Fetching Water in Rural India

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Comments are welcome.

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Abstract

In 18.6% of rural Indian households in 1999, somebody (usually female) had to devote an average of 47 minutes per day to fetching water – time which could have been put to more productive use. The provision of tap water illustrates two crucially important and linked aspects of the development process – the problem of organizing collective action which can potentially improve the well-being of all residents of a locality and the distribution of the potential benefits of such co-operative behaviour. This paper uses micro data from the 1998-99 Indian Time Use Survey (ITUS) conducted in Gujarat, Tamil Nadu, Madhya Pradesh, Meghalaya, Orissa and Haryana (covering 77,593 persons in 18,592 households). The ITUS provides direct observation of time spent in social interaction, enabling comparison of the relative quantitative importance of social interaction and of inequality in land ownership and caste status for local infrastructure – e.g. the availability of tap water. The paper also examines the intra-household allocation of the task of carrying water and the adverse implications of this task for the education of girls and boys.

Fetching Water in Rural India

"the fundamental scarce resource in the economy is the availability of human time"

-Juster and Stafford (1991:471)

"a minimum water requirement for human survival under typical temperate climates with normal activity can be set at three liters per day. … in tropical and subtropical climates, it is necessary to increase this minimum slightly, to about five l/p/d, ... A further fundamental requirement .. is that this water should be of sufficient quality to prevent water related diseases."

- Gleick (1996:84)

Humans are all alike in facing the basic constraint of time and in needing water to drink every day. As well, water is needed for sanitation, bathing and food preparation. Adding all water needs together, the United Nations High Commissioner for Refugees (1992)[1] suggests that 15 litres per person per day is required while the Human Development Report of UNDP sets a standard of 20 litres per capita per day, and Gleick (1996) argues for a higher minimum – approximately 50 litres per day per person. Whatever the exact level of this basic need, the residents of developed countries (and the majority of Indian citizens) can simply turn the tap and satisfy it immediately, but in approximately 18.6 % of rural Indian households somebody (usually female) has to spend an average of 47 minutes per day fetching it. This paper is about the causes and implications of inequality in access to this basic necessity of life.

Who has to fetch water and why do they not now have the access that most people take for granted? If they could use for other purposes the time that they now have to spend collecting water, what would the implications be – e.g. for the education of children? This paper begins in Section 1 with an overview of water collection in India and a brief description of the Indian Time Use Survey of 1998-99. Section 2 develops a simple model

[1] "Optimum standards in most refugee emergencies call for a minimum per capita allocation of 15 litres per day plus communal needs and a spare capacity for new arrivals. When hydrogeological or logistic constraints are difficult to address, a per capita allocation of 7 litres per person per day should be regarded as the minimum "survival" allocation. This quantity will be raised to 15 litres per day as soon as possible." UNHCR (1992:5)

of water provision. Section 3 then asks why some households have immediate access to water while others do not, and examines in particular the relative importance in enabling the supply of water of community level social capital and inequality in land and in caste. Section 4 documents the highly gendered division of labour within households in fetching water and discusses the determinants of water collection time. Section 5 focuses on the implications for human capital formation of water availability. Section 6 concludes.

1. Overview

1.1 The Time Burdens of Poverty

The daily burden of carrying water does not fit neatly into current debates on world poverty. Although the World Bank, for example, begins its training manual on the measurement of poverty with the general statement: "Poverty is "pronounced deprivation in well-being.", it quickly goes on to note that the starting point for most analyses of poverty is to define "well-being" in terms of "the command over commodities in general, so…. poverty is then measured by comparing an individual's income or consumption with some defined threshold below which they are considered to be poor." (2005:8),

One important debate in this tradition is about whether command over commodities is best measured – conceptually and in actual survey data – by income (i.e. potential consumption) or by actual consumption (perhaps including the services of durable goods). A second debate concerns whether the definition of the poverty threshold should be an absolute standard (e.g. the Purchasing Power Parity equivalent of US$1 or US$2 per day per capita) or relative to the income or consumption norms of the society (e.g. one half of median equivalent income). A general problem with this measurement tradition is its inability to detect inequalities in "command over commodities" *within* households, which implies that gender based inequities are often ignored. But in all this discussion the time cost of obtaining a specific commodity is not a focus of attention.

As the World Bank manual (2005:8) also notes: "a second approach to well-being (and hence poverty) is to ask whether people are able to obtain a *specific* type of consumption good." Given that the human body has a physiological need for water, it is a clear example of a basic necessity. For this reason, the Human Poverty Index of the UNDP includes, as one of its components, the percentage of the population "without sustainable access to an improved water source". By this criterion, the UNDP ranks India (at 14%) as far superior to countries like Mali (52%) or Niger (54%)[2], but "Reasonable access is defined as the availability of at least 20 litres a person per day from a source within 1 kilometre of the user's dwelling". As any reader can easily check, carrying this amount of water for a four person family (i.e. 80 litres) is not at all easy[3] – and a return journey of up to two kilometres takes significant time. Hence, having "access" to water does not really capture the burden of this daily task.

Sen's "capabilities" approach to thinking about deprivation is perhaps the closest in spirit to the current paper, but carrying water is a task, not a capability. For those individuals who physically cannot carry water, individual capability may be crucially important. However, for most people the problem is not that they cannot do this task, but the fact that doing it subtracts from the time and energy available for other tasks. Moreover, whether this task is small or large depends on the local community facilities for water provision – i.e. carrying water is both an individual task and a community characteristic.

Nevertheless, people who have to spend a significant part of every day carrying water have a clear claim to be experiencing "pronounced deprivation in well-being" – and it is easy to observe that this deprivation is very unequally shared within households. Piping water to a dwelling, rather than having to carry it in a bucket, is also as clear an example of capital/labour substitution that improves well-being as one is likely to find. If some people can afford to dig their own private wells, but the construction and maintenance of public water distribution infrastructure requires community organization, the fact that the affluent do not now have to carry water is likely to be crucially important in determining tap water availability. Analysis of the time and energy people spend carrying water therefore raises, in a very concrete way, some central concerns about inequality, gender, public goods and social capital in the development process.

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[2] See Human Development Report (2005: pages 229 and 360.

[3] A fit male weighing 80 Kilograms can carry 25 litres of water one kilometre in 18 minutes on flat sidewalks – since it takes 11 minutes to walk the empty journey, and 5 minutes to fill buckets, the total time required for one round trip is about 34 minutes. The authors conjecture that 25 litres (which weighs 55 pounds, in Imperial units) is not far from the maximum practicable weight for a single trip, given the awkwardness of the load. Smaller stature, uneven terrain or poorer nutrition – the reality of most people who do this daily – imply that multiple journeys with smaller loads would typically be required. A family of four using the UNDP minimum of 20 litres per person per day would need eighty litres – which weighs 80 Kilograms (approximately 176.4 pounds in Imperial units) and necessarily involves several trips.

1.2 Data Description

Between June, 1998 and July, 1999, the Central Statistical Organization of India conducted a pilot Time Use Survey in Haryana, Madhya Pradesh, Gujarat, Orissa, Tamil Nadu and Meghalaya states. A stratified random sampling design, as followed in the National Sample Surveys (NSS), was used to survey 18,592 households (12,751 rural and 5,841 urban) with 77,593 persons, of whom 53,981 were rural and 23,612 were urban residents. The survey was conducted in four rounds during the year to capture seasonal variations in the time use patterns of the population. Two person teams of male and female interviewers stayed in each village or urban block for nine days to compile time diaries for normal, abnormal and weekly variant days. Respondent households were first visited to assess their weekly pattern of time use and then revisited to complete a complete diary of activities concerning the previous day for all household members over six years of age. Although the sample design was explicitly constructed to capture differences in time use between normal and weekly variant or abnormal[4] days, in practice Hirway (2000:24) noted that "On an average, of the total 7 days, 6.51 were normal, 0.44 weekly variant day and 0.05 was abnormal day… in rural areas people continue their normal activities on holidays also." This paper therefore focuses on time use on "normal" days.

As Pandey (1999:1) noted: "India has lot of socio-economic, demographic, geographic and cultural diversities. To ensure that all aspects of diversities are captured, Haryana, Madhya Pradesh, Gujarat, Orissa, Tamil Nadu and Meghalaya were chosen to represent northern, central, western, eastern, southern and north-eastern regions respectively." Although one might wonder whether six states' data could fully capture the diversity of India, Hirway (2000: 11) has argued "cross-checking of the results has

[4] The personal interview methodology was very labour intensive, but was considered necessary to collect reliable diary data from respondents who are, in some cases, illiterate. For a discussion of the advantages of the diary methodology in improving recall and imposing consistency see Gersuny (1998). An "abnormal" day is defined in the "Instruction Manual for Field Staff" (1998: 23) as "that day of the week when guest arrives, any member of the household suddenly falls sick, any festival occurs, etc.". The "weekly variant" is "determined according to the pattern of the major earners holiday. If the major earner does not holiday, then school children's holiday will be taken. If even this is not applicable, then day of weekly hat (bazaar) may be taken".

confirmed that the sample is fairly representative of the country". In any event, this data would be interesting even were this not the case, i.e. even if the data were only seen as a sample of the 233 million people inhabiting these six states[5].

Figure 1 plots the distribution of total water collection time in the 18.6% of rural households who have to collect water while Table 1 presents some basic descriptive statistics on who collects water in rural and urban areas. Within each panel of Table 1, the left column reports the percentage of all time spent, by all people, collecting water. Column R1 indicates, for example, that in rural areas approximately 1.3% of all water fetching work is done by boys and another 7.0% is done by adult men. Column U1 shows that in urban areas boys do 0.3% of this work and men do about 11%. The conditional probability that, if a household has to collect water, a particular type of person will have to do it is given in columns R2 and U2 of Table 1. Since bar graphs may help to confirm visually the relative size of demographic differences, Figures 2 and 2A show the relative probability, and percentage of total water collection time, of boys, men, girls and women. Clearly, "carrying water" is a heavily gendered task – in both the urban and rural areas of India adult women do about 87% of this kind of work.

The third columns in each panel report the average time spent in a normal day by people who have to collect water. For those people who have to do it, carrying water is clearly a significantly important task. As column R3 shows, on the average rural women who fetch water spend more time (47 minutes daily) than rural men (40 minutes), but approximately the same time as boys (48 minutes). Moreover, in rural households where the girls are sent to do this task, it is little more onerous (50 minutes per day). Column U3 indicates that the time spent on water collection is actually not very different in urban areas, except for girls who spent much less time.

In our sample, although there is a wide range of variation across individual villages and districts in the percentage of people who are members of scheduled castes or scheduled tribes, the percentage of scheduled caste members and of other castes who collect water is

[5] The stratified sampling procedure used in the Time Use Survey was designed to ensure representation for four strata – above/below median population density and above/below median scheduled tribes proportion in the population. As a result, state level proportions along a particular dimension (like water availability) may not align well with Census data. The Census did not collect time use data, but it did ask about water source. Appendix B to this paper compares the Census information available on water collection at the state level with respondent reports of time use in water collection, which are sometimes higher, and sometimes lower, than might be expected from the Census data. For this reason, this paper concentrates on aggregate national data.

not very different (36.0% as compared to 34.7%) and neither is the length of time required (48 minutes daily as compared to 45 minutes). As the bottom row of Table 1 indicates, paid collection of water is very small relative to unpaid household collection – in rural areas only 1.2% of water collection time was paid, and in urban areas only about 1.4%. This paper will therefore focus on unpaid collection of water – and because the context of water collection is so different in urban and rural areas, the remainder of the paper will focus on rural areas, leaving the fetching of water in an urban context to further research.

Table 1
Water Collection Time by Age, Gender, Social Group and Remuneration - Normal Days, 1998/99 Indian National Pilot Time Use Survey

	Rural			**Urban**		
	% of total water collection time ***R1***	% of individuals of type in households gathering any water. ***R2***	Average daily time spent (minutes) ***R3***	% of total water collection time ***U1***	% of individuals of type in households gathering any water. ***U2***	Average daily time spent (minutes) ***U3***
Boys (6-14 yrs)	0.0128	0.0437	48.46	0.0037	0.0167	42.19
Men (>14 yrs)	0.0704	0.0705	39.96	0.1092	0.0964	39.80
Girls (6-14 yrs)	0.0479	0.2052	50.13	0.0197	0.0964	36.03
Women (>14 Yrs)	0.8689	0.7461	47.06	0.8674	0.7047	43.06
Scheduled Tribe	0.0907	0.0405	55.17	0.0465	0.2848	58.33
Scheduled Caste	0.2737	0.3620	47.99	0.0844	0.3821	38.77
Others	0.6355	0.3472	45.08	0.8691	0.3457	42.30
For Payment	0.0123	0.0042	48.16	0.0136	0.0063	31.92

Categories refer to:

R1 & U1: % of total water collection time of all people performed by persons in category Xi.

R2 & U2: % of individuals in households that gather any water of type Xi who are involved in water collection

R3 & U3 Average daily time spent (in minutes) by all individuals in group Xi who are involved in water collection.

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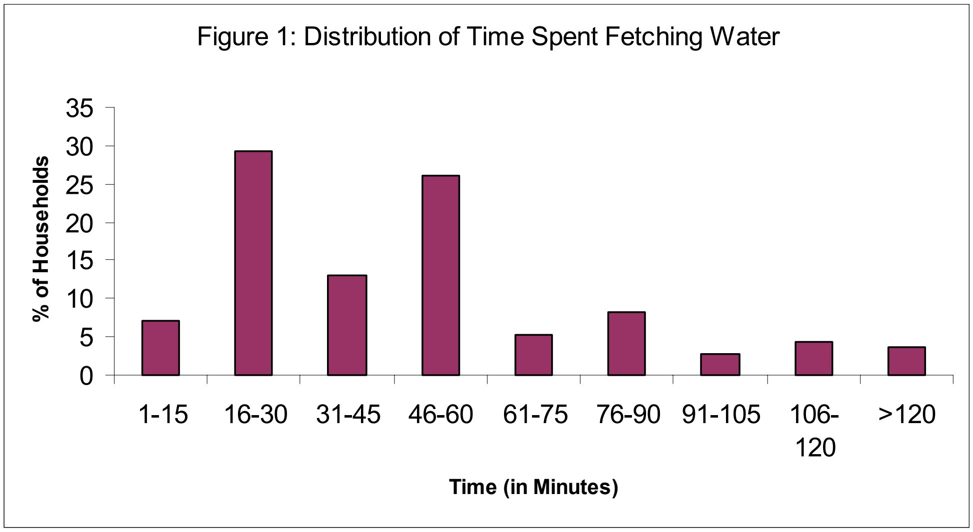
Figure 1: Distribution of Time Spent Fetching Water
% of Households
35
30
25
20
15
10
5
0
1-15
16-30
31-45
46-60
61-75
76-90
91-105
106-120
>120
Time (in Minutes)

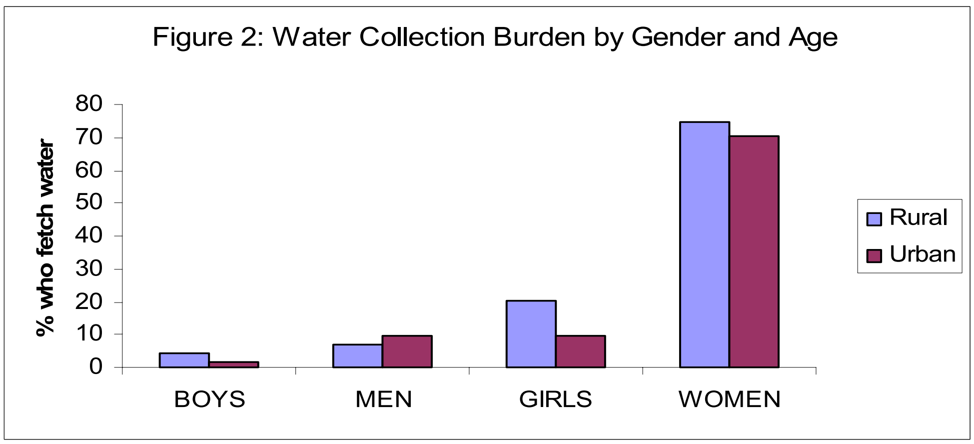
Figure 2: Water Collection Burden by Gender and Age
% who fetch water
80
70
60
50
40
30
20
10
0
BOYS
MEN
GIRLS
WOMEN
Rural
Urban

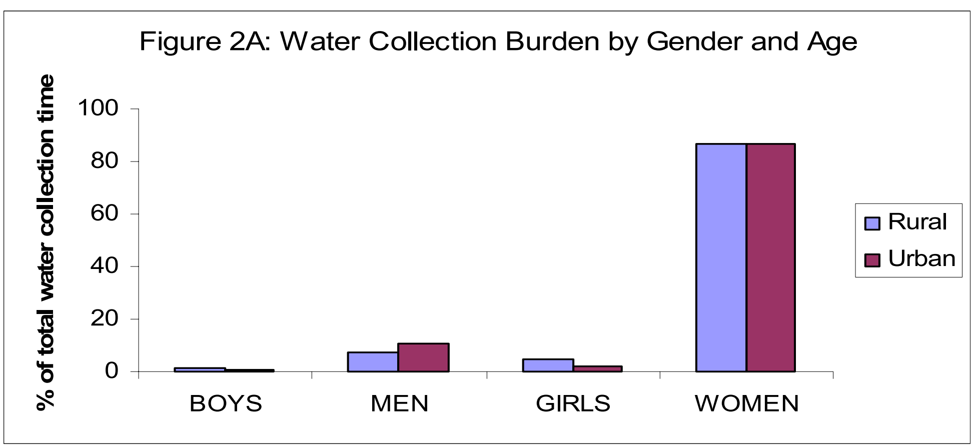
Figure 2A: Water Collection Burden by Gender and Age
% of total water collection time
100
80
60
40
20
0
BOYS
MEN
GIRLS
WOMEN
Rural
Urban

2. A Simple Model of the Supply of Tap Water

Any geographic locale populated by humans must have some source of water supply – hence the major issue on the supply side of water markets is the delivery mechanism[6]. What determines whether the infrastructure to deliver tap water is constructed or whether households have to carry water from whatever source exists? Tap water delivery requires the construction of distribution facilities that are often beyond the means of individual households in poor countries. In addition to the fixed cost of pumping stations and the marginal costs of piping and maintenance, there is a cost to the negotiations required to arrange construction and the rights of way needed for water distribution – negotiations which face the problem that the benefits of piped water are unequally distributed.

A simple model to capture the essence of the issue starts by abstracting from the specificities of geography and assuming that a point source of water – a well with finite capacity – now serves a population that is uniformly distributed on a featureless plain. Suppose that this well can supply N households and each individual household is located at a given distance from the well. We can summarize their cost in time and effort of collecting water from the well as a fixed time cost of filling containers and a linear function of distance, which for households with a given opportunity cost of time w can be represented as line OC in Figure 4.

We assume that the technology of tap water supply is characterized by the fixed cost of building a pumping station, whose annualized value is given by b_0, and a constant annualized per meter marginal cost (b_1) of connective piping and maintenance. If individuals closer to the well are already connected to the distribution system, the marginal cost function can be represented as the line MC in Figure 4.

The main point of Figure 4 is to illustrate a dilemma in piped water systems. Households located close to the water source have relatively little to gain, because their current time costs of carrying water are small – indeed Figure 4 is drawn to illustrate the case where households closest to the well are not willing to pay even the marginal cost of

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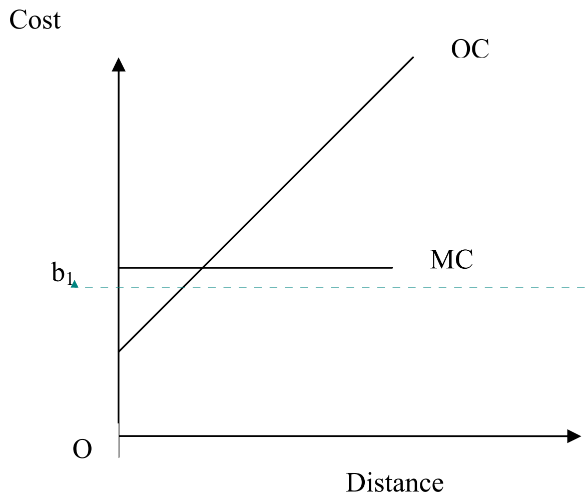
[6] Since humans will die without drinking water, one could argue that any individual utility-based consumer demand function should specify consumption of at least enough water to ensure survival. It is straightforward to add such a constraint to a standard consumer demand model and complete the demand side of the water market, recognizing that Section 2 above only sketches the supply side.

connection. However, more distant households can only connect at the marginal cost of service if service to their nearer neighbours already exists.

Figure 4



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If land ownership is fragmented[7] and if each household behaves selfishly, a very complicated game of bluff, holdup and reneging on contracts could ensue. We presume that discriminatory pricing is not feasible, and that the basic issue is whether the median voter[8] will support a community water supply authority[9] which prices at average cost.

Institutions (like water supply authorities) do not, however, drop without cost from the sky. A costly process of negotiation is needed to establish a public authority and determine its pricing policy. If all individuals received the same benefit from the public authority, such negotiations would likely be short, as all would agree immediately on whether to establish it. Negotiation is necessary if interests diverge and tends to be more

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[7] If all land were owned by a single landlord, the landlord could operate as a price discriminating monopolist, who could extract all the consumer surplus in water distribution.
[8] More generally, given the imperfections of effective democracy in rural areas, supporters of community infrastructure may need to mobilize more than 50% + 1 – but the basic point remains, whatever the critical quantile of the distribution of voters.
[9] Market-based solutions require some credible institutions for the enforcement of long term contracts since no agent would otherwise make irrevocable investments in fixed cost facilities and piping. Substantial transactions costs would also be incurred if each household were to atomistically buy from upstream and exploit their downstream market power. The non-existence of such institutions is arguably a crucial part of the development problem.

protracted if mutual trust is absent. We presume that the total cost of negotiation depends multiplicatively on both the total absolute difference between residents in the net benefits they will receive from the water system and the level of mutual mistrust.

Inequality in the net benefits of a piped water system is inherent, since the opportunity cost of not having a water distribution system depends on the distance water must otherwise be carried. In addition, inequality in net benefits is accentuated by any inequality in the opportunity cost of time *w* – which will vary with household wealth, in both human capital and land ownership. As well, if water carrying is a gendered task and if the benefits of piped water in saved labour are received by women while the cash costs of municipal water rates are paid partly by men, inequality in power within households will affect the perceived net benefits of the family patriarch, who may be the relevant "voter".

If we summarize "mistrust" as a parameter b_2, Equation 1 expresses the total cost of water supply (*TC*) as the sum of the fixed costs (b_0) and variable costs of connection (b_1N) and negotiation costs.

$$TC = b_0 + b_1 N + b_2 \Sigma_i \Sigma_j \left| u_i - u_j \right| \qquad (1)$$

Average costs of piped water supply (*ATC*) are then given by equation 2[10]. If the crucial issue for political support of a water authority is whether or not the critical voter is better off (i.e. whether *ATC* < *OC*), this implies that the important variables are the fixed cost of supply and the levels of inequality in the benefits of piped water and of mistrust.

$$ATC = \frac{b_0}{N} + b_1 + b_2 \frac{\Sigma_i \Sigma_j \left| u_i - u_j \right|}{N} \qquad (2)$$

Some inequality in benefits of tap water is unavoidable, given the varying distances which people live from water sources – but in the ITUS data on rural villages there is also evidence of substantial variation in the degree of inequality in wealth and income, which also contributes to inequality in benefits. The ITUS data also contain plausible proxies for the cost of negotiation. Since the social capital perspective (e.g. Grootaert and van Bastelaer 1999:11) emphasizes the importance for development of "cognitive social capital— in the form of trust emanating from personal contacts" and a reasonable presumption, in the

[10] Recall that the Gini index is defined by $\frac{\Sigma\Sigma \left| u_i - u_j \right|}{2\mu N^2}$, where μ is the average benefit, which we normalize to 1.

context of rural India, is that caste barriers may impede co-operation, we can write equation 3 as:

$$b_2 = f_1 \text{ (social interaction, \% scheduled caste or tribe)} \qquad (3)$$

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It follows that a reduced form expression for the probability of a local water system being supported by the critical voter can be expressed as:

$$\text{Prob (ATC} < \text{OC)} = f_2(b_0\text{, social interaction, \% scheduled caste / tribe, Gini (wealth))} \qquad (4)$$

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3. Why do some households have to collect water?

The question "Why do some households have to collect water?" really has two components:

1] Why do some localities have access to tap water, while other localities do not?

2] Why, when local facilities exist, do some households not benefit, because they are not connected to the local water distribution system?

The likelihood that a particular household will not have to spend any time fetching water is a compound probability – i.e. the product of the probability that tap water is available from a local well or pipe system and the conditional probability that the household can connect to the local distribution system, if it exists. In our data, we observe this compound probability, and the issues we want to examine are the characteristics of communities that determine the local availability of drinking water and the characteristics of households that determine access to locally available supplies.

3.1 Household Characteristics and Access to Water

The natural perspective of economists is to think of price and individual income effects as possible explanatory variables in predicting household demand for a service (such as tap water) – but the size of such effects, relative to the influence of other possible explanatory variables, is an empirical issue. Table 2 reports the results of a probit model of the probability that a rural household will have tap water – i.e. that all members of a given household will report spending zero minutes, in a normal day, on the task of collecting water. It presents four slightly different specifications, which differ only in the way that community level variables are specified (as Section 3.2 will discuss).

The ITUS data does not contain any direct measurement of the money price of water. Since water supply in rural India is not metered, the money price of water, at the margin, is zero. However, hook-up charges or local taxes to defray distribution costs may still imply that "ability to pay" could be a significant barrier to having tap water, even where it is locally available, so Table 2 examines the case for an individual household "wealth effect".

Current income can approximated in the ITUS by aggregate monthly household *expenditure* per capita. However, since the respondents to the ITUS were asked a single summary question about total average monthly expenditures by the household (rather than the series of questions on categories of consumption which a household expenditure survey would use to add up total consumption) we are cautious about possible measurement error in this variable[11] – particularly since it is unlikely to include self-production of food and fuel. Since income is not the variable of theoretical interest for this paper we therefore present two sets of empirical results, in order to demonstrate that our conclusions are unaffected by the inclusion or exclusion of this variable. In Appendix C to this paper we report probit regression results in which reported monthly per capita household expenditure is included as a determinant of tap water access – and has the expected positive sign, and is statistically significant in specifications A and B. Tables 2 and 2A in the main body of the text report regression results which are identically specified, except that reported monthly expenditures per capita are omitted as an independent – it is notable that the sign and statistical significance of other variables is unaffected by the inclusion/exclusion of this variable, and that point estimates of coefficient size are typically well within one standard error.

Moreover, since digging one's own well, or connecting to a local pipe system, represents an investment with a long term return in time and energy, one could arguably expect *wealth* and not *income* to be the more important individual household determinant of access to tap water. If one interprets occupation as indicator of human capital wealth, the

[11] Our caution is also partly due to the relatively small reported differentials in monthly expenditure for households with large differentials in land owned. The correlation between monthly per-capita expenditure and land ownership is also very low (0.16).

negative coefficient in Table 2 on a dummy variable ("labourer") indicating that the primary source of income (more than 50%) is from agricultural or other labour and the positive coefficient on "professional" (e.g. engineer, doctor etc.) status are both as expected (both are strongly statistically significant). Table 2 also indicates that home ownership is strongly statistically significant, with the expected positive sign – but the *amount* of land owned plays no further role.

Table 2: Probit Analysis of the probability that a rural household will not fetch water

Variable	**Model A**	**Model B**	**Model C**	**Model D**
Intercept	-0.76623*** (0.061271)	-0.761863*** (0.061178)	1.699897*** (0.1959)	1.754393*** (0.192477)
Laborer Household	-0.091615*** (0.031412)	-0.092102*** (0.031414)	-0.083503*** (0.031996)	-0.083528*** (0.032008)
Professional Household	0.16509** (0.060725)	0.167461*** (0.060723)	0.164042*** (0.061764)	0.16967*** (0.061783)
Owns Homestead	0.245252*** (0.03086)	0.24572*** (0.030871)	0.088446*** (0.034131)	0.085052* (0.034221)
Land Owned (in Acres)	0.005418 (0.003905)	0.005654 (0.003904)	0.001406 (0.004001)	0.002031 (0.004005)
Dependency Ratio (Unpaid Members/Household Size)	-0.18092*** (0.052594)	-0.18115*** (0.052594)	-0.219302*** (0.053675)	-0.223346*** (0.05369)
Female Household Head	-0.017219 (0.044493)	-0.016931 (0.044489)	-0.009615 (0.04498)	-0.011681 (0.044967)
Scheduled Caste or Tribe	-0.082362** (0.029666)	-0.084384*** (0.02964)	-0.032958 (0.033147)	-0.03175 (0.033146)
Percentage of Scheduled Caste and Tribes in the District			-0.697205*** (0.083892)	-0.732666*** (0.082571)
Gini of Land Ownership for the District			-2.928081*** (0.211549)	-2.963222*** (0.20985)
Average Social Interaction Time for the Village (in minutes)	0.005001*** (0.001466)			
Average Male Social Interaction Time for the Village (in minutes)		0.003954*** (0.001229)		
Average Social Interaction Time for the District (in minutes)			0.021554*** (0.003764)	
Average Male Social Interaction Time for the District (in minutes)				0.017985*** (0.003066)
Replenishable Ground Water Per-Capita for the State (Billions of Cubic Metres per year)	0.032311*** (0.000933)	0.032256*** (0.000932)	0.021554*** (0.003764)	0.017985*** (0.003066)
Sample Size	12689	12689	12689	12689
Log Likelihood	-5274	-5275	-5112	-5112

Number of Households that do not fetch water: 10329 (81.40%)
*** 99% Confidence Level. ** 95% Confidence Level. *90% Confidence Level
Standard Errors in Parentheses

Table 2A: Marginal Effects and Elasticities for the probability that a household does not fetch water

Variable		Model C		Model D	
	Base Value	**Effect**	**Elasticity**	**Effect**	**Elasticity**
Laborer Household***	0.0000	-0.0227		-0.0212	
Professional Household***	0.0000	0.0391		0.0430	
Owns Homestead ***	1.0000	0.0343		0.0215	
Land Owned (in Acres)	2.0495	0.0003	0.0000	0.0005	0.0000
Dependency Ratio (Unpaid Members/Household Size)***	0.4581	-0.0464	0.0147	-0.0566	0.0152
Female Household Head	0.0000	-0.0024		-0.0030	
Scheduled Caste or Tribe	0.0000	-0.0047	0.0003	-0.0080	0.0003
Percentage of Scheduled Caste and Tribes in the District***	0.4012	-0.1769	0.1488	-0.1856	0.1639
Gini of Land Ownership for the District***	0.7311	-0.8238	2.6239	-0.7508	2.6813
Average Social Interaction Time for the District (in minutes)***	4.1612	0.0053	0.0001		
Average Male Social Interaction Time for the District (in minutes)***	5.1707			0.0046	0.0001
Replenishable Ground Water Per-Capita for the State (in Billions of Cubic Metres per year)***	47.5353	0.0083	0.0003	0.0084	0.0003

*** Statistically Significant at 99 % Confidence Level
* Statistically Significant at 90% Confidence Level

For the dummy variables (= 1 if Labourer Household, Professional Household, Owns Homestead, Female Household Head and Scheduled Caste or Tribe; = 0 otherwise) the marginal effect constitutes a change from 0 to 1.

This result is plausible if one thinks of water as a basic necessity, and water collection as an onerous chore, since one would expect that one of the first things a household does with additional affluence is obtain tap water (where it is available), but that additional acres of land holdings might have no further marginal impact. However, as a measure of ability to pay, expenditure is incomplete without some consideration of household income needs, so Table 2 includes as well the household dependency ratio, which is statistically significant and has the expected negative sign in all specifications.

In the context of rural India, members of scheduled castes may be prevented by informal social barriers from having convenient access to the same stand pipe or well as other village residents, and the village level specifications (A and B) in Table 2 indicate that such people are less likely to have water access. However, there is no statistically significant impact of female headed status on the likelihood that a household will have to collect water.

3.2 Community Characteristics and Access to Water

Why might *community* characteristics affect an *individual household's* access to tap water? Water is not a classic "public good" since it is both rival in consumption and easily excludable. However, wells, reservoirs, piping and other water production facilities have significant indivisibilities and economies of scale[12]. As well, the efficient distribution of water often requires piping or aqueducts which may have to cross many individuals' properties – which implies that water provision and distribution requires either a very high degree of voluntary co-operation or some public sector "eminent domain" rights to construct facilities. Hence, in most countries the public sector is deeply involved in provision of water infrastructure [13]. In affluent nations, tap water supply is nearly universal, but, as Table 1 indicated, in developing countries like India coverage may be far from complete.

The provision of tap water can thus be seen as illustrating, in a very concrete way, two crucially important linked aspects of the development process – the problem of organizing collective action which can potentially improve the well-being of all residents of a locality and the problem of distribution of the potential benefits of such co-operative behaviour. In recent years, an emergent literature has stressed the importance of local "social capital" for the organization of co-operative action – either in direct voluntary supply of local infrastructure or in the mobilization of political pressure which produces public sector action (see, for example, Dayton-Johnson, 2000, 2001). The World Bank's website on Social Capital is particularly rosy:

> "Social Capital refers to the norms and networks that enable collective action. It encompasses institutions, relationships, and customs that shape the quality and quantity of a society's social interactions. Increasing evidence shows that social

[12] Pipe capacity, for example, varies with the pipe's cross-sectional area (which, if r is the pipe's radius, is given by πr^2) while pipe cost typically varies with a pipe's circumference (which is given by $2\pi r$).

[13] Albeit sometimes, as in the UK, the state may define its role as licensing and regulating privately owned local water utility monopolies.

capital is critical for societies to prosper economically and for development to be sustainable. Social capital, when enhanced in a positive manner, can improve project effectiveness and sustainability by building the community's capacity to work together to address their common needs, fostering greater inclusion and cohesion, and increasing transparency and accountability[14]."

Putnam has variously defined "social capital" as "connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them" (Putnam, 2000:19) or as "features of social organization, such as networks, norms, and trust, that facilitate co-ordination and co-operation for mutual benefit" (Putnam, 1993). For Woolcock and Narayan (2000: 227) "social capital refers to the norms and networks that enable people to act collectively."

As many authors have noted, such norms and networks can "bond" individuals into mutually exclusionary, divisive, small social groups or "bridge" social groups to link individuals to the wider society – so "social capital" is not inherently either positive or negative in its implications for development. Nevertheless, Mogues and Carter (2005) are representative of a large literature which sees local social capital as potentially determinative of the co-operative behaviour on which development depends. As they note, individuals can invest time in relationships with others to produce a personally valuable asset – their network of relationships. Aggregating these individual networks will produce a set of social networks. Since "knowing people who know people" generates indirect social contacts, network-building has economies of scale, but each individual will, in their network building, always have to work within the constraints on social interaction which their local society has inherited from the past. The amount of "bridging" social capital which might affect development therefore depends on both the strength of inherited social divisions and the intensity of current social interaction among local residents.

A unique aspect of time use data is its direct measurement of the time individuals spend in the social interaction which produces and embodies social networks. In coding the time use of Indian respondents, both formal political and "civil society" types of

[14] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALDEVELOPMENT/EXTTSOCIALCAPITAL/0,,contentMDK:20642703~menuPK:401023~pagePK:148956~piPK:216618~theSitePK:401015,00.html

interaction[15] and informal socialization were separately identified. Except for politicians and full time activists, however, political and civil society activity tends to be highly episodic – so, as Table 3 indicates, a relatively small percentage of the population reports such activity on any given "normal" day. But, as Putnam (2000) argues (and as any practicing politician can attest) the personal connections and networks of trust which are the basis of political organizing and civil society are formed (or not formed) in normal social interaction. Since the Time Use Survey data reports the time individuals spend in "*SOCIAL AND CULTURAL ACTIVITIES, MASS MEDIA, ETC.*" we can identify the average local level of social interaction[16]. As Table 3 indicates, social events are also somewhat episodic – implying that on any given randomly selected normal day one only observes about one male in twenty engaged in a recorded social event, with an average duration of about one hour and twenty minutes[17].

Table 3: Time Spent on Community/Civic Activities and on Social Interaction

	Male	Female	All
Time on Community Activities			
Average Time (over individuals who spend positive time)*	96.57	93.29	95.01
Percentage involved	1.13%	1.09%	1.11%
Average Time (over the total population)	1.09	1.01	1.05
Time on Social Interaction			
Average Time (over individuals who spend positive time)	77.91	73.47	76.04
Percentage involved	5.00%	3.85%	4.44%
Average Time (over the total population)	3.89	2.83	3.37

* All times in minutes/normal day.

[15] Specifically, the following activities were identified under *Community Services and Help To Other Households:* 611. community organised construction and repairs: buildings, roads, dams, wells, ponds etc.
621. community organised work: cooking for collective celebrations, etc.
631. volunteering with for an organisation (which does not involve working directly for individuals)
641. volunteer work through organisations extended directly to individuals and groups
651. participation in meetings of local and informal groups/caste, tribes, professional associations, union, fraternal and political organisations
661 involvement in civic and related responsibilities: voting, rallies, attending meetings, panchayat
671. informal help to other households
681. community services not elsewhere classified
691 travel related to community services

[16] Specifically, we examine total time spent in:
811. participating in social events: wedding, funerals, births, and other celebrations
812. participating in religious activities: church services, religious ceremonies, practices, kirtans, singing, etc.
813. participating in community functions in music, dance etc.
814. socializing at home and outside the home.

[17] Recall from footnote 3 that an "abnormal" day is defined as "that day of the week when guest arrives, any festival occurs" and is separately coded.

Since more time spent collecting water means less time available for all other potential uses, there might be some degree of arithmetic endogeneity between time spent collecting water and social time – at least for women. However, given the gendered nature of water carrying, it is highly unlikely that male socialization time is causally affected by the availability of tap water. Since we can measure both the average social time of men and the average social time of women – both of which arguably might be important for social networking – we can check whether there is any difference in results when we examine the impacts of male social time, female social time or both aggregated.

In the ITUS data, twelve households were sampled in each village or urban block, implying that we indirectly have observations on approximately 1554 local micro communities (1,066 rural and 488 urban). With only twelve household observations in each village, sampling variability can be expected to bedevil estimation of characteristics of these local communities which are aggregated from *household* observations at the village level. (Estimation of the characteristics of local village society derived from the approximately 50 adult *individuals* in each village can be expected to be more robust.) However, in thinking about the implications of social capital for the provision of local public goods, it is not obvious whether it is the local district or the village within that district which is the appropriate sampling frame. Many of the administrative decisions which affect these local villages are taken by the 51 different administrative districts within which they are located (within the six states examined). As local political units, it is arguably the districts which are the locus within which social capital will have its impact (or not), so it can be argued that we should focus on differences across districts instead of differences among villages.

The probit regression results reported in the four columns of Table 2 differ because average social time is differently measured in each and because in Columns C and D we use district level data on land ownership inequality and scheduled caste and scheduled tribe membership. To illustrate the robustness of our results, Columns A and B are estimated using average social time where the average is taken among the adults of each village – Column A takes the average of all adults (18+) while Column B reports the average social time only among men. Columns C and D are estimated using district level data on average social time – Column C using the average for all adults and Column D using just men. We present all four specifications to demonstrate that our results on the importance of social capital for local water availability are robust – in all specifications the social capital variable is statistically significant, with the expected positive sign.

Whether or not rural residents can mobilize effectively for collective action, the supply of tap water depends partially on cost[18]. From national water resources data we can obtain estimates of replenishable ground water reserves per capita in different states. The more easily local wells can be dug to access water, the more likely we expect it to be that a particular household will not have to fetch it. Whether it is because state governments can afford to supply more rural communities with piped water when it is cheaper to do so or because individual households can dig wells more easily when water is more accessible, ground water availability is an important constraint. Our interest is in the characteristics of villages that are associated with local water supply, *given* the costs of supply – but we note that in Table 2 our proxy for cost of supply has the expected positive sign, is stable in empirical magnitude and is highly statistically significant in all four specifications.

However, given the cost of providing water, we expect that provision will be more likely where co-operative action can be more readily organized. In some localities, villagers may themselves be able to organize the construction and maintenance of local water supply, but it is more common for households to depend on supply by local district water authorities, which tend to respond to political pressure. Where a local community is internally divided, such social capital as exists may be of the "bonding" variety, and we would expect that mobilization of political or voluntary action will be more difficult.

Indian villages are divided both by the social barriers of membership in Scheduled Castes and Scheduled Tribes and by economic inequality in household income and land ownership. Hence, a clear implication of the social capital perspective on local public goods provision is the expectation that a household's probability of not having to fetch water will be lower where there is greater economic inequality (e.g. in land ownership) and where the percentage of scheduled castes and tribes in the district's population is higher.[19]

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[18] In the simple model of Section 2, we represent this fixed cost as b_0.

[19] With only 12 households sampled in each village, village level estimates of land inequality and caste composition have too much sampling variability to be reliable – but district-level data has an average of approximately 250 households.

Of course, the expectation that caste and class inequalities may hinder the mobilization of co-operative effort and economic development is not exactly new. A long tradition in thinking about development in India has emphasized the barriers of caste and class[20] – the innovation in the social capital approach is its optimistic, indeed curiously classless, perspective that social interaction can create networks of mutual trust that facilitate co-operative action, *given* the structural divisions of class and caste. The innovation of this paper is our assessment of the relative quantitative importance of social interaction and the structural barriers of caste and class – which is only possible because the novelty in time use data is its direct observation of time spent in social interaction, whose impacts can be compared to the impact of inequality in land ownership, income and caste status.

Table 2 confirms a role for social interaction in enabling water access - all the social interaction variables are highly statistically significant, with the expected sign. Their different specifications address two substantive points: [1] whether or not, in a patriarchal society, it is male social interaction or social interaction among all adults that matters for local public goods provision and [2] whether micro-level social networking at the village level or the larger social networks of the local political unit are more important. Notably, comparing columns A and B, and comparing columns C and D, leaves the same impression – adding female social interaction time to male social time increases the coefficient observed, but since the increase is only about one standard error, one cannot say that it makes a statistically significant difference. However, the coefficient on social time in columns C and D is about five times larger than in columns A and B. This can be interpreted as an indication that it is the social capital of a political unit – i.e. the district – not the differences in social capital among villages within that political unit, which really matters for local public service provision. For this reason, and because columns C and D indicate a significantly better statistical fit, we would emphasize the district level results – particularly those of specification D.

[20] Within Western social science, this tradition goes back to Weber and Marx. Among modern development economists, Myrdal (1968) and Dreze and Sen (2002) are a few of the authors who have discussed how caste and class barriers hinder participatory growth in India. See Gupta (1997) for an overview of the literature on caste.

As Table 2 indicates, greater social time in each local community is positively and statistically significantly associated with a greater probability that rural Indian households will have tap water. The positive correlation of greater local social interaction and greater local availability of water is consistent with Putnam's perspective on the positive social externalities of social interaction – and in this sense our results are consistent with the World Bank's recent emphasis on "social capital" in development.

However, statistical significance does not necessarily imply quantitative importance. The probit coefficients reported in Table 2 do not directly indicate the marginal impact of each independent variable, so Table 2A presents the change in probability of water collection corresponding to the regressions reported in Table 2, evaluated for a "typical respondent" – i.e. a non-female headed, non-scheduled caste or tribe, non-labourer, non-professional, homestead-owning household with sample average landownership and income, average number of dependents and average district and village inequality in caste and class. For continuous variables, we report the elasticity and for dichotomous variables we report the change in probability associated with a change in status (e.g. from non-professional to professional household head), holding all other variables at their base case values.

Looking first at the role played by individual household characteristics, the statistically significant effects of the dependency ratio, occupational status of the household head and home ownership translate into impacts of the order of 0.02 to 0.04 on the probability of not collecting water. Given that the underlying probability of not collecting water is 0.814, these can be classed as empirically small, but nontrivial effects.

Similarly, although social interaction time within the local district is statistically significant as a determinant of access to tap water, its effect size is relatively small – in both the specifications reported in Table 2A, a doubling in daily social interaction time (which would be a huge social change) would be associated with only about a 2.2 percentage point increase in the probability of a household having tap water.

By contrast, the differences in probability of access to tap water associated with local area economic or social inequality are much larger. As Table 2A indicates, the elasticity with respect to the fraction of the district population that is scheduled caste or scheduled tribe is about 0.15. If one conducts the thought experiment of comparing a district with the sample mean fraction (0.401) with a zero percentage scheduled caste or class, the associated percentage point change in the probability of having tap water is 7.1 to 7.4 (i.e. enough to about halve the chances a household would fetch water).

Inequality of land ownership is hugely important as a determinant of probability of access to tap water. The negative elasticity of tap water access probability with respect to land inequality of 2.6 implies that – at the margin – a one percent difference in the Gini index of inequality in land holdings is associated with a 2.6 percent change (i.e. a 2.1 percentage point change) in the probability of having tap water.

Our results are therefore consistent with the view that social interaction helps, but that land reform, and a reduction in caste barriers, are the crucial issues in the social co-operation which is the basis for local public goods supply in rural India.

4. Who goes to fetch the water?

Given that somebody in the household has to go to get water, who gets to do this chore? Table 1 has already provided a simple cross-tabulation indicating that 87% of the time devoted to carrying water in rural and urban India is done by adult women, so the main novelty in Table 4 may be the estimates it summarizes of the magnitude of gender relative to other influences.

The coefficient on a dummy variable for "female" is far larger than any other influence – holding constant literacy, age, disability, employment and marital status, etc., men have a 76 percentage point lower probability than women that they will have to go to get water. In fact, given that the effect of the size of disability status is 37 percentage points, Table 4 implies that a disabled female is 39 percentage points more likely to have to go get the water than an otherwise similar non-disabled male. In Table 4A we report the joint impacts of gender and disability on the probability of fetching water, holding all other variables at base case values - the probability that a disabled male will collect water is essentially zero, but 27% of disabled females can expect to do this job.

If there are more women and girls in a household, the probability that a particular person is chosen to fetch water is lower, but not by much – each additional woman in the household decreases the chance that a particular person will have to get water by about 14 percentage points (which may indicate some sharing of multiple trips). The quadratic in age reported in Table 4 has a maximum at 32.4 years, quite close to the sample mean – and there is only a 18.4% percentage point lower probability of water carrying for someone aged 60. The strength of gender norms is, in some sense, shown implicitly in the lack of statistical significance of variables which indicate the opportunity cost of time in the market (e.g. literacy and unemployment status) and which might have been expected to provide an economic rationale for changes in the intra-household assignment of tasks.

The ITUS asked interviewers to code each respondent as to "whether participating in decision making – Yes=1;No=2".[21] It may be some indication of the subtleties of gender relations that overwhelmingly both husbands and wives in married couples answered "Yes" to this variable (97.50% of husbands; 90.26% of wives). The adults who were coded "No" were predominantly (49.22 %) married, but in terms of their relationship with the head of the household, were also often (32.36 %) unmarried children still residing in the parental home.

One possible interpretation of the ITUS data might be that carrying water is such a deeply gendered and traditional task that no possibility of decision making about male and female roles is perceived. Adult males who do not participate in household decision making are only very slightly more likely to collect water than decision participants (0.08 compared to 0.05). But female decision makers are *more* likely than non-decision makers (0.65 compared 0.50) to carry water, which may reflect both the symbolic and practical[22] significance attached to this task. While this task has to be entrusted to women, it may be too important to be entrusted to non-decision makers among them.

[21] The Interviewer Instruction manual states: "Economic decision making is to be decided mainly with respect to the decision about buying cloths for the family and consumer durable goods such as TV, Radio, bicycle, furniture etc. It is generally observed that persons earning the money have generally the decision power. However, in some cases, like women and children, even though they may be earning, the decision about the use of their earning are generally taken by their husbands, parents or head of the household. Before recording the codes in this column for 'Yes' and 'No' proper probing may be done by the investigator. The basic purpose of this question is to know the extent to which women participate in the Economic decision making within the household"

[22] Note that fetching water has implications for family well being and hygiene.

Table 4A*:

Gender, Disability and the probability that an individual will fetch water

	Female	**Male**
Disabled	0.269	0.0037
Able	0.652	0.0473

Table 4B*: Gender, Participation in economic decision making and the probability that an individual will fetch water*

	Female	**Male**
Decision Participant	0.652	0.0473
Non-Decision Participant	0.497	0.0802

*Probability computed from Probit Regression reported in Table 4, at "base case" values for other variables. Children (younger than 18 years) are counted as not participating in decision making.

Table 4:
Probit Model of probability that a particular individual will not fetch water, given that the household he/she belongs to fetches water

Variable	**Estimate**	**Base Value**	**Effect**	**Elasticity**
Intercept***	1.623893 (0.17287)			
Age less than 15 years	0.002559 (0.088564)	0	0.000946	0.000007
Age***	-0.06307 (0.008142)	31.5865679	-0.023319	0.004223
Age*Age***	0.000974 (0.000097334)	1276.54	0.000360	0.000001
Disabled***	1.004893 (0.244618)	0	0.371526	1.072084
Literate	0.060581 (0.043908)	1	0.022398	0.003896
Female***	-2.06179 (0.055366)	1	-0.762278	4.513120
Unemployed	-0.01602 (0.235752)	0	-0.005924	0.000273
Not in the Labor Force***	-0.45521 (0.046046)	0	-0.168300	0.219998
Does not participate in economic decision making***	-0.26817 (0.084965)	0	-0.099149	0.076352
Female*Non Decision Maker***	0.665045 (0.080851)	0	0.245879	0.469560
Unmarried	-0.00671 (0.053584)	0	-0.002481	0.000048
Number of Females***	0.391147 (0.021800)	1.881947	0.144614	0.162431
Sample Size	7832			
Log Likelihood	-3022			

*** Significant at 99% Confidence Level, * Significant at 90% Confidence Level
Standard Errors in Parentheses

The "base case" for the probit model reported in Table 4 is a male married adult who participates in household decisions, is non-disabled, illiterate and employed – effect sizes are calculated at the average sample age (31.6 years) with average number of female adults in the household.

5. Why does time spent collecting water matter for development?

How much priority should expansion of rural water supply have in public sector budgets? What are the costs and benefits? In thinking about such issues, it is crucial to have some estimate of what uses the time and energy now spent collecting water in rural India might be put to. One can expect that time savings would be devoted in some proportion to leisure, home production or income earning work – and that the distribution of those benefits within the household would probably be quite unequal. Since water collection in India is such a heavily gendered task, adult women would be the immediate recipients of almost all (i.e. 87%) of the time savings involved in tap water delivery. However, the ultimate impact of the benefits of tap water would depend on the division of resources within the household and any reallocation of working time, household production or leisure.

For the development process, an important implication of carrying water is its possible impact on human capital acquisition – specifically, on the probability that children will remain in school. Rural women who spend an average of 47 minutes a day carrying water do not have that time available to spend attending to their children – unless perhaps they can delegate the task of fetching water to their teenage daughters, which may be part of the reason their daughters withdraw from school. Even if children are not asked to carry water themselves, the fact that someone (usually the mother) has to spend time on this task means that children may be asked to perform other household chores – which implies that total household time spent in water collection may affect school attendance.

Table 5 therefore presents the results of a probit regression in which the dependent variable is school attendance.[23] For present purposes, the key variable of interest is the total time which the household has to spend collecting water. Separate regressions are presented for girls and boys, aged 6 to 14 and aged 15 to 18, because we expect the nature of the impact of water carrying to vary by age and gender. Carrying water is heavy work, which small children are unable to perform very effectively. Hence, the primary impact of water carrying time on very young children is due to the availability of their mother's time – if maternal time and attention, or the greater time demands of other chores, are important in encouraging school attendance, children who live in households where more time is being

[23] In the ITUS, every individual's principal status (e.g. working in the household, working as a casual labourer etc.) is given. We have direct information on whether every individual is attending an educational institution or not.

spent collecting water may be less likely to attend school. As Table 1 indicated, in households that collect water 20.5% of girls aged 14 or less and 4.4% of boys spend part of their day at this task, but such work is almost entirely done by children aged 10 or 11 or more[24].

The literature on the determinants of school attendance is vast,[25] and although the ITUS data enable us to focus on the possible influence of a specific household chore, we recognize that it does not allow us to control for all other important influences. Nevertheless, the regressions reported in Table 5 also include a number of control variables, such as age of child, relationship to household head, income, presence of literate role models in the household, caste and female-headed household status.

Since some children are late starting school, while others leave early, one can interpret the results of Table 5 as reasonable – within the age group 6 to 14 the child's age is positively related to probability of school attendance, but for the 15 to 18 age group the increasing likelihood of leaving school shows up in a negative coefficient. Social disadvantage might be expected to negatively affect school attendance and the ITUS data record whether the child is not a child of the household head, but no statistically significant effect is found. Scheduled tribe or caste status is likewise statistically insignificant (except for girls aged 15-18). As noted earlier in Section 2, the per capita household expenditure level may be measured with error – in Table 5 it is positively associated with remaining in school only for older boys and girls.

[24] Tabulations available on request. Note that we do not have, in the ITUS data, any direct measure of the amount of water carried. The smaller stature and strength of young children imply that they cannot carry as much water on any given trip – hence their time is an imperfect substitute for adult time in this task.
[25] For the Indian context, see De and Dreze (1999) and the references therein, also Kingdon et. al. (2003), Kingdon and Dreze (2001) and Dreze and Sen (2002).

Table 5:
Probit Analysis of the probability that a child is attending school

Variable	Girls (6-14 years)	Girls (15-18 years)	Boys (6-14 years)	Boys (15-18 years)
Intercept	-1.5932*** (0.220515)	5.190538*** (1.292543)	-1.7961*** (0.1946)	6.303885*** (1.045489)
Age (in years)	0.254086*** (0.011295)	-0.3573*** (0.071557)	0.3151*** (0.0124)	-0.423828*** (0.060378)
Child of the Household Head	-0.012223 (0.125743)	0.188294 (0.245965)	0.1152 (0.1149)	0.246473 (0.228747)
Monthly Per-Capita Expenditure (in Rupees)	-0.000170 (0.000225)	0.000719** (0.000345)	-0.00008113 (0.000218)	0.001386*** (0.000342)
Scheduled Caste or Tribe	0.041814 (0.081134)	0.374961** (0.173156)	-0.042918 (0.078498)	0.059507 (0.144243)
Female Household Head	-0.086288 (0.153693)	0.157131 (0.260266)	0.164788 (0.154481)	-0.202008 (0.215943)
No Literate Adult Males	0.013127 (0.227257)	-0.417847 (0.312940)	-0.264622 (0.206822)	0.400686 (0.342651)
No Literate Adult Females	-0.44001*** (0.099036)	-0.66903*** (0.197893)	-0.24644*** 0.101906	-0.280092* (0.170843)
No Literate Adult Males*No Literate Adult Females	-0.221607 (0.247267)	-0.445063 (0.409861)	0.066270 (0.228095)	-0.731289** (0.384151)
Number of Females in the Household	0.015299 (0.036076)	0.106229 (0.081164)	-0.022526 (0.036720)	0.080978 (0.065455)
Time spent by the house hold on fetching water	-0.000975 (0.000946)	-0.002987* (0.001710)	-0.0023*** (0.000981)	-0.001972 (0.001673)
Sample Size	1534	335	1765	406
Log Likelihood	-664.94126	-171.83077	-685.68306	-234.16339
Number at school	608	121	806	204

*** 99% Confidence Level, ** 95% Confidence Level, * 90% Confidence Level
Standard Errors in Parentheses

Table 5 supports, very strongly, the importance of maternal literacy in encouraging school attendance. To control for the influence of role models for education, we use dummy variables for the absence of literate adult females, and for the absence of literate adult males in the household, and for the joint absence of any literate adult. For both boys and girls, and for both children 6 to 14 and 15 to 18, Table 5 indicates that school attendance is significantly less likely in households with no literate adult females. The effect of adult male illiteracy is smaller in empirical magnitude, and not statistically significant.

Controlling for these other influences, Table 5 indicates that household water collection time is a statistically significant negative determinant of school attendance probability for both boys aged 6 to 14 and for girls aged 15 to 18. Although physical strength and stature may be a barrier to fetching significant amounts of water for both girls and boys aged 6 to 14, this is not likely to be an issue for the 15 to 18 age group, who are clearly potential direct substitutes for adult female labour time in this aspect of household production. However, any time that teenagers spend collecting water (or performing other chores because their mother is collecting water) cannot be spent on schooling. The more onerous the household's burden of water collection, the less likely they will have the time to devote to education – the question is whether the education of girls and boys aged 15 to 18 is equally influenced by this household time burden. Although the number of adult females in the household is included in Table 5 as a control for the possible sharing of this task, household water collection time is still a statistically significant, and empirically large, negative determinant of school attendance probability for females aged 15 to 18. Evidently, the gendered nature of this task implies that in the within-household allocation of resources, collecting water takes priority over the education of girls – but not the education of boys.

The marginal effects and elasticities for all variables for girls aged 15-18 and boys aged 6-14 are presented in Table 5A. To assess the importance of water collection time for school attendance, we conduct the thought experiment of asking what the impact on school attendance would be of providing tap water to a household which now spends the average amount of time collecting water. We use the benchmark case where the child is a son or daughter of the household head, is of average age and is from a non-scheduled caste/tribe and non-female headed household, with average monthly per-capita expenditure and average number of females, with at least one male and female adult who is literate. We show that for girls aged 15-18, the probability of school attendance increases by nine percentage points or almost a fifth (from 0.465 to 0.557). For boys aged 6-14, the corresponding figure is five percentage points or almost a tenth (from 0.559 to 0.609).

Given that Table 5 also shows the importance of adult female education for the school attendance of their children, this impact of water collection time on female school attendance can be expected to have implications over many future generations.

6. Implications

Most readers will not be surprised by the evidence on the gendered inequality in carrying water that this paper has provided. Many readers will also find our documentation of the importance of inequalities of caste and class in rural India unsurprising. Our contribution is perhaps in showing the relative empirical importance of inequality in land ownership and caste, compared to the size of the impact of social interaction, in determining the probability that a household will have to fetch water. We interpret this result to indicate that although the recent literature on "social capital" has provided important insights into the development process, the cleavages of caste and class are more fundamental – as the early literature in economic development emphasized.

We have also shown that when a household has to carry water, it is primarily women who get the job – and we have shown that the bigger the task, the more likely that teenage girls will be withdrawn from school to do it, or other household chores. Greater inequality in land ownership, and social inequality in caste, therefore helps create some of the *general* conditions (i.e. lack of tap water) which accentuate inequality within the family, which in turn produces greater inequality in opportunity between generations – with particularly adverse consequences for poor women in rural India. The daily burden of carrying water in rural India is therefore a concrete example of how the links between inequality in wealth, inequality within the family and inequality in opportunity show up in time use data.

Table 5A: Marginal Effects and Elasticities for Education Regressions

	Girls (Ages 15-18)			Boys (Ages 6-14)		
Variable	**Base Value**	**Effect**	**Elasticity**	**Base Value**	**Effect**	**Elasticity**
Age (in years)	16.4618***	-0.1420	0.1091	6.4779***	0.1243	0.0700
Child of the Household Head	1.0000	0.0748	0.0303	1.0000	0.0454	0.0094
Monthly Per-Capita Expenditure (in Rupees)	467.0405**	0.0003	0.0000	430.3427	0.0000	0.0000
Scheduled Caste or Tribe	0.0000**	0.1490	0.1201	0.0000	-0.0169	0.0013
Female Household Head	0.0000	0.0624	0.0211	0.0000	0.0650	0.0191
No Literate Adult Males	0.0000	-0.1661	0.1491	0.0000	-0.1044	0.0494
No Literate Adult Females	0.0000***	-0.2659	0.3823	0.0000***	-0.0972	0.0428
No Literate Adult Males*No Literate Adult Females	0.0000	-0.1769	0.1692	0.0000	0.0261	0.0031
Number of Females in the Household	2.9400	0.0422	0.0096	2.1560	-0.0089	0.0004
Time spent by the house hold on fetching water	77.78915*	-0.00118712	$7.62*10^{-6}$	55.30257***	-0.0009	$3.7*10^{-6}$

*** 99% Confidence Level, ** 95% Confidence Level, * 90% Confidence Level

For the dummy variables (Child of the head of the household, Scheduled Caste or Tribe, Female Household Head), the marginal effect is an increase from 0 to 1

Appendix A

Descriptive Statistics of Some Important Variables

Variable Name	***Description***	***N***	***Mean***	***Std Dev***	***Min***	***Max***
HHSize	*The number of individuals present within the household.*	12750	4.206	105.953	1.000	23.000
LandOwn	*Land owned by the household (acres).*	12750	2.049	279.876	0.000	250.000
LandPoss	*Land possessed by the household (acres).*	12750	2.094	318.483	0.000	360.000
Labourer	*The Primary (more than 50%) Source of Household Income is Agricultural or Other Labour*	12750	0.519	27.738	0.000	1.000
Homestead	*Household is a homestead. (0-no, 1-yes).*	12750	0.639	26.636	0.000	1.000
Female HHH	*Household is headed by a female member (0-no, 1-yes).*	12750	0.099	16.580	0.000	1.000
SC_OR_ST	*Household is either a scheduled tribe or caste (0-no, 1-yes).*	12750	0.376	26.874	0.000	1.000
MPCEX	*The monthly per-capita expenditure of the household (Rs).*	12750	463.700	14743.020	0.000	4200.000
Age	*Age of the household member (Years).*	53981	26.007	19.028	0.000	99.000
Dependency Rate	*Number of unpaid individuals in a household divided by the total number of individuals in household.*	15606	0.541	15.006	0.000	1.000
GrndWtr	*Replenishable groundwater available per person in the selected sample state.*	6	47.535	20.544	23.416	84.276
DistrictST	*Percentage of individuals that belong to a scheduled tribe at the district level.*	51	0.222	0.291	0.000	0.988
DistrictSC	*Percentage of individuals that belong to a scheduled caste at the district level.*	51	0.179	0.125	0.000	0.603
Village Gini	*Gini coefficient of per capita expenditure computed at the village (rural)*	1103	0.149	0.071	0.000	0.464
Landgini	*Gini of Landholdings for the district*	51	0.731	0.0961	0.506	0.925
Exp_Gini	*Gini of Monthly Per-capita expenditure for the district*	51	0.219	0.0451	0.131	0.315

Appendix B

Tables B1 and B2 are largely based on data from the 2001 Census of India.

Table B1:

Water Use Statistics, Rural Areas,

2001Census & 1998/99 TUS

State	***Haryana***	***Madhya Pradesh***	***Gujarat***	***Orissa***	***Tamil Nadu***	***Meghalaya***
2001 Census: Location of Water Source						
Within HH	30.7	14.0	29.3	13.7	12.0	12.1
Near HH	42.7	58.6	49.9	53.9	74.7	55.6
Away HH	26.6	27.3	20.8	32.4	13.3	32.3
Total	100	99.9	100	100	100	100
Water Source						
Tap	37.8	10.7	49.1	2.8	60.5	24.4
Handpump	35.7	48.0	22.8	31.3	20.3	2.2
Tubewell	7.6	2.8	5.0	28.8	4.5	2.8
Well	16.5	35.6	18.3	29.1	11.3	31.7
Tank, Pond, Lake	0.7	0.3	0.6	2.1	1.6	6.5
River/Canal	0.5	1.7	0.7	2.9	0.4	5.2
Spring	0.2	0.7	0.3	2.5	0.5	25.1
Other	1.0	0.2	3.3	0.5	0.9	2.1
Total	100	100	100.1	100	100	100
No. of HH	2,454,463	8,124,795	5,885,961	6,782,879	8,274,790	329,678
Rural Population						
1998 TUS: Activity						
% HH Spending Any Time Fetching Water	60.1	4.8	0.03	1.1	32.6	77.7
No. of HH in Sample	984	3801	1676	2244	3640	408

Table B2:

Water Use Statistics, Urban Areas

2001Census & 1998/99 TUS

State	*Haryana*	*Madhya Pradesh*	*Gujarat*	*Orissa*	*Tamil Nadu*	*Meghalaya*
2001 Census: **Location of Water Source**						
Within HH	76.0	55.2	73.5	52.1	48.2	49.3
Near HH	16.5	29.4	20.0	27.1	41.3	33.6
Away HH	7.5	15.3	6.5	20.9	10.4	17.1
Total	100	99.9	100	100.1	99.9	100
Water Source						
Tap	71.7	67.9	83.0	45.9	65.5	71.3
Handpump	22.5	13.5	7.1	10.9	14.4	1.0
Tubewell	3.1	7.1	5.3	15.6	6.1	1.3
Well	0.8	9.9	1.4	25.2	9.6	11.7
Tank, Pond, Lake	0.2	0.3	0.0	0.5	0.2	2.0
River/Canal	0.1	0.2	0.0	0.8	0.3	0.7
Spring	0.1	0.1	0.0	0.5	0.4	10.4
Other	1.4	0.9	3.1	0.7	3.6	1.6
Total	99.9	99.9	99.9	100.1	100.1	100
No. of HH	1,075,179	2,794,858	3,758,028	1,087,248	5,898,836	90,568
1998 TUS: **Activity**						
% HH Spending Any Time Fetching Water	19.0	1.3	0.0	0.1	22.4	40.5
No. of HH in Sample	360	1260	1485	552	2020	168

Appendix C

Table 2: Probit Analysis of the probability that a rural household will not fetch water

Variable	Model A	Model B	Model C	Model D
Intercept	-0.6345*** (0.0766)	-0.6324*** (0.0766)	1.2769*** (0.2072)	1.2775*** (0.2051)
Monthly Per-Capita Expenditure of the household (in Rupees)	0.0001** (0.0001)	0.0001** (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Laborer Household	-0.0979*** (0.0315)	-0.0983*** (0.0315)	-0.0901*** (0.0321)	-0.0907*** (0.0321)
Professional Household	0.1668*** (0.061)	0.1687*** (0.061)	0.1522* (0.0618)	0.1562* (0.0619)
Owns Homestead	0.25*** (0.0309)	0.2501*** (0.0310)	0.1409*** (0.035)	0.1373*** (0.035)
Land Owned (in Acres)	0.004 (0.004)	0.0041 (0.004)	0.0007 (0.0041)	0.0013 (0.0041)
Dependency Ratio (Unpaid Members/Household Size)	-0.1809*** (0.0532)	-0.1809*** (0.0532)	-0.1818*** (0.0544)	-0.1854*** (0.0544)
Female Household Head	-0.0117 (0.0446)	-0.0113 (0.0446)	-0.008 (0.0451)	-0.0096 (0.0451)
Scheduled Caste or Tribe	-0.0924*** (0.0301)	-0.0940*** (0.0301)	-0.0208 (0.0336)	-0.0189 (0.0336)
Percentage of Scheduled Caste and Tribes in the District			-0.6781*** (0.0844)	-0.7070*** (0.0831)
Gini of Monthly Per-Capita Expenditure for the Village	-1.4174*** (0.2121)	-1.424*** (0.212)		
Gini of Monthly Per-Capita Expenditure for the District			2.4788*** (0.357)	2.6814*** (0.3608)
Gini of Land Ownership for the District			-3.2474*** (0.2175)	-3.2931*** (0.2156)
Average Social Interaction Time for the Village (in minutes)	0.0045*** (0.0015)			
Average Male Social Interaction Time for the Village (in minutes)		0.0036*** (0.0012)		
Average Social Interaction Time for the District (in minutes)			0.0234*** (0.0038)	
Average Male Social Interaction Time for the District (in minutes)				0.0213*** (0.0031)
Replenishable Ground Water Per-Capita for the State (Billions of Cubic Metres per year)	0.0332*** (0.001)	0.0332*** (0.001)	0.0335*** (0.001)	0.0333*** (0.001)
Sample Size	12689	12689	12689	12689
Log Likelihood	-5251.282	5251.759	-5087.257	-5082.823

Number of Households that do not fetch water: 10329 (81.40%)

*** 99% Confidence Level. ** 95% Confidence Level. *90% Confidence Level

Standard Errors in Parentheses

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