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The Impact of Household Labor-Saving Technologies along the Family Life Cycle*

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Abstract

This paper investigates heterogeneity of the impact of labor-saving technologies on household time use across stages of the family life cycle. Using the Ghana Living Standards Survey 5, we assess the impact of two treatments – piped water and borehole water supply technologies. Results confirm the hypothesis that technology is more useful for relaxing the time constraint in households with children. The effect is stronger the more labor-saving is the technology. In households with young children (0 to 6 years old), however, the technologies show no significant effect. Parents in that stage of the family life cycle are in such an extreme time constraint that the relatively small amount of time saved with the water supply technology is not enough to significantly release their burden.

Keywords: labor-saving technology; household production; family life cycle.
JEL classification: D12, D13

1 Introduction

Who works more, husband or wife? This popular topic in casual conversations has motivated scientific discussions about gender roles, household production, and the measurement of working time (Blackden and Wodon, 2006). The distribution of workload across individuals' lifetime suggests that men work more hours than women in paid activities across the entire time span. Women, however, work disproportionately more than men in unpaid work: doing domestic chores. With regards to total work – paid and unpaid – women work in fact longer hours than men across the lifespan. The intensity of workload, particularly of unpaid work, is also not flat across the individuals' age: data from Ghana show that the workload peaks when individuals are between 25 and 40 years old, and it

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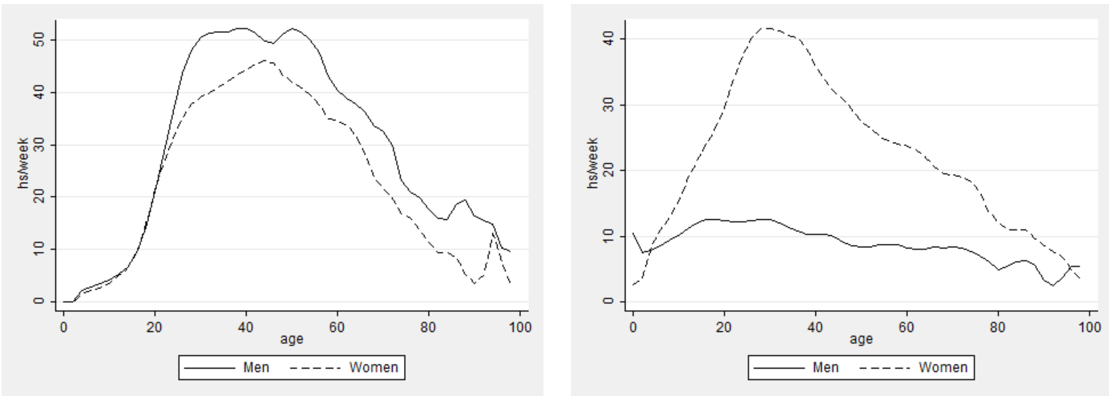
is particularly evident among women (see Figure 1).

The peak in workload on an individual's lifetime usually coincides with the age when families have small children. A plausible explanation to the sharp increase in unpaid work, particularly among women, is that at that stage of the family life cycle housework raises as family size abruptly increases.[1] It coincides with the stage when families are forming and growing, as children arrive. The sharp increase in unpaid workload consists of an increase in the demand for home production (child care, domestic chores, housework in general), as the new family members, the children, are not yet able to contribute to household production, neither through paid work nor housework. Adults then need to increase their labor supply in either or both activities in order to keep steady the household standard of living.

Figure 1: Workload along lifetime in Ghana



(a) Paid work (b) Unpaid work

Note: Kernel estimates of weekly hours of work of individuals at specific ages. Unpaid work includes any activity that is not remunerated (e.g. washing clothes, doing the dishes, cooking, ironing, collecting water and firewood, running other household errands, taking care of children). Source: GLSS5, restricted sample.

This paper investigates when, along the family life cycle, does a labor-saving technology has the highest impact on parental time use. If a labor-saving technology releases the work burden of adults, we should be able to observe different impacts depending on the time constraint of the household. And this latter is much related to the family life cycle. Hence, we investigate households with and without labor-saving technologies along different stages of the family life cycle. In addition, technologies may differ in their labor-saving potential. More efficient technologies – those that save larger amounts of time – should trigger higher impact on households' welfare, as more time is potentially

[1] One additional member in a family previously composed of a couple means 50 percent increase in the household size. Using the OCDE equivalence scale, a child born in a two-person household accounts for a 29.4 percent increase in household consumption: $(1 + 0.7 + 0.5)/(1 + 0.7)$.

freed up. Thus, we also investigate whether *more efficient* labor-saving technologies yield higher impact on household production than *less efficient* ones.

The paper contributes to the literature on the impacts of infrastructure on household welfare by exploring heterogeneity in a dimension not yet investigated: along the family life cycle. We use data from Ghana and explore the lack of water supply infrastructure – a typical problem in developing countries. We find that it is indeed important to account for the demographic composition of households, apart from the economic characteristics of beneficiaries, in order to capture the full effect of a policy of household infrastructure provision. This result might be of interest to governments and to organizations that have been actively working to improve access to water in developing countries. [2] It supports targeting at the household level as a manner to maximize the benefits of water policies, as well as allows a more accurate measure of the impact of such policies by knowing demographic characteristics of the population.

The paper is structured as follows: Section 2 discusses the link between infrastructure and time-use. Section 3 presents the concept of family life cycle and outlines the conceptual framework of impact of labor-saving technologies on adult's labor supply. Section 4 describes the data and empirical strategy. Section 5 provides the results and Section 6 concludes.

2 Problem Statement

The absence of basic infrastructure (water, sanitation, electricity, transportation) makes home production very time-consuming. This reinforces time poverty particularly among income-poor households, who are less likely to afford privately provided substitute services.[3] Improving household infrastructure with labor-saving technology can enhance productivity in home production, as individuals would produce more with a constant labor endowment (the sum of the time endowment of each household member). Or, alternatively, more time could be spent on leisure, what is also welfare enhancing.

Lack of basic infrastructure is an important contributing factor to time poverty in developing countries, especially where gender division of labor is salient. Blackden and Wodon (2006) collect a series of empirical evidence in Africa showing that women are

[2]The total annual Official Development Assistance tied to the water supply and sanitation sector had a four-fold increase in the last decade, from USD 2.1billion to USD 8.5billion between 2002 and 2012. Data retrieved from OCDE Qwids, accessed on August 30, 2013.

[3]Let us denote *household production* as the overall production of the household (inside and outside the dwelling) and *home production* as the provision of domestic commodities, such as clean clothes, meals, child care, etc. Time poverty is defined as the state of working longer hours per week than a socially accepted threshold, for instance above the median workload of population or above an absolute number of hours defined as the time poverty line.

more likely to be time-poor than men. They attribute this to women's large amounts of time collecting water, firewood, and doing household chores, in addition to their paid and (often) unpaid labor in the fields. Studies about transportation in small villages show that women spend about three times as much as men collecting natural resources – water, firewood – in Ghana, Tanzania, and Zambia. In volume, women perform about four times what men do on those activities (Malmberg-Calvo, 1994; Barwell, 1996). Hailu et al. (2011) also show that women and children in urban areas in Kenya and Burkina Faso spend more time than men in water collection.

A rich literature in economic development has documented the impact of improved household infrastructure in ameliorating health and social outcomes. Jalan and Ravallion (2003) and Kremer et al. (2011) investigate the impact of improved water supply on the incidence of diarrhea, and Gamper-Rabindran et al. (2010) study infant mortality. Growing interest has also been focused on the impact of improved cooking stove technologies on household health, although findings are yet not conclusive (Grimm and Peters, 2012; Hanna et al., 2012; Yu, 2011). This is an empirical literature and most studies use experimental data. They attribute better outcomes (particularly in health) to improvements in infrastructure in the treated population. An economic impact is expected to follow as healthier individuals would become more productive.

The most immediate effect on households following the adoption of a labor-saving technology might, however, not be on health. It is on time-saving. An increase in consumption will depend on how that additional time is employed. And different consumption choices may further lead to health improvements. There is, however, no consensus in the literature regarding whether people will indeed employ the extra time productively. Greenwood et al. (2005) argue that technological advances in household appliances explain more than half of the historical rise in female labor-force participation during the last century in the U.S. Mulligan and Rubinstein (2008) show that the bulk of the gender pay gap close between 1970's and 1990's was due to selection, where the most able female entered the paid market while the less able left it. Conciliating both ideas, technology might have contributed to such selection process, as the most able women are more likely to make choices concerning the adoption of labor-saving technologies. In addition, increasing paid work when allowing more time would be the expected rational behavior among time-and-income-poor households, if there are no market constraints to employment. In line with that reasoning, Ilahi (2000) suggests that poor household infrastructure in Pakistan increases the total work burden of women, and this contributes to their reduced time devoted to market activities.

Another strand of the literature argues that individuals may not necessarily increase production when allowed a gift of time. Lee et al. (2012) observe an increase in leisure in Korea and Japan when the law has limited the maximum weekly hours of employment. Indeed when a high level of development is achieved, it might be expected that individuals will allow themselves extra leisure when forced to reduce market work, instead of increasing home production. The curious evidence is that poor households in the developing world also seem to not systematically increase productive employment when they are granted some 'free' time through access to a labor-saving technology. Using experimental data on a water-supply policy intervention in Morocco, Devoto et al. (2012) find that easier access to water increases leisure and school attendance of children, but not paid work among adult women. This can be related to our hypothesis of capacity-poverty of these women, and would be an interesting extension to their work. Also in this vein, Koolwal and van de Walle (2013) analyzed surveys in nine developing countries and found no systematic increase in paid work when households have access to water-supply infrastructure.

This paper proposes that the impact of a labor-saving technology depends on how time-constrained households are, and on the existence of substitute labor endowment in the household. If adults work close to the time poverty line (having few 'time' opportunities to expand activities or leisure), labor-saving technologies should importantly affect the household production. Accounting for heterogeneity in the adults' time constraint and in the household demographic composition could conciliate the mixed results so far found in the literature.

We test this hypothesis exploring heterogeneity of impact along stages of the family life cycle. The idea is that the demographic composition of families change across time and at certain periods, different 'stages of the family life cycle', parents might be more or less time constrained. For instance, parents with young children might be more time constrained than parents with teen or adult children. In the first case, children demand lots of attention and care of parents. In the latter, children could even help parents in household production, releasing them from the housework burden. The effect of a labor-saving technology on household production can hence be very different depending on what stage the family is.

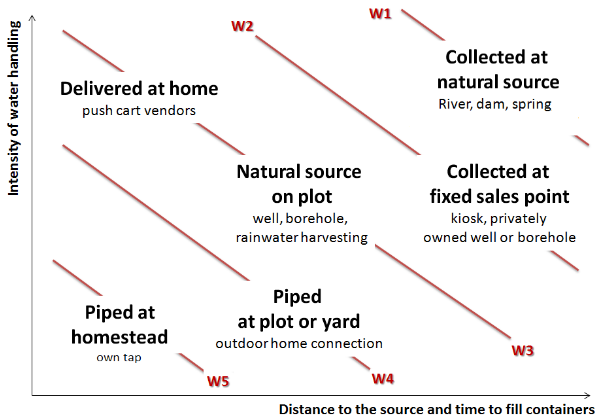
3 Conceptual Framework

The extensive literature on family sociology introduces the concept of family life cycle based on eight stages (Duvall, 1962, 1988; Hill and Rodgers, 1964; Neighbour, 1985; Olson, 1988; Rodgers and White, 1993; Thompson, 1984): pairing/marriage (no children), childbearing (oldest child, birth within 30 months), family with pre-school age children (oldest child 2.5–6 years old), family with school age children (oldest child 6–13), family with adolescent children (oldest child 13–20), family as 'launching ground'/letting go (first child gone to last child's leaving home), middle years (empty nest to retirement), and old age. The stages are based on milestones of family demographics and changes in position and role of household members along the life course. For instance, the arrival of a baby to a couple puts them into the position of parents and fulfilling exclusively the role of providers to that child. In families with adolescent children or at launching stages, parents might not be the exclusive providers as children start to conquer financial or social independence.

The hypothesis of impact heterogeneity of a technology along the family life cycle comes from the empirical evidence of the importance of home production on the total time allocation of the household. A large literature investigates the trade off between market work and housework, particularly regarding the work-family balance with the arrival of children and its significant impacts on job satisfaction, work success and even life success (Erickson et al., 2010; Higgins et al., 1994; Hill et al., 2014).

Water-supply technologies can save a little or a lot of time. They can be classified according to their labor-saving potential in terms of: (i) distance to the water source (including the round-trip time to the water source and time required to fill in the containers); and (ii) intensity of water handling (e.g. time spent on storage, purification, etc.). Figure 2 suggests how to classify water supply technologies according to their labor-saving potential. The most labor-saving technology is piped water at the homestead. It entails the shortest distance to the water source and the lowest intensity of water handling, thus requiring the lowest time inputs for the production of a liter of water. The least labor saving technology is water collection at a natural source away from the homestead. That is also the least safe source in terms of water quality.

Figure 2: Water supply technologies in a two-dimensional classification of time requirement for water production



Note: Simplified framework suggesting a hierarchy of labor-saving potential among water supply technologies. From left to right: W5 is the most labor-saving technology, i.e. the technology that requires the least labor effort for the production of a liter of water. On the other extreme, W1 is the most time-consuming technology, or the least labor-saving. It requires high amount of time to collect the water, due to usually large distances from the homestead, and also requires a large amount of time on water handling (transport, storage, purification). Source: The authors.

4 Data and Empirical Strategy

4.1 Data

We use the Ghana Living Standard Survey 5 (GLSS 5) which is a consumption and expenditure household survey with information on time use of each household member above 7 years old. GLSS 5 covers 8,687 households in the period 2005/2006.[4] We focus on rural households, where the least labor-saving technology (water collection from natural sources) is a method of water supply adopted by several households. We excluded the following from the sample: 421 polygamous households were dropped because the time-use decisions between spouses might follow different norms than in monogamous households. Three-generation households (626 households) where the household head is not the parent of children (e.g. head is the child's grandparent) were also excluded since it is not clear how decisions about the time use of adults, in particular the children's parents, are taken. Finally, we also excluded a few households that have co-habiting kids between 7 to 17 years old that are paid domestic helpers (4 households) or are non-relatives (95 households).

The dependent variables consist of the individual time-use of adults (household head and spouse only), disaggregated in market work, housework and paid work. The stages

[4] A comprehensive description of the dataset can be found at the Data Appendix, section ?? in this thesis.

of the family life cycle are defined according to the presence of children and their age, as in Table 1. Based on the stages proposed by Duvall (1962) and the age of the oldest child, we use an adjusted-version of demographic milestones that (i) focuses on children's age, and (ii) fits the information available in the GLSS 5 dataset.[5]

Table 1: Demographic milestones by stages of the family life cycle

Stage	Demographic milestone
1	singles or couple with no child
2	oldest child is at pre-school age (<6 years old)
3	oldest child is at school age (6 to 12 years old)
4	oldest child is adolescent (13 to 17 years old)
5	oldest child is adult (18 years old or more)

Source: Own classification.

In order to reduce dimensions we focus on two main labor-saving technologies: piped water and borehole. Piped water is the most labor-saving technology available to households. Borehole is the most widely adopted labor-saving technology by rural households in Ghana (see Table 2) and it has an intermediary labor-saving potential (Figure 2). Our sample consists of 4,575 individuals, who are either the household head or spouse. The average labor supply of adults to each activity is show in Table 3.

Table 2: Sample size according to stage of the family life cycle and labor-saving technology

Treatment	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	All stages
control	309	302	330	269	261	1,471
treated: borehole	609	500	534	541	537	2,721
treated: piped water	110	58	61	71	83	383
Total	1,028	860	925	881	881	4,575

Source: GLSS 5, restricted sample. Unweighted.

[5]It was not possible to distinguish in the survey families without children between Duvall (1962)'s stages of 'single or couple with no children', 'empty nest' and 'retirement'.

Table 3: Summary statistics, GLSS5 restricted sample, adults only

	Control			**Treated: piped water**			**Treated: borehole**		
Variable	Mean	St.dev.	N	Mean	St.dev.	N	Mean	St.dev.	N
housework (hours/week)	25.54	27.11	1471	20.59	19.25	383	24.58	25.76	2721
water collection (hours/week)	2.17	3.88	1471	0.7	1.38	383	1.72	3.33	2721
paid work (hours/week)	41.67	25.54	1471	46.16	28.58	383	44.18	26.44	2721
total work (hours/week)	69.37	36.25	1471	67.45	29.03	383	70.48	35.43	2721
low-income class*[1]	0.26	0.44	1471	0.15	0.36	383	0.4	0.49	2721
middle-income class*[1]	0.41	0.49	1471	0.22	0.41	383	0.28	0.45	2721
high-income class*[1]	0.34	0.47	1471	0.63	0.48	383	0.31	0.46	2721
electricity*	0.12	0.33	1471	0.87	0.34	383	0.39	0.49	2721
own house*	0.72	0.45	1471	0.23	0.42	383	0.45	0.5	2721
durable walls*	0.13	0.34	1471	0.74	0.44	383	0.28	0.45	2721
durable floor*	0.57	0.49	1471	0.94	0.24	383	0.94	0.25	2721
household size	4.13	2.13	1471	4.11	2.25	383	4.37	2.35	2721
number of children 0-18 years old	2.26	1.89	1471	2.29	1.9	383	2.5	2.03	2721
time-poor mother*	0.56	0.5	1471	0.5	0.5	383	0.56	0.5	2721
time-poor father*	0.27	0.44	1471	0.47	0.5	383	0.32	0.47	2721
capacity-constrained mother*	0.67	0.47	1471	0.27	0.44	383	0.45	0.5	2721
capacity-constrained father*	0.45	0.5	1471	0.17	0.37	383	0.29	0.46	2721

Source: GLSS 5, restricted sample. Note: (1) income class cutoffs based on 33rd and 66th percentiles, by household per capita expenditure. (*) Dummy variables. *Durable walls* – dummy refers to concrete, cement, brick or stone. *Durable floor* – dummy refers to cement, tiles, marble, wood, or bamboo. Time-poor indicates that the adult works per week more than the adult median hours of work in the population. Capacity-constrained indicates that the adult's education is below the secondary level.

4.2 Multiple treatment effects with inverse probability weighting

The empirical strategy consists in estimating the treatment effects of water-supply labor-saving technologies on adult time-use, considering two sources of heterogeneity: (i) outcome heterogeneity – the impact at distinct stages of the family life cycle; and (ii) treatment heterogeneity – technologies have different labor-saving potential. The fact that distinct types of water supply have different labor-saving potential allows us to investigate heterogeneity in the treatment intensity using techniques of treatment effects for multiple treatment. The treatment information is the type of water supply technology adopted by the household. We compare households using either piped water or borehole labor-saving technology, with the control group being households using the most time-consuming technology, surface water collection.

In a simple version of the model, the effect on household welfare or consumption of adopting the labor-saving technology is given by the set of parameters τ in the model as follows:

$$y_i^k = \alpha + \tau' W_{ji} + \eta' \mathbf{X}_i + u_i \tag{1}$$

where k indexes the activity (housework, water collection, paid work), W_j is a set of dummy variables that indicate whether the households uses the j labor-saving technology, and $\mathbf{X}_i$ is a vector of controls.

Taking as outcome variable the weekly adult labor supply to some productive activity, according to the classification in Figure 2, we might expect that $\tau_5 \geq \tau_4 \geq ... \geq \tau_1$, i.e. the most labor-saving technology has higher impact on adult's labor supply as more time is saved from water collection. If the outcome variable is hours spent on water collection, on the other hand, the opposite sign is expected: households using the least labor-saving technology, W_5, spend more time on water collection.

Having addressed heterogeneity of the impact according to the technology's labor-saving potential, we are interested in heterogeneity of the effect across the family life cycle. The model is extended to include family stage variables and interaction terms of the technology variable and the life cycle stages, as follows:

$$y_i^k = \alpha + \tau' W_{ji} + \beta' s_{hi} + \delta' W_{ji} s_{hi} + \eta' \mathbf{X}_i + u_i \quad \forall j = 1, ..., 5 \ ; \ h = 1, ..., 8 \tag{2}$$

where δ is the vector of coefficients that capture the treatment effect of a given technology at a given stage of the family life cycle. s is the household stage in the family cycle: s_1 indicates a household in the first stage (pairing/marriage), s_2 in the second stage (child-bearing), and so on. Similar to Equation (1), y are hours spent on housework, water collection, or paid work per week, W_i is a vector of water supply technologies and $\mathbf{X}_i$ is a vector of controls.

There are a few possible treatments, as a household could choose among the different water-supply labor-saving technologies in Figure 2. Taking advantage of this fact and following Cattaneo (2010), we estimate the effect of multiple treatments using a single model. With this reasoning, it is possible to think of the technologies as different intensities of a treatment (some technologies are more while others are less labor-saving).

We observe data at only one point in time and adoption of a water supply technology might not be a random event. The estimation of Equation (2) by OLS may yield biased estimates of the treatment effects. One may worry about endogeneity regarding the choice of technology and time-use: it could be that households that choose to adopt a labor-saving technology are smarter than the others. It is also likely that these 'smarter' households would always choose to employ their time in more productive activities. Hence, an increase in production observed in households using a certain labor-saving technology might not be purely the effect of the technology, but also incorporate some influence of the unobserved type of the household.

To try and pin down the causal effects of the technology, households are weighted according to their probability of being of a certain type – of adopting a given technology. This should address the endogeneity regarding the choice of technology and time-use. Then, in order to calculate the treatment effects, we use the propensity to receive a given treatment to calculate the inverse probability weights in the estimation of Equation (2). Our empirical strategy consists of the following two steps.

First, the propensity to use a certain type of water supply technology is calculated for each individual using a multinomial logit model. To make the model more tractable, we focus in only two labor-saving technologies – boreholes (the most frequently used water supply technology) and piped water. Water from a natural source is the control group. We estimate for each adult the probability of using either a natural source, a borehole or piped water. The explanatory variables are a set of observable characteristics regarding income, dwelling facilities, household demographic composition and the household time and capacity constraints.

In the second step, average treatment effects are estimated using the entire sample through propensity score matching. , weighted by the inverse propensity of treatment obtained in the previous step. The procedure consists in computing the weighted averages for each treatment, and the average treatment effect is the difference between these weighted averages across the treatment levels (StataCorp, 2013). We use the Stata routine *teffects ipw*, that implements the estimation based on the "means of the observed outcomes weighted by the inverse probability of treatment" (StataCorp, 2013, p.77). Since we are interested in three outcome variables – housework, water collection work, and paid work –, the treatment effects model is estimated for each outcome and each labor saving-technology, respectively.

Finally, to assess the robustness of our results, we loop the procedure in step two (the estimation of the treatment coefficients) by 50 times. This becomes a relevant exercise once the point estimates of the treatment effect estimation might vary slightly depending on the (random) seed picked by the computer to perform the estimation. Looping allows us to draw the upper and lower bounds of the estimates, and thus show with higher confidence the average treatment effect reported in our results. In Section 5 we present and discuss the median coefficients. The entire distribution of results for each estimated treatment coefficients is provided as a graphical boxplot in the Appendix.

5 Results

Table 4 shows the average treatment effects of piped water and borehole technologies on housework, water collection, and paid work activities of adults. We can read Table 4 in two directions. From top to bottom, the coefficients show treatment effects across stages of the family life cycle. Then, for each outcome variable, at each stage of the family life cycle, we can compare horizontally the intensity of the effect between piped water (the most efficient labor-saving technology) and borehole (the rather less efficient labor-saving technology). In general, we observe that piped water has a significant effect on decreasing both housework (left panel) and hours spent on water collection (central panel) in almost all stages of the family life cycle. Piped water has no effect on paid-work (right panel). The effect of a borehole is both less strong and less frequent than that of piped water. It mostly decreases hours of water collection (central panel), and has a small effect on housework (left panel) and paid work (right panel) at only two family stages.

The effect of piped water on housework across the family life cycle (Table 4, left panel) shows a strong effect on households with children aged 6 years and older - stages 3, 4 and 5. Access to piped water causes a reduction in housework of about 9 hours 48 minutes (=9.81 $\times$ 60 minutes) in households with no children, and a reduction of more than 10 hours if households are in one of the other stages of the life cycle. The largest effect of the technology is observed among households with pre-school children: piped water reduces by 15 hours and 45 minutes housework among them (=15.75 $\times$ 60 minutes). This confirms our hypothesis that labor-saving technology has a stronger effect on releasing work burden when parents are more time constrained, i.e. a the younger their children. No effect, however, was found for households at stage 2 of the family life cycle – households whose oldest child is below 6 years of age. Curiously, this is the stage of the family life cycle when parents are probably the most time-poor due to the many tasks related to child care. Our explanation for the non-significant effect is that in this stage of the family life cycle the time-constraint of parents, particularly in housework, is so large that the relatively small amount of hours saved with piped water is not enough to significantly

Table 4: Average treatment effect of piped water and borehole labor-saving technologies on adults' labor supply, by stages of the family life cycle

Family stage	**Housework**		**Water collection**		**Paid work**	
	Piped	**Borehole**	**Piped**	**Borehole**	**Piped**	**Borehole**
1	-9.81***	-2.45	-1.53***	-0.68***	1.48	-3.08
	(2.52)	(1.84)	(0.29)	(0.22)	(7.42)	(2.23)
2	1.24	-2.02	-0.22	-0.41**	2.73	0.46
	(3.63)	(1.53)	(0.67)	(0.19)	(5.96)	(2.14)
3	-15.75***	-3.76	-1.28***	-0.23	4.67	1.54
	(3.87)	(2.29)	(0.18)	(0.19)	(4.33)	(1.55)
4	-11.09***	-4.12**	-1.46***	-0.72***	-7.48	1.81
	(4.15)	(1.72)	(0.30)	(0.24)	(8.87)	(1.74)
5	-14.59***	-1.47	-0.93***	0.04	-3.44	4.05*
	(2.12)	(1.64)	(0.18)	(0.19)	(8.08)	(2.36)
Total	-11.49*	-2.83	-1.23**	-0.41	0.23	1.42
	(6.90)	(2.10)	(0.60)	(0.37)	(8.66)	(2.97)

Notes: Median estimated value of coefficients from 50 repetitions. Respective standard deviations in parentheses. The five stages of the family life cycle are: 1 - singles or couple with no child; 2 - oldest child is at pre-school age; 3 - oldest child is at school age; 4 - oldest child is adolescent; 5 - oldest child is adult.
Significance level: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Source: GLSS 5, restricted sample.

reduce parents' work burden.

The effect of piped water on time collecting water (Table 4, central panel) is similar to that of housework. Piped water decreases by almost 2 hours per week the time spent on water collection in the case of households with no children. It has no effect on households with small children (0 to 6 years old) and the impact is again significant in households with older children. Regarding magnitudes, in spite of the coefficients for water collection are much smaller than those of housework, meaning less hours saved per week on that first activity, one must have in mind that the total hours spent in water collection is in fact much lower than in housework. In terms of relative impact, therefore, the main effect of the piped-water labor-saving technology is on water collection activity (see Table 3 for the average hours of labor supply).

The effect of a borehole on water collection is also significant and, as expected, less strong compared to households with piped water. Boreholes are associated with a reduction of about 40 minutes (=0.68 $\times$ 60 minutes) per week in water collection among households with no children , 24 minutes among households with small children (0 to 6 years old) and about 43 minutes among those households with adolescent children (13 to 17 years old). Boreholes show a significant reduction of 4 hours in housework only among households with adolescent children (stage 4).

Neither piped water nor borehole have any effect on adults' labor supply to paid activities, except for households with adult children.

6 Concluding Remarks

We investigated the impact of two types of labor-saving technologies on adults' time-use: piped water and boreholes. We further investigated heterogeneity of this impact across stages of the family life cycle.

Our results confirm that technologies with higher labor-saving potential have a larger impact on the adults' time-use. Access to piped water, for instance, significantly decreases both the amount of time spent collecting water as well as the amount of time spent on housework. Boreholes, a technology with less labor-saving potential than piped water, has similar effects, yet smaller in magnitude. Boreholes, moreover, only have an effect in certain stages of the family lifecycle.

Perhaps an interesting finding is that access to piped water or boreholes also makes housework more efficient and significantly less time consuming. Difficult access to water thus significantly increases the amount of time required to perform basic domestic chores. Daily activities such as washing clothes or dishes, for instance, are considerably less time-consuming when one has piped water, compared to when one must first collect water for completing these tasks. Think of how one can easily use and discard tap water instead of managing clean and used water in a few different buckets while washing clothes or dishes, if one has to collect water from a distant source, for instance. The reduction in housework is the largest benefit of a reduction in labor-saving technology.

Interestingly, despite significant savings in time for water collection and housework, we did not find any significant increase in paid work activities. We offer three possible explanations. First, paid work opportunities are scarce in rural areas in Ghana. Thus, households either increased leisure or they increased own agricultural production. Unfortunately, we are unable to test this hypothesis because we did not collect data regarding agricultural production and if we had time-use data on agricultural production.

Second, some adults might have limited employability in the paid market because they lack capacity or skills. This relates to our hypothesis of capacity-poverty. In this case, even though adults might have more time available as result of the adoption of a labor-saving technology, they will not be able to increase paid work.

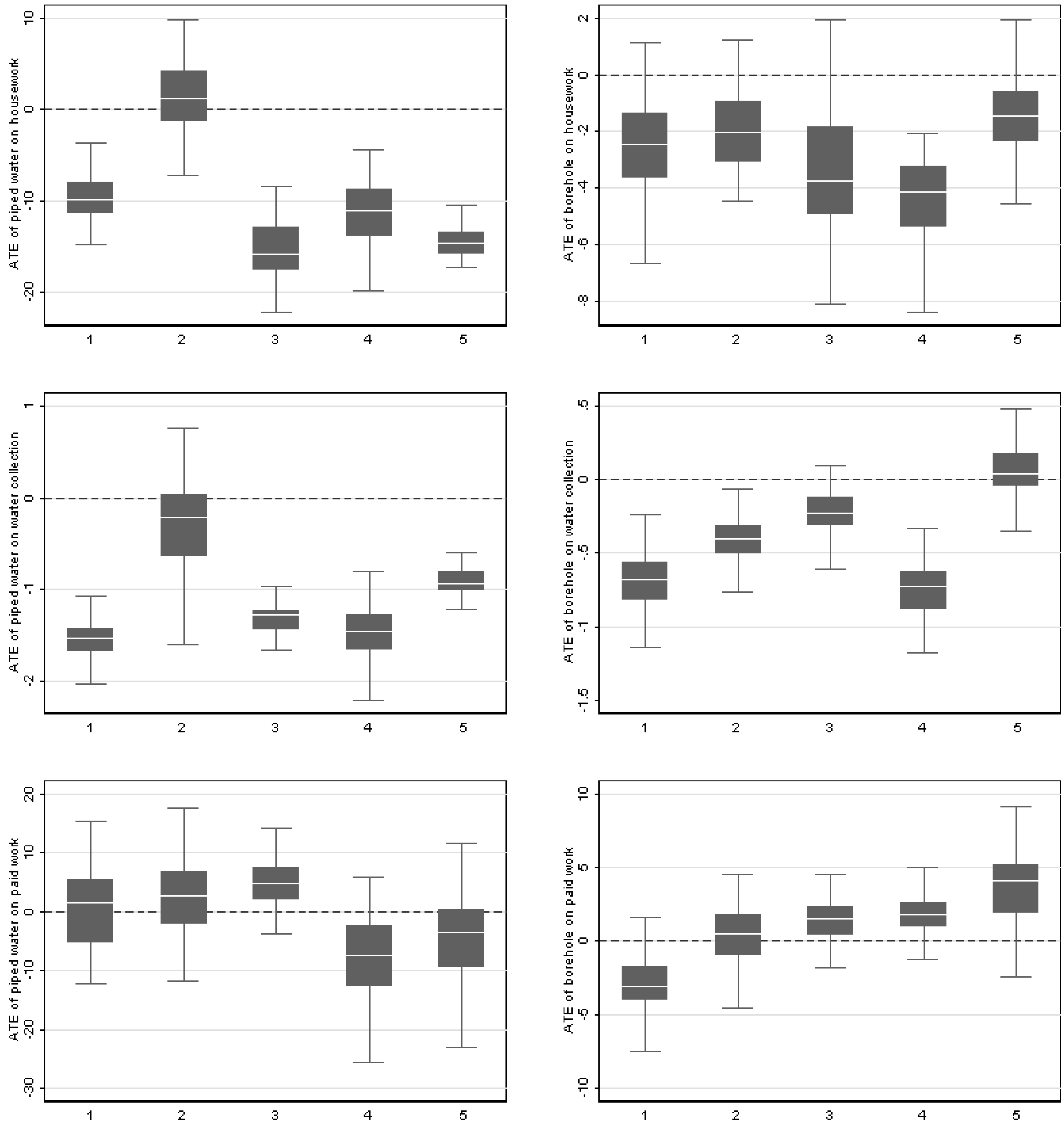
Finally, the third hypothesis is that adults are in such a tight time constraint that any additional time saved with the labor-saving technology is best enjoyed as leisure or time for personal care. We believe that this third hypothesis might indeed prevail in the geographical area studied in this paper. It conciliates with the results for stage 2 (families with small children) and helps us to take in the interesting results of not significant effects of the labor-saving technologies on adults' time-use at that stage of family life cycle. Parents of small children (below 6 years old) are probably in such an extreme time constraint that the relatively small amount of time saved with the water supply technology is not enough to significantly release their burden.

As for policy implication, we learned that the demographic composition of households matter much in defining the benefits of having access to a labor-saving water supply technology. The stage of the family life cycle is a valuable information. Hence, it would be of benefit to take that variable into consideration when selecting beneficiaries or when calculating the expected impact of a water supply policy intervention.

A Appendix

The boxplots in Figure 3 show the distribution of the estimated average treatment effect coefficients of the water supply labor-saving technologies on adults' weekly hours of work. The x-axis represents stages of the family life cycle and the y-axis measures the average treatment effect in terms of reduced (values below zero) or increased (values above zero) hours of work. A technology with significant impact in reducing (increasing) adults' hours of work is that in which the estimates lie below (above) the zero line.

Figure 3: Boxplot distribution of average treatment effects of piped water and borehole labor-saving technologies on hours of work per week, across stages of the family life cycle



(a) Treatment: piped water (b) Treatment: borehole

Note: Average treatment effects (ATE) of the labor-saving technology on hours per week of housework (upper panel), water collection (central panel), and paid work activities (bottom), respectively. The left panel estimates effects of piped water treatment technology, and the right panel, borehole. The five stages of the family life cycle, in the x-axis, are: 1 - singles or couple with no child; 2 - oldest child is at pre-school age; 3 - oldest child is at school age; 4 - oldest child is adolescent; 5 - oldest child is adult. Source: GLSS 5, restricted sample, adults only.

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