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The Time Value of Public Water Supply

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Women: Walking and Waiting for Water
The Time Value of Public Water Supply

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Abstract

Public funding of water supply infrastructure in developing countries is often justified by the expectation that the time spent on water collection significantly decreases, leading to increased labor force participation of women. In this study we empirically test this hypothesis by applying a difference-in-difference analysis to a sample of 2000 households in rural Benin where improved water supply was phased in over time. Time savings per day are rather modest at 35 minutes: even though walking distances are considerably reduced, women still spend a lot of time waiting at the water source. Moreover, a reduction in time to collect one water container induces women to collect a higher number of containers per day. Our results indicate that time savings are rarely followed by increased labor supply of women: men are the first to be freed from water fetching activities.

JEL classification: I38, J22, J16

Keywords: Water Supply, Behavioral Change, Time Savings, Labor Supply, Gender Bias.

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1 Introduction

Several studies report that women in rural Sub-Saharan Africa spend a considerable part of their day collecting water (e.g. Rosen and Vincent, 1999; Blackden and Wodon, 2006; Koolwal and Van der Walle, 2010; Sorenson et al., 2011). Estimates vary largely but, on average, it takes women about 30 minutes to collect one container, and they spend about 2 hours collecting water each day (Rosen and Vincent, 1999). Mehretu and Mutambirwa (1992) find that women spend up to 25% of their daily working hours collecting water for the household.

Apart from improved water quality/ quantity and a reduction of water related diseases (see e.g. Fewtrell et al., 2005) time savings are, hence, considered an important objective of improved water supply in poor rural areas (FAO, 2008; Hutton et al., 2006). This objective becomes even more relevant, given the fact that several recent studies have shown that improved public water supply does not have the desired effects on water quality consumed and on the health of the target population (Wright et al., 2004; Zwane and Kremer, 2007; Waddington and Snilstveit, 2009).[1]

The underlying assumption is that a newly constructed village pump reduces the distance, and therefore also the time households have to spend collecting drinking water. Time gains from improved water infrastructure may be used for income generating activities and/or for prolonged schooling and can therefore (Hutton et al., 2006; Morrison et al., 2007; Ray, 2007; Koolwal and Van der Walle, 2010). Rural water supply interventions therefore improve the general living conditions for the target population even if no health effects are achieved through improved public water supply. Moreover, any time gains achieved should particularly benefit women as 70-80 percent of the individuals responsible for collecting water in developing countries are women and/or girls (e.g. Ray, 2007; Koolwal and Van der Walle, 2010; Sorenson et al., 2011).

Surprisingly, very few studies have empirically analyzed the impact of the installation of an improved water source on time savings (Rosen and Vincent, 1999). Table A1 in

[1] The same has been found for the data at hand. In a difference-in-difference analysis we have shown that improved public water supply leads to an improvement of the water quality at the point of source (POS), but does not change water quality at the point of use (POU). Nor do the interventions affect the diarrheal incidence of the target population (Günther and Schipper, 2012). See Appendix A3 for a replication of these estimates.

the Appendix gives an overview of the identified literature.[2] The range of results across these studies is wide: from time savings of 30 minutes up to 300 minutes per day. However, nearly all studies have at least one limitation with regard to sample size, sample selection and/or endogeneity. Most studies apply cross-sectional techniques – comparing villages with improved to villages with traditional water sources - with only limited possibilities to control for differences in village characteristics. Moreover, many studies are based on a very limited sample size (2 to 16 villages). A notable exception is a recent study by Devoto et al. (2012) who use an experimental design to study the reduction in water collection times due to *private* household connections in *urban* areas. They find time savings of 27 minutes per day.

We aim to add to this latest empirical study by analyzing the impact of *public* water point provision on water collection times and usage in *rural* areas. As a randomized setting was not feasible within the national program analyzed, we apply a difference-in-difference (DD) analysis in combination with a phasing-in approach using a sample of 2000 households within 200 villages in rural Benin. We disaggregate the water collection process into various components: *walking and waiting time* on the one hand, and *time per roundtrip and number of roundtrips* on the other hand. To the best of our knowledge, no previous study has quantified the role of population pressure at the water source (leading to increased waiting times) and behavioral change (leading to an increased number of roundtrips) in the context of public water provision and time savings. Moreover, we test who within the household benefits from decreased collection times and whether time savings are transformed into economic activities.

Our main findings can be summarized as follows. A newly installed water pump leads to considerable time savings of 18 minutes for each water collection trip. These time gains are the result of both a reduction in walking time (8 minutes) and a reduction in waiting time (10 minutes) at the water point; the latter is the result of lower population pressure on all water points due to a newly installed water point. Time savings per day are only 35 minutes for each household. This is due to the fact that water installations also lead to an increased number of water containers collected per day; in other words, households trade off time savings and water quantity when a new source is installed. This latter result might also explain why we find only limited evidence that time gains

[2] This overview focuses on studies for Sub-Saharan African countries.

increase the market labor supply of women. Moreover, men (and not women) seem to be the first to be totally freed from the task of water collection. The economic (opportunity) value of the annual time saving achieved is around 1-2 percent of households' expenditure and between 7-11 percent of the investment costs of public water infrastructure, leading to amortization times of more than 12 years.

The paper is structured as follows. Section 2 describes our data set as well as the methodology applied. Sections 3 and 4 show our main results with regard to time savings and economic outcomes. Section 5 provides some robustness checks and Section 6 discusses the results and concludes.

2 Treatment, Methodology and Data

The water installations studied in this paper are part of the second national water strategy in two regions of rural Benin (Mono-Couffo in Southern Benin and Collines in Central Benin) which has been ongoing since 2005. Under this strategy, either public standpipes or public manual pumps are installed, depending on the groundwater level and the population size of a village. Hence, villages which receive a public standpipe are on average larger (107 households) than villages receiving a public pump (63 households). Both technologies are considered to be improved water sources according to the official WHO-UN definition (WHO, 2008; WHO/UNICEF, 2012). The investment costs are about $55,000 USD (FCFA 25,000,000) for a public standpipe and $20,000 USD (FCFA 9,000,000)[3] for a public manual pump, which are mostly covered by donor agencies. Villages have to contribute about 1 percent - $450 USD (FCFA 200,000) for a standpipe and $225 USD (FCFA 100,000) for a pump - to the construction to demonstrate demand for an (additional) improved water point. Moreover, beneficiaries have to collect water fees of around $1.6 USD per m^3 consumed (FCFA 20 for a container of 25-35 liters) for the maintenance of the water points.

The main objective of this paper is to estimate the impact of such public water points on the time a household spends collecting water and to estimate the effect of achieved time savings on women's labor supply. A key methodological problem when

[3] The exchange rate used throughout this paper is 450 FCFA= $ 1USD.

analyzing this question is the endogenous placement of infrastructure, which is particularly relevant in the demand-led system described above. To overcome this problem, our empirical strategy has three elements: (1) double differencing, (2) phase-in sampling, and (3) (for about half of the sample, i.e. for the region of Collines) selection of control villages based on matching pre-baseline census data.

Any correlation between treatment status and observed or unobserved time-invariant village characteristics is eliminated by applying a double differencing approach. Second, treatment villages were randomly sampled from the planning lists of the *Direction Générale de l'Eau* for the year under consideration, whereas control villages were sampled from the water planning lists for the year after. This phase-in sampling (Duflo et al., 2006) should ensure that control villages are, from the viewpoint of treatment eligibility, not different from treatment villages: the second Beninese Water Program already started in 2005. All villages in our sample are hence "late appliers" for public water provision and the order of construction within two years is due to capacity limits rather than any endogenous placement strategy.[4] Third, the selection of control villages (in the region of Collines) from the planning lists of the consecutive year was not random, but used a matching procedure based on pre-baseline observables, thus further enhancing comparability between the treatment and control groups.[5]

Adding *phase-in sampling* and *matching based on census data* to the double-differencing approach should strengthen the plausibility of the identifying assumption of parallel trends in the absence of treatment, underlying any difference-in-difference approach. We provide further robustness checks with respect to the identifying assumption of our methodology in Section 5. For all our outcome variables of interest we estimate the following equation:

$$Outcome_{ijt} = \alpha + \beta_1 * Time_t + \beta_2 * Treatment_j + \beta_3 * (Time_t * Treatment_j) + \delta_1 * X_{ijt} + \delta_2 * Y_{jt} + \eta_{jt} + \varepsilon_{ijt}$$

where *Outcome* is the outcome of interest for household i in village j at time t. *Treatment* is a dummy which is equal to one if the household is located in one of the

[4] This is also confirmed by Table A3 – at least for observable characteristics.

[5] More precisely, a propensity score with respect to receiving the intervention in 2009 (rather than in 2010) was estimated using pre-baseline data from both the 2002 Census and a water point mapping survey done in Collines in 2007. For each treatment village the control village with the nearest match in terms of predicted propensity score was selected (a summary description of the method is provided in Appendix A2).

intervention villages, i.e. if it had received an improved village water point between the baseline (2009) and follow-up survey (2010). *Time* is a dummy that is equal to one if the observation was made after the intervention took place (2010), and zero if the observation was made before the intervention took place (2009). The parameter of primary interest is β_3 which measures the impact of improved village water provision on the outcome variable of interest. *X* and *Y* represent time-variant household and community characteristics that may or may not be correlated with treatment allocation. η and ε are idiosyncratic error terms at the village and household level, respectively.

The data analysis is based on two socio-economic household and two village surveys in two rural regions (Mono-Couffo and Collines) of Benin during the dry seasons of 2009 (1st wave) and 2010 (2nd wave). The survey was conducted in 200 villages: 100 villages were randomly selected out of 254 villages on the planning lists for for Mono-Couffo and 100 villages were selected based on a matching procedure out of 285 villages on the planning lists for Collines. For all sampled villages a complete household listing was performed to extract a random sample of 10 households per village. The target was hence to survey 2000 households, but five villages had less than 10 households which led to a total sample size of 1989 households. For the empirical analysis we further dropped observations with missing values of the dependent variables and/or severe outliers (top 1% level) of the dependent variables. This correction decreased the number of households analyzed to 1838. The replacement rate for the second wave was very low, at 3.2% (42 replacement households).[6]

The sample is comprised of 78 treatment villages (40 percent of the sample) and 122 control villages (60 percent of the sample). Treatment villages receive a new improved water source in 2009 (a public standpipe or pump), control villages in the consecutive year. For an overview of the geographic location of the treatment and control villages see Figure A5 in the Appendix.

Table A4 in the Appendix presents the control and treatment group sample means at baseline before the interventions took place. Table A4.1 shows the comparison for the

[6] Households that had to be replaced either moved to another village or could not be found anymore. Households were replaced by the central survey supervision drawing random households from the original household lists.

whole sample, Table A4.2 shows the comparison after the sample has been corrected for outliers. Differences between treatment and control households are not statistically significant (at a 10 percent level) for all (except one) household and village characteristics[7] and do not vary between the whole and the corrected sample. This supports, firstly, the assumption that treatment and control villages are similar and, secondly, that outliers are not correlated with treatment.

Note that no household in our sample had a private, in-house or compound water connection before or after the survey. However, the proportion of the population already using an improved public water source *before* treatment takes place is at 40 percent in both control and treatment villages (see Table A4 in the Appendix). The analysis in this study hence does not provide an estimate of the impact of access to improved water at a time when coverage rates in rural areas are close to zero (as might have been the case in the 20th century in sub-Saharan Africa). Instead, we study the impact of current and or future water interventions in Benin, when almost half of the rural population already uses water from improved public water sources. Benin is, however, no exception to other SSA countries, so we also claim external validity of the results of this paper: according to WHO/UNICEF (2012), rural (improved) water coverage rates in 2009 in neighboring countries of Benin were: 40% in Togo, 42% in Nigeria, 71% in Burkina Faso, and 39% in Niger. Across sub-Saharan Africa, 48% of the rural population had access to safe water in 2009 (WHO/UNICEF, 2012).

Pump installations in villages with an existing improved water source might either be required to achieve adequate service levels of not more than 250-500 households per water point (SPHERE, 2002).[8] Or, infrastructure targeting might be imperfect (and/or corrupted).[9]

[7] After outlier correction, the difference in number of containers collected between treatment and control villages becomes statistically significant at the 10 percent level.
[8] Since 2000, the standard in Benin is one water point per 250 individuals (Danida, 2004).
[9] For the case of Benin, about 50 percent of the villages on the water planning lists had no previous modern water point, 25 percent had inadequate service levels (i.e. more than 250 individuals per water point), and about 25 percent were adequately served even before the intervention.

3 Time Savings

Table 1 provides the difference-in-difference estimates (in minutes) of the impact of an improved public water point on the time to collect one container of water.[10] During the dry season, the effect is negative and significant as expected (Table 1, Column 1).[11] The construction of an improved water source decreases the average time for one roundtrip to collect water by 18 minutes. The treatment effect does not change considerably if we include further control variables.[12]

Table 1: Time Savings

	(1) Time round trip (minutes)	(2) Time per day (minutes)	(3) Containers collected per day (number)
Treatment Effect	-18.330***	-34.645**	0.396*
	(5.661)	(17.515)	(0.216)
Time Effect (2010)	27.790***	53.759***	-1.239***
	(4.411)	(12.455)	(0.153)
Village Effect	0.742	-3.126	-0.295
	(3.972)	(14.448)	(0.218)
Constant	29.606***	124.609***	5.142***
	(2.462)	(9.243)	(0.151)
Observations	3,676	3,676	3,482
R^2	0.079	0.025	0.052

Notes: Standard errors in parentheses are clustered at the village level. *** p<0.01, ** p<0.05, * p<0.1.

The total time spent per day on water collection decreases by 35 minutes (Table 1, Column 2). At first sight, these daily time savings seem low: daily water collection times are a function of the time needed to collect one container of water (of about 25-35 liters) and the number of containers collected per day (i.e. the number of roundtrips). In 2010, households collected on average 4 containers of water per day

[10] The question asked in the household survey: “Combien de temps faut-il pour aller là-bas, prendre de l’eau et revenir?“ would translate to English as: “How long does it take you to go to the water point, collect water and come back to the house?“

[11] In a subsample of households (1000 households in Collines), a baseline and follow up survey were also conducted during the rainy season. We find no evidence for a treatment effect during the rainy season (results available from the authors on request). 70 percent of households indicate that they use rainwater as a main drinking water source during the rainy season. Rainwater is, in most cases, collected in front of the house, so that during the rainy season the reported time to collect water is close to zero both for treatment and control villages before and after the intervention.

[12] Results are available from the authors on request.

(i.e. 4 roundtrips) whereas measured daily time savings of 35 min are only twice the measured roundtrip savings of 18 min, which would imply 2 roundtrips per day.

As indicated by Column 3 (Table 1), part of the reason is that the number of collected water containers per day increases with a new water point.[13] An increase in water quantities consumed is indeed another important objective of improved water supply (Hutton et al., 2006).[14] Moreover, any economist would assume that the demand for a normal good (water) increases with a decrease in price (time). However, increased water quantities and reduced time spending are, unfortunately, contradictory goals that might not easily be achieved together. To get a full picture of the impact of *public* water infrastructure on the time spent collecting water, it is therefore important to analyze both time savings per roundtrip as well as time savings per day, which depend on the endogenous choice of households and on the water quantity collected.

Table 1 also shows large time fixed effects, with an increase of 27 minutes per roundtrip over time. At baseline, households were asked for the time needed per roundtrip. In the follow-up survey, we additionally gathered information on the time spent walking one way, waiting at the water point, and chatting at the water point (see discussion below). We note that asking the aggregate question during baseline might have underestimated the true time taken to collect one container of water. This effect has also been shown in studies on consumption expenditure where collecting information on a larger number of expenditure items led to higher aggregate expenditure estimates (e.g. Deaton, 1997; Jolliffe, 2001; Pradhan, 2009; Beegle et al., 2012). Increased disaggregation should, however, be uncorrelated with treatment.

In a next step, we analyze the drivers of the time gains achieved. We start with the distance to the water source, estimated with self-reported distance categories and with GPS (Global Positioning System) based distance measures. Given that households were unable to provide the exact distance to their main water source, we asked them to estimate the distance based on the following four categories: (1) private water access at the household level, (2) less than 200m distance, (3) 200m-1000m, (4) >

13 A second reason is a pure mathematical one: if q_i is the number of collected containers per day by household i and t_i is the time this household needs to collect one container of water, and I is the total number of households analyzed then $\sum x_i t_i / I$ is not equal to $\sum x_i / I * \sum t_i / I$.

14 In case the service level increases from low access (more than 1km distance to a water point) to basic access (water point within 1km of the household) the volume of water per capita is expected to increase to basic water access of 20 liters per day (WHO, 2008).

1000m distance. According to the WHO (Howard and Bartram, 2003) an improved water source within 1000 meters can be considered as basic water access, and within 200 meters as intermediate water access (>1000m is considered as no access and private as optimal access). No household reported private water access. The self-reported distance is hence a binary variable that takes the value one if the household states that its water source lies within a distance of between 200 and 1000 meters. The GPS measure provides the distance in meters between the household and the household's water source. Unfortunately, GPS data is only available for the follow-up survey in 2010, which restricts us to calculating simple differences for the GPS measure.

Table 2 (Column 1 and 2) shows that the probability of using a water source within 200 or 1000 meters increases by 15 of 17 percentage points for households living in villages that received a public water point. Moreover, we find that the distance between households and their main water source is on average 200 meters shorter in villages where a public water point was constructed recently than in control villages, which did not receive a new water point (Table 2, Column 3). Given that the self-reported distance to the water source does not differ significantly between control and treatment groups at baseline (see Table A4, Appendix), we think that the observed 2010 difference in average distance to the water point between control and treatment villages, measured using more precise GPS data, can be cautiously interpreted as causal.

Table 2: Distance to Water Source

	(1) Distance self reported <=200m	(2) Distance self-reported <=1000m		(3) Distance in meters (GPS measure 2010)
Treatment Effect	0.153***	0.168***	Control Villages	473.55
	(0.145)	(0.223)		(81.212)
Time Fixed Effect (2010)	0.071	-0.036	Treatment Villages	273.08
	(0.081)	(0.157)		(37.083)
Village Effect	-0.049	-0.238		
	(0.145)	(0.188)		
Constant	-0.143	0.965***	Single Difference	-200.5**
	(0.092)	(0.126)		(89.277)
Observations	3,676	3,676		1,492

Notes: Standard errors in parentheses are clustered at the village level; *** p<0.01, ** p<0.05, * p<0.1, Columns 1 and 2 are the marginal effects of a probit regression[15]; Column 3 shows the single difference between control and treatment group in 2010. Due to connection errors of the GPS device and wrongly recorded digits of the UTM codes by interviewers the GPS sample comprises only 1492 households for 2010 (instead of 1838).

Even if we assume a conservative walking speed of 2 km/h (considering that a container of 25 to 35 liters of water has to be carried on the way back), a distance reduction of about 200 meters should translate into a time reduction of not more than 12 minutes.[16] The estimated time savings of 18 minutes per roundtrip (see Table 1) can therefore not be explained by a reduction in distance alone. Table 3 therefore provides the breakdown of the water collection process into its three main components: walking to and from the water source, time spent queuing at the water point, and time spent chatting (apart from queuing and walking). The data are available for 2010 only.

Table 3 suggests that the difference in time for a roundtrip between control and treatment villages does not stem from a decrease in distance only, i.e. walking time to and from the source, but also from shorter waiting times. Improved water supply reduces the walking time by 8 minutes (implying a walking speed of 3 km/h), and the waiting time by another 10 minutes. This phenomenon is especially relevant for larger villages where households mainly benefit in the form of waiting time reductions (13 minutes) and only marginally from decreased walking times (2 minutes). In contrast,

[15] Probit regressions, i.e. non-linear estimations, make the interpretation of the treatment effect, which constitutes an interaction term, difficult (Ai and Norton, 2003). For all probit estimations (and the respective Tables) we therefore compute conditional marginal effects.
[16] If a woman takes 60 minutes to walk 2000 meters, a 400 meter reduction in walking distance (for the roundtrip) should transfer into (60 minutes/2000 meters)*400 meters=12 minutes time savings.

smaller villages benefit to a large extent from reduced walking times (14 minutes) and to a lesser extent from decreased waiting times (7 minutes). No significant difference is found between the treatment and control groups with regard to the time spent *talking with friends at the water source*: the time women use for talking should not be influenced by a water intervention.

Table 3: Disaggregated Collection Process

	(1) Time Walking	(2) Time Waiting	(3) Time Talking
Control Village	24.28	28.18	6.12
	(2.524)	(3.212)	(0.589)
Treatment Village	16.87	18.05	6.05
	(1.292)	(1.636)	(0.489)
Single Difference	**-7.403*****	**-10.13*****	**-0.0665**
	(2.831)	(3.562)	(0.767)
p-value	0.009	0.004	0.931
Small Control Village	31.09	21.54	6.05
	(4.375)	(4.162)	(0.913)
Small Treatment Village	17.17	14.89	6.49
	(2.099)	(1.674)	(0.746)
Single Difference	**-13.92*****	**-6.648**	**-0.440**
	(4.857)	(2.689)	(4.457)
p-value	0.004	0.137	0.709
Large Control Village	18.39	33.92	6.18
	(2.227)	(4.701)	(0.804)
Large Treatment Village	16.59	21.10	5.63
	(1.518)	(2.770)	(0.635)
Single Difference	**-1.797**	**-12.82*****	**0.548**
	(5.427)	(1.174)	(1.028)
p-value	0.505	0.019	0.595
Observations	1,867	1,862	1,860

Notes: Figures represent minutes. Data is for 2010 only. Villages with more than 50 households (approx. 300 individuals) are defined as large villages

Reduced waiting times at the newly installed water point could be the result of improved technologies, which speed up the process of collecting water at source. Another reason for reduced waiting times is the decrease of "population pressure" at the new *and* existing water points in the village. With the available data we can only analyze the relevance of the second hypothesis. Table 4 Column 1 shows that the installation of an improved water point leads to an increase by 40 percent of households using an improved water source up to 80 percent of the population covered. This means that about 20 percent of households continue to use unimproved sources. Furthermore, the share of households that use two water sources increases by 17 percentage points after the installation of an improved water point (Table 4, Column 2). This indicates that 17 percentage points of households do not use the improved water source all the time.

Note that in contrast to the "old" water source, the improved water comes at a cost of about $1-2 Cents USD per container collected, so some households prefer to continue to consume unimproved but free water. In other words, a considerable number of villagers either never, or only sometimes, uses the newly constructed water point, which means that a newly constructed water point reduces the population pressure on all water sources within a certain village. This certainly is a positive result from a time perspective but not desirable from a health perspective. The relevance of population pressure for water collection times is also supported by Table 3: firstly, the reported waiting time in smaller villages is much shorter than in larger villages in general, and secondly, a new water point has a much higher impact on waiting times in large villages than in small villages.[17]

Table 4: Time Savings and Population Pressure

	(1) Use of Improved Water Source	(2) Use of Second (Traditional) Source
Treatment Effect	**0.402*****	**0.174*****
	(0.167)	(0.183)
Time Effect (2010)	0.046	-0.084
	(0.072)	(0.113)
Village Effect	-0.256	-0.015
	(0.186)	(0.164)
Constant	0.000	-0.563***
	(0.124)	(0.107)
Observations	3,676	3,676

Note: Standard errors in parentheses are clustered at the village level; *** p<0.01, ** p<0.05, * p<0.1. Coefficients are the marginal effects of a probit analysis.

Table 3 also shows that - even in villages where new public water infrastructure has been installed - the average time needed to collect one container of water is still substantial and longer than 30 minutes, even though the average distance to the water source is below 300 meters (Table 2). A large part of this time is spent at the water point (i.e. waiting and chatting) and not traveling to and from the water point. Given

[17] Note that the difference in waiting times between smaller and larger villages is not due to differences in the amount of water consumed per household between smaller and larger villages. Results are available from the authors on request.

these results, we think that distance is not a good proxy for the time to collect water and that it is important to always collect data on both distance and time to a water source to evaluate whether water is accessible for households. In contrast, in several reports on water accessibility, a 30 minutes roundtrip to the water source is used as a "synonym" for a water source distanced within 1000 meters (for example WHO, 2003; WHO, 2004).

4 Labor Supply and Opportunity Costs

At the time of the baseline, an average of 1.9 persons per household (out of an average of 5.6 household members) were engaged in water collection. In 46 percent of households, only one person is responsible, in 27 percent of households 2 persons are responsible and in 27 percent of households more than 2 household members are engaged in water collection activities. 75 percent of individuals engaged in water fetching activities are female: 13 percent are girls below the age of 15 and 62 percent are women aged 15 or over. Men only make up 25 percent of the people responsible for water fetching (10 percent boys and 15 percent men). Any time savings achieved should therefore mainly benefit women, if it is not selectively men who are "freed" from the water collection process after modern water supply installations.

Estimating the effect of water interventions on the number of household members responsible for water fetching was found to be statistically insignificant for all population groups (see upper part of Table 5). Hence, apart from considerable time savings for the household, nobody seems to be totally relieved of the responsibility for collecting water. One reason might be that, in many households (46 percent), only one person was responsible for water collection already at baseline, and someone from the household still needs to collect water after treatment, even if it takes less time.

In a second step, we therefore constrained our sample to households where two or more household members were responsible for water collection before public water points were constructed (see lower part of Table 5). For households with two or more water carriers, the construction of an improved water source significantly decreases the number of household members involved in water fetching activities (column 1) by

0.2 members. Compared to the counterfactual mean[18] of 2.2 household members involved in water collection this means a reduction of 10 percent of individuals involved in water collection.

Interestingly, this effect is mostly driven by a lower involvement of 0.1 men (column 5) and not of women (column 2) even though this group is usually expected to benefit most from water infrastructure given that they take over most of the water collection burden at baseline. However, it seems that water collection is seen as a women's task and men only help in the most severe water conditions. Once these improve, water collection is left to women and the benefits of improved access are not shared equally.

Table 5: Number of persons responsible for water collection

All households	(1) All individuals	(2) Girls<=14	(3) Women >14	(4) Boys<=14	(5) Men>14
Treatment Effect	-0.075	-0.017	-0.029	0.009	-0.021
	(0.074)	(0.039)	(0.043)	(0.035)	(0.020)
Time Effect (2010)	-0.231***	-0.045**	-0.174***	-0.047*	0.008
	(0.053)	(0.022)	(0.034)	(0.028)	(0.013)
Village Effect	-0.075	-0.041	0.064	-0.083***	-0.028
	(0.071)	(0.036)	(0.047)	(0.028)	(0.053)
Constant	1.943***	0.266***	1.149***	0.204***	0.514***
	(0.049)	(0.022)	(0.031)	(0.023)	(0.037)
Observations	3,676	3,676	3,676	3,676	3,676
R^2	0.021	0.005	0.016	0.011	0.001
Households with two or more water carriers	(1) All individuals	(2) Girls<=14	(3) Women >14	(4) Boys<=14	(5) Men>14
Treatment Effect	-0.197*	-0.053	-0.159	0.110	-0.093*
	(0.113)	(0.098)	(0.110)	(0.082)	(0.050)
Time Effect (2010)	-1.153***	-0.263***	-0.466***	-0.287***	0.015
	(0.061)	(0.060)	(0.081)	(0.062)	(0.039)
Village Effect	-0.018	-0.028	0.249**	-0.221***	-0.063
	(0.058)	(0.089)	(0.103)	(0.071)	(0.109)
Constant	3.384***	0.645***	1.656***	0.530***	0.789***
	(0.038)	(0.050)	(0.077)	(0.053)	(0.078)
Observations	987	987	987	987	987
R^2	0.369	0.043	0.085	0.066	0.003

Note: Standard errors in parentheses are clustered at the village level; *** p<0.01, ** p<0.05, * p<0.1.

[18] The counterfactual mean is calculated as the mean value of the treatment group plus the change in the control group and can thus be interpreted as the mean value in case the treatment group would not have been treated.

Collecting daily time diaries was unfortunately not feasible within the framework of this study. All women who started to use a new water point within the last year were therefore asked how the time savings achieved through an improved water point were being used. Only 35 percent of women reported that they use the time gains for income generating activities such as agriculture, trading or handicrafts. This value seems reasonable given that only 32 percent of all women reported pursuing an income generating activity as their main activity at baseline (see Table A4 in the Appendix). The other 65 percent said that they mainly use the time gains for additional housework or increased leisure time. Moreover, a difference-in-difference analysis of women's (and men's) reported main activity does not show any significant increase in the share of women (or men) working in agriculture or professional off-farm work.[19]

This result is in line with a recent cross-sectional study by Koolwal and Van der Walle (2010) and an experimental study by Devoto et al. (2012). Koolwal and Van der Walle (2010) studied whether reduced (self-reported) time to collect water is correlated with off-farm work by women for nine developing countries. They find that the reported duration for collecting one container of water is not correlated with the engagement of women in productive activities. Devoto et al. (2012) conducted a randomized control trial in urban Morocco and found that obtaining private access to the public water grid generates important time gains, which are, however, only used for leisure and social activities.[20]

Even though time savings are only rarely translated into economic activities and increased financial incomes, we can still analyze the economic (opportunity) value of the time savings achieved. We follow Whittington et al. (1990) and value time savings at the approximate average rural wage for unskilled labor. To do so, we take the daily wage of unskilled labor in the villages surveyed in 2010 of $2 USD (FCFA 1,000) per day, which is approximately equivalent to the national minimum wage in Benin of FCFA 30,000 per month (ILO, 2012). If we assume a work day of 8 hours and 240 days per year (excluding the four months of the rainy season during which we could

[19] Results are available from the authors on request.
[20] We also do not find that girls and/or boys are more likely to report being enrolled in school following improved water access (results are available from the authors on request). Firstly, time savings per day are only moderate at 35 minutes per day. This freed time is probably not enough to keep children in school who would otherwise need to do chores. Moreover, we did not find any evidence that girls and/or boys are freed from the water collection process following the installation of improved public water supply (see Table 5).

not detect any time savings), time savings of 35 minutes per day translate into 140 hours or 17.5 days of time saved per household per year (Table 6). The economic value of time savings due to the installation of an improved water point is hence $35 USD per household per year. This represents about 1.6 percent of a rural household's annual expenditure, which was estimated at $2,150 USD (FCFA 971,054) for rural Mono-Couffo and Collines by a national representative household survey in 2007.[21]

Table 6: Economic Value of Time Savings

	Unit	Value	Explanation
Time savings per day/household	minutes	35	see Table 1
Time savings per year	hours	140	assuming 240 water collection days
Working days per year	days	17.50	assuming a work day of 8h
Opportunity cost per year and household	USD	35.00	valued at $2USD daily wage for unskilled rural labor
As % of annual household expenditure	%	1.63	in relation to average household expenditure of 2007=$2,150 USD
Opportunity cost per year and village (pump)	USD	2205	calculated at village size of 63 households
Opportunity cost per year and village (standpipe)	USD	3745	calculated at village size of 107 households
As of public water supply costs (standpipe)	%	11.02	in relation to the investment cost of a pump =$20,000 USD
As of public water supply costs (pump)	%	6.81	in relation to the investment cost of a standpipe =$55,000 USD

The average village size in our sample is 107 households for villages where a standpipe is installed, and 63 households for villages where a pump is installed. The economic value of the time savings per village per year is equal to 11 percent of the investment costs for a village pump ($20,000 USD) or 7 percent of a standpipe respectively (Table 6). This implies that the net present value of the investment in a pump, assuming a discount rate of 5 percent common for water supply investments (KfW, 2011) is positive after 13 years of use for a pump and 18 years of use for a standpipe. Hence, the (opportunity cost of) time savings generated by public water supply interventions pay off the investment cost if the infrastructure lifetime is at least 13 or 18 years, respectively.

Note again that public water supply does not improve the health of the population (see Appendix A3 and introduction). Hence, the economic value of time savings is crucial for any cost-benefit analysis of public water supply. Taking into account that only 35

[21] The Enquête Modulaire Intégrée sur les Conditions de Vie des Ménages 2006 (EMICOV) was carried out by the national statistical office (INSAE) in 2007.

percent of people use the time gains for income generating activities, this calculation of opportunity costs certainly overestimates the financial benefits of time savings (the respective numbers in Table 5 would have to be divided by about three). The presented numbers in Table 6 should hence be considered as an upper-bound estimate of the economic value of public water supply.

5 Robustness Checks

The validity of double-difference analysis rests on the identifying assumption that the trend in the dependent variable, absent the treatment, is equal for intervention and control groups. This assumption cannot be tested directly but we provide a number of indirect robustness checks that strengthen the plausibility of this assumption (apart from applying a phase-in approach to select the control group).

A first test is to replace the outcome variable by alternative dependent variables which should not be affected by the treatment intervention but which might be correlated with the outcome variables of real interest and estimate the "hypothetical" treatment effect for this new variable (Duflo, 2002). Secondly, we interact several characteristics that were initially different (although statistically insignificant) between control and treatment group with the time, village and treatment effect to test whether the impact would be significantly different for the control group taking into account that it shows somewhat different characteristics to the treatment group. Thirdly, we are able to match 84 out of the 200 villages in our sample with the 2002 Census which contains one of our outcome variables "use of an improved water source". The subsample includes 52 control and 32 treatment villages to estimate a difference-in-difference regression at the village level between 2002 and 2009 (i.e. before our studied water supply intervention took place).

Table 7 shows the robustness check of the difference-in-difference estimates for outcome variables which should not be influenced by the treatment but which might be correlated with the outcome variable(s) of interest, namely: household head's education, household size, poverty status of a household[22] and household has access via paved road. The double difference impact of treatment on these alternative outcome variables is not significant. These results indicate that there seems to be no trend (during the time period of observation) of conditions in the treatment villages relative to the control villages that might decrease the time to collect water.

Table 7: Robustness Check I: Alternative dependent variable

	(1)	(2)	(3)	(4)
Dependent Variable:	Household head without education	Household size	Poor household	Village has access via paved road
Treatment Effect	**0.01**	**0.11**	**0.02**	**0.10**
	(0.082)	(0.111)	(0.034)	(0.215)
Time Effect (2010)	0.07	0.16**	-0.01	-0.18
	(0.042)	(0.076)	(0.020)	(0.166)
Village Effect	0.13	-0.16	-0.01	-0.17
	(0.093)	(0.131)	(0.110)	(0.270)
Constant	0.45***	-0.33***	-0.94***	-1.03***
	(0.060)	(0.098)	(0.074)	(0.179)
Observations	3486	3641	3647	397

Note: Standard errors in parentheses are clustered at the village level; *** p<0.01, ** p<0.05, * p<0.1. Columns 1, 3 and 4 show the marginal effects of a probit analysis.

Table 8 shows the difference-in-difference analysis (with time for a roundtrip as the dependent variable) when including an interaction term of treatment and education of the household head (column 1), household size (column 2), poverty (column 3), and paved road access (column 4). A first finding is that the size of the treatment effect is reasonably close to the basic estimate (minus 18 minutes) and stable across specifications. Moreover, we find no indication of differential treatment effects across household characteristics.

[22] An asset index is constructed using 30 housing conditions and households' durable assets. If a certain item is present in a household the binary variable is 1 and otherwise 0. We apply principle component analysis to construct an asset index. Being poor is defined as belonging to the lowest two quintiles of the asset index distribution.

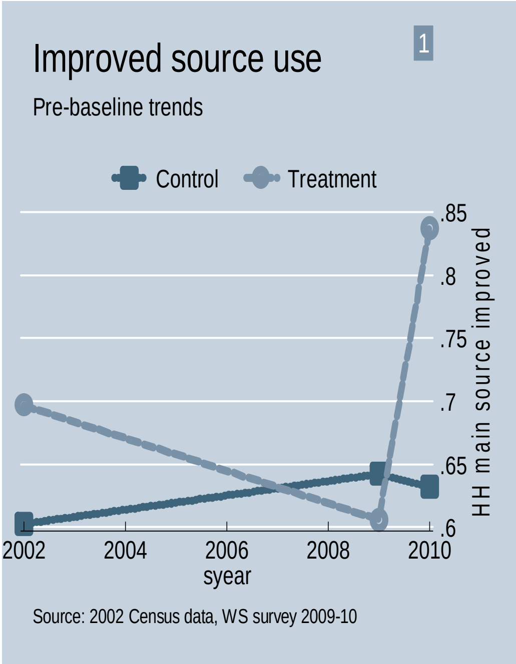
Table 8: Robustness Check II: Interaction of treatment with HH characteristics

	(1)	(2)	(3)	(4)
Dependent Variable:	Time roundtrip (in min)			
	X= Household head without education	X= Household size	X= Poor household	X= Village has access via paved road
Treatment Effect	-18.08***	-25.16**	-20.87***	-16.27**
	(5.516)	(10.324)	(5.768)	(6.260)
Time Effect (2010)	26.42***	23.30***	33.99***	25.66***
	(3.561)	(7.808)	(4.750)	(4.746)
Village Effect	3.46	-2.67	2.15	-0.73
	(4.510)	(6.384)	(3.474)	(4.513)
X	5.33**	-0.74*	11.58***	-8.40*
	(2.503)	(0.382)	(3.426)	(4.777)
Treatment Effect*X	-0.63	1.53	4.20	-14.58
	(6.522)	(1.564)	(9.339)	(13.036)
Time Effect (2010)*X	2.68	0.82	-15.48**	15.57
	(4.798)	(1.230)	(6.162)	(10.959)
Village Effect *X	-3.40	0.61	-2.23	8.82
	(4.573)	(0.771)	(5.939)	(7.721)
Constant	25.68***	33.69***	25.24***	30.89***
	(2.498)	(3.725)	(2.369)	(2.831)
Observations	3,486	3,656	3,641	3,628
R^2	0.086	0.085	0.088	0.081

Note: Standard errors in parentheses are clustered at the village level; *** p<0.01, ** p<0.05, * p<0.1.

Last, Figure 1 indicates that there is a large increase in "use of a modern water sources" in the treatment group through the studied program which is clearly not the continuation of a pre-baseline trend. In the period prior to the baseline survey, the treatment villages have a slightly downward sloping trend in comparison to the control villages. A regression further shows that the pre-baseline (placebo) treatment effect is not significant. We therefore cannot reject the hypothesis of a parallel trend in treatment and control villages before the studied program intervention. The evidence from the three robustness checks discussed here supports the identifying assumption that our findings are not the result of a trend difference between treatment and control villages.

Figure 1: Pre-baseline trend (2002-2009)



	Village uses an improved water source
Placebo treatment	-0.130
	(0.282)
Treatment group	0.0937
	(0.272)
Time trend (2009)	0.0395
	(0.595)
Constant	0.603***
	(0)
Observations	168
R-squared	0.009

P-value in parentheses *** p<0.01, ** p<0.05, * p<0.1

Spillover effects could be another problem of our approach. Estimated impacts would be (probably downward) biased if households from control villages also started to use the newly built water points of treatment villages. On average, treatment and (the closest) control village are 10.5 km apart in Collines and 12.5 km apart in Mono.[23] 50% of control villages are less than 5 km away from the next treatment village. If spillover effects prevail, the time to collect water for treatment villages might increase due to higher population pressure (from households of control villages also using the new water point). On the other hand, the time to collect water for control villages might decrease or increase depending on whether the distance to the newly built water point in the treatment village is smaller or larger than the distance to the previously used (traditional) water source.

Exploiting detailed village level information on water points from the follow-up survey, we find no evidence that control villages started to use treatment water points. In 2010, only 3 control villages report having started to use a new water point within the last 12 months. In these 3 cases, spillover effects might occur, but in general we

[23] Distances between treatment and control group are calculated using GPS data on the main water point in the village. Averages reflect the distance between treatment villages and the *closest* control village.

think we can neglect spillover effects from the treatment to the control group. Spillover effects might still affect other (non-control) villages in the survey region: each newly installed water point is, on average, used by 2 villages (i.e. the treatment village plus one additional village). This implies that the estimated time gains could even be larger for villages that receive a new water point if other villages were excluded from using it. A difference-in-difference analysis does, however, show that water supply interventions do not increase the number of villages using a water point in the treatment villages.[24] In other words, water points are, on average, shared with one other village and, if a new water point is installed, it will also be shared with this village, but will not attract additional villages to collect water.

6 Discussion and Conclusion

This study analyzes the impact of improved water supply on time savings and women's labor supply applying a combination of a difference-in-difference analysis and a phase-in approach. Our results confirm former studies which found a reduced time burden. We find that a new water point saves households an average of 35 minutes per day for water collection activities. As women are mainly engaged in water fetching activities they should benefit most from water supply interventions. However, we find that it is first of all men who are freed from water collection activities and that only 35 percent of women use the achieved time gains for income generating activities. This estimate translates into a yearly economic value of less than 1-2 percent of a household's annual income.

The estimated time savings per day (of 35 minutes) are at the lower end of previous studies, which did, however, rarely control for endogeneity, or used very small and/or non-random samples. A second explanation is that the baseline proportion of households already using an improved water source is 40 percent in our sample, whereas it might be lower in other studies: unfortunately, few studies report on baseline coverage rates. We think that our results are, however, very relevant for current and future public water supply programs, which are confronted with similar coverage rates in rural areas. Water supply interventions in such settings should

[24] Results are not reported here, but are available from the authors on request.

expect the same time savings if need-based targeting – excluding any villages that already have access to improved water sources (in neighboring villages) – is not improved.

Moreover, our results suggest that it is not only the distance to the water point which is reduced, but that waiting times at all water sources, including traditional sources, seem to be shortened. Since there is often "congestion" at public water points, users of the improved source benefit from the fact that not all households (at all times) switch to the new water point. Hence, the number of users per water point, and the waiting time, decreases for all water points, including the new one. If all households switched to the new water point, waiting times would not change significantly after the installation of an improved water point. From a policy perspective, only shortening the distance to a water source may decrease water collection times less than expected. Large time savings can only be achieved if the population pressure at the water point, i.e. waiting times, is also reduced.

This result also points at two important measurement issues. First, distance to a water source is not a good proxy for the time to collect water. Water collection times equally depend on the number of households per water source and the distance to the source. Second, in the follow-up survey we noticed significantly longer times reported for a roundtrip due to a disaggregation of the water collection process. We therefore conclude that asking just one single question about the time spent fetching water – as, for example, was the case in the DHS surveys - will underestimate the actual time needed to collect water. This last hypothesis obviously asks for further research.

Last, we note the importance of taking a "quantity-time" trade-off into account when evaluating time savings. Once the unit cost of water consumption is reduced, households consume more of it which, subsequently, causes overall time gains to be lower than might be expected from time savings per water collection round trip. From a measurement perspective this means that surveys should collect information both on the time to obtain one container of water and on the water quantity collected per day. A "quantity-time" trade-off might also be one reason why labor supply does not significantly increase.

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Appendices

Table A1: Literature Review

Author	Year	Time roundtrip	Time saving due to modern source	Sample and Setting	Sample design
Feachem	1978	improved: 15-35 minutes; unimproved: 50-100 minutes	**15-30 minutes per roundtrip** using improved source	16 villages, Lesotho	Non-random villages, cross-sectional analysis
Cairncross and Cliff	1987	improved: 25 minutes; unimproved: 131 minutes	**106 minutes per day** using improved source	670 households in 2 villages, Mozambique	Non-random households, cross-sectional analysis
Bevan et al.	1989	5-35 minutes	**41 minutes per day (150 hours per year)** using private connection	24 villages and 800 households, Kenya 26 villages and 500 households, Tanzania	Multi-stage stratified random sample, cross-sectional analysis
Blum et al.	1990	improved: 60 minutes **per day**; unimproved: 360 minutes **per day**	**300 minutes per day** using improved source	1400 households in 4 villages, Nigeria	Random sampling of villages from program planning lists, random sampling of households, before-after comparison
Devoto et al.	2012	7 minutes	**27 minutes per day (82 minutes per 3 days)** using private connection	793 households in 1 city, Morocco	Random allocation of treatment and control groups, difference-in-difference analysis
Whittington et al.	1990	Kiosks: 41 minutes; Well: 57 minutes	not analyzed	69 households in 1 village, Kenya	Random households, cross-sectional analysis
Rosen and Vincent	1999	60 minutes	not analyzed	Kenya, Mozambique, Lesotho, Sudan, Nigeria, Burkina Faso, Zimbabwe, Tanzania, and Uganda	Meta-analysis and literature review
Thompson et al.	2000	1967: 9 minutes 1997: 21 minutes	not analyzed	448 households in 8 Kenyan, 5 Tanzanian and 8 Ugandan cities	Repeated cross-section of urban areas
Blackden and Wodon	2006	32-80 minutes **per day**	not analyzed	Rural areas Benin Madagascar, Ghana	National representative time surveys, cross-sectional analysis
Sorenson et al.	2011	17-37 minutes	not analyzed	Burundi, Malawi, Burkina Faso, Cameroon, CAR, Cote d'Ivoire, Gambia, Ghana Guinea-Bissau, Nigeria, Sao Tome and Principe, Sierra Leone, Togo	National representative MICS surveys, cross-sectional analysis

A2: Summary of pre-baseline matching procedure

During villgae sampling in Collines, matching of treatment and control villages was done using pre-baseline data. This approach was not be followed for Mono-Couffo because of missing data; for this reason village sampling was done randomly from program lists in Mono-Couffo.

In Collines two sets of pre-baseline data could be used for matching: first, village level data from the 2002 Census and village level data from a "water mapping" data set collected by the Service Eau Collines between March and August of 2007 with technical support from the French Development Cooperation. To improve the matching of control to treatment villages we merged the water planning lists (of 2009 and 2010) with the 2002 Census and the 2007 water mapping data using village names (unfortunately, administrative village codes were not available).

After the three datasets were merged the psmatch2 (Leuven and Sianesi, 2003) Stata routine was used to calculate for each locality the propensity score for receiving the intervention already in 2009 (and not in 2010), conditioning on the following independent village and commune level variables:

From 2002 Census: connected to water network (AEV), connected to telephone network, post-office present; percentage share of households with main water source: private piped water from state water company, piped water from state water company elsewhere, other type of public piped water, village pump; (rain)water storage tank, protected well, traditional well, river, other surface water, source not given.

From 2007 water mapping survey: estimated population size 2007, km distance to school, km distance to vocational training, km distance to health facility, number of successful borehole drillings (i.e. water was found), number of unsuccessful borehole drillings (i.e. water was not found), number of protected wells, number of traditional wells, number of public taps.

For each randomly sampled treatment village (programmed to receive an improved water point in 2009), the "nearest neighbor" in terms of propensity score was identified and selected from the lists of control villages (those villages programmed to receive a water point in 2010). This procedure allowed us to improve selection of counterfactual villages compared to random sampling from the program lists of 2010.

Table A3: Health and Water Quality Outcomes

	(1)	(2)	(3)	(4)
	E. Coli at POS	E. coli POU	Diarrhea all household members	Diarrhea age<5
Treatment Effect	**-0.309*** **	**0.115**	**0.003**	**-0.011**
	(0.061)	**(0.074)**	**(0.017)**	**(0.043)**
Time Effect (2010)	-0.033	-0.177***	0.053***	0.170***
	(0.064)	(0.044)	(0.010)	(0.025)
Village Effect	0.122	-0.091*	0.004	0.017
	(0.097)	(0.053)	(0.013)	(0.035)
Observations	268	2,491	24,006	3,194
CF mean	0.304	0.180	0.113	0.309

Note: Standard errors in parentheses are clustered at the village level; *** p<0.01, ** p<0.05, * p<0.1. Regressions in columns 3 and 4 are at the individual level. Column 1 is at the village level for a subsample of 134 villages with microbiological water analysis (see Günther and Schipper (2012) for a more detailed description of this analysis). Column 2 is at the household level for households with water tests in the subsample of 134 villages.

Table A4: Baseline comparison

A 4.1 Whole sample

Household Characteristics	Sample Mean	se	Control Group	se	Treatment Group	se	Diff.	p-value
Household uses improved public source	0.46	(0.036)	0.50	(0.048)	0.40	(0.054)	-0.11	0.133
Households uses traditional well	0.25	(0.029)	0.23	(0.034)	0.29	(0.052)	0.06	0.366
Households uses surface water	0.16	(0.030)	0.14	(0.038)	0.19	(0.047)	0.05	0.419
Households uses a private tap	0.00		0.00		0.00			
Time roundtrip in minutes	33.25	(2.711)	34.66	(3.906)	30.89	(3.127)	-3.77	0.452
Containers per day	5.80	(0.377)	6.10	(0.571)	5.30	(0.308)	-0.80	0.217
Water point within 200m distance	0.44	(0.027)	0.45	(0.035)	0.42	(0.044)	-0.03	0.644
Water point within 1000m distance	0.81	(0.026)	0.83	(0.032)	0.77	(0.042)	-0.06	0.252
# of persons responsible for water fetching	1.99	(0.037)	2.03	(0.050)	1.94	(0.054)	-0.09	0.218
Women with income activity								
Age of household head	43.61	(0.597)	44.23	(0.789)	42.58	(0.880)	-1.65	0.164
Female headed household	0.17	(0.013)	0.16	(0.018)	0.17	(0.020)	0.01	0.842
Household Size	5.92	(0.143)	6.05	(0.191)	5.71	(0.204)	-0.34	0.233
Head without education	0.68	(0.016)	0.66	(0.022)	0.72	(0.022)	0.06	0.048
Asset Index	0.37	(0.012)	0.36	(0.017)	0.37	(0.015)	0.01	0.556
Share of poor households	0.33	(0.025)	0.35	(0.035)	0.31	(0.030)	-0.04	0.358
Number of rooms	2.68	(0.063)	2.64	(0.070)	2.74	(0.118)	0.10	0.455
Household uses sanitation	0.10	(0.013)	0.11	(0.018)	0.08	(0.018)	-0.03	0.262
Number of hand washing activities per day	5.58	(0.122)	5.53	(0.175)	5.67	(0.148)	0.14	0.537
Number of children aged<5	0.93	(0.039)	0.94	(0.053)	0.92	(0.055)	-0.01	0.856
Observations	1989							
Village Characteristics								
Village Size (households)	94.19	-6.184	77.7	-6.936	87.26	-11.738	9.56	0.48
Primary School available	0.76	-0.038	0.75	-0.051	0.78	-0.056	0.04	0.63
Access via earth road	0.95	-0.014	0.94	-0.021	0.97	-0.015	0.03	0.23
Access via paved road	0.14	-0.03	0.15	-0.042	0.12	-0.039	-0.04	0.53
Electricity in locality	0.20	-0.034	0.19	-0.045	0.20	-0.05	0.01	0.90
Observations	200							

A 4.2 Outlier corrected

Household Characteristics	Sample Mean	se	Control Group	se	Treatment Group	se	Diff.	p-value
Household uses improved main source	0.46	(0.037)	0.50	(0.049)	0.40	(0.054)	-0.10	0.168
Households uses traditional well	0.24	(0.029)	0.22	(0.034)	0.28	(0.052)	0.06	0.356
Households uses surface water	0.17	(0.031)	0.15	(0.041)	0.20	(0.048)	0.05	0.435
Households uses a private tap	0.00		0.00		0.00		0.00	
Time roundtrip in minutes	29.89	(1.932)	29.61	(2.461)	30.35	(3.116)	0.74	0.852
Containers per day	4.54	(0.097)	4.66	(0.134)	4.33	(0.130)	-0.33	0.070
Water point within 200m distance	0.44	(0.028)	0.44	(0.036)	0.42	(0.044)	-0.02	0.737
Water point within 1000m distance	0.81	(0.026)	0.83	(0.032)	0.77	(0.043)	-0.07	0.213
# of persons responsible for water fetching	1.91	(0.036)	1.94	(0.049)	1.87	(0.051)	-0.07	0.292
Women with income activity	0.32	(0.027)	0.34	(0.037)	0.27	(0.037)	-0.08	0.147
Age of household head	43.15	(0.606)	43.86	(0.821)	42.01	(0.848)	-1.85	0.119
Female headed household	0.17	(0.014)	0.17	(0.019)	0.17	(0.021)	0.00	0.954
Household Size	5.64	(0.139)	5.73	(0.188)	5.49	(0.196)	-0.24	0.385
Head without education	0.69	(0.016)	0.67	(0.022)	0.71	(0.024)	0.04	0.187
Asset Index	0.36	(0.012)	0.35	(0.017)	0.37	(0.015)	0.02	0.371
Share of poor households	0.35	(0.026)	0.37	(0.037)	0.32	(0.031)	-0.05	0.269
Number of rooms	2.62	(0.060)	2.58	(0.071)	2.70	(0.107)	0.12	0.358
Household uses sanitation	0.09	(0.013)	0.10	(0.016)	0.09	(0.019)	-0.01	0.610
Number of hand washing activities per day	5.60	(0.131)	5.56	(0.189)	5.67	(0.158)	0.12	0.636
Number of children aged<5	0.91	(0.041)	0.92	(0.056)	0.90	(0.058)	-0.02	0.795
Observations	1838							
Village Characteristics								
Village Size (households)	94.19	-6.184	77.7	-6.936	87.26	-11.738	9.56	0.48
Primary School available	0.76	-0.038	0.75	-0.051	0.78	-0.056	0.04	0.63
Access via earth road	0.95	-0.014	0.94	-0.021	0.97	-0.015	0.03	0.23
Access via paved road	0.14	-0.03	0.15	-0.042	0.12	-0.039	-0.04	0.53
Electricity in locality	0.20	-0.034	0.19	-0.045	0.2	-0.05	0.01	0.9
Observations	200							

Figure A5: Geographic Location of Treatment and Control Villages