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Water Works: The Economic Impact of Water Infrastructure*

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Abstract

Billions of hours are spent each year on water collection in developing countries. This paper explores whether improvements in water technology enable changes in household time allocation patterns and, thereby, productivity gains. To do so, it exploits differences in the timing of shared public water tap construction across Kyrgyz villages to provide evidence on the extent to which such changes in time allocation are aided by access to better water infrastructure, a technology that decreases the labor intensity of home production. Households in villages that receive this labor-saving technological improvement are, on average, 15% more likely to be within 200 meters of their water source. This, in turn, reduced the time intensity of home production activities that are impacted by water, such as bathing, going to the doctor, and caring for children. Village-level incidence of acute intestinal infections amongst children fell by 30%. Although adults themselves show no signs of improved health, they benefit from the reductions in time spent caring for sick children. These reductions in the time intensity of home production allowed for greater time allocated towards leisure activities and market labor, specifically work on the household farm. As a result, average production of cash crops (specifically, cereals such as wheat and barley) increased by 645 kilograms per household per year. The labor supply and productivity estimates imply a rate of return to labor valuing approximately $0.43/hour, which mirrors the hourly wage for farm labor. Taken together, these results suggest that the main channel of influence through which productivity gains were realized was increased labor supply in an environment where the classic separation of household production and consumption activities appears to hold.

JEL: J22, O13, O53, Q12, Q25.

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1 Introduction

Processes of economic development are often accompanied by significant changes in within-household time allocation patterns.[1] Some have credited time-saving household technologies with reducing the time intensity of home production activities and increasing historical labor supply.[2] Empirical research supports the hypothesis that time-saving technologies have increased labor force participation for married women in developed countries (Coen-Pirani, Leon, and Lugauer, 2010; Cavalcanti and Tavares, 2008). Technological progress in the household sector has been found to be more of a driver of such labor-force participation increases than wage increases. Simply put, "technological progress in the household sector erodes the value of labor in the home" (Greenwood et al., 2011). However, causality has proven difficult to disentangle. This paper makes use of quasi-experimental variation in access to domestic water infrastructure to provide causal estimates of how technological progress in household production can lead to productivity gains.

The context I explore is important. In developing countries, households without water infrastructure spend billions of hours collecting water for domestic use every year (Cosgrove and Rijsberman, 1998). Given that water is necessary for life and used for numerous purposes beyond drinking, it is critical in household production. Lack of water infrastructure can drive up the time intensity of home production, thereby diverting time from potentially income-generating activities, such as formal work, agricultural labor, and small businesses (Harvey and Taylor, 2000; Blackden and Wodon, 2006). Advocates claim that the reallocation of these time savings are "one of the greatest returns to improved access to water" (Bjorkland et al., 2009; Human Development Report, 2006) and can "lay the groundwork for economic growth" (UN Millennium Project, 2005). Improvements in household technologies can help shift time allocation from basic household tasks related to water collection to increased market production, but the extent to which remains a question.

By analyzing a large-scale water infrastructure project implemented in rural Kyrgyzstan, this paper sheds light on the channels by which labor-saving water technologies may help decrease the time intensity of home production. The project's stated objective was "to increase the supply and coverage of potable water to rural communities" with "time savings due to greater proximity to water collection points" listed as the primary expected benefit prior to

[1] See Goldin (1995) for a discussion of the U-shaped relationship between development and female labor force participation.

[2] For example, there is evidence that technological progress in the United States during the 1900s, in the form of household time-saving products such as washing machines, vacuum cleaners, and frozen foods, contributed to cutting down the home labor and increasing the market work performed by women. As housework declined over time with the diffusion of new time-saving appliances, the participation of females in the labor-force increased (Greenwood, Seshadri, and Yorukoglu, 2005).

the project[3] (World Bank, 2001). I investigate the extent to which changes in household time allocation are aided by water infrastructure and that can, in turn, change labor supply and productivity outcomes.

Rural households in northern Kyrgyzstan own six acres of land, on average, and the majority of working-age people are self-employed on their household's own small farm.[4] These households are labor-constrained, due to small family size[5] and low levels of mechanization, a characteristic common of less developed countries. The household members must therefore carefully allocate their time between work in the market, work at home (which includes water collection, amongst other forms of home production), and leisure activities. I use household-level panel data on agricultural inputs and production, along with individual-level time budget diaries[6] to identify how household members re-allocate time saved after the construction of drinking water infrastructure. If people work more in the market, does this result in greater crop production? And if so, through which channels does the increased farm production occur?

Given the non-random placement of water supply systems in villages, it is possible that unobserved village-level characteristics, such as political connectedness, might be correlated with both water supply system placement and the outcomes variables. To isolate the effects of receiving water infrastructure, I use differences in the timing of construction across villages. This difference-in-differences approach controls for the unobserved, fixed characteristics of villages that might bias simple cross-sectional analyses.

When lacking water at their home, household members must bring water from other sources, either improved (wells, protected springs, shared standpipes and taps) or unprotected (streams, rivers, unprotected springs, lakes, irrigation canals). Rural households can require substantial amounts of time for water collection, as each round-trip from home to water source can be lengthy and multiple trips per day are required. The average time required per round-trip to collect drinking water in rural areas is 36 minutes in Sub-Saharan Africa and 23 minutes in Asia (United Nations, 2010).[7] Rural households in Kyrgyzstan similarly suffer from this burden. Households that lack water infrastructure spend an average of 26 minutes per water collection trip (see Table 1). Of such households, approximately one-quarter spend between

[3]The second expected benefit was "health benefits resulting from reduced incidence of water borne disease, lower infant mortality rates, lower medical costs, less income loss from sickness, etc." (World Bank, 2001). The pre-project cost-benefit analysis quantified only the time savings benefits, not the health benefits.

[4]This is based on calculations from the 1999 Kyrgyz Census.

[5]Since independence, the birthrate in Kyrgyzstan has decreased, resulting in smaller families (Dekker, 2003).

[6]Historically, there has been an absence of time budget diary data and recall methods are considered less reliable, as respondents are not bound by a twenty-four hour constraint in recording (Gronau, 1986).

[7]These calculations were computed by the United Nations Statistics Division using data from Macro International, Demographic and Health survey (DHS) reports; Macro International, DHS STAT compiler; and UNICEF, Multiple Indicator Cluster Survey (MICS) reports (United Nations, 2010).

30-40 minutes per trip and more than 10 percent spend more than an hour per trip (see Figure 1 for distribution) (UNICEF MICS, 2007).[8]

The proposition that labor-saving technologies can increase labor force participation is rooted in Becker's model of household time allocation (1965). In Gronau's (1977) model, which distinguishes between home production and leisure activities, a household will optimize where the marginal product of home production equals the market wage (Gronau, 1986). A key implication is that different technologies can decrease the value of time spent working at home, which increases the probability of market work (Blau, Ferber, and Winkler, 2002).

Evidence from developing countries also supports the proposition that shifts from home production to market work can result from certain household sector technological changes. Field (2007) found that improving property rights in urban Peru freed households from time previously spent protecting informal claims to the land. By not having to stay home to protect their property, households were able to increase the time allocated towards outside work. Similarly, fuel wood collection required two working days per week before electrification in South Africa enabled males and females to increase their hours of market work (Dinkelman, 2011).

Each of the existing papers on the labor impacts of water infrastructure have found that access to water infrastructure results in less time spent collecting water; however, from there the results diverge. In urban Morocco, a randomized study found that shifting households from free public taps to individual household connections did result in time gains, however, such time was re-allocated towards leisure and social activities (Devoto et al. 2011). The benefits of any water intervention will depend on the location, technology, and circumstances of implementation (Whittington et al., 2008); therefore it is understandable that market and non-market tradeoffs will differ between urban and rural contexts.

All three of the studies focusing on rural households limit their analyses to females. Ilahi and Grimard (2000), the most similar in concept to my study, develop a household model that is based on Becker (1965) and Gronau (1977). Testing the model with cross-sectional data for female household members in rural Pakistan, they find that time working on "market-oriented activities" decreases with distance of water collection point. However, the existence of unobservable household characteristics that are correlated with both distance of the water source and female labor participation may bias their results. Using a matched difference-in-difference method, Lokshin and Yemstov (2005) assess the impacts of multiple types of rural infrastructure projects, including water supply systems, in rural Georgia and they find no

[8] Unfortunately, the MICS survey did not collect the number of water collection trips per day.

significant impact of the water infrastructure on the share of working-aged women employed in wage labor. Koolwal and van de Walle (2010) perform a cross-sectional study utilizing data from nine developing countries to estimate the extent to which water infrastructure affects female labor force participation. The authors exclude farm self-employment from their measure of labor force participation and find no impact on women's participation in market-based activities.[9]

This paper makes multiple contributions to this literature. First, it utilizes data from detailed time budget diaries, which provide a more in depth and reliable assessment of the shifts in time allocation than studies that rely on recall data. Second, to the best of my knowledge this is the first paper which combines rich data on household time allocation with a quasi-experimental source of variation in water technology. Third, detailed data on farm and home production, combined with the fact that both men and women collect water and engage in agriculture, allow me examine impacts on household production and provide a simple benchmark test that allows me to examine separation.[10] Fourth, using village-level data on incidence of water-related diseases, I can evaluate the health impacts of shared public water taps to better understand the role of health in time use patterns. Fifth, this paper contributes to the literature on the labor market impacts of infrastructure construction in developing countries.[11] Lastly, a detailed analysis of the time trade-offs between home production, market production, and leisure activities, following the construction of water infrastructure provides insight on the value of time spent collecting water and thereby enables an informed cost-benefit analysis of the welfare impacts of water infrastructure.

Results indicate that households located in villages that received the water infrastructure are, on average, 12 to 15% more likely to use a domestic water source that is less than 200 meters from their home. This reduces the time burden of water collection. Critically, having water closer to the house translated into time savings. Less time is spent on activities that require substantial water collection, including activities related to care of one's own physiology (e.g. time spent looking after oneself, bathing, and going to the doctor) and care of children (e.g. bathing and caring for them when sick).[12] Reductions in the time intensity of home production come with an average increase of more than two hours per day in leisure activities and one hour per day in farm labor. The additional farm work translates into 645 kilograms more of cereals produced, specifically wheat and barley, which are critical for household income-

[9]They do, however, find impacts on children's schooling and anthropometric z-scores for some countries.

[10]Benjamin (1992) provides a thorough discussion and multiple tests of the separation of consumption and production in the farm household.

[11]See Dinkelman (2010) for her point as to how this is a shift from primarily focusing on the "poverty, health, and education" impacts of physical infrastructure

[12]A description of the time use categories is in Appendix Table 3.

generation.

I investigate the extent to which the water infrastructure might have impacted human capital and labor productivity via incidence of water-related diseases. Although there are significant decreases in the incidence of acute intestinal infections amongst children, there is no evidence of such impact amongst the adult population. In addition, calculations of the average cereal production per hour worked do not provide any indication that adults are significantly healthier in the villages that received the water infrastructure. Therefore, it appears as though the main channel through which reductions in water-related illnesses affect adult labor is through their children. The time parents must spend caring for children decreases when their children are sick less often.

Having shown that the water infrastructure increases both time spent working on the farm and production of crops, I test the extent to which the increase in production is due to additional hours worked. Instrumental variables calculations of the agricultural returns to labor indicate that each additional hour of labor allocated to the household farm produces approximately \$0.43 in cereals harvested. This estimated return to labor is within the range of reported farm wages in this time period.[13] These results contribute to the empirical literature testing models of household decisions and separation between the household's production and consumption decisions.[14] According to the standard agricultural household model, the farm's production should be determined by market wages and technology, not by the household's consumption. If labor in the market and home are perfect substitutes, the household optimizes by allocating its labor such that the marginal product of home production equals the market wage (Strauss and Thomas, 1995). Therefore, assuming that the marginal product of labor is constant, these results do not indicate a failure of separation.

To determine whether the magnitude of the water infrastructure's effects on time reallocation is reasonable, I perform some basic calculations based on the principle that 50 liters are required per person per day to provide for basic drinking, hygiene, bathing, and laundry needs (UNDP, 2006).[15] These calculations indicate that the water infrastructure could result in approximately 136 minutes per adult per day of time savings directly due to water collection. This simple calculation suggests that the magnitude of my time reallocation results is plau-

[13] The average hourly wage in 2003 for "market-oriented skilled agricultural and fishery workers" was \$0.19/hour (World Bank, 2007). Discussions with farmers living in such villages indicated that the wage in 2011 would be approximately between \$0.55/hour and \$0.80/hour.

[14] Singh, Squire, and Strauss (1986) and Strauss and Thomas (1995) provide discussion of the recursive property See Pitt and Rosenzweig (1986) and Benjamin (1992) for examples of tests of separation.

[15] To provide context, the average water use per person per day is more than 550 liters in the United States, approximately 300 liters in Norway, 135 liters in India, 85 liters in China, and 45 liters in Bangladesh and Kenya (UNDP, 2006).

sible; however, it suggests a gap between the size of pure time savings from water collection and the amount of time I find is reallocated to leisure and farm labor. This could be due to reductions in the time intensity of other components of home production that result from the water infrastructure. For example, the gap could be accounted for by reductions in the time spent caring for sick children. On average, adults spend 24 minutes per day less caring for children, as a result of the infrastructure. Together with the back-of-the-envelope calculation from above, the pure time savings account for 160 minutes per day. It is, however, possible that my estimate of time reallocation to leisure and farm labor is above a plausible upper bound and other factors have a role. Although my village-level results show no indication of reductions in the adult incidence of water-related diseases, it is still possible that adults are healthier and thus able to work more. In this case, separation of household farm production and consumption would not hold.

Finally, I undertake a cost-benefit analysis of the water infrastructure. Lacking empirical evidence, many previous cost-benefit analyses are based on assumptions of the value of time spent collecting water (Whittington, Mu, and Roche, 1990). However, I can make an informed calculation by decomposing the time savings from home production (approximately three hours) according to where it is reallocated (approximately two hours to leisure and one hour to market labor). Just based on time reallocated towards farm work alone, the benefits substantially outweigh the costs: assuming a 12% discount rate, the water infrastructure has a net present value of $89.4 million[16] with an internal rate of return to these water infrastructure investments of 44%.

The remainder of the paper is organized as follows. Section 2 provides background information on drinking water access and labor in the Kyrgyz agricultural sector. Section 3 provides a conceptual framework of the links between water, time, and farm production. Section 4 addresses the empirical framework, including the identification. Section 5 explains the contents of the various datasets used in this research and baseline characteristics. Section 6 addresses the water infrastructure's impacts on time allocation, disease outcomes, agricultural production, and returns to labor. The cost-benefit analysis is described in Section 7. Section 8 concludes.

[16] I have calculated this cost-benefit with different discount rates to provide a sense of the role that it plays in calculating the net present value (NPV). With a 10% discount rate, the NPV equals $109.6 million and with a 8% discount rate, the NPV equals $135.5 million.

2 Background on Kyrgyzstan

Kyrgyzstan is the second poorest country from the Former Soviet Union with approximately fifty percent of the population living below the poverty line (World Bank, 2001). According to the 2010 Human Development Index, one standard measure of well-being, Kyrgyzstan is considered to be of "medium human development."[17] This section provides background on the baseline state of water infrastructure and the role of agriculture for rural households in Kyrgyzstan.

2.1 Domestic water supply systems in rural Kyrgyzstan

While part of the former Soviet Union, some rural areas of Kyrgyzstan gained improved access to drinking water sources in the form of shared taps (also known as standpipes). However, the country saw marked decreases in the level of water supply services following the country's declaration of independence in 1991, with many of the existing water supply systems falling into disrepair. This left a large proportion of the Kyrgyz population drinking from sources contaminated by fertilizers, fecal matter, and other pollutants from cotton and rice production (USAID, 2006), such as irrigation canals, unprotected springs, rivers, or ponds. In the study regions, prior to the intervention approximately 50% of villages had no water service at all, 30% of villages provided service to 20-40% of households, and 15% of villages provided service to 41-60% of households (DFID and World Bank, 2007).

2.2 Labor and agriculture in Kyrgyzstan

In Kyrgyzstan, the agricultural sector accounts for more than one-third of the country's GDP (World Bank, 2004) and on-farm growth has been credited as a driver for increases in non-farm goods and services, thereby galvanizing off-farm growth and employment (World Bank, 2007). Kyrgyzstan's agricultural sector relies on the production of cereals, specifically wheat, maize, and barley (FAO GIEWS, 2011). According to the 1999 census, 64.7% of the population of Kyrgyzstan, totalling approximately 3.14 million people, lives in rural areas. With 75.3% of the rural population over 15 years old working in agriculture (National Statistical Committee of the Kyrgyz Republic, 1999 Census), a substantial proportion of rural households rely on income from their own farms as their main source of income. In the three provinces of interest (Naryn, Issyk Kul, and Talas), rural households have an average of 5.7 acres of land. This area is divided across an average of 1.8 plots of land, which typically include a home garden

[17] According to the HDI, Kyrgyzstan is ranked 112th of all countries, falling directly between Indonesia and South Africa. According to the IMF's 2010 GDP (PPP) per capita rankings, Kyrgyzstan is ranked 144th between Papua New Guinea and Cameroon.

and a small farm plot (calculated from the 2003 Kyrgyz Integrated Household Survey (KIHS) data). In these poor, mountainous regions, roads can be ill-maintained and impassable at times, making commuting for labor opportunities challenging and therefore perpetuates the reliance on agriculture for income generation.

There are several key differences between home gardens and small farms. A summary of the differences is presented in Appendix 1. Home gardens tend to be small plots of land (between 0.1 ha to 2.0 ha in size) that are adjacent (or at least very close) to the home. Chemical inputs (fertilizer or pesticides) and farm machinery are not typically used in home gardens. Home garden plant products are used daily for households (Currey, 2009). Only a very small proportion of home gardens are formally irrigated (calculated from KIHS data, 2003). However, given the crop production[18] and the livestock and poultry that are kept on the land plot (Currey, 2009), household activities occurring within the home gardens require a substantial amount of water. Often, the household will use water collected from the nearest source to water the crops grown on that land. For this reason, when the installation of shared water taps provides water that is closer than the household's previous source for watering the home garden, individuals in the household will not have to walk as far to gather water for this household activity. As a result, household members should save time on this work in the home garden.

In contrast to the home garden, the household's small (or "peasant") farm tends to be a larger plot of land that is located in the area surrounding the village. Following the independence of Kyrgyzstan, collective farms were sub-divided and allocated to residents in rural areas; most of land previously held by collective farms was shifted to peasant farms during in the process of land reform (Akramov and Omuraliev, 2009). However, the farms tend to be constrained by the amount of labor available through the family. A peasant farm is created by a family (or group of families) with its privately-owned land and these farms primarily rely on family labor (Lerman, Csaki, and Feder, 2004). In addition, peasant farms appear to require more labor per hectare than the collective and state farms did (Dekker, 2003), which could be the result of less machinery available on the peasant farms. Land on the small farms is three times more likely to be formally irrigated than land in the home garden (calculated from KIHS data, 2003). Given the higher levels of formal irrigation and the location of the peasant farms on the outskirts of a village, households are unlikely to use domestic water on their farm plots.

There are also several key distinctions in the allocation of crops grown on the two different

[18]Home gardens developed in Kyrgyzstan during collectivization and are now of great importance. In 2007, home gardens contributed approximately one quarter of the country's agricultural production (based on market value) (Currey, 2009).

types of land plots. Most fruits and nuts are grown in the home gardens. Vegetables may be grown in either the home garden or the small farm, depending on the type of vegetable. Fodder (grasses for hay) and cereals are grown almost solely on the small farms.

The potential income-generation of the plots is connected to the crops grown on each. Although 83% of home gardens are cultivated solely for household consumption, 67% of farmlands are cultivated for both family consumption and sales (calculated from KIHS data, 2003). An in-depth study of home gardens in a few villages within this paper's study region found that most vegetables grown in home gardens are kept for household consumption, whereas fruit, in particular apples, pears, and apricots, may be sold (Currey, 2009).

3 Conceptual framework of the links between water, time, and household farm production

To understand the links between water, time, and agricultural production, one must understand how water infrastructure can impact the time intensity of home production. To do so, I consider a basic agricultural household model[19] in the spirit of Becker (1965) and Gronau (1977).[20] As in Strauss and Thomas (1995), households are assumed to maximize their utility from commodities purchased in the market and produced at home and leisure, subject to a budget constraint, time constraint, and home production function. A household must trade off between allocating time towards leisure, home production, and work in the market.[21]

This section provides a framework through which to understand these relationships and details on the water infrastructure introduced to alleviate the burden of water collection.

3.1 Water infrastructure and the time intensity of home production

In the context of this study, home production includes activities such as collecting water, performing housework (including cooking, washing dishes, doing laundry, sewing, cleaning the home, producing or buying food and non-food items, and other types of domestic labor), caring for one's own physiological needs (including bathing, looking after oneself physically, going to public bathhouses, going to the hospital or doctor, eating, sleeping, and other needs), caring for children (including time spent bathing, feeding, and caring for sick children, as well

[19]Singh, Squire, and Strauss (1986) thoroughly discuss agricultural household models.

[20]Of the previous work on the time impacts of water provision, two other papers, Koolwal and van del Walle (2010) and Ilahi and Grimard (2000), also examine such questions explicitly in the framework of such models.

[21]I follow Gronau's (1977) distinction between time spent in home production and leisure.

as helping them with homework and playing with them), and helping other relatives.

Households lacking water infrastructure typically collect water for many purposes beyond drinking, such as preparing food, cleaning homes, bathing children, growing food in the family home gardens, and watering domestic animals (Schouten and Moriarty, 2003). As such, home production is more time intensive for households lacking water infrastructure in two ways. First, such households must collect the water for these domestic purposes and the collection takes time. Second, these households are limited by the water that they can transport to their homes and the constraints on water availability can make certain household activities, such as cleaning the home and washing dishes, more cumbersome and thus time intensive.

Given that households use the water for many domestic purposes, household members typically either make multiple water collection trips per day or send more than one household member to the water source.[22] The time required to make a roundtrip from home to water source and back depends on a few factors. First, distance from household to water source plays a large role. Water sources can be located a substantial distance from the house. Second, the physical characteristics of naturally-occurring sources (e.g. rivers and streams) and the surrounding terrain may increase the difficulty of collection. For example, in Kyrgyzstan, children can fall into rapidly-moving rivers when collecting water, resulting in injury or sickness, particularly during the winter. Other sources may dry up late in the summer and fall, making it difficult to fill water containers. Third, many households rely on the same source can result in crowding and queuing at the source. For example, Kyrgyz villages with water infrastructure at baseline had an average of 64 houses (but at times more than 200 households) sharing one tap (DFID and World Bank, 2007). As such, time required to collect water can be much greater than one would expect just based on distance to the source.

Water collection is often primarily a women's duty in many developing countries. However, based on data collected via the MICS survey, the duties of water collection tend to be shared between males and females in Kyrgyzstan. Overall, in rural communities in Kyrgyzstan, approximately 60 percent of households have females (women and girls) as their primary water collector. However, in the three provinces in which this study was implemented an opposite pattern exists (UNICEF MICS, 2006). Appendix 2 shows that in Issyk kul, Naryn, and Talas approximately 60 percent of households have males as their primary water collectors. Therefore, in this context, lack of water infrastructure increases the time intensity of home production for both men and women.

[22]For example, households in some areas of rural western Kenya make, on average, almost seven water collection trips per day to their water source (Kremer et al., 2011).

Water infrastructure can address all of the constraints above by making water closer to the household, eliminating the risks of collecting from dangerous sources, and reducing the number of households per collection point. To address the lack of water infrastructure in rural Kyrgyzstan, a large-scale effort was launched in the early 2000s to construct water infrastructure, in the form of shared water taps, to rural communities throughout the country. Villages were informed of the project and, if interested, they applied to receive the infrastructure. Given that there was not enough funding to provide all villages with the infrastructure, a village selection process was carried out between 2003 and 2006 (see Appendix for greater detail on the selection process). Of the 255 villages that applied 194 were selected to receive the water infrastructure.

Project villages received either a new or reconstructed water supply system, which was comprised of communal water taps at locations throughout the village. According to project reports, the intervention brought water sources closer to households and reduced queuing; after the construction an average of twelve households shared each water tap. Most households reported that the water infrastructure improved their ability to clean their homes and their children. Teachers reported that tardiness decreased amongst schoolchildren. Adults reported working on their farms and spending more time with their children with the time saved. The infrastructure improved domestic water quality and households reported reductions in incidences of stomach pains amongst children (DFID and World Bank, 2007). Anecdotal reports indicated that people visited the doctor less and spent less time caring for ill family members. Additionally, the hazard of children being injured collecting water was negated.[23]

3.2 Alternative time uses: leisure and market work

The decreased time intensity of home production frees time for leisure activities and market work. Leisure includes activities varying from listening to the radio, playing sports, spending time with friends, and reading, amongst others. Market work is the potentially income-generating labor, which in this context is predominantly work on the household's own small farm, but also includes formal employment that earns a salary (teachers, government employees, and health care workers), and entrepreneurial activities, trade, and other informal employment.

Although peasant farms appear to require more workers than larger farms, they tend to rely on family members for labor (Lerman, Csaki, and Feder, 2004; Dekker, 2003). The average household is approximately 5 people, which is relatively small given that households have an

[23]Personal communication with PMC Team Leader, Roberto Lo Cicero Vaina on February 16, 2011.

average of 6 acres of land (calculated from KIHS data, 2003). Since agriculture is the main source of income in rural areas and family size is relatively small for the average size of landholdings, we know that households are to some extent labor-constrained. Ex ante it is not obvious how households will reallocate time savings from the reductions in the time intensity of home production. This paper tests the extent to which time is reallocated to either leisure or market work.

3.3 Ruling out use of domestic water for farm irrigation

The introduction of domestic water infrastructure is a shock that affects the home production activities; however, I rule out the possibility that the domestic water is used for irrigating households' farm land and therefore impacting farm productivity through direct water supply. There are several facts that support this assertion. First, almost all land used for the small farms is irrigated in some fashion, whether by the old Soviet irrigation infrastructure or by less permanent earthen canals (calculated from KIHS data, 2003). Thus, the small farms do not necessarily need the domestic water. Second, most of the household farms are actually located a substantial distance from the home (Currey, 2009) and are on the outskirts of each village,[24] making the domestic water infrastructure an extremely inconvenient irrigation source. Households are therefore unlikely to use domestic water to irrigate their farm plots.

4 Empirical Framework

To isolate the impact of the water infrastructure, I utilize details of the village selection process in conjunction with panel datasets of villages, households, and household members.

4.1 Identification strategy

I estimate the impact of a village being allocated a water supply system on individual time use and measures of household agricultural production. A simple cross-sectional analysis of the difference between villages that receive and villages that do not receive a water supply system is likely to be biased due to unobserved, confounding variables. Given the phased-in selection of villages over several years, I use the differences across villages over time to estimate the impact of being allocated a water supply system on these outcome measures. This allows me to control for the unobserved, fixed confounders that are correlated with both the water

[24] This is as a function of how the collective farms were divided amongst the village households when Kyrgyzstan declared independence from the Soviet Union.

supply system and the outcome measures of interest.

First, I start with evaluating the impact of the being selected for the project on household water access. This is to prove that the project worked by decreasing household reliance on unprotected water sources and increasing the probability that households use shared standpipes and have water closer to their households.

For the difference-in-differences framework, all regressions include village fixed effects and district-year fixed effects (rather than simple year fixed effects), thereby allowing the effect to vary by district. This specification is logical given that most of my outcome measures (particularly the agricultural production and time use) are dependent on rainfall and rainfall has tremendous variation spatially (i.e. rainfall is location-specific). For this reason, it is not uncommon for fixed effects analyses of agriculture-related outcomes to allow the effect to vary by region. Deschenes and Greenstone (2006) use county and state-by-year fixed effects in an analysis of county-level outcomes and Dell, Jones, and Olken (2011) use country fixed effects and region-by-year fixed effects in an analysis of country-level outcomes.

The difference-in-differences estimate of the impact of being selected for the project on water access is calculated through the following equation:

$$S_{hjkl} = \beta_0 + \beta_1 w_{jkl} + \Gamma' d_{hjkl} + (\alpha_k * \delta_l) + \theta_{jk} + \epsilon_{ihjkl} \quad (1)$$

where S_{hjkl} represents the three binary outcome variables indicating water access, specifically use of an unprotected water source, use of shared standpipes, and distance of the water source of household h in village j and district k in year l; w_{jkl} indicates whether village j was allocated a water supply system two years prior; d_{hjkl} is a vector of household-level controls, which in this case includes household income and number of rooms in a household; $(\alpha_k * \delta_l)$ represent district-year fixed effects; and θ_{jk} are village fixed effects.

After showing that the project worked to improve water access, I estimate the impact of the infrastructure on individual-level time allocation. The difference-in-differences estimate of the impact of the water supply system construction on individual time use is obtained through the following OLS regression:

$$T_{ihjkl} = \beta_0 + \beta_1 w_{jkl} + \beta_2 d_{hjkl} + \Pi' x_{ihjkl} + \Omega' z_{ihjkl} + (\alpha_k * \delta_l) + \theta_{jk} + \epsilon_{ihjkl} \quad (2)$$

where T_{ihjkl} is the number of minutes in one day individual i of household h in village j and district k allocated towards a given activity in year l; w_{jkl} indicates whether village j in district k was allocated a water supply system two years prior to year l; d_{hjkl} refers to the size of household h; x_{ihjkl} is a vector of individual-level controls, including age and gender; and z_{hjkl} is a vector of interview round controls, specifically season and day of week on which the interview occurred.

Similar to equation (1), the following regression estimates the impact of being allocated a water supply system on agricultural outcomes, such as crop harvests:

$$A_{hjkl} = \beta_0 + \beta_1 w_{jkl} + \Gamma' d_{hjkl} + (\alpha_k * \delta_l) + \theta_{jk} + \epsilon_{ihjkl} \tag{3}$$

where A_{hjkl} is the amount harvested by household h in year l of a particular crop (or group of crops), as measured in kilograms; and d_{hjkl} is a vector of household-level controls, which is in this case includes household farm characteristics, such as the total plot size, the proportion of land irrigated, the number of land plots owned by the household, proportion of cultivated land, and household expenditures on farm-related things.

5 Data

This paper relies on data at the household- and individual-level, as provided by the Kyrgyz Integrated Household Survey (KIHS), and village-level, as provided by Kyrgyz National Census and the Ministry of Health data. All data sources are described below.

5.1 Village selection process

Data on the village selection process and whether a village was ultimately allocated a water supply system were collected. The selection process is described in greater detail in Appendix 3. This selection dataset is therefore limited to the 255 villages that applied for a water supply system, by having expressed an interest and need for a water supply system.

Data on village selection include the date that the water supply system was officially registered with the government as being completed; however, it was not uncommon that the onset of water service from the infrastructure was prior to that date. For this reason, this official date of water supply system completion is not necessarily an exact date of when the village began to use the system for water provision. Calculations indicate that the average length of time between village selection and this official completion date is approximately two years. The distribution of the time between selection and water supply system completion for villages is shown in Appendix 4. Given that the average water supply system construction is officially approved within approximately two years, but the date of official government approval is not synonymous with the actual onset of water provision to a given village, I assume a two-year lag between selection and construction completion in all analyses.[25] The data on village selection are then matched with the village-level census data, village-level data on water-related diseases, household-level data on agricultural production and other household characteristics, and the individual-level data on time use.

5.2 Kyrgyz Integrated Household Survey

The Kyrgyz Integrated Household Survey (KIHS), which has been implemented annually by Kyrgyz National Statistics Committee since 2003, provides household-level data through 2009. The KIHS is a rotating panel, with one-quarter of the households changing each year. The sampling method employed for the KIHS is a two-stage stratified design. From the 1999 census, primary sampling units (PSUs) were identified. Stratifying by province and whether the location is rural or urban, 456 PSUs were randomly selected. In rural areas, a PSU is equivalent to a village. PSUs have primarily remained the same over the 2003-2009 period used for this study. Households (5,016 in total) were then randomly selected from the PSUs, with the probability of selection proportional to size.

Within the 3 provinces in which the water supply project was implemented, there are 66 rural PSUs surveyed through the KIHS. Of these PSUs, 40 PSUs are villages that applied to receive an improved water supply system through the project. Of these 40 PSUs, 24 were villages selected to receive the water supply systems and 16 were not selected. Household-level data from these 40 rural PSUs were used to create a panel dataset of approximately 450 households surveyed each year between 2003 and 2009.

The KIHS was developed to collect data on households and their members, including information on household characteristics and consumption and individual education, health, and employment. Given the large proportion of rural households that survive on agricultural production on their small farms, the survey collects quarterly agricultural data, such as crop production, land characteristics, and expenditures on farm-related activities.

Additionally, in 2005 and 2010, the KIHS included a module on individual time use. Households were allocated in such a way that all days of the week were represented proportionally. Individuals 12 years and older were asked about their allocation of time in previous twenty-

[25]To ensure the robustness of this assumption, I present the first set of results (those showing the impact of the project on water access) for both the two-year lag and the government date of completion. Results from the two methods are very similar.

four hours (1440 minutes) of the current month. Appendix 5 shows the different categories of time use. There is, however, no category specific to water-collection, so water-related time use accrues in category in which the activity is associated. For example, if water were collected for the purpose of cleaning one's home, then time would be counted as housework. If the water were collected for bathing, then the time would be counted in the survey as time spent on self-care.

5.3 Village-level data

The Kyrgyz National Statistics Committee and the Kyrgyz Ministry of Health State Sanitary Epidemiological Surveillance (SSES) provided village-level data collected on village characteristics and disease incidence, respectively.

Census data are collected once a decade and are available for 1999 and 2009, providing village-level characteristics for one period prior and one following the water intervention. Such data include population size, average household size, education levels, income sources, and the proportion of population self-employed.

Annual village-level data were collected on incidences of the following diseases over the period of 2000 to 2009: Hepatitis A, acute intestinal infections[26], and acute respiratory infections. These data were collected by SSES via village-level health facilities, the Medical Assistant-Midwifery Points (MAMP), which are primary medical preventive institutions that report cases of diseases to district centers. The district-level Sanitary Epidemiological Stations (SES) collate data and report to SSES. Incidence of each disease per 100,000 people was calculated based on yearly village population estimates.

Using data reported through the government health system provides both advantages and disadvantages. These government-collected data provide a strong alternative to self-reported incidence of disease and mortality. Some experts on the topic have expressed concern regarding the strength of studies relying on self-reported child diarrhea (Schmidt and Cairncross, 2009) collected through surveys, as frequent surveying may lead to respondent fatigue, social desirability bias, and health protective behaviors (Zwane et al., 2010). These factors could potentially impact the responses of survey respondents and potentially bias the results. In contrast, the village-level health outcomes, which are collected through village health-care providers, used in this study provide an advantage over self-reported measures, as they are

[26]The SES definition of acute intestinal infections includes dysentery, giardia, enterobaeces, acariasis, and acute viral hepatitis.

less susceptible to such biases.

The village-level health data utilized here may be subject to other biases. It is possible that the villages without MAMPs are smaller or more remote than those with MAMPs, and therefore poorer. If this is the case, then the poorest populations are excluded from this part of the study, as there would be no data on the incidence of water-related diseases for these locations. A few of the existing studies addressing heterogeneity of impacts indicated that poorer populations might be impacted differentially than those that are better off (Jalan and Ravallion, 2003; Galdo and Briceno, 2005; Galiani, Gertler, and Schargrodsky, 2005); however, there is no agreement as to the direction of that effect.

5.4 Baseline characteristics

I look at baseline characteristics, via the 1999 census data, for the villages that applied to receive the water supply system. Column 1 of Table 2 shows that the average village in that group had 1,641 residents spread across approximately 333 households, averaging 5.16 people per household. The average village reported that 51% of households receive income from forms of self-employment and slightly more than that, 56%, of adults had completely at least a secondary school education.

Using the same data, we can compare the baseline characteristics of villages that will eventually be allocated a water supply system ("program villages") with those that will not ("non-program" villages). There are some baseline differences between the two groups at the village-level (shown in column 4 of Table 2), the largest of which are that program villages have a larger average household size and a greater proportion of households that are not employed. These are both characteristics that tend to be positively correlated with higher poverty levels, which, as indicated earlier, was one a consideration in village selection.

In addition, there are some baseline differences between households in program and non-program villages. In particular, households in program villages were on average more likely to use unprotected water as their primary source (Table 3, Panel A) in both baseline years of 2003 (column 4) and 2004 (column 7). Program villages are expected to be worse off at baseline with respect to water access given that village need for water comprised 40% of the score for selection. Although baseline differences exist between program and non-program villages with respect to village-level indicators of poverty and household water access, the pre-intervention trends are shown to be the same below, as required for the identification strategy.

5.5 Testing parallel trends

The identifying assumption in the proposed difference-in-differences estimation is that, in the absence of the construction of the water supply systems, the program and the non-program villages would have changed identically between periods. I test this "parallel trends" assumption using household-level data for the 2003-2004 periods in the dataset, which is prior to the completion of any water supply systems. The results, which are presented in column 8 of Table 3, show that there is no statistically significant difference in trends of households in the two groups during the pre-intervention period (2003 to 2004). This is true for two sets of household-level outcome variables: household water access, as shown in Panel A, and agricultural production, as shown in Panel B. In addition, Panel B also shows that the parallel trends assumption holds for household small farm characteristics (including baseline and farm-related expenditures), which will serve as control variables.

Time use data were collected via the KIHS in 2005 and 2010. Some program villages are considered "treated" in 2005, so there is no pure pre-infrastructure baseline with the time use data. For this reason, I cannot test the parallel trends assumption with the time use data.

I do calculate the overall means of different time uses (as shown with the results in Table 5). Women's total time allocated towards labor is approximately 100 minutes more than men (approximately 500 minutes within a twenty-four hour period, in comparison to 400 minutes). The majority of women's time allocated towards labor is spent on housework, although women do work on the farm and in the home garden. In contrast, approximately half of the male time allocated towards labor is spent working on the household farm. Men and women spent approximately the same amount of time on self-care; however, men spent nearly an hour more on leisure activities.

6 Impacts of Drinking Water Infrastructure

6.1 Water access

The difference-in-differences results shown in Table 4 indicate that the project worked; households in a village that was allocated a water supply system are more likely to use shared piped water and less likely to use unprotected sources for their main water supply. Importantly, these households are also 12 to 15% more likely to have their water source less than 200 meters from the household. These results hold when assuming a two-year lag between selection and construction completion (Panel A) and when using the official government date of completion (Panel B). The results in Panel A and Panel B are quite similar. As discussed above, I use the two-year lag throughout the rest of the analysis.

6.2 Time allocation

There is no specific category in which respondents report water collection. For this reason, water collection accrues to the activities for which the water collection occurs. For example, time spent collecting water for the livestock kept in the family's home garden would be counted as time spent working with the livestock in the home garden.

The results presented in Table 5 show that the water infrastructure resulted in a reallocation of time for all individuals 12 years and older (Panel A), for males only (Panel B), and females only (Panel C). There is no change in the total amount of time spent working for all individuals and males and females separately.[27] This result holds whether we look at work (column 3) and housework (column 2) separately or grouped together (column 1).[28] However, individuals are working half an hour less in their home gardens (column 5), albeit this is not statistically significant. Individuals, on average, spend an hour more per day working on their households' small farm (column 4). This indicates that the water infrastructure is freeing up time that people are then able to reallocate towards other productive labor. Taken together, these results are consistent with the belief that households are labor-constrained and are trading off between work in the market and work in home production.

As a result of the water infrastructure, individuals spend less time caring for themselves (column 8), through activities such as bathing oneself, looking after oneself, going to bathhouses, going to the hospital or doctor, and any other related needs, as well as caring for their children (column 7). In many contexts, one might expect to see time effects of water infrastructure provision lead to time savings primarily for women rather than men. However, males are the primary water collectors in approximately 60 percent of households in the three provinces included in this study. So in this scenario, one might expect impacts of the water infrastructure to be evident for both males and females. The decreases in time spent on self care are of a

[27] Since the data were collected for ages 12 and older, there is not a large enough sample of children to look at the impacts on time spent on education.

[28] There is no statistically significant change in the amount of time people spend on formal labor (wage-paying jobs) or informal, entrepreneurial jobs (not shown in table). This is not surprising as the rural villages do not have many opportunities for formal labor and therefore most adults living in rural areas work on their own farms and are considered self-employed. In addition, in the three provinces, there are not many opportunities for people to travel outside of the village for other work, unless they move to one of the cities. In 2005, people reported spending, on average, 10 minutes getting to and from their work location. This is likely the time required to walk to their farm land. There is no evidence that the time savings from the new infrastructure frees people to seek work outside of the village, as I find no impact on time spent commuting to and from work (not shown). It can be challenging to commute from the villages into the larger towns, particularly in the winter when many roads are closed or have not been cleared of snow.

similar magnitude for males and females, indicating that both sexes benefit from the increased ease of bathing and looking after oneself that comes with more convenient and closer access to water. A similar pattern is evident also with the time allocated towards caring for children.

Both men (105 minutes per day) and women (143 minutes per day) have statistically significant increases in the amount of time allocated towards leisure activities ("free time"), which is consistent with Devoto et al. (2011) findings in urban Morocco. Interesting, in this study, the increase in free time is roughly equivalent in magnitude to the combined decrease in time spent on care activities (i.e. both self care and care for children combined). It appears as though households are trading-off between their time spent on certain types of necessary household chores and their primary income-generating activity, which is work on the household's farm.

6.3 Water-related diseases

Water infrastructure could affect labor by improving workers' health. The water infrastructure increased cereal production. I look for evidence as to whether this increase in cereal production occurred due to an indirect effect, with healthier people either being able to spend more time working or more productive when they do work. Revisiting the time use results, the infrastructure had no impact on the total number of hours worked, so there is no support for the hypothesis that workers are healthier and can work more. However, it is possible that healthier people could spend greater amounts of time on labor that is more physically demanding (assuming that farm labor is more challenging than other types of labor). Therefore, I look for evidence of health impacts from the water infrastructure.

I use the data on village-level incidence of water-related diseases to further investigate whether the labor allocation could be the result of health impacts. The first two diseases, acute intestinal infections and Hepatitis A, are traditionally considered to be water-related, whereas acute respiratory infections are not and are therefore included as a check. Table 8 shows results per 100,000 people for two age groups: children 0 through 14 years old (Panel A), and adults aged 15 and older (Panel B). These results provide evidence of reductions in village-level incidence of acute intestinal infections, however, only for children.

For adults, the impact of the water infrastructure on village-level incidence of three diseases (acute intestinal infection, Hepatitis A, and acute respiratory infection) is ambiguous. The data are too noisy to provide a definitive answer (i.e. cannot rule out that the noise is due to the fact that there is not enough data). Also, given that there are only 10 observations per village, the specifications including village fixed effects might be too demanding.

Additionally, I check to see whether households in villages that received the water infrastructure are producing more cereals per hour worked on the farm. Although the relationship is positive, there is no statistically significant increase in productivity. Taken together, these results indicate that the primary channel through which adult labor is affected by water-related diseases is through time; children are healthier and therefore parents have to care for sick children less often.

6.4 Agricultural production

Given that there is an increase in time working on the household farms, one might expect to also see an increase in farm production. I test whether households, on average, in villages that receive the infrastructure have greater crop production from their farms. To do so, I look for impacts on the crop groups that are grown solely on the farms. If the shift in time resulted in greater production on the farms, we could expect to see increases in crops grown almost solely on the farm land, which includes fodder and/or cereals.

Results presented in Table 7 indicate that individuals' reallocation of time towards working more on their households' small farms come in conjunction with greater production in certain food groups.[29] There is a substantial and significant increase in cereal production. Results are shown in columns 6 through 9) investigate the types of cereals in which the largest gains occur. There are substantial and significant increases in the amount of wheat and barley harvested as a result of the reallocation of time towards farm labor. It is not surprising that, if able to work more on the farms, households would try to produce greater amounts of wheat, given its importance as a cash crop and that its price was rising towards the end of the time period covered in this study.

6.5 Returns to additional farm labor

Thus far, results indicate that the infrastructure brought water supplies closer to households, decreasing the time required for water collection, increasing the time spent working on household small farms, and increasing farm production. Next, I estimate the extent to which the additional farm production is the result of additional hours of farm work, in an effort to investigate the channel through which domestic water infrastructure might be affecting agricultural production. These calculations are analogous to the returns to capital calculated

[29] Regressions drop the top 1% of observations in each category to ensure that results are not altered by a few very large producers.

by de Mel, McKenzie, and Woodruff (2008). Specifically, I estimate the effect of time spent working on the household small farms on the production of cereals, the group of crops that is almost solely grown on farm land. This calculation uses whether the village is allocated a water supply system as an instrument for the time allocated toward farm work and requires that water does not directly increase output (i.e. domestic water is not used for irrigating the farmland). This provides the local average treatment effect (LATE).

To perform these calculations, I match data from the KIHS agricultural production (available for 2003-2009) and expenditures module, data from the time use module (available 2005 and 2010), and data on the agricultural land. This analysis is limited, as the only year in which data from all modules overlap is 2005, with a sample of 245 households across 20 villages.

The first-stage estimates the difference in total household time allocated toward farm labor in villages that receive the water infrastructure and is calculated through the following equation:

$$T_{hjkl} = \beta_0 + \beta_1 w_{jkl} + \beta_2 d_{hjkl} + \Omega' z_{hjkl} + \alpha_k + \epsilon_{hjkl} \quad (4)$$

where T_{hjkl} is the total amount of time (number of minutes out of a total of 1440 minutes per day) household spent working on their small farm.[30]

The second stage equation then estimates the increase in cereal production that results from the additional time of farm labor:

$$A_{hjkl} = \beta_0 + \beta_1 T_{hjkl} + \beta_2 d_{hjkl} + \Omega' z_{hjkl} + \alpha_k + \epsilon_{hjkl} \quad (5)$$

where A_{hjkl} is the amount of cereals harvested by household h in district j year l, as measured in kilograms; w_{jkl} indicates whether village j in district k was allocated a water supply system two years prior; T_{ihjkl} is the total number of minutes of time allocated in one day towards working on household h's farm by all individuals 12 years and older in household h; z_{hjkl} is a vector of interview controls, specifically the season and day of week on which the household members were interview occurred; d_{hjkl} is a vector of household-level controls including household size and the number of dependants pensioners in the household, and farm characteristics, such as the total plot size, the proportion of land irrigated, the number of land plots owned by the household, proportion of cultivated land, and household expenditures on farm-related things; and α_k represents district fixed effects. All standard errors are clustered at the village-level.

[30]There are 3.4 workers per household (on average) in this sample. In comparison, the average household size is 5.1 people. This difference between the average household size and the average number of workers is due to children under 12 years old in the household.

These are not difference-in-differences calculations. With only one year of data, the estimates are calculated using district fixed effects, rather than district-year fixed effects. With the variation in water supply system during 2005 occurring at the village-level, we do not include village fixed effects. However, given the need to control for overall village-level characteristics, I include the score designated to the village in the selection process. As discussed earlier in the paper, this composite score represents a suite of baseline characteristics for the village and was shown to highly correlate with both baseline poverty levels and need for water.

As shown in Table 8, an average of one additional minute per day in the total household farm labor over a year (totaling 365 minutes) results in an additional 21.08 kilograms, or an average value of 2.55 USD, of cereals harvested.[31] This equals an hourly wage of approximately .43 USD to .53 USD per hour, which is between \$0.19/hour, which is the calculated 2003 hourly wage for farm labor (World Bank, 2007), and the estimated hourly wage of .55 USD per hour that laborers might be paid to perform farm-related work in 2011.[32] In an effort to isolate the impact of farm labor on farm-grown crops, I only include cereal production in the calculations of the returns to labor. These calculations omit the effort the additional labor might have had on other crop groups and therefore provide a lower bound for returns to labor.

This instrumental variables approach is contingent upon the identifying assumption that the water infrastructure is only impacting agricultural production through the channel of farm labor. The obvious concern is whether households use the drinking water to irrigate the crops grown on the farms, as that could lead to greater farm production. This does not appear to be the case, as farm lands are on the outskirts of villages and thus a distance from the drinking water infrastructure. Also, many villages have some irrigation infrastructure, albeit decaying infrastructure, remaining from the Soviet Union. Still, I investigate whether households might replace the farm irrigation water with drinking water, by testing whether the drinking water infrastructure has any impact on the amount households pay in irrigation fees. There is no impact on irrigation fees (results not shown).

6.6 A cross-check of time savings

To determine whether the magnitude of the water infrastructure's effect on time reallocation (two additional hours to leisure plus one additional hour to farm labor per day) is reasonable, I perform some basic calculations. According the Human Development Report 2006, 50 liters per person per day are required to meet the needs of drinking, basic hygiene, bathing, and

[31]Calculations are based on FAO data for producer prices for cereals in 2005.
[32]Hourly-wage is based on estimates from village residents on the cost of hiring someone for their farms.

laundry (UNDP, 2006). With the average household size of 5.2 people (per the 1999 Kyrgyz census), the average household requires 260 liters per day. Assuming that a single person can carry 20 liters (which weighs 20 kgs) in a trip from the water source,[33] then 13 person-trips per day are required to collect enough water for the entire household.[34] Given that the majority of households in my study regions report that an adult (either male or female) is their primary water collector (UNICEF MICS, 2007), I assume that the time spent collecting water is divided by two adults. The average time for water collection is 26 minutes round-trip for households using unprotected water sources (based on calculations using the UNICEF MICS (2007) data), resulting in water collection requiring 338 minutes per household (or 169 minutes per each of the two adults) per day at baseline. Once a village receives the water supply system, I assume that a round-trip for water collection is reduced to 5 minutes per trip, equalling 65 minutes per household (or 32.5 minutes per adult person) per day. These time savings directly from water collection equal 136 minutes per adult per day.

7 Cost-benefit Analysis

From a policy perspective, it is important to understand the welfare consequences of the infrastructure. To do so, I perform a cost-benefit analysis in which I assume the water infrastructure has a lifespan of 20 years, per the World Bank's analysis (World Bank, 2009).

The costs of the water infrastructure include the upfront costs for the infrastructure construction, which totalled approximately $24 million, and ongoing maintenance costs. The upfront costs were comprised of a loan from the World Bank ($17.99 million)[35], an upfront contribution from the Government of Kyrgyzstan ($3.2 million) and a 15% labor contribution ($2.99 million) from the villages. I use data on the monthly budget for village water tariffs as the measure for on-going maintenance costs, which equal approximately $560,000 in the first year and are assumed to increase by 2% each year throughout the 20-year life of the water infrastructure. Using a 12% discount rate results in costs of approximately $28.185 million.

In calculating the benefits, I include only the benefits from the time savings for adult bene-

[33] This assumes that households are not using livestock to carry more than 20 liters per trip.

[34] How this is carried out could vary widely. For example, there could be 13 trips by one person in the household or multiple trips by a few people in the household.

[35] Here, for ease, I am assuming that the entire value of the loan is a cost incurred at the project outset. However, I have also performed the analysis under the specific financial conditions of the loan (which are 0.75% for 40-year period with a 10-year grace period). The specific choice of analysis depends on whether one is analyzing the project from the lender's perspective or that of the borrowing country. For a cost-benefit analysis, my current approach is the more conservative alternative, as costs are upfront and therefore not discounted.

ficiaries. This is due to the lack of time use data for children. This provides a lower bound of the infrastructure's total benefits, as it omits non-time benefits for adults and all benefits for children, such as reductions in incidence of water-related diseases and improved school attendance.

To estimate the benefits, I assume the time savings begins at the time of construction completion (which is, on average, two years after village selection occurred). I assume the time savings accrue for the 20 year life of the water supply system. To count the number of people benefiting from the project, I calculate the baseline total working-age adult population for all of the villages that received water infrastructure through the project, based on the 1999 census. Although this population will presumably grow over the twenty-year period, I assume that the infrastructure can serve only the population size at construction completion and that any additions to that population will not benefit. Therefore I assume a constant population of project beneficiaries throughout the life of the infrastructure.

As discussed in Whittington, Mu, and Roche (1990), a dearth of data on how people value time spent in water collection has made it challenging to value the time savings that result from water infrastructure. Using a discrete choice model to analyze household decisions in a region of Kenya, they found that households value the time spent on water collection at roughly the value of the unskilled wage rate (Whittington, Mu, and Roche, 1990). However, in practice, cost-benefit methods typically either assume time savings to be valued at a percentage of the market wage rate for relevant unskilled labor or they specify a proportion of time saved that is assumed to be spent in market production.[36] I do not have to make such assumptions. I can perform regressions based on the Gronau-style (1977) time constraint, in which all time is allocated to one of three time use categories: leisure, home production, or market production. I then perform an analysis parallel to the time use regressions shown earlier, but with each of these three time allocation categories (leisure, home production, and market production) as the outcome measures. This allows me to decompose the time savings according to how the time is reallocated. Results indicate that time in overall home production decreases by approximately 3 hours per day, and of that time saved, slightly less than 2 hours per day is reallocated towards leisure and slightly more than one hour is reallocated towards labor. This supports the results shown earlier that, on average, approximately one hour per day of additional time allocated to farm labor, as a result of the infrastructure project.

To estimate the benefits of the water infrastructure, I use the hourly wage rate for unskilled

[36]For example, the pre-project cost-benefit analysis for this project assumed that half the time saved could be reallocated toward "commercially productive uses" (World Bank, 2001).

farm labor.[37] This is multiplied by the total working-age population benefiting from the project, as discussed above. Future benefits are assumed to accrue for the 20-year life of the infrastructure and are discounted assuming a 12% discount rate.[38] This results in estimated benefits equaling $117.6 million. Finally, I assume that farm labor only occurs for three quarters of the year (spring through autumn). This results in estimated benefits of approximately $381.6 million. As a lower bound, I can calculate the benefits including only those hours reallocated to market work, which results in estimated benefits of $117.6 million.

Calculating the benefits of rural water supply systems solely on time reallocation, I find that the benefits substantially outweigh the costs. Based on the above calculations, the net present value of the water infrastructure is between $89.4 million and $353.5 million.[39] This analysis suggests that even in contexts in which health benefits are ambiguous, the time use benefits may justify the infrastructure.

8 Conclusion

This paper investigates how individuals re-allocate time saved from improved drinking water infrastructure. Given that processes of development often are associated with changes in household time allocation, it is important to understand how people re-allocate time saved. Using differences in the timing of selection across villages, I identify the impacts of shared water infrastructure on household distance to water sources, individual time use, and agricultural production. The analysis indicates that access to this drinking water infrastructure results in several changes in the time allocation for people 12 years and older living in these villages. Although there is no change in the overall amount of time spent working, people do change the way in which time is allocated. There is less time allocated towards self care, less time caring for children, and more time working on small farms. Time reallocations occur with both male and female time use, which is logical given that they both partake in water collection.

The greater amount of time spent working on the small farms appears to translate into greater production of cereals, which are grown solely on the small farms. The significant changes in yields occur with wheat and barley, which are historically the two of the largest crops grown in Kyrgyzstan and are often sold by farmers for income-generation. Calculations of returns

[37] This hourly wage in 2003 was $0.19/hour. I assume this grows at 2% per year.

[38] This is the discount rate that was used in the pre-project cost-benefit analysis (World Bank, 2001).

[39] I have calculated this cost-benefit with different discount rates to provide a sense of the role that it plays in calculating the net present value (NPV). With a 10% discount rate, the NPV equals $109.6 million and with a 8% discount rate, the NPV equals $135.5 million.

to the additional farm labor provide no obvious rejection of separation.

To date, much of the empirical work estimating the impacts of drinking water provision has been related to the health impacts. This study shows that even in the absence of obvious health impacts, such infrastructure might be making households better off by permitting a reallocation of labor resulting in higher production of income generating crops. Although time savings from a decreased burden of water collection is a frequently-mentioned benefit of water infrastructure, until now there has been no study with rigorous evidence on the topic.

This paper ties to other contexts in which households are labor-constrained and therefore must make this trade-off between activities that are necessary for survival and income-generating activities. Additionally, these results are applicable to locations that may not currently be labor-constrained, but where water scarcity is a concern. The IPCC has documented increasing frequency and intensity of droughts in certain areas of Africa and much of Asia, with climate change projections indicating increased future water stress in Africa and decreased freshwater availability in many parts of Asia (United Nations, 2010). In locations where water is becoming increasingly scarce, some households will face greater travel time to water sources and/or longer queues at their sources. In the face of increasing water scarcity, it is important for policy-makers to understand how the time intensity of home production due to insufficient water infrastructure and how they deal with this time allocation trade-off.[40]

[40] Analogously, there is some indication that deforestation (as proxied by increases in time spent collecting firewood) is associated with decreases in fuelwood consumption and decreases in farm labor (Kumar and Hotchkiss, 1988).

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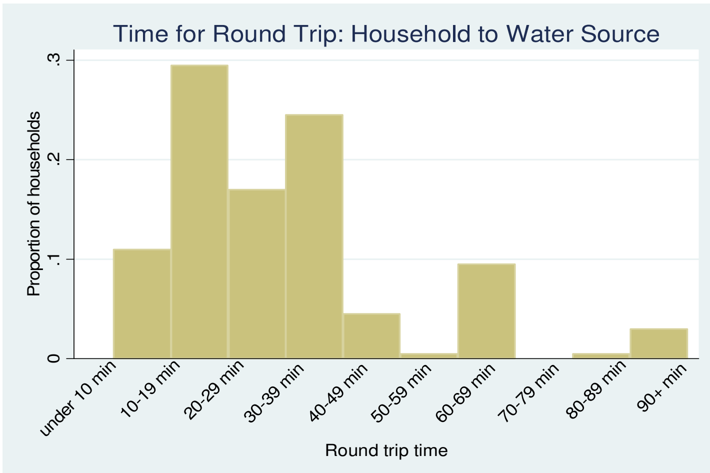
Table 1: Length of Time from Household to Water Source in Northern Kyrgyzstan

Region	**Average number of minutes per trip**	**Number of households**
Issyk Kul	27.42	215
Naryn	25.36	288
Talas	24.04	273
All North	25.68	776

Notes: Calculated for rural households relying on unimproved water sources (rivers, streams, etc.) in northern 3 regions. Calculations made using the UNICEF Multiple Indicator Cluster Survey (2006).

Figure 1: Length of Time from Household to Water Source in Northern Kyrgyzstan



Notes: Calculated for rural households relying on unimproved water sources (rivers, streams, etc.) in northern 3 regions. Calculations made using the UNICEF Multiple Indicator Cluster Survey (2006).

Table 2: Village Baseline Characteristics

	(1) All	(2) No program	(3) Program	(4) Difference
Population	1641	1801	1550.2	-250.8
				(236.1)
Number of households	332.6	389.2	299.96	-89.24
				(58.53)
Household size	5.161	5.019	5.242	0.223
				(0.083)***
Proportion of (working age) population not employed	0.268	0.219	0.297	0.078
				(0.034)**
Proportion of HHs receiving income from				
Formal employment	0.371	0.371	0.3706	-0.0004
				(0.012)
Govt pensions	0.0988	0.102	0.097	-0.005
				(0.004)
Govt assistance	0.00881	0.00942	0.00842	-0.001
				(0.002)
Self-employment	0.514	0.505	0.5192	0.0142
				(0.008)*
Proportion with at least secondary education completed (adults)	0.563	0.564	0.561	-0.003
				(0.012)
Observations (# of villages)	216	79	137	

Notes: Characteristics are calculated based on 1999 Census data from the Kyrgyz National Statistics Committee. Calculations include only villages that applied to receive a water supply system. Standard errors are in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1).

Table 3: Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		2003			2004			
Panel A: Household characteristics	All	No program	Program	Difference (3-2)	No program	Program	Difference (6-5)	Difference in Difference
Main drinking water source is								
Shared piped water	0.478	0.434	0.4086	-0.0254	0.570	0.5137	-0.0563	-0.0309
				(0.130)			(0.143)	(0.0997)
Unprotected water	0.219	0.0686	0.3196	0.251	0.0640	0.328	0.264	0.0130
				(0.112)**			(0.118)**	(0.0601)
Water <200m from HH	0.717	0.753	0.6887	-0.0643	0.739	0.7148	-0.0242	0.0401
				(0.109)			(0.113)	(0.134)
Panel B: Farm characteristics								
Number of land plots	1.800	1.623	1.83	0.207	1.789	1.899	0.110	-0.0970
				(0.145)			(0.141)	(0.0736)
Total size of plots (sq. meters)	21942	12655	23837	11182	21476	26718	5242	-5940
				(4475)**			(5319)	(3590)
Proportion of land cultivated	0.946	0.983	0.945	-0.0380	0.973	0.9043	-0.0687	-0.0307
				(0.0247)			(0.0315)**	(0.0403)
Proportion of land privately owned	0.978	0.992	0.9658	-0.0262	0.996	0.9695	-0.0265	-0.000349
				(0.0156)			(0.0117)**	(0.0147)
Proportion of land irrigated	0.963	0.989	0.9659	-0.0231	0.973	0.9359	-0.0371	-0.0140
				(0.0162)			(0.0307)	(0.0359)
Total farm-related expenditures (Kyrgyz soms)	2929	2677	2979.2	302.2	2752	3170.9	418.9	116.7
				(1060)			(937.1)	(581.1)
Average annual household harvest (kg) of								
Cereals	1699	1109	2295	1186	1702	1468.1	-233.9	-1419
				(899.0)			(628.5)	(932.8)
Vegetables	3367	4761	2894	-1867	4223	2503	-1720	146.5
				(1807)			(1243)	(984.5)
Fruits	238.9	342.3	58.4	-283.9	350.9	274.23	-76.67	207.2
				(140.3)*			(214.6)	(245.8)
Nuts	0.628	0.222	0.00	-0.222	1.589	0.778	-0.811	-0.589
				(0.198)			(1.167)	(1.223)
Fodder	56.26	21.09	34.58	13.49	148.9	33.8	-115.1	-128.6
				(12.07)			(95.32)	(96.55)
Observations (# of households)	858	175	247		175	261		
Number of villages		15	22		15	23		

Notes: Results are for difference-in-differences regressions using household survey data collected via the Kyrgyz Integrated HH Survey for baseline years (2003 and 2004). The sample for these calculations is limited to those villages that indicated a need for water by applying to receive a water supply system. Standard errors are clustered at the village level and in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Household Water Access, Difference-in-Differences

	(1)	(2)	(3)	(4)	(5)	(6)
Main drinking water source is	shared piped water		unprotected water		water <200m	
Panel A: Assuming a two-year lag between village selection and WSS completion						
Allocate WSS	0.330		-0.349		0.148	
	(0.137)**		(0.136)**		(0.0824)*	
Panel B: Using government date for official WSS completion						
Post WSS completion		0.258		-0.274		0.122
		(0.124)**		(0.123)**		(0.0570)**
Mean baseline water access	0.478		0.219		0.717	
Observations	3076	3076	3076	3076	3076	3076
R-squared	0.543	0.546	0.614	0.615	0.301	0.302
Number of villages	40	40	40	40	40	40

Notes: Results are for difference-in-differences regressions using the household survey data collected via the Kyrgyz Integrated HH Survey between 2003 and 2009. Sample is restricted to those villages that applied to receive a water supply system. Baseline means are calculated for 2003-2004. All regressions include controls for (1) household characteristics (the number of rooms in the home and the total reported household income); (2) district-year fixed effects; and (3) village fixed effects. Standard errors are clustered at the village level and in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Time Use of Household Members, Difference-in-Differences

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				----- Sub-categories of total work ---					
	Total labor (work + housework)	Total housework	Total work	Total work on HH farm	Total work in home garden	Total free time	Caring for children	Self care excluding sleep	Total self care
Panel A: For males and females, the number of minutes spent...									
Allocate WSS	13.77	12.47	1.299	60.36	-26.09	123.7	-23.58	-52.42	-96.20
	(36.55)	(30.47)	(38.05)	(25.56)**	(26.49)	(35.72)***	(10.77)**	(11.95)***	(18.34)***
Mean	379.9	203.8	176.1	72.34	55.73	324.1	32.41	167.3	656.4
Observations	2242	2242	2242	2242	2242	2242	2242	2242	2242
R-squared	0.242	0.456	0.378	0.442	0.283	0.287	0.216	0.481	0.415
Number of villages	38	38	38	38	38	38	38	38	38
Panel B: For males, the number of minutes spent...									
Allocate WSS	30.20	4.754	25.44	80.56	-30.55	105.0	-18.96	-40.36	-95.70
	(36.24)	(15.89)	(49.17)	(33.41)**	(33.96)	(24.54)***	(6.768)***	(8.933)***	(18.69)***
Mean	338.7	92.34	246.4	119.1	75.56	356.0	12.41	162.4	656.2
Observations	1109	1109	1109	1109	1109	1109	1109	1109	1109
R-squared	0.300	0.328	0.388	0.543	0.310	0.334	0.268	0.498	0.451
Number of villages	38	38	38	38	38	38	38	38	38
Panel C: For females, the number of minutes spent...									
Allocate WSS	-7.588	-1.610	-5.978	65.50	-31.85	142.5	-33.31	-68.21	-102.8
	(70.42)	(56.92)	(33.89)	(20.00)***	(26.21)	(61.60)**	(17.72)*	(15.38)***	(20.14)***
Mean	420.3	312.9	107.4	26.56	36.33	292.8	51.99	172.1	656.5
Observations	1133	1133	1133	1133	1133	1133	1133	1133	1133
R-squared	0.210	0.163	0.276	0.332	0.309	0.267	0.172	0.509	0.430
Number of villages	38	38	38	38	38	38	38	38	38

Notes: Results are for difference-in-differences regressions. Time use data were collected for household members 12 years and older via the Kyrgyz Integrated Household Survey in 2005 and 2010. Time use is measured in number of minutes per twenty-four hour period (totalling 1440 minutes). "Allocate WSS" is an indicator of whether the village received the water infrastructure. Sample is restricted to those villages that applied to receive a water supply system. All regressions include controls for (1) season, (2) day of week, (3) respondent age and gender, (3) size of respondent's household, (4) district-year fixed effects, and (5) village fixed effects. For a description of the time use categories, see Appendix. Standard errors are clustered at the village level and in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Village-level Health Outcomes, Difference-in-Differences

	(1)	(2)	(3)	(4)	(5)	(6)
	Acute intestinal infection		Hepatitis A		Acute respiratory infection	
Panel A: Village-level incidence in children 14 years old and younger (per 100,000 children)						
Allocate WSS	-91.65	-137.5	-22.16	-12.69	-535.5	-113.5
	(49.43)*	(52.95)**	(44.33)	(42.45)	(536.9)	(688.8)
Mean baseline incidence	305.9		201.7		3916.2	
R-squared	0.452	0.338	0.368	0.265	0.462	0.324
Panel B: Village-level incidence in adults 15 years and older (per 100,000 adults)						
Allocate WSS	-11.24	-10.88	10.01	1.322	52.33	152.1
	(18.68)	(21.72)	(13.35)	(13.33)	(282.7)	(314.5)
Mean baseline incidence	106.9		51.71		2146.1	
R-squared	0.531	0.405	0.312	0.236	0.537	0.367
Dist-year fixed effects	Yes	No	Yes	No	Yes	No
Year fixed effects	No	Yes	No	Yes	No	Yes
Observations (# of village observations)	2230	2230	2230	2230	2230	2230
Number of villages	223	223	223	223	223	223

Notes: Results are for difference-in-differences calculations using village-level health data collected by the Kyrgyz Ministry of Health for the year between 2000 and 2009. Their definition of acute intestinal infections includes dysentery, giardia, enterobaeces, acariasis, and acute viral hepatitis. All regressions include village fixed effects. Sample is restricted to those villages that applied to receive a water supply system. "Allocate WSS" is an indicator of whether the village received the water infrastructure. Baseline means are calculated for 2000-2004. Standard errors are clustered at the village level and in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Household Crop Harvests, Difference-in-Differences

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
						------------------ Sub-categories of cereals -----------------			
	FODDER	NUTS	FRUITS	VEGETABLES	CEREALS	WHEAT	BARLEY	CORN	OTHERS
Allocate WSS	-0.229	0.388	-4.473	-328.8	645.4	380.0	2.392	216.2	80.36
	(4.595)	(0.334)	(49.33)	(249.7)	(225.5)***	(161.2)**	(3.757)	(75.84)***	(82.38)
Number of HH obs	2908	2908	2908	2908	2908	2908	2908	2908	2908
R-squared	0.490	0.425	0.536	0.680	0.512	0.480	0.276	0.381	0.616
Mean baseline production (kg)	56.26	0.628	238.9	3367	1699	1317	335.3	37.12	147.7
Number of villages	40	40	40	40	40	40	40	40	40

Notes: Results are for difference-in-differences regressions using the household survey data collected via the Kyrgyz Integrated HH Survey between 2003 and 2009. Sample is restricted to those villages that applied to receive a water supply system. Results omit top 1% of producers. Baseline means are calculated for 2003-2004. Amounts harvested are in kilograms. "Allocate WSS" is an indicator of whether the village received the water infrastructure. All columns include controls for (1) Controls for land characteristics; (2) number of people and children 14 and younger in a household; (3) district-year fixed effects; and (4) village fixed effects. Controls for land characteristics include: total plot size, proportion of land irrigated, number of land plots total, proportion of land that is privately owned, proportion of land that is cultivated, and total farm-related expenditures. Standard errors are clustered at the village level and in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Returns to Labor

	(1)	(2)	(3)
	CEREALS harvest value	Log CEREALS harvest value	CEREALS harvested
farm_work_total	2.55	0.0109	21.08
	(1.044)**	(0.0048)**	(8.148)**
First-stage F-statistic	13.21	13.21	13.21
Number of villages	21	21	21
Observations: # of HHs	258	258	258

NOTES: Data are for 2005 only. Cereals harvested are measure in kilograms. Cereals harvest value is the price farmers were paid in 2005 for cereals (calculated by FAOSTAT). Farm_work_total is the total number of minutes for all workers in the household spent working on the farm in that one day. Workers are households members 12 years and older. All regressions omit the top1% of cereal producers. All specification include controls for season and day of the week in which the data were collected, score assigned in selecting the village, total size of the farm, proportion of land that is irrigated, total farm-related expenditures, proportion of the household's land that is farm land, number of people in the household, number of children in the household, number of household members that are elderly, and district fixed effects. Standard errors are clustered at the village level and in parentheses. Statistical significance is denoted by: *** p<0.01, ** p<0.05, * p<0.1.

Appendix

Appendix 1: Common characteristics of home gardens and small farms (2003)

	Home gardens	Small farms
Typical location	Adjacent to house	Outskirts of village
Average size	.29 acres	4.7 acres
Labor provided by	Both males and females	More males than females
Typical crops grown	Most fruits and nuts, some vegetables	All cereals, all fodder/hays, some vegetables
Income potential	83% of home gardens cultivated solely for household consumption	30% of farms cultivated solely for household consumption 67% of farms cultivated for both family consumption and sales
Irrigation	Typically households carry water from nearest source, only 11% of land is irrigated by canals	35% of land is irrgated by canals and 59% is irrigated by diverted river water

Notes: Calculations of average land size and irrigation coverage are based on 2003 household data from the Kyrgyz Integrate Household Survey.

Appendix 2: Percent distribution of households according to the person collecting water used in the household (2006)

Region	Adult women	Girls < age 15	Adult men	Boys < age 15	Total adult
Issyk Kul	28.2	6.8	47.4	13.4	75.6
Naryn	27.5	8.5	46.2	13.2	73.7
Talas	37.9	5.3	47	8.2	84.9

Source: UNICEF Multiple Indicator Cluster Survey, 2006.

Appendix 3: Description of village selection process

An effort was made to select villages for the intervention in a transparent and fair manner to receive the water supply systems. All villages in the three provinces, 322 in total, were informed of the upcoming large-scale project and the process of applying to participate, should their village require an improved water supply system. If interested, village heads were required to send a letter of intent on behalf of their constituents. This resulted in 255 villages indicating their need in this manner. Between 2003 and 2006, approximately 200 rural villages in the northern 3 provinces of Kyrgyzstan were selected to receive an improved water supply system, in the form of communal standpipes, through this effort. Each village that expressed a desire to participate was scored based on five factors:

(1) Need for water: determined through a participatory community appraisal and through the observations of the project engineers;
(2) Poverty levels: determined based on numbers of people living in poverty as calculated by the local government;
(3) Economic and technical feasibility: based on the project engineers calculations of the cost per person, which was typically higher if the water source was located far enough away to necessitate long distances of water pipes; and
(4) Community participation: based on expressions of support from community groups and their participation in previous projects.

The villages need for water was allocated twice the weight of the other score components. Efforts were taken to try to ensure that the scores were not manipulated for political reasons; final scores were an average of scores provided by a panel of representatives from government agencies and international organizations.

These scores were then used to determine whether or not a village received a water supply system through this program. Selection occurred annually from 2003 to 2006, with some portion of villages selected each of those years. Villages not selected in any given year could be reconsidered for the project in later years; however, villages reconsidered were re-scored. Of the 255 villages that expressed interest in participating in the project, 194 were selected between 2003 and 2006. Due to an effort to ensure that all districts in the three northern provinces would be represented, albeit not equally, yearly selection was stratified by district.

Appendix 4: Time between village selection and water supply system completion

Notes: Calculations based on data from PMC.

Appendix 5: Major Categories of Time Use

Variables	Description
Total work	Includes formal work, informal work, farm work, and work in home gardens.
Formal work	Includes work that is paid a salary.
Informal work	Includes work that is entreprenurial, intermediary, trade, or individual working activity.
Work in farms	Includes work in farms for crops and livestock.
Work in home gardens	Inclides work in home gardens for crops and livestock.
Transportation to/from work	Time spent commuting to work.
Housework	Includes rime spent buying groceries and non-food items, cooking, dishes, laundry, sewing, cleaning, taking care of elderly family members, and other types of domestic labor.
Education	Includes studies, training, and self-education.
Free time	Includes various leisure activities, such as time spent going to the cinema or theater, watching TV, listening to the radio, walking with friends, sports and exercise, hobbies, religious activities, and doing nothing.
Self care	Includes time spent bathing, looking after oneself, eating, going to hospitals and bath houses, and sleeping.
Care of children	Includes time spent feeding, washing, bathing, and attending to children.
Helping others	Includes helping relatives and acquaintances.