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Institutional Determinants of the Impact of Community-Based Water Services: Evidence from Sri Lanka and India*

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Using data from community-based water services in Sri Lanka and India, this paper shows first that: (a) improved household health and reduced water collection times are associated with better service design and construction: (b) well-designed services involve more community members in the design process and final decision-making about service type; and (c) well-constructed services have effective mechanisms to monitor household contributions to construction. The paper then shows that these service-level institutions are endogenously determined: in communities with higher levels of social capital--in particular, with more active community groups and associations--design participation is more likely to be high and monitoring mechanisms are more likely to be in place. This suggests a way to place an economic value on this form of social capital in the context of water projects: as the net present value of the marginal increase in health associated with active civic associations. These results suggest that designers and supervisors of community-based water projects need to pay attention to the prevailing levels of social capital as one of the factors that will influence performance. When targeting a range of communities, the allocation of investment resources for water services programs may need to be adjusted to take into account the lack of this form of social capital in some villages: possible adjustments include increased investments in social mobilization efforts (for example, through the strengthening of local organizations) and in more direct supervision to oversee system performance.

I. Introduction

As she fills her water vessel at a standpost and then balances it carefully on her head, Arpana, a mother of five, describes how clean water arrived to her community. Three years ago, a government extension worker had informed her and her neighbors that they could get a new water service if they contributed cash or labor for its construction and took responsibility for its operation and maintenance. Arpana, with most of the members of her women's group, attended sessions where community leaders led a discussion on the selection of the type of service and locations of the new standposts. Her husband also contributed labor to the construction of the new service. Now, she and her friends who use the water pay a monthly user fee, and a caretaker, a neighbor, looks after operation and maintenance. "My friends and I are very satisfied with this new water service," she notes. "It has cut the time I spend daily fetching water by over an hour, and my two youngest children no longer suffer from 'loose stools'."

In another community, Madhumitha is also hauling water from a standpost financed by the same government program. Madhumitha complains that, in her community, water from the standpost is not available many days because of leaks, so she and her daughter often still collect water from the local spring. She also complains about the inconvenient location of the standposts. As far as she knows, the views of community members about possible sites were never solicited. "We have a caretaker who is supposed to maintain the system", Madhumitha says, "but he is not doing his job properly." But no one in this community seems to care. "Everybody just takes care of their own business and waits for others to act. Anyway, taking care of the water service is not my responsibility," she sighs, and slowly walks away.

Development agencies and donors currently promote a community-based approach to the provision of rural water services. This demand-responsive approach calls for a joint effort by community members and government staff in service design, construction, and operation and maintenance (O&M). Community members are typically expected to participate in the design process: in particular, to choose collectively the type and the level of service based on their willingness to pay. In addition, communities may be asked to contribute cash or labor to construction, and take care of operation and maintenance.[1] However, the outcomes of this approach have greatly varied, so development practitioners now wonder: “Under what circumstances is the community-based approach more likely to succeed?”

The objective of this paper is to start unraveling that question by analyzing selected institutional determinants of the impact and performance of community-based water services. Using quantitative and qualitative data from 1,088 rural households and 50 water committees, the paper investigates how service rules and practices, social capital, and governmental and non-governmental organization (NGO) institutions affect the impact and performance of services supported by three World Bank-financed projects in Sri Lanka and India.[2] The paper focuses on measuring and econometrically analyzing selected aspects of project design and implementation, such as the importance of community participation in service design and decision-making.[3] This paper is also one of the first to measure and econometrically analyze the effect of social capital on the impact of community-based water services.[4]

II. Impact and Performance of Projects in Sri Lanka and India

A. Community-based Projects in Sri Lanka and India

In the early 1990s, three community-based rural water projects were prepared and implemented in Sri Lanka and in two states of India--Karnataka and Maharashtra. Their objectives were to provide potable water to selected small rural communities that did not have reliable access to safe water within a kilometer or less.[5]

These projects adopted different ‘community-based’ strategies. The Sri Lankan households were supposed to contribute 20 percent of construction costs, either in cash or labor. The Indian households, by contrast, did not formally contribute to construction: water services were fully financed through government grant funds. In Sri Lanka and Karnataka, communities were supposed to take responsibility for O&M (including the levying of household tariffs to cover O&M costs). In Maharashtra, by contrast, district and local governments were supposed to take formal responsibility for O&M.

B. Impact and Performance

To analyze the impact and performance of water services provided by these projects, data were collected from 50 communities. Quantitative data were collected through a survey of 1088 households and 50 water committees.[6] Qualitative data were gathered through focus group interviews with community members and interviews with local government officials.

Analysis of these data indicates that the impact and performance of these water services have been mixed. Means and standard deviations of several indicators of service impact and performance are reported in Table 1. Two types of self-reported household-level impact indicators are used: indicators of improved health and of time savings. ‘Improved health’ and ‘decreased incidence of diarrhea’ indicate, respectively, that the family’s health has improved and that the incidence of diarrhea has decreased since the implementation of the new water service. ‘Change of collection time’ indicates the daily change (in minutes) for collecting water.[7] Performance variables indicate project achievements at the design, construction, and O&M stages. 'Satisfied with service design', based on self-reported household-level responses, indicates that a household was satisfied with service design. 'Good quality construction', 'no construction defects', 'non-colored water', and 'non-turbid water', based on technical evaluations of the system by the community water committee, indicates services with these characteristics.

The results suggest that the projects in India have had a greater positive impact on health than the project in Sri Lanka. Fifty-four percent of households in Maharashtra reported that their family's health has improved, as opposed to 45 percent in Karnataka and 36 percent in Sri Lanka. The reduction in the incidence of diarrhea was highest in Karnataka, and about the same in Sri Lanka and Maharashtra.[8]

Also, projects in India have resulted in large time-savings. In Karnataka and Maharashtra, households reduced daily collection time by 62.6 and 53.9 minutes, respectively. The respective reduction in Sri Lanka was 40.6 minutes. The within-project differences were also large (as indicated by the relatively large standard deviations). For example, in the two Indian projects, 10 percent of households report that they still spend two hours or more collecting water after the project has been implemented.

Many performance indicators , however, suggest that the performance of the Sri Lankan project has been superior. For example, 86 percent of households in Sri Lanka were satisfied with service design, as opposed to 71 percent and 45 percent, respectively, in the Indian projects. The average quality of water delivered was highest in Sri Lanka. (although the average quality of construction was highest in Karnataka.)

How can improved health be higher among households in Maharashtra if the project has worse performance? Likewise, how can improved health and time savings be lower among the Sri Lankan households compared to the Indian households, despite generally better performance? The health impact results may be explained by lower initial health conditions in Maharashtra than in Karnataka and Sri Lanka: households that did not use a project-financed water system had significantly higher incidence of diarrhea in Maharashtra (23%) than in Karnataka (13%) and much lower incidence and medical treatment of diarrhea in Sri Lanka.[9] Accordingly, the results in Table 1 are consistent with decreasing returns to health interventions: as a result of the same intervention, households with better initial health experiencing smaller health improvements than households with worse initial health. Likewise, the absolute time savings in Sri Lanka project were lower because the pre-project collection times were significantly lower than in the Indian projects: 76 minutes as opposed to 147 and 129 minutes, respectively.

C. Two case studies

The variation of performance and impacts was confirmed by qualitative beneficiary assessments. Gallella and Passaramulla, two communities served by the Sri Lankan project, provide good examples.

In Gallella, the new water service provided connections to 214 households that, prior to the project, had consumed water from unprotected wells, springs or streams. As service design began, community members, collaborating with government and NGO representatives, agreed that household connections be provided and that the connection cost will depend on household distance from the main pipeline. Households contributed about 43 percent of total construction costs (well above the required 20 percent) in the form of unskilled labor. As the project began, the water committee in Gallella --which had many pre-existing community groups and civic activities -- coordinated community participation, monitored household construction contributions, and hired caretakers to handle routine maintenance. The committee established clear procedures for tariff collection to cover O&M expenses: caretakers collect monthly fees and retain written records of payments. Ninety percent of households pay the required fee, which is the highest recovery rate among the surveyed communities, and households get together monthly to clean the water tank. Overall, water services in Gallella have had substantial impacts. Twenty-one percent of households report that the incidence of diarrhea has decreased, and the time-saving for women has been dramatic: an average daily reduction of an hour.

In Passaramulla, only one pipe-borne gravity system was in operation three years after service implementation. Seven other systems were in place but inoperable; many others were incomplete. As service design began, a local NGO was hired to mobilize the community and to help to launch a water committee. The local government failed to monitor the efforts of this NGO, which were half-hearted: staff members conducted social-mobilization programs poorly and remained detached from the community. They managed to establish a water committee but did not ensure that committee members had adequate information and training. The committee did not organize monitoring and quality control of construction, which resulted in defective construction work. The subsequent performance of the water committee has been poor. Committee members rarely meet, and financial records have been haphazardly kept. Further, operations have not been transparent: while most households do not receive any water, the committee chairman has a working household connection. The water service in Passaramulla ranks as the worst in Sri Lanka, and with very poor performance, it has had little impact.

III. Determinants of Impact and Performance: The Framework

The community-based approach to water delivery calls for collaborative design and construction among community members, government officials, and NGO staff. Their incentives will determine whether, in practice, they actually collaborate, and institutions affect these incentives. In the delivery of community-based water services, institutions are the formal and informal rules and practices that govern behavior of different groups.[10] By limiting opportunistic behavior, they can hold the groups to their commitments in the design, construction, and O&M of water services, thereby improving service performance and impact.

Figure 1 illustrates a chain of causality from three sets of institutions--service rules and practices, social capital, and governmental and NGO rules and practices -- to service performance and impact. Each box in Figure 1 contains a list of indicators and proxies used in this paper to measure these determinants (as well as non-institutional determinants.)

First, water service performance will impact household health and time-saving (*link 1*). A well-designed, well-constructed, and well-maintained water service that is conveniently located for most households and provides a constant flow of clean water is likely to improve household health and reduce water collection time.

Second, service rules and practices water will influence service performance (*link 2*). In community-based water services, users, in collaboration with government officials and NGO staff, are expected to craft rules and practices about user participation in decision-making, design, construction, and O&M; monitoring of participation and usage; and sanctions to deter non-compliance.[11] Mechanisms such as monitoring and sanctioning procedures, for example, limit free riding and provide incentives for community members and other stakeholders to hold to their commitments and contribute the required inputs to the design, construction, and O&M of water services.[12]

Third, social capital is likely to influence the existence and effectiveness of service rules and practices (*link 3*). Social capital refers to the norms and networks that facilitate collective action.[13] Community-level social capital is likely to help community members to craft and enforce the service rules that govern the design, construction, and O&M. The collective demand for the type and level of services is more likely to be clearly expressed when community members are accustomed to working together, where leaders are accountable, and where all stakeholders have a voice. Water users groups are more likely to succeed in communities with cohesive community groups and regular civic activities. Formal and informal social ties deter community members from free riding and constrain community leaders from shirking and expropriating funds.

Fourth, governmental and NGO institutions are also likely to affect the existence and effectiveness of service rules (*link 4).* Government officials and NGO staff helped to implement these projects: facilitating the establishment of a functioning water committee; assuring that communities could make informed decisions about service selection; overseeing construction quality; ensuring that selected community members had adequate training in hygiene and financial management; and verifying that the service caretaker had access to spare parts and tools.

Finally, non-institutional determinants are also likely to affect the existence and effectiveness of service rules (*link 5*).[14] These include household assets, household size, level of human capital, and environmental conditions. For example, the availability of alternative water source will affect a community's willingness to craft effective system rules and practices.[15]

IV. Determinants of Performance and Impact: Empirical Evidence

Does the framework presented in the previous section hold in practice? This section provides empirical evidence for the linkages in the framework, using data from the household and water committee surveys.[16]

A. Proximate determinants of impact

The first link in the framework ties service performance to impact. To estimate the proximate determinants of health impacts, begin with an econometric model based on the following relationship:

$$H_{ij}^* = \beta_0 + D_j\beta_1 + C_j\beta_2 + \mathbf{X_{ij}}\boldsymbol{\beta_3} + \varepsilon_{ij}, \qquad (1)$$

where H_{ij}^* is a latent random variable for household *i* in community *j* which is some measure of the changed health of the household since the implementation of a community-based water service. Assume that H_{ij}^* is a linear function of a set of non-stochastic independent variables and an error term (ε_{ij}). These covariates include (as discussed in the previous sections): D_j, design performance of the water service in community *j;* $C_{j,}$ construction performance of the water service in community *j*; and $\mathbf{X_{ij}}$, a vector of household-specific characteristics.

The dichotomous variable 'improved health,' is used as the dependent variable (with Probit estimation) to test the relationship presented in equation (1), because the available data do not include continuous measures of the change of household health.[17] The community-level independent variables used to test these relationships (summarized in Appendix Table 1) are 'community design satisfaction', the share of households in each community that were satisfied with project design; and 'good quality construction', a dummy variable for well-built water systems. The household-level independent variables are 'hygiene training', a dummy variable for households that have attended a hygiene class; 'household size', the number of residents in the household; and 'household assets', a composite index of household durable goods.[18]

The results of testing the linkage between performance and health impacts (equation 1), are listed in Table 2 and summarized as follows:[19]

- Improving community satisfaction with service design enhances the service's health impact. 'Community design satisfaction' is a significant and positive determinant of improved health in all three projects. Based on the standard deviations reported in Appendix Table 1 and the change in probabilities reported in Table 2, a one-standard deviation increase in 'community design satisfaction' is associated with an increase in the probability of improved health of 0.09 in Sri Lanka, 0.13 in Karnataka, and 0.11 in Maharashtra..[20]

- Ensuring that water services are well constructed enhances the service's health impact. 'Good quality construction' is a significant and positive determinant of improved health in Sri Lanka and Maharashtra (and positive in Karnataka).[21] A change from bad quality (the presence of serious construction defects) to good quality (the absence of serious construction defects) construction is associated with an increase in the probability of improved health of 0.13 in Sri Lanka and 0.18 in Maharashtra.[22]
- Providing hygiene training (or ensuring that hygiene training is provided by other sources) enhances the service's health impact. Enrollment in a hygiene class is associated with an increase in the probability of improved health of 0.13 in Sri Lanka and 0.20 in Maharashtra.[23]
- Non-institutional household variables (household size and assets) are not significant determinants of improved health in any of the three projects. This is true also of indicators (not reported here) such as household demographics and wealth[24] and the type of previous drinking water source used by the household (for example, hand-dug well or spring).[25]

A similar econometric framework is adopted to estimate the proximate determinants of time-saving impacts. In this case, the econometric model is based on the following relationship:

$$T_{ij} = \alpha_0 + D_j\alpha_1 + \mathbf{X_{ij}\alpha_3} + \eta_{ij}, \quad (2)$$

where T_{ij} is a continuous measure of the time-saving of household *i* in community *j*.[26] The estimation procedure must account for the fact that time savings are likely to be greater in households in which the pre-project collection times are significantly higher, as discussed before. Accordingly, using the logarithm of time-saving as the measure of T_{ij} allows one to estimate the percentage change of time-saving per household.[27]

The results of testing the linkage between performance and time savings (equation 2) are listed in Table 3 and summarized as follows:

- Improving community satisfaction with service design reduces water collection times. 'Community design satisfaction' is a significant and positive determinant of time-saving in all three projects. A one-standard deviation increase in 'community design satisfaction' is associated with a decrease of collection time of 19 percent in Sri Lanka, 45 percent in Karnataka, and 32 percent in Maharashtra. Based on the means of the pre-project collection times, households, on average, will save 15, 67, and 41 minutes, respectively, with such an increase.
- The determinants of household time savings – based on a community-level decision about the placement of a new water system – are not at the household level. With the exception of 'household size' in Karnataka and 'hygiene class' in Maharashtra[28], household variables are not significant determinants of time-

saving. Again, this is true of the variables reported here, as well as alternative household indicators (not reported here).

Overall, the results in this section suggest that well-designed and well-constructed water services are likely to improve household health, and that well-designed water services are likely to lower collection times. They also underline the importance of providing hygiene classes in conjunction with a water project for improving household health. While these conclusions are certainly not ground breaking, these results allow one to establish the statistical significance and relative magnitudes of the importance of well-designed and well-constructed water services across three different projects.[29] More importantly, these results allow one to test econometrically the less explored linkages of this framework: how institutions underlie the performance indicators.

B. Institutional determinants of performance

Does community participation and decision-making lead to higher satisfaction with service design, as suggested by the framework? To answer this question, three household-level dummy variables were created from survey questions about the service design process. First, 'local initiation' indicates that community members, as opposed to government officials or other outsiders, had the *original idea* to build the water system. Second, 'design participation' indicates that the household participated in service design. Third, 'local decision-making' reflects that community members, as opposed to government officials or other outsiders, made the *final decision* about what type of system to build.[30]

Table 4 reports results from probit estimates of the household-level determinants of ‘satisfaction with service design’, with community fixed effects. The results can be summarized as follows[31]:

- Households are no more satisfied with service design when the original idea to build a system comes from community leaders rather than from outsiders.
- User participation in design leads to greater satisfaction with service design. A discrete change from not participating to participating leads to an increase in the probability of being satisfied with service design of 0.196, 0.253, and 0.419 in Sri Lanka, Karnataka, and Maharashtra, respectively.[32]
- Letting locals make the decision about the system type leads to greater satisfaction with service design. A discrete change from stating that local decision-making did not prevail to stating that it did leads to an increase in the respective probabilities of 0.191, 0.322, and 0.540.

These results conform to the analytical framework. Households are more likely to be satisfied with service design when they have participated in the design process and when the community makes the final decision about service type. This is true within each project and within each community (given the use of community fixed effects), despite different approaches to service design among the projects. In addition, these results indicate that the initiation of well-designed services can begin from outside *or* inside of the community, as long as local participation in design and decision-making is ensured.

What are the institutional determinants of good construction? Is construction better when household contributions are monitored and sanctions against misconduct are imposed, as suggested by the framework? Since ‘good quality construction' is a community-level variable, the sample size for addressing these questions econometrically must be 50, the number of communities in the sample. Table 5 lists the within-project associations between 'good quality construction' and two indicators of service rules and practices. 'Construction monitoring' is the community share of households that said that the required construction contributions (cash or labor) were monitored by other community members. 'Construction sanctions' is the community share of households that said that households that did not contribute their share were charged a financial penalty.[33]

The analysis yields the following results about the determinants of 'good quality construction':

- Existence of monitoring mechanisms leads to better quality construction. A one-standard deviation increase in 'construction monitoring' increases the probability of 'good quality construction' by 0.38.
- Existence of construction sanctions does not measurably improve construction quality.[34]

Overall, the results in this sub-section show that community participation and decision-making in service design lead to well-designed services, and monitoring of household contributions to construction lead to better-constructed services.

C. Social capital and service rules

Finally, the framework suggests that existence of service rules depends on social capital. This section tests if social capital is a significant determinant of 'design participation' and 'construction monitoring'.

An econometric model based on the following relationship is used to assess the influence of social capital on service rules:

$$P_{ij}^* = \theta_0 + S_{ij}\theta_1 + \mathbf{X_{ij}}\theta_2 + \mathbf{X_j}\theta_3 + \mu_{ij} ,$$

(3)

where P_{ij}^* is a latent random variable for of household *i* in community *j* which is some measure of the intensity[35] of design participation; S_{ij} is a measure of household-level social capital; $\mathbf{X_{ij}}$ and $\mathbf{X_j}$ are vectors of household and community characteristics that could affect the participation decision, and μ_{ij} is an error term. The dichotomous variable 'design participation' is used as the dependent variable (with Probit estimation) to test the relationship presented in equation (3), because the available data do not include continuous measures of the intensity of design participation (for example, number of hours spent at a community meeting).

The primary indicator of social capital used is the 'social capital index', a composite index of the quantity *and* quality of local groups (based on the 'Putnam index' in Narayan and Pritchett 1999), that attempts to capture the underlying behavior of interest: that a household has established a pattern of working cooperatively with other households and community leaders. As summarized in the second part of Appendix Table 1, this indicator is created as follows. First, 'number of groups' is the number of community groups to which a household belongs. This includes economic groups (such as, farmer's groups and credit/finance groups), religious groups, and social groups (such as, women's groups and youth groups). Second, 'group characteristics' is an additive sub-index of various characteristics of each household's most important group, including heterogeneity of members by caste and religion, heterogeneity of members by occupation, the nature of decision-making mechanisms, and effectiveness of group functioning. The additive sub-index is increased by one unit if a household's most important group has: caste groups that are proportionally represented; different religions that are proportionally represented; members with different occupations; leaders with different occupations; or participatory decision making. In addition, it is increased by one unit with each increment in the five-point functioning rating (from 'very poor' to 'excellent'). For example, a rating of 'poor' adds two units, where a rating of 'very good' adds four units.[36] The 'social capital index' is the product of 'number of groups' and 'group characteristics.'[37] For example, a household that belongs to two groups ('number of groups' = 2) and whose most important group has a proportional representation of castes, members with different occupations, and is rated as functioning poorly ('group characteristics' = 4) would have a social capital index of 8.[38]

Summary statistics for 'number of groups', 'group characteristics', and the social capital index reveal a dramatic difference in the quantity of associational activity in Sri Lanka and India (see Appendix Table 1). On average, households in Sri Lanka belong to 2.4 groups. In Karnataka and Maharashtra, this figure is 0.19 and 0.49, respectively. The means of group characteristics and the social capital index are: 7.48 and 25.38; 1.10 and 1.55; and 1.81 and 3.14, respectively.[39]

An alternative social capital indicator is 'help from outsiders', a dummy variable that indicates that a household could get help from non-family members in difficult times. Community members that can do so are likely to have established productive norms and networks with neighboring households. The project-level means for this indicator are 0.61, 0.62, and 0.60, respectively.

- The results summarized in Table 6 reveal that social capital and design participation are associated. Higher household-level social capital is positively associated with participation in the service design. Specifications (1), (3) and (5) shows a statistically significant relationship between the 'social capital index' and 'design participation'. A one-standard deviation increase in the 'social capital index is associated with increases of 0.06, 0.08 and 0.13, respectively, in the probability of design participation (compared to project means for design participation of 0.84, 0.11 and 0.21).
- The statistically significant relationship between social capital and design participation survives the inclusion of other potential covariates. Specifications (2), (4) and (6) reveal that the inclusion of 'household assets' and 'family size', with community fixed effects, does not change the basic relationship between the 'social capital index' and 'design participation'.[40, 41]

The robustness of these results is confirmed in two ways. First, in all six specifications, replacing the 'social capital index' with either of its the sub-indices or 'help from outsiders' yields the same statistically significant relationship between a measure of social capital and design participation.[42] Second, in the two specifications for Sri Lanka, the only project that required household participation in construction, replacing the ‘design participation’ with the equivalent ‘construction participation’ yields a statistically significant relationship (not reported here). A one-standard deviation increase in the social capital index is associated with a 0.09 increase in the probability of construction participation. Two of the three alternative social capital indicators (‘number of groups’ and ‘help from outsiders’) also yield statistically significant relationships.

Also, community-level social capital is a positive and significant determinant of construction monitoring. Table 8 lists results from community-level specifications--in India and Sri Lanka, respectively--of the determinants of construction monitoring: in addition to the community-level social capital indicator, each specification includes (not shown) community-level averages of assets, household size and (in the case of India), a dummy variable for Karnataka. With two of the four indicators in Sri Lanka and three of the four indicators in India, community-level social capital is a positive and significant determinant of construction monitoring.

The results in this sub-section show that household-level social capital leads to participation in service design: in communities with effective community groups, participation in service design is likely to be higher. The results from Sri Lanka show –that social capital also tends to increase participation in construction design. Finally, social capital is positively associated with construction monitoring.

D. Magnitudes of the effect of institutions on impact

The previous results suggest a chain of causality from institutions –(social capital and service rules) to project performance and impact. This section calculates the implied magnitudes of the effect of institutions on service impact, improvement of household health and reduction of water collection time.

The first part of Table 8 presents some calculations of such magnitudes for improved health. The first row of the table presents the effect of a one-standard deviation increase in design participation on improved health, based on the underlying structural equations summarized in Tables 2 and 3. Note that the three project figures, from 0.051 to 0.068, are within a plausible and fairly narrow range, despite the large difference in the nature of the quantity and quality of the underlying variables across these three projects (particularly between Sri Lanka and the two Indian projects). For each project, this is calculated by multiplying the standard deviation of design participation with the coefficients within the framework that lead from 'design participation' to 'design satisfaction' (link 2) and from 'design satisfaction' to 'improved health' (link 1). For example, in Sri Lanka, the figure is 0.051 = (.360)*(.196)*(.72), where the three respective multiplicands are: the standard deviation of design participation; the partial affect of 'design participation' on 'design satisfaction'; and the partial affect of 'design satisfaction' on improved health. The second row of the table presents calculations of the effect of a one-standard deviation increase in construction monitoring on improved health, based on similar calculations from the underlying structural equations. The third row of the table presents the total of these magnitudes. These figures suggest an order of magnitude for how service-level institutions affect improved health. These total magnitudes translate to improved health for 17 to 18 households in a community of 200 households (the means community size in the sample) because of more design participation and better construction monitoring.

The final two rows of Table 8 present similar calculations of these magnitudes for time-saving, based on similar underlying equations. The calculations from the structural equations, from 0.012 to 0.024, are also within a plausible range, despite the large differences among the projects. These magnitudes translate to time-saving of 9, 35, and 25 minutes, respectively, from more community-level design participation.

Since both 'design participation' and 'construction monitoring' are endogenous in this framework (that is, they are determined by social capital and other factors), another way to calculate the effect of institutions on service impact is with 'reduced form'[43] estimations, where the community-level social capital index replaces both 'community design satisfaction' and 'good quality construction' in the specification tested in Table 2 and 3. Single-stage reduced form estimates are consistent on the condition that: the indicators of social capital accurately measure the patterns of social interaction and norms of trust and reciprocity among water users and their neighbors; and these patterns are mostly exogenous to the delivery of water. If these conditions do not hold, instrumental variable (IV) reduced form estimates are consistent.[44]

Table 9 presents the estimates of single- and two-stage reduced form models. In single-stage estimation, probit models show that only in the case of Maharashtra is the village-level social capital index positive and significant (coefficients of 0.0269 and 0.0244 respectively).[45]

In the IV estimation, two instruments for the social capital index are used, based on additional survey questions about community activities. ‘Household community activity’ is the community-level average of households that participated in a community-level activity; and ‘multiple community activities’ is the community-level average of households that reported multiple community activities. The *a priori* case for using these as instruments for the social capital index is that more community activities are positively associated with the quality and quantity of associational activity, but do not have an independent effect, outside of this framework, on improved health.[46]

Table 9 shows that the IV results are positive and significant in the case of Sri Lanka and Maharashtra, with coefficients of 0.0286 and 0.0417, respectively.[47] Using these IV results, a one-standard deviation increase of community-level social capital is associated with an increase 0.17 and 0.13 in the probability of improved health.[48] These magnitudes are slightly larger than the sum of the magnitudes of design participation and construction from the structural equations.[49] Accordingly, the evidence from the two-stage reduced form equations, in two of the three projects, suggests that more social capital -- the critical determinant of design participation and construction monitoring -- leads to improved household health for about 26 to 34 households in a community of 200 households.

The final two rows of Table 9 present calculations from comparable OLS and IV estimates for time-saving. In single-stage estimation, the village-level social capital index positive and significant in the cases of Sri Lanka and Maharashtra (coefficients of 0.0047 and 0.0916, respectively). In the IV estimation, this is true of Maharashtra (0.0807). Using the IV result, a one-standard deviation increase of community-level social capital is associated with a reduction of water collection time by 26 percent. This corresponds to daily time-saving of about 33 minutes.

V. Conclusion

Using data from Sri Lanka and India, this paper has shown that well-designed and well-constructed water services lead to improved household health and reduced water collection times. The results suggest that one can promote well-designed services—(that is, increase user satisfaction with the service design) by involving community members in the design process and by letting community members, not outsiders, make the final decision about the service type. Ensuring that communities have effective mechanisms to monitor household contributions to construction is in turn an effective way to promote well-constructed services.

However, household participation in service design and ability to craft and enforce monitoring mechanisms are not automatic. The empirical results presented here suggest that in communities with high levels of social capital--in particular, with active community groups and associations--design participation is more likely to be high and monitoring mechanisms are more likely to be in place. In those communities, households are accustomed to working together and social ties deter free riding. This suggests a way to place an economic value on community-level social capital in the context of water projects: as the net present value of the marginal increase in health associated with active civic associations.[50]

What do these results, in particular the results about social capital, imply for designers of community-based water projects? They do not necessarily suggest that projects should avoid investing in community-based water systems in communities with low levels of social capital. Indeed, while many poor communities with the most urgent need for improved water systems are likely to have low levels of social capital[51], people in many of these communities are likely to reliably report a willingness to pay and maintain a water system. Instead, these results suggest that designers of community-based water projects need to pay attention to the prevailing levels of social capital, as one of the factors that will influence the performance of the project, in communities to be served by the project. When targeting these communities, the allocation of investment resources for water services programs may need to be adjusted to take into account the lack of social capital. Possible adjustments include increased investments in social mobilization efforts (for example, through the strengthening of local organizations) and in more direct supervision by project personnel working in these communities to oversee system performance.[52]

Table 1. Summary Statistics of Impact and Performance of Water Services in Sri Lanka and India

	Sri Lanka	Karnataka	Maharashtra
Health Impact			
Improved health	0.36	0.45	0.54
	(0.48)	(0.50)	(0.50)
Decreased incidence in diarrhea	0.21	0.29	0.20
	(0.41)	(0.45)	(0.40)
Time savings impact			
Change of collection time	40.6	62.6	53.9
	(52.7)	(76.9)	(80.7)
Design Performance			
Satisfied with service design	0.86	0.71	0.45
	(0.35)	(0.46)	(0.50)
Construction and O&M Performance			
Good quality construction	0.66	0.74	0.26
	(0.47)	(0.44)	(0.44)
No construction defects	0.67	0.84	0.57
	(0.47)	(0.37)	(0.50)
Non-colored water	0.94	0.87	0.92
	(0.24)	(0.34)	(0.27)
Non-turbid water	0.94	0.74	0.78
	(0.23)	(0.44)	(0.42)
Number of households	377	290	421
Number of communities	18	12	20

Notes:

Means and (standard deviations) of impact and performance indicators. See text for more detailed description of these indicators.

Impact and design performance indicators from household surveys; Construction and O&M performance indicators from water committee surveys.

Table 2: Determinants of improved health

	Sri Lanka	Karnataka	Maharashtra
<u>Community-level</u>			
Community design satisfaction	0.72 ***	0.84 ***	0.38 ***
	(0.26)	(0.20)	(0.09)
Good quality construction	0.13 **	0.10	0.18 ***
	(0.05)	(0.07)	(0.06)
<u>Household-level</u>			
Hygiene class	0.13 **	0.01	0.20 ***
	(0.05)	(0.12)	(0.05)
Household size	0.01	-0.01	0.01
	(0.014)	(0.006)	(0.006)
Household assets	0.00	0.00	0.00
	(0.003)	(0.003)	(0.002)
Number of households	377	290	421
Number of communities	18	12	20

Notes:
Dependent variable is household-level improved health.
Probit estimation, with Huber-adjusted standard errors (in parentheses).
Estimates are marginal changes in probability of independent variable.
Significance levels are: *** (.99%); ** (.95%); * (.90%)
See text for descriptions of variables.

Table 3: Determinants of time savings

	Sri Lanka	Karnataka	Maharashtra
Village-level			
Community design satisfaction	1.63 *	2.92 ***	1.06 ***
	(0.95)	(0.95)	(0.38)
Household-level			
Hygiene class	0.06	-0.36	0.77 ***
	(0.22)	(0.62)	(0.23)
Household size	-0.056	-0.047 *	0.015
	(0.062)	(0.028)	(0.032)
Household assets	-0.002	0.014	0.000
	(0.012)	(0.011)	(0.011)
Number of households	288	188	249
Number of communities	18	12	20

Notes:
Dependent variable is the log of household-level time-saving.
OLS estimation, with Huber-adjusted standard errors (in parentheses).
See text for descriptions of variables.

Table 4: Institutional determinants of satisfaction with service design

	Sri Lanka	Karnataka	Maharashtra
Local initiation	0.063	0.049	-0.126
	(0.040)	(0.087)	(0.100)
Design participation	0.196 ***	0.253 **	0.419 ***
	(0.094)	(0.069)	(0.096)
Local decision-making	0.191 ***	0.322 ***	0.540 ***
	(0.055)	(0.086)	(0.128)
Community fixed effects	Yes	Yes	Yes
Number of households	336	265	381
Number of communities	16	11	18

Notes:
Dependent variable is household satisfaction with the design of the water system.
Multivariate probit estimation, with Huber-adjusted standard errors (in parentheses).
Estimates are for discrete changes of independent dummy variables.
Significance levels are: *** (.99%); ** (.95%); * (.90%)
See text for descriptions of variables.

Table 5: Institutional determinants of good quality construction

	Specifications	
	(1)	(2)
Construction monitoring	1.02 ***	-
	(0.37)	
Construction sanctions	-	-0.07
		(0.27)
Karnataka dummy	0.40 *	0.08
	(0.17)	(0.20)
Maharashtra dummy	0.33	-0.39 **
	(0.26)	(0.17)

Notes:
Dependent variable is 'good quality construction'. Sample size is 50.
Probit estimation, with Huber-adjusted standard errors (in parentheses).
Estimates are marginal changes in probability of independent variable.
Significance levels are: *** (.99%); ** (.95%); * (.90%)
See text for descriptions of variables.

Table 6: Determinants of participation in service design

	(1)	(2)	(3)	(4)	(5)	(6)
	Sri Lanka		Karnataka		Maharashtra	
Household indicators						
Social capital index	0.0040 ***	0.0053 ***	0.0182 ***	0.0148 ***	0.0181 ***	0.0142 ***
	(0.0016)	(0.0017)	(0.0049)	(0.0043)	(0.0035)	(0.0044)
Household assets		-0.0022		0.0038 **		0.0022
		(0.0019)		(0.0013)		(0.0023)
Household size		0.0005		0.0132		0.0000
		(0.0098)		(0.0025)		(0.0055)
Community fixed effects	No	Yes	No	Yes	No	Yes
Number of households	367	367	290	264	421	315
Number of communities	18	18	12	11	20	15

Notes:
Dependent variable is household participation in the design of water system.
Probit estimation, with Huber-adjusted standard errors (in parentheses).
Estimates are marginal changes in probability of independent variable.
Significance levels are: *** (.99%); ** (.95%); * (.90%)
See text for descriptions of variables.

Table 7: Determinants of construction monitoring

Social capital indicator				
Sri Lanka (n=18)	(1)	(2)	(3)	(4)
	Social capital index	Number of groups	Group characteristics	Help from outsiders
	0.014	0.095	0.283***	1.006***
	(0.011)	(0.094)	(0.111)	(0.312)
India (n=32)	(5)	(6)	(7)	(8)
	Social capital index	Number of groups	Group characteristics	Help from outsiders
	0.031***	0.164***	0.063***	0.0401
	(0.008)	(0.050)	(0.016)	(0.144)

Notes: OLS estimation, with standard errors (in parentheses).
Results from other independent variables not reported.
Estimates are marginal changes in probability of independent variable.
Significance levels are: *** (.99%); ** (.95%); * (.90%)
See text for descriptions of variables.

Table 8: The effect of selected institutions on the impacts of water projects		Sri Lanka	Karnataka	Maharashtra
Improved health				
	Design participation	0.051	0.068	0.065
	Construction monitoring	0.037	0.021	0.017
	Total	0.088	0.089	0.083
Time savings				
	Design participation	0.115	0.236	0.182

Alternative measures of the change of impacts based on a one-standard deviation change of institutional determinants.
See text for descriptions of the underlying models and the calculation of the magnitudes.

Table 9: The effect of social capital on the impacts of water projects

Impact indicator	Estimation Procedure	Sri Lanka	Karnataka	Maharashtra
Improved health				
	Probit	0.0047	-0.0325	0.0269 ***
		(0.0043)	(0.0203)	(0.0087)
	Instrumental variables	0.0286 ***	0.0033	0.0417 ***
		(0.0076)	(0.0422)	(0.0100)
Time savings				
	OLS	0.0047 ***	0.0718	0.0916 ***
		(0.0174)	(0.1091)	(0.0276)
	Instrumental variables	-0.0004	0.2747	0.0807 ***
		(0.0304)	(0.2757)	(0.0378)

Notes: Reduced form estimates of the determinants of impact of water services.
Indepent variable is the 'social capital index.'
Results from other independent variables (as in Table 2) not reported.
Huber-adjusted standard errors (in parentheses).
See text for descriptions of variables.

Appendix Table 1: Summary statistics for determinants of improved health and indicators of social capital

	Sri Lanka	Karnataka	Maharashtra
Determinants of improved health			
<u>Village-level</u>			
Good design	0.86	0.71	0.45
	(0.12)	(0.16)	(0.30)
Good quality construction	0.66	0.74	0.26
	(0.47)	(0.44)	(0.44)
<u>Household-level</u>			
Hygiene class	0.41	0.08	0.33
	(0.49)	(0.27)	(0.47)
Household size	1.65	2.69	2.70
	(3.17)	(1.80)	(2.43)
Household assets	10.70	12.96	7.72
	(9.81)	(11.84)	(10.51)
Indicators of social capital			
Number of groups	2.41	0.19	0.49
	(1.63)	(0.56)	(1.04)
Group characteristics	7.48	1.1	1.81
	(1.55)	(2.64)	(3.07)
Social capital index	25.38	1.55	3.14
	(14.05)	(4.61)	(6.99)
Help from outsiders	0.61	0.62	0.6
	(0.49)	(0.49)	(0.49)
Number of households	377	290	421
Number of communities	18	12	20

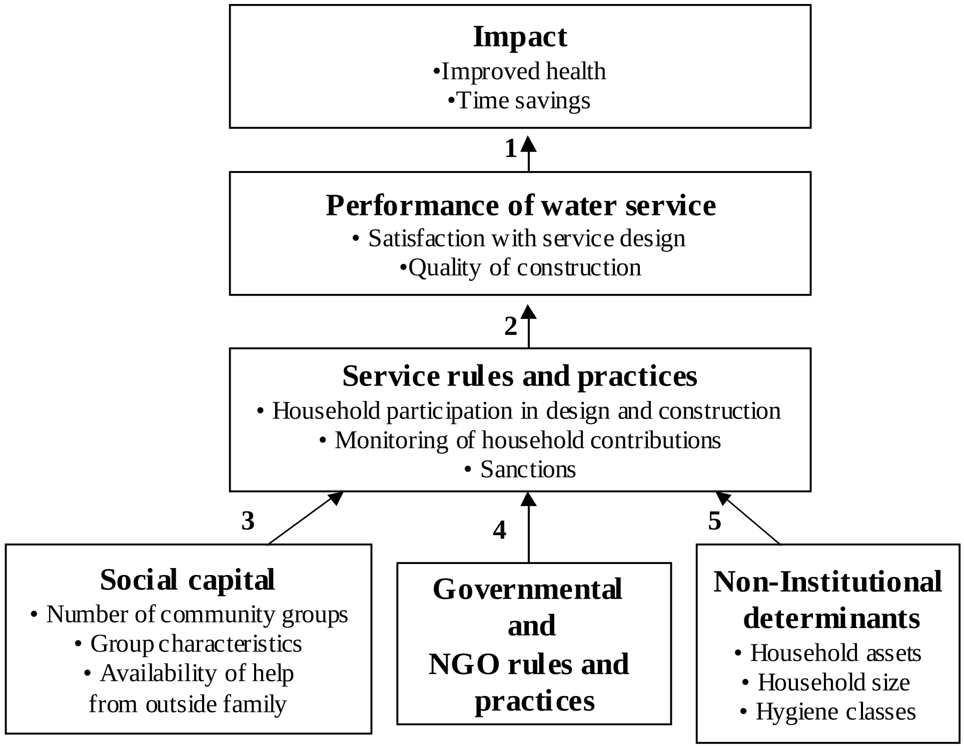
Notes:

Means and (standard deviations) for selected variables.

Means of group characteristics among households that belonged to groups are 7.56, 7.23 and 6.47, respectively; means of the social capital index among households that belonged to groups are 25.65, 10.47 and 11.41, respectively.

See text for descriptions of variables.

Figure 1. Determinants of Impact and Performance



Notes

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[1] For a review of the poor performance of the top-down approach and the economic underpinnings of the new community-based approach, see John Briscoe and Harvey A. Garn, "Financing water supply and sanitation under Agenda 21," *Natural Resources Forum*, 19 (1) (1995): 59-70; and Harvey A. Garn, "An Institutional Framework for Community Water Supply and Sanitation Services," mimeographed. (Washington, DC: The World Bank).

[2] Community Water Supply and Sanitation Project (Cr. 2442-CE) in Sri Lanka; Maharashtra Rural Water Supply and Environmental Sanitation Project (Cr. 2234-IN); and

Karnataka Rural Water Supply and Environmental Sanitation Project (Cr. 2483-IN).

[3] As discussed, for example, in Gabrielle Watson and N. Vijay Jagannathan, "Participation in Water," Environment Department Papers Participation Series (Washington, DC: World Bank, 1995); and World Bank, "Paraguay Impact Evaluation Report: Community-Based Rural Water Systems and the Development of Village Communities," (Washington, DC: World Bank, 1998).

[4] In doing so, it builds on the survey instruments and evaluation approaches for water projects found in Deepa Narayan, "The Contribution of People's Participation: Evidence from 121 Rural Water Projects," ESD Occasional Paper Series 1 (Washington, DC: World Bank, 1995); Jonathan Isham, Deepa Narayan, and Lant Pritchett, "Does Participation Improve Performance?: Establishing Causality with Subjective Data," *World Bank Economic Review* 9 (2) (1995): 175-200; Jennifer Sara, and Travis Katz, "Making Rural Water Supply Sustainable: Report on the Impact of Project Rules," (Washington, DC: UNDP/World Bank Water Program, 1998); and for social capital found in Deepa Narayan , and Lant Pritchett, "Cents and Sociability: Income and Social Capital in Rural Tanzania," *Economic Development and Cultural Change* 47(4) (1999): 871-97; and Christian Grootaert, "Social Capital, Household Welfare and Poverty in Indonesia," mimeographed (Washington, DC: World Bank, 1998). For a comparable study, see Jonathan Isham and Satu Kähkönen, "How Do Participation and Social Capital Affect Community-Based Water Projects? Evidence from Central Java, Indonesia." Forthcoming in *Social Capital and Development*, Christiaan Grootaert and Thierry Van Bastelaer, Eds. Cambridge: Cambridge University Press.

[5] See World Bank, "India Impact Evaluation Report: Comparative Review of Rural Water Systems Experience," (Washington, DC: World Bank, 1998); and World Bank, "Sri Lanka Impact Evaluation Report," (Washington, DC: World Bank, 1998) for details.

[6] Communities were selected randomly from a list of all communities that had had access to potable water through the project for at least a year. The survey was carried out in 68 communities, but 18 of these had to be dropped from the analysis in this paper because of incomplete answers or absence of water committees. All these communities were in India. Neighborhoods and households to be polled were selected randomly. The interviews were conducted at times that were convenient to the villagers to ensure maximum participation of both women and men. In some communities the water committee was part of the local government.

[7] Practitioners in the delivery of water and sanitation services typically highlight health improvements and time savings as the principle household-level impacts (for a good summary, see John Briscoe, "When the Cups Half Full: Improving Water and Sanitation Services in the Developing World," *Environment*, May 1993, 35(4) (1993): 6 – 20. Briscoe notes that new economic opportunities can be another important impact of water services: the surveys of these three projects found that less than 3 percent of households reported that they had started new economic activities since the implementation of the service. Alternatively, could can use measures of efficiency -- such as the relative unit cost of the linear length of a water supply network. We thank an anonymous referee for suggesting that we also use time-saving as a household-level impact indicator.

[8] To verify the impact of the new service on household health, households in Karnataka and Maharashtra that did not use the new water service were also surveyed as a control group. The results show marked differences in the incidence of diarrhea among the users and non-users of project-financed water services. At the time of the survey, five percent of households using new water systems in Karnataka and 15 percent using new water systems in Maharashtra had suffered diarrhea in the past two weeks, while the incidence of diarrhea among non-users was 13 percent in Karnataka and 23 percent in Maharashtra.

[9] World Bank, "India Impact Evaluation Report: Comparative Review of Rural Water Systems Experience," (Washington, DC: World Bank, 1998); and World Bank, "Sri Lanka Impact Evaluation Report," (Washington, DC: World Bank, 1998).

[10] Institutions are often confused with organizations because of the use of the word "institution" in this sense in common parlance. The basic concept of institutions in economics is,

however, something more fundamental than organizations. Institutions are the rules and practices that coordinate the actions of individuals in an organization. Examples in the context of an organization are rules about hiring and firing and about performance monitoring. For a comprehensive analyses of how institutions, defined as they are in this paper, can affect development outcomes, see Robert Picciotto, "Putting Institutional Economics to Work: From Participation to Governance," *Institutions and Economic Development: Growth and Governance in Less-Developed and Post-Socialist Societies*, ed. Christopher Clague (Baltimore: The Johns Hopkins University Press, 1997); and World Bank, *World Development Report*, (New York: Oxford University Press, 1997).

[11] For a detailed discussion of crafting service rules in the context of irrigation projects, see Elinor Ostrom, *Crafting Institutions for Self-Governing Irrigation Systems*, (San Francisco: ICS Press, 1992).

[12] In a global study on the performance of community-based water systems in Benin, Bolivia, Honduras, Indonesia, Pakistan, and Uganda, Sara and Katz found that unless the service rules gave all community members a chance to express their preferences about service, community representatives often failed to consider the demand of certain segments of the population, such as women or the poor. In addition, unless there were adequate monitoring and sanctioning mechanisms, community representatives often did not act in good faith.

[13] Michael Woolcock, "Social Capital and Economic Development: Toward a Theoretical Synthesis and Policy Framework," *Theory and Society*, 27 (2) (1998): 151-208, presents a multi-disciplinary synthesis of social capital and economic development. Paul Collier, "Social Capital and Poverty," The Social Capital Initiative: Working Paper No. 4 (Washington, DC: World Bank, 1998), presents a clear and concise economic framework for how social capital can affect a variety of development outcomes. Jonathan Isham, Thomas Kelly, and Sunder Ramaswamy (editors), *Social Capital, Economic Development and the Environment*, Edward Elgar Publications (forthcoming) present a collection of theoretical and empirical essays on social capital and development and environmental outcomes.

[14] Though not explicitly shown in the diagram, governmental and NGO institutions and non-institutional determinants (for example, enrollment in hygiene classes) may also directly affect service performance and impact.

[15] Empirical studies on irrigation management by Robert Wade, *Village Republics: Economic Conditions for Collective Action in South India*, (San Francisco: ICS Press, 1994); and Normal Uphoff, M.L. Wickramasinghe, and C.M. Wijayaratna, "Optimum Participation in Irrigation Management: Issues and Evidence from Sri Lanka," *Human Organization* 49 (1) (1990); indicate that households are likely to act collectively in irrigation projects where they face sufficient water scarcity and are assured that organization could make a substantial difference in their yields. According to Uphoff, households in the middle range of the irrigation system, where water is neither abundant (as in the head-end of the system) nor absolutely scarce (as in the tail-end of the system) and thus returns to cooperation high, are most likely to act collectively. While there were no data available to test the impact of community-level water scarcity on household-level participation in this paper, we do allow for this possibility in the estimation procedures below by testing for community-level fixed effects.

[16] Since no quantitative data on governmental and NGO institutions were collected, this paper does not provide empirical evidence of their significance. Qualitative evidence on the importance of governmental and NGO institutions for service performance is found in the two case studies in Section II.

[17] Using the notation in equation (1), let 'improved health' be relabeled H_{ij}, so that $H_{ij} = 1$ if $H_{ij}^* > 0$ and $H_{ij} = 0$ if $H_{ij}^* \leq 0$. Probit estimation is used here: in no case does using other techniques for analyzing dichotomous dependent variables, including linear probability or logit analysis, alter the fundamental results reported below.

[18] As in Narayan and Pritchett, we build a composite index of household wealth from a weighted sum of household durable goods such as radios, refrigerators, and sewing machines. It is also possible to use self-reported consumption expenditures as a proxy for long-run household

economic status; Deon Filmer, and Lant H. Pritchett, "Estimating Wealth Effects with Expenditure Data—or Tears: With an Application to Educational Enrollments in States of India," World Bank Policy Research Working Paper No. 1998, (Washington, DC: World Bank, 1998); argue that an asset index works better than consumption expenditures as this proxy.

[19] The econometric procedures in this section use the following guidelines, except where noted in the text. First, because of the differences in project design discussed in Section II (and the likelihood of region-specific omitted variables), all econometric results are reported by project. Second, all results use household-level dependent variables. Third, since heteroskedasticity (non-constant variance of the error term) is likely in the underlying econometric equations, all results are reported with Huber-adjusted standard errors. We thank Chris Grootaert for his suggestions in this regard.

[20] These results on 'community design satisfaction' could be biased upward due to reverse causality if improved household health leads the household to report that they are satisfied with project design. To test for this possibility, 'community design satisfaction' was replaced with "neighbors' design satisfaction", the share of all other community members that were satisfied with the project design. In similar specifications, the respective coefficients for this variable are 0.67, 0.77, and 0.37, all at significance levels greater than 0.99%.

[21] In Karnataka, the magnitude of the coefficient is similar to that of the other projects, but the significance level is much lower. Evaluation of the data gathering in Karnataka suggests that there is large measurement error, another justification for separating the results by project.

[22] Similar results can generally be shown using a set of alternative measures of construction quality based on more detailed questions (for example, 'leakage in networks' and 'frequent system failures').

[23] The latter result may be subject to reporting bias. It is possible that households who have taken a class will report 'improved health', even when an objective analysis would show no measurable improvements.

[24] For example, number of children in the household and self-reported household income and expenditures.

[25] One possible objection to these results is that the self-reported 'improved health' variable is not an accurate indicator of the project impact. Within each project, self-reported 'improved health' is positively correlated (at the 10 percent significance level or better) with most of the other impact and performance indicators in Table 1, including the performance indicators from the technical assessments. The exceptions are 'change of collection time' in Sri Lanka, 'no construction defects' in Karnataka, and 'non-colored water' in Sri Lanka and Karnataka.

[26] Since household-level time-saving depend primarily on community-wide decisions made during service design about the location of the water services, it is not necessary to include C_j, the measure of construction performance in community *j*, in this model. Inclusion of 'construction monitoring' in the estimations reported below (not reported here) does not significantly change the overall results on 'design participation' and the other independent variables.

[27] For example, β_1 ($= \partial \ln(\text{time savings})/\partial D_j$,) is the percentage change in time savings associated with a marginal change in design performance. (These relationships are not expressed as elasticities to facilitate the comparison between the magnitudes of health impact results.) Another way to account for the difference in initial conditions (which gives similar results as those reported below) is to use time-saving (in minutes) as the dependent variable and to include the pre-project collection time as an independent variable.

[28] It is hard to know what to make of the result on 'hygiene class' in Maharashtra (where enrollment in a hygiene class is associated with a decrease of collection time of 77 percent).

[29] While many case studies support these overall findings, there is a surprising lack of empirical studies that test the basic determinants of performance of community-based water services. The approach used here does build on the survey instruments and some of the findings of Narayan and Sara and Katz.

[30] The summary statistics for these variables underline the different approaches to service

design across each project, as discussed in Section II. In particular, the means for 'design participation' (0.84, 0.11, 0.21, respectively) and 'local decision-making' (0.72, 0.56, 0.30, respectively) confirm that the Sri Lanka project was the most participatory in terms of soliciting local opinions and giving community members a voice in the design process.

[31] Note that the sample sizes in these specifications are smaller than in Table 2 because they use community fixed effects and in two communities in Sri Lanka, one community in Karnataka and two communities in Maharashtra, there is no household that that reported satisfaction with project design.

[32] In this context, it would have been helpful to know whether households fully understood the financial obligations that they incurred by the choice of one system over another. However, data to analyze this were not available.

[33] The means and (standard deviations) for 'construction monitoring' and 'construction sanctions' are 0.43 (0.37) and 0.20 (0,29), respectively. Even though not required by project design, some households in India--particularly in Karnataka--reported contributing cash or labor to service construction and noted the existence of monitoring and sanctioning of these contributions.

[34] This may reflect the fact that only a small share of households in each community reported that sanctions were imposed on non-contributors. Most households stated that even though there may have been rules about sanctions, nothing in practice happened to non-contributors. The rules about sanctions were never enforced. Another possibility is that informal social sanctions, in the presence of effective monitoring, are a constraint against household free riding.

[35] Intensity of design participation would be measured, for example, by hours per household. As pointed out by a peer reviewer, this is to be distinguished from the quality of participation.

[36] As discussed below, a household that reports no group affiliation receives a value of 0 for this sub-index.

[37] Notwithstanding the obvious difficulties in trying to capture in a common metric the very different phenomena of group heterogeneity, participation, and functioning, this type of index (as in Narayan and Pritchett) attempts to identify, from microeconomic data, characteristics of social capital that have been shown to be important elsewhere, including: Milton Esman, and Norman Uphoff, *Local Organizations: Intermediaries in Rural Development*, (Ithaca: Cornell University Press, 1984); and Robert Putnam, *Making Democracy Work*, (Princeton: Princeton University Press, 1993); See the discussions in Narayan and Pritchett and Grootaert on the pros and cons of using an index of social capital. In particular, Grootaert makes the point that using this kind of multiplicative index means that the group characteristics act like a productivity shifter for the number of groups

[38] The use of an additive sub-index based solely on the survey questions assigns, by default, a relative weight to the value of each question. As in Narayan and Pritchett, we experimented with different weights for the questions that comprise 'group characteristics', including weights generated from factor analysis. Since the use of different weights did not dramatically change the overall results, we retain these 'default' weights.

[39] These village-level means are much lower in Karnataka and Maharashtra since both group characteristics and the social capital index take on the value of 0 when a household has no group membership. As noted in Appendix Table 1, the means of group characteristics among households that belonged to groups are 7.56, 7.23 and 6.47, respectively; the means of the social capital index among households that belonged to groups are 25.65, 10.47 and 11.41, respectively. These differences show that groups in Sri Lanka and Karnataka are slightly more heterogeneous, participatory, and effective than those in Maharashtra; and that the index of social capital is more than twice as large among households that belonged to groups in Sri Lanka compared to India

[40] Using community-level fixed effects means that these specifications are capturing the household-level effect of social capital on design participation, controlling for the possible effect of a vector of community-level variables $\mathbf{X_j}$ that could affect the participation decision. Note that the sample sizes in specifications 4 and 6 are smaller because in one community in Karnataka and five

communities in Maharashtra, there is no household that that reported participating in project design.

[41] It is important to verify that the results reported in this table are not overly biased by the way that the social capital index is constructed--with a 0 assigned to all households without any group membership. Sets of alternative specifications with only households that report group membership (not reported here) show very similar results. The one exception is an alternative specification (6) among 94 households in Maharashtra, where the coefficient is positive (0.0029) but insignificant.

[42] These supplementary results are not reported here. The notable exception is 'help from outsiders' in Maharashtra, with a negative marginal effect and a p-value of 0.06.

[43] A reduced form model attempts to use only truly exogenous independent variables as potential determinants.

[44] Both the single- and two-stage reduced from models proposed here also have the underlying assumption that most of the effect of social capital occurs through 'design participation' and 'construction monitoring' not other service level rules that are uncorrelated with these two.

[45] The same results can be derived using a linear probability model (which serves as a reference for the subsequent instrumental variables estimation with improved health.

[46] More technically, these community-level variables are 'good' instruments if they are positively correlated with the social capital index and are not strongly correlated with the error term in the reduced form equation. The pairwise correlation coefficients between community-level social capital index and 'household community activity' and 'multiple community activities' are 0.83 and 0.76, respectively.

[47] It also shows that the test for over-identifying restrictions can be rejected (p-values of 0.83 and 0.16, respectively). Similar results can be generated using the two-stage method of Whitney Newey, "Efficient Estimation of Limited Dependent Variables Models with Endogenous Explanatory Variables, Journal of Ecomonetrics (36) (1987), 231 – 250.

[48] In the previous draft of this paper, this change in the probability of improved health was calculated by multiplying the coefficients of 'household community activity' and 'multiple community activities' in the first stage (where the dependent variable is the social capital index) times their respective standard deviations, and then multiplying the sum of these terms times the coefficient on the social capital index in the second stage (where the dependent variable is improved health). We thank numerous readers and seminar participants for suggesting this more parsimonious method.

[49] The divergence between the results from the structural equations and the reduced form in Karnataka (in both parts of this table) may be due to the fact that, as previously noted, there were larger errors associated with the data collection in Karnataka.

[50] See Collier for a general discussion of this point.

[51] For empirical evidence of this general result, see Narayan and Pritchett and Grootaert.

[52] For more on this last point, see Jonathan Isham, "Can Investments in Social Capital Improve Local Development and Environmental Outcomes? A Cost-Benefit Framework to Assess the Policy Options," in Isham, Kelly and Ramaswamy, Eds.