Reducing the Cost of Remoteness: Community Health Workers, Fertility Choices and Child Health Investments♣

Catalina Herrera-Almanza and Maria F. Rosales-Rueda

Draft Version July 2018

Abstract-100 words

Distance to health centers can represent a significant healthcare cost for poor households. We analyze the effects on fertility and child health investments of a large-scale community-based health worker program that aims to reach remote areas distant from health facilities in Madagascar. We use a triple-difference model that exploits time and geographic variation in the program rollout and the geocoded household distance to the closest health facility. In remote areas, the program did not change women's probability of conception, but it improved vaccination uptake. Our evidence suggests that high-fertility preferences could have offset the program's fertility reduction in remote areas.

Key words: Community Health Workers, Remoteness, Fertility, Child Health, Africa

JEL codes: I11, I12, I 15, J13, O15

♣Catalina Herrera-Almanza, Assistant Professor, Department of Economics and International Affairs Program, Northeastern University. E-mail: c.herreraalmanza@neu.edu. Maria F. Rosales-Rueda, Assistant Professor, Department of Economics, Rutgers University. E-mail: maria.rosales@rutgers.edu. We would like to thank Leonel Borja, Allie Smith, and Shuang Wang for their excellent research assistance and INSTAT-Madagascar, particularly Harivelo Rajemison, for providing access to and assistance with the databases. The authors thank Jere Behrman, Günther Fink, Anne Fitzpatrick, Adrienne Lucas, Mindy Marks, Silvia Prina, Rebecca Thornton, Josselin Thuilliez, Joshua Wilde and the seminar participants at the 2017 Population Association of America Conference, 2017 Eastern Economics Conference, and 2017 Princeton's Center for Health and Wellbeing seminar lunch, 2018 American Economic Association Conference, 2018 Ohio State Agricultural and Applied Economics Seminar Series and 2018 Paris Sorbonne Sustainable Development Seminar Series for helpful comments and discussions. The authors are grateful for funding support from the Population Reference Bureau and the Hewlett Foundation.

Introduction

A substantial proportion of maternal and child deaths in low-income countries can be prevented through appropriate health care; however, the lack of primary health care use and provision still constitutes a barrier to achieve this goal (Dupas, 2011).[1] This problem is exacerbated in remote and rural areas where households need to walk long distances or incur high transportation costs to reach their nearest health center. Distance and time constraints can become significant household hassle costs for the take-up of primary health services (Adhvaryu and Nyshadham, 2015; Kremer and Glennerster, 2011; McLaren et al., 2014; Thornton, 2008). In fact, geographic distance to the closest clinic is positively associated with poor health outcomes (Karra et. al., 2016; Lucas and Wilson, 2017; Baranov and Kohler, 2018). In remote and poor areas, community health workers (CHWs) have emerged as an alternative to extending primary health care delivery to reach the underserved population (Singh and Sachs, 2012; Das et al., 2016). Although a growing body of research has examined the effects of CHWs on maternal and child health (Barham, 2012; Joshi and Schultz, 2013; Björkman et al. *forthcoming*), the results are mixed and little is known about whether large-scale CHW programs can mitigate households' hassle costs and potentially improve health investments and outcomes.

This paper aims to fill this gap by examining the effects of a large-scale community health worker-based intervention on fertility choices and child health investments in Madagascar, one of the poorest countries in the world.[2] The *Santenet2* program was implemented in 2009 and benefited half of the population of Madagascar by 2011, reaching 800 of 1,566 communes (the smallest administrative unit in the country). The program had two main components. First, at the commune level, *Santenet2* generated demand for preventive health care through disseminating information (i.e., radio campaigns) and establishing supply points to ensure a steady, reliable supply of essential health commodities and medicines.[3] Second, in each treated commune, two volunteer CHWs were deployed in remote areas, defined as villages located more than 5 kilometers (km) from the closest primary health clinic.[4] One CHW specialized in maternal and reproductive health services,

[1]Maternal and infant mortality persist in Sub-Saharan Africa; 550 women die daily due to complications in pregnancy and childbirth and the risk of a child dying before age 5 (81 deaths/1000 live births) is 11 times higher than the average risk in high-income countries. The leading causes of infant mortality are pneumonia, respiratory infectious diseases, diarrhea and malaria (WHO 2015; Haines et al. 2007).
[2] In Madagascar, 77% of the population lives in poverty (World Bank, 2017)
[3] Essential health commodities and medicines include bed nets, family planning products, ORS, etc.
[4] 65% of the population lives 5 km from the closest health facility (USAID, 2014).

including promotion and provision of family planning, and the second volunteer worker focused on the promotion of child preventive health services, including encouragement to obtain vaccinations.[5] By making some specific and essential primary health services easily accessible and disseminating information to remote households, the program aimed to decrease the hassle costs imposed by the distance to the closest primary health clinic.[6]

We estimate the effect of *Santenet2* on women's fertility choices and child health investments (prenatal care and vaccinations) using a recently available nationally representative survey, Madagascar's Millennium Development Goals Survey (2013 ENSOMD). Our empirical strategy starts with a difference-in-difference (DD) specification that compares the outcomes of interest between *Santenet2* and non-*Santenet2* communes before and after the program rollout. However, this specification does not take into account that the CHW component of the program targeted households living in remote places from the health clinic. Therefore, our main identification strategy relies on a difference-in-difference-in-differences (DDD) strategy. We combine the geographic and timing variation of the commune rollout of the program with a third difference, the exact distance from each household to the closest health facility. By combining precise household GPS locations with a national administrative census of the health centers (before program implementation), we identify remote households targeted by the program as those located more than 5 km from the closest health center.[7] This empirical framework allows us to estimate the variation in health indicators of interest before and after *Santenet2* rollout for remote relative to non-remote households in treated communes relative to comparison communes. To provide evidence of the validity of our empirical strategy, we show parallel trends in the pre-program period between treated and non-treated communes as well as across remote areas, in addition to performing several robustness checks that validate our identification strategy.

Using the DD model, we find that *Santenet2* reduced the quarterly probability of conception by 10%, with respect to the mean, among women living in *Santenet2* communes relative to women living in *non-Santenet2* communes. This overall effect of the program corresponds to a

[5] The Child CHWs also performed community-based Integrated Management of Child Illnesses (IMCI); however, we cannot analyze morbidity outcomes because we lack pre-program variation data for these outcomes.

[6] In Madagascar, the total fertility rate is high, at 4.9 children per woman, and modern family planning use is only 29%; additionally, fewer than half of the births are attended by skilled personnel, and full vaccination is only administered to 44% of children over 8 months (DHS, 2008-09).

[7] We also estimate models in which we distinguish remote households as those: i) between 5 and 10 km and ii) 10 or more km from the closest health facility.

decrease of 9% in the total fertility rate. When estimating the triple difference model, we find that the effects on fertility are concentrated among women living close to a health facility: whereas the program reduced the quarterly probability of conception by 12% for women living within 5 km of the closest health facility, it did not have a sizable and statistically significant effect among women living in remote households.

Regarding the child's health investments, we find no effect of the program on vaccination uptake using the DD model. Nevertheless, when estimating the triple difference model, we find that the CHWs improved vaccination uptake among children who live more than 10 km from the closest health facility, suggesting the positive effects of their role in mobilizing households to vaccination campaigns or the nearest health facility. Furthermore, we find no evidence of program effects on prenatal care utilization and birth delivery at the formal health facility in any of our specifications. These results are consistent with other empirical evidence in Sub-Saharan Africa, suggesting that the provision of maternal health care information does not necessarily increase women's utilization of facility-based birth delivery, potentially due to perceived low returns on formal health care (Godlonton and Okeke, 2016).

Despite a positive effect of the program on vaccination uptake in remote areas, we do not observe a sizable and statistically significant effect on fertility reduction in these areas. These seemingly counterintuitive results can be explained as follows. First, according to the children quantity-quality tradeoff theory (Becker 1960), we should expect a significant fertility reduction in remote areas. However, this predicted result might change when child investments are considered club rather than private goods: vaccinations are non-rival goods that are available to young children and disproportionally benefit early childhood health. Within a family, young children benefit from immunizations rather than compete for them with their siblings (Jones, 2014).[8] Second, it is plausible that fertility decline might be slower in remote areas and the results we observe are only short-term effects. Consistently, we find no evidence of the program on infant mortality in remote areas, suggesting that fertility behavior in these areas was not a result of changes in replacement of children and precautionary childbearing (see models of fertility such as Barro and

[8]There is ambiguous empirical evidence of the trade-off between the quantity and quality of children. For example, some studies have found that an increase in family size decreases child schooling (Rosenzweig and Wolpin 1980; Rosenzweig and Zhang 2009) while other evidence shows no negative effects of larger family size on schooling and health outcomes (Angrist et al. 2010; Black et al. 2005, 2010; Caceres-Delpiano 2006; Qian 2009).

Becker, 1989 and Doepke, 2005).[9]

Third, it is also possible that demand-side determinants of fertility vary by the distance to the closest health facility, preventing the program from being effective in remote areas even in the short-term. Therefore, we examine two potential factors: fertility preferences and women's empowerment (Field et al., 2016; Behrman, 2015; Ashraf et.al, 2014). First, we find suggestive evidence that both women and men in remote areas prefer a larger number of children than their counterparts in areas close to a clinic. Second, we find no evidence that women's empowerment, measured by a household decision making index, is different across remote and non-remote areas. These results highlight that reproductive health and family planning programs should identify potential demand-side determinants of fertility that could offset their intended effects.

Although we find some suggestive demand-side mechanisms that can explain the differences in fertility responses by distance, we cannot rule out that supply-side factors related to weak coverage and performance of the CHWs contributed to the absence of sizable effects on fertility in remote areas. However, our results on vaccination uptake are an indication that the health workers were active in remote areas. We lack data on the CHWs' performance and monitoring to test this hypothesis. In fact, there is little empirical evidence on how to ensure CHWs' high-performance in large-scale interventions in developing countries (Ashraf et al.2016, Björkman et al., *forthcoming*).

Our paper contributes to two strands of research within the literature on health interventions and determinants of health and fertility behaviors. First, this paper is closely related to empirical studies that analyze the role of CHWs in providing primary health care services in low-income settings.[10]The most widely known intervention is the Maternal and Child Health and Family Planning program in Bangladesh that was implemented in the Matlab region at the end of the 1970s. Exploiting its quasi-experimental design, studies have shown that this program reduced fertility and improved children's health and education outcomes in the short and long-term (Phillips et al. 1982; Joshi and Schultz, 2013; Barham, 2012). Recent experimental evidence, particularly in Sub-Saharan Africa, has found mixed results. For example, Björkman et al. (*forthcoming*) show that a

[9] Despite extensive research on the relationship between fertility and child mortality in developing countries, still the empirical results are ambiguous in developing countries (see Wilde, et al. 2017 for a review)

[10] Although some systematic reviews find positive effects of CHW programs on health behaviors and provision of basic and curative services (Bhutta et al., 2010; Gilmore and McAuliffe, 2013; Bhutta et al. 2014), experimental evidence is mixed (Baqui et al., 2009; Bandhari et al., 2012)

financially incentivized community health delivery program in Uganda reduced all causes of under-five child mortality. In contrast, Björkman et al. (2017) show that a volunteer community health educator intervention in Nigeria increased antenatal and postnatal care utilization but does not increase the likelihood of birth delivery at a formal facility or improve maternal or neonatal health outcomes such as birth weight or neonatal mortality.

Second, our work is related to studies that evaluate whether non-monetary costs such as the convenience of access or hassle costs are important barriers to the take-up of preventive and primary health services (i.e., Wagner et al., 2017 and Kremer and Glennerster, 2011 for a review). Several studies have found that take-up of cost-effective health investments such as HIV testing (Thornton, 2008), antiretroviral therapy (Lucas and Wilson, 2017), water source improvement (Kremer et al., 2011), and immunizations (Banerjee et al., 2010) are sensitive to distance. Furthermore, evidence shows that distance is positively associated with children's mortality in developing countries (Karra et al., 2016) and with a lower use of formal health care (Adhvaryu and Nyshadham, 2015 and McLaren et al., 2014).

Our paper makes several important contributions to these two strands of empirical evidence. First, to the best of our knowledge, we provide the first quasi-experimental evidence of the effects of a large-scale volunteer CHW intervention in the context of a low-income country. While most empirical evidence on CHW programs comes from studies in specific geographic areas within countries, we complement this evidence by examining a recent large-scale CHW intervention that reached half of the population in Madagascar.[11] Second, we analyze whether this at-scale program can mitigate the hassle costs imposed by the distance to the primary health facility and influence women's fertility choices and child health investments in a context where health insurance and other pecuniary costs are low (Adhvaryu and Nyshadham, 2015). Third, our results are policy relevant as *Santenet2* was incorporated into the government health policy and the adoption of these at-scale community-based health programs will presumably continue to grow in other low-income countries. Our findings suggest the importance of identifying household demand-side factors such as high fertility preferences that could potentially attenuate the intended effects of these at-scale programs.

[11]While Matlab, a specific sub-district in Bangladesh, reached 149 villages benefiting approximately 100,000 individuals (Barham, 2012), *Santenet2* reached 5758 villages, benefiting approximately 11 million people.

The rest of the paper is organized as follows. Section 2 describes the data and the program. Section 3 explains the empirical strategy and reports the results regarding the effects on fertility, and Section 4 focuses on child investments. Section 5 presents the robustness checks and placebo tests of our empirical results. Finally, Section 6 presents the discussion and conclusions.

2. Program and Data Description

The supply of primary health services is a salient issue in Madagascar, where 77% of the population lives in poverty and 65% lives in rural areas (World Bank, 2017). Poor transportation infrastructure and a shortage of medical personnel limit the basic health access to the population living in remote areas. In fact, 65% of the population lives 5 km from the closest health facility (USAID, 2014) and the average travel time to the closest hospital is 4.5 hours (Hernandez and Moser, 2013). The number of nurses/midwives (per 1000 people) is 0.22, compared with 1.12 in sub-Saharan Africa, far below the average of 8.9 in high-income countries (WHO 2012-2013).[12] This lack of health infrastructure occurs in a context where maternal and child mortality are still persistent and above the Sustainable Development Goals. Madagascar has a maternal mortality ratio of 498/100,000 live births and the under-5 mortality rate is 72/1000 live births (WHO, 2013). Unsurprisingly, the total fertility rate is 4.9 children per woman, and the prevalence rate of modern family planning use is only 29 % among women aged 15–49 (DHS, 2008-09). Furthermore, fewer than half of the births are attended by skilled personnel and full vaccination among children over 8 months is only 44% (DHS, 2008/09), which can be even lower among remote and vulnerable populations that lack access to roads and formal clinics (Clouston et al. 2014).

2.1 *Santenet2* community-based health program

In response to the above challenges, the United States Agency for International Development (USAID) -one of the largest bilateral donors to Madagascar- funded the *Santenet2* community health program in 2009, which was implemented by RTI international in collaboration with the national government and local NGOs. This program was a community-based integrated primary health care services intervention that included the deployment of volunteer community health workers in remote areas. *Santenet2*'s main goals were to i) empower community participation and

[12] Information retrieved from https://data.worldbank.org/indicator/SH.MED.NUMW.P3

accountability in setting and achieving health goals; ii) reduce maternal, child and infant mortality, the fertility rate, the prevalence of malaria and chronic malnutrition in children under age 5; iii) expand access to water, sanitation and hygiene (WASH); and iv) maintain a low HIV prevalence rate (USAID, 2014).[13]

Santenet2 was rolled out between 2009 and 2011 and implemented in 800 of 1566 communes, corresponding to 16 of 22 regions and 72 of the 119 districts in Madagascar. The program targeted communes where USAID had a strategic development focus and that also met certain criteria such as a minimum road infrastructure, a high unmet need for family planning, and a high population density. In the intervention communes, the program reached 5,758 villages (*fokontanys*) located more than five km from the nearest public primary health center, training 13,086 CHWs during this period and benefiting approximately 11 million people, approximately half of the population of the country (USAID, 2014).

The program had two main components. First, at the treated commune level, the program aimed to generate demand for primary and preventive care through disseminating information about healthy behaviors and practices. For instance, the program used local radio broadcasts as communication channels, which covered a range of topics including maternal and child health (i.e., antenatal care, promotion of immunization campaigns, child nutrition and use of insecticide-treated bed nets); reproductive health and family planning; water, sanitation and hygiene; and community engagement. Additionally, at the commune level, the program established community supply points across the commune to ensure a steady, reliable supply of family planning, curative medicines, and other health commodities (i.e., bed nets). Second, within the treated communes, the program deployed CHWs to bring basic health care closer to remote villages, identified as those located more than 5 km from the closest public primary health clinic.

The volunteer CHWs were chosen by the community members following eligibility requirements such as having completed primary education, the ability of reading, writing and counting skills and being socially accepted by the community (USAID, 2013a). According to USAID, "*the selection process ensured that volunteer CHWs have real influence and benefit from their community's trust and respect, which resulted in an enhanced social status for these community workers*" (USAID, 2013a). *Santenet2* worked with 16 implementing partners and local NGOS to

[13]The HIV/AIDS prevalence in Madagascar is 0.8%; however, it remains a serious public health concern (Sharp and Kruse, 2011).

establish the structure to engage the communities in the planning, implementation, support, and monitoring of the CHWs' activities to promote community members' health status. In each community, local committees oversaw and worked closely with the CHWs to: i) assess the community-level health priorities, ii) provide technical support in the activities to mobilize community members, raise awareness, and iii) coordinate health interventions such as vaccination campaigns with the local health clinics and establish supply chains for the distribution of health products.

Each treated remote village in *Santenet2* communes had two volunteer CHWs: one who specialized in maternal and reproductive health services and another who focused on child health. The program implemented a comprehensive training program for the CHWs that was designed according to the Ministry of Health standards (USAID, 2014). The training of these CHWs occurred at two levels. For level 1 of the maternal health services, CHWs received integrated training on Family Planning (FP), including counseling and distribution of contraceptive products, as well as information on STI/HIV-AIDS prevention, safe motherhood (i.e., use of prenatal care, delivery at a formal facility) and postpartum FP. After three months of service, their performance was assessed. The CHWs who achieved the best results and met several criteria (attendance, regular reporting, supervision of results) were trained on the administration of injectables (i.e., Depo-Provera) and became level 2 maternal health CHWs.[14] Information from the program's monitoring system indicated that the number of regular family planning users doubled from 79,157 to 164,091 between 2010 and 2013 among the 800 treated communes.

Similarly, for level 1 of the child health services, the CHWs received training on essential nutrition actions, growth monitoring, and prevention of common diseases (malaria, diarrhea, acute respiratory infections) and disseminated information on the vaccination schedule and immunization campaigns. After three months of service, their performance was assessed and the most qualified CHWs were trained on Community-Based Integrated Management of Childhood Illness (c-IMCI), becoming level 2 child health CHWs (USAID, 2013a).

Santenet2 also employed a system of regular monitoring and supervision of CHW activities and performance by community-level committees. External evaluations favorably assessed the performance of the CHWs on the prescribed tasks, particularly those related to the application of injectables (Gallo et. al, 2013). However, we lack data on CHWs' performance and monitoring activities to examine the program implementation.

[14]We lack information regarding the CHWs' training performance and their attainment of levels 1 and 2.

Maternal and child health community workers were responsible for promoting and disseminating information on health behaviors and for distributing health products such as family planning products including pills, condoms, injectables, and cycle beads as well as paracetamol, oral rehydration salts (ORS), zinc, and iron/folic supplements. The program established supply points for distribution where the CHWs collected the products and distributed them to the villages. These health products are heavily subsidized in Madagascar; for instance, family planning products are free or heavily subsidized by the government or NGOs. Only 0.2% of women ages 15-49 who are non-family planning users indicated price as a reason for not using modern contraception in the future (DHS, 2008-09).[15] Therefore, CHWs did not make a profit from the sales of these products to beneficiary families.

Notably, these workers were *volunteers* and did not receive a stipend for performing these program activities. *Santenet2* lacked a central system of monetary incentives to motivate the CHWs. For instance, only when the CHWs traveled for training did they receive a stipend that only covered their board and lodging during the training. Many CHWs stated that they were de facto motivated to work for the wellbeing of their communities, which is why they agreed to take on their roles as health promoters (USAID, 2013b). Despite the lack of monetary incentives, external evaluations of the program quantified that the attrition rate of the CHWs was only 8% from the program rollout to 2013, which is favorable compared to other contexts in developing countries (USAID, 2014). USAID, in collaboration with the Ministry of Health, fully upscaled the *Santenet2* model of health services to the national level from 2012 to the present (USAID, 2015).

We focus our analysis on the following outcomes targeted by the program: fertility and child health investments, including vaccination, antenatal care and birth delivery. We acknowledge that we are unable to examine the effects of *Santenet2* on child morbidity measures because we lack pre-program data on these outcomes.

2.2 Data Description

In this paper, we combine administrative information about the rollout of *Santenet2* CHWs across time and communes with nationally representative household surveys in Madagascar. In this section, we describe the multiple sources of data used in this paper.

[15] Distance was listed as a separate reason for not using family planning

1) Rollout of *Santenet2* and Community Health Workers

We obtained information on the starting month and year for each commune that participated in *Santenet2.* The program was rolled out in three phases: 1) January 2009-October 2009; 2) November 2009-January 2010; and 3) February 2010-February 2011. Figure 1 shows a map of the phased rollout of *Santenet2*.

<< Insert Figure 1 here>>

The *Santenet2* rollout data at the commune level is combined with the following sources of microdata sets on households in Madagascar, which contain information on the commune location of households:

2) 2012-13 Millennium and Development Goals survey (ENSOMD)

The Madagascar's National Institute of Statistics (INSTAT) conducted a large-scale national survey, the Madagascar Millennium Development Goals National Monitoring Survey (ENSOMD) from September 2012 to November 2013 to assess Madagascar's progress towards meeting the Millennium Development Goals. The survey was conducted among 16,000 households. Its design is similar to that of the Demographic Health Surveys-DHS and contains detailed information on women's fertility behaviors and birth history. In addition, for children less than age 5, the ENSOMD collects health-related data including prenatal care use, birth delivery, vaccinations, morbidity, anthropometrics, and other related indicators. Because this dataset was collected from one to three years after the implementation of *Santenet2,* it is our main source of outcome variables.

3) Demographic Health Surveys-DHS

The Demographic and Health Surveys (DHS) are nationally representative population-based household surveys. They are publicly available and collect a rich set of data on women of reproductive age (15 to 49) including fertility history, family planning use and women's education, marital status, household assets, and child health indicators. We use the 2008-09 DHS to explore whether fertility and child outcomes in *Santenet2* communes had a similar trend to that of non-participating communes before the program rollout.

4) Geocoded health facility and distance variable data

As explained above, because the *Santenet2* intervention deployed CHWs in villages located more than 5 km from the closest health clinic, we use geocoded data (longitude and latitude) from both households in the ENSOMD and a census of 3309 public health facilities to identify the sample households targeted by the CHWs. Geographic information about these clinics was obtained from the health care mapping software of the Madagascar Ministry of Health, which was updated in 2011 with the support of the Japan International Cooperation Agency (JICA). The geographic location of the health facilities is used with the household location information collected in the ENSOMD to calculate the distance of each household from the closest health clinic in *Santenet2* and *non-Santenet2* communes. This distance variable allows us to identify the remote households targeted by the CHWs as well as the corresponding counterfactual in non-treated communes.

We calculate the Euclidian (straight line) distances between each household in the ENSOMD and the closest clinic within the commune.[16] All the estimations in the paper use our calculated distance from the household to the closest clinic. As a robustness check, we show that the results are robust to using the distance between the centroid of the village and the closest clinic (see Section 6.2).[17]

We merge the *Santenet2* rollout dates information and the location of health facilities with the ENSOMD household data using geographic identifiers at the commune and village levels. Table 1 shows the summary statistics of socio-demographic characteristics for the sample women and their children used in the empirical analysis.

<< Insert here Table 1>>

3. Fertility Outcomes: Empirical Strategy and Findings

3.1 Empirical Strategy

Existing empirical evidence in developing countries shows that disruptions or negative shocks and improvements in family planning provision can affect fertility in the short-term (Miller and Babiarz, 2016). Therefore, it is plausible to expect that *Santenet2*'s family planning and reproductive health component might affect women's fertility decisions in the short-term.

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[16]USAID used the closest health facility within the commune to identify remote villages.

[17]Geographic data from the Madagascar BNGRC (National Disaster Management Office) is used to calculate the centroid of each village. We chose this dataset because it is the most recent and complete geographical country-level dataset available at the time of the current research. The dataset was published September 2011 by the United Nations Office for the Coordination of Humanitarian Affairs. We calculate the distance between the centroid of the village and the health clinic using ArcGIS.

To estimate the causal impact of *Santenet2* on fertility outcomes, we start with a difference-in-difference (DD) specification that compares the probability of conception between women in *Santenet2* and *non-Santenet2* communes before and after the program rollout. Using data from women's fertility histories included in the 2012-13 ENSOMD surveys, we construct a quarterly (quarter-year) panel to estimate the following equation:[18]

$$Y_{itc} = \alpha + \beta Santenet_c * post_{itc} + X'_{it}\varphi + \delta_t + \theta_c + \varepsilon_{itc} \quad (1)$$

where Y_{itc} is the quarterly probability of conceiving, a dummy variable that captures whether woman *i* in commune *c* conceived a child in quarter *t*. $Santenet_c$ is a dummy variable for whether the woman's commune of residence *c* was part of the *Santenet2* program and $post_{itc}$ is a dummy variable for whether quarter *t* is after the start date of the program in commune *c*. X_{it} is a set of women's characteristics such as their age cohort, education, quintiles of the household asset index,[19] and parity up to quarter *t*. δ_t is quarter-time fixed effects that allow us to capture time trends and the seasonality of births in the period of analysis and θ_c is commune fixed effects. We cluster the standard errors at the commune level. The coefficient of interest is β, which measures the DD estimate of the effect of *Santenet2* community-based health intervention on the quarterly probability of conception.

However, the DD specification does not take into account that the CHW component of the program targeted households living in remote areas. Therefore, our main specification relies on a difference-in-difference-in-difference (DDD) approach. We exploit the variation in access to *Santenet2* across time and communes combined with the variation in the distance between a woman's residence and the closest health facility. This triple-difference model addresses the differential trends between remote and non-remote households as well as the differential trends in the communes that did and did not receive the program. Intuitively, our triple difference model creates a treatment group of women who i) lived in *Santenet2* communes, ii) were exposed to the program (with respect to the date of the arrival of the program), iii) and their households were located more

[18]The construction of the panel implies that older women at the time of the survey have longer quarterly time panels. We restrict the panel analysis from the first quarter of 2007 to the first quarter of 2013 when the ENSOMD data was completed. We also restrict our analysis to women in the panel who were 15 to 49 and sexually active. We exclude women who were pregnant at the time of the survey (10% of the sample), however, our results are robust to the inclusion of this group of women. These results are available upon request.

[19] The household asset index was constructed using a principal component analysis and household variables such as dwelling characteristics including the roof and wall material and type of floor and bathroom, as well as ownership of durable goods (i.e., radio, bicycle).

than 5 km from the closest primary health facility. Women who satisfied none or some these conditions (i.e., women who live further from the health facility in a non-*Santenet2* commune) are part of our comparison group. More precisely, we estimate the following DDD model:

$$Y_{itc} = \alpha + \beta Santenet_c * post_{itc} * dist_{ic} + \gamma Santenet_c * post_{itc} + \vartheta Santenet_c * dist_{ic} + \rho dist_{ic} + \delta_t * dist_{\boldsymbol{ic}} + X'_{it}\varphi + \delta_t + \theta_c + \varepsilon_{itc} \quad (2)$$

where $Dist_{\boldsymbol{ic}}$ is a dummy variable that captures the distance between woman's *i* household, located in commune *c,* and the closest health facility within commune *c*; it takes the value of 1 if the household is 5 km or more from the closest clinic and 0 otherwise. We use 5 km as a cut off to identify remote households following the program criteria. The rest of the variables in equation (2) are as defined above. We are interested in two coefficients. First, $\boldsymbol{\beta}$ measures the effect of being exposed to *Santenet2* for women living more than 5 km from the health facility, which captures all variation in the probability of conception specific to remote women (relative to that of close women) in treated communes (relative to that of the comparison communes) before and after the program rollout. Second, $\boldsymbol{\gamma}$ represents the *Santenet2* effect among women living close to the health facility.

An important assumption of our empirical approach is that before the program, both groups of communes had similar trends in the potentially affected outcomes. We present several pieces of empirical evidence supporting the idea that, in the absence of *Santenet2*, the treated communes would have followed a similar trajectory to that of the non-*Santenet2* communes. First, using the 2008-09 DHS fertility data, we create similar quarterly panel data and estimate the effect of *Santenet2* on the risk of conception in the pre-program period (from 2004 to 2008). Figure 2 shows the coefficients of the interaction between the program and the time-quarters variable conditioning on the same set of women's characteristics and commune fixed effects. The results indicate that women's probability of conception does not statistically significantly differ between *Santenet2* and non-*Santenet2* communes before the program implementation. Furthermore, using the 2008-09 DHS fertility data, Figure A.2 shows that women in *Santenet2* and *non-Santenet2* communes have similar trends in raw fertility outcomes such as birth rates before age 16 and the median age at first birth before the program was implemented.

<< Insert Figure 2 here >>

Second, we estimate equation (2) using the ENSOMD quarterly panel data in the pre-program period (between 2004 and 2008) to validate the parallel trends assumption across remote areas, which is key for the triple-difference analysis. Figure 3 shows the triple interaction coefficients of equation (2), indicating that there is no statistically significant evidence of a differential trend for villages located further than 5 km in treated and non-treated areas before the program implementation.[20]

<< Insert Figure 3 here >>

Third, we show in Table A.1 in the Appendix that there are no statistically significant differences between *Santenet2* and non-*Santenet2* communes in pre-program socio-economic characteristics including poverty, women's education, age at first marriage, and age at first birth. This evidence from the DHS 2008-09 suggests that there is no selection on observables.[21]

Fourth, to further address potential concerns that our estimates may be biased by the presence of omitted variables, we move the rollout dates of *Santenet2* between 2009 and 2011 by lagging these dates 20 time-quarters (i.e., 2004-2006), and we test if these "fake" rollout dates have a statistically significant effect on women's fertility outcomes. Table A.2 shows that this lagged *Santenet2* program does not have a statistically significant effect on women's risk of conception.

3.1. Results: Probability of Conception

We start our analysis by presenting the difference-in-difference model as depicted in equation (1), which uses only the geographic and time variation of *Santenet2* and does not differentiate the effect of the program in remote areas. Column 1 of Table 2 shows that the probability of conception decreases by 0.3 percentage points among women living in *Santenet2* communes relative to women living in non-*Santenet2* communes, a 10% decline with respect to the average probability of conception. It is worth noting that this is the total effect of the program, including the information component at the commune level as well as the deployment of CHWs in remote areas.

Column 2 shows the relevant coefficients of the triple difference model specified in equation (2): the first row shows the estimates of the *Santenet2* effect for women living in households

[20] We are not able to implement this robustness check using the 2008-09 DHS data because this survey does not have precise information about the distance between the households and the closest health facility.

[21] Using the 2008-09 DHS survey, we also check that there are no statistically significant differences in these socio-economic characteristics within *Santenet2* communes across the different years in which the program started. Results are available upon request.

located close to health facility (γ), and the second row presents the effect of the program on women in remote households (β), the triple difference coefficient. There is no statistically significant effect of *Santenet2* on the risk of conception among women living more than 5 km from the closest primary health facility, but the program reduced the quarterly probability of conception by 0.44 percentage points, an approximate 12% reduction from the average quarterly probability of conceiving (mean 3.6%) for women living near the health facility (i.e., 0 to 5 km). The estimate of the triple difference coefficient suggests that there are no significant changes in the probability of conception of remote women relative to that of closer women in *Santenet2* communes relative to those in comparison communes. In columns 3 and 4, we also present the estimation of the difference-in-difference model for households living less than 5 km and further than 5 km. Consistent with the results of the triple difference model, the effects of *Santenet2* are concentrated among women living relatively close to the health facilities (column 3). Among women in remote areas, the program did not have a sizeable and statistically significant effect (column 4). Indeed, Table A.3 shows consistent results when analyzing only the raw means of the probability of conception before and after the program by close and remote areas from the health clinics.

To interpret the magnitude of the overall effect of the program on the probability of conception and in remote areas, we compare the coefficients in columns 1-2 with the total fertility rate (TFR), estimated at 4.9 in 2009 (DHS, 2008-9). Specifically, we estimate the size effect on the TFR by multiplying the yearly coefficients of Table 2 by the number of female cohorts analyzed between ages 15 and 49. In column 1 (DD model), the point estimate implies that *Santenet2* could decrease the TFR by 8.82%, and according to column 2 (DDD model), the program could reduce the TFR by 10.78% in areas close to the primary health clinic. This size effect is approximately 36% to 44% of the Matlab's impact on fertility after two years of implementation (Phillips et al., 1982). However, the intensity of the Matlab program in one region might limit its replicability at scale (Miller and Babiarz, 2016), and therefore, its comparability with *Santenet2*. Although we find that these effects on the probability of conception are sizable and concentrated in the areas close to a public primary health clinic, it is plausible that demand-side factors explain the heterogeneity in the fertility outcomes across distance among our sample women.

<<Insert Table 2 here>>

Furthermore, we explore heterogeneous effects by women's birth cohort, education, and asset index. Table 3 shows the estimation of equation (2) by women's cohort age groups. The largest effects of *Santenet2* on the risk of conception are among women born in 1963-1971, 1972-1977, and 1984-1989; however, we do not find statistically significant effects among women born in 1990-1997, the youngest cohort in our sample. These findings plausibly indicate that women might use modern family planning methods more for spacing (and limiting for the oldest cohort) than delaying the first birth. In fact, 38% of women use family planning for the first time only after they have at least one child (DHS, 2009). Table 4 shows that the program is more effective in reducing the risk of conception among women who have more than 5 years of education and are in the fourth and fifth quintiles of the asset distribution.

<<Insert Table 3 here>>

<<Insert Table 4 here>>

We also explore if *Santenet2* has a differential effect on women living more than 5 km from the closest health facility. Thus, we change the variable $Dist_{ic}$ in equation (2) to a categorical variable of the distance between a woman's household and her closest health facility as follows: i) strictly less than 5 km; ii) between 5 and 10 km and iii) equal to or more than 10 km. Table 5 shows that the program did not have an effect on the risk of conception among women in remote areas between 5 and 10 km or more than 10 km from the closest primary health facility.

<< Insert Table 5 here>>

3.2. Results: Family Planning Use

We test for potential mechanisms through which *Santenet2* might affect the probability of conception. We evaluate whether the program increased the current use of modern family planning among women of reproductive age. Furthermore, conditional on women's contraceptive use, we explore whether the program affected the distribution places where women obtain their contraceptive methods.

Because we lack information on women's history of family planning use and we only observe their current contraceptive use at the time of the survey, we cannot use the *time* variation of the program across communes. Therefore, we exploit the variation in access to *Santenet2* for women across communes combined with the variation in women's residence distance to the closest health facility. We estimate the following model:

$$Y_{icd} = \alpha + \rho Santenet_c + \beta Santenet_c * dist_{ic} + \vartheta dist_{ic} + X'_i\delta + \theta_d + \varepsilon_{icd} \quad (3)$$

where Y_{icd} is the current use of modern family planning methods for woman i in commune *c*. $Santenet_c$ captures whether woman *i* resides in a *Santenet2* commune *c* and $Dist_{ic}$ is the distance between the woman's household, located in commune *c,* and the closest health facility as defined earlier. X_i is a set of women's characteristics such as age cohort, education, marital status, household asset index, and number of children. We also control for district fixed effects (θ_d).

<<Insert Table 6 here >>

Columns 1 and 2 of Table 6 show that *Santenet2* did not affect the likelihood of women's current use of modern family planning.[22] Nevertheless, among women who were family planning users at the time of the survey, columns 3 and 4 indicate that women in *Santenet2* communes were more likely to obtain contraceptive supplies at the primary health clinic or through CHWs- the two program supply channels for family planning - by 15 percentage points (i.e., a 25% increase with respect to the baseline outcome). This result might suggest that *Santenet2* improved the distribution channels for family planning supplies but it did not have a differentiated effect among women living far from a health facility. Finally, columns 5 and 6 show that the program did not have a statistically significant effect in addressing unmet family planning needs, defined as married women of reproductive age who did not want to have more children or wished to postpone childbearing by at least two years and who were not currently using family planning.

3.3 The role of fertility preferences and women's empowerment in explaining fertility responses across distance

We explore potential mechanisms on the household's demand-side for reproductive health services that could explain the differences in fertility responses to *Santenet2* between close and remote areas from the nearest health clinic. Empirical evidence shows that realized fertility is correlated with the desired fertility of both men and women within a couple, particularly in developing countries (Doepke and Tertil, 2018). Under the assumption that the program addressed the supply

[22]Similarly, we find no effect when we restrict the current contraceptive use to family planning methods distributed by the program (i.e., pills, injectables, condoms, and cycle beads).

constraint of family planning methods, we analyze men's and women's fertility preferences across both the distance to the closest clinic and the communes targeted by the program.

As a proxy of stated preferences for family size, we use women's and men's ideal number of children. The 2013 ENSOMD includes a set of related questions[23] for both women and men; we take advantage of the male information as this is not a common feature of household surveys in developing countries (Field et al. 2016). We conduct this analysis by identifying couples in the data to test if there was a potential misalignment of preferences between spouses, which could also play a role in a household's fertility decisions. Men usually desire larger families than women, and this possible disagreement between spouses can affect household bargaining and women's empowerment, which in turn can determine women's fertility outcomes (Doepke and Tertil, 2018).

Similar to equation 3, we exploit the cross-section variation in access to *Santenet2* across communes and the variation in a couple's residence distance to the closest health facility. We estimate the following the model:

$$Y_{ijcd} = \alpha + \rho Santenet_c + \beta Santenet_c * dist_{ijc} + \vartheta dist_{ijc} + X'_{ij}\delta + \theta_d + \varepsilon_{ijcd} \quad (4)$$

where Y_{ijcd} is i) the ideal number of children of woman *i* or man *j* living in commune *c* and district *d*; and ii) the difference in the ideal number of children between husband *j* and wife *i* (a dummy variable if a man wants more children than his wife). We control by X_{ij}, a set of characteristics of husband *j* and wife *i* such as age cohort, education, and an asset index for the household. The other variables $Santenet_c$, $Dist_{ijc}$ and district fixed effects (θ_d) are defined as before. This model is restricted to the sample of couples living in the same household that we could identify in our survey.[24]

<<Insert Table 7 here >>

Table 7 shows the fertility preferences results for both married women and men. Columns 1-4 show that men and women living more than 5 km from the closest clinic desire a larger number

[23]The question regarding the ideal number of children in our survey is *"If you could go back to the time when you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?"* This is the same wording used in the DHS surveys.

[24]The number of couples does not correspond to the number of married men and women in the sample because we exclude individuals that we could not identify as husband and wife living in the same household using the household roster. Additionally, we exclude from the analysis polygamous households, which represent 1% of the couple sample.

of children, and this is not different for couples where *Santenet2* was present.[25] It is plausible that households living in remote areas prefer a larger number of children because they are more likely to work in agricultural activities in which children can be considered productive assets (Schultz, 2007). While 63% of households living close to the clinic report they have worked their land in agricultural activities in the last 12 months, this percentage increases to 90% among households living more than 5 km from the clinic.[26]

Furthermore, we do not find meaningful statistically significant differences between spouses over fertility preferences (columns 5 and 6 of Table 7), suggesting that misalignment of preferences among spouses does not appear to be a factor that can lead to conflict over intra-household fertility decisions. This consideration is important because the effects of contraception access to women might be hindered if men have more bargaining power than their wives on household decision-making over fertility (Ashraf et al. 2014; McCarthy, 2016).

Indeed, we explore whether women's intra-household decision-making power is different across distance to the clinic and intervention areas. Using available information in the survey, we construct a household decision index for the sample of married women.[27] Estimating a similar model as in equation (4), Table A.4 in the appendix shows that there are no differences in bargaining power between women in close and remote areas or between women in remote areas in treated and non-treated communes. Therefore, we find no evidence that low women's intra-household bargaining power could be linked to contraception and fertility choices, as indicated by previous empirical evidence in developing countries, particularly in Sub-Saharan Africa (Ashraf et al. 2014,

[25]It is possible that the ideal family size might be biased by cohort trends and the number of surviving children (Berhman, 2015). Thus, we also analyze an indicator of "very high desired fertility," defined by whether a woman (or a man) reports 6 or more as an ideal number of children. This variable addresses these potential biases because 80% of the women in our sample had no more than 5 living children at the time of the survey; therefore, the surviving children at the time of the survey would not influence the desire for six or more children. When we analyze the "very high desired fertility" indicator, we find similar evidence (results available upon request).

[26]A natural question is whether fertility preferences translate into realized fertility. To investigate the difference between desired and actual fertility, it would be ideal to limit the couples to those wives who are age 45 or older, but that results in small sample sizes. Instead, we examine the gap between these two variables for older women (over 40) whose fertility can be considered complete. We find that, in both close and remote households, women's preferences seem to predict actual fertility, as there is no evidence of a gap between preferences and realized fertility (results available upon request).

[27]The ENSOMD survey includes information on whether a woman reports having a joint say with a partner, complete say, or no say at all on the following decisions: decisions on her own health care, making large (important) household purchases, making household purchases for daily needs, and visits to family or relatives. For each of these decisions, we create a dummy variable if the woman is only the one who takes the decision. Then, we construct the household decision index using principal component analysis based on these 4 decisions; the higher the index, the higher a woman's bargaining power in the household decisions.

McCarthy, 2016).

Overall, this evidence suggests that, despite the goal of improving access to contraceptive methods in remote areas, the *Santenet2* CHW intervention may fail to decrease fertility in the presence of demand-side barriers such as high fertility preferences in remote areas.

4. Children's Health: Empirical Strategy and Findings

4.1. Empirical strategy

One goal of the *Santenet2* program was the promotion of prenatal and child health services such as prenatal care, birth delivery at a formal health facility, and immunizations. In this section, we focus on examining the effect of *Santenet2* on these outcomes related to child health investments. Similar to the case of women's probability of contraception, we start by estimating a difference-in-difference (DD) specification that compares child health investments in *Santenet2* and non-*Santenet2* communes before and after the program rollout:

$$Y_{icb} = \alpha + \beta Santenet_c * Bornafter_{icb} + X'_i\varphi + \delta_b + \theta_c + \varepsilon_{icb} \quad (5)$$

where Y_{icb} denotes the health outcome of interest of children i in commune c born in year b. We examine prenatal health investments and immunization outcomes. Prenatal health investment outcomes include i) if the child's mother received four or more prenatal care consultations from professional medical personnel (either a doctor, a nurse or a midwife); ii) whether the child's birth delivery was assisted by professional medical personnel; and iii) whether the child's delivery was at a formal health facility such as a hospital, health center, private clinic or another public health facility. Immunization outcomes are measured as i) having a health card, ii) the number of polio vaccine doses (maximum 3), iii) the number of DTCOQ (Diphtheria-Tetanus-Pertussis) doses (maximum 3), iv) receiving the Rougeole vaccine, and v) the total number of vaccinations (maximum 7).[28]

The variable $Santenet_c$ is a dummy variable equal to 1 if the child's commune was part of the *Santenet2* program. $born\_after_{icb}$ is an indicator equal to 1 if child i was born after the program rollout date in a *Santenet2* commune. X_i is a vector of children and maternal sociodemographic characteristics that includes the child's gender and birth order, maternal birth cohort and

[28] According to UNICEF– Madagascar, these seven vaccinations should be received during the first year of life.

education, and asset index. δ_b are child's year-of-birth fixed effects, which capture unobserved shocks that affected children born in the same year. θ_c are commune fixed effects that absorb time-invariant unobserved characteristics at the commune level. The standard errors are clustered at the commune level. The coefficient of interest is β, which measures the DD estimate of the effect of *Santenet2* community-based health intervention on different proxies of child health investments.

To take into account that the CHW component of the program targeted households living in remote areas, our main specification relies on a difference-in-difference-in-difference (DDD) design that exploits three sources of variation: geographic (commune), cohort of birth, and distance. Therefore, our strategy compares the investments in children in places far from the closest health clinic with those in households close to a health facility in *Santenet2* and *not-Santenet2* communes born before and after the program was rolled out. Specifically, we estimate the following equation:

$$Y_{icb} = \alpha + \beta Santenet_c * Bornafter_{icb} * dist_{ic} + \gamma Santenet_c * Bornafter_{icb} + \vartheta Santenet_c * dist_{ic} + \rho dist_{ic} + \delta_b + \delta_b * dist_{ic} + X'_i\varphi + \theta_c + \varepsilon_{icb} \quad (6)$$

The variable $dist_{ic}$ is a dummy variable that captures whether a child's household j is 5 km or more from the closest health facility. The rest of the variables are defined as above. In this DDD specification, there are two main coefficients of interest. First, $\boldsymbol{\beta}$ measures the estimate of the DDD effect of exposure to *Santenet2* CHWs on the health investments of children living in remote places, 5 km or more from the health facility, who are the target population of the CHWs. This coefficient captures all variation in child health investments specific to remote children (relative to close children) in *Santenet2* communes (relative to non-*Santenet2* communes) before and after the program rollout. Second, γ measures the effect of the program on children living close to a health clinic.

To provide evidence of the validity of our empirical strategy, we rely on the 2008-09 DHS data collected before the program implementation to show that children's outcomes followed similar trends in places that were exposed and not exposed to *Santenet2*. Figure 4 plots the coefficients of the interaction between being born in a *Santenet2* commune and the year of birth of the child, conditioning on child and mother's socio-demographic characteristics, district, and year-of-birth fixed effects.[29] These estimates capture the differences in the means of child outcomes by cohort and *Santenet2* status. The results indicate that, before the intervention, prenatal and postnatal investments did not differ by *Santenet2* status. Figure A.3 in the Appendix shows that children's health measures in *Santenet2* and non-*Santenet2* communes had similar trends in outcomes such as birth delivery at a formal health facility and professional assistance in delivery.

<< Insert here Figure 4>>

4.2 Results

Child Health Investments

We start our analysis by estimating the difference-in-difference (DD) model, which only exploits geographic and cohort variation. Table 8 presents these results and shows that there is no statistically significant effect of exposure to the program on prenatal and health investments or on vaccination status.

<< Insert here Table 8>>

Next, we estimate the DDD specification that additionally exploits the distance to the closest clinic to capture the effect of the CHW component of the program. The results, shown in Table 9, suggest that there is no statistically significant evidence that prenatal and birth health investments changed in remote households in *Santenet2* communes after program implementation in the short-term (panel A). These results of no statistically significant effects on outcomes related to formal birth delivery are consistent with other empirical evidence in Sub-Saharan Africa, suggesting that the provision of maternal health care information does not necessarily increase women's utilization of facility-based birth delivery, potentially due to perceived low returns on formal health care (Björkman et al., 2017, Godlonton and Okeke, 2016). Regarding vaccination uptake, the results of the DDD analysis (Table 9 panel B) suggest no statistically significant effects of *Santenet2* on any of our measures of immunization records among targeted children (those living in remote households, 5 km or more from the closest health facility).

<< Insert here Table 9>>

[29]Figure 4 and Figure A.3 also display morbidity outcomes related to the program: the prevalence of cough and fever in the last 2 weeks.

In Table 10, we present the results of the DDD that differentiate remote households living between 5 km and 10 km and more than 10 km from the closest health facility within the commune. Panel A shows that there are no statistically significant effects of *Santenet2* on prenatal and birth investments for children in places between 5 and 10 km or more than 10 km from the closest clinic. However, for child's vaccination outcomes (Table 10 Panel B), we find that *Santenet2* had a positive and statistically significant effect on all our measures of immunization status for children in the most remote areas. Children in *Santenet2* communes in households more than 10 km from the closest health facility relative to children in close households in *Santenet2* communes relative to non-*Santenet2* communes experienced an increase in the number of Polio doses, DTCOQ doses and total vaccinations by 0.55, 0.49 and 1.2 doses, respectively. This evidence suggests that *Santenet2* CHWs successfully promoted vaccination uptake among young children in the most remote places by mobilizing families to vaccination campaigns. This result is not surprising as it is consistent with previous empirical evidence in Madagascar: using the 2008-09 DHS, Clouston et al. 2014 indicate that the lack of access to roads and formal clinics is a barrier to increasing immunization coverage, especially among remote and vulnerable populations.[30]

<< Insert here Table 10>>

According to the trade-off between the quantity and quality of children theory (Becker 1960, Becker and Lewis 1973; Becker and Tomes 1976), the improvement in vaccinations should go hand in hand with a sizable and significant fertility reduction in areas more than 10 km from the closest health facility, as the theory predicts that parents invest more in children in smaller families. Nevertheless, this predicted result might change when child investments are considered club rather than private goods: vaccinations are non-rival goods that are available to young children and disproportionally benefit early childhood health. Within a family, young children benefit from immunizations rather compete for them with their siblings (Jones, 2014).[31]

Infant Mortality

Lastly, one long-term goal of the *Santenet2* community-based program was to reduce child mortality. Although our data is short-term after the program rollout, we examine the effects on

[30] In our sample data, the average total number of vaccinations among children under age 5 living in households within 5 km of the nearest health facility is 5.11, whereas this measure is 4.19 in households more than 10 km away.

[31] Jones (2014) finds that children with a larger vaccine-eligible age cohort were significantly more likely to receive immunization in Senegal.

infant mortality (deaths during the first year of life) for children aged 1 to 5 using the 2013 ENSOMD. Table A.5 presents the estimates from the DD (column 1) and DDD models (column 2-3), which suggest that *Santenet2* does not affect the likelihood of infant mortality in the short-term, between 1 and 3 years after program rollout. Notably, these results are consistent with our evidence of no effects on fertility in remote areas, suggesting that fertility choices in these areas did not respond to changes in the replacement of children and precautionary childbearing (see the models of fertility of Barro and Becker, 1989 and Doepke, 2005). Despite these findings, we highlight the importance of re-estimating the effects of the program on infant and child mortality in the medium and long-terms.[32]

5. Robustness Checks

5.1 Selective Migration

One potential concern is whether the rollout of the program could be associated with selective migration to *Santenet2* communes. However, we lack adequate data to test this hypothesis directly, as information about migration is very limited in the ENSOMD survey. The available information measures whether a woman has never moved from her current village and, if she moved, how long she has been living in the current place; however, there is no information on the origin village.

With the available information and using cross-sectional variation in a specification similar to equation (3), we estimate whether exposure to *Santenet2* was associated with the likelihood of never moving, which is defined as a dummy variable equal to 1 if a woman permanently lived in her current village and 0 otherwise. The results suggest that there is no evidence that exposure to *Santenet2* was correlated with the likelihood of moving (Table A.6).

5.2 Education Trends and Distance Definitions

We report alternative specifications to our main models that estimate the *Santenet2* effects on the risk of conception and children's outcomes. We add education time trends and specific to

[32]As noted in Section 2.1, *Santenet2* aimed to improve the distribution of child curative medicines and insecticide-treated bed nets (ITNs). In Appendix II, we further examine other child outcomes including illnesses, nutrition and the use of bed nets; we lack data on the pre-post variation of these outcomes, preventing us from using our preferred triple difference model. We only use the cross-sectional variation across communes and distance (similar to equation 3). We find no significant effects on measures of morbidity such as having diarrhea or coughing. Interestingly, we find that the children in close areas in *Santenet2* communes experienced an increase in the likelihood of sleeping under a bed net.

remote areas to our models in equation (2) and (6). Specifically, we add triple interactions of the women's cohort, their education level and the dummy variable for remote households. We also separately add to our models the interactions of the women's education and the quarter-time panel variable for the risk-of-conception model, and the interactions of the mother's education and child's birth year for the children's estimations. Tables A.7 and A.9 indicate that our results are robust to these alternative specifications.

We also estimate the results of our models using different specifications of the distance variable that identifies a household's remoteness. First, we estimate the main models using the logarithm of the household's distance to the closest health clinic instead of the dummy variable approach explained above. Second, we estimate our models using the Euclidian distance from the centroid of the village to the closest health facility within the commune instead of the household distance. Tables A.8, A.10 and A.11 indicate that our findings are similar when using these alternative definitions of distance.

5.3 Placebo tests

We also perform placebo regressions on outcomes that should not be affected by the program. In particular, we validate whether the child health investment results are explained by unobserved factors that are not captured in our specifications. Table A.12 shows that the *Santenet2* program did not have a statistically significant effect on the household's per-capita consumption or on the households' probability of being poor. These results validate our specification, as we do not expect that the program should affect consumption and poverty levels in the short-term.

6. Discussion and Conclusions

A majority of maternal and child deaths in low-income countries are preventable (Dupas, 2011). Empirical evidence, mostly experimental, has indicated specific demand- and supply-side interventions that can be effective in improving maternal and child health outcomes limited to certain contexts, but there is a paucity of evidence on the replicability at scale of such interventions in poor-resource settings (Dupas and Miguel, 2017). This paper analyzes the effects of a *large-scale* community-based health delivery program on short-term fertility and child health investments in Madagascar. This program consisted of two components. First, at the commune-level, the program disseminated information on preventive health care and guaranteed the supply of health products (i.e., FP, bed nets, medicines). Second, in the treated communes, the program trained two members of the community in maternal and child primary health care services in remote villages located more than 5 km from the nearest primary health clinic.

Distance is one of the major economic costs of preventive and formal health care access in remote and rural areas in developing countries (Adhvaryu and Nyshadham, 2015). Thus, our main econometric specification uses a triple difference model that combines the geographic and time variation of the commune rollout of the program with a third difference that is the household's distance to the closest health facility. We use nationally representative household survey data to measure the short-term effects of the program, between 1 and 3 years after rollout, on fertility and child prenatal investments and vaccinations.

Our findings indicate that the program reduced the probability of conception among women living within 5 km from the closest health facility. Nevertheless, the program did not have a sizable and statistically significant effect on the probability of conception among women in remote households, i.e., those located more than 5 km from the closest primary health facility, the targeted group of the CHW component of the program. The results in the areas close to the health facilities are consistent with suggestive evidence that the program improved the procurement of family planning products in these areas, as female users of family planning were more likely to obtain their contraceptive supplies through the primary health facilities and community health workers- the distribution channels of the program.

Consistent with the empirical evidence on the dissemination of information on health outcomes in developing countries, our findings on the CHWs' role in providing health information are ambiguous (see Dupas, 2011 for a review). On the one hand, we find that the CHWs improved vaccination uptake among children living more than 10 km from the health facility, suggesting the positive effects of their role in mobilizing households to vaccination campaigns or the nearest health facility. On the other hand, we do not find statistically significant effects of the program on children's outcomes such as prenatal care and birth delivery at the formal health center.

To understand the differential fertility effects of the program by distance to the clinic, we examine the role of potential demand-side mechanisms. This analysis reveals some suggestive evidence on the potential limitations faced by interventions that improve access to primary health care for remote populations. Under the assumption that the program improved the contraception supply, particularly through the CHW component, we find that the differential fertility responses by distance can be explained by male and female fertility preferences for a larger number of children in remote areas than in areas close to the nearest clinic.

Although we cannot rule out that only demand-side mechanisms are at play, it is plausible that we do not find statistically significant and sizable effects in the probability of conception in remote areas due to weak coverage and performance of the CHW program. However, the fact that we find results on vaccination uptake is an indication that the health workers were somehow present in remote areas. We lack data to test the *Santenet2* CHWs' performance and monitoring. While the CHWs received a small revenue margin from selling the family planning and other health products, it is possible that this financial incentive was not large enough to improve their performance in remote areas. This is an important consideration for further research, as recent empirical evidence has shown the important role of financial incentives in the CHWs' impact on health outcomes in Sub-Saharan Africa (Ashraf et al., 2014, Ashraf et al., 2016; Björkman et al., *forthcoming)*.

Empirical evidence has indicated that CHW programs can be an alternative to extend the supply of primary health care in low-income settings such as Madagascar; nevertheless, our findings indicate that these large-scale interventions might face implementation challenges and demand-side barriers to reap the benefits of access to basic health care for remote and poor populations. Future research should investigate other demand-side barriers that might limit access to primary health care.

Santenet2 was incorporated into the government health policy due to its large scale and the adoption of these community-based health programs will presumably continue in other low-income countries. Narrow empirical evidence analyses the effects of government supply-side interventions on health outcomes in developing countries (see Cesur et al., 2017 in Turkey; Reis et al., 2014 in Brazil). Therefore, more research is needed on how to enhance CHWs' performance by designing incentives that trigger their intrinsic and extrinsic motivation as well as define the role of the government in supporting the implementation of such interventions (Ashraf et al., 2016).

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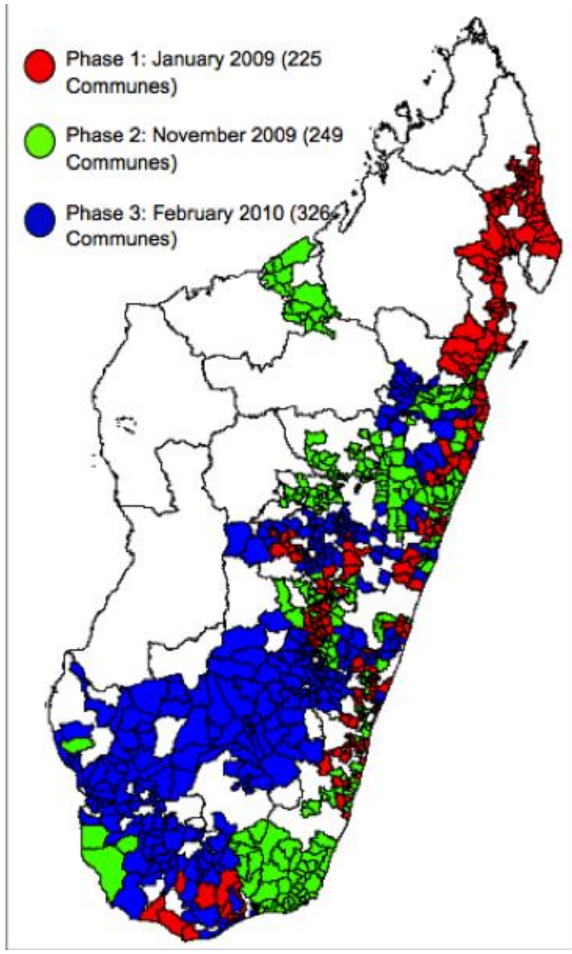
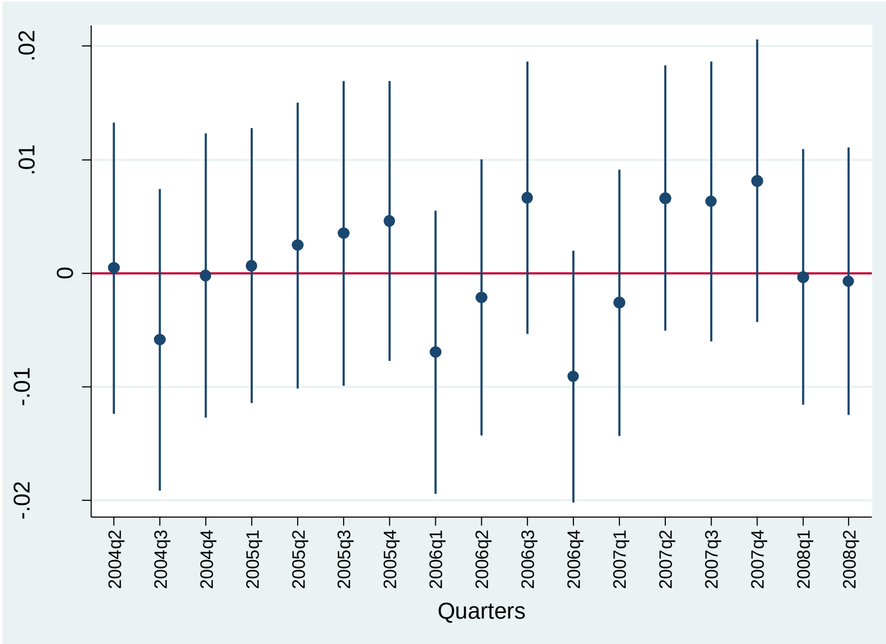
TABLES AND FIGURES

Figure 1: Rollout of the *Santenet2* Program.



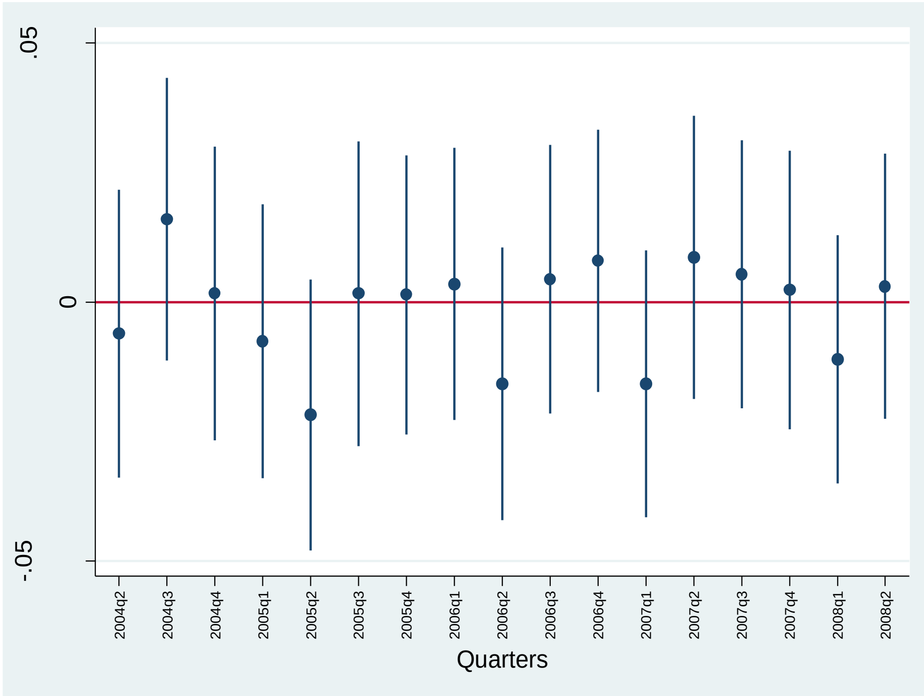
Source: USAID (2013)

Figure 2: Parallel Trends Pre-*Santenet2* using 2008-09 DHS-Quarterly Probability of Conception



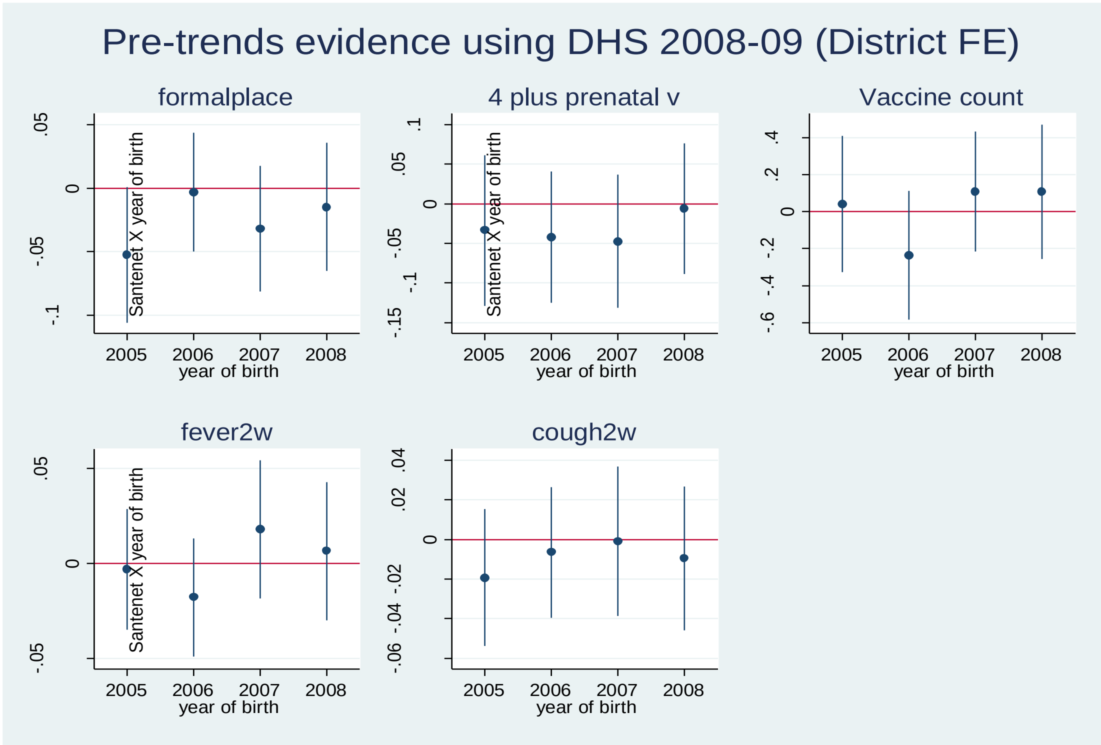
Notes: Figure 2 depicts the coefficients of the interaction between panel quarter-year and Santenet2 communes, controlling for the woman's education, asset index, cohort of birth and district fixed effects. 95% confidence intervals are shown.

Figure 3: Parallel Trends in Remote Areas Pre-*Santenet2* using 2012-13 ENSOMD-Quarterly Probability of Conception



Notes: Figure 3 depicts the coefficients of the interaction between panel quarter-year, *Santenet2* communes and a dummy variable for household distance greater than 5 km from the closest clinic controlling for the corresponding double interactions, the woman's education, parity, asset index, cohort of birth and quarter-panel variable and commune fixed effects (specification similar to equation 2). 95% confidence intervals are shown.

Figure 4: Parallel Trends Pre-*Santenet2* using 2008-09 DHS-
Child Health Investments and Outcomes



Note: Figure 4 depicts the coefficients of the interaction between being born in a *Santenet2* commune and the year of birth of the child controlling for child and mother's socio-demographic characteristics, district and year-of-birth fixed effects. 95% confidence intervals are shown.

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TABLES

Table 1: Summary Statistics Characteristics of Women and Children in the Sample

	Full Sample		Distance 0-5 km		Distance 5 + km	
	Mean	SD	Mean	SD	Mean	SD
Santenet	0.45		0.44		0.45	
HH Distance to closest clinic	6.47		2.02		12.37	
Woman's age	29.63	9.64	29.72	9.68	29.38	9.51
Woman’s edu (yrs)	4.53	3.98	5.55	4.07	2.45	2.77
% Poor	0.57		0.44		0.85	
Sexually active	0.90		0.88		0.94	
Ever had a child	0.77		0.74		0.84	
Number of children	2.73	2.56	2.48	2.42	3.26	2.76
Child is male	0.50		0.50		0.50	
Child age (months)	34.76	20.82	34.93	20.76	34.54	20.90
Child birth order	3.46	2.39	3.25	2.27	3.73	2.51
Delivery in formal place	0.38		0.51		0.21	
Total vaccinations (max 7)	4.90	2.60	5.11	2.55	4.48	2.65
Diarrhea last 2 wks	0.11		0.10		0.11	
Observations	13,398		7,641		5,757	

Table 2: *Santenet2* Effects on Women's Probability of Conception

	Double Difference-DD model	Triple Difference DDD model	DD: HH located close to health facility (0-5 km)	DD: HH located farther from health facility (5 km+)
	(1)	(2)	(3)	(4)
Santenet*post	-0.0036***	-0.0044***	-0.0043***	-0.0022
	(0.0012)	(0.0015)	(0.0015)	(0.0023)
Santenet*post*Dist5km+		0.0022		
		(0.0026)		
Mean of Y	0.036	0.036	0.032	0.043
Mean Santenet*post	0.203	0.203	0.192	0.224
Observations	322450	305672	199868	105804
R^2	0.017	0.018	0.016	0.019

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observation is woman-quarter. All models control for the woman's age cohort, education and parity, household asset index quintiles, commune and quarter-time fixed effects and interactions of *Santenet2* exposure, distance and time trends.

Table 3: Effects of *Santenet2* on the Probability of Conception by Age Cohort

	All Women	1963-1971	1972-1977	1978-1983	1984-1989	1990-1997
	(1)	(2)	(3)	(4)	(5)	(6)
Santenet*post	-0.0044***	-0.0044**	-0.0060*	-0.0006	-0.0080**	-0.0021
	(0.0015)	(0.0022)	(0.0032)	(0.0033)	(0.0033)	(0.0037)
Santenet*post*Dist5km+	0.0022	0.0065	-0.0012	0.0034	0.0064	-0.0023
	(0.0026)	(0.0044)	(0.0056)	(0.0058)	(0.0055)	(0.0062)
Mean of Y	0.036	0.013	0.031	0.041	0.047	0.041
Observations	305672	53524	56525	59900	69625	66098
R^2	0.018	0.020	0.020	0.020	0.019	0.025

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observation is woman-quarter. All models control for the woman's age cohort, education and parity, household asset index quantiles, commune and quarter-time fixed effects and interactions of *Santenet2* exposure, distance and time trends.

Table 4: Heterogeneous Effects of *Santenet2* on the Probability of Conception

	All women	More educated (5 years or more schooling)	Less educated (4 years or less schooling)	Non-poor (Upper asset quintiles)	Poor (Lower asset quintiles)
	(1)	(2)	(3)	(4)	(5)
Santenet*post	-0.0044***	-0.0035*	-0.0021	-0.0037*	-0.0018
	(0.0015)	(0.0020)	(0.0020)	(0.0021)	(0.0022
Santenet*post*Dist5kms+	0.0022	0.0010	0.0003	0.0035	-0.0005
	(0.0026)	(0.0049)	(0.0032)	(0.0048)	(0.0033)
Mean of Y	0.036	0.027	0.042	0.026	0.043
Observations	305672	119425	186247	125743	179929
R^2	0.018	0.017	0.018	0.015	0.018

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observation is woman-quarter. All models control for the woman's age cohort, education and parity, household asset index quantiles, commune and quarter-time fixed effects and interactions of *Santenet2* exposure, distance and time trends.

Table 5: Effects of *Santenet2* on the Probability of Conception by Distance

	All Women	Distance 0-5 km	Distance 5-10 km	Distance 10 km+
	(1)	(2)	(3)	(4)
Santenet*post	-0.0044***	-0.0043***	-0.0015	-0.0033
	(0.0015)	(0.0015)	(0.0027)	(0.0030)
Santenet*post*Dist5-10km	0.0031			
	(0.0030)			
Santenet*post*Dist10km+	0.0010			
	(0.0042)			
Mean of Y	0.036	0.032	0.0432	0.0442
Observations	305672	199868	61370	44434
R^2	0.018	0.016	0.020	0.020

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observation is woman-quarter. All models control for the woman's age cohort, education and parity, household asset index quantiles, commune and quarter-time fixed effects and interactions of *Santenet2* exposure, distance and time trends.

Table 6: Effects of *Santenet2* on Family Planning (FP) Use

	Current use of modern FP methods		FP methods obtained at health clinic or from CHWs		Unmet need for FP	
	(1)	(2)	(3)	(4)	(5)	(6)
Santenet	0.0143	0.0093	0.1510***	0.1482***	-0.0081	-0.0038
	(0.0285)	(0.0284)	(0.0449)	(0.0444)	(0.0293)	(0.0298)
Santenet*Dist5km	-0.0068		0.0120		0.0054	
	(0.0265)		(0.0377)		(0.0362)	
Santenet*Dist5-10km		-0.0147		0.0217		-0.0273
		(0.0282)		(0.0447)		(0.0408)
Santenet*Dist10km		0.0034		-0.0233		0.0505
		(0.0316)		(0.0700)		(0.0522)
Mean of Y	0.283		0.577		0.4761	
Observations	12674		3781		5650	
R^2	0.111	0.112	0.250	0.251	0.124	0.126

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Models control for the woman's age cohort, education, parity, civil status, household asset index quantiles, and district fixed effects.

Table 7: Women's and Men's Fertility Preferences

	Men's ideal No. of children		Women's ideal No. of children		Men want more children (=1)	
	(1)	(2)	(3)	(4)	(5)	(6)
Santenet	0.2267	0.2392	0.1576	0.1691	0.0264	0.0261
	(0.2149)	(0.2155)	(0.1647)	(0.1631)	(0.0278)	(0.0282)
Dist5kmplus	0.3055*		0.3217**		0.0433*	
	(0.1807)		(0.1605)		(0.0259)	
Santenet*Dist5km+	0.1353		-0.0076		-0.0416	
	(0.2535)		(0.2302)		(0.0357)	
Dist5-10km		0.2566		0.2720		0.0448
		(0.2109)		(0.2008)		(0.0292)
Dist10km+		0.3975		0.4089**		0.0409
		(0.2556)		(0.1867)		(0.0375)
Santenet*Dist5-10km		0.1567		0.0324		-0.0450
		(0.3039)		(0.2744)		(0.0422)
Santenet*Dist10km+		0.0918		-0.0764		-0.0362
		(0.3504)		(0.2792)		(0.0501)
Mean of Y	5.6050	5.6050	5.1095	5.1095	0.3366	0.3366
Observations	3527	3527	3524	3524	3419	3419
R^2	0.386	0.386	0.391	0.391	0.080	0.080

Notes: The dependent variable "Men want more children" is defined as a dummy variable if the man's ideal number of children is higher than that of his wife. The dependent variable "Fertility preference gap" is defined as the difference between the ideal number of children of the husband and his wife. Models estimated only among married couples. * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Models control for the husband's and wife's age cohort and education, the wife's parity, household asset index quantiles, and district fixed effects.

Table 8: Effects of *Santenet2* on Prenatal and Postnatal Investments - DD Approach

Panel A: Prenatal and birth investments

	Delivery in formal place	Professional assistance in delivery	>=4 Prenatal visits
	(1)	(2)	(3)
Santenet*Born after	-0.0010	-0.0073	0.0307
	(0.0136)	(0.0136)	(0.0234)
Mean of Y	0.3813	0.4463	0.5936
Observations	12650	12634	6980

Panel B: Postnatal investments (vaccinations)

	Health card seen	Polio count (max=3)	DTCOQ count (max=3)	Rougeole dummy	Total vac-cinations (max=7)
	(1)	(2)	(3)	(4)	(5)
Santenet*Born after	0.0197	-0.0003	-0.0279	-0.0163	-0.0445
	(0.0127)	(0.0667)	(0.0668)	(0.0292)	(0.1507)
Mean of Y	0.7531	2.1928	2.1637	0.5427	4.8992
Observations	12218	4612	4612	4612	4612

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for the child's gender, birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies and commune fixed effects.

Table 9: Effects of *Santenet2* on Prenatal and Postnatal Investments - DDD Approach

Panel A: Prenatal and birth investments

	Delivery in formal place	Professional assistance in delivery	>=4 Prenatal visits
	(1)	(2)	(3)
Santenet*Born after	0.0079	0.0008	0.0301
	(0.0192)	(0.0191)	(0.0288)
Santenet*Born after*Dist5km	-0.0190	-0.0173	0.0017
	(0.0269)	(0.0284)	(0.0476)
Mean of Y	0.381	0.446	0.594
Observations	12650	12634	6980

Panel B: Postnatal investments (vaccinations)

	Health card seen	Polio count (max=3)	DTCOQ count (max=3)	Rougeole dummy	Total vaccina-tions (max=7)
	(1)	(2)	(3)	(4)	(5)
Santenet*Born after	0.0107	-0.0349	-0.0485	-0.0260	-0.109
	(0.0226)	(0.0815)	(0.0812)	(0.0357)	(0.186)
Santenet*Born after*Dist5km	-0.0230	0.101	0.0539	0.0271	0.182
	(0.0300)	(0.137)	(0.139)	(0.0528)	(0.301)
Mean of Y	0.377	2.193	2.164	0.543	4.899
Observations	12218	4612	4612	4612	4612

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for the child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects.

Table 10: Effects of *Santenet2* on Prenatal and Postnatal Investments - DDD Approach by Distance

Panel A: Prenatal and birth investments

	Delivery in formal place	Professional assistance in delivery	>=4 Prenatal visits
	(1)	(2)	(3)
Santenet*Born after	0.0079	0.0009	0.0305
	(0.0192)	(0.0192)	(0.0288)
Santenet*Born after*Dist5-10km	-0.0455	-0.0409	0.0180
	(0.0320)	(0.0341)	(0.0551)
Santenet*Born after*Dist10km+	0.0177	0.0136	-0.0307
	(0.0328)	(0.0366)	(0.0739)
Mean of Y	0.381	0.446	0.594
Observations	12650	12634	6980

Panel B: Postnatal investments (vaccinations)

	Health card seen	Polio count (max=3)	DTCOQ count (max=3)	Rougeole dummy	Total vaccina-tions (max=7)
	(4)	(5)	(6)	(7)	(8)
Santenet*Born after	0.0108	-0.0366	-0.0500	-0.0263	-0.113
	(0.0226)	(0.0817)	(0.0814)	(0.0358)	(0.186)
Santenet*Born after*Dist5-10km	-0.0266	-0.0685	-0.106	-0.0200	-0.194
	(0.0352)	(0.153)	(0.155)	(0.0569)	(0.329)
Santenet*Born after*Dist10km+	-0.0185	0.569***	0.493**	0.160*	1.222**
	(0.0348)	(0.216)	(0.220)	(0.0902)	(0.484)
Mean of Y	0.377	2.193	2.164	0.543	4.899
N	12218	4612	4612	4612	4612

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for the child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects.

ONLINE APPENDIX (NOT FOR PUBLICATION)

I. Additional Tables and Figures

Table A.1: Balance Test using 2008-09 DHS Socio-economic Characteristics.

	5 years or more of Schooling	Years of Schooling	Poor (1,2,3 Quintiles)	Ever Married	Age of First Marriage (18 years and younger)	Age of first Birth (19 years and younger)	Number of children younger than 5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Santenet	0.0360	0.3248	-0.0145	-0.0186*	0.0062	0.0102	0.0089
	(0.0247)	(0.2155)	(0.0376)	(0.0105)	(0.0129)	(0.0144)	(0.04572)
Mean of Y	0.39	4.33	0.60	0.86	0.62	0.60	1.12
Observations	17364	17364	17373	17373	14165	12943	15284
R^2	0.270	0.362	0.519	0.446	0.162	0.168	0.135

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the district level. All models control by women's year of birth, rural residence, and district fixed effects

Table A.2: "Fake *Santenet2* Treatment" Effects on Women's Probability of Conception

	Lagged Santenet 20 quarters	Lagged Santenet 21 quarters	Lagged Santenet 19 quarters
	(1)	(2)	(3)
"*FakeSantenet*"*post	0.0028	0.0018	0.0015
	(0.0019)	(0.0019)	(0.0018)
"*FakeSantenet*"*post*Dist5km+	-0.0005	-0.0017	0.0002
	(0.0035)	(0.0037)	(0.0035)
Observations	249321	249374	242540
R^2	0.010	0.010	0.010

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observations is woman-quarter. All models control by women's age cohort, education and parity, household asset index, commune and quarter fixed effects and interactions of *Santenet2* exposure, distance and time trends. The calendar time for the panel is between 2002Q1 and 2008Q1.

Table A.3: Sample Means of Women's Probability of Conception across *Santenet2* and Distance

	Before 2009	After 2009	Single Difference (after -before)	Double Difference
Close 0-5 km -Santenet	0.0445	0.0306	-0.0139	
Close 0-5 km Non-Santenet	0.0332	0.0236	-0.0096	
Double difference				**-0.0043**
Remote> 5km Santenet	0.0527	0.0393	-0.0134	
Remote> 5km Non -Santenet	0.0504	0.0366	-0.0138	
Double difference				0.0004
Triple Difference				**0.0047**

Table A.4: Women's Empowerment across Distance and *Santenet2*

	Household Decision Index	
	(1)	(2)
Santenet	-0.0526	-0.0640
	(0.0971)	(0.0978)
Dist5km+	-0.0588	
	(0.0701)	
Santenet*Dist5km+	-0.0257	
	(0.1039)	
Dist5-10km		-0.0194
		(0.0850)
Dist10km+		-0.1285
		(0.0878)
Santenet*Dist5-10km		0.0108
		(0.1215)
Santenet*Dist10km+		-0.0756
		(0.1353)
Mean of Y	0.016	0.016
Observations	8483	8483
R^2	0.120	0.120

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01.Standard errors clustered at the commune level. Models control by women's age cohort, education, household asset index quintiles, and district fixed effects.

Table A.5: Exposure to *Santenet2* and Infant Mortality

	Infant mortality		
	DD model	DDD model	
	(1)	(2)	(3)
Santenet*Born After	-0.0109	-0.0117	-0.0118
	(0.0083)	(0.0105)	(0.0105)
Santenet*Born After*Dist5km+		0.0016	
		(0.0149)	
Santenet*Born After*Dist5-10km			-0.0097
			(0.0167)
Santenet*Born After*Dist10km+			0.0188
			(0.0190)
Mean of Y	0.038		
Observations	10772		

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects.

Table A.6: Exposure to *Santenet2* and Selective Migration

	Non-Mover	
	(1)	(2)
Santenet	0.0027	0.0019
	(0.0233)	(0.0235)
Santenet * Dist 5km+	0.0046	
	(0.0287)	
Santenet * Dist5-10km		0.0004
		(0.0335)
Santenet * Dist10km+		0.0108
		(0.0396)
Mean of Y	0.480	0.480
R^2	0.0730	0.0730
Observations	14373	14373

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control by women's age cohort, education, household asset index quintiles, and district fixed effects.

Table A.7: Adding Education Trends to Women's Probability of Conception Models

Panel A	(1)	(2)	(3)
Santenetexpost	-0.0044***	-0.0045***	-0.0027*
	(0.0015)	(0.0015)	(0.0015)
Santenet*post*Dist5km+	0.0022	0.0024	0.0008
	(0.0026)	(0.0026)	(0.0026)
Trends Cohort*education*distance	N	Y	N
Trends Quarterpanel *education	N	N	Y
Observations	305672	305672	305672

Panel B	(1)	(2)	(3)
Santenet*post	-0.0044***	-0.0045***	-0.0027*
	(0.0015)	(0.0015)	(0.0015)
Santenet*post*Dist5-10km	0.0031	0.00329	0.00026
	(0.0030)	(0.0030)	(0.0028)
Santenet*post*Dist10km+	0.0010	0.0011	0.0017
	(0.0042)	(0.0048)	(0.0038)
Trends Cohort*education*distance	N	Y	N
Trends Quarterpanel *education	N	N	Y
Observations	305672	305672	305672

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, household asset index quintiles, commune and quarter fixed effects and interactions of *Santenet2*exposure, distance and time trends.

Table A.8: Alternative Distance Measures: Women's Probability of Conception

	Centroid Distance		Ln HH Distance
	(1)	(2)	(3)
Santenet*post	-0.0031**	-0.0031**	-0.0034**
	(0.0015)	(0.0015)	(0.0014)
Santenet*post*Dist5+	-0.0001		
	(0.0026)		
Santenet*post*Dist5-10km		-0.00002	
		(0.0029)	
Santenet*post*Dist10km+		-0.0002	
		(0.0041)	
Santenet*post*Ln HHdistance			0.0001
			(0.0009)
Mean of Y	0.036	0.036	0.036
Observations	313695	313695	305672
R^2	0.018	0.018	0.018

Notes: The dependent variable is a binary indicator for conceiving in a given quarter. Significance levels: *p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at the commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, household asset index quintiles, commune and quarter fixed effects and interactions of *Santenet2* exposure, distance and time trends.

Table A.9: Adding Education Trends Specific to Remote Areas - Main Child Outcomes

Panel A:	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
	(1)	(2)	(3)	(4)
Santenet*Born after	-0.0346	-0.0475	-0.0252	-0.107
	(0.0807)	(0.0806)	(0.0357)	(0.184)
Santenet* Born after*Dist 5km+	0.0876	0.0471	0.0205	0.155
	(0.138)	(0.139)	(0.0526)	(0.301)
Mean of Y	2.193	2.164	0.543	4.899
Observations	4612	4612	4612	4612

Panel B:	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
	(1)	(2)	(3)	(4)
Santenet* Born after	-0.0367	-0.0493	-0.0255	-0.112
	(0.0811)	(0.0809)	(0.0359)	(0.185)
Santenet* Born after*Dist.5-10km	-0.0704	-0.103	-0.0225	-0.196
	(0.153)	(0.154)	(0.0576)	(0.330)
Santenet* Born after* Dist10km+	0.550**	0.479**	0.169*	1.197**
	(0.220)	(0.223)	(0.0915)	(0.488)
Mean of Y	2.193	2.164	0.543	4.899
Observations	4612	4612	4612	4612

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects. All of these specifications additionally control for mother's cohort*mother's education*distance fixed effects. Results controlling for the interaction of the mother's education and child's birth year for the children's estimations are available upon request.

Table A.10: Alternative Distance Measures: log – Main Child Outcomes

	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
	(1)	(2)	(3)	(4)
Santenet* Born after	-0.0492	-0.0756	0.00645	-0.118
	(0.0887)	(0.0875)	(0.0408)	(0.201)
Santenet* Born after* Ln Distance	0.0559	0.0517	-0.0206	0.0871
	(0.0540)	(0.0533)	(0.0248)	(0.120)
Mean of Y	2.193	2.164	0.543	4.899
Observations	4612	4612	4612	4612

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects.

Table A.11: Alternative Distance Measures: Village Centroid to Closest Clinic – Main Children Outcomes

Panel A:	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
	(1)	(2)	(3)	(4)
Santenet*Born after	-0.0560	-0.0678	-0.0194	-0.143
	(0.0814)	(0.0810)	(0.0362)	(0.186)
Santenet*Born after*Dist 5km+	0.143	0.102	0.0181	0.263
	(0.132)	(0.134)	(0.0569)	(0.294)
Mean of Y	2.195	2.167	0.546	4.908
Observations	4738	4738	4738	4738

Panel B:	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
	(1)	(2)	(3)	(4)
Santenet* Born after	-0.0575	-0.0694	-0.0198	-0.147
	(0.0815)	(0.0811)	(0.0363)	(0.186)
Santenet* Born after*Dist5-10km	-0.0102	-0.0403	-0.0667	-0.117
	(0.153)	(0.155)	(0.0639)	(0.336)
Santenet* Born after *Dist10km+	0.520***	0.449**	0.194**	1.163***
	(0.181)	(0.177)	(0.0828)	(0.398)
Mean of Y	2.195	2.167	0.546	4.908
Observations	4738	4738	4738	4738

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects.

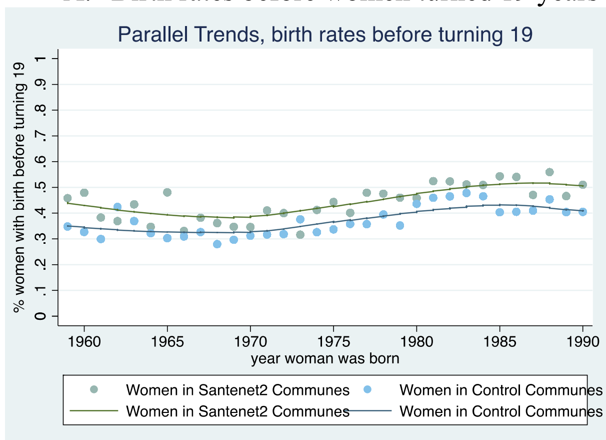
Table A.12: Placebo Test, *Santenet2* Effects on Per-capita Consumption and Poverty

	Per-capita Consumption		Poor Household (Y=1)	
	(1)	(2)	(3)	(4)
Santenet*Born after	14668.0	14710.6	-0.519	-0.441
	(16035.7)	(16117.4)	(1.646)	(1.645)
Santenet*Born after*Dist5km+	-19144.9		1.102	
	(20104.7)		(2.168)	
Santenet*Born after*Dist5-10km		-20872.5		2.036
		(23985.4)		(2.430)
Santenet*Born after*Dist10km+		-16063.9		-0.285
		(18591.4)		(2.415)
Mean of Y	398038.2	398243.9	79.38	79.35
Observations	9863	9831	9863	9831
R^2	0.394	0.394	0.397	0.397

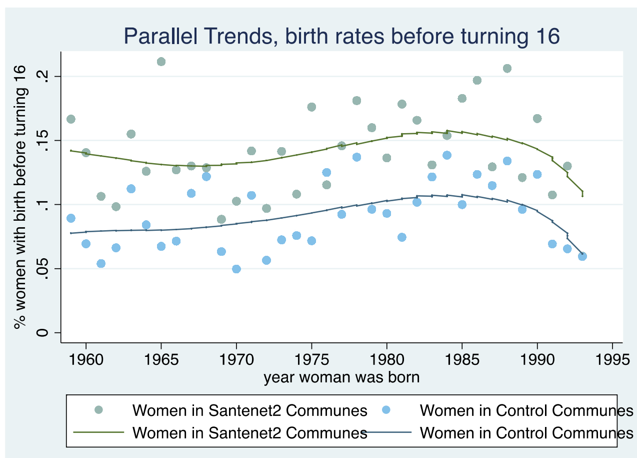
Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, child birth year dummies, *Santenet2* interaction term with the distance dummy, and commune fixed effects.

Figure A.2: Parallel Trends Fertility Outcomes

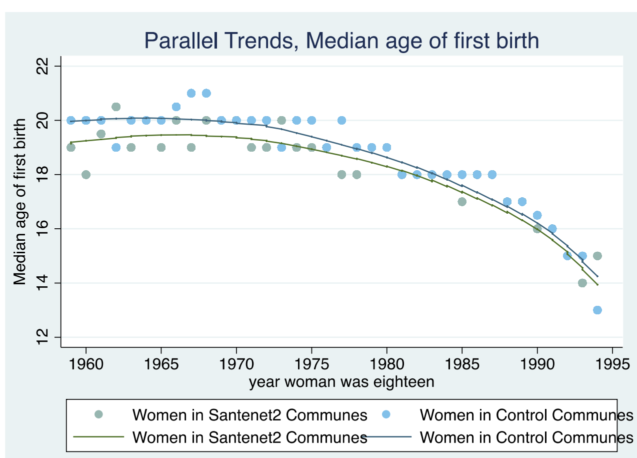
A. Birth rates before women turned 19 years



B. Birth rates before women turned 16 years



C. Median age of first birth



Source: Calculations based on DHS 2009

Figure A.3: Parallel Trends for Children Outcomes

Source: 2008-09 DHS

II. Appendix: Additional Child Health Outcomes

A. Illnesses and nutrition outcomes

Empirical strategy

The *Santenet2* program trained one CHW per remote village (i.e., located further than 5 km from the closest health facility) on Community-based Integrated Management of Childhood Illness (c-IMCI) of main preventable diseases such as malaria, diarrhea, and acute respiratory infections (ARI). In this section, we aim to provide evidence of the program effects on children's illnesses and nutritional status.

The empirical strategy we use in this section differs from the main DDD approach employed before because the ENSOMD survey data only asked about the incidence of illnesses in the last two weeks, thus, we lack *time variation* (pre-program vs. post). Therefore, to analyze the effects of the program on these outcomes we only exploit cross-sectional variation from the geographic dimension of the roll-out of the program (*Santenet2* vs. *non-Santenet2* communes) and distance from the household to the closest clinic. We estimate the following regression model similar to the equations (3) and (4):

$$Y_{icdb} = \alpha + \beta Santenet_c * dist_{ic} + \rho dist_{ic} + \delta X_i + \theta_d + \delta_b + \varepsilon_{icdb} \quad (A.1)$$

Where Y_{icdb} denotes the illnesses and nutrition outcome of interest of children i in commune c, in district d and born in year b. We examine as outcomes: i) the likelihood of suffering fever; ii) coughing; and iii) diarrhea in the last two weeks; and iv) indicators of short-term malnutrition: weight for age Z-scores (WAZ) < 2SD, and wasting defined as weight for height Z-scores (WHZ) <2 SD. Similar to earlier specifications, $dist_{ic}$ is a dummy variable that captures whether a child's household j is 5 km or more apart from the closest health facility and X_i is a vector of children and maternal sociodemographic characteristics. δ_b and θ_d are child's year of birth fixed effects district fixed effects.

Results

Table A.13 presents the estimates of equation (A.1) in our sample. We do not observe a statistically significant effect of *Santenet2* on measures of morbidity and nutrition among children who live in remote households, except for a decline in the probability of having fever in the last two weeks of 2.7 percentage points (20% decline with respect or the mean) for children in *Santenet2* communes in remote households at the 10 % of statistically significance level. Table A.14 shows the results that distinguish children living in households between 5km and 10km and more than 10km apart from the closest health facility within the commune. We find no statistically significant effects of *Santenet2* on illnesses and nutrition for neither children in places between 5 and 10km nor children in places more than 10 km away from the closest clinic. It is important to acknowledge that these outcomes may be ambiguously related to the program as the CHWs management of childhood illnesses was more curative than preventive.

<< Insert here Table A.13>>

<< Insert here Table A.14>>

B. Health Practices and Behaviors

Additionally, we examine whether exposure to the program affected the use of treatments for child illnesses and the use of bed nets as one of the child CHW tasks was the distribution of curative medicines and Insecticide-Treated bed nets-ITNs.

Since we lack time variation in these outcomes (pre-post), we only use cross-sectional variation to estimate specifications similar to the one depicted in equation (A.1). Table A.15 shows that exposure to the program increased the use of medicines for treating fever or coughing by 7.7 percentage points (10% of the mean) for those children living close to the health clinic. Similarly, children living in non-remote places experienced an increase of 5 percentage points (10% of the mean) in the probability of sleeping under a bed net the day before the survey. However, there is no evidence that children in remote households experienced strong effects on the use of illness treatment or bed nets as expected due to the CHWs component of the program. These patterns of results suggest that the significant effects of *Santenet2* may be linked to the overall commune-level component of information and improvement of supply points of medicines and preventive products.

<< Insert here Table A.15>>

Table A.13: Effects of *Santenet2* on Children's Illnesses and Nutrition Outcomes

	Diarrhea in Last 2 Weeks	Fever in Last 2 Weeks	Cough in Last 2 Weeks	Underweight (Weight-for-Age <-2)	Wasting (Weight-for-Height <-2)
	(1)	(2)	(3)	(4)	(5)
Santenet	-0.0083	0.0112	0.0279	-0.0134	-0.0114
	(0.0120)	(0.0128)	(0.0175)	(0.0196)	(0.0110)
Santenet*Dist5km+	0.0053	-0.0273*	-0.0140	0.0190	-0.0070
	(0.0155)	(0.0158)	(0.0207)	(0.0231)	(0.0141)
Mean of Y	0.106	0.128	0.183	0.310	0.0807
Observations	12055	12032	12038	9383	9321

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies and district fixed effects.

Table A.14: Effects of *Santenet2* on Children's Illnesses and Nutrition Outcomes - by Distance

	Diarrhea in Last 2 Weeks	Fever in Last 2 Weeks	Cough in Last 2 Weeks	Underweight (Weight-for-Age <-2)	Wasting (Weight-for-Height <-2)
	(1)	(2)	(3)	(4)	(5)
Santenet	-0.0084	0.0126	0.0237	-0.0123	-0.0104
	(0.0120)	(0.0126)	(0.0172)	(0.0196)	(0.0110)
Santenet * Dist5-10	0.0013	-0.0237	-0.0232	0.0409	0.00390
	(0.0168)	(0.0175)	(0.0246)	(0.0257)	(0.0161)
Santenet * Dist10km+	0.0113	-0.0335	0.00243	-0.0156	-0.0247
	(0.0223)	(0.0212)	(0.0255)	(0.0320)	(0.0192)
Mean of Y	0.106	0.128	0.183	0.310	0.0807
Observations	12055	12032	12038	9383	9321

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, and district fixed effects.

Table A.15: Effects of *Santenet2* on Children's Health Behaviors

	Conditional on being sick							
	Seek treatment for illness		Use ORS (Oral Re-hydration Salts)		Use medicine for fe-ver and cough		Kid sleep under Bed net	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Santenet	0.0468	0.0424	-0.0216	-0.0269	0.0776**	0.0751**	0.0491**	0.0497**
	(0.0364)	(0.0363)	(0.0499)	(0.0508)	(0.0329)	(0.0329)	(0.0223)	(0.0223)
Santenet*Dist 5km+	-0.0139		-0.0472		-0.0328		-0.0391	
	(0.0454)		(0.0577)		(0.0399)		(0.0288)	
Santenet*Dist5-10km		-0.0259		-0.0983		-0.0423		-0.0310
		(0.0529)		(0.0652)		(0.0454)		(0.0323)
Santenet*Dist10km+		0.0052		0.0232		-0.0165		-0.0514
		(0.0617)		(0.0772)		(0.0538)		(0.0384)
Mean of Y	0.48		0.2		0.74		0.55	
Observations	3362		1276		2650		12089	

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at the commune level and appear in parenthesis. All columns control for child's gender, and birth order, mother's cohort dummies and education level, household asset index quintiles, child birth year dummies, and district fixed effects.