

Magnitude and Distribution of Electricity and Water Subsidies for Households in Addis Ababa, Ethiopia

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Abstract

In Addis Ababa, an increasing block tariff has been used to calculate households' monthly bills for electricity and water services. This study estimates the magnitudes of the combined water and electricity subsidies received by households with private connections to the electricity grid and piped water network in 2016, and it evaluates the distribution of these subsidies among wealth groups. Customer billing data supplied by utility companies are matched with socioeconomic information collected through a household survey. It is the first detailed analysis of the combined effects of increasing block tariffs for electricity and water in an urban area in a developing country. The results show that

the combined subsidies are large. The average household receives a subsidy of US\$26 per month, about 6 percent of household income. The findings also show that electricity and water subsidies under the increasing block tariff disproportionately accrue to richer households, with even less targeting when both sectors are considered jointly. The poorest quintile receives 12 percent of the total subsidies for electricity and water services, while the richest quintile receives 31 percent. The water increasing block tariff's targeting of subsidies was somewhat worse than that of the electricity increasing block tariff.

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Introduction

In Addis Ababa, Ethiopia, increasing block tariff (IBT) structures have been used to calculate households' monthly bills for both electricity and water services.² These IBT structures have two principal objectives. The first is to ensure the fair, equitable, and affordable provision of these utility services; the second is to use the higher prices in the IBT's upper "blocks" to promote energy and water conservation. Our paper focuses on the first objective and analyzes the incidence of electricity and water subsidies delivered under these two IBTs to 366 households—with private connections to the electricity grid and to piped network water—for the exclusive use of their household members.

Our analysis is restricted to this 366-household subsample, which is derived from a large and representative household survey of Addis Ababa that includes 987 observations, because we have data for the subsample households—which have private electricity and water connections—from their monthly electricity and water bills; these data include the quantities of electricity and water used as well as the households' socioeconomic status. We are thus able to calculate the magnitude of both the electricity and water subsidies that the 366 households received in 2015, and we can also examine the distribution of electricity and water subsidies by wealth groups within the subsample.

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² The electricity IBT was in force until November 2018, while the water IBT remained in force at the time this paper was issued. In December 2018, electricity tariff reforms were implemented in Ethiopia. One objective of the reforms is to achieve cost recovery in the medium term. The IBT was replaced with a volume-based tariff that will increase in over time. The average tariff will increase from US\$0.02 per kWh in 2018 to US\$0.07 per kWh by 2021 in four annual increments.

These 366 households are substantially more prosperous than the overall population of Addis Ababa. Many poor households in this capital city share either an electricity connection, a piped water connection, or both—or have no water connection. Yet for households with a shared water connection, we are unable to estimate their water use and monthly water expenditures with sufficient accuracy to estimate the subsidies they receive. Nevertheless, we believe it is worth examining the subsample of 366 households with private connections to both the electricity grid and the piped water network because scholars can rarely estimate the magnitude of both electricity and water subsidies received for a given household.

We derive these estimates by using data from four sources: (1) our own estimates of the total average costs of water and electricity services in Addis Ababa, which are mainly based on utility financial reports; (2) customer billing records from the electricity utility; (3) customer billing records from the water utility, which we match with data from the electricity utility; and (4) in-person interviews with respondents in the sample households. We are able to match household electricity and water billing records with the household demographic and socioeconomic data collected via our household survey. In a companion paper (Cardenas and Whittington 2019) we report the magnitude and distribution of electricity-only subsidies across the entire sample of 987 households.

Our analysis makes three contributions to the literature on the incidence of electricity and water subsidies. First, most previous research on the distribution of such subsidies is limited to only one of the utility services and so it is not possible to assess either the magnitude of the cumulative subsidies that different household wealth groups receive or how these subsidies interact with each other. Second, few previous studies match actual customer billing records with household socioeconomic data—and none match both electricity and water customer billing records with such data. Third, most previous studies do not base their subsidy calculations on the actual cost of service

of the electricity and water utilities in the study location; instead, they tend to assume local costs are the same as national or international cost estimates. Our analytical approach addresses all of these limitations.

The results reported here show that the combined water and electricity subsidies received by households in Addis Ababa with both private water and electricity connections are surprisingly large. The average Addis Ababa household with both a private electricity and private water connection receives a subsidy of \$26 per month,³ which is equivalent to some 6% of household income. In Addis Ababa, the lowest quintile of the in-sample wealth distribution (i.e., the poorest 20% of the 366 households) receives 13% of the subsidies delivered through subsidized electricity services, 11% of the subsidies delivered through the subsidized water services, and 12% of the cumulative subsidies provided by both electricity and water services to these households. In contrast, the richest quintile receives 28% of the subsidies delivered through subsidized electricity services, 34% of the subsidies delivered through the subsidized water services, and 31% of the cumulative subsidies provided by both electricity and water services to the 366 households. This clearly suboptimal targeting of subsidies was evident even though both the electricity and the water utility used an IBT to price their services.

In Section 1 of the paper we summarize findings from the literature that addresses (1) the effectiveness of IBTs at targeting electricity and water subsidies in low- and middle-income countries and (2) the reasons why IBTs seldom perform as anticipated. We find that there is little research reporting on the magnitude and incidence of subsidies when both the electricity and the water utility in a city use an IBT, as is the case in Addis Ababa.

³ We report all monetary values in US dollars (USD).

In Section 2 we describe the two increasing block tariff structures currently used in Addis Ababa to determine residential customers' electricity and water bills, and in Section 3 we discuss our data collection, sampling strategy, and fieldwork. Section 4 presents the methodology we use to calculate the subsidies received by our sample Addis Ababa households. Results from our analysis of the 366 households with private connections to both the electricity grid and the piped water network—for the exclusive use of their household members—are reported in Section 5. We conclude in Section 6 with summary observations.

1. Literature on the incidence of electricity and water subsidies in low- and middle-income countries

In this section we review studies that examine both water and electricity subsidies to residential customers in developing countries. We include papers that were published in refereed journals or working papers of the World Bank or other international development institutions. We seek the answer to the following questions. (i) What was the scope and type of data used by previous studies? (ii) What differences and similarities between water and electricity subsidies received by residential customers have been reported in the literature on subsidy incidence? We then briefly describe what the literature has reported about the performance of IBTs.

Scope and type of data in previous studies

Very few studies in the literature examine the subsidy incidence of the municipal water supply and electricity sectors simultaneously. Foster (2004) evaluates cost recovery for several public service sectors—including gas, transport, electricity, and water—in Argentina. Foster and Araujo (2004) analyze the water, electricity, and telecommunications sectors in Guatemala; Foster and Yepes (2006) estimate the extent of cost recovery for water and electricity services for Latin American utility

companies serving the region's larger cities. Melendez (2008) analyzes subsidies for electricity, water, gas, and phone services in Colombia.

The majority of these studies use household survey data on expenditures to back-calculate household water and electricity use (Foster 2004; Foster and Araujo 2004; Melendez 2008).⁴ This estimation strategy is also common in subsidy incidence analyses that examine electricity and water subsidies only. Appendix A summarizes studies that examine the incidence of subsidies in the water supply sector (for a review of subsidy incidence analyses in the electricity sector, see Cardenas and Whittington 2019). However, there are two main problems with this back-calculation approach. First, when self-reporting their electricity and/or water bill, the respondent may simply guess the past month's bill because its amount is either not remembered or unknown. Second, researchers in this vein typically use the average price paid based on the existing tariff structure. Yet if the price structure used by a utility company is based on an IBT, then the result is an error in the estimation of the levels of water and electricity actually used.

Another factor that merits consideration is that, in these studies, the estimates of costs of production and delivery are based on national or regional cost estimates—not on data from the utility companies themselves (Foster 2004; Foster and Araujo 2004; Melendez 2008). Foster and Yepes (2006) focus on cost recovery levels of water and electricity utility companies in Latin America, but they do not have access to information on the full average cost of service provision. Hence they rely on data from Global Water Intelligence for estimates of operation costs and of maintenance and capital costs for water and electricity utility companies. There are very few studies in the literature that obtain or estimate the average unit cost based on data from the utility companies actually serving

⁴ Foster (2004) uses data from a household survey that asked respondents to present their electricity/water bills, when available: 28% of the respondents were able to show their water bill and 35% were able to show their electricity bill. At the same time, 42% were unable either to present a water bill or to report their water expenditure; and 35% were unable to show their electricity bill or report their electricity expenditure.

the location being studied (Fuente et al. 2016). Furthermore, no previous studies have obtained such information from both utility providers (water and electricity) for the same location. Finally, we found no studies in the literature that matched household socioeconomic data to billing records obtained from both water and electricity utility companies.

In short, hardly any studies have simultaneously analyzed the incidence of residential water and electricity subsidies. Of the few that do, none have used customer billing records from utilities to determine household water and electricity use. In this study we match households' customer identification (ID) numbers—obtained from our household survey of socioeconomic conditions—with the billing records of the water and electricity utility companies in Addis Ababa, Ethiopia.⁵ Also, we estimate the total average cost of both services using financial data collected from the electricity and water utility companies serving the Addis Ababa population.

Comparison of water versus electricity subsidies in the residential sector

Most studies on subsidy incidence and the cost recovery of water and electricity public services report that utilities use IBTs to calculate household bills. Foster and Yepes (2006) look at both the water and electricity sectors and present an analysis of cost recovery by these utilities for several large cities in Latin America. Utilities in most of those cities use IBT structures. Of the 17 water utilities, 15 use IBTs, and 8 of 14 electricity utilities use IBTs. Komives et al. (2006) review previous studies on water and electricity subsidy incidence in the residential sector in developing countries. Their case studies come from 21 different countries. For 12 cases in the water sector, these authors find that seven utilities used IBTs, one used geographically defined tariffs with IBTs, one used a uniform volumetric tariff, and three used means-tested discounts. For the electricity sector, four of 12 cases

⁵ We were able to nearly match all our observations of electricity private connections to the electricity utility database. In addition, we were able to match 70% of our observations of private water connections to the water utility database; for the remaining 30%, we relied on customer self-reports and back-calculations.

used IBTs, two used geographically defined tariffs with IBTs, two used a uniform tariff, two used volume-differentiated tariffs (VDTs) with specific thresholds, and two used means-tested discounts.⁶ Other studies in the literature that have examined water-only or electricity-only cases confirm this predominance of IBT structures in the developing world.⁷

With regard to subsidy “leakage” rates and the progressiveness (or regressiveness) of water and electricity subsidies for the residential sector, it is well documented that subsidies allocated through quantity-based mechanisms (IBTs, VDTs, or other consumption thresholds) perform worse than those allocated through administrative selection—namely, geographic targeting or means testing. Table 1 lists the studies that analyze both water and electricity subsidies for the same location. This table reveals that the same subsidy-targeting mechanisms are applied to water and electricity, and it shows also that the results for quantitative mechanisms have been regressive, while results for administrative-selection mechanisms have been progressive.

⁶ A volume-differentiated tariff, also known as a “ratchet” IBT, is used to calculate a household’s service bill when households use more than the lifeline (lowest-priced) block. In that case, the household is charged—for their entire use of electricity (or water)—the price per kilowatt-hour (resp., per cubic meter) in the highest block within which their electricity/water use falls.

⁷ Appendix A summarizes studies that analyze water-only subsidy incidence. See Cardenas and Whittington (2019) for a summary of electricity-only subsidy incidence analyses.

Table 1: Literature Review of Subsidy Incidence Case Studies that Analyze Water and Electricity Subsidies in the Residential Sector in Developing Countries

Author (s)	Country	Area	Year of study	WATER						ELECTRICITY							
				Type of tariff structure at time of study	Errors of exclusion	Errors of inclusion	Regressivity	Magnitude of bill (% of income)	Magnitude of Subsidy (% of income)	Magnitude as Expenditure of National Budget	Type of tariff structure at time of study	Errors of exclusion	Errors of inclusion	Regressivity	Magnitude of Bill (% of income)	Magnitude of Subsidy (% of income)	Magnitude as Expenditure of National Budget
Foster (2004)	Argentina	Urban & metropolitan areas	2002	Provincial means-tested subsidy	73% (simulation)	44% (simulation)	quasi Gini coefficient -0.15 ♦	Water & sewerage Q1: 4.8 Q2: 2.9 Q3: 2.4 Q4: 1.7 Q5: 1.2	n.r.	~US\$ 8 million (2002) annual cost of water subsidies	Provincial means-tested subsidy (simulation)	39% (simulation)	93% (simulation)	quasi Gini coefficient -0.37 ♦	Q1: 8.5 Q2: 6.2 Q3: 4.2 Q4: 3.1 Q5: 2.0	n.r.	~US\$ 18 million (2002) annual cost of water subsidies
Melendez (2008)	Colombia	Bogota	2007	Geographical defined tariffs with IBTs	5%*	75%	Focalization Index:** 1.48	Q1: 5.3 Q2: 4.0 Q3: 3.5 Q4: 2.9 Q5: 2.1	Q1: 3.5 Q2: 1.6 Q3: 1.0 Q4: 0.5 Q5: 0.3	n.r.	Geographical defined tariffs with IBTs	3%*	75%	Focalization Index:** 1.36	Q1: 6.4 Q2: 4.5 Q3: 3.8 Q4: 3.2 Q5: 2.4	Q1: 2.6 Q2: 1.3 Q3: 0.9 Q4: 0.6 Q5: 0.3	n.r.
Foster and Araujo (2004)	Gautemala	National	2000	Flat rate up to 15, 25 or 40 m3 and subsequent consumption by volumetric rate	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	VDT with 300 kWh threshold with social tariff	60%	65%	90% of total subsidies captured by non-poor	Poor households: 2.7 Non-poor households: 2.6	Poor households: 1.0 Non-poor households: 1.5	US\$57 million (2000) annual cost of the electricity social tariff.

♦ In the case of Argentina, the national average shows a relatively progressive concentration coefficient of -0.15, although there is a wide variation of -0.80 to +0.28 in the different provinces.

(Quasi Gini coefficient: coefficient bounded within an interval from -1 to +1: positive values indicate regressivity, negative values indicate progressivity).

* In the case of Colombia, the error of exclusion takes into account households from the poorest quintiles 1 and 2 and households with no access to the public service.

** In the case of Colombia, the focalization index is calculated based on the two poorest quintiles. If this index is less than 1 is regressive and if it is more than 1 is progressive, if it is =1 then it is neutral.

Foster (2004) evaluates a province-level, means-tested subsidy for water and electricity in Argentina and reports a relatively progressive concentration coefficient for both sectors: a -0.15 Gini coefficient for water and a -0.37 Gini coefficient for electricity. Although the results are progressive, there is considerable variation (from -0.80 to $+0.28$) across the provinces, which is related to the percentage of population with access to these public services.⁸ Melendez (2008) examines subsidies in the water and electricity sectors in Colombia, where a geographically targeted subsidy scheme was used, and finds that the results were progressive. Foster and Araujo (2004) analyze the case of Guatemala, which applied quantitative-based mechanisms: a VDT with a 300-kilowatt-hour (kWh) threshold for electricity; and flat rates for water that incorporated various thresholds—15, 25, or 40 cubic meters (m^3)—depending on location. The authors report a leakage rate only for electricity, where 90% of the subsidies are captured by *non*-poor household. Studies that have looked at water-only or electricity-only cases similarly report regressive results for quantity-based mechanisms.⁹

The subsidy incidence findings in studies that simultaneously look at water and electricity sectors show high levels of errors of inclusion and exclusion in both sectors and for various subsidy-targeting mechanisms. In the case of Argentina, Foster (2004) reports inclusion errors amounting to 44% of the subsidies for water and 39% for electricity as well as exclusion errors of 76% for water and 93% for electricity.¹⁰ In the case of Bogota, Colombia, Melendez (2008) reports low levels of exclusion errors—but high levels of inclusion errors—for both water and electricity. For Bogota, this author estimates that exclusion errors in 2007 amounted to 5% for the water sector and 3% for the

⁸ The quasi-Gini coefficient that we adopt is a concentration coefficient bounded within an interval that ranges from -1 to $+1$; positive values indicate regressiveness whereas negative values indicate progressiveness.

⁹ See Cardenas and Whittington (2019, appendix. A).

¹⁰ This highly deficient allocation of electricity subsidies to poor households reflected several factors. In particular, the funds for these social tariffs were divided among provinces—Buenos Aires province received only 2% of the fund's resources despite being home to 40% of the country's poor. Also, provinces had some discretion regarding exactly how the resources would be used for social tariffs; whereas some provinces used the resources to subsidize isolated systems, others compensated industrial customers for seasonal price fluctuations.

electricity sector. She also estimates inclusion errors of 75% for both the water and electricity sectors. For the electricity sector in Guatemala, Foster and Araujo (2004) report exclusion errors of 65% and inclusion errors of 60%. Foster and Yepes (2004) and Komives et al. (2006) present a summary of inclusion and exclusion errors for water-only and electricity-only case studies. In general, there is no pattern found for differences in errors of exclusion or inclusion between the water and electricity sectors in the different countries where this topic has been analyzed. Both sectors, and a variety of subsidy-targeting schemes, generally exhibit high percentages of both inclusion and exclusion errors. Although Colombia stands out for having a low level of exclusion errors, its inclusion errors are quite high.

A few authors have highlighted some interesting differences in subsidy incidence analyses between the water and electricity sectors. Foster and Yepes (2006) analyze the cost recovery by selected utility companies and report low levels for both sectors. Yet they also indicate that, by 2002, the electricity sector was much closer to cost recovery than the water sector. These authors report that, “while 85% of countries (and 69% of low-income countries) achieve some degree of [capital] cost recovery for electricity, only 60% of utilities (and 12% of low-income utilities) achieve some degree of [capital] cost recovery for water.”¹¹ In a study examining the distributional incidence of residential water and electricity subsidies in selected countries, Komives et al. (2006) report higher metering rates for electricity than for water utilities. Some authors report better tariff design in the electricity sector than in the water sector; these design elements include lower fixed charges, lower subsistence blocks, and steeper gradients that rise more rapidly toward cost recovery levels (Foster and Yepes 2006; Komives et al. 2006). Komives et al. (2006) also mention that consumption differentials between poor and non-poor customers are greater for electricity service than for water

¹¹ We have not found a study along these lines that uses more recent data.

service, which allows the non-poor to capture a larger absolute value of the electricity subsidy and thereby perpetuates regressive results in the electricity sector. Foster and Yepes (2006) also report a stronger correlation between consumption and income for electricity than for water. The existing literature posits some factors that could affect the performance of alternative subsidy-targeting mechanisms, including connection rates among poor households and aspects of the tariff design—especially the consumption level thresholds used to establish an IBT’s subsidized blocks and the so-called social tariff (Foster 2004; Foster and Araujo 2004; Komives et al. 2006).

In sum, no previous studies have examined the combined distributional effects of IBT structures for electricity and water for the same households in a city located in a developing country. Only three other studies have evaluated water and electricity subsidy incidence with secondary data. Hence we are motivated to examine in detail the combined incidence of electricity and water subsidies in Addis Ababa, where IBTs are used for the calculation of both electricity and water bills.

Background on IBT performance

There is now a large literature documenting that IBTs, as currently designed and deployed in the Global South, do not work as anticipated (Walker et al. 2000; Pattanayak and Yang 2002; Prokopy 2002; Wodon et al. 2003; Foster 2004; Foster and Araujo 2004; Angel-Urdiola and Wodon 2005; Foster and Yepes 2006; Komives et al. 2006; Groom et al. 2008; Komives et al. 2009; Trimble et al. 2011; Ahmed et al. 2012; Mayer et al. 2015; Fuente et al. 2016). The IBTs neither target subsidies to poor households effectively nor send an economic signal that would encourage households to conserve their use of electricity and water. There are six principal reasons for these failures.

First, although most poor households in urban areas are connected to the electricity grid, the same cannot be said with regard to water. Thus many poor households are not connected to a piped

water network. These unconnected households are typically the poorest of the poor, and subsidies delivered through IBTs do not reach them.

Second, when households *share* a metered electricity or water connection, the group of households sharing the connection uses more of both utilities than does a household that uses the utilities only for its own members, driving the group's use into the higher-priced blocks. In contrast, a higher proportion of the utility consumption by a household with a private connection for the exclusive use of its members is billed at the lifeline rate, or the price in the lowest block of the IBT. Since houses sharing a connection are generally poorer than households with a private metered connection, it follows that the former tend to pay higher average prices than do the latter.

Third, the notion that IBTs effectively target subsidies presupposes that poor households consume only small amounts of electricity and/or water and that rich households consume large quantities. Notwithstanding this conventional wisdom, however, there is most often only a weak correlation between a household's income and its utility use; the correlation is especially low (0.1–0.2) with respect to water use. One of the primary reasons that the correlation is low is that household size is an important determinant of both household electricity and water use, and the correlation between household size and income is low. The low correlation between household electricity and water use and income means that many rich households have low use, and many poor households have high use. Utility staff and regulators rarely check the correlation between household income and electricity (water) use before adopting an IBT because water utilities do not have income data on their customers.

Fourth, the lifeline blocks of IBTs as currently designed are too large. Many households, both rich and poor, are billed for a substantial portion of their electricity and water use at the price in the lifeline block. At the same time, the utility prices in current IBTs' upper blocks are too low. Thus

throughout the Global South, the price of water in the upper blocks is still below the total average cost of water. This means that the more water a household uses, the larger the absolute value of the subsidies it receives.

Fifth, because IBTs are complex and often difficult for customers to understand—and since electricity and piped water services are so heavily subsidized that average water bills are low—it is seldom worth a customer’s time and effort to figure out how a monthly electricity or water bill would decline in response to reduced consumption. It is simpler just to pay the monthly bill without worrying too much about how the IBT factored into the amount due. Hence customers do not respond to the economic signals that the utility and the regulator want the IBT to send.

Sixth, poor households often rent their housing unit and share a connection with a household that is both the landlord and the utility’s primary customer. These renters often do not pay an additional charge for the water they consume, as it is included in the rent. If the primary account holder receives a subsidy through the IBT, then there is little reason to believe that much of it would be passed through to poor renters who share the connection.

2. Description of electricity and water tariffs in Addis Ababa

In Addis Ababa, both electricity and piped water services are provided by publicly owned utilities. The Ethiopian Electric Utility Company (EEU) is responsible for electricity distribution, while the Addis Ababa Water and Sewerage Authority (AAWSA) provides water and sewerage services throughout the metropolitan area. In 2016, the year of this analysis, the EEU and the AAWSA each used a seven-block IBT to calculate their residential customers’ monthly bills for electricity and water use, respectively. The electricity tariff structure, shown in Table 2, was in force since 2014 until

November 2018.¹² The water tariff, which we reproduce in Table 3, has been used since 2011 to the present date. Neither tariff structure makes a distinction between a private connection for the exclusive use of household members and a connection shared by more than one household.¹³

Table 2: Tariff Structure for Electricity Provision Services in Addis Ababa (2016)

Consumption Charge			Fixed Monthly Charge for Service*		Minimum Charge	
Tariff Block	Monthly Consumption (KWh)	Tariff (USD/KWh)	Monthly Consumption (KWh)	Tariff (USD)	Monthly Consumption (KWh)	Tariff (USD)
Block 1	0-50	0.0132	0-25	0.068	0 - 20	2.03
Block 2	51-100	0.0172	26-50	0.165	20 - 220	0.98
Block 3	101-200	0.0241	51-105	0.330	220 - 100000000	0.49
Block 4	201-300	0.0266	106-300	0.495		
Block 5	301-400	0.0274	>300	0.660		
Block 6	401-500	0.0284				
Block 7	>500	0.0336				

* Fixed charge that changes dependent upon the range of household monthly consumption.

Table 3: Tariff Structure for Water Provision Services in Addis Ababa (2016)

Tariff Block	Monthly Consumption (m3)	Tariff (USD/m3)	Solid Waste Management Charge (As percent of water Bill)
Block 1	0 - 7	0.08	20%
Block 2	8 - 20	0.18	20%
Block 3	21 - 40	0.23	20%
Block 4	41 - 100	0.29	20%
Block 5	101 - 300	0.36	20%
Block 6	301 - 500	0.45	20%
Block 7	> 500	0.56	20%

¹² The electricity tariff in Ethiopia has undergone major changes over the years. In 1959, there was a flat tariff rate for electricity with an average annual increase of about 5% (although the tariff increased in some years and not in others). Tariff increases were not linked to inflationary or other economic trends, however. During that period, tariffs differed depending on the type of customer and the type of system (self-contained vs. interconnected).

¹³ In other words, the same IBT is used to calculate the monthly bill for a household with a private electricity (or water connection) and for a group of households that share a connection.

The EEU's tariff structure for electricity services has three components: a minimum monthly charge, a fixed monthly charge, and a volumetric charge. From a global perspective, EEU's tariff structure is unusual because both the minimum monthly charge and the fixed monthly charge vary as a function of the customer's monthly electricity use: both charges increase if monthly electricity use exceeds the quantity thresholds shown in Table 2.¹⁴

The AAWSA's tariff structure for water services is a single-part tariff with a volumetric charge; there is no fixed charge or minimum bill. The first 7 m³ used are billed at \$0.08/m³, and any water consumption in excess of 7 m³ (but no more than 20 m³) is billed at \$0.18/m³. A household that uses more than 20 m³ per month (but no more than 40 m³) is billed at \$0.23/m³ for the amount over 20 m³, and so on. This IBT structure for water services is unusual in three respects. First, the second and third blocks are very wide. Second, there is only a modest increase in the volumetric charge from the second to the third block. Third, there are several (four) blocks above 40 m³ per month, which is quite a large volume of water for a single household to use in just one month.

3. Data collection, sampling strategy, and fieldwork

Collection of customer billing records from electricity and water utilities

We obtained the complete set of monthly billing records from the Ethiopian Electricity Utility and the Addis Ababa Water and Sewerage Authority for their residential customers in metropolitan Addis Ababa for the one-year period from April 2015 through March 2016. Data from EEU included

¹⁴ The minimum monthly charge and the fixed monthly charge are both part of the algorithm used to calculate the monthly electricity bill for a connection. A fixed charge plus a charge for volumetric use are calculated for every connection (both private and shared). The total amount is then compared to the minimum charge associated with the volumetric use. If this total is *greater* than the minimum charge, then the monthly water bill is the total (i.e., the minimum monthly charge does not affect the monthly bill). Yet if the total of the fixed charge and volumetric charge is *less* than the minimum bill, then the connection's owner is billed the minimum charge for that month.

7,778,000 records, corresponding to one year of monthly bills for 649,000 residential customers;¹⁵ data from AAWSA included 4,368,000 records, corresponding to one year of monthly bills for 364,000 residential customers.¹⁶ The billing records of both EEU and AAWSA included customers with connections for the exclusive use of family members and for customers that share the service with other households, and they also included customer identification numbers. During the household survey, we collected utility customer ID numbers from respondents whose households had EEU and AAWSA connections; thus we were able to match the data in the utilities' billing records with the socioeconomic information collected in the household survey.

Collection of information on the costs of electricity and water supply services

To calculate the total average cost of electricity and water services, we collected data on each utility's capital and operation and maintenance (O&M) costs, production levels, and losses during production and distribution. From the EEU we collected information on various departments (e.g., Projects Office, Budgetary Control Office, Finance Department) related to generation, transmission, and distribution. From the AAWSA we collected data on the Planning Department and the Project Finance Department; these data enabled us to estimate the costs of water and sewerage services separately.

Sampling

Figure 1 summarizes the different electricity and water service household situations encountered during our fieldwork in Addis Ababa, and it shows the households that were included in (or excluded from) our sample of 366 households with private electricity and private water connections. The first-

¹⁵ A small number of residential customers in Addis have prepaid electricity meters. Such households are excluded from our sample.

¹⁶ Eight AAWSA billing offices serve the various geographical locations in Addis Ababa, and each office provided us with their customers' billing records.

stage sampling frame for our household survey was EEU’s residential customers. Thus we randomly selected 660 electricity customers from the electricity utility’s database (electricity coverage in Addis Ababa is 98%). We interviewed the head of household or spouse of all these 660 sample EEU residential customers and asked them a series of questions about, inter alia, their electricity service and use, about their water supply situation, and about socioeconomic, demographic, and housing characteristics. We also asked whether their electricity connection was shared with other households. Of the 660 households, 497 had EEU connections for the exclusive use of their own household members while 163 provided electricity to other households.

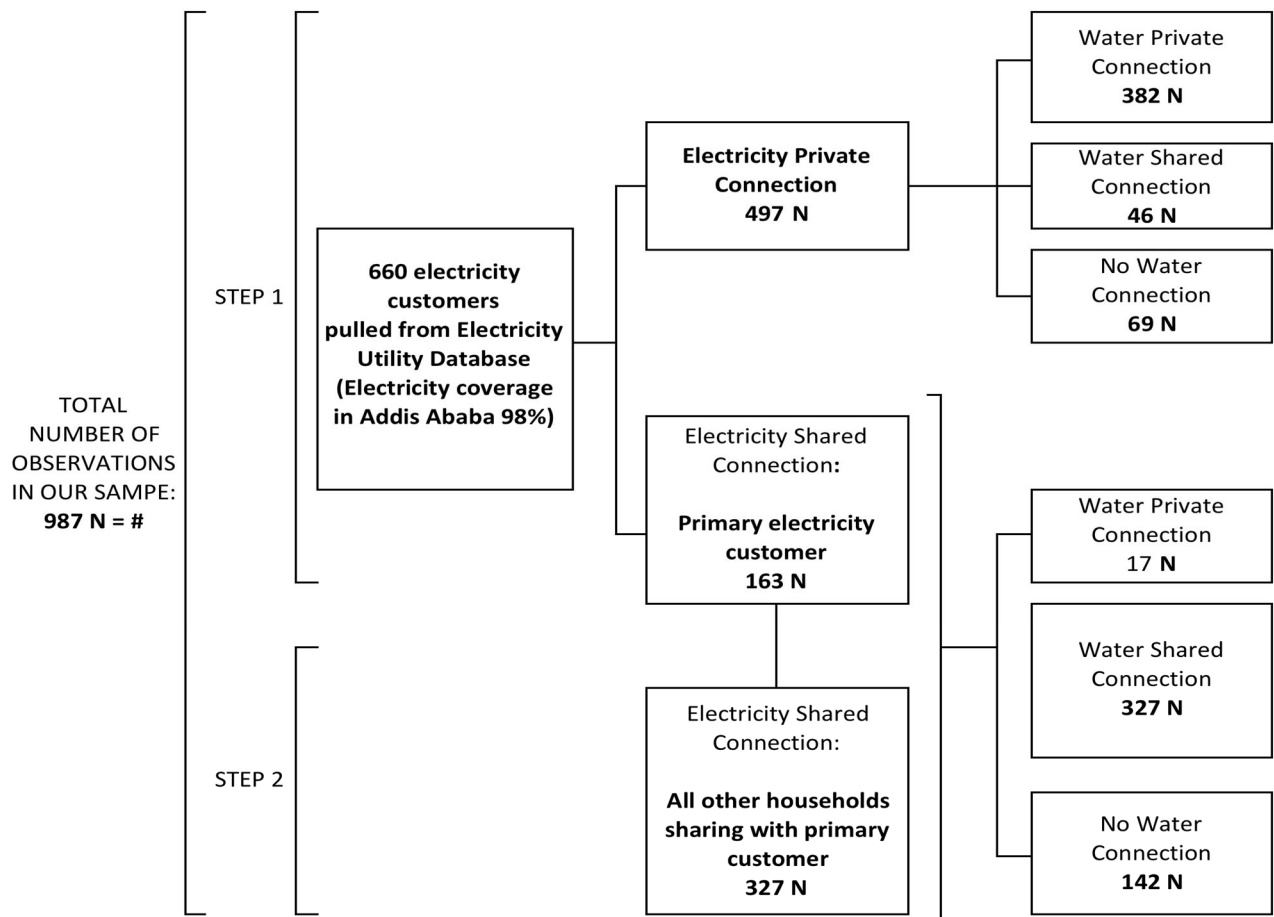


Figure 1.: Types of connections of water and electricity in fieldwork (Addis Ababa 2015/2016)

For the 497 customers with EEU connections for the exclusive use of their household members, we asked the respondent whether their household was in one of three possible water supply situations: (1) private water connection from AAWSA for the exclusive use of its household members; (2) a shared connection from AAWSA, whereby the household either had primary responsibility for the collection or simply paid a share of the water bill received by the direct AAWSA customer; or (3) no AAWSA water connection. Among these customers, 76% (382 observations) said they had a private water connection for the exclusive use of their household members (and that they also had a private electricity connection). However, 16 of them did not provide ID numbers that we were able to match with AAWSA customer billing record numbers. So our final number of households with both a private electricity and a private water connection for the exclusive use of household members is 366. These 366 households constitute the subsample used for the analysis in this paper. (More details on other households in the full sample may be found in Cardenas and Whittington 2019.)

Household questionnaire

The survey instrument had 12 sections: one on demographics, nine about households' use of electricity and piped water services (and about alternative sources of each), and two on the household's socioeconomic characteristics. During the survey design, special attention was paid to the collection of data on household income and wealth intended for use in the subsidy incidence analysis as well as to the matching of household data with the utilities' customer billing records.

Survey implementation

A total of 20 enumerators and four field supervisors were deployed for the pilot tests and survey implementation. Three pilot tests were conducted in April 2016, after which the final survey was implemented from April 26 to May 25 in that year. If a sample household could not be interviewed—

because (say) no one was home or the respondent was too busy—then enumerators made as many as two return visits. If the enumerator was unable to complete the interview after three attempts, a new household from the same neighborhood was selected.

During the interview, respondents were asked to show their electricity and water bills. The enumerator recorded respondents' utility customer ID numbers on the questionnaire form. In the case of electricity, the ID number allowed us to verify that the household interviewed was the same household that had been randomly selected; we were then able to match this sample household with their EEU customer billing record. In the case of water, the customer ID number helped us identify the sample household in the AAWSA customer billing records. We were able to match 99% of the completed interviews to the electricity utility records.¹⁷ Yet we could match only 70% of our observations of water private connections to the water utility database; as mentioned in note 3, for the remaining 30% we relied on self-reports and back-calculations.¹⁸

4. Analytical framework for calculating the distribution of household electricity and water subsidies

Basic subsidy incidence calculation

This section describes how we estimated (a) the electricity and water subsidy received by each of the 366 households with both private electricity and private water connections and (b) the incidence of subsidies across these 366 households. For each household i , we calculated the subsidy it received for

¹⁷ Only nine electricity customer ID numbers could not be matched to the electricity utility records. These observations were not included in our final sample.

¹⁸ The remaining sample households had either shared connections (394) or no water connection (211 households). Most households with shared connections were not able to show a water bill to the enumerator, which prevented us from obtaining the billing ID that would have allowed for matching with the water utility's billing records data set.

service j (either electricity or water) as the difference between the cost of supplying the household with the service and the amount it paid for the service:

$$S_{i,j} = (AC_j \times Q_{i,j}) - EXP_{i,j}.$$

Here

$S_{i,j}$ = subsidy received (in USD/month) by household i for the service j , where

$j = e$ (electricity) or $j = w$ (water);

$Q_{i,j}$ = household i 's monthly use of service j (kWh/month or m³/month);

AC_j = total average cost of providing service j in Addis Ababa (\$/kWh or \$/m³); and

$EXP_{i,j}$ = household i 's expenditure for service j (\$/month).

Since it is possible in theory for the cost of providing utility service to be either more or less than household i 's expenditure, it follows that the household could (respectively) either receive a subsidy or make a payment in excess of the actual cost of service. For every household we analyzed, however, the monthly cost of service ($AC_j \times Q_{i,j}$) was greater than its monthly expenditure for both electricity and water service.

To determine the incidence of the subsidies received by the 366 households, we needed a wealth or income indicator for each of them. We used respondents' answers to our household survey instrument's questions about asset ownership and housing characteristics to construct a wealth index via principal components analysis (Filmer and Pritchett 2001; Filmer and Scott 2008).¹⁹ Using this wealth index score for each of the 366 households, we grouped them into wealth quintiles and report the average electricity and water subsidies received by the households in each quintile. We also

¹⁹ Details on the variables included in the wealth index, along with the principal component scores, are given in Cardenas and Whittington (2019).

ranked all 366 households by their wealth index score and report a cumulative distribution of subsidies by cumulative percentage of sample households.

Calculation of the total average cost of electricity and water services

Another critical parameter when calculating the subsidy received by each household i for service j is AC_j , or the total average cost of providing service j in Addis Ababa. We calculated AC_j using data from the utility companies and the following formula:

$$AC_j = (OM_j + K_j) / (P_j - L_j) \quad \text{for } K_j = R_j \times OM_j.$$

In this expression, OM is annual value of operation and maintenance (O&M) costs, K is the annual capital cost, R_j is the ratio of capital costs to O&M costs, P is the annual production level, and L is the level of annual losses during production and distribution.²⁰

These data were provided directly by various departments of the utility companies: the EEU's Budgetary Control Office Finance Department and Planning Department; and the AAWSA's Finance Department and Project Planning Department. For both water and electricity, we also collected data on capital costs, which were sometimes inconsistent among departments. Even so, the average information on capital costs helped us verify that the data underlying R (the ratio of capital costs to O&M costs) were a viable proxy. For electricity provision, O&M costs were considered to be 5% of the total cost and the full financial costs (including all investment costs) were considered to be 95% of the total cost; for water provision, the full financial costs of water production (including all investment costs) were considered to be 3 times higher than the O&M costs. Because our estimates are annual costs, we collected data from the most recent years 2012–2015 for the purposes of our

²⁰ Energy and water losses play an important role in the calculation of costs because they increase the average unit cost. In Addis Ababa, during the last three years, there have seen losses of 18%–22% in electricity provision. Also, in 2015 there were losses of 35%–40% in water production. (Data collected in 2016 from EEU, and AAWSA.)

calculations for electricity, and 2014-2015 for the case of water. In the case of EEU, the utility company also provided information on capital cost shares of electricity generation, transmission, and distribution. In the case of AAWSA, the provided information helped us to separate the costs for providing water from those for providing sewerage services. Table 4 summarizes the total average unit costs calculated for water and electricity.²¹

**Table 4: Summary of Average Unit Costs for Water And Electricity
(Addis Ababa, 2015/2016)**

	Electricity (USD / kWh)	Water (USD / m3)
Cost component by type of cost		
Operation and Maintenance	0.004	0.19
Capital cost	0.088	0.70
Total Cost	0.092	0.89
Cost component by production step		
Distribution	0.023	
Transmission	0.014	
Generation	0.055	
Total Cost	0.092	

Authors calculation based on primary data collected from the utility company

(1 US Dollar = 20.68 Bir)

5. Results

Description of sample households

Our subsample of households with private water and electricity connections for the exclusive use of household members represent about 39% of households in Addis Ababa. Households in this subsample are wealthier than those with shared water or electricity connections (or both) or without a water connection. The mean household income of our 366-household subsample is approximately

²¹ Appendix B presents further details, including the assumptions underlying our estimates for average unit costs of water delivery in Addis Ababa. Details regarding our estimates for average unit costs of electricity delivery are given in Cardenas and Whittington (2019).

twice the mean household income of the remaining households in the full sample. This finding is consistent with our information on household assets. Households that have private water and electricity connections are more likely to own their houses and to own more expensive appliances (e.g., electric injera stoves, televisions, computers, washing machines, refrigerators). They are less likely to cook with traditional fuels (biomass). Such households are also more likely to have a toilet inside their home, and their homes are less likely to be constructed with low-quality materials. Moreover, the households in our subsample have more rooms in their dwelling and more cell phones than households in the rest of the full sample. Yet the household head's number of years of schooling does not differ much among the two groups, and neither does the proportion of female-headed households. See Table 5.

Table 5. Socio-economic characteristics of sub-samples with private connections, shared connections and all sample, (Addis Ababa, 2016)

	Private connections for electricity & water (exclusive use of household members) *					Shared connections or no-water connection**					All sample				
	Mean	Median	St. Dev	p10	p90	Mean	Median	St. Dev	p10	p90	Mean	Median	St. Dev	p10	p90
Head of household is female	0.32	0	0.47	0	1	0.28	0	0.45	0	1	0.30	0	0.46	0	1
Years of school of head of household	8.99	11	5.02	0	14	8.27	10	4.57	0	14	8.55	10	4.76	0	14
Household size	4.95	5	2.03	2	7	3.43	3	1.87	1	6	4.02	4	2.07	1	7
Number adults in household	3.55	3.00	1.53	2	6	2.42	2	1.33	1	4	2.86	2	1.51	1	5
Total household monthly income (USD)	398	256	492	68	829	210	155	191	58	411	283	193	353	58	556
House ownership	0.51	1.00	0.50	0	1	0.29	0	0.45	0	1	0.37	0	0.48	0	1
Electric injera stove	0.93	1.00	0.26	1	1	0.48	0	0.50	0	1	0.65	1	0.48	0	1
Cook with biomass	0.21	0.00	0.41	0	1	0.33	0	0.47	0	1	0.28	0	0.45	0	1
Number of mobile phones in household	3.26	3.00	1.71	1	6	2.23	2	1.26	1	4	2.64	2	1.54	1	5
Access to internet	0.81	1.00	0.39	0	1	0.63	1	0.48	0	1	0.70	1	0.46	0	1
TV	0.97	1.00	0.16	1	1	0.81	1	0.39	0	1	0.87	1	0.33	0	1
Computer (laptop or desktop pc)	0.30	0.00	0.46	0	1	0.12	0	0.32	0	1	0.19	0	0.39	0	1
Car	0.25	0.00	0.43	0	1	0.05	0	0.21	0	0	0.12	0	0.33	0	1
Washing machine	0.21	0.00	0.41	0	1	0.05	0	0.22	0	0	0.11	0	0.32	0	1
Refrigerator	0.81	1.00	0.40	0	1	0.38	0	0.49	0	1	0.54	1	0.50	0	1
Separate kitchen inside the house	0.31	0.00	0.46	0	1	0.09	0	0.28	0	0	0.18	0	0.38	0	1
Toilet inside home	0.72	1.00	0.45	0	1	0.45	0	0.50	0	1	0.56	1	0.50	0	1
Use of bottled water	0.18	0.00	0.38	0	1	0.13	0	0.33	0	1	0.15	0	0.35	0	1
Dwelling with low-quality materials***	0.05	0.00	0.21	0	0	0.25	0	0.43	0	1	0.17	0	0.38	0	1
Number of rooms in dwelling	3.55	3.00	1.70	2	6	1.91	2	1.08	1	3	2.55	2	1.57	1	5

* Household survey data matched to utility billing records for both water and electricity.

** This category shows a sub-sample of households that have electricity or water shared connections or no water connection.

*** Walls made of wood and mud and floor made of mud/dung.

Figure 2 plots the distribution of the 366 households with private electricity and water connections across wealth quintiles that are defined by the full sample of 987 households. Only 16 (fewer than 5%) of the 366 households are part of the two lowest wealth quintiles, and 150 (41%) of them are in the highest quintile. Figure 2 shows clearly that the 366 households with both private electricity and water connections for the exclusive use of their household members are among the wealthiest households in Addis Ababa.

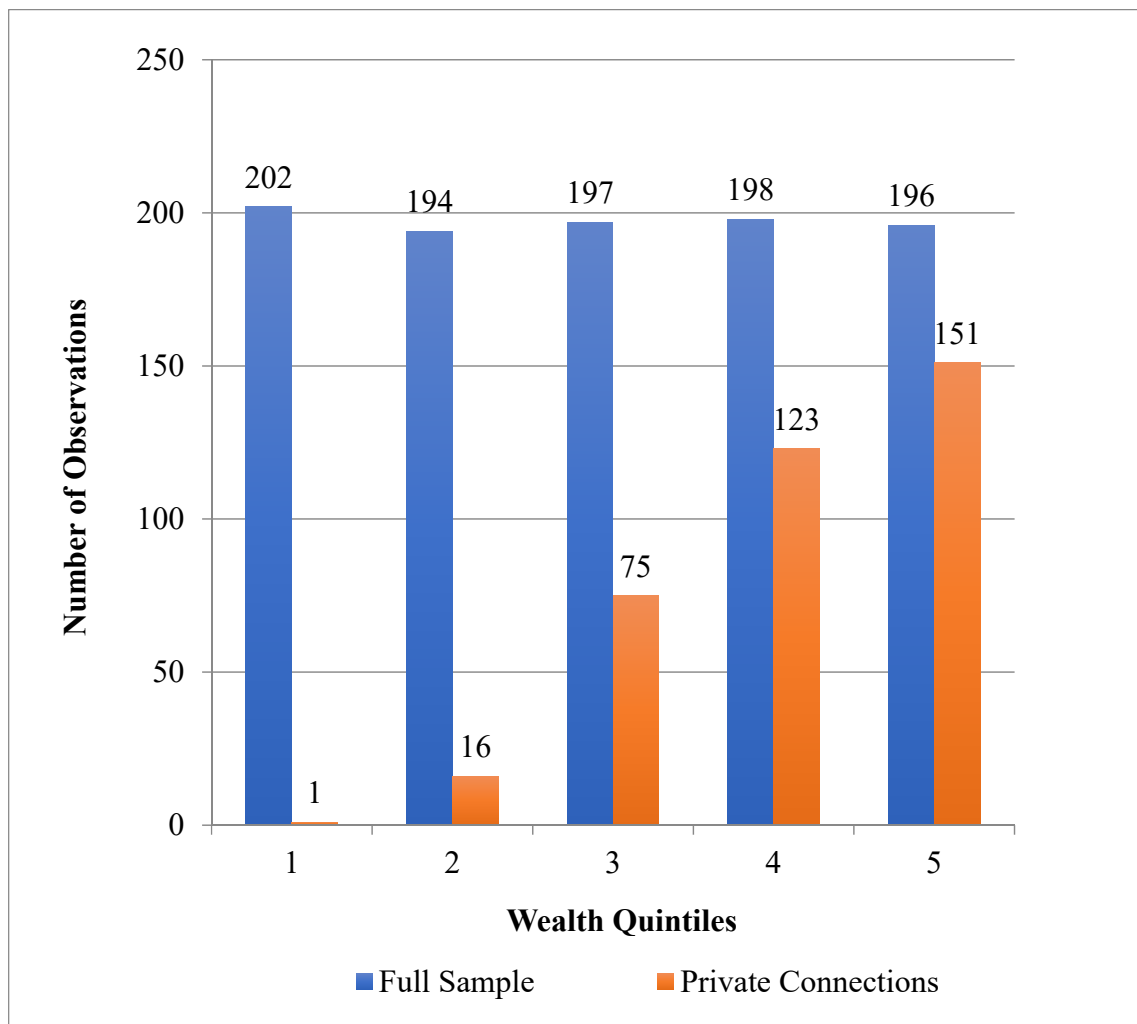


Figure 2: Private connections distribution within the entire sample's wealth quintiles

Table 6 reports the number and percentage of these 366 households whose electricity consumption was in each of the IBT's seven blocks. We can see that the electricity consumption by only 2% of these households qualified for the lowest block and only 11% for the two lowest blocks. The majority (69%) of these households consumed 100–400 kWh per month, placing them in the third, fourth, or fifth block of the IBT.

Table 6. Percentage of Sub-sample of Private Connections in Each Tariff Block of the Electricity IBTs (Addis Ababa, 2016)

Electricity			
Block No.	No. Observations	Percentage	Average price paid by households in this block
1 [0 – 50 KWh]	8	2%	0.013
2 [>50 – 100 KWh]	34	9%	0.015
3 [>100 – 200 KWh]	89	24%	0.018
4 [>200 – 300 KWh]	89	24%	0.020
5 [>300 – 400 KWh]	77	21%	0.022
6 [>400 – 500 KWh]	39	11%	0.023
7 [>500 KWh]	30	8%	0.025
Total	366	100%	

Table 7 presents the corresponding information for households' water use. In contrast to electricity, 50% of the 366 households' water was in the first (lifeline) block and 91% was in the two lowest blocks. None of these households' water use was in the fifth, sixth, or seventh block.

Table 7. Percentage of Sub-sample of Private Connections in Each Tariff Block of the Water IBTs (Addis Ababa, 2016)

Water			
Block No.	No. Observations	Percentage	Average price paid by households in this block
1 [0 – 7 m3]	182	50%	0.08
2 [>7 – 20 m3]	151	41%	0.18
3 [>20 – 40 m3]	28	8%	0.23
4 [>40 – 100 m3]	5	1%	0.29
5 [>100 – 300 m3]	0		
6 [>300 – 500 m3]	0		
7 [>500 m3]	0		
Total	366	100%	

Estimates of the magnitude of electricity and water subsidies received by households with both private electricity and private water connections

The average monthly electricity use for the 366 households with private electricity and water connections was 276 kWh. The average monthly cost for the utility to provide such service was \$25, yet customers paid a monthly electricity bill of about \$6.50; hence their average monthly subsidy was \$18.40, which amounted to some 4.5% of household income. The average monthly water use for the 366 households with private electricity and water connections was 10 m³. Since the average cost of providing this service was \$8.50 and since costumers paid a monthly water bill of only \$1.30, it follows that their average monthly water subsidy was \$7.20 (1.8% of household income). Thus the magnitude of the electricity subsidy was more than twice that of the water subsidy. The combined

subsidy for electricity and water provided to these mainly upper-income households totaled \$26 per month, or 6% of average household income; see Table 8.

Table 8. Residential Electricity & Water Monthly Consumption, Payment and Subsidy for Private Connections, (Addis Ababa, 2016)

	Mean	Median	St. Dev	p10	p90
Electricity					
Average monthly use (Kwh)	276	249	151	96	482
Average monthly bill (USD)	6.5	5.7	4.1	1.8	11.9
Average monthly subsidy received (USD)	18.4	17.1	9.6	6.8	31.6
Bill as percentage of household income	1.6%	1.9%	4.1%	0.6%	6.2%
Subsidy as percentage of household income	4.5%	2.9%	5.5%	1.0%	8.9%
Water					
Average monthly use (m3)	10	7	8	2	20
Average monthly bill (USD)	1.3	0.8	1.5	0.2	2.9
Average monthly subsidy received (USD)	7.2	5.7	5.8	1.8	14.4
Bill as percentage of household income	0.3%	0.3%	0.7%	0.1%	1.0%
Subsidy as percentage of household income	1.8%	2.0%	3.8%	0.6%	6.1%
* Household survey data matched to utility billing records for both water and electricity.					

Estimates of the distribution of electricity and water subsidies received by households with both private electricity and private water connections

Table 9 shows the distribution of electricity and water subsidies received by the 366 households with private electricity and water connections as a function of subsample wealth quintiles. There is substantial variation in household income across the five wealth quintiles. The monthly household income in the highest wealth quintile (\$825) was 4 times the monthly income of households in the lowest quintile (\$206).

**Table 9. Electricity and Water Subsidy for Private Connections
by Wealth Quintiles (Addis Ababa, 2016)**

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	All Quintiles
No. Observations (households)	74	73	73	73	73	366
Household Income (USD)	206	212	356	445	825	408
Billing						
Electricity monthly bill (USD)	3.7	5.2	6.9	6.8	9.7	6.5
Water monthly bill (USD)	0.6	0.7	1.1	1.5	2.5	1.3
Total bill (electricity + water) as percentage of household income	2.1%	2.8%	2.3%	1.9%	1.5%	1.9%
Subsidies						
Electricity monthly subsidy (USD)	11.7	15.6	19.5	19.1	26.0	18.4
Water monthly subsidy (USD)	4.0	4.7	6.5	8.5	12.2	7.2
Total subsidy (electricity + water) as percentage of household income	7.6%	9.6%	7.3%	6.2%	4.6%	6.3%

These observations reveal that, despite the utilities' use of IBT structures, subsidies are not being targeted to households in the lowest quintiles. Indeed, the opposite is true for electricity and water both—that is, subsidies have been targeted to households in the upper-income quintiles. Thus, for instance, households in the wealthiest quintile received an average electricity subsidy of \$26 per month as compared with \$12 for those in the lowest-income quintile; households in the wealthiest quintile received an average water subsidy of US\$12 per month compared to US\$4 for households in the lowest-income quintile.

The combined electricity and water subsidies illustrate even more starkly the failure of the two IBTs to target subsidies to households in the lower-income quintiles. Households in the wealthiest quintile received an average combined subsidy of \$38 per month as compared with \$16 for those in the lowest-income quintile. The combined subsidies constituted a higher percentage of income for the lowest-income households (8%) than for the highest-income households (5%).

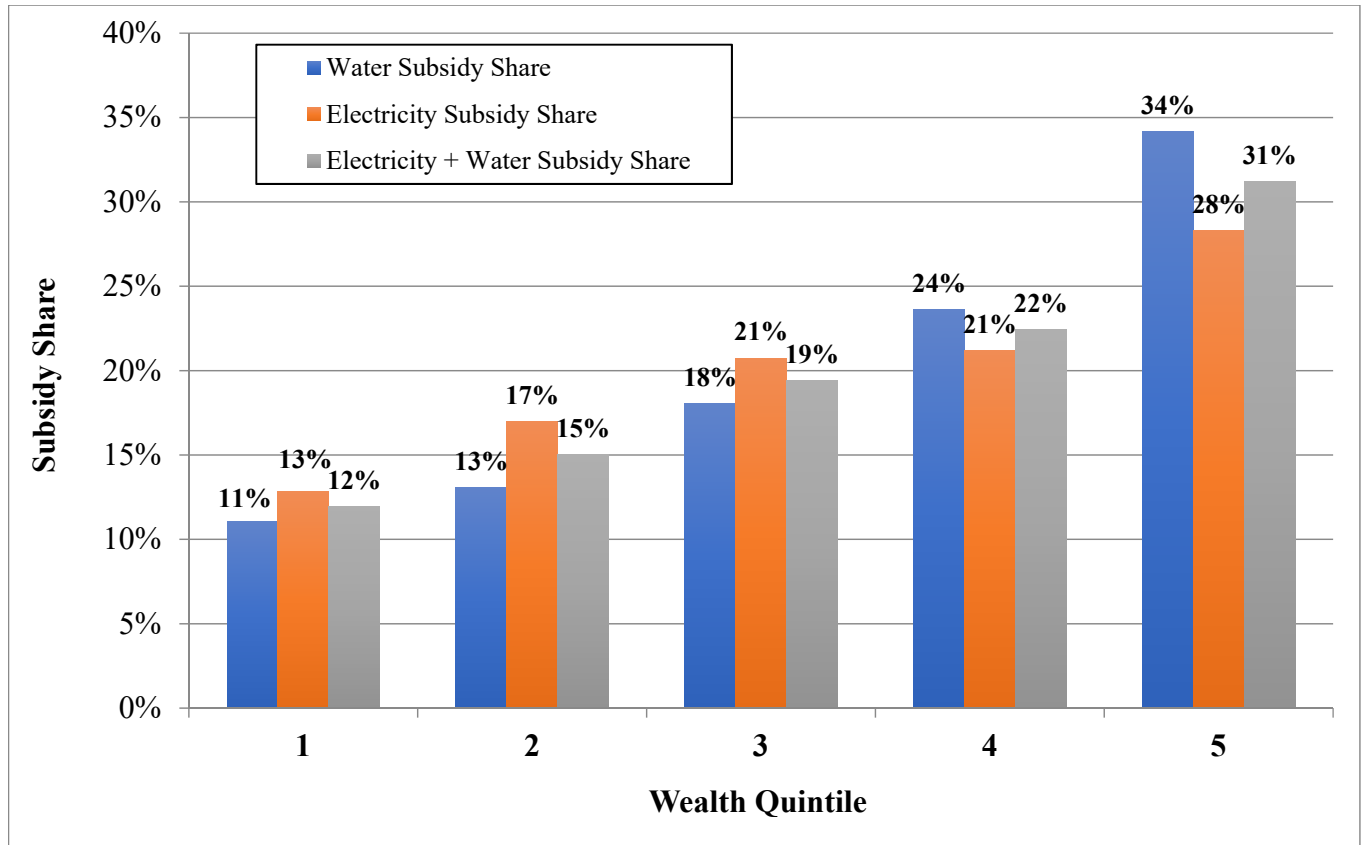


Figure 3. Electricity & water subsidy shares for private connections by wealth quintile (Addis Ababa, 2016)

Figure 3 plots the share of electricity, water, and total subsidies received by households with private electricity and water connections as a function of in-sample wealth quintile. For both electricity and water we can see that, the greater a household's wealth, the higher the share of total subsidies it receives. This outcome is, of course, diametrically opposed to the intentions of the respective utilities' IBT structures. The targeting of water subsidies is slightly worse than the targeting of electricity subsidies.

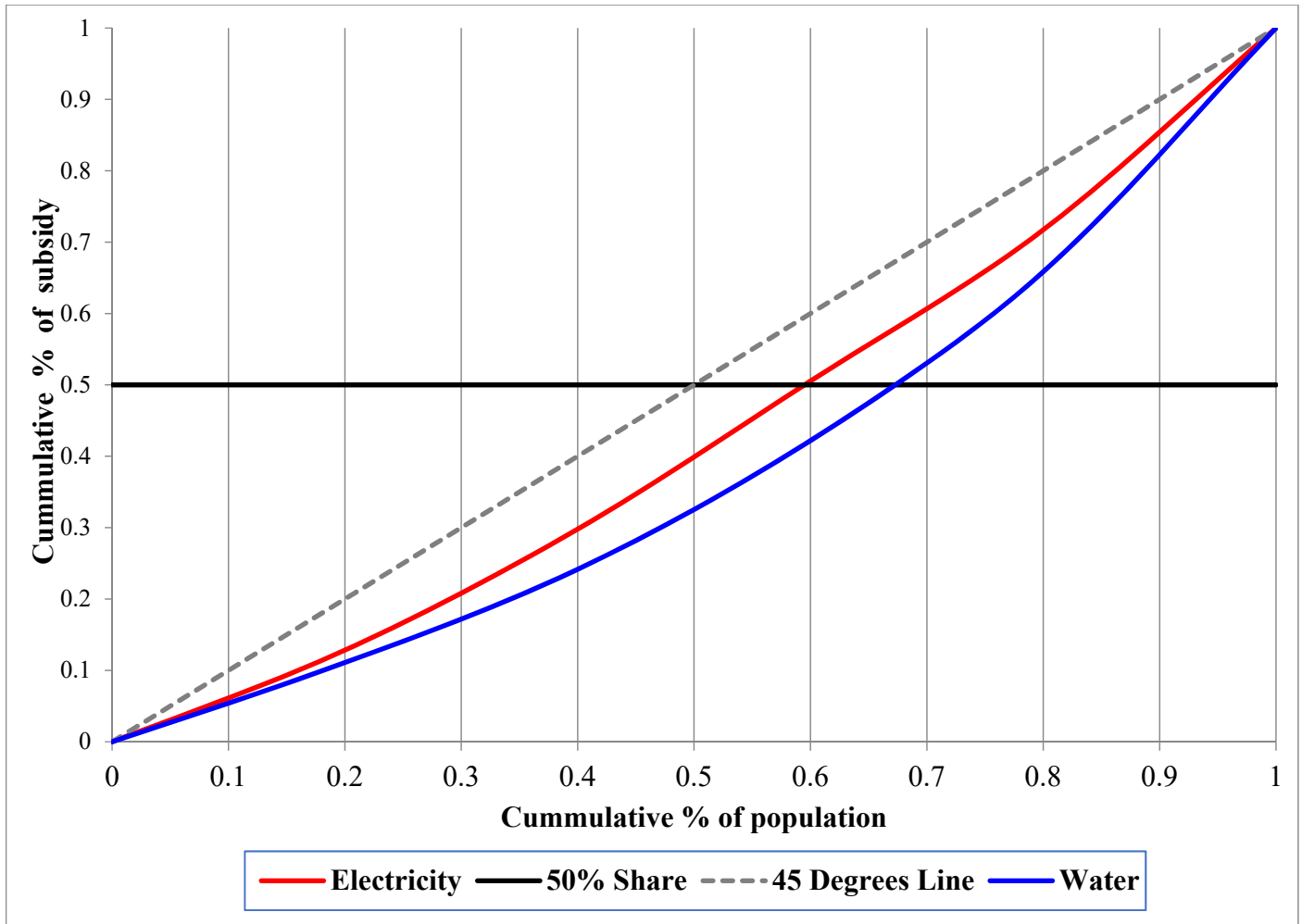


Figure 4. Cumulative percentages of electricity and water subsidies for private connections by wealth ranking, (Addis Ababa, 2016)

Figure 4 presents the cumulative proportion of electricity and water subsidies received in terms of the proportion of households ranked by wealth. The curves for electricity and water in this figure are both convex, which means that—in our 366-household subsample—subsidies in both sectors are skewed toward middle- and upper-income households. For example, the poorest half of the 366 households (by wealth ranking) received about 40% of the electricity subsidies and only 32% of the water subsidies.

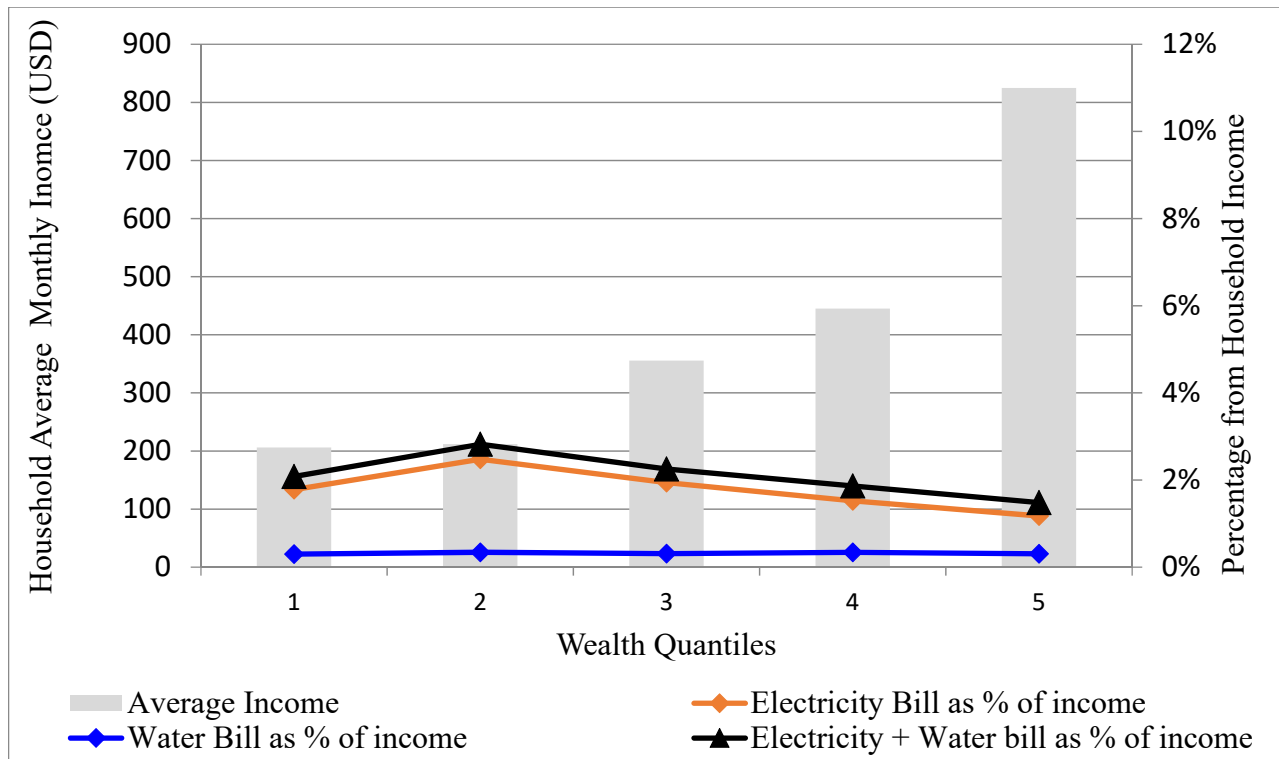


Figure 5. Electricity and water bills as percentage of income by wealth quintiles (households with private connections Addis Ababa, 2016)

For our 366 households, Figure 5 shows the electricity bill, the water bill, and the combined bill as a percentage of household income (by wealth quintile); Figure 6 shows the electricity subsidy, the water subsidy, and the combined subsidy as a percentage of household income (by wealth quintile). In both figures, the horizontal axis marks the wealth quintiles and the leftmost vertical axis represents the average monthly household income associated with those quintiles. The rightmost vertical axis in Figure 5 stands for the percentage of household income represented by the electricity bill, the water bill, and the combined bill; in Figure 6, that axis stands for the percentage of household income represented by the electricity subsidy, the water subsidy, and the combined subsidy.

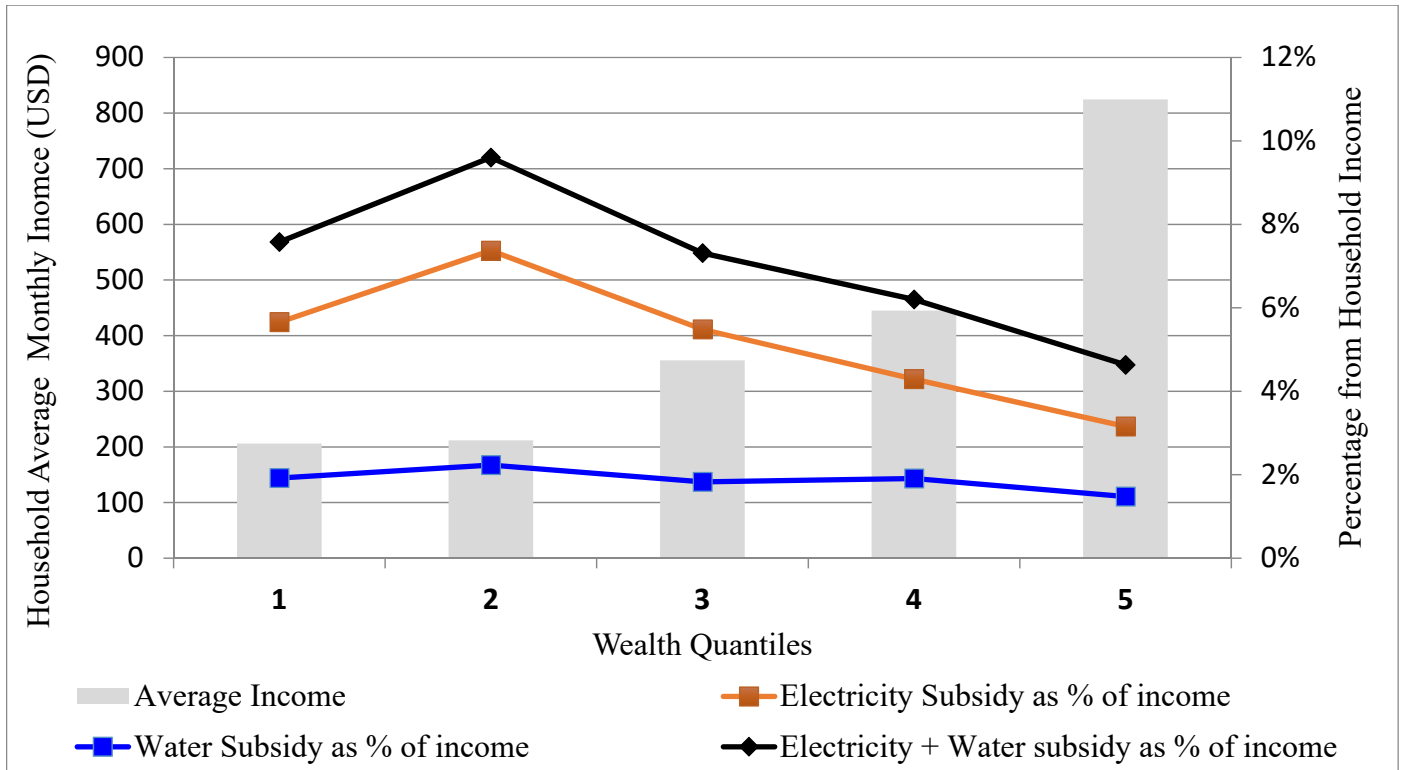


Figure 6. Electricity and water subsidies as percentage of income by wealth quintiles (households with private connections Addis Ababa, 2016)

Households in all five wealth quintiles pay between 2% and 3% of their income for their combined electricity and water bills. Most of this expenditure is for electricity. Across all five wealth quintiles, monthly water bills are equivalent to only about 0.3% of income. Households in the poorest wealth quintile receive combined subsidies amounting to about 7% of their income, a value that increases to more than 9% for households in the second-poorest quintile. This percentage falls to about 5% for households in the richest wealth quintile.

6. Concluding remarks

Ours is the first paper to examine the combined effects of IBT structures for both electricity and water on a given set of households in a city of the Global South. It is also the first to match data on water

and electricity use and monthly bills from utilities' customer billing records with socioeconomic data collected through a household survey.

Using a sample of households with both private electricity and water connections for the exclusive use of household members in Addis Ababa, we find that both the electricity and the water IBT subsidies disproportionately target richer households. When these poor targeting outcomes are considered jointly, the regressive results are striking. Our sample's 366 households with private water and electricity connections were substantially richer than the general population of Addis Ababa. Yet even within this middle- and upper-income sample, the cumulative electricity and water subsidies were disproportionately received by the richer households. Households in the wealthiest quintile received an average combined subsidy that was more than twice as large as households in the lowest wealth quintile (\$38 vs. \$16 per month).

The water IBT's targeting of subsidies was somewhat worse than that of the electricity IBT. One reason could be that the water consumption of most households was within the first (lifeline) block of the IBT; in contrast, the electricity consumption of households was more evenly spread throughout the seven blocks of that utility's IBT. This difference might reflect the greater ease with which people can visualize the extent of their water consumption (which is measured in cubic meters) than that of their electricity consumption (measured in kilowatt-hours).

However, we find no difference between water use and our wealth indicator (+0.48, p value=0.00) and between electricity use and our wealth indicator (+0.48, p value=0.000).²² Figure 7 and Figure 8 illustrate the distribution, by wealth quintile, of (respectively) electricity and water use among our sample of households with private connections. These figures confirm the relatively low correlation between resource use and wealth.

²² When the correlations are measured not with respect to our wealth quintiles but instead to self-reported income, we obtain values of 0.36 ($p = 0.000$) for water consumption and 0.24 ($p = 0.0000$) for electricity.

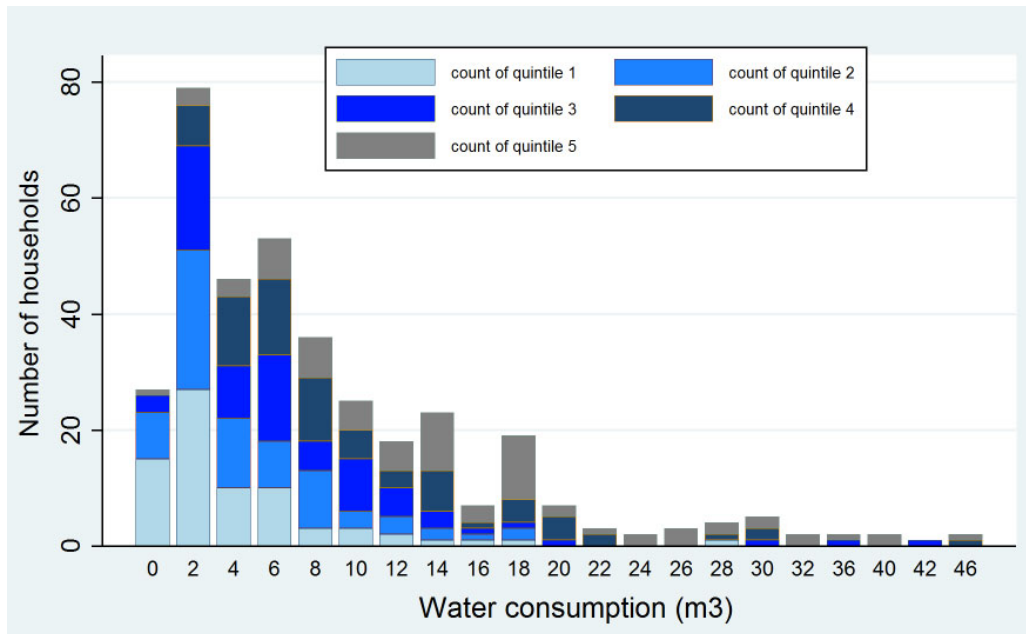


Figure 7. Distribution of water consumption among sample of private connections and by wealth quintile (Addis Ababa, 2016)

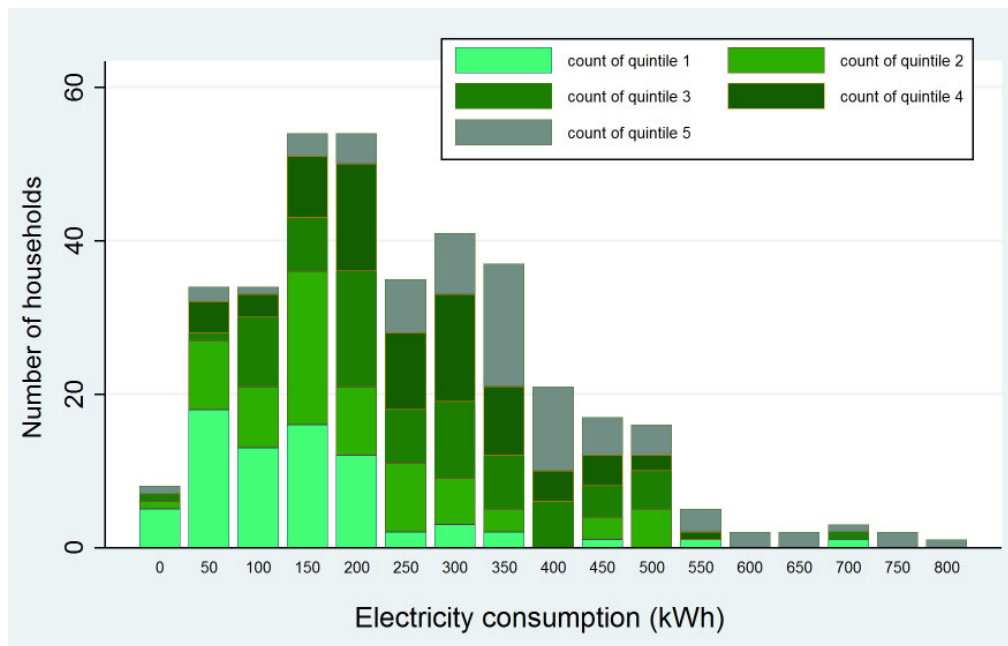


Figure 8. Distribution of electricity consumption among sample of private connections and by wealth quintile (Addis Ababa, 2016)

Household expenditures on water and electricity as a percentage of income are low in all wealth quintiles, for which they represent between 1.5% and 3% of household income. The magnitude of the subsidies provided to households in all wealth quintiles is substantial—not only as a percentage of household income but also in absolute terms. It is unlikely that households in Addis Ababa are aware of the magnitude or distribution of the electricity and water subsidies they are receiving. A public information campaign would therefore be a first useful step in any tariff reform process.

Finally, we emphasize that the poorest Addis Ababa households share water and electricity connections or have only an electricity connection and collect water from outside the home. Our analysis did not examine the magnitude of the subsidies these poorer households receive through shared connections, but their combined electricity and water subsidies are undoubtedly much less than those that we estimate are received by the 366 households with both private electricity and water connections. Therefore, estimating the magnitude and distribution of the cumulative subsidies received by the entire population of Addis Ababa is a high research priority.

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Appendix A: Literature Review of Subsidy Incidence Case Studies of Water Provision from Developing Countries

Author (s)	Country	Area	Year of Study	Type of tariff structure at time of study	Type of data on Consumption	Cost Estimation	Cost Estimate (US\$/m ³)*	Analysis by Connection Type shared vs. private	Average estimated subsidy	Estimated share of total subsidies	Type of subsidy distribution	Magnitude of Subsidy
Groom et al (2008)	China	Beijing	2002	3 block IBT	Self-reported household survey expenditure data	Reference estimate (source: n.r.)	0.67	No	0.39 (US\$ /m ³)	n.r.	Most households are subsidized, most consume within the lifeline block.	n.r.
Walker et al (2000)	Nicaragua El Salvador Venezuela Panamá	Urban areas	1995 - 1998	IBTs (various number of blocks)	Self-reported household survey expenditure data and volume consumption registered from meters if available	Cost projection, including O&M and capital costs (financial charges plus depreciation)	Mangua 0.47 Panama 0.71 Cities in El Salvador: 0.18-0.21 Merida 0.13	No	Mangua: 0.3 Panama: 0.36 Merida: 0.07 Cities in El Salvador: -0.03 to -0.01 (US\$ /m ³)	Mangua: Poorest quintile: 17% Richest quintile: 15% Panama: Poorest quintile: 20% Richest quintile: 24% Merida: Poorest quintile: 20% Richest quintile: 12% Cities in El Salvador: Poorest quintile: -3.6% Richest quintile: 51%	Regressive	n.r.
Barde and Lehmann (2014)	Peru	Lima	2011-2012	4 block IBT	Self-reported household survey expenditure data	Reference from utility company "long-term average cost"	0.62	Exclude shared connections	n.r.	(Not analyzed per quintile) Average subsidy received by group in relation to average subsidy received by all population: Extremely poor: 0.80 Poor: 0.73 Non-poor: 1.03	Regressive	n.r.
Fuente et al (2016)	Kenya	Nairobi	2014	4 block IBT	Data collected from utility companies' meters	Utility company's audited financial statements on operations and maintenance costs	1.46	No	n.r.	Poorest quintile: 16% Richest quintile: 29%	Regressive	n.r.
Gomez-Lobo and Contreras (2003)	Chile Colombia	Urban areas	Chile: 1998 Colombia: 2003	Chile: means-tested discount Colombia: Geographically targeted scheme	Chile: (survey that identifies subsidy beneficiaries: Household Survey) Colombia: data from 15 utility companies on subsidies by classification of dwellings.	National reference estimate	n.r.	No	Chile: 0.6	Chile: more than 60% of subsidies accrue to households that are above the third decile. Colombia: almost all households receive a subsidy (high level error of exclusion).	Progressive (but still with large errors of exclusion in Colombia and inclusion in Chile)	Chile: 42.5 million USD (0.03% of GDP)
Prokopy (2002)	India	Bangalore	2001	IBT with 25m ³ first block Public tap (free of charge)	Self-reported household survey expenditure data for metered households; # containers for those that use public taps; imputed data for unmetered private taps.	Reference from engineering consultants' studies for O&M costs. And an estimate of full financial costs that is 3 times higher than O&M costs	1.02	No	Private taps: 0.78 US\$/m ³ (average consumption: 20 m ³) Public taps: 0.74 US\$/m ³ (average consumption: 5 m ³)	Poorest quintile: 16% Richest quintile: 32%	Regressive	n.r.
Pattanayak and Yang (2002)	Nepal	Kathmandu	2001	IBT with 10m ³ first block Public tap (free of charge)	Self-reported household survey expenditure data for metered households; # containers for those that use public taps; imputed data for unmetered private taps.	Reference from engineering consultants' studies for O&M costs. And an estimate of full financial costs that is 3 times higher than O&M costs	0.51	No	Private taps: 0.44 US\$/m ³ (average consumption: 20 m ³) Public taps: 0.59 US\$/m ³ (average consumption: 1 m ³)	Poorest quintile: 10% Richest quintile: 25%	Regressive	n.r.

* Expressed in US Dollars of the year the subsidy was analyzed in the study. Calculated using the data from each study deflated by the average exchange rate from the World Bank development indicators for that year.

** Total subsidy costs from study and relation to national GDP from study, when available. If this is not available, % of GDP is calculated based on World Bank development indicators on national GDP, inflation and exchange rates.

n.r. = not reported

Appendix B: Estimation of Average Unit Cost of Water Provision

Table A2. Average Unit Cost of Water Provision in Addis Ababa
(Years 2007 Ethiopian Calendar -2014 /2015 Gregorian Calendar-) - US Dollars 2015 Constant Prices

	Unit	2014/2015 GC 2007 EC
Days	unit	365
Daily Production	m3	528,000
Annual Production	m3	192,720,000
Annual Production (without revenue water)	m3	115,632,000
Annual O&M Cost: Only Water Provision	USD	22,400,000
Annual Capital Cost: Only Water Provision	USD	80,950,000
Average unit O&M cost	USD / m3	0.19
Average unit Capital cost	USD / m3	0.70
Total average unit cost	USD / m3	0.89

* Data collected from AAWSA Financial and Planning Departments

** Assumes 70% of O&M costs that goes to water provision services

Key assumptions:

- Percentage of O&M costs from total capital costs: 28% (Data from AAWSA)
- Percentage of water losses and non-revenue water: 40% (Data from AAWSA)
- Percentage of AAWSA costs on water provision only: 70% (30% correspond to costs that AAWSA is allocating to sewerage projects – sewerage is a new service where AAWSA is just starting and with a current very low coverage) (Data from AAWSA)