

# Happiness on Tap: Piped Water Adoption in Urban Morocco<sup>1</sup>

Florencia Devoto, PSE  
Esther Duflo, MIT  
Pascaline Dupas, UCLA  
William Parienté, UC Louvain  
Vincent Pons, MIT

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## Abstract

We study the demand for home water connections among households in urban Morocco, and their effects on household welfare. In the northern city of Tangiers, among homeowners without a private connection to the city's water grid, a random subset was offered a simplified procedure to purchase a home connection on credit. Take-up was high, at 69%. Since all households in our sample had access to the water grid through free public taps, home connections did not lead to any improvement in the quality of the water households consumed; and despite significant improvement in the quantity of water, we find no change in the incidence of waterborne illnesses. Nevertheless, we find that households are willing to pay a substantial amount of money every month to have a private tap at home. Being connected generates important time gains, which are used for leisure and social activities, rather than productive activities. Because water is often a source of tension between households, home connections improve social integration. Overall, within 6 months, self-reported well-being improved substantially among households in the treatment group, despite the financial cost. Our results suggest that access to credit can enable households to invest in substantial quality-of-life improvements that can significantly increase welfare, even if they do not result in income or health gains.

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## 1. Introduction

Households in developing countries spend considerable amount of time fetching water. For example, Kremer et al. (2009) estimate that a rural household in Western Kenya does around seven water-fetching trips per day, with each trip requiring a 20-minute walk on average. In urban Morocco, the setting of this study, households that rely on public taps spend more than seven hours a week collecting water, despite the higher density of water taps. The time-burden of water collection does not typically spare anyone in the household, but in many countries it is borne primarily by women and girls. This burden generates considerable stress and tension. For example, in Morocco, 65% of households without a water connection report that water is a major source of concern, 15% have had a water-related conflict within the family and 12% with their neighbors; thus, both within the family and between families, water seems to be an important source of stress and tension.

Most interventions to connect poor households to the drinking water network are primarily concerned with physical health. Yet, over and beyond its direct effect on physical health, improved water access could have important effects on the household well-being. By reducing the time burden of water collection, it not only frees up time that could be spent on additional leisure or production, it also removes an important source of stress and tension. On the other hand, if women face restricted mobility besides their daily trips to the public water source, a home water connection could cut off an important source of opportunities to socialize, and possibly reduce their well-being.

The first order effects of access to clean water on health, even in cities, have been amply demonstrated (Merrick (1985), Galiani, Gertler and Schardrotsky (2005) and Gamper-Rabindran, Khan and Timmins (*forthcoming*)). Given these first-order effects, it is difficult, in most settings, to separate the effects of clean water directly due to health from the effect due to the reduced burden of water collection. This paper uses a randomized design to study the effects of in-home water connections on poor urban households in Morocco. Because the households already had access to clean water from a public tap, the connection did not result in access to water of better quality, allowing us to identify the specific effect of a reduced water-collection burden on time use, social integration, and mental well-being. We find considerable improvement in all these dimensions, without any change in the incidence of water-borne diseases. This suggests that the time and resources spent on water collection

substantially reduce welfare of poor households, a finding consistent with their high willingness to pay for a home connection.

We worked in collaboration with Amendis, the local affiliate of an international private utility company, which operates the electrical and wastewater collection networks as well as the drinking water distribution in Tangiers, Morocco. In 2007, Amendis launched a social program to increase access to piped water. As of the end of 2007, approximately 845 low-income households living in “on-the-grid neighborhoods” of Tangiers (i.e. in principle easily connectable) did not have a household water connection because they could not afford the connection fee. These households had free access to public taps installed in their neighborhood, and they had access to sanitation at their house. The Amendis program provided a subsidized interest-free loan to be applied to installing a water connection. The loan was to be repaid in regular installments with the water bill over three to seven years. The subsidy did not cover the cost of installing the connection or the cost of water consumed. To pilot-test the program, a door-to-door awareness campaign was conducted in early 2008 among 434 households, randomly chosen from the 845 that needed a connection. Those households received information about the credit offer as well as help with the administrative procedures needed to apply for the credit. The remaining households (the comparison group) were eligible to apply for a connection on credit if they wanted to, but they received neither individualized information nor procedural assistance.

We find that households are willing to pay a substantial amount of money to gain access to a private tap at home: by August 2008 (6 months after the information campaign), 69% of households in the treatment group had purchased a connection (against 10% in the control group), and as a result their average monthly water bill doubled, from 73 to 143 Moroccan dirhams (MAD), or US\$9 to \$18 a month.<sup>2</sup> The quality of water was unchanged, since public taps are also maintained by Amendis and the water flowing into public or private taps comes from the same source. There was, however, a large increase in the quantity of water consumed, which some have argued could be as important for health as quality (Esrey et al. (1991). Despite this change in water quantity, we find no change in the incidence of water-borne diseases, such as child diarrhea. This confirms the meta-analysis results by Fewtrell and Colford (2004).

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<sup>2</sup> The cost at baseline was non-zero because some household were purchasing water from their neighbors.

In contrast, the connection generated important time gains. This time gain did not lead to increases in labor market participation, income, or schooling attainment. Rather, the spared time was used for leisure and socializing time. The private connection reduced the risk of conflict or ill-feelings between neighbors. Overall, despite the financial cost, we observe that households' mental well-being improves substantially when they get connected to the water system. These results echo those of Cattaneo et al. (2009), showing that a program in Mexico replacing dirt floors by cement floors significantly improved adult welfare, as measured by increased satisfaction with their housing and quality of life. However, Cattaneo et al. (2009) find that cement floor also improve child health, and they hypothesize that it may be a source of the increase in happiness.

Given the important change in well-being we observe among households in the treatment group, a natural question is whether the experience of these households encouraged their neighbors or social contacts to also invest in a home water connection. By August 2009 (18 months after the awareness campaign had taken place among treatment households), the fraction of control households that had applied for a connection had risen to 27% (from 10% a year earlier). To test whether this rise can be attributed to social diffusion effects, we exploit the random variation in the density of households sampled for the "treatment". Among control households that had at least one other study household within 20 meters of their house, holding the number of study households within that radius constant, we find that those who had at least one treatment household within 20 meters were 18 percentage points more likely to have bought a water connection by August 2009 than those who did not have any treatment households within 20 meters. This difference is significant at the 5% level, and suggests important social diffusion effects.

To our knowledge, this paper provide the first experimental estimates of the effect of providing households with the option to connect to the piped water system, in contrast with only providing public taps, arguably a cheaper way to ensure everyone has access to safe drinking water. Improving access to safe drinking water and basic sanitation is one of the Millennium Development Goals, and accordingly, many initiatives in the developing world, such as the "National Initiative for Human Development" in Morocco, are planning or in the process of increasing access to safe drinking water by helping poor households get connected to piped water. Our results suggest that such initiatives, while they may not improve child

health, can have substantial welfare effects at relatively low public cost, since households are willing to pay for them. Our findings also suggest that access to credit, rather than costs, may be a significant barrier to improvement in household infrastructure. Overall, our results suggest that access to credit can enable households to invest in substantial quality-of-life improvements that can significantly improve welfare, even if they do not result in income gain.<sup>3</sup>

## **2. Research Design**

### **2.1. Amendis's BSI program**

Amendis is a public-private partnership responsible for the management and operation of public services such as potable water, sanitation and electricity distribution networks in the city of Tangiers.

One of Amendis's mandates is to increase access of low income households to basic infrastructure. As such, Amendis' created a program called "Social Home Connections" (in French, "Branchements Sociaux Individuels" or BSI), which allows low income households to buy a connection to the water and sanitation network *on credit*. The price of a connection is a function of the works required to install a pipe from the network to the home entrance, and it is typically at least 3,500 MAD (around US\$500), a relatively important lump sum that many households without access to formal credit cannot pay upfront. The BSI program offered interest-free credit to households in Tangiers' inner city interested in getting a connection. Households have to repay the credit over a period of 3, 5 or 7 years (depending on the cost of their connection) at a monthly rate of 105 MAD or \$15.

### **2.2. Sampling Frame**

Using detailed maps of the city of Tangiers, and merging them with information on existing water connections registered in the Amendis database, we first identified 4,600 "plots" that did not seem connected to the city water system but that fell within the three zones that Amendis had delineated for the BSI program. A team of surveyors inspected these plots and carried out a quick survey to estimate their eligibility. Eligibility required that (1) the plot was

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<sup>3</sup> This finding is consistent with that of Banerjee, Duflo, Glennerster and Kinnan (2009), who find that, in India, households use microcredit loans to purchase assets for their homes more often than to start a new business.

indeed not already connected to a water network (12% of plots did not meet this criteria); (2) the plot was used for residential purposes (25% plots were excluded because they were empty, and 14% were excluded because they were used for commercial purposes); (3) the plot hosted the main residence of at least one owner or non-paying family occupant (20% of plots were excluded because they were occupied by tenants).

Our final sample includes 845 households residing on 732 plots. These plots host relatively small houses, with a surface below 100 square meters for 96% of the houses. Most plots were inhabited by only one household (79% of plots), but 15% included two households, and 6% of plots included three or more households. Close to 60% of households relied on the public tap as their main source of water. The rest were getting their water from a neighbour (either directly through a hose, or by filling in containers), in which case they shared the water bill with them.<sup>4</sup>

### **2.3. Experimental Design**

Households in the sample were randomly assigned to a “treatment” and a “control” group. The “treatment” consisted of an information and marketing campaign about the BSI program, along with assistance in preparing the application. The three main hurdles in the application process were the following: obtaining an authorization from the local authorities, providing photocopies of important identification documents, and making a down payment at the branch office. We simplified these procedures radically for households in the treatment group, by obtaining pre-approval from the authorities, making digital copies of their identification document (with cameras), and bringing a branch officer to their home to collect the payment. Thus, control households could have obtained a connection (some did), but they would have to be aware of the new program, and manage all the paperwork.

Since part of the strategy relied on differential access to information, in order to avoid assigning immediate neighbours to different treatment, the assignment of households to the treatment and control groups was done after clustering by location. But we also wanted to be able to test for the presence of “post-connection” spillovers, e.g. to test whether non-connected households who interact with newly connected households are more likely to apply for a connection. For this reason, the randomization was done at an intermediate cluster level:

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<sup>4</sup> More summary statistics are presented in Table 1.

neither at the household level, nor at the water source level, but at what we could call the “block level”.

Specifically, the 732 plots in the sample were grouped in "clusters" as follows: two adjacent plots, or two plots facing each other on the street or up to 1 house apart, were considered part of the same cluster. In total, this method generated 626 clusters. These clusters then randomly assigned to one of the two following groups: the treatment group (315 clusters, including 372 plots and 434 households) and the control group (311 clusters, including 360 plots and 410 households). These clusters are sufficiently close to each other that the information can probably flow from one cluster to the next. In section 6, we study the diffusion of the information on the water connection to geographic neighbours who were not directly targeted by the intervention.

The random allocation of clusters between treatment and control groups was stratified by location, water source, the number of under- children, and number of households within the cluster.

As shown in Figure 1, this randomized encouragement design led to a very strong first stage. By August 2008, 7 months after the initiation of the encouragement for the treatment group, 298 (68.7%) of the 434 households in the treatment group had gotten connected to the water system. In contrast, only 40 out of 411 households in the control group (9.7%) were connected. On average, households received the water connection 25 days after completing their application and submitting their file.

### **3. Data**

#### **3.1.Data Collection**

##### ***Baseline Household Survey***

A baseline survey was administered in August 2007. It included modules on socioeconomic characteristics, work and work-related conditions, health, hygiene practices, water collection, storage and treatment practices, social networks, as well as a time use survey for the female head and the main child in charge of fetching water. In addition, for a random subsample of households, the drinking water was tested for levels of chlorine and the presence of the fecal coliform bacteria *E coli*.

***Incidence of illnesses: daily follow-up via « illness calendars »***

We carried out an initial month-long survey in December 2007 to estimate the occurrence of illnesses among children (diarrhea, fever and vomiting) and to collect data on their schooling (registration in school, presence at school and time allocation to homework). Data collection of this type requires multiple successive visits to the households in order to record an evolution in the occurrence of illnesses.

As these questions only concern children under the age of 15 years, the daily health-schooling follow-up took place only with 437 households who had declared having children in this age bracket at the time of the initial survey.

In each household, a first visit was made to distribute the “illness calendars” (the calendar is presented in Appendix). The adult identified as the primary caretaker of the children (the mother in most of the cases) would then fill out the calendar each day, and mark with crosses the occurrence of fever, vomiting or diarrhea attacks. The calendar had been designed in such a way that even an illiterate person would be able to fill it out.

At the end of each of the 4 weeks of the survey, a surveyor visited the households to collect the week’s information and, if necessary, complete and correct the calendar tables for that week. Information on schooling was only collected in the final week of the survey.

Treatment and control households with children under the age of 15 years participated in a follow-up survey in the months of May, August and November 2008. During each of these three months, the households filled an “illness calendar” with the regular help of a surveyor. The calendar was identical to the one used in the initial survey of December 2007 and recorded the occurrence of fever, vomiting and diarrhea attacks for children. Each week, the surveyors collected the calendars for the week gone by, which they verified and corrected in case of a mistake.

During the surveys of May and November 2008, the surveyors also asked questions related to children’s schooling on each of their weekly visits. For children enrolled in school, they noted the number of days of school attendance during the week and the time spent on homework in the last two days.

### ***Endline Household Survey***

A final survey, similar to the initial survey, was carried out in August 2008, 4 months after the end of the information and marketing campaign, and on average, 5 months after the installation of household connections for the treatment group.

Height, weight and arm circumference measurements of children under 7 years were taken as part of the endline survey. In addition, new drinking water samples were collected to measure the level of chlorine and detect the presence of *E coli*.

Among the 845 households who participated in the baseline survey, only 794 households (94%) could be resurveyed. Attrition was due to the following: around 2% of the baseline household had moved house, without leaving behind their new address. 2% refused to answer, despite repeated efforts made by the surveyors. The remaining 2% consisted of households who were absent (on vacation, Hajj pilgrimage etc), or households who no longer existed due to the death of their sole member.

### **3.2.Data Quality Assurance**

To obtain truthful information from households and to avoid creating any desirability bias in the “treatment” group, the data collection efforts were completely separated from the BSI program implementation itself. Namely, the staff that conducted the information campaign and assisted households in the treatment group with their connection application was completely different from the team of enumerators that administered surveys. We obtained a waiver of informed consent from the IRB in order to not be obligated to disclose the full design of the study to the participants until the very end.<sup>5</sup> This also enabled us to ensure that the survey team *did not know* about the research team’s relationship with the BSI program.

## **4. Results: First Stage**

### ***4.1. Verifying Randomization***

Table 1 presents summary statistics for households in the sample, separately for the control and treatment groups. We also show the difference between the means of the two groups and

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<sup>5</sup> At the end of the study, we fully informed all participants about the study, and asked them for informed consent to let us use the data collected from them over the previous two years.

report the p-value of a test of the null hypothesis that they cannot be distinguished from each other.

Overall, households in the two groups are extremely similar. Out of 57 differences shown in Table 1, only 4 are significantly different from zero at the 10% level and only 2 are significant at the 5% level, as should be expected.

As mentioned above, at baseline 58% of households used the public tap as their main source of water. Of those, 22% (13% of the total) lived sufficiently close to the public tap to use a hose to fill their water containers at home. The remainder (45% of our sample) had to take their containers to the public tap. On average, those households who carried containers to and back from the public tap lived 240 meters away from the closest public tap. At baseline, they reported filling 55 containers per week. The average time spent fetching water was around 7.5 hours for these households. Water collection trips are common among both men and women, but done mostly by adults: while households do more than 7 trips per week to the public tap, less than one trip per week is done by a child under 15.

#### ***4.2. The Demand for Private Taps: Take-up of the BSI credit offer***

By August 2008 (four months after the end of the marketing campaign), 298 (68.7%) of the 434 households in the treatment group had gotten connected to the water system. In contrast, only 40 out of 411 households in the control group (9.7%) were connected.

Among households in the treatment group who did not get connected to the water system, the most commonly cited reasons for refusing the BSI offer were the following: *inability to pay*, especially for households with just one member, who was typically an elderly person; *inheritance problems* (namely refusal by other heirs to the house applying for the water connection; plans to move out); *plans to move out*; and, finally, *access to running water* obtained from a neighbor with a water connection.<sup>6</sup>

Households that got connected had to install taps inside their house. 27% installed only one tap (typically in the bathroom or in the kitchen), 32% installed two taps, and 24% installed three taps. Only 17% installed more than three taps. In August 2008, only 2% of treatment

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<sup>6</sup> The installation of a new water meter would have allowed a more just distribution of costs between neighbors. It would also help households sharing a water connection save money (due to the system of subsidized consumption brackets) but these advantages would have mainly benefited households that were already connected, and not those that needed to pay for a new water meter.

households that got a connection reported selling water from their tap to neighbours, and 7% reported having given water to neighbours in the previous 7 days.

## 5. Results: Effects of the water connection

The effect of access to water is estimated through two parameters of interest. First the effect of being assigned to the treatment group, examined for each outcome using the following specification:

$$Y_i = \alpha_1 + \beta_1 Treated_i + X_i \varphi_1 + \varepsilon_{i1}$$

where  $Treated_i$  is equal to 1 if the household has received the encouragement and is equal to 0 otherwise and  $X_i$  is a vector of households and respondents characteristics. By construction, random assignment ensures us that  $E(\varepsilon_{i1} | X_i, Treated_i) = 0$ .

Secondly, we are interested in evaluating the average effect of actually having a connection on each outcome. This is estimated with the following specification:

$$Y_i = \alpha_2 + \beta_2 Connected_i + X_i \varphi_2 + \varepsilon_{i2} ,$$

where  $Connected_i$  (equal to 1 if the household is connected to the water system and equal to 0 otherwise) is instrumented with  $Treated_i$ , being assigned to the treatment group, such as  $Connected_i = \pi + \vartheta Treated_i + X_i \sigma + \eta_i$ . For all specifications, standard errors are clustered as the plots were grouped in clusters when they were located close to each other.

All results presented from Table 2 to Table 9 in appendix display the two parameters of interest.

### 5.1. Quality and Quantity of water used

The impact of the BSI offer on the quality and quantity of water used is analyzed in Table 2. We find no effect of getting connected to the water system on the main indicator of the quality of drinking water, the level of fecal bacteria *E coli* detected (column 1,2) even though there is a positive effect on the chlorine level with a 15 points increase for the treatment households (column 3,4). These results suggest not only that the quality of water coming from public taps is high but also that there is no contamination during the transport of water carried home and from the way the water is stored.

While there is no effect on the quality of drinking water, getting connected seems to lead to a substantial increase in the quantity of water available. Households in the treatment group are 20 percentage points more likely to report having enough water for bathing (the mean in the control group is 67%) and 16 percentage points more likely to report having enough water for cleaning. The IV estimates suggest that water shortages are completely eliminated for households that get connected. Finally, respondents in the treatment group report increasing their frequency of baths and showers: the number of times respondents in the treatment group had a bath or shower at home during the last 7 days is 18% (0.51/2.74, Panel B column 9) higher than in the control group.

## **5.2. Costs**

Table 3 estimates the impact of the BSI offer on the time and financial costs experienced by households. Overall, we find that home connections generate a substantial time gain for their beneficiaries, but at the same time generate a substantial financial cost since households now have to pay for their water as well as repay the BSI credit.

Columns 1 to 8 of Table 3 show that the connection considerably reduced the number of water fetching trips in the treatment group. The time spent fetching water reduced from 1053 minutes to 178 minutes on average. The effect on the treated is larger, with a reduction to essentially zero. This result is more interesting than it seems. While water at public taps is free, households have to pay for the water that is piped directly to their home. Therefore one of the concerns at the time the BSI program was designed was that people would keep using the public tap and limit their private tap usage, in order to limit the size of their water bill. We find little supporting evidence for this.

The spared time comes at a cost. First, households had to pay a relatively large fixed cost to get connected (column 9 and 10). Second, once connected, households have to pay both their monthly water bill and their monthly installment. Overall, the IV estimates suggest that the average monthly water costs more than doubled, from 73 to 192 Moroccan dirhams (MAD), a jump from US\$ 9 to 24 (Table 3, columns 11-12).<sup>7</sup>

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<sup>7</sup> By August 2009, the water company reported that 34% of treatment households were late in paying at least one credit installment. This is despite the fact the BSI credit is interest free. This suggests that the financial cost associated with the connection is not a trivial issue for this population.

### **5.3. Health**

The major result arising from the analysis of our health data is the absence of any systematic positive effect of the program on health of either children or adults. The data on the incidence of water-related illnesses (diarrhea (shown in Table 4), vomiting, or fever) collected through detailed health diaries show no significant pattern. The addition of various control variables does not change the results. We collected data on two other water-related illnesses (skin and eye infections among adults and children, and digestive problems for adults), but also find no effect of the treatment on any of these, for any age groups (data not shown but available on request). We also do not find any effect when we look at the number of medical visits reported at endline (data not shown).

The lack of effects on health is probably due to the fact that the households already had access to good quality water as well as good access to sanitation. Most households reported using the Amendis sanitation system to discharge used water and 95% reported having a toilet at home.

Nevertheless, positive effects could have been expected from the improvement in quantity and the corresponding increase in the washing frequency of households' members. The fact that we find no health effects despite the effect on quantity suggest that water quantity, alone, plays at best a small role in health.

### **5.4. Time Use**

As shown earlier, the connection generated large time gains for households who no longer needed to spend time fetching water. Four months or more after they got connected, these time gains were still very salient for households. Table 5 presents estimates of respondents' self perception of time availability. When asked to compare their current situation with that a year before, respondents in the treatment group reported significantly more gains in time for daily activities such as shopping, housework, going to the market or watching television than the control group (column 1 to 6). Respondents in the treatment group also reported having gained comparatively more time to engage in social activities, such as visiting or receiving the visit of family or friends, or simply spending time with other members of their households (columns 7 to 18).

Table 6 presents estimates of the respondents' actual use of time. On most leisurely activities, the effects are positive but insignificant. When we combine the estimates (using seemingly

unrelated regressions), the average effect on leisure and social activities becomes positive and significant.

Table 7 presents results on two other time categories: labor market participation and schooling participation. Data on labor market participation comes from the question: “did this person engage in an income generating activity in the past 30 days”, which was asked at endline to the main respondent (typically the female head of the household) about each household member. If the answer was yes, we then asked the income gained over the past 30 days. The data on schooling participation presented in columns 11-14 also comes from the endline: school completion is a dummy equal to 1 if a boy or a girl completed the school year in June 2008 (the endline was administered in between two academic years). We also collected detailed school absenteeism data through the use of diaries (similar to the health diaries).

Overall, the results are very clear: the time gained with the water connection had absolutely no impact on productive activities, as measured in Table 7. Table 7 shows no increase in the probability that either male or female heads in treatment households participate in the labor market. As a result, the program had no effect on income (although our income data is extremely noisy and the standard errors are extremely large, even with trimming). While it is possible that the impact of time gains on productive activities might take more than 6 months to be effective and thus was not captured in our endline survey, we also cannot rule out the possibility that our labor market participation and income data suffer from under-reporting biases. While there is no reason to believe that the under-reporting bias would be correlated with the water connection itself, it has been shown that under-reporting of income increases as income goes up.

Finally, we find no effect on school participation.

### ***5.5. Social Integration***

While getting a home connection might have reduced the opportunities to socialize while fetching water, the overall impact of the treatment on social integration seems to have been positive. Table 8 presents results on various measures of the strength of social ties. The first two columns suggest that the treatment increased the likelihood that households belong to a social group. While overall participation in social of groups is very rare (only 2% of the control group report participating), it is twice as high in the treatment group. This effect is entirely driven by an increase in the likelihood that households belong to a rotating savings

and credit association (ROSCA). This suggests that some households in the treatment group decided to join such a group after taking on the BSI credit, which requires saving rigor in order to repay the monthly instalments.

In addition, gaining access to a private water connection seems to ease the tensions that surround access to water when people share a public tap, or share a private tap and need to divide water bills among relatives or neighbors. Water is indeed a common source of conflict: at endline, 12% of control households stated that they were in conflict or disagreement with neighbors on water-related problems, and 16% were in disagreement with family members on such issues. Even within the household, both the allocation of the task of fetching water and the allocation of the water at hand among possible uses can be a source of tension. These sources of tensions were almost completely eliminated as a result of the program, as shown in columns 3-4 and 9-10 of Table 8. The ITT estimates show a 70% reduction in the proportion of households in conflict or disagreement with neighbors or relatives on water-related problems, and the IV estimates of a complete elimination of such conflicts for those who got a connection. Note that treatment households are not less likely to report conflicts with respect to matters unrelated to the treatment (property or heritage issues, in columns 5-9 and 11-12), which suggests that the observed decrease in reported conflicts linked to water is not a reporting artefact.

In addition or perhaps as a result of reducing the occurrence of conflicts between family members or neighbors, access to a private water connection seems to also enhance the social status of beneficiary households. Indications of such an effect are presented in columns 13 to 16 of Table 8. They show that the proportion of households entrusted with valuable goods in the last 30 days was 40% higher in the treatment group than in the control group (11% compared to 7%). The connection also increased the likelihood that a household member was consulted on family issues by 23 percentage points, compared to an average of 38 percent in the control group.

### ***5.6. Mental Well-Being***

Overall, the endline satisfaction of households on water-related issues had dramatically improved in the treatment group relative to the control group. Table 9 presents estimates of the effects on several measures of satisfaction. While 65% of control households mentioned water when prompted to list their 5 major sources of concerns, only 22% of treatment households did so. This went down to zero among households that did get connected, as

shown by the IV estimate in Panel B. Similarly, the proportion of households that mention their house is cleaner than it was at the same time a year earlier is nearly three times greater (from an average of 13% of households in the control group to 34% in the treatment group, column 7 and 8). Again, these reported levels are not driven by social-desirability bias: when asked whether the water they have access to now tastes good, treatment households are not more likely to say yes than treatment in the control group. This should be expected since all households have access to same water – the only difference between them is how far that water is from them.

In addition to this higher level of satisfaction with water-related issues, Table 9 also shows that the BSI program, more generally, improved households' perceived quality of life. While only 24% of households in the treatment group report that their life has improved compared to a year ago, this rises to 49% in the treatment (columns 11 and 12). The IV estimates in Panel B suggest an effect on the treated of +44 percentage points, corresponding to almost an 80% increase compared to the control group. Measures of mental health shown in columns 9 to 14 suggest that respondents in the treatment group are less stressed, but the effects are insignificant.

Finally, respondents were asked to rank their satisfaction with life on a scale from 1 to 10. The mean of the ranking for the treatment group (5.61) was slightly above the one of the control group (5.45). The cumulative distribution function of these rankings is presented in Panel A of Figure 2. The distribution for the treatment group appears to dominate the distribution for the control group although a Kolmogorov-Smirnov test does not reject the hypothesis of equality of the two distributions. In contrast, in Panel B, the distributions of rankings for households' satisfaction with their health, an outcome for which we objectively observe no program effect, are virtually indistinguishable from each other, not only statistically, but also by the eye. Once more, this coherence between the self-reported measures and the more objectives measures lend credibility to our estimates of the program effect on social integration, well-being and satisfaction levels, for which we need to rely on self-reports since objective measurements are difficult to come by.

## **6. Spillover effects : Adoption of Piped Water by Control Households**

Given the large positive impacts we observe on the well-being households in the treatment group, a natural question is whether the experience of these households encouraged their

neighbors or social contacts to also invest in a home water connection. By August 2009 (18 months after the awareness campaign had taken place among treatment households), the fraction of control households that had applied for a connection had risen to 27% (from 10% a year earlier). To test whether this rise can be attributed to social diffusion effects, we exploit the random variation in the density of households sampled for the “treatment”.

Specifically, using GIS coordinates, we compute, for each control household, the number of sampled households that live within a given radius, and the number and share of them who were sampled for the treatment. We then regress whether a control household bought a connection on these measures of “exposure” to treated neighbors. We control for the total number of neighbors sampled for the study within each radius, since that is not randomly assigned.

The results are presented in Table 10. They suggest important diffusion effects. For example, among control households that had at least one other study household within 20 meters of their house, holding the number of study households within that radius constant, we find that those who had at least one treatment household within 20 meters were 18 percentage points more likely to have bought a water connection by August 2009 than those who did not have any treatment households within 20 meters (column 5).

## **7. Conclusion**

This paper studies the impact of granting households in urban Morocco the option to purchase a private connection to the water system on credit. We find that the demand for individual house connections is high, with 68% of households taking on a 5- or 7-year loan to get connected. After six months, this investment turned out to have important private returns. While it freed up a lot of time for household members, it did not generate increases in labor market participation and income, but it led to important improvements in quality of life and welfare. In particular, it increased reported happiness and social integration. While the private returns are high, the public health returns seem low, if not nonexistent. In the study context, home connections do not reduce the incidence of waterborne diseases compared to the existing system of public taps. This lack of health effect suggests that investing public funding in expanding access to home connections might not be justified from a public finance

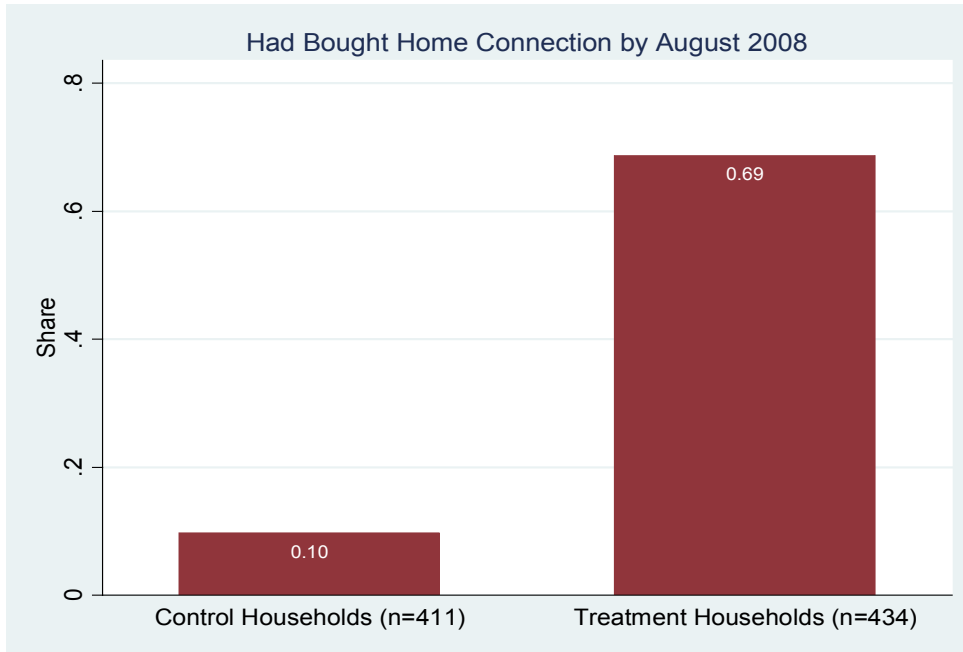
standpoint. However, the high private returns and high observed willingness to pay suggests that relaxing credit constraints for poor households might be sufficient to generate important private investments in water connections.

#### 4 References

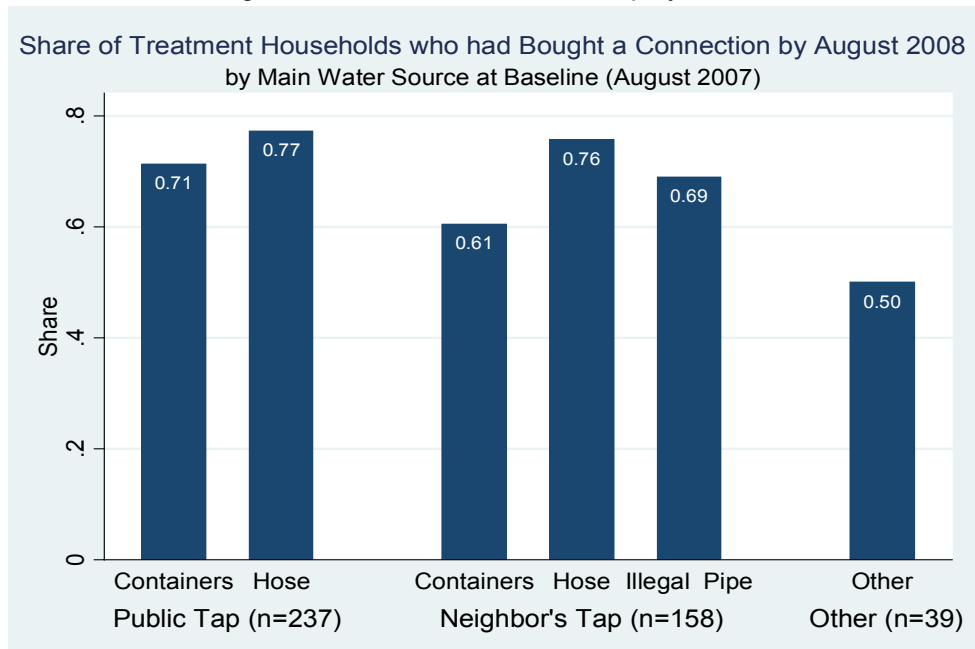
- Banerjee, Abhijit, Esther Duflo, Rachel Glennerster and Cynthia Kinnan (2009). “The Miracle of Microfinance ? Evidence from a Randomized Evaluation”, unpublished manuscript.
- Cattaneo, Matias D., Sebastian Galiani, Paul J. Gertler, Sebastian Martinez, and Rocio Titiunik (2009) “Housing, Health, and Happiness.” *American Economic Journal: Economic Policy*, 1(1): 75–105.
- Esrey, S.A., J.B. Potash, L. Roberts, and C. Shiff, “Effects of improved water supply and sanitation on ascariasis, diarrhea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma”, *Bulletin of the World Health Organization*, 69(5), 1991, pp. 609-621.
- Fewtrell, Lorna, and John M. Colford, “Water, Sanitation and Hygiene: Interventions and Diarrhea. A Systematic Review and Meta-analysis”, HNP Discussion Paper, World Bank, July 2004.
- Galiani, Sebastien, Paul Gertler and Ernesto Schargrotsky (2005). “Water for life: The impact of the privatization of water supply on child mortality”. *Journal of Political Economy*, Volume 113, pp. 83-120.
- Gamper-Rabindran, Shanti, Shakeeb Khan and Christopher Timmins (forthcoming). “The Impact of Piped Water Provision on Infant Mortality in Brazil: A Quantile Panel Data Approach,” *Journal of Development Economics*.
- Kremer, Michael, Jessica Leino, Edward Miguel and Alix Zwane (2009). “Spring Cleaning: Rural Water Impacts, Valuation and Institutions”, unpublished manuscript.
- Merrick, Thomas W. “The Effect of Piped Water on Early Childhood Mortality in Urban Brazil, 1970 to 1976”, *Demography*, 22(1), February 1985, pp. 1-24.

**Figure 1. First Stage: Impact of the Encouragement Design**

Panel A. Fraction of Households that Bought a Connection



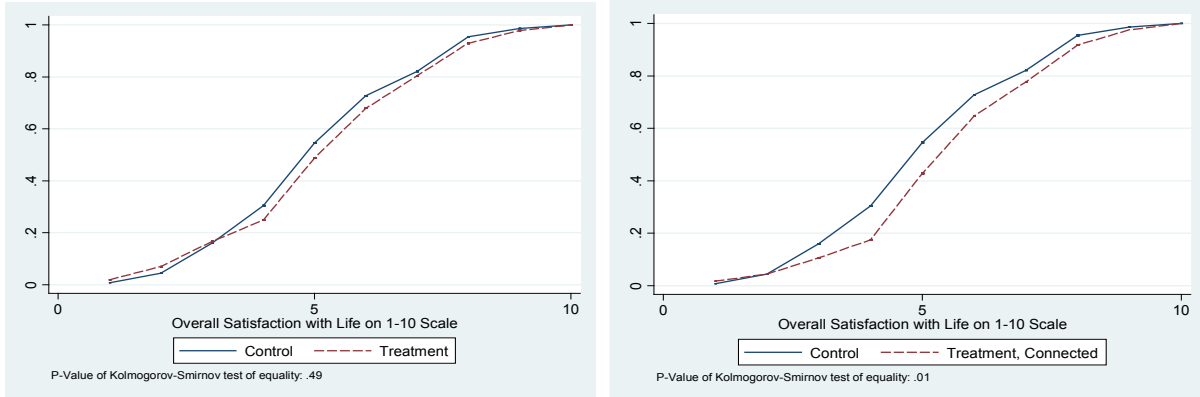
Panel B. Among Treatment Households: Take-up by Baseline Water Source



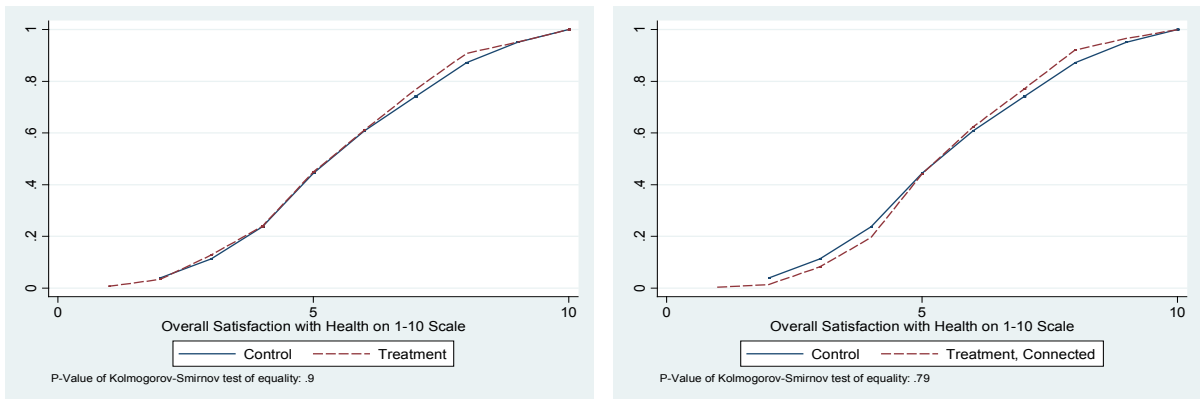
Notes: Data on connection status collected in August 2008. No household had a connection to the piped water system at baseline (August 2007). The encouragement intervention took place between February and April 2008.

**Figure 2. Subjective Assessment of Life Quality at Endline**

**Panel A. Life Satisfaction**



**Panel B. Health Satisfaction**



**Table 1: Summary Statistics**

	Comparison Households		Treatment Households		Diff	P-value Treatment = Control	Obs.
	Mean	Sd	Mean	Sd			
<u>Household composition</u>							
Household size	4.55	2.54	4.74	2.47	0.19	0.272	840
Number of members 15 or older	3.23	2.03	3.41	2.01	0.19	0.187	836
Number of female members 15 or older	1.61	1.17	1.61	1.15	0.00	0.980	835
Number of members under 15	1.14	1.45	1.21	1.34	0.07	0.446	832
Number of female members under 15	0.54	0.86	0.62	0.86	0.08	0.169	832
Number of children under 5	0.40	0.73	0.43	0.70	0.02	0.675	831
Is this an extended family?	0.23	0.42	0.23	0.42	0.00	0.966	832
<u>Head of the household</u>							
Male head	0.74	0.44	0.79	0.41	0.05	0.122	831
Head's age	50.90	15.00	49.63	14.02	-1.27	0.217	799
Head married	0.66	0.48	0.69	0.46	0.04	0.233	831
Head has no education	0.46	0.50	0.43	0.50	-0.03	0.438	831
Head has 1 to 6 years of education	0.39	0.49	0.41	0.49	0.02	0.528	831
<u>Household members involved in economic activities</u>							
Number of adults, in past 30 days	1.07	0.97	1.16	0.95	0.09	0.193	831
Number of children, in past 30 days	0.01	0.10	0.00	0.05	-0.01	0.158	831
<u>Socio-economic status</u>							
Number of rooms in the house	3.20	1.34	3.31	1.46	0.11	0.251	838
Income index	4.21	2.52	4.42	2.50	0.21	0.256	759
Assets index	-0.14	1.96	-0.07	1.97	0.07	0.596	842
<u>Hygiene and health</u>							
Index of knowledge of causes of diarrhea	1.25	1.09	1.23	1.12	-0.02	0.784	842
Ranking of own's health	6.58	2.50	6.38	2.33	-0.20	0.248	806
Expenditures for individual hygiene	67.33	78.03	74.03	95.21	6.70	0.297	745
Expenditures for house cleaning	57.28	100.74	74.23	90.53	16.95	0.011	838
Number of times respondent bathed in previous 7 days	4.27	3.77	4.30	3.27	0.02	0.923	818
Number of times respondent washed hands yesterday	2.84	1.50	2.97	1.60	0.13	0.237	837
Index of cleanness of the house (surveyor's observation)	0.67	0.20	0.66	0.19	-0.01	0.516	623
<u>Social insertion</u>							
Participation of the respondent to a group	0.05	0.22	0.06	0.23	0.01	0.690	837
Total number of activities with others listed	0.38	0.68	0.41	0.68	0.02	0.617	845
Total number of friends listed when asked for 5 names	1.73	1.41	1.86	1.47	0.14	0.169	845
Has someone to talk to about one's problems	0.67	0.47	0.71	0.46	0.03	0.290	831
Satisfaction level with one's life (on a scale from 1 to 10)	8.38	17.28	7.08	12.84	-1.30	0.214	839
<u>Water and storage</u>							
Are you storing water right now?	0.82	0.38	0.85	0.36	0.03	0.308	838
In how many containers are you storing water?	3.72	4.33	3.58	3.62	-0.14	0.618	840
Do you treat the water?	0.07	0.25	0.05	0.21	-0.02	0.217	706
Presence of chlorine in water sample	0.56	0.50	0.63	0.49	0.07	0.290	250
<u>Water Source and Collection</u>							
Main water source = public tap, using containers	0.45	0.50	0.42	0.49	-0.04	0.289	797
Main water source = public tap, using hose	0.13	0.34	0.16	0.37	0.03	0.257	797
Main water source = neighbor's tap, using illegal pipe	0.22	0.42	0.21	0.41	-0.01	0.770	797
Main water source = neighbor's tap, using hose or containers	0.17	0.37	0.17	0.38	0.01	0.794	797
Distance to the public tap (in meters, self-reported)	212	284	252	414	41	0.220	467

*continued next page*

**Table 1: Summary Statistics (continued)**

	Comparison Households		Treatment Households		Diff	<i>P</i> -value Treatment = Control	Obs.
Time spent fetching water over the past 7 days (minutes)	233	420	228	482	-5	0.886	824
Time spent in social activities while fetching water over the past 7 days (min)	8.2	44.1	7.6	37.9	-0.6	0.845	822
# of Containers filled with water over the past 7 days	35.4	53.0	34.2	50.9	-1.2	0.745	824
Volume of water consumed over the past 7 days (liters)	334	591	385	816	51	0.309	821
Payment made to get water over the past 7 days (dirhams)	20.05	70.67	19.79	55.88	-0.26	0.95	829
Number of times a child (< 15) fetched water in the past 3 days	0.53	2.09	0.48	1.88	-0.05	0.729	841
Number of times a grown-up (>= 15) fetched water in the past 3 days	3.68	5.23	3.87	6.06	0.19	0.623	841
Number of times a male fetched water in the past 3 days	1.86	3.56	2.35	4.86	0.50	0.094	841
Number of times a female fetched water in the past 3 days	2.35	4.91	2.00	4.29	-0.35	0.271	841
<i>Households with main source of water = public tap, using containers</i>							
Distance to the public tap (in meters, self-reported)	239	306	305	377	66	0.081	332
Time spent fetching water over the past 7 days (minutes)	445	533	481	657	37	0.575	331
Time spent in social activities while fetching water over the past 7 days (min)	5.6	26.5	7.8	35.5	2.3	0.512	329
# of Containers filled with water over the past 7 days	55.3	53.9	53.3	50.3	-2.0	0.733	331
Volume of water consumed over the past 7 days (liters)	361	336	433	467	72	0.107	328
Payment made to get water over the past 7 days	4.42	39.06	2.08	10.37	-2.34	0.458	336
Number of times a child (< 15) fetched water in the past 3 days	0.78	2.30	0.90	2.54	0.12	0.654	346
Number of times a grown-up (>= 15) fetched water in the past 3 days	6.91	6.14	7.42	7.52	0.52	0.486	346
Number of times a male fetched water in the past 3 days	3.40	4.22	4.74	6.35	1.34	0.021	346
Number of times a female fetched water in the past 3 days	4.29	6.50	3.58	5.77	-0.71	0.284	346

*Notes: Household averages collected during baseline survey (August 2007).*

**Table 2: Impact on Water Quality, Water Quantity, and Hygiene**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Quality of Drinking Water				Water Quantity				Hygiene			
	Number of <i>E Coli</i> detected in drinking water		Chlorine detected in drinking water		HH reports having enough water for bathing		HH reports having enough water for cleaning		Number of baths or showers taken at home in the past 7 days?			
									Respondent		Youngest Child <16 (if any)	
<b>Panel A. ITT</b>												
Treatment	3.07 (2.98)	1.92 (3.47)	0.15 (0.06)***	0.15 (0.06)**	0.20 (0.03)***	0.26 (0.04)***	0.16 (0.03)***	0.20 (0.04)***	0.31 (0.16)*	0.22 (0.18)	-0.03 (0.24)	0.02 (0.28)
Treatment X Illegal pipe linked to neighbor's tap		1.84 (7.01)		-0.11 (0.14)		-0.21 (0.05)***		-0.17 (0.05)***		0.31 (0.45)		-0.22 (0.56)
Primary water source at baseline was an illegal pipe linked to neighbor's tap		-2.70 (4.26)		0.09 (0.09)		0.29 (0.05)***		0.23 (0.05)***		-0.30 (0.29)		-0.10 (0.42)
Number of children under 15 at baseline		0.68 (1.17)		-0.01 (0.02)		0.03 (0.01)***		0.04 (0.01)***		0.22 (0.07)***		0.13 (0.10)
Quintile in asset distribution		-1.69 (0.84)**		0.02 (0.02)		0.01 (0.01)		0.00 (0.01)		0.12 (0.05)**		-0.20 (0.08)**
Quantity of water consumed the week before baseline (liters/1000)		0.08 (0.16)		0.01 (0.01)		0.00 (0.00)*		0.00 (0.00)		0.00 (0.01)		0.02 (0.01)*
Distance to public tap (meters/100)		-0.46 (4.70)		-0.10 (0.11)		-0.06 (0.06)		-0.03 (0.06)		-0.66 (0.30)**		-0.69 (0.46)
Observations	375	345	375	349	797	730	796	729	794	728	446	424
R-squared	0.00	0.01	0.02	0.03	0.06	0.13	0.04	0.11	0.00	0.04	0.00	0.03
Mean in Control Group	10.38	10.38	0.43	0.43	0.67	0.67	0.71	0.71	2.74	2.74	3.66	3.66
<b>Panel B. IV</b>												
Connected	4.82 (4.69)	2.86 (5.13)	0.23 (0.09)***	0.23 (0.09)**	0.33 (0.05)***	0.40 (0.06)***	0.27 (0.05)***	0.31 (0.05)***	0.51 (0.27)*	0.33 (0.27)	-0.04 (0.35)	0.02 (0.38)
Connected X Illegal pipe linked to neighbor's tap		3.03 (11.07)		-0.15 (0.22)		-0.30 (0.09)***		-0.24 (0.09)***		0.67 (0.84)		-0.41 (1.00)
Primary water source at baseline was an illegal pipe linked to neighbor's tap		-3.40 (5.34)		0.11 (0.12)		0.32 (0.06)***		0.26 (0.05)***		-0.41 (0.37)		-0.02 (0.57)
Number of children under 15 at baseline		0.56 (1.22)		-0.02 (0.02)		0.01 (0.01)		0.03 (0.01)**		0.20 (0.07)***		0.13 (0.10)
Quintile in asset distribution		-1.81 (0.86)**		0.01 (0.02)		-0.01 (0.01)		-0.01 (0.01)		0.10 (0.06)*		-0.20 (0.08)**
Quantity of water consumed the week before baseline (liters/100)		0.08 (0.17)		0.01 (0.01)		0.00 (0.00)*		0.00 (0.00)		0.00 (0.01)		0.02 (0.01)*
Distance to public tap (meters/100)		-0.53 (4.70)		-0.10 (0.11)		-0.06 (0.06)		-0.03 (0.05)		-0.66 (0.30)**		-0.69 (0.46)
Observations	375	345	375	349	797	730	796	729	794	728	446	424
R-squared	10.38	10.38	0.43	0.43	0.18	0.26	0.16	0.22	0.03	0.05	0.00	0.03

Notes: Clustered standard errors in parentheses. Columns 1-4: Water quality tests were performed on a random subsample of participating households.

IV specification: "Connected" instrumented with "Treatment"

**Table 3: Impact on Time and Financial Costs**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Number of times a child (< 15) fetched water in the past 3 days		Number of times a grown-up(>= 15) fetched water in the past 3 days		Minutes Spent Fetching Water in the past month		Minutes Spent Socializing while Fetching Water in the past month		Fixed Water Costs paid by Household in past year (dirhams)		Monthly water expenditures (in dirhams)	
<b>Panel A. ITT</b>												
Treatment	-0.82 (0.29)***	-1.08 (0.37)***	-2.44 (0.30)***	-2.86 (0.30)***	-874.36 (136.91)***	-1191.66 (180.02)***	-32.47 (16.65)*	-42.95 (22.19)*	70.67 (16.91)***	69.81 (14.26)***	397.75 (41.81)***	456.67 (51.41)***
Treatment X Illegal pipe linked to neighbor's tap		1.13 (0.40)***		2.09 (0.65)***		1033.37 (216.57)***		41.03 (19.79)**		6.75 (68.15)		-170.64 (88.32)*
Primary water source at baseline was an illegal pipe linked to neighbor's tap		-1.09 (0.34)***		-2.27 (0.59)***		-965.33 (178.35)***		-63.43 (31.28)**		80.29 (24.45)***		-40.69 (51.31)
Number of children under 15 at baseline		-0.07 (0.11)		-0.11 (0.09)		-33.62 (48.67)		5.19 (8.85)		17.27 (5.32)***		48.98 (15.83)***
Quintile in asset distribution		0.42 (0.23)*		-0.28 (0.08)***		110.00 (80.75)		6.01 (6.58)		7.22 (7.19)		6.27 (12.23)
Quantity of water consumed the week before baseline (liters/100)		0.00 (0.01)		0.00 (0.01)		11.78 (11.13)		-0.19 (0.41)		3.30 (2.05)		2.65 (4.25)
Distance to public tap (meters/100)		1.02 (0.80)		0.51 (0.58)		725.47 (421.35)*		-12.22 (21.36)		-29.62 (15.01)**		-58.32 (60.83)
Observations	457	433	793	727	797	730	797	730	848	733	848	733
Mean in Control Group	0.03	0.10	0.08	0.16	0.06	0.12	0.01	0.01	0.02	0.06	0.13	0.16
<b>Panel B. IV</b>												
Connected	-1.25 (0.44)***	-1.51 (0.51)***	-4.05 (0.50)***	-4.37 (0.45)***	-1453.08 (229.01)***	-1817.97 (275.60)***	-53.96 (27.55)*	-65.53 (33.57)*	119.09 (27.10)***	106.95 (21.00)***	670.28 (56.28)***	700.09 (64.69)***
Connected X Illegal pipe linked to neighbor's tap		1.58 (0.58)***		2.81 (1.18)**		1478.24 (357.07)***		60.43 (28.60)**		40.08 (125.08)		-144.00 (133.37)
Primary water source at baseline was an illegal pipe linked to neighbor's tap		-1.30 (0.41)***		-2.52 (0.76)***		-1115.54 (217.10)***		-69.90 (33.89)**		70.20 (31.82)**		-46.55 (48.99)
Number of children under 15 at baseline		-0.02 (0.11)		0.06 (0.09)		34.37 (47.89)		7.58 (9.96)		12.29 (5.29)**		19.56 (13.73)
Quintile in asset distribution		0.42 (0.23)*		-0.14 (0.08)*		166.68 (82.90)**		7.97 (7.46)		2.29 (8.30)		-21.14 (10.93)*
Quantity of water consumed the week before baseline (liters/100)		0.00 (0.01)		0.01 (0.01)		12.88 (11.05)		-0.15 (0.42)		3.28 (2.04)		2.30 (4.22)
Distance to public tap (meters/100)		1.17 (0.83)		0.58 (0.59)		748.71 (423.53)*		-11.40 (21.23)		-31.25 (15.36)**		-68.31 (49.61)
Observations	457	433	793	727	797	730	797	730	848	733	848	733

Notes: Standard errors clustered at the "cluster" level

IV specification: "Connected" instrumented with "Treatment"

**Table 4. Impact on child health: Data from Health Diaries (1 month each)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)		
Average Weekly Number of days with intense diarrhea <sup>†</sup> :												
Children 0 to 6 years old at baseline												
	1st follow-up: Mai 2008			2nd follow-up: Aout 2008			3rd follow-up: November 2008			Average effect over three follow-ups		
<b>Panel A: ITT</b>												
Treatment	0.02 (0.10)	0.05 (0.12)	-0.08 (0.11)	-0.04 (0.12)	-0.06 (0.14)	-0.12 (0.12)	0.10 (0.12)	0.03 (0.11)	-0.03 (0.07)	0.021 (0.072)	-0.027 (0.057)	-0.020 (0.055)
Treatment X Illegal pipe linked to neighbor's tap		-0.17 (0.22)	-0.06 (0.25)		-0.1 (0.29)	0.00 (0.31)		0.14 (0.31)	0.32 (0.35)			
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
Control for # of Intense Diarrhea days observed in baseline diary			Yes			Yes			Yes			Yes
Observations	301	283	243	304	286	242	293	275	235			
R-squared	0.03	0.05	0.17	0.01	0.03	0.04	0.07	0.11	0.19			
Mean in Control Group	0.345	0.345	0.345	0.322	0.322	0.322	0.291	0.291	0.291	0.29	0.29	0.29
<b>Panel B: IV</b>												
Connected	0.03 (0.17)	0.09 (0.20)	-0.11 (0.17)	-0.07 (0.21)	-0.09 (0.22)	-0.18 (0.18)	0.16 (0.19)	0.04 (0.17)	-0.06 (0.11)	0.03 (0.12)	-0.04 (0.09)	-0.03 (0.08)
Connected X Illegal pipe linked to neighbor's tap		-0.30 (0.41)	-0.14 (0.46)		-0.22 (0.55)	-0.06 (0.56)		0.27 (0.57)	0.61 (0.67)			
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
Control for # of Intense Diarrhea days observed in baseline diary			Yes			Yes			Yes			Yes
Observations	301	283	243	304	286	242	293	275	235			
R-squared	0.03	0.05	0.16	0.02	0.04	0.04	0.06	0.10	0.17			

Notes: Clustered standard errors in parentheses. IV specification: "Connected" instrumented with "Treatment"

Respondent controls include: gender, age, education, headship, and whether respondent had earned income in the 30 days prior to the baseline survey.

Household controls include: assets quintile, number of children, and whether the primary water source at baseline was an illegal pipe connected to a neighbor's tap.

<sup>†</sup> Intense diarrhea defined as follows: at least three loose stools within 24 hours

**Table 5: Perceived Time Availability**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Compared to last year, do you have less/as much as/more time to ...														
	.. do housework?	...go to the market?	...watch tv?	...visit your family?	...visit friends/ neighbors?	...receive the visit of friends/ neighbors	...spend time with members of your household?							
Treatment	0.10 (0.049)**	0.13 (0.060)**	0.13 (0.050)**	0.21 (0.059)***	0.17 (0.051)***	0.23 (0.058)***	0.12 (0.045)***	0.12 (0.052)**	0.08 (0.045)*	0.05 (0.06)	0.03 (0.04)	-0.05 (0.05)	0.16 (0.043)***	0.19 (0.053)***
Treatment X Illegal pipe linked to neighbor's tap		-0.12 (0.11)		-0.34 (0.117)***		-0.26 (0.117)**		0.02 (0.11)		0.13 (0.11)		0.31 (0.098)***		-0.13 (0.11)
Respondent Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH Controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	726	670	651	606	695	642	749	695	600	552	603	549	697	651
R-squared	0.05	0.04	0.04	0.07	0.05	0.08	0.02	0.04	0.02	0.03	0.03	0.07	0.04	0.06
Mean in Control Group	-0.02	-0.02	-0.12	-0.12	-0.05	-0.05	-0.17	-0.17	-0.17	-0.17	-0.07	-0.07	0.04	0.04
<b>Panel B. IV</b>														
Connected	0.17 (0.080)**	0.20 (0.089)**	0.21 (0.081)**	0.30 (0.086)***	0.28 (0.085)***	0.35 (0.087)***	0.20 (0.074)***	0.18 (0.079)**	0.14 (0.076)*	0.07 (0.08)	0.04 (0.07)	-0.08 (0.08)	0.27 (0.071)***	0.28 (0.081)***
Connected X Illegal pipe linked to neighbor's tap		-0.16 (0.19)		-0.55 (0.211)***		-0.40 (0.211)*		0.08 (0.19)		0.29 (0.23)		0.58 (0.192)***		-0.17 (0.19)
Respondent Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH Controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	726	670	651	606	695	642	749	695	600	552	603	549	697	651
R-squared	0.07	0.06	0.06	0.07	0.06	0.10	0.01	0.04	0.01	0.00	0.04	0.00	0.05	0.07

Notes: Standard errors clustered at the "cluster" level

Answers to the questions were coded as follows: less time: -1; same time: 0; more time: +1.

Respondent controls include: gender, age, education, headship, and whether respondent had earned income in the 30 days prior to the baseline survey.

Household controls as in Tables 2 and 3.

IV specification: "Connected" instrumented with "Treatment". Respondent controls are gender, head/spouse status, age and education, as in Panel A.

**Table 6: Actual Time Use**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
	Over the past 7 days, did you...										Average effect on 8 leisurely activities (timetable data) <sup>‡</sup>		
	...watch tv at least once a day?	...visit your family two or more times?	...visit friends/ neighbors two or more times?	...receive the visit of your family two or more times?	...spend time with members of your household at least once a day?								
Treatment	0.058 (0.036)	0.059 (0.043)	-0.008 (0.031)	-0.014 (0.037)	0.006 (0.022)	0.009 (0.026)	0.046 (0.026)*	0.029 (0.029)	0.015 (0.038)	0.027 (0.044)	0.084 (0.048) *	0.087 (0.048) *	
Treatment X Illegal pipe linked to neighbor's tap		-0.049 (0.087)		-0.016 (0.077)		-0.008 (0.056)		0.095 (0.062)		-0.078 (0.083)			
Respondent Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
HH Controls				Yes		Yes		Yes		Yes		Yes	
Observations	768	705	771	708	771	708	769	706	770	707			
R-squared	0.06	0.12	0.01	0.01	0.04	0.05	0.02	0.03	0.08	0.10			
Mean in Control Group	0.43	0.43	0.23	0.23	0.09	0.09	0.12	0.12	0.61	0.61	1.55	1.55	
<b>Panel B. IV</b>													
Connected	0.096 (0.061)	0.089 (0.065)	-0.014 (0.051)	-0.021 (0.056)	0.010 (0.037)	0.014 (0.040)	0.077 (0.043)*	0.043 (0.044)	0.026 (0.063)	0.041 (0.067)	0.134 (0.077) *	0.138 (0.077) *	
Connected X Illegal pipe linked to neighbor's tap		-0.068 (0.157)		-0.037 (0.140)		-0.011 (0.101)		0.192 (0.120)		-0.137 (0.151)		0.00 (1.21)	
Respondent Controls	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	1.00	
HH Controls		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	768	705	771	708	771	708	769	706	770	707			
R-squared	0.07	0.13	0.01	0.01	0.04	0.05	0.00	0.00	0.08	0.10			

Notes: Standard errors clustered at the "cluster" level. Respondent controls and households controls as in Table 5.

<sup>‡</sup> Across 8 leisurely activities, average number of 30-min periods for which the respondent recalls performing activity. The 8 activities are: resting, watching TV, exercising, being on the phone, going on a walk, praying, visiting other people or receiving other people at home.

IV specification: "Connected" instrumented with "Treatment"

**Table 7: Labor Market and School Participation**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Male Head had an income generating activity in past 30 days	Female Head had an income generating activity in past 30 days	A child under 15 had an income generating activity in past 30 days	Income generated by Male Head in past 30 days	Income generated by Female Head in past 30 days	Boy under 15 completed school year	Girl under 15 completed school year							
<b>Panel A. ITT</b>														
Treatment	-0.01 (0.03)	-0.01 (0.04)	-0.02 (0.02)	-0.03 (0.03)	-0.01 (0.01)	-0.01 (0.01)	18.75 (67.29)	5.54 (77.19)	-26.33 (34.22)	-29.88 (40.68)	-0.02 (0.04)	-0.04 (0.05)	-0.03 (0.04)	0.01 (0.05)
Treatment X Illegal pipe linked to neighbor's tap		-0.06 (0.08)		0.08 (0.06)		0.00 (0.02)		-86.24 (170.42)		63.22 (83.14)		0.10 (0.09)		-0.11 (0.09)
Respondent controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	773	710	773	710	773	710	748	687	768	706	249	236	240	231
R-squared	0.20	0.25	0.16	0.16	0.00	0.07	0.19	0.23	0.11	0.10	0.03	0.05	0.04	0.10
Mean in Control Group	0.51	0.51	0.15	0.15	0.02	0.02	707.00	707.00	161.58	161.58	0.87	0.87	0.87	0.87
<b>Panel B. IV</b>														
Connected	-0.010 (0.05)	-0.010 (0.06)	-0.040 (0.04)	-0.050 (0.04)	-0.020 (0.02)	-0.020 (0.02)	30.910 (110.71)	8.450 (116.16)	-43.580 (56.63)	-45.170 (61.30)	-0.020 (0.05)	-0.050 (0.06)	-0.050 (0.07)	0.020 (0.07)
Connected X Illegal pipe linked to neighbor's tap		-0.120 (0.14)		0.140 (0.11)		-0.010 (0.03)		-155.270 (301.74)		106.160 (147.75)		0.160 (0.14)		-0.220 (0.16)
Respondent controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	773	710	773	710	773	710	748	687	768	706	249	236	240	231
R-squared	0.20	0.25	0.16	0.15	0.00	0.06	0.19	0.23	0.11	0.10	0.03	0.05	0.03	0.09

Notes: Standard errors clustered at the "cluster" level. Respondent controls and households controls as in Table 5.

IV specification: "Connected" instrumented with "Treatment"

**Table 8: Social networks**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	The respondent is in conflict or disagreement with:												Over past 30 days:			
	Do you belong to a social group or association?		People from his/her family on water matters		People from his/her family on property matters		People from his/her family on heritage matters		Neighbors on water matters		Neighbors on property matters		A HH member was entrusted with valuables		A HH member was asked for advice on a family matter	
<b>Panel A. ITT</b>																
Treatment	0.02 (0.01)*	0.03 (0.01)**	-0.11 (0.02)***	-0.12 (0.03)***	-0.02 (0.02)	-0.01 (0.02)	-0.02 (0.02)	-0.03 (0.03)	-0.08 (0.02)***	-0.09 (0.03)***	0.01 (0.01)	0.01 (0.01)	0.04 (0.02)**	0.04 (0.03)	0.24 (0.13)*	0.15 (0.15)
Treatment X Illegal pipe linked to neighbor's tap		-0.03 (0.03)		0.07 (0.05)		0.00 (0.03)		0.03 (0.04)		0.05 (0.04)		0.01 (0.02)		0.01 (0.06)		0.44 (0.32)
Respondent controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	771	708	772	709	772	709	772	709	769	706	771	708	770	707	767	704
R-squared	0.01	0.02	0.05	0.06	0.01	0.02	0.00	0.02	0.04	0.06	0.01	0.02	0.02	0.03	0.02	0.05
Mean in Control Group	0.02	0.02	0.15	0.15	0.06	0.06	0.10	0.10	0.12	0.12	0.01	0.01	0.07	0.07	0.38	0.38
<b>Panel B. IV</b>																
Connected	0.03 (0.02)*	0.04 (0.02)**	-0.18 (0.04)***	-0.19 (0.05)***	-0.03 (0.03)	-0.02 (0.03)	-0.04 (0.04)	-0.05 (0.04)	-0.13 (0.04)***	-0.14 (0.04)***	0.02 (0.01)	0.02 (0.02)	0.07 (0.04)**	0.06 (0.04)	0.39 (0.21)*	0.23 (0.22)
Connected X Illegal pipe linked to neighbor's tap		-0.05 (0.05)		0.08 (0.08)		0.00 (0.05)		0.05 (0.07)		0.06 (0.07)		0.03 (0.04)		0.03 (0.10)		0.92 (0.63)
Respondent controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	771	708	772	709	772	709	772	709	769	706	771	708	770	707	767	704
R-squared	0.01	0.01	0.07	0.09	0.02	0.03	0.01	0.03	0.06	0.09	0.00	0.00	0.01	0.02	0.01	0.03

Notes: Standard errors clustered at the "cluster" level. Respondent controls and households controls as in Table 5.

IV specification: "Connected" instrumented with "Treatment"

**Table 9: Satisfaction and Well-Being**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Respondent mentions water as major source of concern		Home is cleaner than a year ago		Water tastes good		Overall, the life of the household has improved compared to a year ago		Within past 7 days, respondent felt, more often than not:					
									Sad		Worried		Satisfied	
<b>Panel A. ITT</b>														
Treatment	-0.43 (0.04) <sup>***</sup>	-0.51 (0.04) <sup>***</sup>	0.21 (0.03) <sup>***</sup>	0.23 (0.04) <sup>***</sup>	0.01 (0.02)	0.00 (0.02)	0.25 (0.04) <sup>***</sup>	0.26 (0.04) <sup>***</sup>	-0.03 (0.03)	-0.05 (0.04)	-0.04 (0.04)	-0.02 (0.05)	0.03 (0.04)	0.04 (0.05)
Treatment X Illegal pipe linked to neighbor's tap		0.29 (0.08) <sup>***</sup>		0.02 (0.07)		0.03 (0.05)		0.04 (0.09)		0.00 (0.08)		-0.09 (0.09)		0.02 (0.10)
Respondent controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	765	702	761	698	771	708	726	665	770	708	769	707	768	706
R-squared	0.20	0.27	0.07	0.09	0.01	0.04	0.11	0.13	0.02	0.03	0.02	0.03	0.01	0.01
Mean in Control Group	0.65	0.65	0.13	0.13	0.57	0.57	0.24	0.24	0.23	0.23	0.47	0.47	0.43	0.43
<b>Panel B. IV</b>														
Connected	-0.72 (0.05) <sup>***</sup>	-0.77 (0.05) <sup>***</sup>	0.35 (0.05) <sup>***</sup>	0.34 (0.05) <sup>***</sup>	0.02 (0.03)	0.00 (0.03)	0.44 (0.06) <sup>***</sup>	0.41 (0.06) <sup>***</sup>	-0.06 (0.05)	-0.08 (0.06)	-0.07 (0.06)	-0.04 (0.07)	0.05 (0.06)	0.07 (0.07)
Connected X Illegal pipe linked to neighbor's tap		0.35 (0.14) <sup>**</sup>		0.12 (0.12)		0.06 (0.09)		0.22 (0.18)		-0.03 (0.14)		-0.18 (0.17)		0.06 (0.17)
Respondent controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH controls		Yes		Yes		Yes		Yes		Yes		Yes		Yes
Observations	765	702	761	698	771	708	726	665	770	708	769	707	768	706
R-squared	0.37	0.43	0.18	0.18	0.00	0.02	0.23	0.23	0.03	0.03	0.02	0.02	0.02	0.02

Notes: Standard errors clustered at the "cluster" level. Respondent controls and households controls as in Table 5.

IV specification: "Connected" instrumented with "Treatment"

**Table 10: Social Diffusion: Adoption of Water Connection by Control Households**

	(1)	(2)	(3)	(4)	(5)	(6)	sample mean [std. dev.] of indep. var.
	Dep. Var: Bought BSI Connection						
# of households assigned to treatment within 20 meters	0.107 (0.046)**						0.61 [1.04]
# of households assigned to treatment within 50 meters		0.020 (0.020)					1.83 [2.20]
Share of households assigned to treatment within 20 meters			0.151 (0.082)*				0.26 [.38]
Share of households assigned to treatment within 50 meters				0.125 (0.066)*			0.42 [.36]
At least one household assigned to treatment within 20 meters					0.18 (0.076)**		0.36 [.48]
At least one household assigned to treatment within 50 meters						0.091 (0.054)*	0.68 [.47]
Total # of households sampled for study within 20 meters	0.009 (0.035)		0.057 (0.028)**		0.042 (0.030)		1.91 [1.48]
Total # of households sampled for study within 50 meters		0.014 (0.016)		0.023 (0.010)**		0.02 (0.011)*	3.94 [3.01]
Observations	221	345	221	345	221	345	
Mean of Dep. Var.	0.23	0.25	0.23	0.25	0.23	0.25	

Notes: For each radius choice, sample restricted to households with at least one sampled household within the chosen radius. Robust standard errors in parentheses, clustered at the cluster level. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.