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Red Wells or Green Wells and Does It Matter? Examining Household Use of Arsenic-contaminated Water in Bangladesh[1]

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7.1 Introduction

Bangladesh currently faces a major health calamity because of arsenic contamination of groundwater aquifers. Bangladesh has copious quantities of ground water, but the alluvial aquifers of the Ganges delta are polluted by naturally occurring arsenic (Nickson et al. 1998). Approximately 27 percent of shallow tube wells in Bangladesh are estimated to have arsenic content that exceeds the government's safety standards of 50 mg/liter (Caldwell et al. 2006; BGS and DPHE 2001).[2] Some 46 percent of wells exceed the safety standards set by the World Health Organization of 10 mg/liter (BGS and DPHE 2001).[3] For Bangladesh, this means that an estimated 27 to 60 percent of its population is at risk from arsenic exposure (Smith, Lingas, and Rahman, 2000).

Historically, Bangladesh has been very successful in providing its population with access to safe drinking water. Death due to cholera and diarrheal disease was effectively contained in the seventies and eighties by replacing

[1] The data used in this chapter was collected as part of a research project undertaken by Zakir H. Khan and was sponsored by SANDEE. We are grateful to SANDEE's sponsors for financial support and for SANDEE's advisors who helped with earlier stages of this work. We also thank David Starrett and Scott Barrett for their comments, which helped improve the chapter substantially.

[2] Based on a national sample of 3,534 tube wells.

[3] Air and water quality international standards set by the World Health Organization can differ from national standards. The World Health Organization's arsenic standards apply in several developed countries but many developing countries have set their own standards for practical reasons.

existing sources of drinking water with tube wells, a strategy that was vigorously pursued by the Government of Bangladesh, UNICEF, and other donors. Tube wells were bored to obtain clean water from thirty to hundred feet below the surface. This water did not have to be boiled and was free of many bacterial contaminants. Shallow tube wells were cheap, could be installed close to homes and women found them extremely convenient. Notably, the expansion of tube wells occurred at a period when oral re-hydration treatment was also widely distributed. While, there is evidence that oral re-hydration therapy, more so than the availability of tube-well water, was responsible for the reduction in diarrheal mortality, tube wells grew rapidly as a dominant water source (Caldwell et al. 2006). As of 1997, some 97 percent of the rural population in Bangladesh obtained their drinking water from tube wells (Farouque and Alam 2002). Since the discovery of arsenic in ground water in 1993, Bangladesh has struggled once again with the problem of delivering safe water.

Arsenic poisoning, or arsenicosis, can cause numerous health problems ranging from skin lesions to cancer and cardio-vascular diseases. We discuss some of these symptoms in detail later. Exposure to high concentrations of arsenic can result in rapid onset of diseases, but this is not the case in Bangladesh. Ingestion is mainly through low doses of arsenic in water, resulting in symptoms appearing over a long period of time. Because the presence of arsenic in water is impossible to detect through our normal senses and because health effects are not immediately obvious, it can be difficult to convince households about the threats of arsenic.

Over the last decade, the Bangladesh government, donors, and NGOs have made different investments to provide arsenic-free water and run health campaigns to inform people about the risks of arsenic. The government's main campaign to inform people about the presence of arsenic in drinking water sources is through a binary color-coding system. A green-colored tube well is safe for collecting drinking and cooking water while a red-colored one is not, that is, the arsenic content in red wells is higher than the government safety standards of 50 mg/liter. NGOs have also undertaken door-to-door awareness programs and information has been disseminated through the media. Nonetheless, either due to limited alternative sources of water or for other reasons, many households continue to use water from unsafe tube wells.

It is in this context, that this study examines arsenic exposure and people's responses in two Upazilas[4] in Bangladesh. We seek to understand if providing information on arsenic contamination contributes to reduced exposure. We are particularly interested in the efficacy of different sources of information. We also identify the costs of using arsenic-contaminated

[4] Administratively, Bangladesh is divided into several tiers: Division, District, Upazila, Union and Ward. The local government structure begins at the district level and the Upazila is the second tier of local government.

water. The study attempts to answer three questions: (a) how effective are different sources of information in reducing household use of contaminated water? (b) do households that are able to reduce their exposure to red wells have specific characteristics, that is, are they wealthy or have larger families, allowing them to find alternatives? And (c) what are the costs to households of continuing to use red wells? We try to address these questions by examining the behavior of households that drink water from red (unsafe) and green (safe) wells. We assess how the probability of using red wells is affected by information and other household characteristics. We also examine medical expenditures and sick days that occur as a result of arsenic-related symptoms. Investigating these issues will help us understand the impacts of government and NGO activities and may contribute towards designing better public health strategies.

Information campaigns are a well-tried strategy for regulating pollution and natural resource use (Tietenberg and Wheeler 2001). There is a sizable literature on the viability of information, with several studies examining the effect of labeling, news and media information, and government disclosure of data, on firm, farmer, investor, and consumer behavior (Khanna et al. 1998; Kathuria 2007; Lemos 2008; and Wang et al. 2004). Summarizing this literature, Tietenberg and Wheeler (2001) conclude that information strategies can be effective in changing consumer and firm behavior. However, how information is provided, how much is provided, and what kinds of complementary actions are taken, play a role.

An earlier paper by Madajewicz et al. (2007) offers a careful analysis of the impact of information on health risks in Bangladesh. This study was a joint effort by a large number of scientists and public health specialists in collaboration with professors from Columbia University. Households were provided with information on the health consequences of drinking arsenic-contaminated water and the results of a health exam. The study scientists were also able to run tests on 6,500 wells in one district and inform households about the contamination in their wells. The same households were visited six to twelve months later to assess the effect of information. Household response to the information campaign was quick and significant. Knowing that wells have an unsafe level of arsenic raised the probability that a household switches to a new alternate source of well within a year by 0.37. This switch was done despite a fifteen-fold (4.3 minutes per round trip) increase in the time spent collecting water from alternate sources. An interesting and very important finding from this study is that media communicated general information is as effective (in terms of awareness generation) as expensive house-specific information. However, media campaigns are less able to induce behavioral change and awareness does not necessarily lead to action.

Another study of relevance to our work is Jalan et al. (2009) on the determinants of water-purification behavior among a country-wide sample of Indian respondents. Jalan et al. (2009) treat schooling, media exposure, and the presence of diarrhea as indicators of awareness of health risks. They ask how these indicators influence households to purify water. Using a large dataset, they find that each of these variables has a significant effect on home-purification activities, independent of household characteristics such as wealth. For example, the probability of purification increases by 8 percent points if a female household member reads a newspaper at least once a week. The probability that a household boils water for drinking increases by 5 percent if the household has experienced a previous health shock. The impact of education is also significant. Overall, the effect of "information and awareness" are comparable in magnitude to wealth effects.

Our study is not based on multiple surveys and control and treatment groups as found in Madajewicz et al. (2007) and is more along the lines of Jalan et al. (2009). It also builds on an earlier study by Aziz et al. (2006) that examines the determinants of knowledge of arsenic symptoms and household decisions to switch wells. Like these other studies, we are interested in the role of education versus media versus government and NGO campaigns on water use behavior. The Columbia University study also established the cost of switching wells using information on time costs of collecting water from alternate sources. We attempt to estimate the benefits of switching by looking at medical and time costs resulting from illness.

In the following sections, we first provide background information on the extent of arsenic contamination in ground water in Bangladesh and health effects. We then discuss our study area and the data used to examine the impact of different sources of information. Section 7.4 presents the analyses on the role of information. In section 7.5, we assess the costs of illness associated with arsenic contamination in Bangladesh. Our final section concludes and discusses next steps.

7.2 BACKGROUND

Bangladesh is a very densely populated country with a population of over 140 million (BBS 2009). With a per-capita GDP of USD 444 in 2005 (BER 2005), Bangladesh is also one of the least developed countries in the world. Nevertheless, Bangladesh has made significant strides in accelerating economic and human development. Providing access to clean water is a major development goal of the government. Until the discovery of arsenic, 97 percent of households were estimated to have access to clean water. Because of the presence of arsenic, this number is now down to 74 percent (Khan 2007).

Out of 4.95 million tube wells screened in Bangladesh in 2002 to 2003, 1.44 million or 29 percent were estimated to be contaminated with arsenic above the safe standards of 50 mg/liter.[5] Since several million tube wells are yet to be screened, the official estimate is that nationwide some 20 percent of tube wells or one in five shallow tube wells is contaminated with arsenic above the 50 mg/liter safety standard (DPHE website 2011, UNICEF, Bangladesh 2011).[6] The state of affairs is dire in some parts of Bangladesh. A 2009 situation analyses indicates that only 4 percent of nine million people who live in areas where over 80 percent of wells are contaminated, have arsenic-free water (UNICEF, Bangladesh 2011).

In terms of people affected, according to the Government of Bangladesh's Department of Public Health and Engineering (DPHE), there are some 38,380 arsenic-affected patients in Bangladesh. This is a small number given Bangladesh's current estimated population of over 140 million (BBS 2009). However, this may be the tip of the iceberg since arsenicosis is a slow-growing disease. Screening done by the Bangladesh Arsenic Mitigation and Water Supply Programme, in fact, demonstrates that the figure might be as high as 1.1 cases of arsenicosis per thousand (World Bank 2002).

While the overall number of cases of illness is hard to estimate given lack of data on symptomatic patients, some understanding of exposure is possible. A national sample survey, the Bangladesh Household Survey 2004, found that some 7.9 percent of the sampled population drank from wells that had arsenic over the safety standards of 50 mg/liter (Khan et al. 2007). Using the same safety standards, the Bangladesh Department of Health and Engineering estimates the exposed population to be higher at 30–35 million Bangladeshis (conservatively about 20 percent of the population) (DPHE website 2011). The government's estimates are comparable to UNICEF's estimate of 20 million people who are exposed to high levels of arsenic contamination (UNICEF, Bangladesh 2011). Thus, while there is clear information on the number of wells contaminated with unsafe levels of arsenic, there is uncertainty regarding the exposed population and even more uncertainty about the number of cases of illness.

The primary pathway to arsenicosis is prolonged exposure through drinking arsenic-contaminated water,[7] with symptoms taking five to twenty years to develop. Because of its slow progress, the evolution of the disease is divided into several stages. In the primary stage, an arsenicosis patient may develop several symptoms, sometimes simultaneously, such as blackening of parts of the body (melanosis), thickening and roughness of the palms and soles

[5] These numbers are slightly higher than the estimates referred to earlier by BGS and DPHE (2001).

[6] <http://www.dphe.gov.bd> (accessed 30 August 2011) and <http://www.unicef.org/bangladesh/Arsenic_Mitigation_in_Bangladesh.pdf> (UNICEF media notes, accessed 30 August 2011).

[7] Absorption of arsenic through the skin is minimal. Thus hand-washing, bathing, and laundry done with water containing arsenic does not pose human health risks.

(keratosis), redness of the eye (conjunctivitis), inflammation of the respiratory tract and nausea and vomiting (gastroenteritis). If a patient continues to be exposed to arsenic-contaminated water and if adequate preventive measures are not adopted, the symptoms advance and become more visible: white intermittent dots within blackened areas (called leukonelanosis or Rain Drop Syndrome), nodular growth on the palms and soles (hyper-keratosis), swelling of the feet and legs (non-pitting edema), and peripheral neuropathy as well as liver and kidney disorders. In the tertiary stage, an arsenicosis patient's physical condition deteriorates rapidly and the condition becomes irreversible. Gangrene, cancer of the skin, lungs and bladder, and kidney and liver failure become manifest (Khan 2007).

Numerous studies in Bangladesh have documented the health consequences of arsenic contamination. Chen and Ahsan (2004) estimate a doubling of lifetime mortality risk from liver, bladder, and lung cancer in Bangladesh, because of arsenic exposure through drinking water. A cohort analysis between 1991 and 2000 of 115, 903 people in Matlab Upazila suggests that the death rate due to cancers, cardiovascular disease, and infectious disease increases by a factor of 1.44, 1.16, and 1.30, respectively for patients exposed to contaminated water higher than the Bangladesh safety standards (UNICEF, Bangladesh 2011). In other work, Smith et al. (1999) show arsenic contamination may be mainly responsible for bladder and lung cancer relative to other cancers.

Given the severity of the problem, several Government, NGO and international institutions are engaged in providing technical and financial support for arsenic detection, research, and mitigation projects. However, alternatives to drinking water from tube wells are limited. Dug wells that draw water from close to the surface are an option, but there is fear of microbial contamination. The growth of shallow tube wells was historically a great achievement precisely because it provided people with cheap bacteria-free water. Now, finding a new substitute poses a huge water-supply and economic challenge. Deep tube wells that obtain water from over 150 meters below the ground are a limited option because they are expensive, which explains why there are currently relatively few private deep tube wells. There are also some household-level technologies available for arsenic control, but these are possibly less affordable.[8]

Since all wells in a particular location are not contaminated, well testing and switching is another important strategy. Given the spatial variability of arsenic content in water, well-switching could be a viable in all but 29 Upazilas, where 80 percent of the wells are unsafe (van Geen et al. 2002). However, we note that people also like to use shallow tube wells because the water is conveniently available for bathing and washing; it is only drinking water that poses

[8] There are several processes through which arsenic in water can be reduced to the 'safe' level. Some are at the household level using small filtration units; others are at the community level.

health hazards. It is in this context, that we try to understand the reasons why households continue to drink from unsafe red wells.

7.3 DATA AND STUDY AREA

The data used in this chapter is based on a 2005 survey of 5,563 individuals from 878 households in two Upazilas (sub-districts) of Bangladesh (Khan 2007; Khan and Haque 2011). The data was collected as part of a research project undertaken by one of the authors, Zakir H. Khan, and was sponsored by SANDEE.

The study area, Upazilas Matlab and Laksham, are located in the southeastern part of Bangladesh, which is the most arsenic-prone region in the country. The two Upazilas are located within fifty kilometers of each other. Matlab has had numerous health-related interventions because of work by the International Centre for Diarrheal Diseases Research, Bangladesh, while Laksham seems to have had more government interventions. The government has marked a large number of tube wells (though not all) in this area as red (unsafe for drinking) or green (safe). Data provided by DPHE at the time of the study indicated that only 30 percent of the wells in our study sample fell within the green safety standards of 50 mg/liter.

To identify households for our study, we developed a sampling frame based on a DPHE database. The database contained information on wells, location of wells, and households using the wells. As described in Khan and Haque (2011), a two-step procedure was used to select households. In the first stage, 900 tube wells were randomly chosen (450 from each Upazila) from three Unions[9] in Matlab and four Unions in Laksham. Since the same tube well is shared by several households, at the second stage, one household from each tube-well user group was randomly selected from the DPHE database. The total number of households selected was 878.

The 2005 survey collected data on: (a) household level socioeconomic information; (b) individual health symptoms and demographic information; and (c) workdays lost, income loss, sick days, and averting and mitigating activities both at household and individual levels. Avertive activities refer to actions taken by households to avoid use of contaminated water. Mitigating activities refer to doctor and hospital visits. Survey enumerators were trained to identify different variants of arsenicosis based on symptoms narrated by respondents.

[9] Union is at the third tier of local government and is comprised of ten wards. Each Union has a chair and thirteen elected members (one from each ward plus three women members).

Table 7.1 Household and individual socioeconomic information

	Mean	Mean red well	Mean green well
Household size	6.33 (2.43)	6.41 (2.39)	6.24 (2.48)
Male/female ratio	1.28 (0.98)	1.33 (1.04)	1.22 (0.92)
Age of household head (years)	52.8 (15.3)	53.8 (15.8)	51.5 (14.4)
Age (full sample)	27.49 (20.25)		
Percent of individuals over 7 years illiterate	13.6 (17.9)	15.2 (19.5)	11.5 (15.7)
Percent of individuals over 7 years with primary or secondary education	78.5 (20.7)	78.1 (21.3)	79.1 (20.1)
Education (years)	5.17 (4.15)		
Male (years)	5.6 (4.1)	5.44 (4.03)	5.82 (4.10)
Female (years)	4.8 (3.8)	4.6 (3.75)	4.98 (3.86)
Wealth	51.62 (12.4)	51.8 (12.9)	51.4 (11.7)
Radio ownership (%)	53.3 (49.9)	52.2 (50.0)	55.0 (49.8)
TV ownership (%)	27.1 (44.5)	26.8 (44.3)	27.7 (44.8)

Note: Standard errors in parenthesis

Table 7.1 provides a brief summary of statistics at the individual and household level. The average household size in our study area is 6.3. If we examine the number of working members, households have some 4.5 members over the age of 14. The average age of the individuals in the sample is 28 years and the male to female ratio is 1.28, which is higher than the Bangladesh average. Individuals in our sample have about five years of schooling on average. Women have approximately one year less education than men. Some 14 percent of individuals over seven years of age have no education; while 79 percent of individuals have either primary or secondary education, and about 7 percent of individuals have more than secondary education.

To determine the wealth status of the household, we used a checklist of forty-three assets. Using this list, each household was assigned a number on a wealth index that ranged from 0 to 100.[10] The wealth distribution of the sampled households follows a tight bell-shape curve (Khan 2007). In terms of assets, ownership of radio and TV are important for understanding the role of

[10] The wealth index is given by:

$$WI_i = \left[\frac{\sum_{1}^{43} a_{ij} - \min(a_{ji})}{\max(a_{ji}) - \min(a_{ji})} \times 100 \right]$$

where, j refers that the holding of i number assets (a) and $a_{ij} = 1$ if the i^{th} household has the jth asset, and 0 = otherwise $i = 1,2,3,\ldots m$ representing households, and $j = 1,2,3,\ldots n$ representing the assets available at the household. The minimum of a_{ji} means holding by j^{th} household of the lowest number of i assets

Table 7.2 Drinking water in the study area

	Households %
Percent drink water from tube well	85
Average no. of years of drinking from tube well (among households that drink from tube wells)	11.45
Percent of all water sources owned by individual households	74
Percent aware of arsenic in main source of water	66
Percent drinking water from red wells	55
Percent who follow some form of purification	18
Percent Yes to averting technology	12

information. Table 7.1 indicates that some 53 percent of households owned a radio while 23 percent owned a television.

In order to understand how households were exposed to arsenic, we looked at sources of drinking water. Table 7.2 indicates that 85 percent of the households obtain their drinking water from tube wells. On average, these households had been using the same source of tube well water for over eleven years. Less than 11 percent of households have access to deep tube wells (over 150 meters deep), which are generally arsenic-free. Furthermore, over three-quarters of all water sources are privately owned. Thus, our understanding is that over the last twenty or more years, households have drilled individual tube wells for themselves and use of public sources of water is limited. Very few households use surface water or get water from taps at home, less than 0.5 percent people use filters and only 0.2 percent use water from arsenic removal plants. Most importantly, Table 7.2 indicates that fifty five percent of households still drink water from red tube wells. This shows the extent of vulnerability of the population to arsenicosis.

Table 7.3 shows that approximately 5 percent of the sampled population suffered from arsenicosis. A slightly larger percentage of women (6 percent) versus men (4.6 percent) had symptoms. Interestingly, Madajewicz et al. (2007) also found that some 6 percent of the sample population in nearby Araihazar Upazila showed signs of arsenic impacts. In our sample, some 19 percent of households ~~in the sample~~ had at least one person sick from arsenic exposure. If we divide our sample into red well and green well users, we find that a small percentage of green well users are also sick from arsenic. This may be because they were previously exposed and switched water sources over time. If we look at only red well users, 9 percent of the sample females show signs of arsenic contamination.

Most of the individuals who suffered from some form of arsenic exposure were in the early stages of the disease (see Table 7.3). Some 34 percent of sick individuals exhibited signs of kertosis or thickening of the palms and soles. Some 45–50 percent of sick individuals also indicated that they had other symptoms of arsenic poisoning such as redness of the eye and gastro-intestinal problems. Between 2–3 percent of the population exhibited advanced

Table 7.3 Presence of arsenic symptoms

	%
Total individuals with arsenic symptoms	5.3
Male	4.6
Female	6.0
Percent of households with at least one sick from arsenic	19
Distribution of arsenic disease among sick individuals	
Primary Stage	
Melanosis or black spots in the body	8.6
Keratosis or thickening of the palms and soles	34.3
Redness of the eye or conjunctivitis	58.6
Inflammation of the respiratory system	45.7
Gastrointestinal problem	46.4
Secondary Stage	
Hypo-pigmentation or white spots	5.7
Hyper-keratosis or nodular growth	15
Swelling of the feet and legs	12.1
Peripheral neuropathy	17.1
Liver or kidney disorder	7.1
Tertiary Stage	
Gangrene of the distal organs	3.6
Cancer of the skin, lung or urinary tract	2.9
Liver or kidney failure	2.1

conditions of arsenic poisoning. Given that this is a late acting disease that can take twenty-odd years to set in, the distribution of the disease is not surprising.

7.4 THE ROLE OF INFORMATION

In this study, we are interested in the role of information in reducing household exposure to arsenic-contaminated water. Some 66 percent of households in our sample indicated that they were aware of the presence of arsenic in their wells. These numbers echo results from Aziz et al. (2006) who found that some 70 percent of their sample of households in Matlab Upazila were aware of the arsenic problem in their water. As Table 7.4 shows, the main sources of arsenic-related information amongst our study households are: NGOs (43 percent of households), DPHE (25 percent) and other government sources, including health facilities (17 percent). Some 32 percent of households had attended awareness programs organized by NGOs. Not surprising, since NGOs activities cover nearly 50 percent of the rural Bangladeshi population. Some 15 percent of households got their information from a TV or radio. It is possible

Table 7.4 Sources of information and reasons for drinking contaminated water

	Households %
Main Source of information on arsenic contamination came from:	
DPHE	24.5
TV/Radio	14.6
Newspaper	0.59
Government	16.7
NGO	42.9
Other	0.24
Reasons for drinking from red wells (among those who reported drinking from red wells (n = 485 HHs))	
Safe or arsenic free source of water unavailable	47.42
Taste of the water is good	14.02
Shortage of money	5.57
Do not know the effect of drinking from red wells	27.01
Other	5.99

that households got information from multiple sources. Our survey, however, probed and obtained data on the "main" source of information.

One of the questions we try to address in this chapter is whether different sources of information available through the government, NGOs, or the media has an impact on household use of arsenic-contaminated water. As previously noted, many wells in this area are painted red or green but households continue to use both kinds of wells. There are clearly various reasons why households continue to use contaminated "red" wells but the most important reason identified is lack of alternate sources (see Table 7.4). However, as Table 7.1 shows there are no systematic differences in terms of wealth or demographics between red-well and green-well users. Indicators such as household size, age, male female ratio and wealth do not vary much across people who imbibe from red wells versus green. Green-well users are slightly more educated. We think the main reasons for why some households may use red versus green may be two-fold: (a) geological, that is, because of their location some households have better access to red wells; and (b) behavioral—because of information available some households may have switched to green wells.

To examine this question of why some households use red wells versus green more carefully we ask what factors affect the probability of a household using a "red" well. In particular, we ask if different sources of information in the form of TV or Radio, NGO awareness activities and information by the Department of Public Health have influenced the use of red wells. We are also interested in the role of education.

We use the following model to assess factors that influence household use of red versus green wells:

$$Y_1 = \sum \beta_i X_i + \gamma_2 Y_2 + \eta_k + u_1 \quad (1)$$

where Y_1 is a binary variable (1 for drinking from red, 0 for drinking from other sources, including green tube wells), X's are a set of independent variables including information sources, Y_2 is the number of household members affected by arsenic in a household, and η_L is a Union fixed effect.[11] We estimate equation 1 to assess the impact of different sources of information on the probability of drinking from red wells. We discuss below our empirical strategy for addressing the endogeneity problem posed by the inclusion of Y_2.

Drinking from red wells is expected to be affected by household characteristics such as wealth, the relative number of females in the household, which reflects knowledge about water sources and ability to carry water, and whether the well is owned privately. We hypothesize that wealth increases access to alternate sources of water or purification technologies, and the percent of females in the household decreases the probability of drinking from red wells. Whether the well is privately or publicly owned is an interesting variable. Our hypothesis is that if a household owns the private well that it has access to, it may be reluctant to switch because of investments already made. This hypothesis builds on results by Madajewicz et al. (2007), who find that well-switching is negatively related to well ownership. If the household doesn't own the well, switching may be more likely. Since we are not able to link household use with household specific ownership rights, we are unable to hypothesize on the sign of the coefficient on private well ownership.

The right-hand side variables in the above model include three information-related indicator variables: (a) whether the household obtained arsenic information from various government sources (mainly from the health sector); (b) whether the household obtained its information from the electronic media such as TV or Radio, and (c) whether the household obtained its arsenic information from NGOs. In the empirical estimation of Y_1 in equation (1), the coefficients of these variables are ascertained relative to the default position of the households obtaining information from DPHE. We do this because we partly want to assess whether the role of DPHE is as important as other information campaigns. We are also interested in the effect of education as this could be considered an indicator of awareness of health risks (Jalan et al. 2009).

Following Jalan et al. (2009), we hypothesize that households are less likely to use red wells if they already have sick people in the household. As previously noted, some 19 percent of the households have at least a member who is sick with arsenicosis. We hypothesize that health shocks are likely to make the household more aware of sources and use of alternate water. We also hypothesize that, given cultural biases, if there are more men than women in

[11] Union is a lower-level political unit in Bangladesh and includes groups of villages.

the household that are sick with arsenicosis, this decreases the probability of drinking from red wells.

The inclusion of arsenic patients in the household as an "awareness" indicator creates an endogeneity problem while estimating equation (1). The presence of arsenic patients in the household (Y_2 in equation (2) below) is itself dependent on drinking water from red wells (Y_1). In order to remove this potential endogeneity in our model, we use a two-stage instrumental variable approach. In the first stage, we estimate the number of arsenic-affected people in a household (Y_2). Since the number of arsenic-affected people is a discrete non-negative integer; we use a negative binomial model to estimate equation (2). When the left-hand side variable is a count of one kind or the other, it is appropriate to model this information assuming that the data follows a Poisson or negative binomial distribution. The first-stage results are presented in Table 7.10 of the appendix, which shows that the coefficient *alpha* (the negative binomial variance parameter) is significantly different from zero, indicating that the negative binomial is better suited than the Poisson model. Thus, we use the negative binomial model for the first-stage estimation.

In the first-stage regression, we use two instrumental variables (Z_j), chronic illness and use of tube wells, which are assumed to be correlated with the presence of sick people with arsenicosis, but not correlated with drinking water from red tube wells. Both of these instruments are indicator variables. Since the arsenic effect on the human body depends on the immunity levels of individuals, we use chronic illness as an instrument. Since arsenicosis is linked to drinking of water from shallow-aquifer-based tube wells, we use drinking from tube wells as another instrument. We recognize that these variables are imperfect instruments, but we are constrained by data limitations.

In order to verify the relevance of the instruments, we perform statistical tests. We first run the first-stage regression and perform the joint significance test of the instruments. This joint significance test indicates that coefficients of these two instruments are jointly significant, indicating that they are correlated with the endogenous variable. This suggests that our instruments are good enough to address the endogeneity issue.

Following the first-stage estimation, in the second stage, we estimate a logit regression in which the dependent variable (Y_1) is a binary variable with Y_1= 1 if the household drinks water from tube wells marked as "red" and 0 otherwise. In equation (3) $\widehat{Y}_2$ is predicted from equation (2) as given below:

$$Y_2 = \sum \beta_i X_i + \sum \delta_j Z_j + \eta_k + U_2 \tag{2}$$

$$Y_1 = \sum \beta_i X_i + \gamma_2 \check{Y}_2 + \eta_k + u_3 \tag{3}$$

Table 7.5 Summary statistics of variables used in information regression

Variable	Definition	Mean	SD	Min	Max
drink_red_water	**1** if drinking from red well	0.55	0.5	0	1
ars_affect	Number of household member(s) affected by arsenic-related diseases	0.34	0.89	0	10
PVT_owner	**1** if the households is using a private water source	0.74	0.44	0	1
FEMALE	Ratio of female members to all household members	0.49	0.17	0	1
INFo_GOVT	**1** if main source of information on arsenic was from government	0.16	0.37	0	1
INFO_TVR	**1** if main source of information on arsenic was from TV/radio	0.15	0.35	0	1
Info_NGO	**1** if main source of information on arsenic was from NGOs	0.42	0.49	0	1
info_DPHE	**1** if HH's main source of information on arsenic was from DPHE	0.4	0.49	0	1
F_more	**1** if more female members relative to male members are arsenic-affected in sampled HHs	0.91	0.29	0	1
edu1_10	**1** if at least one member of the household had an education between 1 to 10 years	0.79	0.21	0	1
hedu	**1** if at least one member of the household had education over 10 years	0.08	0.15	0	1
WINDEX	Wealth index	51.62	12.41	0	100
tube wells	**1** if source of drinking water is tube wells	0.84	0.36	0	1
Chro_Ill	**1** if a member of the household has been suffering from any other chronic illness	0.26	0.55	0	4

Table 7.5 presents the summary statistics of the variables used in the two-stage estimation. The results are presented in Table 7.6. Column 1 of Table 7.6 represents the results from a basic logit model without instrumenting for arsenic patients in the household. Column 2 presents the coefficients of the

Table 7.6 Fixed-effect logit regression for the full sample (DepVar: drink from the red tube wells)

VARIABLES	Model 1	Model 2	
	Un-instrumented	Instrumented	
	coefficients	coefficients	Marginal effects
PVT_OWNER	0.494*** (0.176)	−1.695*** (0.316)	−0.01352
FEMALE	−0.802* (0.443)	−1.544*** (0.476)	−0.01231
INFO_NGO	0.00204 (0.314)	−5.510*** (0.729)	−0.04393
INFO_TVRADIO	−0.270 (0.348)	−2.176*** (0.425)	−0.01735
INFO_GOVT	0.263 (0.359)	0.992** (0.389)	0.007907
F_MORE	0.0563 (0.323)	6.652*** (0.844)	0.053034
EDU1_10	−1.096** (0.469)	−5.880*** (0.757)	−0.04688
HEDU	−1.805*** (0.598)	−9.724*** (1.133)	−0.07753
WINDEX	−0.00315 (0.00595)	−0.0306*** (0.00706)	−0.00024
ARS_AFFECTED	0.0478 (0.142)		—
ARS_AFFECTEDP		−7.315*** (0.866)	−0.05832
OBSERVATIONS	878	878	
NUMBER OF UNION	7	7	
LR CHI SQ (10)	21.21**	104***	

Note: Standard errors are within parenthesis. ***, ** and * indicate significant at 1%, 5% and 10% level respectively.

logit equation after instrumenting the number of arsenic patients. These logit equations are estimated after controlling for unobserved heterogeneity at the 'Union (local government)' level. There are twenty-five Unions in Laksham and twenty-two in Matlab. While a number of investment decisions, including those related to water and sanitation, are made at the Union level, we do not have this information. Therefore, we use a Union fixed effect model to account for heterogeneity among Unions. As results from alternative specifications are stable,[12] we restrict our discussion below to results from the two-stage model presented in column 2 (coefficients) and column 3 (marginal effects) of Table 7.6.

As Table 7.6 shows private ownership of wells has a negative impact on the probability of drinking from a red well as does the percentage of women in the family.[13] More women in the house may reflect a higher capacity to carry safe drinking water from a distance. As expected, wealth, which reflects access to alternate water sources and purification possibilities, reduces the probability of drinking from red wells.

Two of the three information variables (TV/radio and NGO information) reduce the probability of a household using a red well relative to information obtained from DPHE. Information coming from NGOs seems to be the most effective. The probability of drinking from red wells decreases by 4.4 percent more when the information comes from NGOs relative to DPHE. Information from the media is significantly more effective than DPHE information but not by a huge degree. Information from other government agencies seems to be less effective than information from DPHE, as indicated by the positive marginal effect of the variable INFO_GOVT. Overall, our analyses suggests that information on arsenic in water provided by non-government sources, including the electronic media, is, at least, if not more effective than information provided by government sources. This is useful to know because government provision of information may be more costly relative to other sources.

Education plays an important role in reducing exposure to arsenic. These results are on par with Jalan et al. (2009) and Aziz et al. (2006), who find that education is significant in inducing behavioral change that reduces health risks. Table 7.6 shows that the marginal effects of higher education (7.8 percent) and studies up to 10th grade (4.7 percent) are both negative. As expected, higher education has a bigger impact on reducing the probability of drinking from red wells. Notably, Madajewicz et al. (2007) find that secondary and higher education increase the probability of well-switching while primary education does not. In our analyses, higher education has the biggest effect relative to all other variables that may induce households to switch from red to green wells.

If the household has more male members affected from arsenic compared to females, then this reduces the probability of using a red well. Thus, even though females may be the managers of water in the household, the likelihood of switching to clean water is higher if more male members are sick as a result

[12] We also estimated an alternative model without wealth index as an explanatory variable, and results are comparable in terms of sign and statistical significance.

[13] It is possible for the variable 'private ownership of tube wells' to be highly correlated with the wealth index. If these variables are highly correlated, we cannot use them together as explanatory variables. In our sample, the correlation coefficient between these two variables, however, is very low (less than 0.08). This is not surprising because, while the well may be privately owned, not all households in our sample own the well from which they obtain water.

of exposure. It may be the case that male members of the households have more influence in deciding where to obtain drinking water.

The coefficient on the number of arsenic-affected household members is positive in the basic model but switches sign and is negative in the two-stage model. Thus, once we correct for endogeneity, it is clear that the number of arsenic patients in the household sends a signal and lowers the likelihood of using a red well. Interestingly, the marginal effect of a health shock on the probability of sickness in our analyses (6 percent) is not that different from the results obtained by Jalan et al. (2009), who find that a health shock increases the probability of households boiling water for drinking purposes by 5 percent.

In general, however, our data and analysis suggest that providing information to households about arsenic contamination in wells––even if this information is very specific––is not sufficient. Fifty-five percent of the wells used by the sample households were contaminated with arsenic at higher than safe levels; yet households continue to use these wells. Education and information campaigns do reduce use, but lack of access to alternate safe sources of water results in households exposing themselves to arsenic poisoning continuously.

An interesting issue that emerged in reviewing our data was that the two Upazilas Laksham and Matlab are quite different from each other. T-tests of mean differences were significant for a number of variables such as higher education, households with members sick with arsenic disease, information sources, water purification behavior and so on. This may be because they are in two neighboring districts, but we note that Matlab also hosts a major field center for diarrheal research in Bangladesh and has had significant NGO presence.

Because the underlying characteristics and access to information in Matlab and Laksham are different, we also ran separate regressions on data from these two sub-districts. These results are presented in Table 7.7. The results from Matlab (column 2) reinforce our overall understanding of what affects the probability of drinking from red wells (obtained from Table 7.6). Thus, as Table 7.7 shows, in Matlab, wealth, percentage of females, arsenic patients in the household, and education have a negative effect on drinking from red. The same information variables (TV/radio and NGO campaigns) have a significant impact. However, the results from Laksham are not as clear. While wealth and education certainly reduce the use of arsenic-contaminated water, the only information variable that is significant is government information (from departments such as health services), which is less effective (positive sign) than the information provided by DPHE. This likely reflects the lack of NGO presence in Laksham and perhaps a stronger role by DPHE.

Table 7.7 Fixed-effect logit regression for two Upazilas (DepVar: drink from the red tube wells)

VARIABLES	MatlabUpazila		LakhsamUpazila	
	Un-instrumented	Instrumented	Un-instrumented	Instrumented
PVT_OWNER	0.0547 (0.241)	−0.391 (0.281)	1.105*** (0.279)	1.223*** (0.308)
FEMALE	−0.704 (0.593)	−2.360*** (0.800)	−0.751 (0.691)	0.515 (0.753)
INFO_NGO	−0.0789 (0.388)	−3.450*** (1.135)	0.883 (0.783)	0.296 (0.859)
INFO_TVRADIO	−0.240 (0.532)	−44.29*** (14.21)	−0.0302 (0.482)	0.384 (0.509)
INFO_GOVT	0.241 (0.464)	0.379 (0.470)	1.052 (0.779)	3.729*** (0.980)
F_MORE	0.292 (0.516)	3.286*** (1.167)	0.00864 (0.445)	2.649*** (0.732)
EDU1_10	−0.887 (0.656)	−2.135*** (0.766)	−1.187* (0.708)	−3.185*** (0.845)
HEDU	−1.554* (0.828)	−6.917*** (1.894)	−1.521* (0.899)	0.621 (0.999)
WINDEX	−0.00905 (0.00825)	−0.0217** (0.00930)	0.00267 (0.00894)	−0.0271** (0.0109)
ARS_AFFECTED	0.266 (0.295)		-0.0319 (0.153)	
ARS_ AFFECTEDP		−2.041*** (0.659)		−5.374*** (0.980)
OBSERVATIONS	436	436	442	442
NO OF UNION	3	3	4	4
LRCHISQ(10)	9.1	18.7**	24.73***	64.4***

Note: Standard errors are within parenthesis. ***, ** and * indicate significant at 1%, 5% and 10% level respectively.

7.5 COST OF ILLNESS

The next question we ask is what kind of a burden households bear as a result of exposure to arsenic contamination. Are households willing to pay to make the switch to clean water and to what extent are they already paying in the way of health costs and workdays lost? In order to address this question, we follow a simple health production function model to estimate health costs. Here, we build on earlier work by Dasgupta and Ray (1986, 1987) on the importance of nutrition for employment and poverty reduction. Dasgupta and Ray (1986, 1987) discuss a context where malnourished workers are less productive, earn less, and are, therefore, simply unable to become more productive. Such workers are caught in a poverty trap. Similarly, we assert that sickness due to arsenic can reduce wage income available to households because of losses in productivity and due to medical expenses. This may well contribute to leaving such households trapped in poverty.

Following Freeman (1993), most health cost studies start with a utility maximizing individual, whose utility function is defined as:

$$U = U(X, L, S) \tag{4}$$

where, X represents a composite market goods, L denotes leisure, and S represents sick days or the health condition of the individual. The partial derivatives are expected to be $(\partial U/\partial X) \geq 0, (\partial U/\partial l) \geq 0,$ and $(\partial U/\partial S) \leq 0.$

The individual's health is determined by her exposure to pollution (*P*), the actions she takes to reduce exposure or her avertive actions (*A*) and medical treatment taken to improve health (*M*). Thus, the sickness or health production function is given by:

$$S = S(A, M, P) \tag{5}$$

The individual's utility maximization problem therefore is:

$$\text{Max } U(X, L, S(A, M, P)) \tag{6}$$

Subject to

$$I + w(T - L - S) = X + P_a A + P_m M \tag{7}$$

where *I* is non-wage income, *T* is the total available time to the individual, p_a is the unit cost of avertive activities, p_m is the price or unit cost of medical treatment and X is treated as the numeraire with normalized price. The individual chooses *X, L, A,* and *M* to maximize her utility.

The simultaneous solution to the first-order conditions of this utility maximization problem establishes the demand for *X, L, M,* and *A*. For example, the demand functions for avertive activities (*A*) and medical treatment (*M*) would be:

$$A = A^*(I, w, p_a, p_m, P) \tag{8}$$

$$M = M^*(I, w, p_a, p_m, P) \tag{9}$$

Further, as Freeman (1993) shows, by maximizing (6), the individual's willingness to pay (MWTP) to reduce pollution can be deduced. This can be shown to equal the sum of four terms:

$$MWTP = w\frac{ds}{dp} + p_a\frac{\partial A}{\partial P} + p_m\frac{\partial M}{\partial P} - \frac{U_s}{\lambda}\frac{dS}{dp} \quad (10)$$

Thus, the *MWTP* for health benefits from a reduction in pollution is the sum of the resulting reduction in the time costs of illness plus the costs of any avertive actions taken plus medical and treatment expenses plus the monetary equivalent of the disutility of illness.

Most health cost studies estimate the health production function *S*, along with the avertive actions (*A*) and mitigating activities (*M*) function to obtain the *MWTP*. The dis-utility of illness is difficult to capture and is often ignored. Because the price of avertive actions and unit costs of medical treatment are difficult to establish, *A* and *M*, are usually estimated as expenditure functions. In our study, we estimate the sickness or dose-response function and the demand function for mitigating activities. Mitigation activities refer to actions undertaken to reduce the effects of arsenic-related sickness and include medical expenses, fees paid to doctors or pharmacists, and travel costs. We do not have data to estimate averting costs.

Survey data shows that arsenic-affected patients have very few sick days, when they fully stop working, and limited medical expenditures. Only eighty-two individuals, out of more than 3,260 individuals with some form of sickness, reported workdays lost due to sickness. In our sample of 5,563 individuals, only eighty-eight reported medical expenditures related to arsenic, even though 296 suffered from arsenic-related diseases. Consequently, instead of using continuous data to estimate the dose-response and mitigating functions, we use binary variables. Sickness takes the value of 1 if the individual reported arsenic-related sickness and 0 otherwise. Similarly, mitigating activities take the value 1 if an individual has any medical expenditure and zero otherwise. Using probit models, we estimate the probability of sickness and the probability of incurring mitigating expenditure due to exposure to arsenic.

A vector of independent variables is hypothesized to affect sickness and mitigating expenditures. These variables include: (a) individual level information such as age measured in years, education and the gender of the individual; and (b) a binary variable indicating the presence of arsenic in drinking water (which equals 1 if the tube well is labeled red or 0 if labeled green). Using a probit model, we determine the marginal effect due to a change in the source of drinking water (from red to green). The marginal effect measures the benefit of switching the source of water to a safe mode. The summary statistics of the variables used in the estimation of the dose-response and mitigating activities regressions are

Table 7.8 Summary statistics for sickness and mitigating costs function

Variable	Mean	SD	Min	Max
Sickness (days)	0.053	0.224	0	1
Medical cost (Taka)	280.04	2,469.75	0	80,000
Age (years)	27.5	20.2	0	110
Education (years)	5.2	3.9	0	13
Male (1=male)	0.503	0.5	0	1
Drink red (1= drink red)	0.559	0.497	0	1

Table 7.9 Estimation of the sickness and mitigating cost functions

Variables	Sickness		Medical_cost	
	Coeffcient	Marginal effect	Coefficient	Marginal effect
Age	0.0536***	0.0042***	0.0427***	0.0009***
	(0.0055)	(0.0004)	(0.0086)	(0.00017)
Age_Squared	−0.0005***	−0.00004***	−0.0003***	−0.000007***
	(0.00006)	(0.000005)	(0.00009)	(0.0000)
Education	−0.0342***	−0.00859*	0.0760	0.0016
	(0.0081)	(0.0006)	(0.0128)	(0.0003)
Male	−0.108*	−0.0086*	0.076	0.0016
	(0.0614)	(0.0049)	(0.0985)	(0.0021)
Drink_Red	0.517***	0.0397***	0.465***	0.0097***
	(0.0665)	(0.0049)	(0.111)	(0.0023)
N	5,549	5,549	5,549	5,549

Standard errors in parenthesis. * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$

presented in Table 7.8. The estimated probit equations and the marginal effects are shown in Table 7.9.[14]

Column 2 of Table 7.9 shows that the probability of sickness is associated with changes in age, and education. Since arsenic is a bio-accumulative element, the probability of arsenicosis increases non-linearly with age at a decreasing rate. Years-of-schooling is negatively associated with the probability of sickness. This reinforces our understanding that education is an indicator of health awareness; it may also be picking up some wealth effects. Finally, the impact of switching from red to green sources of water reduces the probability of sickness by 4 percent, by far the largest gain in terms of reducing sickness.

Column 4 of Table 7.9 shows the marginal effects of the mitigating expenditures regression. The probability of incurring health expenditures

[14] We also estimated these two probit equations jointly and did not find any difference in the results.

increases if the water source is red. Age, as in the previous case, has a non-linear effect.

The next step is to estimate the willingness-to-pay of households for switching to cleaner water sources. We estimate the marginal willingness-to-pay in the following manner:

$$MWTP = w \times \overline{WDL} \times P(S \mid \Delta P) + \overline{M} \times P(M \mid \Delta P) \tag{11}$$

$$= (A) + (B)$$

where $P(S|\Delta P)$ is the marginal effect or change in the probability of sickness (related to arsenic poisoning) for an individual due to changes in the level of arsenic poisoning, ΔP is the change from red to green well; w is average wage of the adult working population, $\overline{WDL}$ is the mean workdays lost, $\overline{M}$ is the mean mitigating expenditure per individual when he/she is affected with arsenic-related diseases and $P(M|\Delta P)$ is the change in the probability of incurring mitigating expenses due to changes in the level of exposure at the individual level. (A) measures the marginal impact in terms of income loss due to changes in the level of exposure to arsenic and (B) measures the marginal effect on mitigating expenditure due to changes in the exposure to arsenic poisoning.

Based on equation (11), and the coefficients from Table 7.9, we calculate the mean cost of illness for an individual from continuing to drink from red wells to be Taka 219 (USD 3) per year. Thus, to avoid sickness to all household members, a household would, on average, have to pay Taka 1,386 (USD 20) per household per year. However, if we consider that all household members are currently not sick, the lower limit on this number (taking into account the percentage currently sick or probability of sickness) is Taka 70 (USD 1) per year. These numbers provide a range for annual household willingness-to-pay for switching from red to green sources of water.

It is useful to compare our estimate of the benefits of switching with some other recent studies on willingness-to-pay (WTP) for clean water in Bangladesh. An earlier study by Ahmad et al., (2002) estimates the WTP for safe water to be Taka 2,831 per household per year. They use contingent valuation based on an understanding that households would have access to clean water either through home connections or stand posts. Madagewicz et al. (2007) estimate the lower bound for WTP based on an assessment of additional time taken by women to walk to alternative water sources. The implied WTP from their study is 90 Taka per month or Taka 1,080 per household per year. It is interesting to note that the time costs to households who switch wells in Madagewicz et al. (2007) is so much higher than the productivity and medical costs accrued by the average household in our study. So at the household level, the benefits of switching may be lower than the costs. This may partly explain why at least some households continue to use red wells.

7.6 CONCLUSIONS

Our analysis of water use in Matlab and Laksham Upazilas in Bangladesh suggests that a majority of households continue to drink from arsenic-contaminated red wells. Fifty-five percent of our sample households indicated that they used red wells, despite the fact that many were aware of arsenic contamination of their main source of water. We note that some 70 percent of the wells in the two Upazilas contain water with arsenic levels higher than the Bangladesh government's safe standard of 50 mg/liter.

There are many factors that constrain households from switching to safer water sources. In nearby Araihazar Upazila, Madajewicz et al. (2007) report that an information campaign lead 60 percent of people who learned that their well was unsafe to switch to a safe well within a year. In our study area, the red-well/green-well strategy is a way of providing households with similar information. Yet, a large percentage of households continue to drink from red wells. It is possible that many households switched to green wells when this information was originally provided by DPHE, but limited access to clean water prevented the remaining population from switching. Madajewicz et al. (2007) find that private well owners share their water mainly with relatives. Thus, there may be both social and distance or opportunity costs-related issues that prevent well-switching. These are topics that need to be further probed.

Higher education is the most important factor that reduces the probability of households drinking from red wells (it is far more important than wealth, for example). There is also an important role for information campaigns in reducing exposure to arsenic contaminated water. We find that information from TV/radio and NGO campaigns are more effective in reducing exposure to arsenic relative to information provided by the official agency DPHE. These effects are independent of other variables that may affect the household's decision to drink from red wells. Our overall conclusion is that non-government and private sector media sources of information are at least, if not more, effective than government sources. This is useful to know because the costs of delivering information through electronic media and NGO operations will differ from costs associated with government strategies.

Some 5 percent of our sampled individuals showed symptoms of arsenicosis. Most patients exhibited early stages of the disease. While this number seems small, the burden of arsenic contamination is clearer at the household level since 19 percent of households have at least one person sick from arsenic. Arsenic is a slow-growing disease. Thus, with continual exposure, we expect the number of sick individuals to continue to grow.

Households pay for their use of unsafe water by the sickness they experience. However, monetary payments in terms of wages lost or medical costs borne are low. We estimated a lower bound to the costs sick individuals bear as a result of arsenicosis and find that this is Taka 219 per year. Given that the per capita GDP in Bangladesh in 2005 was USD 444, the health costs of arsenic exposure amount to about 1 percent of annual income (for sick individuals). This percentage, however, is an underestimate since income in rural districts is likely to be lower than the Bangladeshi average and because we are only able to estimate the costs partially. The stress, the difficult choices households face, the general malaise from using bad water, and the costs of any avertive actions taken are not accounted for in our analyses.

Previous research (Khan 2007) suggests that there are technologies available to remove arsenic that cost less than 1000 Taka to buy and would cost about the same per year to maintain. These seem to be too expensive relative to medical and productivity losses currently sustained by households. UNICEF estimates that an investment of USD 200 million is required to provide arsenic-free water to the most exposed 20 million of the population (assuming 20 people share one tube well) (UNICEF Bangladesh 2011). This suggests an investment cost of USD 10 per person or approximately USD 50 per household. Any such investment may be viable because it would bring benefits that go beyond reductions in arsenicosis. Plus, as we previously noted, the costs of continued exposure to arsenic will increase over time. However, like so many governments in developing countries, the Government of Bangladesh is constrained by resources and ability in terms of the public investments it can rapidly make.

Finally, we note that we are unable to say for sure what factors lead to the actual switch from red wells to green wells. We do not have before-and-after information to answer this specific question. We have also yet to ascertain the independent effect of different types of information awareness campaigns. Further, our results hinge on the use of somewhat imperfect instruments. Thus, there are several issues that require further analyses. Arsenic contamination is a serious long-term issue in Bangladesh. This chapter is mainly an effort to raise awareness about the issue and identify areas for future economics research.

Appendix

Table 7.10 First-stage negative binomial regression

Dep Var: ars_affect	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
Tube wells	−0.531	0.163	−3.260	0.001	−0.850	−0.211
Chro_Ill	0.378	0.082	4.630	0.000	0.218	0.538
Cur_owner	0.069	0.194	0.350	0.723	−0.311	0.449
Female	−0.849	0.241	−3.530	0.000	−1.321	−0.377
NGO_Arsenic_related	−0.107	0.201	−0.530	0.595	−0.502	0.288
News	−16.445	0.759	−21.660	0.000	−17.934	−14.957
Info_DPHE_survey	−0.428	0.215	−1.990	0.046	−0.848	−0.007
F_more	1.978	0.435	4.550	0.000	2.831	1.125
Edu1_10	−1.754	0.446	−3.930	0.000	−2.628	−0.879
Hedu	−3.574	0.403	−8.880	0.000	−4.363	−2.785
WINDEX	0.002	0.005	0.360	0.717	−0.008	0.011
Cons	2.543	0.372	6.830	0.000	1.813	3.273
Alpha	1.303	0.425			0.688	2.469

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