Reducing the Cost of Remoteness: The Effects of Community Health Workers Programs on Maternal and Children's Health in Madagascar♣

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Abstract

Lack of primary health care use can deter preventable maternal and child deaths in low-income countries. In poor-resource settings, community health workers programs have emerged as a supply alternative to deficient formal health care provision among underserved populations, but the empirical evidence on whether such interventions improve health outcomes is inconclusive. We analyze the short-term effects of a large-scale community-based health intervention on fertility and children's health in Madagascar. This program aimed to generate demand for primary and preventive care through information and to decrease the non-monetary costs for remote households to increase their take-up of primary health care services by training volunteer community health workers in delivering modern family planning and managing childhood illness. To identify these effects, we use a triple difference model that combines the roll-out of the program across time and regions with geocoded data on the households' distance to the closest health facility. Our findings indicate that the program decreased the risk of conception among women living close to the health facility but did not have a differential effect among targeted women living in remote areas. In contrast, we find that the program improved several measures of immunization status among children living in remote areas. Nevertheless, we do not find statistically significant effects of the program on the likelihood of birth delivery at a formal health facility. Our results are robust to several falsification and specification checks.

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Introduction

Maternal and infant mortality are still persistent in Sub-Sahara Africa. Despite the progress over the last two decades, about 550 women die daily due to complications in pregnancy and childbirth and the risk of a child dying before completing five years of age (81 deaths per 1000 live births) is almost 11 times higher than the average risk in high-income countries (WHO, 2015). In the region, the leading causes of infant mortality are pneumonia, respiratory infectious diseases, diarrhea and malaria (WHO 2015, Haines et al. 2007). Many of these women and child's deaths can be preventable (Butha et al.; 2014); however, in low-income countries, preventable health care use and provision are relatively low (Dupas, 2011). In the face of resource-constrained formal health infrastructure and medical personnel, added to geographic barriers in access to health care, Community Health Workers programs have emerged as a short-term supply-side alternative to formal primary care among remote and poor populations in low-income countries (Sigh and Sachs, 2012; Das et al., 2016).

This paper analyses the effects of a *large-scale* community-based health intervention with volunteer community health workers (CHW) on short-term fertility and children's health outcomes in Madagascar. The scale-up phase of this program, *Santenet2*, was implemented between 2009 and 2011. At the commune-level, the program disseminated information on preventive health care, guaranteed supply of health products and coordinated massive vaccinations campaigns.[1] Additionally, in remote villages, located in the treated communes, two CHWs were selected by the community to be trained in maternal and child primary health care services, including promotion and provision of family planning and implementation of the Integrated Management of Childhood Illness program. The CHWs program targeted villages located more than five

[1] Commune is the smallest administrative unit in Madagascar. Villages *(or fokontany)* are the administrative units of a commune.

kilometers away from the nearest basic health care center in the treated communes. In Madagascar, more than 65% of the population lives more than five kilometers, or more than one-hour walking distance from the closest basic health facility (USAID, 2014). During this period, the program was implemented in 800 out of 1,566 communes in Madagascar and reached 5,758 villages. Thus, the program intended to decrease the distance between remote villages and primary health care provision. In the context of Madagascar, the analysis of this type of interventions is a salient issue: every day 100 children die, primarily from preventable diseases and 10 women die from complications related to pregnancy and childbirth despite the progress that the country has made during the last recent decades (USAID, 2014). Indeed, the prevalence of modern contraception methods among women between 15 and 49 years old is still at 29%, and the fertility rate is 4.8 children per women (DHS, 2009).

To identify the effects of this large-scale community-based and volunteer CHW program on women and children's health outcomes, we implement 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 that is the distance from each household to the closest health facility within the commune. This empirical framework allows us to compare changes in the short-term health outcomes associated with the timing and geographic variation of *Santenet2* roll-out for treated and non-treated communes among households residing near and far from the health facility. In Madagascar, like other low-income countries where there is no health insurance, and pecuniary health costs are heavily subsidized, distance can be the major economic cost of access to health care and is particularly important in remote and rural areas (Adhvaryu & Nyshadham, 2015).

Our findings indicate that *Santenet2* did not have a differential effect on the probability of conception among women who live in remote households, i.e., those located further than 5 kilometers (km) from the primary health facility. Nevertheless, we find that *Santenet2* did reduce the conception risk for women living within 5 kilometers of the health facility. In contrast, we find that children in *Santenet2* communes living more than 10 km away from the closest health facility experienced significant improvements in several measures of immunization status. Furthermore, we find that child health outcomes such as prenatal care investments, illnesses, measured as the incidence of cough, fever, and diarrhea, and weight-for-age (WAZ) are not affected by the program.

Our paper contributes to the empirical evidence that analyses whether the provision of primary health services in low-income countries improves short-term health outcomes among the poor. One of the main barriers to the use of primary and preventive health care services are non-monetary costs such as convenience of access or hassle costs. Recent studies have found that distance is an important barrier to the take-up of preventive and primary health services (Wagner et al., 2017; Kremer et al., 2011; Thornton, 2008). Also, empirical evidence has shown that reduction in distance and travel time increases the use of formal health care in Tanzania (Adhvaryu & Nyshadham, 2015) and that access to roads can increase the use of preventive health care by rural and remote population in India (Banerjee and Sachhevja, 2015). Furthermore, distance is positively associated with children's mortality in developing countries (Fink et al., 2016). Our study addresses whether the implementation of volunteer CHWs can decrease the costs imposed by the distance to the primary health services and can improve women's and children's short-term health outcomes.

In addition, this paper is particularly related to the set of empirical studies that analyze the role of volunteer community health workers in providing primary health care services in low-income settings. Although there is a consensus that CHWs can extend the supply of primary care services in rural and remote areas (Sigh and Sachs, 2012), the evidence on the effects of volunteer CHWs on preventive care use and health outcomes is inconclusive. While some systematic reviews find positive effects on health behavior and provision of basic and curative services (Bhutta et al., 2010; Gilmore et al., 2013), other experimental evidence indicates mixed results (Arifeen et al., 2009; Bandhari et al., 2012). For example, using a clustered randomized control trial, Bjorkman et al. (2016) show that an incentivized community health delivery program in Uganda reduces under-five child mortality. Also, Bjorkman et al. (2017), using a randomized control trial in Nigeria, show that the relatively weak coverage of the CHWs on treatment areas might explain the null effects on maternal and neonatal outcomes despite the positive effects on utilization of antenatal and postnatal care.

Our paper also contributes to the set of quasi-experimental studies that have analyzed the effect of community health workers' delivery of family planning and other maternal and child health services. The most known program of this type is Matlab, in Bangladesh, which has been shown to significantly reduce fertility and improve children's outcomes (Schultz and Joshi, 2013; Barham et al. 2016). However, similar studies even in the short-term are rare in Africa. To the best of our knowledge, there are no empirical studies that analyze the *large-scale* effects of volunteer CHWs programs on fertility and child health outcomes in a low-income setting, such as Madagascar. More broadly, *Santenet2* was incorporated into the government health policy due to its large scale; therefore, our findings also contribute to the narrow empirical evidence that analyses the effects of government supply-side interventions on health outcomes in developing countries (See Cesur et al., 2015 in Turkey; Reis et al., 2014 in Brazil).

The rest of the paper is organized as follows. Section 2 reviews the empirical evidence about primary and preventive health in developing countries. Section 3 describes the data and the program. Section 4 explains the empirical strategy and reports results regarding the effects on fertility while Section 5 focuses on children's outcomes. Section 6 presents some robustness checks and placebo tests of our empirical results. Finally, section 7 presents the discussion and preliminary conclusions.

2. Literature Review: Primary and Preventive Health in Developing Countries

Our paper is related to the literature on barriers to the use of preventive and primary health services, such as knowledge, price and convenience/hassle costs in low-income countries. The supply intervention that we analyze in this study addresses these barriers in the context of Madagascar. *Santenet2* CHWs targeted households living in remote areas located far away from formal health clinics thus reducing the distance between these households and the provision of primary health care services. CHWs also provided access to family planning and childhood illnesses medications at a subsidized price, and they disseminated and improved knowledge and information about healthy behaviors including the benefits of using contraception and practices to prevent and treat children's infectious diseases. Therefore, we highlight the evidence from the previous literature on these barriers providing support to the research questions we explore in this paper.

One of the main barriers to the use of primary and preventive health care services are non-monetary costs in the form of convenience of access or hassle costs. In remote areas in low - income countries, families and their children may need to walk long distances or incur in high transportation costs to reach their nearest health center. Therefore, distance, time constraints, and inconvenience can interfere with a family health seeking decision making. Several studies have shown that these are important barriers to the take-up of preventive and primary health services

(Wagner et. al., 2017; Thornton, 2008; Kremer et al., 2011). For example, Thornton (2008) found that distance to HIV testing centers and price (including opportunity costs) play a role in the likelihood of seeking HIV testing and getting the results. She finds that living over 1.5 kilometers from the HIV testing center reduced attendance to the clinic to obtain the results by 6 percent. In addition, some studies have shown that community interventions that increase the availability of treatment for preventable illnesses like pneumonia and diarrhea can reduce the morbidity burden of these diseases (see Das et al., 2013 for a meta-analysis).

Poor knowledge and lack of information on illness prevention, treatments, and their benefits are another main explanation for the low use of preventive and primary health care services in developing countries (Dupas, 2011). Some studies have shown that providing information can influence health behaviors because households may lack of knowledge about the returns to investing in preventive behavior (Madajewicz et al., 2007; Jalan and Somanathan, 2008; Cohen et al., 2011; Smillie, 2009; Dupas, 2011). For example, using randomized field experiments in Bangladesh and India, Madajewicz et al. (2007) and Jalan and Somanathan (2008) show that informing households that their drinking water is contaminated (concentration of arsenic in Bangladesh and fecal bacteria in India) changed their safe water seeking behavior. However, the type of information, the source and to whom it is delivered may matter in order to make a difference (Dupas, 2011). In addition, there is evidence that information-only may not be enough and incentives (monetary or non-monetary) may help to overcome the present-bias (time-inconsistent preferences). For instance, Banerjee et. al (2010) show that promotion and immunization camps (improving the supply of services) had a modest effect on vaccination uptake while additionally providing small incentives (lentils) have large positive impacts in poor areas.

Willingness to pay even small or subsidized prices is another reason that can explain the low use of preventive and primary health services. Using RCTs, several studies have shown that even highly subsidized prices can result in decreases in take-up and use of preventive services relative to free-distribution (Wagner et. al., 2010; Kremer and Miguel, 2007; Cohen and Dupas, 2010). However, a concern of free provision is that some recipients may not use the product and waste resources. Some studies have found that charging a small price even non-monetary (small effort) can reduce wasting (or screen out non-users). Dupas et al., (2016) find that combining free provision with a screening mechanism in the form of willingness to incur in a small effort (redemption of a voucher at a local shop) increases use of a water treatment solution while reducing wastage in Kenya.

In our study, the community-based health intervention we are analyzing, *Santenet2*, combined elements that attempt to reduce the role of these demand-side barriers to the low use of preventive and primary health services in Madagascar. The intervention reduced the distance from the households to the provision of family planning and child management of diseases by relying on CHWs in the village instead of large transportation costs to the closest clinic. Also, the intervention provided information on healthy behaviors, implemented vaccinations campaigns, and distributed heavily subsidized health products through CHWs.

In addition, the low uptake of preventive and primary health services is due to the shortage of health workers in remote and rural areas in developing countries. Most highly trained medical staff are concentrated in urban and wealthier areas (Siernells, 2016). Thus, CHWs have emerged as one strategy to address this shortage of health workers in remote areas while improving access to primary health care (Sigh and Sachs, 2012). Due to the lack of professional personnel such as doctors, nurses, and midwives, CHWs can have the capacity to deliver primary care health services to underserved populations that used to be attended by medical personnel. This “task shifting”, as defined by the World Health Organization, is a process in which a group of health care workers is trained to assume new responsibilities for interventions previously performed only by the more high-skilled health worker.

The body of evidence on the effects of volunteer CHWs on preventive care use and health outcomes is ambiguous. While some systematic reviews find positive effects on health behavior and provision of basic and curative services (Bhutta et al., 2010; Gilmore et al., 2013); some experimental evidence indicates mixed results (Arifeen et al., 2009; Bandhari et al., 2012). For example, using a clustered randomized control trial, Bjorkamn et al. (2016) show that an incentivized community health delivery program in Uganda reduces all causes under five child mortality by 27%. They show that the effect is not only driven by access to subsidized medicines but also by an improvement in healthy behaviors, as well as visits and counseling from the CHWs. The authors argue that their results provide evidence that financial incentives can motivate CHWs to engage in pro-social activities. In contrast, exploiting a cluster randomized controlled trial in Nigeria, Bjorkman et al. (2017) show that a volunteer community health educator intervention in Nigeria increases antenatal and postnatal care utilization, but did not increase the likelihood of birth delivery at a formal facility, and did not improve maternal or neonatal health outcomes such as birth weight or neonatal mortality. The authors suggest that the weak coverage of CHWs and the low quality of formal health care may explain these results. Overall, the body of experimental evidence sheds light that CHWs program components and design (i.e. incentives, monitoring and accountability) play a role in explaining the success of these interventions. Therefore, large-scale CHWs programs may face challenges including insufficient incentives to the workers to provide timely and appropriate services and the importance of high quality monitoring and accountability systems.

3. Context, Program and Data Description

3.1 Context and Program

Madagascar is a low-income country where 77% of the population lives in poverty and 65% lives in rural areas (World Bank, 2017).[2] Poor transportation infrastructure combined with a shortage of medical personnel limit the access to basic health of population living in remote areas. For instance, the number of nurses/midwives (per 1000 habitants) is 0.316 while in sub-Saharan Africa is 1.15 (World Bank, 2017). In fact, 65% of the population lives 5 kilometers away from the closest health facility (USAID, 2014) and the average travel time to the closest hospital is 4.51 hours (Hernandez and Moser, 2013). This lack of health infrastructure is reflected in poor health indicators. Every day, 100 children under age of 5 die primarily from preventable illnesses, mainly respiratory infections and diarrhea (USAID, 2014). Also, ten women die from complications related to pregnancy and childbirth in a context where the total fertility rate is five children per woman and 30% of girls between 15 and 19 years old have already a child (DHS, 2008-09).

In Madagascar, USAID -one of the largest bilateral donors to the country-, implemented *Santenet2* between 2009 and 2011. This program was a community-based integrated primary health care services intervention with volunteer community health workers. *Santenet2*'s main goals included: i) empowering community participation and accountability in setting and achieving health goals; ii) reducing maternal, child and infant mortality, fertility rate; prevalence of malaria and chronic malnutrition in children under age 5; iii) expanding access to water, sanitation and

[2] The poverty indicator corresponds to the poverty headcount at USD 1.90 a day (2011 PPP).

hygiene (WASH); and iv) maintaining a low HIV prevalence rate (USAID, 2014). *Santenet2* was implemented in 800 out of 1566 total communes, corresponding to 16 out of 22 regions and 72 of the 119 districts in Madagascar.[3] The program targeted communities where USAID had a strategic development focus and that also met certain criteria such as a minimum road infrastructure, high unmet need for family planning, and high population density. In the intervened communes, the program reached 5,758 villages (*fokontanys*) located more than five kilometers from the nearest health center, training 13,086 CHWs during this period and benefiting approximately 11 million people or about half of the population (USAID, 2014).

Overall, the program has two main components. First, at the commune level, the program aimed to generate demand for primary and preventive care through information about healthy behaviors and practices: i.e. cleaning water sources, importance of family planning, antenatal care, immunization campaigns, and nutrition. For example, the program used as communication channels local radio broadcasts, which covered a range of topics including maternal and child health; malaria; 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 and curative medicines, and other commodities (bednet). Second, on top of the above, for remote villages, the program used CHWs to bring basic care closer to these places. The CHWs component targeted villages located more than 5 kilometers away from the closest public clinic.

The volunteer CHWs were chosen by the community members following eligibility requirements such as having completed primary education and the ability of how to read, write

[3] A commune is the smallest administrative region in Madagascar. Villages in each commune are called fokontanys. Through the paper, we use community to refer to the commune as the smallest administrative level at which *Santenet2* was implemented.

and count as well as being socially accepted by the community (USAID, 2013). According to USAID, "*the selection process ensured that volunteer CHWs have real influence and benefit from their communitie's trust and respect, which resulted in an enhanced social status for these community workers*" (USAID, 2013). *Santenet2* worked through 16 implementing partners and local NGOS to establish the structure to engage the communities from 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 assess the community-level health priorities, provide technical support in the activities to mobilize community members, raise awareness, and coordinate health interventions such as vaccinations campaigns with the local health clinics, and the establishment of supply chains for distribution of health products.

Each treated village in a *Santenet2* commune had two volunteer CHWs: one who specialized in maternal and reproductive health services while the other focused on children's health. The program implemented a comprehensive training program for the CHWs designed according to the Ministry of Health standards (RTI, 2014). The training of these CHWs occurred at two levels. In level 1 of the maternal health services, CHWs received an 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, among others) and postpartum FP. After three months of service, their performance was assessed. The CHWs who achieved the best results and meet a number of criteria (attendance, regularity of reporting, supervision results) were trained on the application of injectables (i.e., Depo-Provera) and became Level 2 maternal health CHWs.

Similarly, for the child health services, in level 1 the CHWs received training on nutrition, growth promotion, information on the schedule of vaccinations and promotion of common disease prevention (malaria, diarrhea, acute respiratory infections). After three months of service, their performance was assessed, and the best qualified CHWs were trained on Community-Based Integrated Management of Childhood Illness (c-IMCI) becoming level 2-child health CHW (USAID, 2013). *Santenet2* also put in place a system of regular monitoring and supervision of CHWs activities and performance by community-level committees. External evaluations have favorably assessed the performance of the CHWs tasks, particularly those related to the application of injectables (Agarwal, et. al, 2013).

Maternal and child health community workers were in charge not only in promoting and disseminating information on health behaviors but also on distributing health products such as family planning including pills, condoms, injectables, and cycle beads as well as paracetamol, oral rehydration salts (ORS), zinc, iron/folic supplements, among others. The program established supply points for the distribution where the CHWs collected the products and then distributed them to the villages. These health products are heavily subsidized in Madagascar; therefore, CHWs did not make a profit from the sales of these products to the beneficiary families.

It is worth noting that 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; they receive some stipend strictly sufficient to cover their board and lodge during the training. Many CHWs stated that they were *de facto* motivated to work for their communities, which is why they agreed to take on their roles as health promoters (USAID, 2013). Despite the lack of monetary incentives, external evaluations of the program have quantified that the attrition rate of the CHWs was only

8% which is favorable compared to other contexts in developing countries (RTI, 2014). USAID in collaboration with the Ministry of Health has expanded the *Santenet2* model of health services at the national level since 2012 up to the present (USAID, 2015).

3.2 Data Description

In this paper, we combine administrative information about the roll-out of Santenet2 CHWs across time and communes and nationally representative household surveys in Madagascar.

1) Roll-out 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 implemented 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 roll-out of *Santenet2* by these phases.

<< Insert Figure 1 here>>

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

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

INSTAT conducted a large-scale national survey, the Madagascar Millennium Development Goals National Monitoring Survey (ENSOMD) between September 2012 and November 2013, to assess Madagascar's progress towards meeting the Millennium Development Goals. This survey was conducted among 16,000 households. It has a similar design to the Demographic Health Surveys-DHS and contains detailed information on women's fertility behaviors and births history. In addition, for children less than age 5, the ENSOMD collects health outcomes such as prenatal care use, birth delivery, birth weight, breastfeeding, vaccinations, morbidity, anthropometrics, and other indicators. Because this data was collected between one and 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 repeated cross-section data, publicly available, which collect socio-demographic information for women of reproductive age (15 to 49) including fertility history, family planning use as well as education, marital status, and household assets. We use the 2008-09 waves to explore whether fertility and child outcomes in *Santenet2* communes had a similar trend compared to non-participating communes before the roll-out of the program.

4) Geocoded data of health facilities and distance data

To identify the villages targeted by the program in each commune (i.e. more than 5 km away from the closest clinic), we rely on geocoded data (longitude and latitude) from both 3309 public health centers, and the centroids of the villages included the ENSOMD. Geographic information about these centers was obtained from the health care mapping software at 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 information of the center of the villages[4] surveyed in the ENSOMD to calculate the distance of each village to the closest health clinic in *Santenet2* and *non-Santenet2* communes.

Distance to health centers is a proxy of supply and access to health services and recent studies have demonstrated an important association between geographic distance to the closest

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

clinic and child morbidity, mortality and other health outcomes (i.e., McLaren et al., 2014; Lucas and Wilson, 2013; Baranov and Kohler, 2017; Karra et. al., 2016; Guenther et al., 2012). We calculate Euclidian (straight line) distances between the center of each village to the closest clinic within the commune using ArcGIS. Additionally, we have a measure of distance to the closest health facility collected by the Japan International Cooperation Agency (JICA), which comes from interviews to the mayor of each village who were asked that distance taking into consideration the road or walking paths (We refer to this distance as JICA distance). All the estimations in the paper use our calculated distance from the center of the village to the closest clinic, we show that the results are robust to using the JICA distance (travel distance).[5]

We merge the *Santenet2* rollout dates information and the distances to the closest health facilities to the ENSOMD data using geographic identifiers at the commune and village level. 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>>

4. Fertility Outcomes: Empirical Strategy and Findings

4.1 Empirical Strategy

Santenet2 had a component to promote reproductive health. Indeed, one of the volunteer community health workers per village was in charge of disseminating family planning information and delivering modern contraception methods, including condoms and pills. In addition, for the first time, CHWs were trained to deliver injectables, the most common contraception method in

[5]The two distances are highly correlated (around 0.6)

Madagascar, among women in remote areas.[6] 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. In fact, some *Santenet2* external studies have positively evaluated the CHWs' knowledge and performance in delivery family planning (Argawal et al., 2014).[7] It is worth noting that family planning products are free or heavily subsidized by the government or NGOs in Madagascar. Indeed, only 0.2% of women, ages 15-49 and who are non-family planning users, indicate price as a reason for not using modern contraception in the future in 2009 (DHS, 2009).[8]

Existing empirical evidence in developing countries shows that disruptions or negative shocks in family planning provision can increase fertility in the short-term (see Salas (2015) in the Philippines, and Jones (2013) in Ghana).[9] 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.

We analyze whether the program has a causal effect on short-term fertility outcomes using as a primary empirical strategy a difference-in-difference-in-difference (DDD) approach. We exploit variation in access to *Santenet2* for women of the same age (birth cohort) across communes and for women of different birth cohorts within the same commune combined with the variation of women's residence distance to the closest health facility. Intuitively, our tipple-difference model

[6]According to 2009 DHS, among women ages 15 to 49 who currently use family planning, 26% of them use injectables.
[7] Through our field work interviews in Madagascar, we noticed that some of the formally trained health personnel such as doctors, nurses, and midwives are concerned with the fact that CHWs are certified to distribute injectables as they are not formally trained to perform this task.
[8] Distance is as a separate reason for not using modern contraception (DHS, 2009).
[9] The relative relevance of supply and demand factors in determining long-term fertility rates in developing countries is a subject of debate in the empirical literature. While Bongaarts (1994) shows that an increase in contraceptive use through Family Planning programs can decrease long-term fertility in developing countries, Pritchett (1994) argues that fertility decline is largely explained by demand factors, mainly, the rising opportunity cost of childbearing that accompanies economic development.

creates a treatment group of women who: i) live in *Santenet2* communes, ii) are exposed to the program (with respect to the date of the arrival of the program), iii) and their households are located further than 5 kilometers from the closest primary health facility. Women who satisfy none or some these conditions (i.e., women who live further to the health facility in a non-*Santenet2* commune) are part of our control group. This method aims to account for 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.

Using data from women's fertility histories included in the 2012-13 ENSOMD surveys, we construct a quarterly (quarter-year) artificial panel data to estimate the following equation[10]:

$$Y_{itc} = \alpha + \beta Santenexpos_{itc} * dist_{ic} + \gamma Santexpos_{tc} + \rho dist_{ic} + \vartheta Sant_c * dist_{ic} + \delta_t * dist_{\boldsymbol{ic}} + X'_{itc}\varphi + \delta_t + \theta_c + \varepsilon_{itc} \quad (1)$$

Where: Y_{itc} is the quarterly probability of conceiving, a dummy variable that captures whether woman *i*, in commune *c* conceived a child at quarter *t*. $Santexpost_{itc}$ is a dummy variable that measures whether a woman *i* is exposed to *Santenet2* up to quarter *t*. This variable depends on both whether women's commune of residence *c* received *Santenet2* and the start date of the program in commune c. $Dist_{\boldsymbol{ic}}$ is a dummy variable that captures the distance between the woman's household, located in commune *c*, and the closest health facility within the commune c; it takes the value of 1 if the household is strictly less than 5 kilometers. X_{itc} is a set of women's

[10]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 for women who in the panel are in the 15 to 49 age range and who are sexually active. We exclude women who are currently pregnant (i.e. represent 10% of the sample); however, our results are robust to the inclusion of this group of women. Results are upon request

characteristics such as age cohort, education, quintiles of the household asset index,[11] and parity up to quarter *t*. δ_t is quarter time fixed effects that allow us to capture time trends and seasonality of births in the period of analysis and θ_c is community fixed effects. We cluster the standard errors at the commune level. $\boldsymbol{\beta}$ is the coefficient of interest which captures the effect of being exposed to *Santenet2* when the woman lives further than 5 kilometers from the health facility.

An important assumption of our empirical approach is that before the program, both groups of communes had similar trends in the outcomes potentially affected. 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 as the non-*Santenet2* communes. First, using the 2008-09 DHS fertility data, we create a similar quarterly panel data and estimate the effect of *Santenet2* on the risk of conception between 2004 and 2008. Figure 2 shows the coefficients of the interaction between the program and the time-quarters variable between 2004 and 2008 conditioning on the same set of women's characteristics and commune fixed effects. The results indicate that women's risk of conception does not statistically significant differ between *Santenet2* and non-*Santenet2* communes before the program implementation.[12]

<< Insert Figure 2 here >>

Second, we estimate the equation (1) using the ENSOMD quarterly panel data between 2004 and 2008 to validate the parallel trends assumption across the remote areas. Figure 3 shows

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

[12] Using the 2008-09 DHS fertility data, Figure A.1 shows that women in *Santenet2* and non-*Santenet2* communes have similar trends in the raw fertility outcomes such as birth rates before age 16 and the median age at first birth before the program operated.

the triple interaction coefficients of equation (1) indicating that there is no statistically significance evidence of a differential trend for the villages located further than 5 km in treated and non-treated areas before the program implementation.[13]

<< Insert Figure 3 here >>

Third, we also show in Table A.1 in the Appendix, that there is no statistically significant difference between *Santenet* and non-*Santenet* communes on pre-program socio-economic characteristics, including poverty, women's education, age at first marriage, the age of first birth, among others. This evidence, using the DHS 2008-09, suggests that there is no selection on observables.[14]

Fourth, to further address potential concerns that our estimates may be biased by the presence of omitted variables, we move the roll-out dates of *Santenet2* between 2009 and 2011 by lagging these dates 20 time-quarters (i.e., 2004-2006), and we test if these "fake" roll-out 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.

4.1. Results: Probability of Conception

We start our analysis by presenting the difference-in-difference model version of equation (1) which only uses 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 risk of conception

[13] We were not able to implement this robustness check using the 2008 DHS since this survey does not have precise information of the distance between the households and the closest health facility.
[14] 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 upon request.

decrease by 0.3 percentage points among women living in *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 (1). While there is no statistically significant effect of *Santenet2* on the risk of conception among women who live further than 5 kilometers from the closest primary health facility, we do observe that the program reduce by 0.44 percentage points the quarterly probability of conception, approximately a 12% reduction from the average quarterly probability of conceiving (mean=3.6%), for women living close to the health facility (i.e., between 0 and 5 kilometers). These findings suggest that the CHW's delivery of family planning did not have a differential effect on the targeted women who live in remote areas, i.e., further than 5 kilometers from the primary health facility. In columns 3 and 4, we also present the estimation of the difference-in-difference model for the households living between 0 and 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. In the remote areas, the magnitude of this effect is negative, but it is imprecise. 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.

<<Insert Table 2 here>>

Furthermore, we explore heterogeneous effects by women's birth cohort, education, and asset index. Table 3 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. This finding might suggest a complementarity of the program's family planning information and technology with women' education.

<<Insert Table 3 here>>

Table 4 shows the estimation of equation (1) 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 of women) 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).

<<Insert Table 4 here>>

We also explore if *Santenet2* has a differential effect on women living further than 5 kilometers. Thus, we change in equation (1) the variable $Dist_{ic}$, for a categorical variable of the distance between a woman's household and her closest health facility as follows: i) strictly less than 5 kilometers; ii) between 5 and 10 kilometers and iii) equal or more than 10 kilometers. Table 5 shows that the program does not have an effect on the risk of conception among women who live in remote villages, located between 5 and 10 or further than 10 kilometers from the closest primary health facility.

<< Insert Table 5 here>>

4.2. Mechanisms: Family Planning Use

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

Since we lack information on women's history on family planning use, and we only observe their current contraceptive use at the time of the survey; we are not able to 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 of women's residence distance to the closest health facility. We estimate the following model:

$$Y_{ic} = \alpha + \beta Santenet_{ic} * dist_{ic} + \rho dist_{ic} + X'_{ic}\delta + \theta_d + \varepsilon_{ic} \quad (2)$$

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

<<Insert Table 6 here >>

Column 1 of Table 6 shows that *Santenet2* does not affect the likelihood of women's current use of modern family planning.[15] Among women who report the use of family planning at the time of the survey, we find in Column 3 that the program increases the likelihood of getting

[15] 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).

contraceptive supplies at the health clinic by 16.6 percentage points (i.e., 30% increase with respect to baseline outcome); however, this effect is only among women who reside close to the health clinic. We do not find any differentiated effect for users who live in remote areas. Furthermore, Column 4 shows that the program increases the likelihood of getting family planning through community health workers, and there is a statistically significant effect for women living in remote areas. However, it is worth noting that only 4% of women, who report current contraceptive use, get their supplies through health workers.

5. Children's Outcomes: Empirical Strategy and Findings

5.1. Prenatal and postnatal health investments

5.1.1 Empirical strategy

One of the goals 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. We start by examining the effect of Santenet2 on these outcomes where we can exploit three sources of variation in a DDD design: geographic (commune), cohort and distance. In this case, our treatment group is children who: i) were born in *Santenet2* communes, ii) are exposed to the program (born after *Santenet2* was rollout), iii) and live in households located more than 5 km apart from the closest health facility within their commune of residence. Children who satisfy none or only some of these conditions act as part of the comparison group. Therefore, our strategy compares the prenatal and postnatal investments of children in places far away from the closest health clinic with children in households close to a health facility in *Santenet2* and *not-Santenet2* communes before and after the program was rolled out. Specifically, we estimate the following equation:

$$Y_{icjb} = \alpha + \beta \boldsymbol{bornafterSant_{icb}} * \boldsymbol{dist_{jc}} + \alpha_1 bornaftersant_{cb} + \alpha_2 dist_{jc} + \alpha_3 sant_c * dist_{jc} + \delta_b + \delta_b * dist_{jc} + X'_i \phi + \theta_c + \varepsilon_{ijcb} \quad (3)$$

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

The variable $born\_afterSant_{icb}$ is an indicator equal to 1 if child *i* was born in a *Santenet2* commune after the program rollout date. $dist_{jc}$ is a dummy variable that captures whether a child's household *j* is more than 5 kilometers apart from the closest health facility; $Sant_c$ is a dummy variable equals to 1 if child's commune was part of *Santenet2* program; X_i is a vector of children and maternal sociodemographic that includes child's gender and birth order, maternal birth cohort and 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. Standard errors are clustered at the commune level. The main coefficient of interest is $\boldsymbol{\beta}$ which measures the estimate of the DDD effect of exposure to *Santenet2* CHW on health outcomes of children living in remote places, 5km or more, from the health facility and who are the affected population by the program.

The key assumption to causally identify the effects of exposure to the CHW program is that before the roll-out both the communes that received *Santenet2* and the ones that did not have similar trends in the outcomes of interest. This means that non-*Santenet2* communes are a suitable counterfactual of the communes that were exposed to the program. To explore the parallel trends assumption, we rely on the 2008-09 DHS data collected before the program implementation. Figure 4 plots the coefficients of the interaction between being born in a Santenet2 commune and year of birth conditioning on child's and mother's socio demographic characteristics and district and year of birth fixed effects. These estimates capture the difference in means of child outcomes by cohort and Santenet2 status. The results indicate that, before the intervention, prenatal and postnatal investments do not differ by Santenet2 status.[16]

<< Insert here Figure 4>>

5.1.2. Results: Child Health Investments

We start our analysis by estimating the difference-in-difference version of equation (3), which only exploits geographic and cohort variation. Table 7 presents these results and shows that there is no statistically significant effect of exposure to the program on prenatal and health investments, nor in vaccination status.

<< Insert here Table 7>>

[16] Figure A.3 in the Appendix shows that children's health measures in *Santenet2* and non-*Santenet2* communes have similar trends in outcomes such as birth delivery at a formal health facility, professional assistance in delivery, the likelihood of fever and coughing in the last two weeks.

Next, we estimate the difference-in-difference-in-difference specification that additionally exploits distance to the closest clinic to capture the effect of the CHWs component of the program. Results, shown in Table 8, suggest that there is no statistically significant evidence that prenatal and birth health investments changed in remote households in Santenet2 communes after the 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 the findings from Bjorkman et al. (2017) in Nigeria. The results of the DDD analysis on immunization status (Table 8 panel B) suggest no statistically significant effects of Santenet2 on none of our measures of immunization records among targeted children (those who live in remote households).

<< Insert here Table 8>>

Table 9 presents results of the DDD redefining remote households as those living between 5km and 10km and more than 10km apart from the closest health facility within the commune. Panel A shows that for prenatal and birth investments there are no statistically significant effects of Santenet2 for neither children in places between 5 and10km nor children in places more than 10 km away from the closest clinic. However, for child's vaccination outcomes (Table 9 Panel B), we find that Santenet2 has a positive and statistically significant effect on all our measures of immunization status for children in the most remote villages. Children in Santenet2 communes located in households more than 10km away from the closest health facility experienced an increase in the number of Polio doses, DTCOQ doses and total vaccinations by 0.55, 0.49 and 1.2 doses. This evidence suggests that Santenet2 CHWs made a difference in improving the vaccination status of children in most remote places.

<< Insert here Table 9>>

5.2. Children illnesses and nutrition outcomes

5.2.1 Empirical strategy

The Santenet2 program trained one community health worker per village on Community-based Integrated Management of Childhood Illness (c-IMCI) of main preventable diseases like malaria, diarrhea, and acute respiratory infections (ARI). Therefore, 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 part of the study differs from the DDD approach employed before because the ENSOMD Survey data only asked about the incidence of illnesses in the last two weeks,[17] thus we lack of *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 rollout of the program (Santenet2 vs. nonSantenet2 commune) and distance from the household to the clinic. We estimate the following regression model that includes similar covariates as before but uses district fixed effects instead of commune FE:

$$Y_{icdb} = \alpha + \beta Santenet_{ic} * dist_{ic} + \rho dist_{ic} + \delta X_{ic} + \theta_d + \delta_b + \varepsilon_{ic} \quad (4)$$

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.

[17] Similarly, the measures of height and weight were collected at the interview date.

5.2.2 Results

Table 10 presents the estimates of equation (4) 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 for children in Santenet2 communes in remote households (20% decline with respect or the mean). Table 11 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 and10km nor children in places more than 10 km away from the closest clinic. It is important to acknowledge that these outcome measures may be ambiguously related to the program as the CHWs management of childhood illnesses was curative and not preventive.

<< Insert here Table 10>>

<< Insert here Table 11>>

5.3. Potential Channels Behind the Effects of Santenet2 of Child's health

Lastly, we explore evidence of some potential mechanisms through which Santent2 might affect children health outcomes. In particular, we examine whether exposure to the program affected the use of treatments for child illnesses and use of bed nets as one key component of the program was the distribution of curative medicines and Insecticide-treated bed nets ITNs.

Since we lack of time variation in these measures (pre-post), we only use cross-sectional variation to estimate specifications similar to the one depicted in equation (4). Table 12 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), in particular 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 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 component of information and improvement of supply points across the communes.

<< Insert here Table 12>>

6. Robustness Checks

6.1 Selective Migration

One potential concern is whether the roll-out of the program could be associated with selective migration to Santenet2 communes. However, we lack of adequate data to test this hypothesis directly as the information about migration is very limited in the ENSOMD survey. The only information that we have measures whether a person has never moved from his/her current village and, if moved, how long has been living in the current place; however, there is no information of the origin village.

With the available information and using cross-sectional variation in a specification similar to equation (4), we estimate whether exposure to Santenet2 is associated with the likelihood of never moving, which is defined as dummy variable equal to 1 if the female has permanently living in the current village and 0 otherwise. Results suggest that there is no evidence that exposure to Santenet2 is correlated with the likelihood of moving (Table A.4).

6.2 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 to our models in equation (1) and (3) education time trends and specific to remote areas. Specifically, we add an interacted variable of women's cohort and education level with a dummy variable for remote villages. Also, we separately, add to our models the interaction of women's educational level and the quarter-time panel variable; for the risk of conception model, and the interaction of mother's education and child birth year for the children's estimations. Table A.5 and A.6 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 households' remoteness. First, we estimate the models in equations (1) to (3) using the logarithm of the household distance to the closest health clinic instead of the dummy variable approach earlier explained. Second, we estimate our models using the Euclidian distance from the center of the village to the closest health facility within the commune instead of the household distance. Finally, the Euclidian household distance in our models might not reflect the "travel distance" to the closest health clinic. To address this concern, we estimate our models using the JICA distance instead of the household distance, a measure of the "travel distance" from the center of the village to the closest health clinic reported by the major of the village. We find that our results on women's risk of conception and child outcomes are robust to these three different specifications. These results are available upon request.

6.3 Placebo tests

We also perform some placebo regressions on outcomes that should not be affected by the program. In particular, we validate whether the children's health outcomes results are explained by unobserved factors which are not captured in our specifications. Table 13 shows that *Santenet2* program does not have a statistically significant effect on the household's per-capita consumption neither 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.

<<Insert Table 13 here>>

7. Discussion and Preliminary Conclusions

Most of the maternal and child deaths can be preventable in low-income countries (Dupas, 2011). While empirical evidence, mostly experimental, has indicated what type of demand and supply side interventions are effective in improving maternal and child health outcomes, there is a paucity of evidence on the effects of *large-scale* interventions on health outcomes in poor-resource settings (Dupas and Miguel, 2017). This paper analyses the effects of a large-scale volunteer Community Health Workers (CHWs) program, on the short-term fertility and children's health outcomes in Madagascar. This program consisted of two components. First, at the commune-level, the program disseminated information on preventive health care, guaranteed supply of health products (i.e., FP, bed nets, medicines, etc.), and coordinated massive vaccinations campaigns. Second, in the treated communes, the program trained in remote villages, located more than five kilometers away from the nearest primary health clinic, two members of the community in maternal and child primary health care services, one in family planning and the other in child disease management.

Distance is one of the major economic costs of preventive and formal health care in remote and rural areas in developing countries (Adhvaryu & Nyshadham, 2015). Thus, our main econometric specification captures the effects of the program in remote areas by using a triple difference model that combines the geographic and timing variation of the commune-rollout of the program with a third difference that is the household's distance to the closest health facility.

Our findings indicate that the program did reduce the probability of conception among women living within 5 kilometers from the closest health facility. Nevertheless, the program did not have a differential effect on the probability of conception among women who live in remote villages, i.e., those located further than 5 kilometers from the primary health facility, in other words, the targeted group of the program by the CHWs. Furthermore, our results indicate that female users of family planning were more likely to get their contraceptive supplies through the primary health facilities and community health workers suggesting that the program might have improved the procurement of family planning products.

Under the assumption that the program was implemented as intended, particularly the CHW component, these differences in the probability of conception between close and remote areas might be related to households' preferences over fertility, and thus, demand for modern family planning. Indeed, we do find that the decline in the probability of conception is driven by women who are more educated and from the upper quintiles of the wealth distribution. As a preliminary investigation of the households' fertility preferences, we examine the differences in women's ideal number of children, a proxy of stated preferences for family size, across *Santenet2* communes and distance to the nearest health center.[18] The ideal family size might be biased by cohort trends and women's current surviving number of children. Thus, following Berhman (2015), we also analyze an indicator of 'very high desired fertility', defined by whether a woman

[18] The question on 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.

reports 6 or more as an ideal number of children. This variable addresses these potential biases bias as 90% of the women in our sample have no more than 5 living children at the time of the survey. Using a similar specification as in equation (2), Table A.7 shows that *Santenet2* has a positive and statistically significant effect on women's ideal number of children, and so does the distance to health clinic; however, the coefficient of the interaction of these two variables is smaller and no longer statistically significant. These results are indicative of differences in preference of family size across remote and close areas. In future analysis, we will test for further related explanations to the different fertility preference responses to the program across the distance to the health clinic.

Alternatively it is plausible that we do not find statistically significant and sizable effects in the probability of conception in remote areas due to a weak coverage of the CHWs program. The CHWs were volunteers and did not receive any salary to compensate for the opportunity cost of their time. Although 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; indeed, some external evaluations of Santenet2 have pointed out the CHWs' dissatisfaction with the economic incentives given by the program (USAID, 2013).[19] This is an important consideration as recent empirical evidence has shown the important role that financial incentives can have in the CHWS's impact on health outcomes in Sub-Sahara Africa (Bjorkman et al., 2016).

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[19] According to the external evaluation some of the CHWs interviewed mentioned: *"The obstacle is the lack of money because if we go out to sensitize, as mothers, with life being so difficult right now you have to help your husband earn money. But sometimes doing the sensitization is not enough, and earning a living takes priority. We want to be paid for our work, and in this way we can include it in the way we plan out time. —Female mother-CHW, 51 years old, secondary education, Anjeva Gare.*

Furthermore, our findings on the CHW's role in providing health information are ambiguous which is consistent with the empirical evidence on the provision of maternal and child health information on health outcomes. On the one hand, we find that the CHWs did improve vaccinations uptake among children who live further than 10 km from the health facility suggesting the positive effects of their role in mobilizing households to the vaccinations campaigns or 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. Nevertheless, this result is consistent with other empirical evidence in Sub-Sahara Africa suggesting that the provision of maternal health care information does not increase women's utilization of facility-based birth delivery, potentially due to perceived low returns to formal health care (Bjorkman et al., 2017, Godlonton and Okeke, 2016).

Although CHWs programs are an alternative to extend the supply of primary health care in low-income settings such as Madagascar, these mixed results suggest that *Santenet2* was not effective in decreasing the distance cost for remote households to use preventive health care except for vaccinations. Our findings show that the program was effective in reducing the risk of conception for women living close to the primary health facility. Therefore, the program had a limited impact on the short-term maternal and child health outcomes in remote areas. Next steps in this research include investigating plausible reasons why this program did not work among the targeted population by the CHWs.

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TABLES AND FIGURES

Figure 1: Roll-out of Santenet2 program.

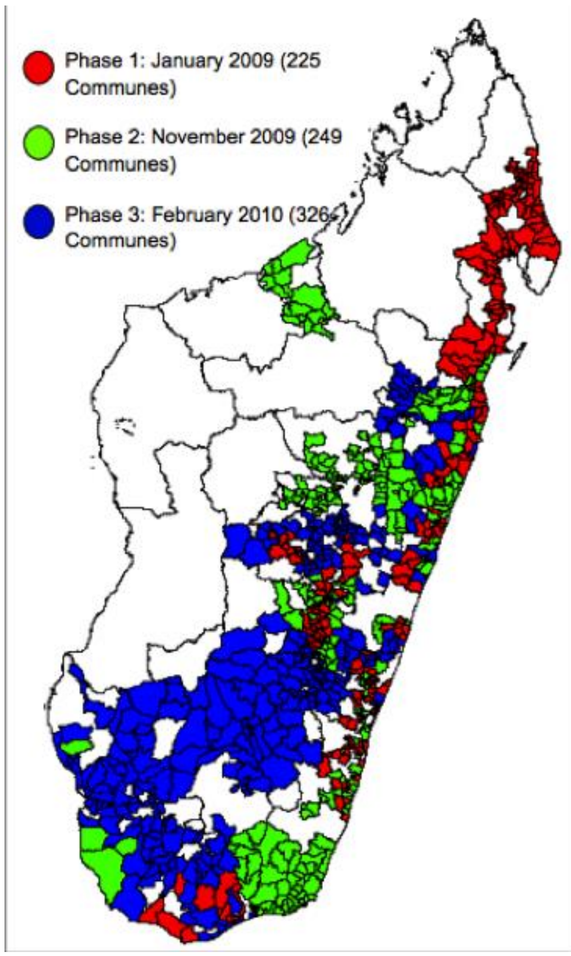


Figure 2: Analysis of parallel trends pre-Santenet2 using 2008-09 DHS

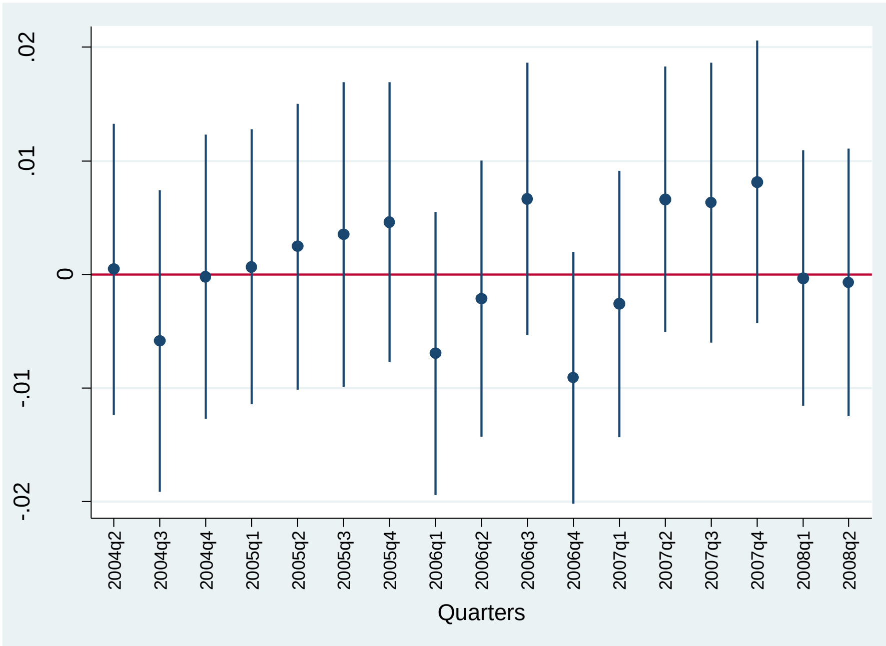


Figure 3: Parallel trends in Remote areas pre-Santenet2 using 2012-13 ENSOMD

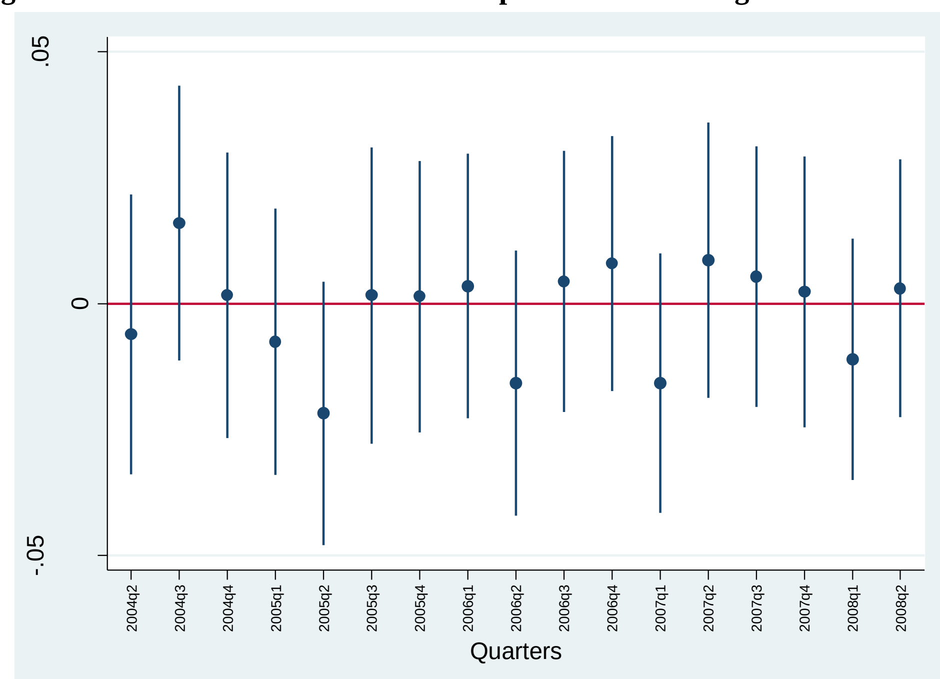
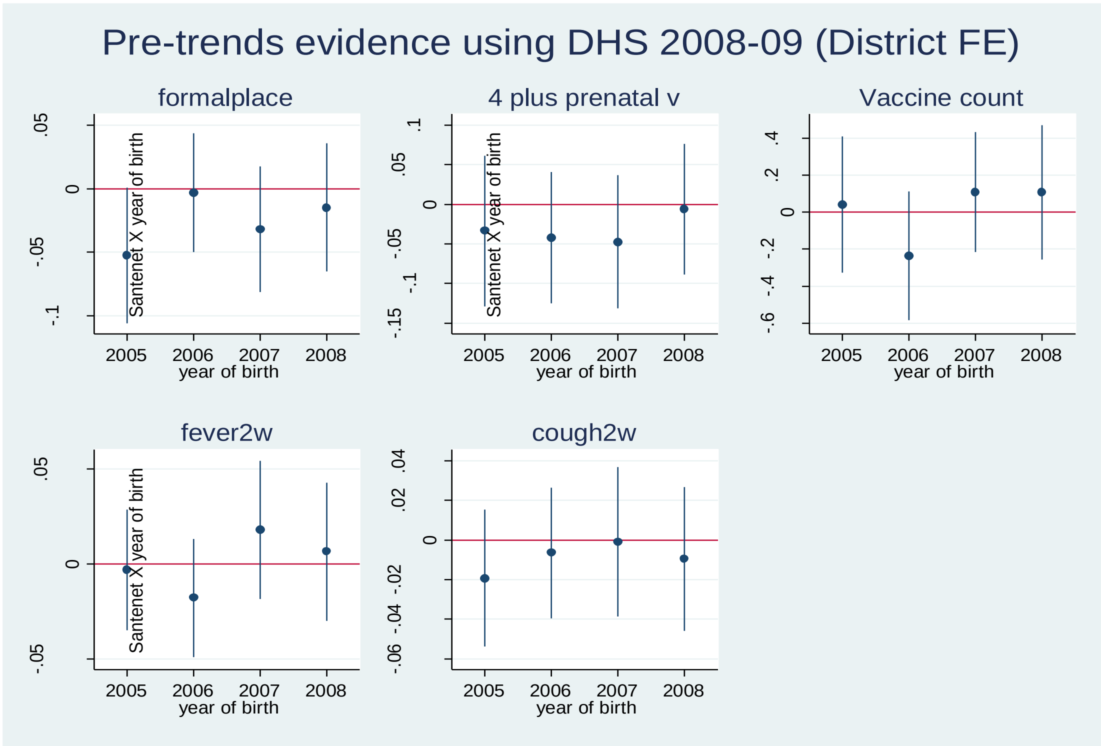


Figure 4 Analysis of parallel trends pre-Santenet2 using 2008-09 DHS - Children's Outcomes



TABLES

Table 1. Summary Statistics: Sample Women and Child Characteristics

	Full Sample		Dist 0-5 km		Dist 5 + km	
	Mean	SD	Mean	SD	Mean	SD
Women and child characteristics						
Santenet	0.45		0.44		0.45	
HH Distance to closest clinic	6.47		2.02		12.37	
Women's age	29.63	9.64	29.72	9.68	29.38	9.51
Women 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
Boy	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	
N	13,398		7,641		5,757	

Table 2: Santenet2 effects on Women's Risk of Conception

	(1)	(2)	(3)	(4)
	Double Difference Model	Triple Difference Model	DD: HH located close to health facility (0-5 kms)	DD: HH located further from health facility (5 km plus)
	Outcome: If conception quarter			
Santenetexpost	-0.003588957***	-0.004386892***	-0.004342369***	-0.002200104
	(0.001246761)	(0.001481647)	(0.001483754)	(0.002251121)
Santenetexpost*Dist5km+		0.002248727		
		(0.002636047)		
N	322450	305672	199868	105804
Mean Quart. Prob. of Conception	0.036	0.036	0.032	0.043
Mean Santenetexpost	0.203	0.203	0.192	0.224
R^2	0.017	0.018	0.016	0.019

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of santenet exposure, distance and time trends.

Table 3: Heterogeneous Effects of Santenet2 on the Probability of Conception

	(1)	(2)	(3)	(4)	(5)
	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)
	Outcome: IF Risk of Conception				
Santenetexpost	-0.004386892***	-0.003500749*	-0.002129298	-0.003674471*	-0.001837310
	(0.001481647)	(0.001993318)	(0.002028449)	(0.002075757)	(0.002164989)
Santenetexpost*Distance5kmsplus	0.002248727	0.001055463		0.003514992	-0.000459975
	(0.002636047)	(0.004913492)	(0.003181551)	(0.004816774)	(0.003318852)
Mean Quarterly Risk Conception	0.036	0.027	0.042	0.026	0.043
N	305672	119425	186247	125743	179929
R^2	0.018	0.017	0.018	0.015	0.018

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of santenet exposure, distance and time trends.

Table 4: Effects of *Santenet2* on the Probability of Conception by Women's age cohort

	(1)	(2)	(3)	(4)	(5)	(6)
	All Women	1963-1971	1972-1977	1978-1983	1984-1989	1990-1997
	Outcome: If Conception Quarter					
Santenetexpost	-0.004386892***	-0.004424434**	-0.005989422*	-0.000572387	-0.008058233**	-0.002102068
	(0.001481647)	(0.002155584)	(0.003216262)	(0.003293897)	(0.003340393)	(0.003726515)
Santenetexpost*Dist5km+	0.002248727	0.006473194	-0.001168334	0.003428280	0.006394208	-0.002322990
	(0.002636047)	(0.004370710)	(0.005611657)	(0.005764569)	(0.005546474)	(0.006204961)
Mean Quart. Prob. of Conception	0.036	0.013	0.031	0.041	0.047	0.041
N	305672	53524	56525	59900	69625	66098
R^2	0.018	0.020	0.020	0.020	0.019	0.025

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of santenet exposure, distance and time trends.

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

	(1)	(2)	(3)	(4)
	All Women	Distance 0-5kms	Distance 5-10 kms	Distance 10 kms plus
	Outcome: If Risk of Conception			
Santenetexpost	-0.004384679***	-0.004342369***	-0.001499952	-0.003330040
	(0.001481703)	(0.001483754)	(0.002685889)	(0.003963826)
Santenetexpost*Dist5-10kms	0.003142108			
	(0.003003102)			
Santenetexpost*Dist10kms+	0.001014636			
	(0.004160218)			
Mean Quart. Prob. of Conception	0.036	0.032	0.0432	0.0442
N	305672	199868	61370	44434
R^2	0.018	0.016	0.020	0.020

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of santenet exposure, distance and time trends.

Table 6: Effects of *Santenet2* on Family Planning Use

	(1)	(2)	(3)	(4)	(5)	(6)
	Current Use FP modern methods		FP methods obtained at Health Clinic		FP methods obtained Through CHWs	
Santenet	0.004188442	-0.0006807	0.166266428***	0.164216263***	0.051466391***	0.056982046
	(0.029932817)	(0.029802991)	(0.042856353)	(0.042768532)	(0.016057694)	(0.038679096)
Sant* Dist5kms	0.001112091		-0.05355277		0.053834984**	
	(0.027134182)		(0.043117638)		(0.022749919)	
Sant*Dist5-10 km		-0.0048763		-0.069566552		0.055388338
		(0.027128064)		(0.052050081)		(0.040496348)
Sant*Dist10km +		0.00818193		-0.019908776		-0.025983201
		(0.034108866)		(0.05844988)		(0.042176793)
R^2	0.106	0.107	0.2	0.2	0.044	0.117
Ymean	0.28		0.52		0.04	
N	12835		3819		3819	

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at district level. Models control by women's age cohort, education, parity, civil status and district fixed effects.

Table 7 : Effects of *Santenet2* on Prenatal and Postnatal Investments - DD approach

Panel A: Prenatal and birth investments	(1)	(2)	(3)
	Delivery in Formal Place	Professional Assistance in Delivery	>=4 prenatal visits
Born after Santenet	-0.0010	-0.0073	0.0307
	(0.0136)	(0.0136)	(0.0234)
Mean of Y	0.3813	0.4463	0.5936
N	12650	12634	6980

Panel B: Postnatal investments (vaccinations)	(1)	(2)	(3)	(4)	(5)
	Health Card Seen	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
Born after Santenet	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
N	12218	4612	4612	4612	4612

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

Table 8 : Effects of *Santenet2* on Prenatal and Postnatal Investments - DDD approach

Panel A: Prenatal and birth investments

	(1)	(2)	(3)
	Delivery in Formal Place	Professiona l Assistance in Delivery	>=4 prenatal visits
Born after Santenet	0.0079	0.0008	0.0301
	(0.0192)	(0.0191)	(0.0288)
Born after Santenet * Dist5 kms	-0.0190	-0.0173	0.0017
	(0.0269)	(0.0284)	(0.0476)
Mean of Y	0.381	0.446	0.594
N	12650	12634	6980

Panel B: Postnatal investments (vaccinations)

	(1)	(2)	(3)	(4)	(5)
	Health Card Seen	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
Born after Santenet	0.0107	-0.0349	-0.0485	-0.0260	-0.109
	(0.0226)	(0.0815)	(0.0812)	(0.0357)	(0.186)
Born after Santenet * Dist5kms	-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
r2	0.0439	0.0462	0.0448	0.250	0.0764
N	12218	4612	4612	4612	4612

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

Table 9 Effects of *Santenet2* on Prenatal and Postnatal Investments - DDD approach by distance

Panel A: Prenatal and birth investments

	(1)	(2)	(3)
	Delivery in Formal Place	Professional Assistance in Delivery	>=4 Prenatal Care Consultations
Born after Santenet	0.00792	0.000909	0.0305
	(0.0192)	(0.0192)	(0.0288)
Born after Santenet * Dist.5-10km	-0.0455	-0.0409	0.0180
	(0.0320)	(0.0341)	(0.0551)
Born after Santenet * Dist 10km+	0.0177	0.0136	-0.0307
	(0.0328)	(0.0366)	(0.0739)
Mean of Y	0.381	0.446	0.594
N	12650	12634	6980

Panel B: Postnatal investments (vaccinations)

	(4)	(5)	(6)	(7)	(8)
	Health Card	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
Born after Santenet	0.0108	-0.0366	-0.0500	-0.0263	-0.113
	(0.0226)	(0.0817)	(0.0814)	(0.0358)	(0.186)
Born after Santenet * Dist.5-10km	-0.0266	-0.0685	-0.106	-0.0200	-0.194
	(0.0352)	(0.153)	(0.155)	(0.0569)	(0.329)
Born after Santenet * Dist.10km+	-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 commune level and appear in parenthesis. All columns control for kid's gender, kid's birth order, mother cohort dummies, mother's education level, asset index quintiles, child birth year dummies, santenet communes and its interaction term with distance dummies, and commune fixed effects.

Table 10: Effects of *Santenet2* on children's illnesses and nutrition outcomes

	(1)	(2)	(3)	(4)	(5)
	Diarrhea in Last 2 Weeks	Fever in Last 2 Weeks	Cough in Last 2 Weeks	Underweight (Weight-for-Age <-2)	Wasting (Weigth-for-Height <-2)
Santenet	-0.0083	0.0112	0.0279	-0.0134	-0.0114
	(0.0120)	(0.0128)	(0.0175)	(0.0196)	(0.0110)
Santenet * Distance (>5km)	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
N	12055	12032	12038	9383	9321

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

Table 11: Effects of *Santenet2* on children's illnesses and nutrition outcomes - by distance

	(1)	(2)	(3)	(4)	(5)
	Diarrhea in Last 2 Weeks	Fever in Last 2 Weeks	Cough in Last 2 Weeks	Underweight (Weight-for-Age <-2)	Wasting (Weigth-for-Height <-2)
Santenet	-0.0084	0.0126	0.0237	-0.0123	-0.0104
	(0.0120)	(0.0126)	(0.0172)	(0.0196)	(0.0110)
Santenet * Distance (5-10km)	0.0013	-0.0237	-0.0232	0.0409	0.00390
	(0.0168)	(0.0175)	(0.0246)	(0.0257)	(0.0161)
Santenet * Distance (>10km)	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
N	12055	12032	12038	9383	9321

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

Table 12: Effects of *Santenet2* on potential mechanisms – children's outcomes

	Conditional on being sick							
	Seek treatment for illness		Use ORS (Oral Rehydration Salts)		Use medicine for fever and cough		Kid sleep under bed net	
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)	(2.20)	(2.23)
Santenet * Distance (5 plus km)	-0.0139		-0.0472		-0.0328		-0.0391	
	(0.0454)		(0.0577)		(0.0399)		(-1.36)	
Santenet * Distance (5-10km)		-0.0259		-0.0983		-0.0423		-0.0310
		(0.0529)		(0.0652)		(0.0454)		(0.96)
Santenet * Distance (>10km)		0.00516		0.0232		-0.0165		-0.0514
		(0.0617)		(0.0772)		(0.0538)		(-1.34)
Mean of Y	0.48		0.2		0.74		0.55	
N	3362		1276		2650		12089	

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

Table 13: *Santenet2* effects on per-capita consumption and poverty

	(1)	(2)	(3)	(4)
	Per-capita Consumption	Per-capita Consumption	Poor Household (Y=1)	Poor Household (Y=1)
Born after Santenet	14668.0	14710.6	-0.519	-0.441
	(16035.7)	(16117.4)	(1.646)	(1.645)
Born after Santenet * Distance (more than 5km)	-19144.9		1.102	
	(20104.7)		(2.168)	
Born after Santenet * Distance (5-10km)		-20872.5		2.036
		(23985.4)		(2.430)
Born after Santenet * Distance (>10km)		-16063.9		-0.285
		(18591.4)		(2.415)
Ymean	398038.2	398243.9	79.38	79.35
R^2	0.394	0.394	0.397	0.397
N	9863	9831	9863	9831

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

TABLES APPENDIX AND FIGURES

Table A.1 Balance test using 2008-09 DHS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	5 years plus of Schooling	Years of Schooling	Poor (1,2,3 Quintiles)	Ever Married	Age of First Marriage (18 yrs and younger)	Age of first Birth (19 yrs and younger)	Number of children younger than 5
Santenet	0.035993563	0.324806472	-0.014503334	-0.018619657*	0.006159152	0.010196097	0.008877855
	(0.024862433)	(0.215480527)	(0.037600970)	(0.010527459)	(0.012925662)	(0.014431652)	(0.045719530)
N	17364	17364	17373	17373	14165	12943	15284
R-squared	0.270	0.362	0.519	0.446	0.162	0.168	0.135
ymean	0.39	4.33	0.60	0.86	0.62	0.60	1.12

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

Table A.2 "Fake Santenet Treatment" effects on Women's Risk of Conception

	Lagged Santenet 20 quarters	Lagged Santenet 21 quarters	Lagged Santenet 19 quarters
	Outcome: If_conception_quarter		
"Fake"SantenetExpost	0.002806181	0.001804750	0.001495129
	(0.001865301)	(0.001901210)	(0.001837935)
"Fake" santenetexpost*Distance5kmsplus	-0.000519338	-0.001652794	0.000232113
	(0.003514150)	(0.003659768)	(0.003535900)
N	249321	249374	242540

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observations is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of santenet exposure, distance and time trends. The calendar time for the panel is between 2002Q1 and 2008Q.

Table A.3: Means of Women's Probability of Conception across Santenet 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
Tripple Difference				**0.0047**

Table A. 4: Exposure to *Santenet2* and Selective Migration

	Non-Mover	
Santenet	0.0027	0.0019
	(0.0233)	(0.0235)
Santenet * Distance (> 5 km)	0.0046	
	(0.0287)	
Santenet * Distance (5-10km)		0.0004
		(0.0335)
Born after Santenet * Distance (>10km)		0.0108
		(0.0396)
Mean of Y	0.480	0.480
R^2	0.0730	0.0730
N	14373	14373

Notes: * p<0.10; ** p<0.05; *** p<0.01. Standard errors are clustered at commune level and appear in parenthesis.

Table A.5: Adding Education Trends- Women's Probability of Conception

	(1)	(2)	(3)
	Outcome: If conception quarter		
Santenetexpost	-0.0044***	-0.0045***	-0.0027*
	(0.0015)	(0.0015)	(0.0015)
Santenetexpost*Distance5kmsplus	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
N	305672	305672	305672

Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of Santenet exposure, distance and time trends.

Table A.6: Adding Education Trends- Children's Outcomes

Panel A: Prenatal and birth investments

	(1)	(2)	(3)
	Delivery in Formal Place	Professional Assistance in Delivery	>=4 prenatal visits
Born after Santenet	0.0100	0.00237	0.0281
	(0.0192)	(0.0191)	(0.0288)
Born after Santenet * Dist. 5km	-0.0214	-0.0187	0.00634
	(0.0265)	(0.0280)	(0.0471)
Mean of Y	0.381	0.446	0.594
N	12650	12634	6980

Panel B: Postnatal investments (vaccinations)

	(1)	(2)	(3)	(4)	(5)
	Health Card Seen	Polio Count (max=3)	DTCOQ Count (max=3)	Rougeole Dummy	Total Vaccinations (max=7)
Born after Santenet	0.0126	-0.0346	-0.0475	-0.0252	-0.107
	(0.0225)	(0.0807)	(0.0806)	(0.0357)	(0.184)
Born after Santenet * Distance (more than 5km)	-0.0266	0.0876	0.0471	0.0205	0.155
	(0.0297)	(0.138)	(0.139)	(0.0526)	(0.301)
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 commune level and appear in parenthesis. All columns control for kid's gender, kid's birth order, mother cohort dummies, mother's education level, asset index quintiles, child birth year dummies, Santenet communes and its interaction term with distance dummies, and commune fixed effects.

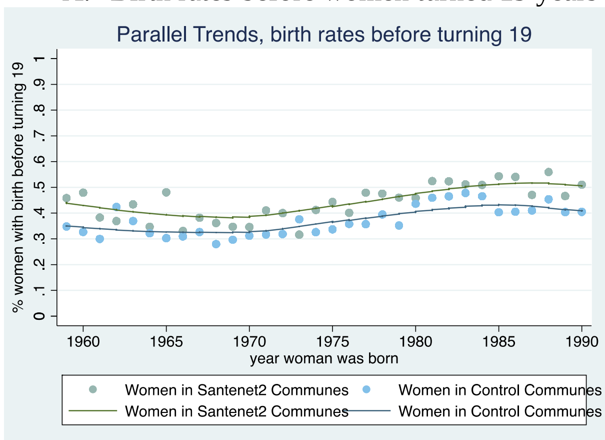
Table A.7: Fertility Preferences across *Santenet2* and distance to the health clinic

	(1)	(2)	(3)	(4)
	Ideal Number of Kids	Ideal Number of Kids	High Desired Fertility	High Desired Fertility
Santenet2	0.28171**	0.28211**	0.03233*	0.03174*
	(0.11447)	(0.11284)	(0.01829)	(0.01815)
Distance5kmplus	0.26985***		0.03794**	
	(0.09993)		(0.01594)	
Santenet2*Distance5kmplus	0.08108		0.00991	
	(0.14155)		(0.02359)	
Distance 5-10 kms		0.29542**		0.04698**
		(0.13223)		(0.01874)
Distance 10kmplus		0.23960**		0.02569
		(0.11728)		(0.02282)
Santenet2* Distance510km		-0.02078		-0.01244
		(0.16941)		(0.02623)
Santenet2* Distance10kmplus		0.24021		0.04437
		(0.18677)		(0.03214)
Y Mean	4.77086		0.30426	
N	13952	13952	13952	13952
R^2	0.419	0.420	0.374	0.374

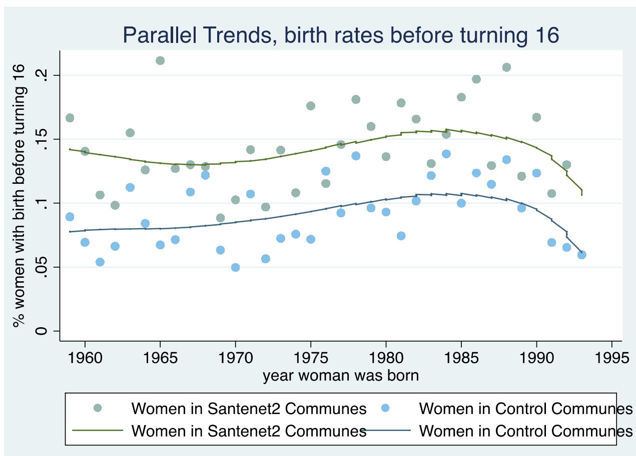
Notes: Significance levels: * p<0.10; ** p<0.05; *** p<0.01. Standard errors clustered at commune level. Unit of observation is woman-quarter. All models control by women's age cohort, education and parity, commune and quarter fixed effects and interactions of santenet exposure, distance and time trends.

Figure A.2: Parallel trends fertility outcomes

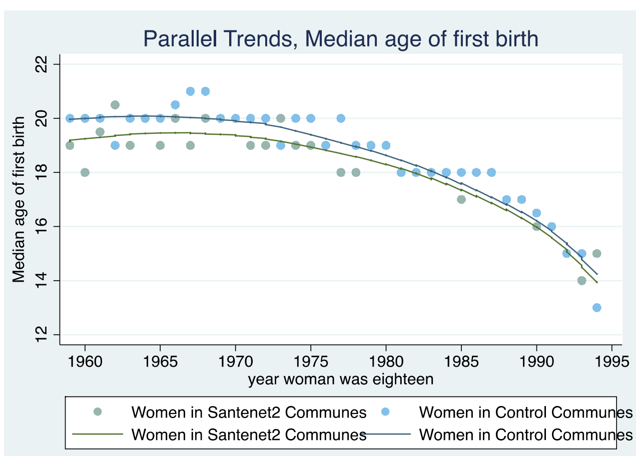
A. Birth rates before women turned 19 years



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