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Synergies among Water, Sanitation and Social Programs and Their Effects on Child Health Outcomes: Evidence from Urban and Rural Panama

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ABSTRACT

The literature shows that social policies in the last decade have emphasized the use of conditional cash transfer (CCT) programs. These programs transfer money to targeted households, typically impoverished, if they satisfy behavioral co-responsibilities, such as school attendance, growth control and vaccinations. While these programs have been successful in increasing household consumption levels and poverty reduction, evidence on improvement in final outcomes is mixed. For example, studies show that while the children of some households receive preventive medical care, such checkups have not always led to better child nutritional status (Fiszbein et al., 2009). These findings might suggest that to maximize their potential effects on the accumulation of human capital, CCTs should be combined with other programs, such as water and sanitation infrastructure improvement given that the literature shows access to and appropriate use of water and sanitation improves child health (Fewtrell et al., 2005; Fink, Günther, & Hill, 2011). This is an area of research not yet explored.

Using a nationally representative sample of approximately 1,150 urban and rural Panamanian children 6 to 60 months of age, gathered in 2014 and a fuzzy regression discontinuity design, we examine the relationship between CCT program participation and having adequate water and sanitation infrastructure. In urban areas, we find that, jointly, CCT participation and sewage system are negatively related with diarrhea prevalence, days of diarrhea for children under 60 months of age; this relationship is even stronger for children 36 to 60 months of age. Similarly, CCT participation and sewage system is negatively associated with stunting for children under 60 months of age; this relationship is greater for children under 36 months of age. In rural areas, we find that, jointly, CCT participation and sewage system are negatively related with diarrhea prevalence, days of diarrhea and wasting for children under 60 months of age and this relationship is driven by the infants and toddlers group (ages 6-36 months of age). Alike, we found that CCT participation and cement floor is negatively associated with acute respiratory infections and days of diarrhea for children under 60 month of age. Again, these results are driven by the infants and toddlers group. This might be explained by the fact that having adequate sanitation infrastructure reduces a household's exposure to germs and worms that cause intestinal diseases.

This study has important policy implications. First, results offer empirical evidence that access to improved sanitation could strengthen the impact of a CCT program on a child's health outcomes. Second, our findings speak to the importance of coordination between public agencies such as the Ministry of Development that administers CCTs program and the Ministry of Health that ensures provision of adequate water and sanitation. Finally, our findings emphasize the importance of managing the supply side of services to account for household heterogeneity.

1. INTRODUCTION

Background

Access to basic services plays a key role in improving the welfare of the poor and their opportunities for social mobility. Critical aspects of basic services include adequate water supply and sanitation, which ensure improved child health outcomes and positive life trajectories.

Panama shows disparities in the provision of its social services. As a middle-income country that has experienced rapid growth in recent years, Panama has reduced its poverty rate by 18% (from 40% to 22%) between 2007 and 2015. Panama also reduced its malnutrition and child mortality rates and improved access to education, electricity, sanitation, and water across the country. Despite achieving these developmental goals, gains were not uniform across all areas in Panama. While all provinces experienced a reduction in poverty, the rates of change were much higher in richer provinces, resulting in poverty being concentrated in regions populated by indigenous groups. These areas have significantly lower access to clean water supplies and improved sanitation facilities, such as piped sewer systems. In addition, in areas that do receive services from public agencies, these services are provided for a shorter duration compared to other areas. Thus, though Panama has achieved the fourth United Nations Millennium Development Goal (MDG) of reducing child mortality by two-thirds on a national level, the national statistics mask the fact that disparities exist at the provincial level.

The main social safety net program in Panama, Red de Oportunidades (RdO), a conditional cash transfer (CCT) program targeted to the poorest Panamanian citizens, has successfully reduced poverty among its targeted population and increased school enrollment and health care use; however, the RdO has not been successful in meeting its health and nutrition impact goals (Synergia, 2014).

This may be due to the poor water and sanitation services as well as the hygiene and sanitation behaviors of RdO participants in indigenous areas.

As such, this manuscript focuses on the interactions between the supply of water and sanitation infrastructure, family behavior, and social protection programs among the poorest population in Panama. We used data from the RdO program to specifically examine the impact of CCT programs on child health, anthropometric, and education outcomes by access to clean water and sanitation services.

Motivation

CCT programs are an innovative way of providing social assistance to poor populations. Originating in Latin American and the Caribbean, the goal of these programs is to reduce present poverty levels while at the same time investing in long-term human capital development (Stampini & Tornarolli, 2012). CCT programs provide money to poor families while requiring adherence to stipulated behaviors such as regular health center visits and school attendance for children. Unlike other social assistance programs, CCT programs focus on increasing the human capital of children within poor families in an attempt to eradicate intergenerational poverty. As such, most established programs include health, nutrition, and education components targeted mainly to children in primary school, and in some cases secondary school as well.

CCT programs were established to overcome some of the shortcomings of traditional social safety net programs which were often not well organized, had high administrative costs, were not well targeted to the poor, and were perceived as paternalistic in nature (Rawlings, 2005). CCT programs are also a response to the perceived shortcomings of the supply side of health and education facilities in that they encourage governments to ensure that poor people have access to high quality health and education services (Rawlings, 2005).

Evaluations of CCT programs in Mexico, Brazil, Honduras, Nicaragua, and Colombia have shown positive effects on school enrollment, child health preventive visits, and vaccinations. Effects with respect to school attendance, however, varied by program, with Nicaragua's Red de Protección Social program having greater effects on attendance than PROGRESA in Mexico. An evaluation of a CCT program in Cambodia found that while a modest cash transfer significantly increased school attendance, larger cash transfers did not produce the same or higher attendance rates. With respect to health outcomes, CCT programs are positively related to child health (Reis, 2010) and have resulted in increased vaccinations. However, the effect on final health outcomes is mixed. While evaluations using a randomized control trial for the CCT PROGRESA in Mexico showed that children who participated in the program had lower rates of illness (Gertler, 2004), had higher birth weight (Barber & Gertler, 2008), and consumed higher calories derived from vegetables and animal products (Hoddinott & Skoufias, 2004), results were different for other CCTs.

For example, Familias en Accion, the CCT program employed in Colombia, showed heterogeneous effects. CCT participation was associated with higher height-for-age z-score and lower probability of chronic undernourishment for children under 24 months of age. However, this association disappeared for children 24 to 48 months of age and older than 48 months. Similarly, CCT participation increased the birthweight of newborns living in urban areas but not of newborns living in rural areas. Morris, Flores, Olinto, and Medina (2004) analyzed the effects of Honduras' Programa de Asignacion Familiar and found no effects on children's nutritional status. Similar effects were found by Morris, Olinto, Flores, Nilson, and Figueiro (2004) for Brazil's Bolsa Alimantacion. In India, Lim et al. (2010) found no evidence of effect of the Janani Suraksha Yojana CCT program on neonatal, perinatal, or maternal mortality. Other studies have examined the effect of CCT programs on stunting and wasting, although only a few have found statistically significant effects. Ferre et al. (2014) examined the effects of a pilot CCT conducted in rural Bangladesh that targeted poor families based on a proxy-mean indicator. Using a panel data approach, the authors found that the program reduced the incidence of wasting for children who were 10-22 months of age when the program started. The pilot lasted 24 months. Behrman & Hoddinott (2001) examined the effects of the Mexican CCT program PROGRESA. Using a randomized rollout design, they found that participation in the program increases child's growth and reduces the probability of stunting. Similar, Kandpal et al. (2016) examined the effect of a CCT in Philippines that targets children under 5 years of age for health outcomes. Using a randomized control trial and an intent-to-treat measure, the authors find that the program reduces severe stunting (greater than -3SD) by 10 percentage points. However, wasting, stunting, underweight and severe underweight did not change. Thus, while results for school attendance and growth and development visits are large and statistically significant, effects for final health outcomes (e.g., birthweight, stunting, wasting, mortality) are mixed.

The importance of adequate water, sanitation, and hygiene to achieving social development and poverty reduction is reflected in the seventh MDG, which set targets for 50% reduction in the proportion of people without access to safe drinking water and basic sanitation by 2015 (Fink, Günther, & Hill, 2011; Prüss-Üstün, Bos, Gore, & Bartram, 2008). While progress has been made in both areas, improvement in sanitation access has been slower than for clean drinking water.

There are various ways to implement WASH worldwide; among those, Cambodia has established innovative and good practices, where sanitation facilities (i.e., latrines) are built with public contribution. In order to aid this contribution, cash transfer is provided through Public Finance of Sanitation. Specifically, the Grow-Up-With-A-Toilet plan targets poor, first-time mothers; finances the family to build a latrine; and provides additional financial awards over the first five years of the child's life if the family maintains certain toilet hygiene criteria, such as using soap or having a handwashing facility (Robinson, 2012).

Reviews by the World Health Organization (as cited in Fink, Günther, & Hill, 2011, p. 1197) revealed that 83% of the world's population had gained access to clean drinking water but only 59% had access to adequate sanitation facilities. This is particularly concerning because about ten percent of the world's diseases, such as those related to diarrhea, malnutrition, malaria, trachoma, and lymphatic filariasis, have been linked to unsafe water and inadequate sanitation and hygiene (Prüss-Üstün, Bos, Gore, & Bartram, 2008).

Although access to and use of clean water and sanitation facilities has increased in the past fifteen years, the achievements in terms of women and children's health status are not widely proven. For example, a study by Clasen et al. (2014) finds a minor positive difference in seven-day prevalence of reported diarrhea among children under five years of age between the communities with high coverage of latrines versus those with low coverage. The literature finds some challenges for internalizing the importance of water and sanitation in communities; for example, Sebastian et al. (2013) noticed that clean water and sanitation are not actively applied to improve the status of women's menstruation hygiene.

Poor water, sanitation, and hygiene conditions have negative consequences for various groups in society; however, children are disproportionally affected. Research shows that children living in households with high quality toilet infrastructure have lower mortality risks than those living in households with no toilet facility (Fink, Günther, & Hill, 2011). Access to high quality water has a large impact on reducing the mortality of children between one month to one year of age (Fink, Günther, & Hill, 2011). Poor water and sanitation conditions have also be found to increase stunting and the incidence of diarrhea (Checkley et al., 2004; Esrey, Habicht, Latham, Sisler, & Casella, 1988; Fink, Günther, & Hill, 2011) as well as the prevalence of other diseases such as cryptosporidium parvum and giardia lamblia among children (Checkley et al., 2004). Importantly, Checkley et al. (2004)

found that better water supply does not result in improved health outcomes if it is not accompanied by improved sanitation and better water storage practices.

One particular disease of utmost concern is environmental enteropathy, a subclinical condition caused by direct oral-fecal contamination. The effect of environmental enteropathy has been undervalued because malnutrition is mainly attributed to diarrhea; however, it is important to emphasize the severity of environmental enteropathy because (1) children are more prone to the disease than adults; (2) it is asymptomatic, without overt diarrhea; (3) it increases the possibility of oral vaccine failure; and (4) it leads to more serious health conditions, namely intestinal permeability, malabsorption, growth faltering, and stunting (Korpe & Petri, 2012). Given that environmental enteropathy has a similar communication process as other diseases owing to poor sanitation conditions, preventive methods for fecal-borne diseases have the potential to also address this widespread child-health problem (Humphrey, 2009).

The communication process of fecal-borne diseases has been studied for decades. A model proposed by Wagner (1958), later modified and called the *F-diagram* has been used in various public health studies (Pruss et al., 2002; Eisenberg, Scott, & Porco, 2007; Ngure et al., 2013). The model describes the transmission of disease from excreta through fluids, fingers, flies, and floors and suggests three sanitation barriers as means to stop the transmission We can think of latrine or toilet, hygiene and hand-washing, and water quality and treatment as these barriers. Food often comes in contact with fluids, fingers, flies, and floors. If a child eats an apple after playing on a dirty floor and not washing his or her hands, or after a fly lands on the apple, the child might get sick. Likewise, if a meal is prepared with dirty hands, or if a fly lands on the food, and the food is not washed with high-quality water (treated to be drinkable) or is washed with contaminated water, the prepared food might create diseases when the child eats it.

Programs worldwide have implemented WASH initiatives to promote the use of clean water, improve sanitation facilities, and change hygiene behaviors and practice. A WASH initiative can be implemented in various forms: it can be one intervention (i.e., to promote the use of clean water or to improve sanitation facilities or to change hygiene behaviors) or a combination of interventions. It can also be integrated with other initiatives in order to achieve greater impact, such as efforts including CTT programs.

The effects of WASH are mixed. For example, a WASH initiative in Northern Pakistan (WASEP) resulted in a significant 33% lower adjusted odd ratio for diarrhea among children (Nanan, White, Azam, Afsar, & Hozhabri, 2003). However, in Odisha, India, seven-day prevalence of reported diarrhea was only marginally higher in intervention groups as compared to control groups (8.8% and 9.1%, respectively; Clasen et al., 2014). In Africa, a study in rural Sudan found that children with stunted growth from homes with clean water and sanitation had a 17% greater chance of reversing stunting than those from homes without these facilities (Merchant et al., 2003). Meanwhile, in Mali, the impact of community-led total sanitation (CLTS) was observed among children with higher average height, less stunting and underweight, but no difference in terms of diarrhea prevalence (Pickering, Djebbari, Lopez, Coulibaly, & Alzua, 2015).

Brown, Cairncross, and Ensink (2013) examine the association between diarrheal diseases and children malnutrition. Using more than 24 studies in a meta-analysis, their report shows that malnourished children are more vulnerable to diarrheal diseases and that diarrheal episodes may severely change the child's nutrition status. This combination of sickness and malnutrition leads to school-absence and mortality concerns.

To address these complex problems, WASH initiatives have been implemented in different setups. In Kenya, a WASH initiative to provide water treatment and sanitation for school children was implemented at the school level to reduce absences; the initiative appears to have had an impact, especially in retaining girls at school (Freeman et al., 2012). WASH initiatives comply with CLTS, which has proved impactful in India and several African countries. Some countries opt for a single intervention WASH program because is less expensive and easier to scale; further, a combination of interventions may diminish the potential achievements of each single intervention (Arnold et al., 2013). However, there are a few initiatives that combine CCT programs with WASH infrastructure.

Bolsa Familia, a CCT program in Brazil with conditions tied to children's health and education, has contributed significantly to reducing malnutrition among children, especially in decreasing childhood mortality owing to poverty-related causes such as malnutrition and diarrhea (Rasella, Aquino, Santos, Paes-Sousa, & Barreto, 2013). Bolsa Familia program results suggest that it might be beneficial to integrate a CCT program with WASH that provides financial support to build sanitation infrastructures (i.e., latrines, wells, and water pipes) in households, community spaces, or schools and enhance the practice of good sanitation behaviors. This approach would work in disadvantaged areas where people have no access to clean water and do not have financial capacity to build necessary facilities for their use.

Contribution

Previous studies suggest that CCT programs should be combined with the provision of quality water and sanitation services to maximize effects on human capital accumulation. However, to our knowledge, no study prior to this report had examined this hypothesized relationship. This study exploits a detailed dataset from Panama's CCT program to identify synergies among information on indigenous households in Panama, program participation, water sources, sewage practices, and lifestyle behaviors. As such, the findings in this report provide robust empirical evidence that improved access to and use of clean water, as well as adequate sanitation and infrastructure, would help CCT programs have a greater impact on child health outcomes.

This study also presents vital information for the improvement of social support programs in Panama and similar Latin American countries. The results highlight the need for collaborative relationships between agencies that manage CCT or social support programs and other public agencies, such as the Ministry of Health, which provide water and sanitation services. Such relationships provide impetus to improve public service delivery in countries like Panama where disparities exist in the provision of water and sanitary services by public agencies, especially in indigenous regions. Further, this study draws attention to the importance of effective service supply management to account for diversity among households and communities.

2. PROGRAM DESCRIPTION

Red de Oportunidades (Network of Opportunities) is a CCT program launched by the government of Panama in 2005 to reduce extreme poverty and promote human development. In the early 2000s, income inequality and high school enrollment were a key problems in Panama: Households in the lowest quintile earned 2.5% of total income while households in the highest quintile earned 60% of total income, and 95% of high-school-age children who lived in households in the highest quintile of income were enrolled in high school while only 50% of high-school-age children who live in households in the lowest quintile of income were enrolled in high school. RdO provides a cash transfer of $100 every two months to a family with a child under 18 years of age if the family complies with two basic conditions: enroll the child in school and ensure the child attends routine preventive care visits.

The initial beneficiaries of RdO were 73,735 households in all nine states and three indigenous regions (*comarcas*). To determine eligibility for the program, the Ministry of Social Development (MIDES) of Panama used a proxy means test (PMT), which uses data on household demographics, durables, assets, and economic activity to proxy household income to predict welfare.

MIDES first used poverty maps at the county level and a marginality composite index based on unsatisfied basic needs criteria to determine which counties were the poorest. In a second stage, MIDES used household data to define the most vulnerable households within the poorest counties. Specifically, MIDES used a Censo de Vulnearabilidad (Vulnerability Census) to collect information on demographics, durables, assets, and economic activity for households. With this information, MIDES created the PMT, which varied by geographical area. The PMT ranges from 0 to 1, where 0 indicates no poverty and 1 indicates extreme poverty.

To qualify for the program, households needed a PMT score of 0.35 or above for urban areas, 0.25 or above for rural areas, and 0.15 or above for indigenous areas. We only use the sample of urban and rural communities because those were the ones for which the eligibility cutoff point was used and for which there was found enough observations below and above the cutoff point.

Households receive a monetary benefit of $50 per month; however, the payment occurred every two months for a total of $100 via bank or check-point. In the case of indigenous populations, most households did not have a bank account or did not have a bank agency close enough and so had to travel to check-points to receive their payments. The single payment day was announced by the "promotor." If the beneficiary did not come to the check-point on that day for any reason (e.g., illness, transportation difficulty), payment was delayed until the next payment day, assuming the beneficiary was able to come to the check-point on that day. In most cases, the beneficiary was the mother in the household; however, in households with sick mothers or single fathers, the beneficiary was the father. In a small number of cases, the beneficiary was the grandmother.

The monetary transfer is intended for health, education, and capacity development; however, MIDES does not have means to verify use of funds. Still, payment is subject to certain requirements. The first set of requirements are educational in nature. Children 4 to 17 years of age must be enrolled in preschool or school and attend at least 90% of school days. Parents are required to show the child's school grade card at the payment check-point as proof of attendance. Absences can be justified due to illness (with a medical certificate), abandonment, death, strong weather conditions, and school transfer.

The second set of requirements to receive the monetary benefit focus on health. For children younger than one year of age, parents must show a health control card as documentation of attending to health centers for well-visits (growth control and vaccination) received every two months. For children between one and four years of age, parents must show documentation of health controls received every six months. Pregnant women must show that they attended prenatal controls every two months.

[Table 2 about here]

3. EMPIRICAL STRATEGY

To isolate the effect of RdO on child's health outcomes, we begin with the following child health function:

$$Y_i = \alpha_0 RdO_i + \alpha_1 f\left(P\tilde{M}T_i\right) + \beta X_i + \mu_i \quad (1)$$

The dependent variable used in our model is Y_i, which represents child's health of child *i*, (stunting, wasting, diarrhea, respiratory infections), X_i is a vector of observed characteristics for child *i*, $f\left(P\tilde{M}T_i\right)$ is a smooth function of the proxy mean test (PMT) as a second degree polynomial, and u_i is an unobserved error term. Because RdO participation is not randomly selected and is specifically targeted to the poor, it is likely that RdO_i is correlated with the error term (parental decisions that make children more disadvantaged also negatively influence their child's health). If that is the case OLS estimates of γ, our parameter of interest, might be biased.

To address this problem, we use a regression discontinuity approach that takes advantage of the fact that RdO participation was defined using a continuous eligibility rule based on the PMT score. The RdO program used a proxy-mean test (PMT) as a proxy for household income. To calculate this PMT, the experts at the Ministry of Social Development (MIDES) used questions from the Censo de Vulnearabilidad (Vulnerability Census). While the census data had more than 50 questions, only eight of them were used to calculate the PMT; the variables used on the PMT varied according to the region (i.e., urban, rural, or indigenous). The questions used on the PMT calculation were unknown to the families; thus, they did not have any way to manipulate their entrance into the program. Because eligibility for the RdO program was mainly determined by the PMT, which was exogenous to households' decision-making processes and could not jointly influence decisions about RdO program participation and decisions about child health, PMT is a good candidate for an instrument.

If households are unable to manipulate the forcing variable, in our case, their PMT score, a result of this is that the variation in RdO participation near the cutoff point (0.35 for urban areas and 0.25 for rural areas) is randomized, similar to a randomized experiment (Porter 2003). Children who are just above the cutoff point are very similar to children who are just below the cutoff point. Why? Because the only difference between children on either side of the cut-off is that some live in a household with a slightly lower PMT score and cannot participate in the RdO program, while others are just above the cutoff point and can participate in the RdO program. On average the level of education of the household head just below the cutoff point should be similar than the level of education of the household head just above the cutoff point. Similarly, gender, maternal education, maternal marital status, and other observed and unobserved characteristics should be similar. A regression discontinuity design has similar properties to a randomized experiment in the vicinity of the cutoff point. A key assumption is that households are not able to manipulate the forcing variable. This seems like a comfortable assumption because the PMT score was determined using only a few variables from the Vulnerability Census that had more than 50 questions and households were not aware of the variables that were used to create the poverty score.

RdO participation is based on the PMT score and is intended only for household scoring more than 0.25 in rural areas and more than 0.35 in urban areas. This allocation mechanism generates a non-linear relationship between RdO participation and PMT score as illustrated in figure 1. Moving from right to left along the x-axis, we observe a sharp spike at the cutoff point and an increase in the likelihood of participating in the RdO as the PMT score increases. In urban areas, households with PMT scores of 0.35 or more are about 50 percentage points more likely to participate in the RdO, while in rural areas, households with PMT scores of 0.25 or more are about 40 percentage points more likely to participate in the RdO.

[Figure 1 about here]

There are two types of well-defined regression discontinuity approaches: sharp and fuzzy. In a sharp regression discontinuity design, the forcing variable, in our case, PMT scores, determines program participation and all who are selected to treatment participate in the program and all who are not selected to participate in the program, do not participate in the program; in other words, this is a situation of perfect compliance. In contrast, in a fuzzy regression discontinuity design, we do not have a situation of perfect compliance, as in our case. Some households who are eligible for RdO do not participate in the program, while some households who are ineligible to participate in the program do participate in the program. As Table 1 shows, RdO participation is not a deterministic function of the forcing variable, PMT. For about 72 percent of the sample (827/1,154) eligibility and program status match, but there are 266 who are eligible but do not receive the program (23 percent) and 61 who are not eligible but participate in the RdO (5 percent). This 'fuzziness' might lead to an endogeneity problem because RdO participation could potentially be associated with observed or unobserved factors that affect child's health outcomes.

[Table 1 about here]

Because RdO participation is determined partly by whether the forcing variable crosses the cutoff-point, we can use the forcing variable as an instrument of RdO participation. As a result, our statistical analysis uses a fuzzy regression discontinuity design that works like an instrumental variable (IV) approach around the vicinity of the cutoff point (Murnane & Willett 2011, Angrist & Pischke 2009). We use the IV method to model RdO program participation as a function of PMT. Given that individuals are not randomly assigned to RdO, individuals who participate in the program can be different from individuals who do not participate in the program; the IV method allows us to correct for the resulting potential selection bias. We use this technique to estimate not only the effect of RdO participation, but remember that we are mainly interested in examining the differential impact of RdO by access and use of water and sanitation infrastructure (i.e., having latrine, having high-quality floor, using a water treatment).. In our first stage, we estimate four different equations. First, we estimate the probability of program participation which is a function of an instrument (Zi), a polynomial of second degree of the PMT score (PMTi) and other variables. The decision rule that determines Z takes a value of 1 for those scoring above the cutoff for the PMT and a value of 0 for those scoring below the cutoff point.

$$RdO_i = \lambda_1 f\left(P\tilde{M}T_i\right) + \lambda_2 Z_i + \delta X_i + \varepsilon_i \qquad (2)$$

The other three equations estimate the interactive effects of RdO participation with WASH. Following the literature, we use the RdO instrument as an instrument for the interactive effect as follows:

$$RdO_i * HQWater = \lambda_1 f\left(P\tilde{M}T_i\right) + \lambda_2 Z_i + \lambda_3 HQWater + \lambda_4 Z_i * HQWater_l + \delta X_i + \varepsilon_i$$

$$RdO_i * HQfloor = \delta_1\ f\left(P\tilde{M}T_i\right) + \delta_2 Z_i + \delta_3 HQfloor + \delta_4 Z_i * HQfloor_l + \varphi X_i + \varepsilon_i \quad (3)$$

$$RdO_i * sewage = \chi_1\ f\left(P\tilde{M}T_i\right) + \chi_2 Z_i + \chi_3 sewage + \chi_4 Z_i * sewage_l + \phi X_i + \varepsilon_i$$

Because our instrument is based on the eligibility rule it is highly likely that it will be correlated with program participation. However, we also need to assume that unobserved factor that determine child's health are not correlated with the instrument. In other words, we assume that the E[Zi*ui|Xi, PMT]=0. If this assumption is satisfied, then we can estimate in the second stage the following equation:

$$Y_i = \alpha_0 E[RdO_i] + \alpha_1\ f\left(P\tilde{M}T_i\right) + \alpha_3 E[RdO * HQwater] + \alpha_4 E[RdO * HQfloor] + \alpha_5 E[Rdo * sewage] + \alpha_6 HQwater + \alpha_7 HWfloor + \alpha_8 sewage + \beta X_i + \mu_i \quad (4)$$

where $E[\ldots]$ denotes the predicted value estimated in the first stage using the IV approach. Equations in both the first and second stages control for geographical location (i.e., dummy variables by community) to control by unique unobserved characteristics that affect each community and by household distances to the school, the health center, and the bank to control by household location within the community. The distance variables control for the fact that some households might be located in remote areas with difficult access to services. Estimates based on (4) provide the average treatment effect for those around the cutoff point for those whose participation in the RdO program has been influenced by the eligibility rule (PMT score). Because of that, the literature calls this effect a local average treatment effect.

It is important to mention that there is not a consensus in the literature about the bandwidth selection. Because different bandwidth choices could produce different estimates, we report four estimates as an informal sensitivity test. Starting with a bandwidth of 5 points on either side of the cutoff, we shrink the interval to 4, 3, and 2 around the cutoff and show that results are not sensitive to the bandwidth choices.

We use the STATA *ivreg* command to run the regressions containing a continuous dependent variable (i.e., days of acute diarrhea, days of acute respiratory infection) and *ivprobit* to run the regressions containing a dichotomous dependent variable (i.e., stunting, wasting, prevalence of acute diarrhea, and prevalence of acute respiratory infection). We then transform our estimates to marginal effects using the command *mfx*.

4. DATA

Background

The government of Panama decided to evaluate the RdO program in 2010 using loans from the World Bank and the Inter-American Development Bank. MIDES issued a Request for Proposals for a firm to create and test a survey instrument, collect data, and conduct analysis. MIDES granted the project to a firm, which collected data representative at the national level and also at the urban, rural, and indigenous areas level. We utilize these data in our analysis.

Sampling Design

MIDES provided a list of all households in the counties with extreme poverty. This list contained the poverty-indicator PMT that takes values from 0 (no poverty) to 1 (extreme poverty). The PMT was created based on Censo de Vulnearabilidad (Vulnerability Census) data, making PMT information available for all households in those communities. Thus, the list (sampling frame) contained information for participants and non-participants of the CCT program. The main criteria to be eligible to the program was the PMT score. For urban areas this score was 0.35 and for rural areas it was 0.25. The sampling frame was designed to use a regression discontinuity design, such that the sampling frame for urban and rural areas was based on all households who were five points below the cutoff point and five points above the cutoff point. In other words, for urban areas, the sampling frame consisted of households with a PMT score that ranged 0.30 to 0.40, and for rural areas, the sampling frame consisted of households with a PMT score between 0.20 and 0.30. Then, the sample was selected using a randomized cluster selection.

Study Population

We used a nationally representative data of urban and rural households collected in 2014 for the MIDES evaluation of the Red de Oportunidades program. We constrained the data only to households with children between 6 to 60 months of age. Our study consists of 1,154 number of children of whom, 481 live in urban areas and 673 live in rural areas.

Variables

We use the following variables in our analysis to examine whether CCTs maximize potential effects on child health outcomes if combined with other programs such as water and sanitation.

Outcome Variables

We use three groups of outcome variables—acute diarrhea, acute respiratory infection, and child's nutritional status, as described below.

Acute diarrhea. We use two variables. First, a dichotomous variable indicates whether a child experienced a diarrhea episode in the last 15 days: "Did the child have diarrhea in the last fifteen days?" This variable takes a value of 1 if the answer was "yes" and 0 if the answer was "no." Additionally, we use a continuous variable that indicates days of diarrhea: "How many days did this disease last?"

Acute respiratory infection. Acute respiratory infection is defined as an infection that interferes with normal breathing. We use two outcome variables: one refers to whether a child had a respiratory infection or not, and the other refers to the number of days with the disease. For our first outcome variable, we use the following survey question: "In the last fifteen days, did you have a cold, cough, pharyngitis or bronchitis?" For the frequency outcome variable, we use the following survey question: "How many days did this disease last?"

Child's nutritional status. Using valid anthropometric measures, age of child in months, and gender from the survey, we constructed two variables: stunting and wasting. We created these variables using the World Health Organization (WHO) algorithm (igrowth STATA data files).

According to the WHO (2010), stunting is defined as growth delay. Stunting occurs due to long-term nutritional deficiency and might affect mental development, intellectual capacity, and performance in school. Stunting takes a value of 1 if height-for-age takes a value below two standard deviations of the WHO Child Growth Standard Median (which varies by gender). Wasting is used as a measure of acute malnutrition and, according to the WHO (2010), is a consequence of deficient food intake or a high prevalence of infectious diseases, such as respiratory diseases or diarrhea. Our wasting variable takes a value of 1 if weight-for-height is below two standard deviations of the WHO Child Growth Standard Median and 0 otherwise.

Key Variables

Our key variables of interest refer to the potential synergies between the CCT's RdO and water and sanitation infrastructure. As such, we used four variables: participation in RdO, water treatment, having a toilet or latrine, and having a high quality floor. The first variable of interest is participation in the RdO program. We use a dichotomous variable to indicate participation; it takes a value of 1 if a child participates in the program and 0 otherwise. The second variable of interest is water treatment; it takes a value of 1 if the household uses a water treatment (e.g. boil, chlorine, etc.) and 0 if the household does not use any water treatment. Our third variable is having toilet or latrine; it takes a value of 1 if the household has a toilet or latrine and 0 if it does not have any type of bathroom. We observe that about 50% of the households have a latrine and about 46% do not have any bathroom. Our last variable of interest is high quality floor; it takes a value of 1 if the household has a floor of cement/concrete, mosaic, tile, brick, granite, or wood (34% of households). If the floor is earth/sand, cane, stick, or debris, the variable takes a value of 0 (66% of households).

Other Variables

Our descriptive statistical analysis uses maternal variables (i.e., age and education); size of household; and distances from household to health center, school, and bank. For regression analysis, we also include dummy variables for each community to control for unobserved characteristics at the community level.

Table 2 shows means and frequencies of our variables of interest for our sample of interest. We report these variables for children 6-60 months of age living in urban and rural areas. We present statistics for four groups: urban children who live in households above the cutoff point (PMT is between .35 and .40), urban children who live in household below the cutoff point and who do not qualify to participate in the RdO (PMT is between .30 and .35), rural children who live in household above the cutoff point and qualify to participate in the RdO program (PMT is between .25 and .30), rural children who live in hosuholds below the cutoff point and who do not qualify to pariticpate in the RDP (PMT is between .20 and .25).

[Table 2 about here]

5. RESULTS

This section presents the validity of the regression discontinuity design and instrumental variable estimates for the first and second stage, as well as sensitivity of the results.

Validity of the RDD

One of the key assumptions of a regression discontinuity design is that households cannot manipulate the forcing variable. We might think that households might be able to manipulate the

PMT score by hiding the assets that can be observed in the house and underreporting the ones that belong to the farm or underreport their level of education. By doing that, they might increase the probability of obtaining a higher PMT score and participating in the program. This is highly unlikely because the PMT score is based on a few questions of the Censo de Vulnerabilidad (Vulnerability Census) and households do not knowledge of the formula involved in these calculations. However, if households were able to manipulate their scores, we would expect a much lower number of cases just below the cutoff point and spike of cases above the cutoff point. However, we do not observe such a discontinuity. A close look at the PMT scores for rural areas show for example that just below the cutoff point there are 66 observation while just above the cutoff point there are 52 observations. Similarly two points below there are 50 observations and two points above, we also find 50 observations. Thus, there is no indication of a spike in the PMT score immediately above the cutoff point. More specifically, we test this assumption using the McCrary test (2008). This test evaluates if the density function of the forcing variable, in our specific case, the proxy mean test (PMT), exhibits a discontinuous jump at the cutoff point. A spike in the number of households just above the cutoff point would indicate possible manipulation of the PMT score (e.g. households know the formula and might misreport their assets, program administrators may give an additional point to households to increase the number of recipients if they were too close to the cutoff point. The assumption of no no manipulation of the PMT score requires a continuous density function of PMT. Figure 2 displays the results of the McCrary test and smoothness of the density function around the PMT cutoff point indicates not manipulation. This is supported by the corresponding statistically non-significant discontinuity estimates reported at the bottom of figure 2.

[Figure 2 about here]

IV Estimates

We used an IV approach to control for endogeneity of RdO program participation. Because households were not randomly selected to participate in the RdO program, we exploited the program's allocation mechanism (the government uses a poverty indicator PMT) and create an instrument that allows us to create IV estimates of the effects of the RdO program on child health outcomes. Additionally, we are interested to examine the synergies between RdO program and WASH infrastructure, so we also instrument these interactions by using the RdO instrument and interact it with the respective WASH infrastructure.

First stage estimates of the relationship between PMT score and RdO participation, and the relationship of the synergies of PMT scores and WASH infrastructure with the synergies of RdO participation and WASH infrastructure, using PMT as an instrument are provided in Table 3. In our first stage we run four different regressions. Each column in table 3 represents a different regression. We only present results for the instrumented variables. We expect for the first equation, the one that instruments RdO, that PMT will be statistically significant. Similarly, for the second equation, the one that instruments the interaction between RdO and water treatment, that PMT*water treatment will be statistically significant and have a positive relationship. Alike, the third regression instruments the interaction between RdO and high quality of floor and we expect PMT * high quality of floor to be positively related and statistically significant. For our last equation, we instrument the synergy between RdO and toilet and expect our instrument, PMT*toilet, to be statistically significant and positive. We observe in both cases, rural and urban areas, that our expected relationships are satisfied. The F-statistics are also highly statistically significant (above 10, as recommended in the literature) and the overall Anderson-Rubing test also shows the jointly significance. Because the Anderson-Rubing test is not statistically significant, it means that we accept that null hypothesis that are instruments are valid and our structural model is specified correctly.

Overall our results support the idea that the forcing variable (or assignment mechanism) is correlated with RdO participation and the interaction between RdO and WASH is also explained by the assignment rule variable, PMT and its interaction with WASH. Therefore, according to the test conducted, our instruments are strong and valid.

We then report our second stage estimates for urban areas are reported in table 4 and rural areas in table 5. For urban area, the IV estimates indicate that participating in the RdO and having a toilet at the same time (interaction) is negatively associated with acute diarrhea, days of acute diarrhea and stunting for the overall sample of children 6 to 60 months of age. This association is driven by the preschool group (36-60 months of age) for acute diarrhea and days of acute diarrhea. In the case of infants and toddlers (6-36 months of age), we observe that participating in the RdO and treating water for drinking at the same time (interaction) is negatively associated with stunting.

Table 5 presents our main results for rural areas. We observe in this case that WASH infrastructure not only seems to have interactive effects with RdO participation through sanitation (having a toilet or latrine), but also through high quality floor (having a cement flooring). We observe that the interaction between RdO participation and having a cement floor is negatively associated with acute respiratory infections and days of diarrhea. Results for the overall group are driven by the infant and toddler group. Our IV estimations also show that the interaction term between RdO participation and having a toilet or latrine is negatively associated with acute diarrhea, days of acute diarrhea and wasting for the overall group of children. These results are again driven by the infant and toddler group of children. While we observe that the interactive terms between RdO participation and having a cement floor, and RdO participation and having a latrine or toilet are negatively associated with days of acute diarrhea, these interactive effects are smaller than the ones found for the infant and toddler group, although statistically significant..

Overall, our second stage regressions suggest that in the case of urban areas, WASH has an interactive effect with RdO participation through sewage infrastructure (having a toilet or latrine) and this is negatively associated with diarrhea, days or diarrhea and stunting. For rural areas, our results suggest that the interaction between RdO participation and sewage infrastructure (having a toilet or latrine) is also negatively associated with child health outcomes, but these outcomes are diarrhea, days of diarrhea (similar to the case of urban areas), but wasting (unlike urban areas). We also found that the interaction between high quality floor and RdO participation was negatively associated with acute respiratory infections and days of diarrhea.

Robustness Checks

We conducted two different robustness checks to test the sensitivity of our main results on the synergies of RdO and WASH infrastructure on child outcomes and present these results on tables 6 and 7. First, we test the sensitivity of our results to different bandwidths. Remember that we used in our main analysis 5 points below and above the cutoff point. For our sensitivity analysis we used 2, 3 and 4 points below and above our cutoff point. We observe that the results are not sensitive to the bandwidth election.

Second, we ran a falsification test. While we expect that synergies between RdO participation and water treatment, high-quality of floor, and sewage have effects on AD or child's malnutrition, we do not expect that other types of infrastructure had such an effect. For example, we do not expect that having electricity plus participating in a CCT program would have a direct effect on AD, stunting, or wasting. Therefore, we run a falsification test in which, in the first stage, we estimate the probability that families participate in the RdO program and the probability of synergies between RdO participation and electricity. Our first stage consists of two equations:

$$RdO_i = \lambda_1 f\left(P\tilde{M}T_i\right) + \lambda_2 Z_i + \delta X_i + \varepsilon_i$$

$$RdO_i * electricity = \lambda_1\ f\left(P\tilde{M}T_i\right) + \lambda_2 Z_i + \lambda_3 electricity + \lambda_4 Z_i * electricity_l + \delta X_i + \varepsilon_i$$

In the second stage, we use those estimates to predict the effect of the RdO program and its synergy with electricity into different health outcomes. Our second stage consists of one equation:

$$Y_i = \alpha_0 E\left[RdO_i\right] + \alpha_1\ f\left(P\tilde{M}T_i\right) + \alpha_3 E\left[RdO * electricity\right] + \alpha_4 electricity + \beta X_i + \mu_i$$

Table 7 shows the results for the falsification test for our overall sample. As expected, interaction between RdO participation and having electricity in the house does not have an effect on any of the health outcomes. Thus, our falsification test indicates that other forms of infrastructure that should not have an effect on health outcomes in fact do not have an effect. This is another indication that the instrument seems to work fine.

6. DISCUSSION

Acute respiratory infections (ARI) are the leading cause of morbidity and mortality in many countries for children under five (Berman & McIntosh, 1985; Tupasi et al., 1988). Sanitation infrastructure, handwashing, and water treatment are fundamental to combating acute diarrhea (AD), ARI, and malnutrition (Curtis & Cairncross, 2003; Huttly, Morris, & Pisani, 1997; Mara, Lane, Scott, & Trouba, 2010; Rabie & Curtis, 2006). A thorough examination of the Red de Oportunidades (RdO) program and its interaction with water and sanitation infrastructure resulted in interesting patterns with respect to child health outcomes.

We used a rigorous statistical technique to attempt to establish causality. We used an instrumental variable approach to control for endogeneity into RdO program participation and jointly estimated the effect of RdO participation and WASH infrastructure. We found that, jointly, RdO participation and having a toilet or latrine are associated with a reduction in the likelihood of prevalence of stunting, prevalence of acute diarrhea and days of acute diarrhea for the overall sample of children 6 to 60 months of age and for children 36 to 60 months of age in urban areas. We also found that, jointly, RdO participation and having a toilet or latrine are associated with a reduction in prevalence of acute diarrhea, days of acute diarrhea and wasting for our overall sample of children 6 to 60 months of age and these results are mainly driven by the group of infant and toddlers (children 6 to 36 months of age). In rural areas. We also found in rural areas that jointly, RdO participating on having a high quality floor (cement) reduces the likelihood of prevalence of acute respiratory infections and days of diarrhea for our overall sample and for our infant and toddlers sample. While for preschoolers (children 36 to 60 months of age), we also found interactive effects of RdO and having a high quality floor and RdO and having a sewage system (toilet or latrine) on days of acute diarrhea, these effects are not as larger as the ones found for infant and toddlers.

These observed associations may be the result of the "family support" component of the RdO program. *Promotores* connect families with Ministry of Health workers who provide family support and help family members develop human capital through training in basic health education practices. The *promotores* then continue to act as advocates by connecting families with workers from other governmental organizations. It is possible that families participating in RdO and who have a latrine use the latrine for its intended purpose. On the other hand, families who do not participate in the program (comparison group) could have a latrine and other WASH resources but not know how to use them. From anecdotal evidence, some families use their latrine for storage instead of for waste disposal. This could explain the negative association between WASH resources and AD for children in the comparison group.

Moreover, the role of the *promotores (paraprofessional leaders)* appears to be crucial. RdO through their *promotores* uses modules to train *its participants (i.e. parents)*; one such training module is about nutrition and health and covers WASH topics. This training plus the training received by workers from the Ministry of Health might be a mechanism through which WASH practices and infrastructure reinforce RdO effects.

A caveat to our findings is that there is a window of opportunity that closes by age two to halt stunting brought on by chronic malnutrition (Black et al., 2013). As such, even when our results suggest that participating in RdO while having a WASH infrastructure decreases wasting in rural areas stunting in urban areas, it is clear that policymakers need to consider additional policy actions in order to reduce stunting during this crucial time period in a child's life.

We recognize some limitations of this study. First, this study attempted to examine causal effects and used an instrumental variable approach to control for selection bias from RdO program participation. However, it is possible that WASH infrastructure is endogenous to the model, and if so, our results could be biased. We do not know whether the government provided monetary support in areas of extreme poverty for building latrines or installing high-quality floors in houses or provided chlorine pills for water treatment. Further, it is possible that parental decisions and knowledge influencing water or sanitation infrastructure also played a role in child health and anthropometric outcomes; however, this is unlikely given that these areas are of extreme poverty and families have scarce resources.

The results of our study have several policy implications. To successfully achieve one of its main goals of providing geographical infrastructure, the RdO program, that is managed by the Ministry of Development could coordinate efforts with the Ministry of Health and provide a list of the targeted communities and their needs to the Water and Sanitation Area of the Ministry of Health (Dirección de Agua Potable y Alcantarillado Sanitario; DISAPAS) and coordinate meetings to address the lack of WASH infrastructure in those areas

Given the results of our study, it might be important to gather information on the use of sanitation infrastructure and quality of floor in areas of extreme poverty, as well as coordinate efforts among different ministries. For example, the Ministry of Government (MINGOB) has started conducting workshops to prioritize investments in WASH. Poverty reduction and development of human capital is the main objective of the ministries of social development, health, and education. Around this ultimate goal, these three stakeholders could provide programs in a coordinated effort. Coordination might enhance the programs as well as the benefits to the target populations.

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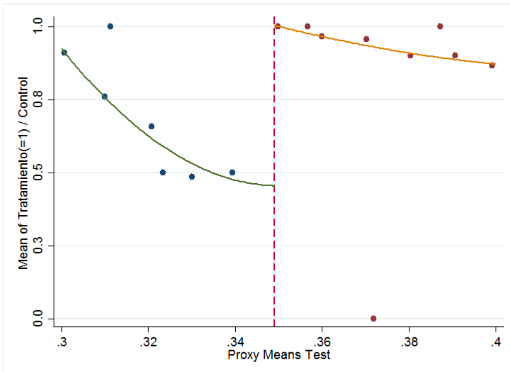
Figure 1: Relationship between treatment and Proxy-mean test

Urban Area



Rural Area

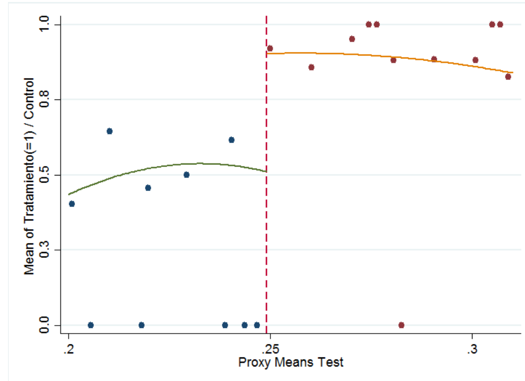
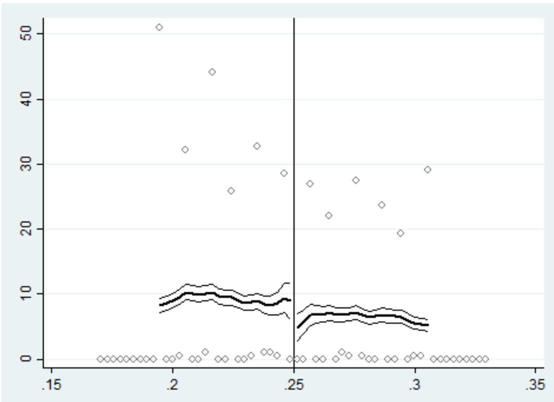


Figure 2: McCrary Test for Manipulation of the Forcing Variable

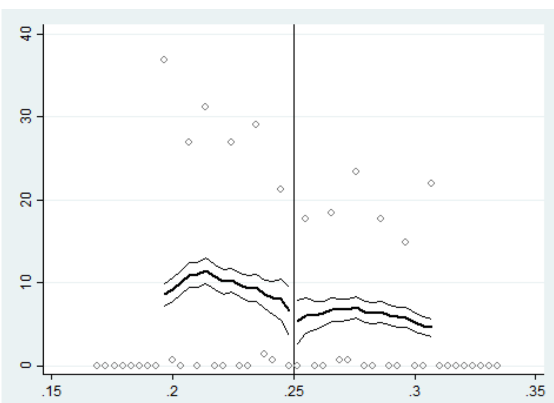
RURAL AREA

Overall



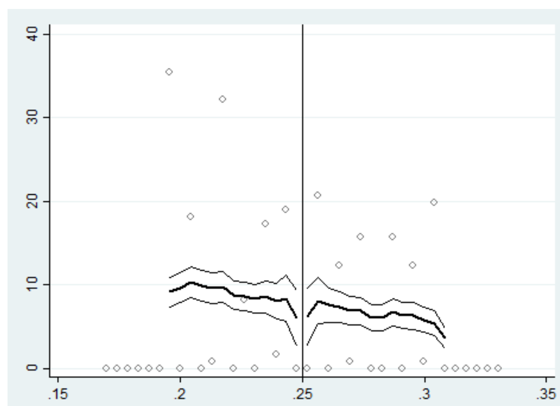
Discontinuity estimate=.706002235,
Standard error=.299003595

Age 6-36 months



Discontinuity estimate -.261546727,
Standard error=.32658

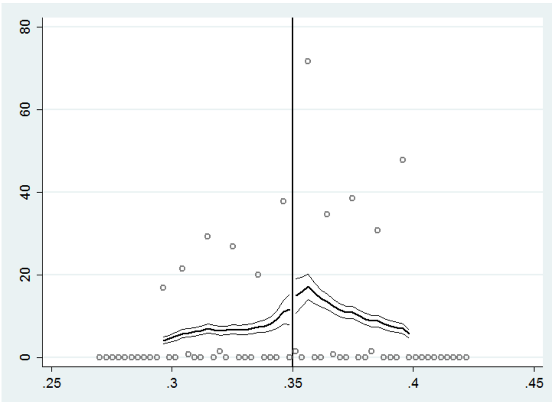
Age 36-60 months



Discontinuity estimate .2160307,
Standard error .539503

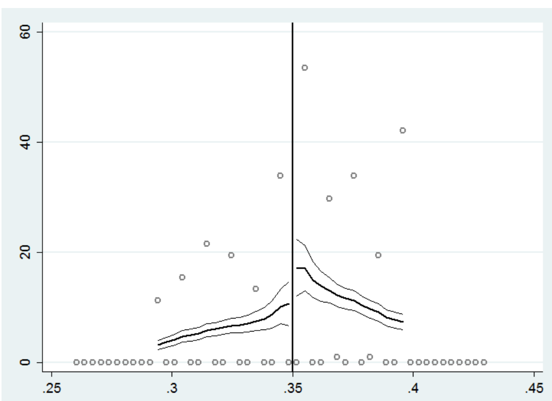
URBAN AREAS

Overall



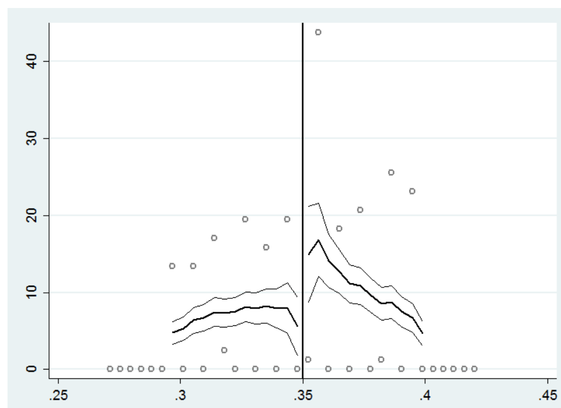
Discontinuity estimate=. 159124682,
Standard error= .23539231

Age 6-36 months



Discontinuity estimate= .4540964,
Standard error=. .268858429

Age 36-60 months



Discontinuity estimate= 1.10114882,
Standard error= .511755356

Table 1: Assignment Rule and Treatment Status

Treatment status	Proxy mean test		
	Below cut-off	Above cutoff	Total
All			
Non-beneficiaries	226	266	492
Beneficiaries	61	601	662
Total	287	867	1154
Urban			
Non-beneficiaries	52	94	146
Beneficiaries	23	312	335
Total	75	406	481
Rural			
Non-beneficiaries	174	172	346
Beneficiaries	38	289	327
Total	212	461	673

Note: Cutoff point is .25 for rural areas and .35 for urban areas.
Households qualify for the program if they are above the cutoff point.

Table 2: Means and frequencies of key variables at the household level

	Urban		Rural	
Variable	Above (n=286)	Below (n=195)	Above (n=327)	Below (n=346)
PMT	0.38	0.33	0.28	0.22
Male child	59%	50%	50%	49%
Child's age	31.36	32.82	32.15	31.82
Distance to closest Health Center	27.48	29.11	42.00	42.46
Distance to closest school	17.01	20.38	18.93	19.00
Distance to closest bank	38.13	39.81	67.82	63.94
Quality of floor				
Cement floor (high quality)	74%	82%	70%	69%
Sewage service				
Latrine	58%	66%	82%	82%
Toilet	37%	29%	16%	14%
None	5%	5%	2%	4%
Water Treatment				
Treatment (or use of treated water)	87%	82%	61%	60%
None	13%	18%	39%	40%

Table 3: First Stage Regressions

Instruments	Variables to be instrumented							
	RdO		RdO * Water treatment		RdO * cement floor		RdO* Toilet	
Rural Area								
Above cutoff	0.850	***	0.262	**	0.095		0.213	**
Above cutoff * Water treatment	0.079		0.382	***	0.075		-0.082	
Above cutoff * Cement floor	0.137		0.136	*	0.336	***	-0.099	
Above cutoff* Toilet	0.301	*	0.170		0.018		0.313	***
F-stat (test of excluded instruments)	37.57	***	18.58	***	18.56	***	30.50	***
Anderson test= 1.31								
Urban Area								
Above cutoff	0.453	*	0.169		0.199		0.329	*
Above cutoff * Water treatment	0.090		0.401	***	0.100		0.088	
Above cutoff * Cement floor	0.137		0.140		0.466	***	0.125	
Above cutoff* Toilet	0.242		0.255		0.307		0.550	***
F-stat (test of excluded instruments)	15.15	***	16.03	***	20.06	***	11.93	***
Anderson test= 1.06								

Notes: n=1,154.

* p<0.10, ** p<0.05, ***p<0.01.

Each column represents a different regression. Regressions control for distance and community geographical location. Robust standard errors are in parentheses. Sampling weights are used in all regressions.

Table 4 - Second Stage Results of IV estimates on Child Health Outcomes, Urban Area

	ARI	ARI days	AD		AD days		Stunting		Wasting
Overall (n=481)									
RdO	-0.02	-0.04	-0.56		-0.25		-0.06		-0.01
Rdo*Water Treat	-0.05	-0.62	-0.25		-0.18		-0.11		0.00
RdO* Cement	-0.03	-0.64	-0.76		-0.37		-0.11		-0.01
RdO*Toilet	0.00	-0.07	-1.04	***	-0.40	**	-0.07	***	-0.01
Water Treatment	-0.03	-0.43	-0.10		-0.13		-0.09		0.00
Cement	-0.04	-0.62	-0.66		-0.30		-0.10		0.01
Toilet	-0.01	-0.12	-0.98	***	-0.37	*	-0.04	*	-0.01
Infants/toddlers (n=278)									
RdO	-0.35	-0.45	-0.14		-0.49		-0.22		-0.04
Rdo*Water Treat	-0.06	-0.36	-0.03		-0.36		-0.10	**	0.00
RdO* Cement	-0.05	-0.82	-0.05		-0.40		-0.02		-0.03
RdO*Toilet	-0.33	-0.15	-0.14		-0.46		-0.35		-0.06
Water Treatment	-0.05	-0.19	-0.02		-0.30		-0.09	**	0.00
Cement	-0.05	-0.85	-0.04		-0.34		-0.03		0.03
Toilet	-0.32	-0.02	-0.10		-0.38		-0.32		-0.05
Preschoolers (n=208)									
RdO	0.00	-0.45	-0.07		-0.05		-0.01		-0.01
Rdo*Water Treat	-0.08	-1.11	-0.11		-0.52		-0.03		-0.01
RdO* Cement	-0.04	-0.48	-0.12		-0.27		-0.04		-0.01
RdO*Toilet	-0.02	-0.01	-0.14	*	-0.76	*	-0.07		0.00
Water Treatment	-0.06	-0.93	0.11		-0.50		-0.04		0.00
Cement	-0.04	-0.45	0.08		-0.13		-0.04		0.00
Toilet	0.00	-0.13	-0.13	*	-0.70	*	-0.06		0.00

Note: * p<0.10, ** p<0.05, ***p<0.01.

Each column represents a different regression. Regressions control for distance and community geographical location. Robust standard errors are in parentheses. Sampling weights are used in all regressions.

Table 5 - Second Stage Results of IV estimates on Child Health Outcomes, Rural Area

	ARI		ARI days		AD		AD days		Stunting		Wasting	
Overall (n=673)												
RdO	-0.01		-0.01		-0.03		-0.28	*	-0.02		-0.02	*
Rdo*Water Treat	-0.03		-0.22		-0.01		0.00		0.00		0.00	
RdO* Cement	-0.05	**	-0.22		-0.01		-0.29	**	-0.01		-0.01	
RdO*Toilet	-0.06		-0.15		-0.05	*	-0.54	***	-0.04		-0.04	**
Water Treatment	-0.01		-0.13		0.00		-0.01		-0.01		-0.01	
Cement	-0.03	*	-0.15		-0.02		-0.26	**	-0.01		0.00	
Toilet	-0.03		-0.11		-0.04	**	-0.47	***	-0.03		-0.03	**
Infants/toddlers (n=400)												
RdO	-0.03		-0.18		-0.05	*	-0.43	*	-0.01		-0.05	
Rdo*Water Treat	-0.03		-0.23		-0.03		-0.11		0.00		-0.01	
RdO* Cement	-0.09	**	-0.55	**	-0.02		-0.41	**	-0.01		-0.02	
RdO*Toilet	-0.09		-0.49	*	-0.05		-0.65	**	-0.03		-0.07	**
Water Treatment	-0.01		-0.15		-0.02		-0.08		-0.01		-0.01	
Cement	-0.07	***	-0.40	***	-0.02		-0.35	**	-0.01		0.01	
Toilet	0.04		0.26		-0.05	**	-0.58	**	-0.05		-0.06	*
Preschoolers (n=273)												
RdO	-0.04		-0.51		-0.03		-0.10		-0.01		-0.01	
Rdo*Water Treat	-0.02		-0.28		-0.01		-0.12		-0.02		-0.02	*
RdO* Cement	-0.02		-0.49		-0.02		-0.26	*	-0.02		-0.02	
RdO*Toilet	-0.03		-0.75		-0.06		-0.44	*	-0.01		-0.02	
Water Treatment	0.00		-0.18		0.00		-0.11		-0.01		-0.01	
Cement	-0.01		-0.38		-0.05		-0.34	**	-0.03		-0.01	
Toilet	0.04		0.42		-0.02		-0.23	*	-0.01		0.01	

Note: * p<0.10, ** p<0.05, ***p<0.01.

Each column represents a different regression. Regressions control for distance and community geographical location. Robust standard errors are in parentheses. Sampling weights are used in all regressions.

Table 6: Robustness Checks, IV estimates on Child Health Outcomes

	ARI	ARI days	AD		AD days		Stunting		Wasting
Urban Area (± 5 points)									
RdO	-0.02	-0.04	-0.06		-0.25		-0.06		-0.01
Rdo*Water Treat	-0.05	-0.62	-0.03		-0.18		-0.11		0.00
RdO* Cement	-0.03	-0.64	-0.08		-0.37		-0.11		-0.01
RdO*Toilet	0.00	-0.07	-0.10	***	-0.40	**	-0.07	***	-0.01
Water Treatment	-0.03	-0.43	-0.01		-0.13		-0.09		0.00
Cement	-0.04	-0.62	-0.07		-0.30		-0.10		0.01
Toilet	-0.01	-0.12	-0.10	***	-0.37	*	-0.04	*	-0.01
Urban Area (±4 points)									
RdO	0.04	0.25	-0.07	*	-0.34	*	-0.12		-0.01
Rdo*Water Treat	-0.05	-0.63	-0.02		-0.05		-0.06		0.00
RdO* Cement	0.01	0.40	-0.03		-0.03		-0.01		-0.01
RdO*Toilet	0.00	-0.06	-0.08	***	-0.41	**	-0.06	***	-0.01
Water Treatment	0.03	0.45	-0.03		-0.10		-0.05		0.00
Cement	-0.02	-0.41	0.02		0.01		0.00		0.01
Toilet	0.01	0.18	-0.09	***	-0.40	**	-0.04	**	-0.01
Urban Area (± 3 points)									
RdO	-0.04	-0.19	-0.10	**	-0.48	**	-0.08		-0.02
Rdo*Water Treat	-0.05	-0.56	0.00		-0.01		-0.05		0.00
RdO* Cement	-0.02	-0.39	-0.01		-0.03		-0.01		-0.01
RdO*Toilet	0.00	-0.05	-0.11	**	-0.43	**	-0.05	***	-0.01
Water Treatment	-0.04	-0.40	-0.01		-0.04		-0.04		0.00
Cement	-0.03	-0.48	-0.01		-0.04		-0.01		0.01
Toilet	-0.01	-0.13	-0.11	**	-0.42	**	-0.03	**	0.01

Note: * p<0.10, ** p<0.05, ***p<0.01.

Each column represents a different regression. Regressions control for distance and community geographical location. Robust standard errors are in parentheses. Sampling weights are used in all regressions.

Table 7: Falsification test: Marginal effects of electricity, RdO participation, and the interaction between electricity and RdO participation on health outcomes

	ARI	ARI days	AD	AD days		Stunting	Wasting
Urban (n=481)							
RdO participation	-0.061	-0.035	-0.059	-0.094		-0.067	-0.012
RdO * electricity	-0.060	0.002	-0.075	-0.161		0.072	0.008
Electricity	0.043	0.003	0.065	0.143		-0.086	-0.007
Rural (n=673)							
RdO participation	-0.007	-0.221	-0.004	-0.037		-0.010	-0.001
RdO * electricity	-0.001	-0.172	-0.003	-0.130		-0.006	0.012
Electricity	-0.005	0.092	0.005	0.118	*	0.008	-0.010

Note: n=1,654. * p<0.10, ** p<0.05, ***p<0.01. *ARI*, acute respiratory infections; *AD*, acute diarrhea. Each column represents a different regression. Regressions control for distance and community geographical location. Robust standard errors are in parentheses. Sampling weights are used in all regressions.