets 2008) and India (Asian Development Bank 2013).

Geographically targeted water CAPs are used in 22% of programs, including in Colombia (Gomez-Lobo and Contreras 2003), Kenya (Mwangi et al. 2015), Mozambique (Jimenez-Redal et al. 2014), Senegal (Lauria et al. 2005), Uganda (Mason 2009), Tajikistan (Jepbarov and Sommer 2012), Morocco (Jagannathan et al. 2009), Bolivia (Komives 1999), Mexico, Nicaragua, Panama, and Venezuela (Komives et al. 2005), the Philippines (Menzies and Suardi 2009), and India (Davis and Tanka 2006). The Colombian subsidy had very high errors of inclusion in this scheme; 83 percent of all households are in one of the three pro-poor subsidy levels. Gomez-Lobo and Contreras (2003) found Colombia's water CAP to be more poorly targeted but less expensive to administer than Chile's means-tested policy.[5] A substantial percentage of the subsidy is the administrative work of targeting it; in the Chile and Colombia policies, it is estimated that the cost of targeting represented 2 to 18 percent of the total value of the subsidy. In Panama, where households were individually interviewed to establish eligibility, it represented almost 40 percent of the cost of the subsidy (Department of Water

[5] Coady et al. (2004) found that data on the administrative costs of targeting was difficult to find. They estimated that means and proxy have comparably high administrative costs, while geographic, demographic and self-targeting were cheaper to administer.

Affairs and Forestry 2002). Demographic targeting is used in 9% of cases, including Mexico (Smets 2008), Panama (Komives et al. 2005) and China (Warford and Xie 2007, Zhong et al. 2008).

Subsidized or free public standpipes are the most common type of self-targeting (or level-of-service targeting), used in 17% of cases, including Ethiopia (Banerjee and Morella 2011), Lesotho, Madagascar, Namibia, Niger, Nigeria, Tanzania, Uganda, Morocco, China (Zhong et al. 2008), India (The Hindu 2003) and Nepal (Bardasi and Wodon 2008, Mason 2009, Komives et al. 2005). Banerjee and Morella (2011) found that Ethiopia, Lesotho and Zambia have issues with third-party operators selling water from public standpipes at prices 3 to 5 times higher than the formal price, implying that the poor still faced higher prices and operators pocketed what could have been utility revenue. Similarly, in Lusaka, independent operators resold subsidized utility tokens, and Bardasi and Wodon (2008) found a similar phenomenon in Niger, resulting in non-revenue water for the utility and errors of exclusion as the subsidy did not benefit its intended beneficiaries. Komives et al. (2005) analyzed public taps in Bangalore, India, and Kathmandu, Nepal. Both suffered from relatively high errors of exclusion, 61 percent and 72 percent, respectively. They also found that 10 percent of the non-poor used the taps in Bangalore, while 25 percent of the non-poor used the taps in Kathmandu. Subsidized shared connections are used in Côte d'Ivoire (Lauria et al. 2005), Gabon, Kenya (Mwangi et al. 2015), Senegal (Lauria et al. 2005), and India (Davis and Tanka 2006). Lauria et al. (2005) found that these group connection subsidies excluded many of the poorest families in Côte d'Ivoire and Senegal because they required household to have tenure to the land the connection would be installed on or live within 12 meters of the main.

4.4 Delivery Strategies

Besides subsidizing public taps (above, 18% of delivery strategies), connection subsidies make up 27% of the CAPs in our survey. In Jakarta, Indonesia, the government paid for all new connections with the assistance of the World Bank's GPOBA (Ehrhardt et al. 2007). Jimenez-Redal et al. (2014) found there was a low uptake of connections after a network expansion in a low-income neighborhood in Maputo, Mozambique; in one neighborhood, only 25 percent of households purchased connections, and only 11 percent in another. They found households were more likely to purchase connections if they could finance it over several months.

Means-tested fractional bills (18%) are used in Kazakhstan, Russia and Ukraine; the government provides compensation for households' housing and utility expenditures, including water, which exceed 30 percent of income in Kazakhstan, 22 percent in Russia and 20 percent in Ukraine. There are relatively high errors of exclusion in these schemes; in Kazakhstan,

28 percent of the population is poor, but only 8 percent receive the subsidy; in Russia, 29 percent is poor and 9 percent receive the subsidy; in Ukraine 27 percent is poor, but 13 percent receive the subsidy (OECD 2003, United Nations Centre for Human Settlements 2001). In the Ukraine Housing Subsidy Program, the rebate is administered on a monthly basis and paid directly to the utility (Davis and Whittington 2004). Fractional bill schemes were also used in Argentina and Panama City, Panama (Vagliasindi 2012, Foster et al. 2000).

Free or discounted volumetric allowances were used in 23% of cases. (Again, note that we excluded any "discounted" volumetric allowances that were untargeted and available to all customers: these are the common IBT programs described above.) Many municipalities in South Africa use volumetric allowances (of 6 m^3) as a part of the free basic water program for indigent customers, including Douglas, KwaZulu-Natal, Lichtenburg, Mbombela, Polokwane, Pretoria, Rustenburg, Volkrust and Cape Town (Smith 2010, Calfucoy et al. 2009, Brown 2005, Szabo 2015, Szabo 2011, City of Cape Town 2015, Department of Water Affairs and Forestry 2002). In Pretoria, Szabo (2015) found that the subsidy has minimal impacts on household consumption and acts as a lump-sum subsidy for the 12 percent of households that are indigent.

We found only two cases of payment flexibility. In Palestine, customers are given a bill discount for an early payment. Murrar (2017) found the policy did not successfully incentivize customers to pay their bills on time. Another example of a financing policy comes from the government of Yerevan, Armenia; customers with water and sanitation debt accumulated prior to 2000 had their arrears forgiven as long as 15 to 20 percent of it had been paid. As a result, 90 percent of customers used the subsidy, and the financial situations of the utilities eventually stabilized (United Cities and Local Governments 2014).

Fixed bills, or a set charge for water no matter a household's consumption, are used to help customers in Macau, China. A proxy measure of household size is used to set the price of water; a household of four people pays $12USD per month for water, which is about 3 percent of the minimum wage (Smets 2008). Some of the literature referenced households having subsidized bills for water; it is unclear if these were fixed bill or fractional cost schemes.

We found no examples of targeted programs offering poor customers conservation assistance in reducing bills through leak detection and repair or incentivizing efficient appliances.

Overall, the CAPs we examined are split between Type 2 (43%) and Type 4 (43%), both of which attempt to target the poor. We classify 13% as Type 3 that preserve economic scarcity signals but do not attempt to target the poor (mainly connection subsidy programs). We classified none as Type 1, largely because we excluded the most common Type 1 policy: untargeted lifeline blocks.

5 Case Studies: Chile and Singapore

5.1 Chile

Easily the most discussed example of an innovative CAP in low- and middle-income countries is Chile's program, introduced in 1990. The program was analyzed in a number of papers, notably the comparison of targeting properties with Colombia's geographic targeting scheme in Contreras and Gomez-Lobo (2003). Contreras et al. (2018) recently updated their analysis and described how the program has evolved since 2003, which we briefly summarize here.

The program is administered by a federal agency (the Ministry of Social Development, or MDS in Spanish), which makes decisions about the total subsidy budget as well as how that budget will be distributed to the regions, discussed more below. Eligible customers pay a reduced percentage of their water and sewer bill for amounts up to 15 m^3 (125 LCD for a 4-person family), but the 16th and subsequent units are charged at the full tariff. This is a volumetric allowance program in our typology, where the first block is subsidized.

There are currently three groups that benefit from the subsidy. The first group is households who qualify for the Chile Solidario welfare program introduced in 2004. This program is intended to serve the very poor, and participants receive both subsidies for a number of essential services and access to social workers. This group receives a 100 percent discount on the first consumption block. The second group is elderly households in the first two quintiles of the income distribution. The third and largest group is households who would pay more than 3 percent of their monthly income on water and sewerage services. Before 2001, this affordability cutoff was 5 percent. In all three groups, eligible households must live in permanent dwellings, not be in arrears to the utility, and have a piped water connection, including a connection to a rural cooperative water system.

The total number of subsidies designated to a municipality is based on the city's water/sewer bill for 15 m^3 and the distribution of income in the municipality, based on a nationwide survey and information from private and public pension funds. This gives an estimate of the number of households who would be paying more than 3 percent of income to the water utility. This number is multiplied by the gap between 3 percent of income and the full tariff for 15 m^3 to determine the subsidies allocated to the municipality. Aggregating these to the regional and then national level and adding subsidies for the Chile Solidario and poor elderly groups gives the total required subsidies, which are funded entirely from general tax revenue and included in the national budget each fiscal year. The water regulator who is responsible for setting tariffs is not involved in the operation of the system or determining overall subsidy levels.

Households must apply for the subsidy at their municipality. If the municipality determines them to be eligible, the service provider is notified and begins crediting the customer's monthly bill. The service provider regularly bills the municipality for all subsidies awarded in the previous billing period. Households must re-apply every three years.

The targeting approach has evolved over the nearly three decades of the program's existence, as discussed in Contreras et al. (2018). The earliest program used proxy measures as reported by households during an in-person survey. As incomes grew and durable asset ownership increased among all households, it became increasingly difficult for an asset-based measure to distinguish the poor from the non-poor, and Chile moved to a socioeconomic vulnerability approach. The FPS program was primarily a demographic targeting scheme (in our typology), measuring the age, education, disability status and income-generating capacity of household members, though with some geographic proxies such as unemployment rates in the municipality. Like the asset-based approach before it, the FPS was subject to manipulation by households during the interview, and a new system took its place in 2016. It centralizes administrative information on the household, including its income (reported to various state institutions such as the Internal Revenue Service) and self-reported socioeconomic attributes. Each household is assigned a score based on this information that determines eligibility for a number of social programs.

Subsidy expenditures have grown 138 percent in real terms between 1998 and 2015, with the number of subsidies awarded growing by 54 percent. This is despite a 38 percent increase in real incomes in the same period nationwide among households that received a subsidy. These increases were driven in part by the change in calculation of subsidies from 5 percent of income to 3 percent, but primarily by large real increases in tariffs. Appendix C shows tariff increases in municipalities over the period ranged from 34 percent to 142 percent, with tariffs more than doubling in six of the 17 service operators.

5.2 Singapore

Another example of an innovative program in a middle-income country is Singapore's U-Save (for Utility-Save) program, first implemented in 1997 (Chang and Fang 2017). The program is funded from general tax revenue and administered by the government. The delivery type is a fixed rebate: eligible households receive a fixed credit deposited directly into their utility accounts (water and electricity) quarterly. Credits can be applied whenever the customer decides to use them, and the credit rolls over and does not expire. U-Save is one of three voucher

programs aimed at offsetting an increased General Goods and Services Tax; the other two are a cash voucher and a health expenses voucher (Medisave).[6]

In our typology, targeting is proxy-based and based on living in public housing (HDB housing). The subsidies are progressive in that smaller 1- and 2-room flats receive larger fixed subsidies than larger flats. The value of the subsidy is such that a 1- or 2-room flat would be able to offset approximately 3 to 4 months of utility bills. At least one household member must be a Singaporean citizen, and no occupants can own a second property.

The most recent increase in the U-Save subsidy budget in July 2017 was explicitly meant to offset the cost of a water tariff increase. The current estimate of the number of beneficiaries is 880,000 HDB households, at a total cost of $265 million per year (The Strait Times 2018). Residents can sign up to receive mobile phone/short message service (SMS) notifications that their U-Save credits have been deposited to their account. We are unaware of estimates of the program's administrative costs.

6 CAP Evaluations

Considerable research was conducted about pro-poor water and sanitation programs in low-income countries from 2000 to 2010. The primary outcome of interest was the performance of competing targeting approaches in delivering subsidies (e.g. errors of inclusion and exclusion). Several publications discussed and compared the effectiveness of Chile's means-tested and Colombia's geographically targeted programs (Gomez-Lobo and Contreras 2003, Serra 2000, Vargas and Heller 2016, Gomez-Lobo 2001). There have also been several comprehensive research efforts aimed at formally assessing the effectiveness of water subsidies on a regional or global level, including Komives et al. (2005), Smets (2008), Banerjee and Morella (2011), and the World Bank's series on Tariffs and Subsidies in South Asia (2001-2003). The data for these studies were usually gathered from a variety of sources, including utility official interviews, household surveys, and country-level demographic data. More recently, South Africa's Free Basic Water policy has been subject to several evaluations since its implementation (Calfucoy et al. 2009, Szabo 2015, Department of Water Affairs and Forestry 2002, Smith 2010, Tissington et al. 2008, Brown 2005). Nevertheless, in over half of the programs we identified, there appears to have been no published evaluation on whether they help intended beneficiaries. Despite policy recommendations to subsidize connections for those who could afford a cost-reflective monthly bill, there are in fact few empirical studies documenting that such programs do better at helping the poor. Geographically targeted subsidies (including

[6] https://www.gstvoucher.gov.sg/Pages/index.aspx

connection or volumetric subsidies) may simply be capitalized into rents (Komives 2003, Anselin 2008) and be captured by landlords.

In contrast, in the U.S., Europe, and Australia, targeting and subsidy leakage are rarely raised as concerns, and evaluated only recently in Australia (Chan 2016). Chan (2016) focused on the State of Victoria, where eligible residents receive a 50% discount on their total quarterly water bill, with a cap of 283.90 AUD. In 2012, around 1.3 million residents, about one-fourth of all Victoria residents, were eligible for water subsidies. In 2012, around 0.67 million households received water subsidies with a total cost of 145 million AUD, paid for by the Victoria state government. The evaluation found that in 2007 the water subsidies scheme had a 68% success rate (successfully targeting eligible households or successfully excluding ineligible households), and had a 32% error rate (either inclusion error via program leakage or exclusion error via under-coverage). A substantial amount of the water subsidy budget was given to non-poor customers (Chan 2016).

We were unable to find any independent cross-utility evaluation studies for programs in the U.S. and Europe. These countries have relatively robust national income reporting to tax agencies and standard poverty definitions (e.g., federal poverty Line), so a focus on subsidy leakage may not be the most important research priority. Eligibility criteria may of course be poorly administered, and such confidence in means-testing misplaced. Instead, the focus of existing research has mainly been on low uptake of the programs among the eligible (errors of exclusion), challenges in funding programs, and the possible administrative benefits of coordinating support among other programs. These reports are typically case studies and descriptions of best practices, and rarely detailed empirical evaluations that are published in peer-reviewed outlets.

Accordingly, we have found very few studies that look carefully at how CAPS might change the water use behavior of customers who participate. This type of study might be very important in a situation where water scarcity means the short-run marginal cost of water is high but where a large number of customers need support to pay ever-increasing tariffs meant to spur conservation (e.g., the current situation in Cape Town, South Africa). Economic theory suggests that CAPs that rebate poor customers a flat amount untied to volumetric use should both preserve the economic signal to conserve and help the poor. If, however, customers react to their average price or total bill rather than marginal price (Ito 2014, Wichman 2014), such a program might lead to less conservation. Providing information to help customers perceive marginal cost and understand tariff structures is an active area of economic research in the U.S., particularly in the energy sector, but this research has not yet connected to the discussion of CAPs in water.

7 Conclusions

We conclude with four lessons from our global review of non-tariff CAPs. First, despite the large literature on targeting evaluations, little is known about whether CAPs "work". This includes connection subsidy programs, which have been recommended for two decades, and the various types of means-tested consumption subsidies used in the U.S. and Europe. In many settings, we do not understand why participation in CAPs is low. It simply may be that administrative hassles or corruption make the task of applying not worth the relatively small benefit. Devoto et al. (2012) in Morocco found that simplifying the application process of obtaining a private connection by sending staff to the doorstep increased the percent of respondents applying for a connection from 10% to 69%, but that even among control households, uptake increased as a higher fraction of neighbors connected.

Second, targeting subsidies effectively will continue to be a challenge in LMICs. Even in Chile, a growing, middle-income country, the transition from a survey-based proxy measure for household income that could be used for means-testing applicants to reliance on centralized administrative data occurred only in 2016. Means-testing via household surveys will continue to be expensive and unreliable, so there will continue to be a role for service-level targeting by subsidizing public taps and shared connections and geographic targeting, particularly for connection subsidies. But technology is rapidly evolving. Many are watching India's experience with Aadhar ("Foundation"), a nationwide biometric identification system that is being used to accurately target a number of subsidies and social service programs, but is also being criticized as an invasion of privacy and a security risk.[7]

Third, there has been little attention paid in the United States and Europe to the intersection of CAPs and water scarcity. Utilities in LMICs can draw from important experiences in the U.S. around subsidy programs to provide free conservation audits, discounted low-flow appliances, and in some cases free plumbing work. These programs have been framed around helping poor customers lower water bills, rather than conservation goals to match water supply and demand. The majority of cases we reviewed are from cities with relatively abundant raw water supplies. These programs have not been tried in LMICs, but might have an important role in places with water scarcity concerns. Programs to replace fixtures are likely to be too expensive, but programs to provide audits, quickly detect leaks, and perhaps to subsidize fixing those leaks (behind the master meter) may be worth exploring in middle-income countries where scarcity is a concern. Without targeting, however, the value of these programs would surely be quickly captured by the non-poor. Furthermore, programs that provide fixed rebates that can be

[7] "'Big Brother' requires fingerprint scans for foods, phones and finances", https://www.nytimes.com/2018/04/07/technology/india-id-aadhaar.html and "India loves data but fails to protect it" https://www.nytimes.com/2018/04/03/opinion/india-data-privacy-biometric-aadhar.html

spent throughout the year (like Singapore's) are more likely to preserve the economic scarcity signal than volumetric discounts or preferential, targeted "lifeline blocks", though this conclusion is based only on economic theory and has not been empirically tested.

Finally, because of historic and continuing progress in connecting urban populations, the WASH sector is likely to face more situations where most households are connected but water tariffs need to rise substantially to maintain the system and finance system expansion needs due to population and economic growth. Some "middle income" customers may find it episodically difficult to pay. These situations are in fact parallel to many small and medium-sized cities in the U.S., and this makes the political economy of tariff reforms different. The main task in these settings should be on how to convince policymakers to transition from implicit (typically capital) subsidies to utilities to explicit political support for cost-reflective tariffs paired with credible, well-evaluated subsidy programs that do better at helping the poor. In the U.S., this discussion is manifesting itself through a conversation about creating a federally funded subsidy program for water and sewer like the existing federal program for low-income heating assistance (LIHEAP). The experiences in the U.S. about maintaining good relationships with customers (managing arrears, forgiveness, subsidies predicated on continuing good faith payments, flexibility) may also become increasingly relevant to the operations of utilities in LMICs.

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<Appendix table listing LMIC cases>