The Media or the Message? Experimental Evidence on Mass Media and Modern Contraception Uptake in Burkina Faso[1]

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Abstract

Mass media can spread information and disinformation, but its impact is hard to rigorously measure. Using a two-level randomized controlled trial covering 5 million people, we test both exposure to mass media (with 1,500 women receiving radios) and the impact of a high-quality, intensive 2.5 year, family planning mass media campaign in Burkina Faso (8 of 16 local radio stations received the campaign). We find women who received a radio in noncampaign areas reduced contraception use by 5.2 percentage points (p=0.039) and had more conservative gender attitudes. In contrast, modern contraceptive use rose 5.9 percentage points (p=0.046) in campaign areas and 5.8 percentage points (p=0.030) among those given radios in campaign areas. Births fell 10%. The campaign changed beliefs about contraception but not preferences, and encouraged existing users to use more consistently. We estimate the nationwide campaign scale-up led to 225,000 additional women using modern contraception, at a cost of US$7.7 per additional user.

JEL codes: J13, J16, L82

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Introduction

The geography of poverty and population is changing. If demographic trends persist, by 2030, 87 percent of extreme poverty will be in sub-Saharan Africa, by 2050 40% of children world-wide will live in sub-Saharan African, and progress on ending extreme poverty will come almost to a halt (UN, 2019, World Bank, 2018). West Africa is at the epicenter of these trends with the highest fertility rates in the world: Nigeria recently overtook India as the country with the most people in extreme poverty (World Bank, 2020). A quarter of women of reproductive age in sub-Saharan Africa report wanting to stop or delay childbearing but are not using contraception (Family Planning, 2020)[2] suggesting a need for cost-effective and scalable ways to help them achieve the lower fertility they currently desire.

Quasi experimental studies have shown that the spread of mass media has been associated with lower fertility and more liberal gender views (Jensen and Oster, 2009) but mass media has also been used for ill (Yanagizawa-Drott, 2014). The mass nature of mass media makes it hard to generate random variation in exposure to mass media and to specific content (La Ferrara 2016, Murray et al. 2018). Causal studies have demonstrated the potential of mass media to change behavior by showing that persuasive messaging and information can change highly consequential behaviors. But most of these studies either provide individually tailored information (e.g. Allende et al., 2019) or deliver messages in specially organized sessions (Jensen, 2010, Banerjee et al., 2019 and Bursztyn et al., 2020) which force people to pay attention, are highly salient, and signal the importance of the information being delivered. Mass media, in contrast, delivers messages in a crowded information environment, with a distracted audience, the opposite of the environment used to rigorously test most information campaigns.

We study the impact of mass media in general and a specific intensive mass media campaign on knowledge, attitudes and behavior related to family planning in Burkina Faso in a two-level randomized trial. To test the impact of mass media in general, 1,550 women (in 1,400 households) who had no radio in their

[2] http://www.familyplanning2020.org/

household at baseline, were randomly selected to receive a radio. Half of the women were in broadcast range of radio stations randomly selected to receive an intensive family planning radio campaign and half were in areas not covered by the campaign. This provides individual-level exogenous variation in exposure to general local radio programming (noncampaign areas) and in access to the campaign itself.

The media campaign, designed by Development Media International (DMI), was introduced in 8 out of 16 randomly selected FM study radio stations that are geographically and linguistically distinct.[3] The sample stations reached an estimated 5.1 million people or more than a quarter of the population of Burkina. The campaign lasted two and half years and consisted of one-minute and thirty second radio spots broadcast ten times a day (with new spots each week) and three one-hour interactive phone-in shows a week. Radio spots and phone-in shows were designed to address, in an entertaining way, the key barriers to contraception adoption identified through intensive formative research.

We use two waves of survey data with 7,500 women (both those with and without radios at baseline) and 461 clinics, as well as monthly administrative data on the number of contraceptives distributed by all clinics located in the study areas, to measure the impact of the media campaign.

The campaign led to a 5.9 percentage point increase (p-value=0.046) in modern contraceptive prevalence rate (mCPR), the primary pre-registered outcome of the study,[4] a 20% increase relative to the control group rate of 29.5%. This impact is driven by women who already had a radio when the campaign started (+7.7 percentage points or +26%) or who received a radio through the experiment (+5.8 percentage points or +17.5%). In contrast, receiving a radio in control areas, in this context, had a *negative* impact on modern contraception uptake (-5.2 percentage points or -16%) and on gender attitudes (11% of standard deviation decline). In

[3] Head et al. (2015) describe the media landscape of Burkina Faso and its suitability for a cluster randomized experiment.

[4] The study design and the primary and secondary outcomes were pre-registered on AEA social science registry (socialscienceregistry.org) with the ID: AEARCTR-0000892 and on clinicalTrials.gov with the ID: NCT02714686.

treatment areas, this negative impact of radio access was more than compensated for by the DMI family planning campaign.

Results from the women's survey are supported by clinic surveys and administrative data from clinics operating within 50 kilometers of the study radio stations. In areas covered by the campaign family planning consultations were 32% higher, [5] injectables 10% higher, and 22% more pills were distributed.

Increased knowledge and a decline in misconceptions about the potential side effects of modern methods appear to explain the positive impact of the campaign. Women in campaign areas were 9 percentage points (35%) less likely to say modern contraceptive methods can make a woman sterile and 8.4 percentage points (22%) less likely to say it can cause sickness. Attitudes toward family planning improved with women 7.8 percentage points (14%) more likely to say that "women should control the number of children they have during their lifetime". We find no significant impact on fertility preferences, attitudes toward birth spacing, or husband preferences (reported by women).

The media campaign was most effective for women using contraception before the campaign (many are not using it consistently), reporting unmet need for contraception, and with more information and positive attitudes toward family planning to begin with. Our findings are consistent with a human capital model of behavior in which women start out with biased beliefs which they update in response to the campaign: those for whom costs and benefits are most closely aligned initially are most likely to change behavior. They are also consistent with a behavioral model in which the campaign increases the salience of contraception for those already convinced of its benefits but for whom attention is a barrier to consistent use. We find no support for the prediction of Bayesian belief models that those with least information initially are most likely to be persuaded by information campaigns (Ackerberg, 2003). Our results suggest that, despite low rates of mCPR use, there are many women close to the margin of contraception use in Burkina

[5] Compared to the control group, the number of family planning consultations increased by 45% in October 2019 and 19% in November 2019, our two reference months. Contraception is free in Burkina Faso in November and thus an important month for distribution.

Faso and that they, rather than those with entrenched opposition to contraception, are good targets for mass media campaigns.

Finally, we find evidence that increased contraception use led to reduced fertility. Women age 29-49, the age group most likely to increase contraception, were 10% less likely to give birth in the year before the endline in campaign areas. This suggests increased use of modern contraception does not simply substitute for alternative practices to limit births including abstinence, even when the increase is primarily among those already aiming to limit their fertility.

As the campaign changed beliefs rather than preferences, corrected misinformation, and mainly changed behavior among women with unmet need, this program is likely to be welfare improving (DellaVigna and Gentzkow, 2010)[6] and we find a large impact on an index of self-assessed health and well-being (+27% of a standard deviation).

Overall, these results demonstrate that mass media is a powerful tool in changing highly consequential behaviors, but that impact depends on the quality and information content of the mass media, with the potential for negative impacts. More specifically, our results suggest high intensity mass media saturation campaigns can significantly impact modern contraception uptake over a prolonged period. This impact can be highly cost-effective in countries like Burkina Faso. We estimate that at least 37,000 additional women are using modern contraception because of the pilot mass media campaign, suggesting an annual cost per additional woman using modern contraception in the pilot of US$ 42.5. Under reasonable assumptions, this annual cost dropped to US$ 7.7 when the media campaign was scaled nationwide.[7] We estimate the national scale-up lead to 225,000 additional women using modern contraception in Burkina Faso. While rigorous data on the cost per Couple-Year Protection (CYP) achieved through other approaches is

[6] This is true independent of whether convincing women to have fewer children is welfare improving.

[7] The campaign was scaled up nationally in January 2019 when the preliminary results from this study became available.

limited, estimates range from US$30 to US$60 (IRC, 2016, Shade et al., 2013, Dulli et al., 2016, Rosen et al., 2019).[8]

Our results build on a broad literature on the role of information and beliefs in persuading people to change behavior (Duflo and Saez, 2003, Gerber et al. 2011, DellaVigna et al. 2014, Adena et al. 2015, Allcott and Gentzkow, 2016) and a small but growing literature suggesting mass media campaigns can positively influence health behaviors (La Ferrara, 2016 and DellaVigna and La Ferrara, 2015). While most studies are nonexperimental (Naugle and Hornik, 2014, Wakefield et al., 2010, Kearney and Levine, 2015), recent randomized experiments include Bernard et al. (2015), Banerjee et al. (2015), and Banerjee et al. (2019) who find that *edutainment* movies had positive impacts in Ethiopia, India and Nigeria respectively. Banerjee et al (2019) emphasize the importance of emotional involvement in the narrative for eliciting behavior change, while Bidwell et al. (2020) find an engaging video was more effective than a "just the facts" audio communication in changing behavior. Murray et al (2015) and Kasteng et al. (2018), in closely related work, are the only other RCTs to our knowledge which test the impact of a mass media campaign under conditions that are representative of the way people typically access media.[9] They find a significant effect on care-seeking for childhood symptoms of malaria, pneumonia and diarrhea and giving birth in health centers.[10] Uniquely, our paper simultaneously randomly varies exposure to mass media at a macro (radio station) level and a micro (individual) level. Consistent with Banerjee et al. (2019), we find information is a key channel for behavior change.

Second, this paper adds to the literature on the impact of general access to the mass media on behaviors and norms. Previous, nonexperimental, studies found

[8] IRC (2016) is noncausal and simply tries to cost provision of family planning through IRC programmes. Shade et al. (2013) and Dullie at al. (2016) have a small number of clusters and Rosen (2019) is a modelling exercise.

[9] In Bernard et al. (2015), Banerjee et al. (2015) and Banerjee et al. (2019), study participants in the treatment group were invited to screening sites to watch an *edutainment* movie.

[10] Murray et al (2015) and Kasteng et al (2018) randomise 14 radio stations into a child survival campaign run by Development Media International. Using clinic level data, they find an increase in care-seeking for childhood disease though no change in household reports of behaviour or on child survival.

access to television led to more gender equal norms and lower fertility in India (Jensen and Oster, 2009), access to progressive soap operas led to a reduction in fertility rates in Brazil (La Ferrara, Chong and Duryea, 2012), and access to community radio led to higher literacy rates and gender empowerment in Benin and Cambodia (Keefer and Khemani, 2014 and Cheung, 2012). In contrast, our results suggest that access to mass media can have negative effects.

Third, this paper speaks to the literature on family planning and contraception in developing countries (see Silva and Tenreyro, 2017 for a review). This literature finds modern contraceptive methods have large health and economic returns. However, many women who express the desire not to get pregnant are not regularly taking modern contraception. Ease of access (Miller 2010), gender norms, and different fertility preferences between men and women (Ashraf et al., 2014) contribute to unmet need (McQueston et al., 2012, Sedgh et al., 2007). Evidence on how to cost-effectively increase contraceptive uptake remains scarce (see Zakiyah et al., 2016 for a review). We contribute to this literature by identifying an intervention that is potentially cost-effective at scale in promoting modern contraception uptake. In addition, this paper highlights the importance of information barriers on potential side effects of modern methods and that many women with positive views on family planning can be encouraged to use modern contraception more consistently.

The rest of this paper proceeds as follows. Section 1 provides background on family planning, modern contraception and access to mass media in Burkina Faso, Section 2 provides details on the experiment design and Section 3 outlines the implementation of the mass media campaign and of the radio distribution. Section 4 describes the data and empirical strategy, Section 5 provides results on primary outcomes and an analysis of mechanisms at work while Section 6 discusses the cost-effectiveness of the intervention. Section 7 concludes and outlines policy implications.

1. Context

1.1. Access to Mass Media and Local Radio Stations in Burkina Faso

A controlled trial using radio is not feasible in most countries, because of the need to exclude national radio and television stations and thus much of the media's reach. While community radio is a major source of information for many in the developing world (La Ferrara, 2016), Burkina Faso currently has a particularly localized, radio-dominated media environment. National stations primarily broadcast in French (spoken by less than 20% of the population in rural areas) while local radios broadcast in local languages and have the largest audience. Radio penetration is high: the Demographic and Health survey (2010) found 68% of households own a radio and 56% of the population listens to the radio at least once a week. In contrast only 25% watch TV at least once a week. Data from our study area suggests that the average woman listens to 3.2 hours a week of radio. 12% of woman in our sample has access to TV and newspapers are virtually nonexistent in the area.

While radio is the dominant source of external information, 45% of households do not own a radio and 96% of women do not own their own personal radio.[11] Women who own their own radio on average listen to 2.4 more hours of radio a week.

Local radio stations broadcast a mix of informational and entertainment programs with a focus on local issues. According to our baseline data), 67% of women who listen regularly to the radio report listening to information shows, 55% to music programs, 51% to sensitization programs (mainly on health and education), 40% to debate and call-in shows, 35% to stories, and 20% to religious programs. While most sensitization programs carry progressive values on family planning and contraception,[12] it is not necessarily the case for other programs like call-in shows, debates, and religious programs. From qualitative interviews with local radio stations directors, we know that conservative gender attitudes are regularly expressed on the radio either during debates or by callers. In this context,

[11] Data on individual radio ownership comes from the endline survey and excludes those who received a radio as part of the programme.
[12] Sensitization programs are mostly co-organized with the Ministry of Health and often involve community health workers.

the potential overall impact of local radio stations on family planning is therefore ambiguous.

1.2. Fertility and Modern Contraception

Burkina Faso is one of a band of high fertility Sahelian countries in West Africa whose population has doubled in the last 25 years. At the start of the campaign, it had a total fertility rate of 5.4 children born to each woman, an mCPR) of 21.5% while 24.2% of women had an unmet need for contraceptive (PMA2020, 2016). Similar fertility, mCPR rates, and unmet need can be found in many countries in Africa.[13]

The desire for large families, and male control over a woman's fertility is thought to have its roots in African societies lineage-based systems[14] suggesting information may not be sufficient to change these attitudes. Within a standard economics framework, information only influences aggregate behavior if there is a systematic over or under estimation of costs and benefits (Dupas and Miguel, 2017, Dupas, 2011, Gong 2015), although behavioral studies have found that information interventions can work through increased salience (without changing knowledge) and reminders (Kremer et al. 2019, Bertrand et al., 2010, Mullainathan et al. 2008). Interventions are most likely to change the behavior of those for whom costs and benefits are initially relatively equally balanced (Kremer and Glennerster 2011). This suggests mass media and mass media campaigns are most likely to change behavior if they: address a widely held misconception; target those who are close

[13] It includes most countries in Africa for which similar PMA2020 data is available: Ivory-Coast (fertility rate of 4.8, mCPR of 21.8%, and unmet need of 25.1%), Ethiopia (4.5, 27% and 16%), Ghana (4, 21.7% and 23.5%), Niger (7.1, 19% and 21%), Nigeria (5.5, 15% and 20%), and Uganda (5.2, 28% and 24%).

[14] In the literature in demography, Caldwell and Caldwell (1987) argue that many traditional religious belief systems in Sub-Saharan Africa (such as the cult of the ancestors) are pronatalist and centered on the continuation of the family line. Continued fertility is associated with virtue and wealth while reproductive failure, family planning and contraception are associated with punishment and evil. Bongaarts and Casterline (2013) find that the ideal family size in Sub-Saharan Africa is higher than in other part of the world, even when controlling for development level. It provides some empirical support for the idea that the fertility transition might be slower in Africa and family planning policies less effective.

to indifferent; and have high intensity. Messages to promote contraception will only be effective if women can access contraception.

2. Experimental Design

To measure the impact of the radio campaign we rely on a clustered randomized design implemented at the radio station level. Sixteen local radio stations were randomly allocated between a treatment group (eight stations) where the media campaign took place and a control group (eight stations) where regular programming continued. These 16 stations were selected because of their large audience and very localized coverage areas which reduces the risk that someone in a control area listens to a radio station in the treatment group. The randomization was conducted within pairs of radio stations with similar baseline levels of the primary outcome (mCPR).[15] Figure (1) shows a map of Burkina Faso with the estimated broadcast coverage areas of the 16 radio stations. The few small areas where coverage overlaps were excluded from the study. While Burkina Faso is uniquely suited to an RCT on radio campaigns 16 is the maximum number of stations with sufficiently distinct coverage areas and high market penetration to include in the RCT (Head et al., 2015).

A small number of clusters creates two challenges: there is a reasonably high probability that balance across treatment and control clusters will not be achieved by random chance (Kasteng et al., 2018, who ran a previous radio station RCT in Burkina Faso encountered this problem); and statistical power is low. To address the first issue, we used pairwise randomization with clusters with similar baseline levels of contraception paired and one of each pair selected. We also selected our study sample in each cluster so that it was representative (on key characteristics) of the entire sample rather than representative of the cluster. This reduced the chance of being unbalanced between treatment and control, reduced variation and thus boosted statistical power (for more detail see section 5).

[15] It was conducted in the office using STATA.

To estimate the impact of access to mass media in the absence of the campaign and to introduce additional (exogenous) variations in exposure to the radio campaign at the household level we distributed radios to a random subset of women who did have access to radios. Using our baseline survey data, we identified 2,787 households (3,138 women) who had no radio in the household and randomly allocated 50% to receive a radio.[16] This additional intervention allowed us to measure the impact of receiving a radio in areas where the mass media campaign was implemented and to compare it with the impact of receiving a radio in noncampaign areas.

3. Program Implementation

3.1. The Radio Mass Media Campaign

The mass media campaign was implemented by Development Media International (DMI),[17] a non-governmental international organization specialized in TV and radio mass media campaigns. The campaign followed an approach developed by DMI called the "*Saturation +*" approach based on the following principles (see Murray et al., 2015, for additional details):

- Saturation: Broadcasting messages 10 times per day on market-leading radio stations, using 90-second spots in local languages. In addition, broadcasting three regular one-hour interactive phone-in programs per week.
- Science: Use qualitative research to understand the values and motivations of the target audience. This includes formative research, pre-testing and feedback research and involved regular visits to rural villages in all areas targeted by the program.
- Stories: stories are designed to craft the emotional climax of the story (the moment of decision, where protagonists must either overcome the obstacles

[16] The randomization was conducted in the office using STATA and was stratified on the following variables: village, using modern contraception at baseline and ever attended formal education.

[17] https://www.developmentmedia.net

or revise their goals) to address the crucial barrier to behavior change, as identified by formative research.

Most radio stations broadcast from 6am until around 11pm which represents 119h per week. DMI content was broadcast for 4h45min per week. Overall it represents 4% of the total content. However, DMI broadcast the majority of its content during the 4 hours of peak listening times early in the morning and in the evenings.[18] DMI content represents 17% of peak listening time.

The main potential barriers to modern contraception uptake identified by DMI's formative research included information on the different modern methods available in this context (implants, injectables, condoms and pills), concerns about side effects and misconceptions about infertility caused by modern contraceptives, information on the health and economic benefits of birth spacing, gender norms and family planning not being perceived as men's responsibility. Examples of stories used during the campaign are available on DMI's website.[19]

The mass media campaign was launched in June 2016 and lasted until December 2018. To limit the incidence of power outages, the 8 radio stations in the treatment group also received new solar systems so they could broadcast with no interruption. In one cluster in the north of the country, the campaign had to be stopped after 6 months for security reasons. This cluster was kept in the study sample.

3.2. Radio Distribution

The 1,557 women (in 1,397 households) who did not have a radio at baseline and were randomly identified by the research team to receive a radio were tracked by DMI employees and 1,130 were found and presented with a radio between March and June 2017. Thus, while the media campaign lasted 2.5 years, women in the additional radio intervention only had their new radio for 1.5 years. Of those

[18] At baseline, 73% of women listening regularly to the radio declared listening to the radio at night and 29% early in the morning. Only 8% and 12% declared listening to the radio at noon and in the afternoon respectively.
[19] https://www.developmentmedia.net/burkina-faso-family-planning-rct.html

targeted to receive a radio, 28% did not receive it. During this period of the year, many women travel to other villages where they have fields and are growing crops and absence from the village was the main reason women did not receive radios. The radios offered by DMI use solar energy which make them particularly adapted to this context where most women don't have access to electricity and may lack money to buy batteries.

To encourage women to keep the radio for themselves, they were told that DMI would come back after some time to their village, and women who still had their radio would be eligible for a lottery for a small cash prize (around US$ 3.5). The lotteries were organized following the endline. Ninety five percent of women who received a radio and were successfully interviewed during the endline still had their radio: 62% of radios were still functioning properly (conditional on still having the radio).

4. Data and Empirical Strategy

Three sources of quantitative data are used to assess impact: survey data on women, surveys of clinics close to the women in our survey, and administrative data on all clinics located in the study areas.[20] Appendix figure (A1) presents the timeline of program implementation and data collection.

4.1. Survey data

The sampling strategy for our women's survey was designed to ensure balance and maximize statistical power with a small number of clusters. First, we randomly selected 16 villages per cluster (252 villages in total) among all villages with the following characteristics: located between 5 and 50 kilometers from our sample radio stations, less than 1,500 inhabitants, not connected to the electricity grid, and within 5 kilometers from a health center. The objective was to select villages where television access is limited (no electricity) and thus radio listenership high, and

[20] In addition, qualitative data were regularly collected before and during the implementation of the program for monitoring purposes and to inform quantitative questionnaire design.

where supply of modern contraceptive was not a major barrier to use. While we lost some external validity by selecting rural villages near clinics, our survey data is still representative of 1.4 million inhabitants or 7.5% of the total population of Burkina Faso in 2018 according to census data. As discussed below our administrative data is more representative.

Second, we selected 7,515 women in these villages in a way that makes our 16 clusters as similar as possible on key characteristics. To do that, we created strata of women with and without education and with and without radio access and then sampled women within each cluster proportionally to their share in the overall sample population.[21] Intuitively, this involved over-sampling educated women in clusters with few educated women and under-sampling educated women in clusters with many educated women. Similarly, we harmonized average distances to a health center across clusters by oversampling women from villages close to clinics in clusters with high average distances to clinics. As a result, our 16 clusters look more similar in our final women sample than in our initial listing survey sample. Appendix A1 provides more details on sampling and shows graphically how averages of three key characteristics (distance to clinic, education and radio access) were *smoothed* by this strategy.[22]

For our clinic sample, we selected all clinics "officially" in charge of the 252 villages sampled for the women survey as well as any clinic identified by village chiefs or respondents. We ended up with 461 clinics. The external validity of this sample is slightly stronger than the external validity of the women survey sample because many women who live in villages that are not in the survey sample visit these clinics.

Baseline survey data on the 7,515 women, 252 villages and 461 clinics were collected in April-June 2016. A follow-up survey took place in November-December 2018. The follow-up rate is 89.5% for the women survey and 97.6% for

[21] We used data from a household listing survey implemented before our baseline survey.
[22] We find similar results when we reweight our data to account for this sampling strategy (see appendix Table A2).

the clinic survey.[23] These rates are statistically indistinguishable in control and treatment areas (Appendix Table A1). Because of security concerns, some surveys had to be conducted by phone (11.5%, balanced by treatment and control, Appendix Table A1).

At baseline, women in our sample were on average 30 years old, 83% were married, 20% had ever been to school and 47% were generating income (Table 1). Women lived on average 4.5 kilometers from a health center and 23% were using modern contraception. This is close to the average found in the nationally representative PMA2020 survey conducted in 2015 (21.5%). Women using a modern contraceptive relied primarily on implants (11%), injectables (8%) and oral pills (2%). All other methods taken together represented less than 1%. Observable characteristics are well balanced on the post-attrition sample (Table 1).

4.2. Administrative Data

We use monthly administrative data provided by the Ministry of Health in Burkina Faso for the period April 2015-December 2018. This contains monthly counts of six methods of contraception sold in health centers (male condoms, female condoms, implants, injectables, intrauterine devices, and pills). This data comes from monthly reports that every clinic in Burkina Faso has to send to their health district. We included in this sample all health centers located within 50 kilometers of a study radio station which corresponds to the estimated broadcasting area of each radio. This generated a sample size of 838 health centers (461 of which overlap with our clinic survey sample) with data for 45 months. The external validity of this sample is stronger than the external validity of the survey sample because it includes health centers located in urban areas or in rural villages with electricity. According to census data, 5.1 million people in 2018 were living in areas covered by our administrative data or 27% of the total population of Burkina Faso.

[23] Due to increased security concerns in 2018 in the northern and eastern parts of Burkina Faso, it was not possible to send surveyors to 32 villages in the sample. In these villages shorter interviews focusing on the most important outcomes were conducted over the phone. 11.5% of women and 5% of clinics were surveyed over the phone. These rates are similar in treatment and control groups.

In our analysis, we focus on implants, injectables and pills. These three methods are the more widely offered by clinics and the more frequently used by women (less than 1 percent of women reported using another modern method). Before the program started, health centers in our sample were distributing an average of 6 implants, 25 injectables and 15 packs of oral pills every month.

4.3. Empirical Strategy

To analyze the impact of the mass media campaign within our women and clinics survey samples, we use the following specification:

$$Y_{i,j,t=1} = \beta_0 + \beta_1 Treat_i + X_i' + \epsilon_{i,j,t=1} \quad (1)$$

where $Y_{i,j,t=1}$ is the outcome variable of women (or clinic) *i* living (or operating) in cluster *j* measured at the follow up survey ($t = 1$), $Treat_i$ is an indicator for being assigned to the treatment group and X_i' a vector of control variables. X_i' includes strata dummy variables (one dummy variable for each pair of clusters used for the randomization) and a dummy variable equal to 1 if the data were collected over the phone (instead of in-person). $\epsilon_{i,j,t=1}$ is the error term clustered at the radio station level. β_1 is our coefficient of interest and gives the effect of living in an area assigned to receive the mass media campaign. To account for the small number of clusters, we implement the wild bootstrap procedure proposed by Cameron et al. (2008) with 2,000 replications to calculate p-values of the test $\beta_1 = 0$. For women survey data, we estimate equation (1) separately for the whole sample and for women who had access to a radio in their household at baseline.

To estimate the impact of receiving a radio in both treatment and control areas, we estimate the following equation, on the sample of women eligible for the radio distribution intervention (i.e. women who had no radio at baseline):

$$Y_{i,h,t=1} = b_0 + b_1 Radio_i + X_i' + \epsilon_{i,h,t=1} \quad (2)$$

where $Y_{i,h,t=1}$ is the outcome of woman *i* in household *h* measured at the follow-up survey and $Radio_i$ an indicator for being assigned to the radio distribution intervention. b_1 is the coefficient of interest and gives the impact of been assigned to the radio distribution intervention. We cluster the standard errors at the household level (at which the radio intervention was randomized). We estimate equation (2) separately for women living in control and treatment areas.[24]

Finally, to estimate the impact of the media campaign on the number of contraceptives distributed using monthly administrative clinic data, we use a difference-in-difference strategy with clinic and time fixed effects. This specification takes advantage of the high-frequency dimension of the database which spans 45 months and starts one year before the program took place:

$$Y_{i,j,t} = \propto_0 + \propto_1 Treat_i * Post_t + c_i + \tau_i + \epsilon_{i,j,t} \quad (3)$$

where $Y_{i,j,t}$ is the outcome variable for clinic *i* in time *t* in cluster j. $Treat_i$ takes the value 1 if the clinic is located within 50 km of a radio station assigned to treatment and 0 if the clinic is located within 50 km of a control radio station. $Post_t$ takes the value 1 in all time periods after the start of the mass media campaigns (April 2016 onward), c_i are clinic fixed effects, and τ_i are time-period fixed effects. The standard errors, $\epsilon_{i,j,t}$, are clustered at the radio station level. $\propto_1$ is our coefficient of interest and provides the average intent-to-treat estimate of the treatment effect. P-values of the test $\propto_1 = 0$ are calculated using the wild bootstrap procedure proposed by Cameron et al. (2008) with 2000 replications.

5. Results

5.1. First Stage: Did the Radio Distribution and Media Campaign Reach Targeted Women?

[24] In alternative specifications presented in appendix Table A3, we estimate equations (1) and (2) with additional controls for the baseline value of the dependent variable. Results are similar.

Results from the endline women's survey show the radio distribution and campaign reached targeted women (Table 2). In control areas, 55% of women had access to a radio in their household, 87% often listened to the radio (an average of 2 hours a week), and 60% listened regularly to the study radio station.[25] The radio distribution intervention doubled the chance that there was a radio in the household from 32 to 68 percent in noncampaign areas and from 34 to 68 percent in campaign areas. The chance that a woman had her own radio increased even more: from 4 to 56 percent in noncampaign areas and 1 to 64 percent in campaign areas. On average women who received radios as part of the treatment reported listening to the radio over an hour more per week in both campaign and noncampaign areas. The impact of the radio distribution on radio ownership and listenership between campaign and noncampaign areas were statistically indistinguishable.

The media campaign had no effect on radio access, radio ownership, amount of time spent listening to the radio or the likelihood a woman listened regularly to the study radio station (Table 2, column 2). The media campaign did change the type of programs women listened to. The share of women who listened to a sensitization program on the radio in the last week increased from 13% to 23% in treatment areas (p-value = 0.005[26])[27], the likelihood a woman had ever heard of family planning on the radio or had heard of family planning in the last month rose from 76% to 97% (p-value = 0.02) and 63% to 80% (p-value=0.003) respectively. Even in control areas, a large share of women regularly heard of family planning on the radio suggesting the main effect of DMI's media campaign was on the intensive margin (i.e. listening more often) as well as the quality of the programming, rather than on the extensive one (ever hearing family planning content).

[25] Many women did not know the name of the radios they are listening to. This number is therefore, likely a lower bound of the real share of women listening to the study radio station.
[26] When applicable, all reported p-values are computed using the wild bootstrap procedure.
[27] We find negative but not significant point estimates on the share of women who listened to music (-5 percentage points), to religious programs (-2.2 percentage points) and to debates and call-in shows (-2.2 percentage points) in the last week. It suggests that sensitization programs broadcasted by DMI replaced these other types of program.

5.2. Impact on Modern Contraception Prevalence Rate

5.2.1. Women Survey Data

Women who received radios in noncampaign areas reduced contraceptive use by 5.2 percentage points (p-value=0.039, Figure 2) compared to women who did not receive a radio. The use of implants fell particularly sharply. We discuss later why access to a radio could have a negative impact on contraception adoption in this context.

In contrast, the mass media campaign increased modern contraceptive prevalence rate (mCPR, our primary pre-specified outcome[28]) by 5.9 percentage points (intention to treat estimate, p-value=0.046). This corresponds to an increase of 20% relative to the control group mCPR of 29.5%. The point estimates for each individual method are positive (and imprecise) suggesting that change in behavior is spread across several methods (Table 3). We find similar results on the share of women willing to use modern contraception in the future or who used a modern method during their last sexual intercourse and when we include effective traditional methods (abstinence, rhythm, and withdrawal). The impact is thus driven by an increase in contraception use and not a substitution towards modern contraception from other forms of contraception including abstinence, withdrawal, and the rhythm method.

The impact is concentrated on the sub-population of women who already had a radio at baseline (Figure 2) for whom the prevalence rate of modern contraception increased from 29.1% to 36.8% (p-value=0.007). There is no significant impact on those without a radio at baseline suggesting limited spillovers (results available upon request).

Women living in areas targeted by the media campaign who received a radio, were 5.8 percentage points (p-value=0.030) more likely to adopt a modern method relative to women who did not receive a radio (Figure 2). This increase in contraceptive use is not due to exposure to mass media in general.

[28] Our primary pre-specified outcomes include total contraception use (modern and effective traditional methods) as well as mCPR. We focus on mCPR because this outcome is more widely used in the family planning literature and very few women in our context report using a traditional method. Results on total contraception use are similar and also presented in Table 3.

The negative impact of the radio distribution in noncampaign areas and the positive treatment effect of the mass media campaign took place at a time when mCPR was rising rapidly: from 23% in the baseline survey to 29.5% in the endline survey. This finding is consistent with data from the nationally representative survey PMA2020 which finds an increase of mCPR from 21.5% in 2016 to 27.3% in 2018 (30.7% for women in union).

5.2.2. Clinic Survey and Administrative Data

Clinic level data on the number of family planning consultations and the number of modern contraceptives distributed provides an important validity check on women's self-reported contraception use from surveys. To account for the large number of zeros and large outliers in the administrative data,[29] we implement three (preregistered) strategies. First, in all specifications, we top-coded our outcomes at the 99th percentile. Second, in some specifications we use logarithmic (for family planning consultations) and inverse hyperbolic sine (IHS) transformations of the outcomes (for contraceptives distribution).[30] Finally, we smooth the highly variable administrative data by using three month and six-month averages as our outcome variable. This smoothing addresses the concern that several months-worth of contraceptives are distributed or reported at one time with zeros reported for other months.

Both clinic survey and administrative data give results that are consistent with a large impact of the mass media campaign on modern contraception uptake

[29] The administrative data contains a high proportion of zeros across all contraceptive methods. Most of the time, these zeros represent no activity or contraceptive distribution during the month. But it some cases, zeros can also correspond to missing values if the clinic did not file a report or the district did not enter the data. Anecdotal evidence also suggests that because these data are gathered on a quarterly basis, some districts sometimes allocate all the contraceptives distributed during the quarter to one month only and report zero for the two other months. In addition, this data includes large range of values for contraceptives sold, high variation from one month to another and some extreme outliers. This likely reflects variation in size of clinic, variation in price (there are two weeks every year when all contraception is free), and possible variability of contraceptive distribution.

[30] The IHS transformation is defined by $IHS = \log\left(y + (y^2 + 1)^{\frac{1}{2}}\right)$. This technique helps address data that includes observations with many high values but still allows for zeros. This transformation is approximately equal to $\log(2y)$ or $\log(2) + \log(y)$ and can be interpreted as a logarithmic dependent variable. Since writing our pre-analysis plan the technique has become less popular because it is hard to interpret results but we include results for completeness.

(Table 4). Using clinic survey data (Panel A), we find the campaign increased the average number of family planning consultations from 31 to 45 in October (p-value=0.048) and from 60 to 71 in November 2018 (p-value=0.203).[31] The number of injectables distributed in October increased from 27.5 to 39 (p-value=0.198) and the number of pills from 16.3 to 32 (p-value=0.094). We find similar results using the administrative data (Panel B).[32] Health centers located in treatment areas distributed on average 2.22 more injectables (+9%, p-value=0.058) and 3.3 more oral pills (+22%, p-value=0.123) per month in our preferred specification using data aggregated quarterly.

The impact for implants is positive and imprecise in the survey data and close to zero in the administrative data. A likely explanation is that many implants are distributed by NGOs and thus not included in clinic registers. Marie Stopes International (MSI), an important NGO working on family planning in Burkina Faso, operates near 68% of the clinics of the control group according to our survey data. This number is 22 percentage points lower for clinics in treatment areas suggesting MSI targeted control areas, potentially because they had lower contraceptive uptake, which might have biased downward our estimate of program impact.[33]

5.3. Mechanisms

5.3.1. Why did giving radios in noncampaign areas reduced contraception use?

The 5.2 percentage point fall in the use of modern contraceptive methods among women given radios in noncampaign or control areas (Table 3, column 6) is concentrated among women who had unmet needs for contraception at baseline and

[31] November is a special month in this context because it includes the week of free contraception. Many contraceptives are distributed during this week. Clinic registers are often incomplete in November as many clinics record contraceptives distributed during the week of free contraception in separate registers.

[32] The coefficient using administrative data is smaller but not significantly different from that found using data from the women's survey.

[33] Discussion with MSI Burkina Faso suggests they were initially differentially targeting our control areas. Once they learned about the study, they agreed to work similarly in both treatment and control areas.

knew most about contraception. While radio distribution, by increasing listenership, increased the probability that women heard about family planning on the radio by 19 percentage points in noncampaign areas (Table 2, column 6), this programming was not effective in increasing knowledge about contraception (Table 5, column 6), suggesting the programming was not effective in changing women's beliefs.

A potential mechanism is that access to media without the targeted DMI campaign had a negative impact on gender attitudes (Table 5, column 6). Women were 3.6 percentage points (5%) more likely to agree with the statement that "*a man is superior to a woman*" and 4.6 percentage points (17%) more likely to agree with the statement "*Boys should have more opportunities and resources for education than girls*". It suggests that in this context, local radio stations (without the media campaign) do not promote progressive values on gender and modern contraception.

This finding is supported by qualitive interviews conducted with the directors of radio stations located in control areas who suggested some radio content might promote negative views of family planning and contraception. Several directors explained that radio call-in shows and debates provided a platform for and amplified conservative gender attitudes found in some parts of the population with, for example, callers expressing negative attitudes towards women who use contraception. Radio directors reported that radio staff in control areas were not sufficiently trained on family planning to respond convincingly to critics and concerns about family planning raised by callers. According to radio directors, most of the official communication on family planning is concentrated around the two weeks of free contraception (one in April/May and one in November every year) and focuses on informing women about where they could find free contraceptives during these two weeks. The advantages of family planning and the pros and cons of each method are rarely discussed on control stations.

5.3.2. Is the Media Campaign Changing Beliefs or Preferences?

A mass media campaign could change behaviors through two key mechanisms: providing information which changes beliefs or by changing attitudes/preferences (La Ferrara, 2016). Distinguishing these mechanisms is critical for drawing welfare

conclusions (DellaVigna and Gentzkow, 2010). We therefore pre-registered six families of outcomes measuring knowledge, attitudes and perception of family planning and contraception and calculated standardized z-scores for each family following the methodology in Kling et al (2007).[34] Coefficients are then measured in percentage of the control group standard deviation (see Appendix 2 for the definition of all variables included in the indexes).

The mass media campaign increased the knowledge of contraception index by 0.29 standard deviation (p-value=0.000) in our main, radio station level, specification (Table 5, column 2). This result is driven by a large reduction in the share of women believing modern contraception can make a woman sterile (from 26% to 17%, p-values=0.002) or cause sickness (from 38% to 30%, p-value=0.016). Women in treatment areas are also more likely to have ever heard of injectable and oral pill methods.

The campaign also improved attitudes toward family planning, driven by increases in the share of women who think that "women should control the number of children they have during their lifetime" (from 55% to 63%) and that it is acceptable to discuss family planning in newspapers (from 95% to 96%) or during cultural events (from 94% to 96%).

Changes in fertility norms and attitudes toward contraception were small and not significant including on questions such as "it's embarrassing to buy a contraceptive", "using a contraceptive is a sign of not trusting your partner", as well as on women's or husband's[35] ideal number of children and time between two births.

We find no significant impact on other pre-specified secondary endpoints (indexes of gender attitudes and women's empowerment) or an index of domestic violence. Data from women who had a radio at baseline (Table 5, column 4) and the radio distribution experiment (column 6) provide additional evidence that

[34] All indexes use a list of pre-specified variables re-coded so that more positive values mean more knowledge or more positive attitudes. We created a z-score for each variable by subtracting the mean and dividing by the standard deviation of the variable in the control group. Finally, we compute the average of all variables composing the index and standardize this average using the mean and standard deviation of the control group.

[35] As declared by the women.

knowledge about contraception is the main mechanism through which the mass media campaign impacted behavior. Both show strong changes in the family planning knowledge index (0.31 and 0.133 respectively) and no changes in norms.

5.3.3. Who changes behavior in response to communication campaigns and what can that tell us about models of persuasion?

Human capital models suggest that people adopt a health technology, such as contraception, if the net present value of expected benefits outweigh the expected costs. Communication only increases adoption if it changes beliefs of expected benefits or costs (for example by reducing the perceived likelihood of negative side effects of contraception) and in a direction that increases net benefits. Those most likely to change behavior are those who were close to the margin of adoption before the intervention. Inconsistent adopters are likely to be at this margin.

In Bayesian belief models, the consumer's level of certainty about their priors matters: the weaker the priors the more weight is given to credible new information and thus the more likely communication is to impact behavior. Under these models, communication is most effective in persuading those with least knowledge of a product including those who have never used it before (Ackerberg, 2001, 2003 and Dupas, 2014). Bayesian models also capture the importance of credibility of messenger: priors are updated more if the messenger is credible.

In behavioral models, mass media can persuade people to change behavior even if they do not change their beliefs or their preferences (DellaVigna and Gentzkow, 2010, Mullainathan et al. 2008). Reminders and increases in salience can lead people to adopt a behavior they want to adopt but undertake only inconsistently because of constraints on their attention. While there is empirical evidence that preferences are malleable, we do not discuss these models here because we find no evidence of changes in preferences in our context.

We examine these alternative hypotheses by estimating equations (1) and (2) separately for women with different baseline characteristics on four dimensions:

use of contraception, age, level of information on modern contraception and attitudes towards fertility and birth spacing.[36]

We find strong evidence for inconsistent use of contraception (Table 6). Nearly half (48%) of women who were using modern contraception at baseline are no longer using it at endline suggesting these women are close to indifferent about adoption. The media campaign was especially effective on these women, increasing the modern contraception prevalence rate from 48% to 61% (p-value=0.000). We find lower but sizable impacts on women who declared unmet need for contraception at baseline (increased from 28% to 33%, p-value=0.005) but no effect on women who declared no unmet needs at baseline. Combined with the finding that the campaign increases the accuracy of beliefs (by addressing misconceptions that contraception caused sterility for example) this suggests the program was welfare improving, whether or not we take a stand on the welfare benefits of increasing women's preference for contraception.

The evidence of inconsistency in contraceptive use and the large program impact on women who were using contraception at baseline is also consistent with a model of limited attention where women want to use contraception but forget and the campaign increases the salience of contraception. The structure of the campaign—with frequent messages over 2.5 years and the focus on engaging programming—was well adapted to influence behavior through this mechanism. The salience mechanism does not require a change in beliefs of the kind observed in this study. However, it is plausible that the two are complements: that a change in beliefs has more impact on behavior if it is more salient and/or delivered in a more engaging way. Casey et al find supportive evidence for this hypothesis.

The media campaign impact was also larger for women older than 22 years old at baseline and for women who had more information on contraception (from 35% to 43%, p-value=0.063) and more positive attitudes toward family planning and birth spacing (from 32% to 41%, p-value=0.007) to begin with. Impact

[36] Alternatively, we could have looked at impact heterogeneity by interacting the heterogeneity variable with the treatment dummy in equation (1) and (2) in a simple regression. This method gives similar results. We choose our method because it allows us to keep the same format as in our previous tables when presenting the result.

on women younger than 22, women who had less information on contraception and more negative attitudes towards family planning are much smaller and not statistically significant. These women had less unmet needs at baseline (38% of women under 22 years old at baseline had unmet needs compared with 48% of women older than 22). These findings are inconsistent with the prediction of some Bayesian belief models that information campaigns are most likely to change behavior for those with least information about a product (Ackerberg, 2003).

5.4. Does increased use of modern contraceptive methods change fertility and well-being?

We examine the impact of the campaign on fertility (Table 7). Childbirth has the benefit of being a more objective outcome than self-reported contraceptive use, but it is less frequently observed and thus we have limited statistical power to detect changes. Examining the impact on fertility also allows us to check that increased use of contraception is not offset by the impact of other changes of behavior (e.g. reduced abstinence).

Consistent with the effect on modern contraception uptake, we find a negative point estimate for the media campaign impact on the share of women who gave birth in the 12 months preceding the endline survey (from 17.4% to 16.1%, p-value=0.38). This negative impact is (marginally) significant among women aged 29-49 years old at baseline (from 15.7% to 14.2%, p-value =0.094), the population who saw the largest increase in mCPR because of the program (as seen in the previous subsection). Given the low statistical power for this outcome we did not prespecify fertility as a primary outcome nor did we prespecify looking at fertility by age of those groups most impacted by the media campaign. This 10% reduction in fertility is consistent with the level of correlation between contraceptive prevalence and fertility identified in the demographic literature (Bongaarts, 2017).[37]

[37] Using the relationship between contraceptive prevalence and fertility identified in Bongaarts (2017) for sub-Saharan Africa, an increase in contraceptive prevalence from 29.5% to 35.4% should correlate with a reduction in fertility from 4.82 to 4.36, a 9.3% reduction.

Consistent with the idea that there was some substitution in ways of controlling fertility we also find a positive impact on the share of women who had sex in the last 3 months which increased from 50% to 58%, (p-value =0.125, not prespecified). Lower fertility among those with unmet need for contraception, and increased sexual activity are consistent with an increase on a pre-specified index of self-assessed health and well-being (0.258 standard deviation, p-value =0.008). This last result is consistent with the program being welfare improving.

5.5. Robustness to Adjustment for Multiple Hypothesis Testing

A push towards greater transparency in economics research has been spurred in part by the risk of over rejection of the null hypothesis from multiple hypothesis testing (Garret and Miguel 2018). Young (2019) finds that the average RCT includes 34 regressions. To guard against this danger, we prespecified a single primary outcome (mCPR). However, in examining mechanisms and secondary impacts we simultaneously examine the impact of the mass media campaign on 10 (pre-specified) indexes (nine in Table 5 and one in Table 7). To reduce the risk of over-rejection of the null, we correct p-values for multiple hypothesis testing using the false discovery rate control method introduced by Benjamini et al. (2006) and described in Anderson (2008). Our results for our indexes of "knowledge of contraceptive methods", "attitudes towards family planning" and "self-assessed health and well-being" are robust to false discovery rate adjustment (Table A3) (q-values are equal to 0.001, 0.041 and 0.038 respectively).

6. Cost-Effectiveness

We examine the cost-effectiveness of the pilot (which reached 5 million people) and estimate the cost-effectiveness of a nationwide scale-up to 39 local radio stations under various assumptions. A nationwide scale-up started in January 2019 when preliminary results of this study became available. We conclude this section by comparing the cost-effectiveness of this intervention to alternative approaches evaluated in other contexts.

6.1. Program Costs

Program implementation costs are calculated using data provided by DMI. We convert all expenses to expenses in the year of analysis (2018).[38] For the pilot program, this data represents actual expenses made by DMI. The total cost of the pilot program was US$ 3.1 million. To estimate the total cost in case of a national scale-up, we use the budget and total amount of money that DMI received from its donors to fund the scale-up of the program across Burkina Faso. We estimate that a national scale up would cost US$ 3.4 million. These cost estimates do not account for the additional costs incurred by the Burkinabe Ministry of Health (including additional contraceptives and additional time spent by health workers counseling women).[39] The Guttmacher Institute estimate the cost of supplies were $3.5 per woman per year, which we add as an additional marginal cost to our cost-effectiveness calculations.

6.2. Number of Women Using Modern Contraception because of the Program

A key challenge is that our measure of the program impact is only valid on the population on which our survey data is representative. As described in Section (4.1), this data is representative of women living in villages with fewer than 1,500 inhabitants, with no electricity, located between 5 and 50 kilometers of the local radio station town and within 5 kilometers of a health center. Using national population census data,[40] we estimate that in 2018, approximately 177,000 women of reproductive age were living in a village reached by the radio campaign and for which our survey data are representative. Using the same data, we estimate that around 448,000 women of reproductive age were also reached by the media

[38] See https://www.povertyactionlab.org/research-resources/cost-effectiveness for more details on our cost-effectiveness analysis methodology.
[39] According to the Guttmacher Institute (2017), the Ministry of Health in Burkina Faso spend US$ 18 million on family planning services in annually, or around US$ 14.22 per woman using modern contraception.
[40] We use projections of the 2018 population calculated using the 2006 national census.

campaign but were living in villages or towns for which our survey data are not representative.

When the program was scaled-up nationally, the number of radio stations broadcasting the campaign increased from 8 to 39. We use data on each radio broadcasting area (computed by DMI) to calculate that approximately 83% of the population of Burkina Faso is reached by the national campaign. Figures A3 in the appendix shows a map of Burkina Faso with the estimated broadcasting areas covered by the 39 radio stations that are part of a national scale-up. Using census data, we estimate that almost 1.2 million women of reproductive age are now reached in areas similar to our survey data and 2.6 million in less similar areas.

For women living in areas for which our survey data are representative, we can use our estimate of the program impact from our survey data (+5.9 percentage points). For other areas reached by the campaign, we must make additional assumptions about the impact of the program. We consider three different assumptions:

- Assumption 1: the program impact was the same everywhere (+5.9 percentage points). Under this assumption, the program increased the number of women using modern contraception by 37,000 in areas targeted by the pilot. This number increases to 225,000 with the national campaign.
- Assumption 2: the program had no impact in areas for which our survey sample is not representative. Under this assumption, the program increased the number of women using modern contraception by 10,000 in areas targeted by the pilot and by 70,000 with the national campaign. This assumption represents the most conservative assumption and a lower bound of the program cost-effectiveness.

Two pieces of data suggest that assumption 1 may be the most valid assumption (and indeed may underestimate impact and thus cost-effectiveness). First, we find larger impacts on women who had access to a radio, were using modern contraception at baseline and had more information on modern contraception to begin with. Urban populations, which constitute a large share of the population for

which we are seeking to extrapolate an effect, include women who have on average more access to a radio (56% of women in urban areas listen weekly to the radio against 41% in rural areas according to DHS, 2010), who are more likely to use modern contraception (44% in urban against 21% in rural according to PMA2020, 2016), and who have more information on contraception (72% in urban against 62% in rural have a good level of information on modern methods according to PMA2020, 2016).

Second, we can use administrative clinic data on contraceptive distribution to estimate the program impact in areas reached by a study radio station (within 50 km of a radio station) but which are not in the clinic survey sample (i.e. not used by women in the women survey sample). We have monthly data for 235 clinics of this type. Results for these (more urban) clinics are presented in the appendix Table A4 and are slightly larger than the results for the overall administrative data sample (Table 4). This provides additional support for assumption 1.[41]

6.3. Annual Program Cost per Additional Woman using Modern Contraception

Using total program costs, population data and impact estimates, we can derive the cost per additional woman using contraception during the pilot study. Under our preferred assumption (Assumption 1) the cost per additional woman using modern contraception was US$85 during the pilot study and drops to US$ 15.3 under the nationwide scale up. To compute the annual cost per additional woman using modern contraception, we assume the program had the same impact for two years (i.e. that the program started to have an impact after 6 months and then the same impact throughout the remaining two years). We can then divide the cost per additional woman using contraception during the pilot by two which gives an annual cost per additional woman using modern contraception of US$ 42.5 for the

[41] While the format of the radio campaign changed slightly (with fewer interactive shows) when taken to national scale, DMI reacted to the results in this paper that information was a key mechanism by reintroducing the interactive segments at no additional cost.

pilot study and US$ 7.7 for a national scale-up ($46 and $11.2 respectively if we include estimated cost of additional supply).

This assumption of rapid and sustained impact is motivated by monthly administrative clinic data which shows the number of contraceptives distributed rose rapidly within a few months of the campaign start and was then relatively constant across the two years (see appendix figure A4).

6.4. How economically significant are the results on contraception and cost-effectiveness?

To benchmark our results, we compare them against results from evaluations of alternative approaches to increasing mCPR use, trends in the use of mCPR in Burkina Faso and other African economies and the costs of supplying contraception in Burkina Faso.

Evidence on the cost-effectiveness of alternative approaches to promote mCPR, especially introduced at scale, is scarce. Integration of family services into other health services is among the most promising approaches tested. Shade et al. (2013) show that integrating family planning into HIV services in 12 clinics in Kenya significantly increased contraception use at a cost of US$65 per new user per year. Dulli et al. (2016) find that integrating family planning into immunization services in 7 clinics in Rwanda increased contraception use at a cost of US$32 per new user. The IRC (2017) estimated the average cost per couple year protection provided across four of their family planning programs was $47: this study did not attempt to calculate impact or cost-effectiveness. The DMI campaign is more cost-effective than these alternatives when done at nationwide scale under our preferred assumption (US$7.7 per additional user) and under our most conservative assumption of no program effect in areas different from our survey data (US$ 24.7 per new user). The cost-effectiveness of the more limited pilot program is however comparable (US$ 42.5 per new user).

Data from nationally representative household surveys across Africa suggest the magnitude of the effect from the DMI campaign is large in comparison

to trends in mCPR usage over time. (PMA 2020). MCPR increased an average of 4.1 percentage points each year in DMI treatment areas. By comparison, PMA 2020 data from various sub-Saharan African countries (including Burkina Faso), shows the average annual increase in mCPR during the same time period ranged between 0.4 and 2.8 percentage points (Figure 3). The treatment effect of the campaign is equivalent to 2.5 years of the improving trend in Burkina Faso (see Appendix Figure A5), illustrating how an effective demand side intervention can complement and accelerate the impact of supply side provision.[42]

Finally, we benchmark the cost-effectiveness of this intervention against the cost of other (primarily supply side) family planning spending in Burkina Faso. The Guttmacher Institute (2017)[43] estimate that US$ 18 million is spent on family planning services in Burkina Faso annually, or approximately US$ 45 million over the 2.5 years of the campaign with an average cost per woman using modern contraception of US$ 14.22 per year. In comparison, the campaign increased contraception use (under our preferred assumption) at a cost of $11.2 per year including the cost of contraceptives. This "marginal" cost is 21% lower than the above estimated average cost of $14.22 (but assumes that health service implementation costs are fixed). The increased use of modern contraception brought about by the campaign, would not have been possible without sufficient supply-side family planning initiatives supplying the contraceptives, but mass media is a highly cost-effective add on.

7. Conclusion and Policy Implications

We provide causal evidence that access to mass media and varying the content of mass media can change a highly consequential behavior (fertility decisions) but that the impact depends critically on the quality of the message being delivered. We find that, in the absence of high-quality programming, access to mass media can lead to

[42] The time trend found in the PMA2020 survey for Burkina Faso is similar to the trend seen in our control data.
[43] See https://www.guttmacher.org/fact-sheet/adding-it-up-contraception-mnh-2017

less progressive attitudes towards women's role in society and lower use of modern contraception. In contrast, a high-quality mass media public health campaign can effectively challenge misconceptions about contraception and increase the use of contraception when delivered at scale in highly realistic conditions. We show that such campaigns can be many times more cost-effective than other effective family planning interventions. We provide evidence that lack of information (especially on side effects of contraceptives) is a constraint to contraception use in low education communities where fertility is high and there is an unmet need for contraception. This is true even though imbalances between the power of men and women over contraception decision making are not addressed. We demonstrate that the challenge of studying mass media impact can be overcome (in some environments) with a multi layered randomization design which combines randomization at the radio station level with individual level randomization of access to radios.

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Figures

Figure 1: Research Design: Clustered Randomized Experiment with 16 Clusters

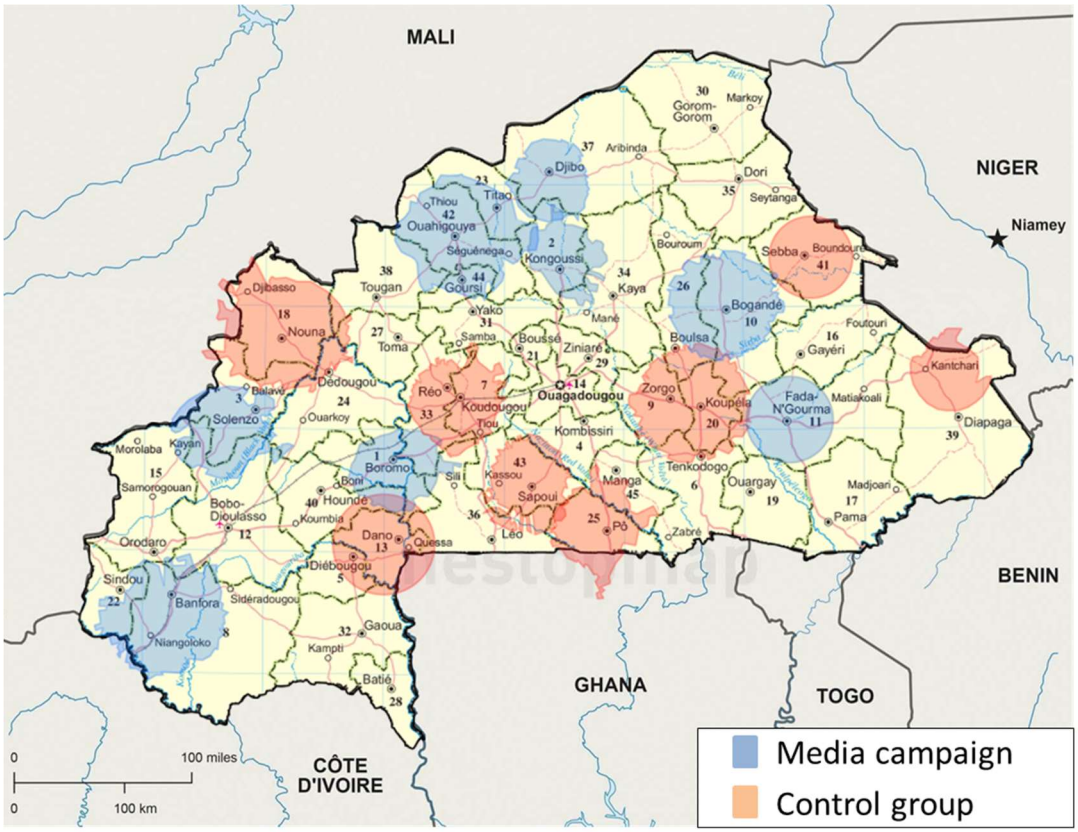


Figure 2: Impact on Modern Contraception Prevalence Rate (mCPR)

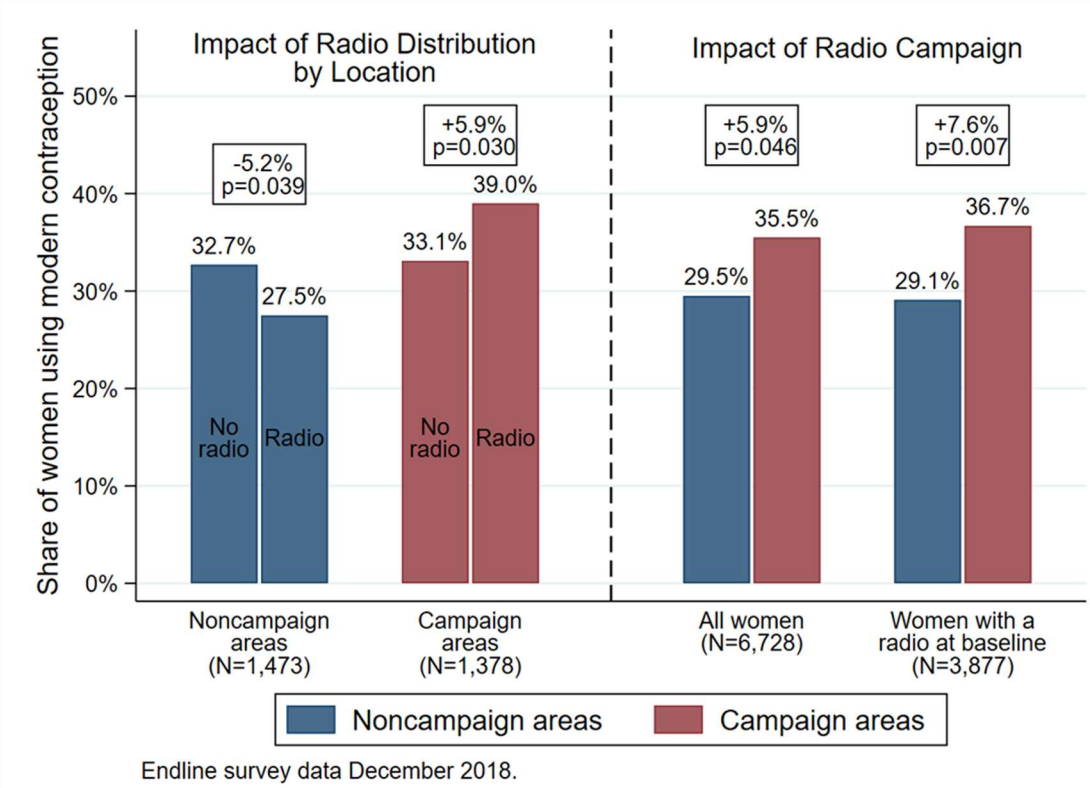
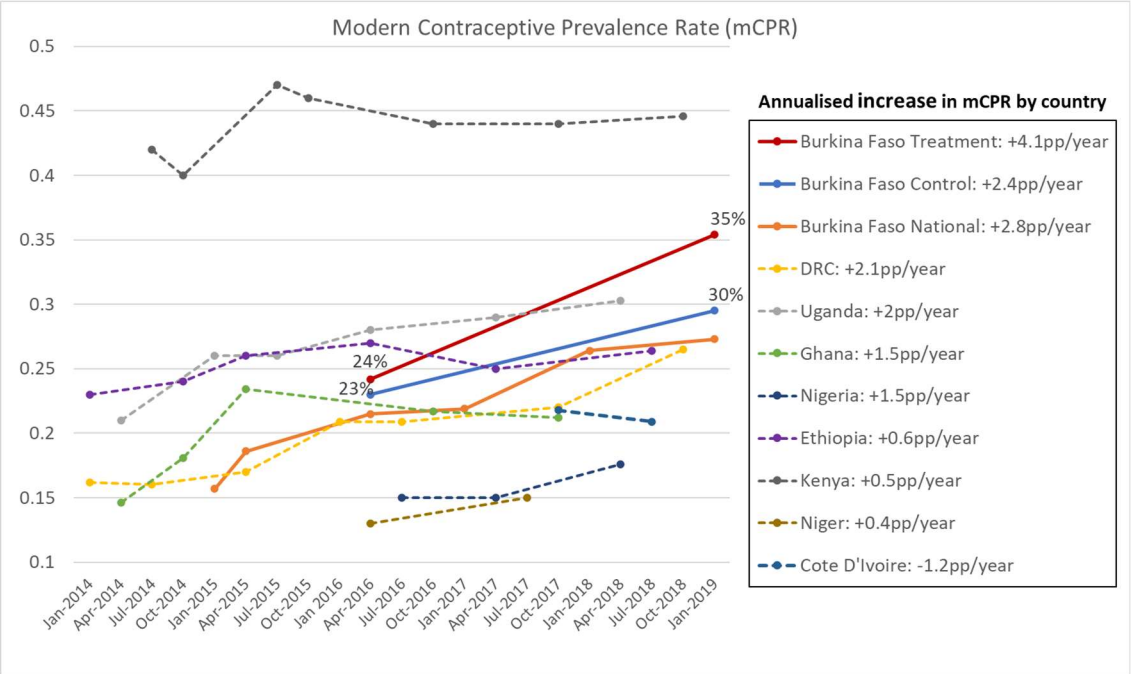


Figure 3: Comparing mCPR Trends to Other Countries in Africa



Notes: Survey data and data from PMA 2020.

Table 1: Baseline Characteristics of Post-Attrition Women Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Overall sample		**Women with a Radio**		**Women with No Radio**			
					In control areas		In treatment areas	
	Control Mean	Treat. Mean P-value	Control Mean	Treat. Mean P-value	No radio Mean	Radio Mean P-value	No radio Mean	Radio Mean P-value
Currently using contraception$^{\alpha}$	23%	24.2% 0.52	24.8%	26% 0.621	21.7%	19.6% -	22.4%	22.7% -
Used a contraception method at last sex	18.8%	19.3% 0.871	20.5%	20% 0.946	17.6%	15.5% 0.2	19%	18.6% 0.723
Want to use contraception in the future	69.4%	70.7% 0.844	70.9%	71.9% 0.839	68%	67% 0.962	68.1%	70.3% 0.372
Current situation wrt. family planning:								
Unmet need for spacing	34.3%	33.1% 0.726	32.5%	31.8% 0.871	36.5%	36.9% 0.869	32.8%	33.7% 0.673
Unmet need for limiting	11.8%	12.4% 0.655	12.2%	11.7% 0.226	10.6%	11.9% 0.657	13.3%	14.6% 0.418
No unmet need	19.2%	17.1% 0.633	18.5%	16.6% 0.698	20.4%	19.5% 0.36	19.4%	17.1% 0.313
Distance to nearest Clinic	4.5	4.6 0.686	4.6	4.6 0.931	4.4	4.2 0.214	4.4	4.6 0.959
Age	30.5	30.1 0.631	30.5	30 0.288	30.7	30.1 0.273	30.5	30.3 0.786
Married	83.2%	84% 0.821	83.5%	84.7% 0.697	84.3%	81.5% 0.087*	82.9%	82.2% 0.807
Total number of pregnancy	4.2	4.3 0.491	4.2	4.3 0.819	4.4	4 0.003***	4.5	4.3 0.392
Ever attended formal school$^{\alpha}$	20%	18.3% 0.381	21.4%	20.3% 0.751	17.5%	19.6% -	14.9%	15.9% -
Generate income	47.1%	45.1% 0.865	50.1%	48.4% 0.822	43.3%	43.4% 0.985	42.3%	41.5% 0.727
Muslim	44%	59.2% 0.47	44.2%	58% 0.239	43.9%	43.6% 0.781	59.1%	54.1% 0.02**
Catholic	29%	19.4% 0.398	30.9%	20% 0.151	25.7%	28% 0.366	19.2%	22.4% 0.175
Protestant	10.8%	8.4% 0.746	9.8%	8% 0.555	11.7%	11.9% 0.282	10.4%	9.2% 0.777
Traditional / animist	14.7%	11.9% 0.768	13.7%	12.8% 0.911	16.3%	15.4% 0.919	10.5%	13% 0.14
Understand radio language	67.7%	86.2% 0.192	67.8%	86.9% 0.332	68%	66.7% 0.455	90.5%	90.5% 0.953
Listen to the radio in the last week	29.3%	28% 0.821	45.1%	41.4% 0.468	10.8%	9.5% 0.634	11.6%	13.6% 0.187
Has access to a radio in her household	55%	54.9% 0.992	100%	100%	0%	0%	0%	0%
N total	3,328	3,400	1,829	1,866	734	739	692	686

Note: Baseline survey data, April 2016. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the radio station level and p-values are computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): Coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standards errors are clustered at the household level. α: variables used for stratifying the randomization of the radio distribution intervention. ***, **, * indicate statistical significance at 1, 5 and 10%

Table 2: Impact on Radio Ownership, Listenership and Content

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	No radio Mean	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
At least a Radio in the household	0.553 [0.497]	0.016 (0.043)	0.603 [0.49]	0.028 (0.063)	0.324 [0.468]	0.356*** (0.027)	0.335 [0.472]	0.342*** (0.029)
Has her own personal radio	0.179 [0.383]	-0.027 (0.017)	0.066 [0.249]	-0.036*** (0.011)	0.044 [0.204]	0.557*** (0.022)	0.012 [0.107]	0.643*** (0.021)
Listen to the radio in the last 7 days	0.347 [0.476]	-0.021 (0.059)	0.357 [0.479]	-0.019 (0.055)	0.271 [0.445]	0.15*** (0.025)	0.201 [0.401]	0.265*** (0.027)
Amount of time listened to the radio in the last 7 days (hours)	2.006 [5.163]	-0.163 (0.324)	2.101 [5.522]	-0.46 (0.359)	1.368 [3.945]	1.172*** (0.273)	1.135 [3.932]	2.007*** (0.282)
Often listen to the radio	0.872 [0.334]	0.023 (0.026)	0.882 [0.323]	0.029 (0.025)	0.79 [0.407]	0.157*** (0.02)	0.819 [0.385]	0.135*** (0.019)
Often listen to the cluster Radio station[α]	0.601 [0.49]	0.009 (0.155)	0.614 [0.487]	0.025 (0.166)	0.532 [0.499]	0.111*** (0.029)	0.552 [0.498]	0.107*** (0.024)
Listen at least once in the last week to :								
Information shows	0.166 [0.372]	0.000 (0.023)	0.184 [0.388]	-0.004 (0.028)	0.104 [0.305]	0.083*** (0.019)	0.1 [0.3]	0.158*** (0.022)
Senzitization programs	0.133 [0.34]	0.097*** (0.01)	0.145 [0.352]	0.09*** (0.02)	0.079 [0.27]	0.075*** (0.018)	0.149 [0.356]	0.22*** (0.025)
Religious programs	0.065 [0.246]	-0.022 (0.017)	0.066 [0.249]	-0.024** (0.013)	0.04 [0.195]	0.041*** (0.013)	0.025 [0.155]	0.056*** (0.013)
Debates and call-in shows	0.165 [0.371]	-0.022 (0.046)	0.18 [0.384]	-0.029 (0.048)	0.095 [0.294]	0.103*** (0.019)	0.092 [0.29]	0.132*** (0.022)
Music	0.167 [0.373]	-0.05 (0.061)	0.177 [0.381]	-0.042 (0.051)	0.124 [0.33]	0.078*** (0.018)	0.072 [0.259]	0.105*** (0.02)
Ever heard of Family planning on the radio	0.759 [0.428]	0.116*** (0.04)	0.772 [0.42]	0.116*** (0.042)	0.653 [0.476]	0.192*** (0.024)	0.821 [0.384]	0.116*** (0.019)
Heard of FP on the radio in the last	0.09 [0.287]	0.139*** (0.04)	0.084 [0.277]	0.141*** (0.043)	0.091 [0.288]	0.029* (0.017)	0.155 [0.362]	0.189*** (0.025)
Heard of FP on the radio in the last	0.633 [0.482]	0.17*** (0.054)	0.631 [0.483]	0.193*** (0.057)	0.529 [0.499]	0.214*** (0.027)	0.725 [0.447]	0.138*** (0.024)
N total	6,728		3,877		1,473		1,378	
N in-person survey	5,860		3,314		1,202		1,307	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. α: information only available in the in-person survey. ***, **, * indicate statistical significance at 1, 5 and 10%

Table 3: Impact on Modern Contraception Uptake: Women Survey Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
Currently using modern contraception (mCPR)	0.295 [0.456]	0.059** (0.03)	0.291 [0.454]	0.077*** (0.03)	0.327 [0.469]	-0.052** (0.025)	0.331 [0.471]	0.058** (0.027)
Method used:								
Implant	0.165 [0.371]	0.026 (0.024)	0.159 [0.365]	0.036 (0.025)	0.199 [0.399]	-0.053** (0.021)	0.169 [0.375]	0.051** (0.022)
Injection	0.107 [0.31]	0.026 (0.016)	0.113 [0.317]	0.026* (0.014)	0.097 [0.296]	-0.001 (0.017)	0.132 [0.338]	0.004 (0.019)
Oral pills	0.022 [0.146]	0.009 (0.007)	0.018 [0.133]	0.016 (0.01)	0.031 [0.174]	-0.002 (0.009)	0.023 [0.15]	0.005 (0.009)
Wants to use contracept. in the future	0.739 [0.439]	0.058 (0.036)	0.74 [0.439]	0.063* (0.034)	0.756 [0.43]	-0.027 (0.025)	0.788 [0.409]	0.017 (0.025)
Used contraception at last sexual intercourse	0.282 [0.45]	0.068** (0.034)	0.284 [0.451]	0.083** (0.037)	0.296 [0.457]	-0.039 (0.025)	0.336 [0.473]	0.02 (0.027)
Currently using contraception incl. abstinence, rhythm and withdrawal	0.304 [0.46]	0.053* (0.028)	0.298 [0.457]	0.073*** (0.028)	0.338 [0.473]	-0.052** (0.026)	0.331 [0.471]	0.06** (0.027)
N total	6,728		3,877		1,473		1,378	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. ***, **, * indicate statistical significance at 1, 5 and 10%

Table 4: Impact on Contraceptives Distribution: Administrative Clinic Data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Number of FP consultations		**Implants distributed**		**Injectables distributed**		**Oral Pills distributed**	
	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Panel A: Clinic Survey Data								
October 2019: top coded at P99 (N= 401)	30.97 [35.2]	14** (6.73)	3.61 [5.41]	2.4 (1.69)	27.52 [27.4]	11.17 (7.03)	16.31 [25.38]	15.68* (8.86)
October 2019: Log/IHS Transformation (N= 401)	3.01 [0.97]	0.42** (0.14)	1.4 [1.11]	0.32 (0.42)	3.53 [1.1]	0.4** (0.19)	2.42 [1.69]	0.85* (0.44)
November 2019: top coded at P99 (N= 448)	60 [53.16]	11.39 (8.09)	12.88 [15.38]	-0.36 (3.36)	33.44 [31.29]	9.32 (6.27)	21.65 [35.66]	9.83 (10.27)
November 2019: Log/IHS Transformation (N= 448)	3.71 [0.97]	0.23** (0.08)	2.47 [1.43]	-0.05 (0.3)	3.75 [1.08]	0.26 (0.19)	2.8 [1.58]	0.41 (0.36)
		0.014		0.873		0.206		0.269
Panel B: Administrative Clinic Data:								
Monthly Data: top coded at P99 (N= 37,710)			5.81 [10.36]	0.07 (0.73)	24.93 [31.09]	2.02* (1.18)	15.08 [29.71]	3.03 (2.18)
Monthly Data: IHS Transformation (N= 37,710)			1.48 [1.42]	0.05 (0.1)	2.91 [1.77]	0.12 (0.08)	1.98 [1.82]	0.12 (0.08)
Quarterly Data: top coded at P99 (N= 13,408)			5.8 [8.02]	0.000 (0.72)	24.92 [28.78]	2.22* (1.17)	14.99 [26.19]	3.31 (2.21)
Six-Months Data: top coded at P99 (N= 7,542)			5.88 [7.69]	-0.15 (0.8)	24.98 [28.46]	2.57** (1.15)	14.85 [25.19]	3.76* (2.25)

Note: Panel A: clinic survey data December 2018. Questions relative to October were not asked in the phone survey. Panel B: administrative data from the Ministry of Health on 838 health centers and 45 months. Columns (2), (4), (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Regressions in Panel B also include time and clinic fixed effects. Standard errors are clustered at the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). ***, **, * indicate statistical significance at 1, 5 and 10%.

Table 5: Mechanisms: Impact on Information, Attitudes and Norms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
Impact on information and knowledge:								
Index of knowledge of family planning$^{\alpha}$	0 [1]	0.157 (0.171)	0.019 [1.009]	0.126 (0.153)	-0.01 [0.997]	0.009 (0.06)	0.114 [1.081]	0.088 (0.06)
Index of Knowledge of contraceptive methods	0 [1]	0.288*** (0.053)	-0.003 [1.02]	0.312*** (0.07)	0.024 [0.968]	-0.016 (0.054)	0.207 [0.893]	0.133*** (0.049)
Including:								
Modern contraceptive methods can make a woman sterile	0.259 [0.438]	-0.091*** (0.035)	0.263 [0.44]	-0.095** (0.04)	0.258 [0.438]	-0.014 (0.023)	0.163 [0.37]	-0.003 (0.021)
Modern contraceptive methods can cause sickness	0.38 [0.486]	-0.085*** (0.034)	0.394 [0.489]	-0.091** (0.038)	0.343 [0.475]	0.031 (0.026)	0.301 [0.459]	-0.028 (0.026)
Ever heard of Implants$^{\alpha}$	0.863 [0.344]	0.014 (0.028)	0.869 [0.338]	0.02 (0.033)	0.867 [0.34]	-0.027 (0.023)	0.864 [0.343]	0.038* (0.02)
Ever heard of Injectables$^{\alpha}$	0.789 [0.408]	0.083** (0.033)	0.79 [0.408]	0.083** (0.036)	0.791 [0.407]	-0.001 (0.026)	0.85 [0.357]	0.033 (0.021)
Ever heard of Oral pills$^{\alpha}$	0.751 [0.432]	0.08** (0.038)	0.761 [0.426]	0.071 (0.041)	0.741 [0.439]	0.009 (0.027)	0.815 [0.389]	0.008 (0.023)
Impact on norms and attitudes:								
Index of attitudes towards family planning$^{\alpha}$	0 [1]	0.128** (0.053)	0.014 [0.98]	0.097*** (0.033)	0.015 [0.922]	-0.047 (0.07)	0.13 [0.801]	0.026 (0.046)
Including:								
Women should control the number of children they have during their lifetime$^{\alpha}$	0.547 [0.498]	0.078* (0.04)	0.575 [0.494]	0.066* (0.037)	0.506 [0.5]	0.012 (0.027)	0.634 [0.482]	0.037 (0.028)
Index of Attitudes towards contraceptive methods	0 [1]	0.106 (0.116)	0.008 [0.988]	0.108 (0.125)	0.021 [0.989]	0.024 (0.056)	0.052 [0.964]	0.043 (0.055)
Index of women's perceptions of fertility and birth spacing	0 [1]	-0.047 (0.16)	0.028 [0.997]	-0.072 (0.179)	-0.024 [1.016]	-0.034 (0.054)	-0.087 [0.982]	0.135** (0.054)
Index of Husband's perceptions of fertility and birth spacing$^{\alpha}$	0 [1]	0.106 (0.137)	0.004 [0.986]	0.049 (0.154)	0.063 [1.031]	-0.103 (0.07)	0.063 [1.04]	0.121* (0.063)
Impact on secondary outcomes:								
Index of gender attitudes (higher values for more positive attitudes)	0 [1]	-0.186 (0.208)	0.031 [0.996]	-0.184 (0.185)	0.01 [0.998]	-0.111** (0.051)	-0.243 [1.018]	0.023 (0.056)
Index of women empowerment$^{\alpha}$	0 [1]	-0.054 (0.133)	-0.07 [0.924]	-0.082 (0.106)	0.078 [1.07]	0.067 (0.069)	-0.038 [0.985]	0.048 (0.057)
Index of domestic violence (higher values for less domestic violence)$^{\alpha}$	0 [1]	0.078 (0.124)	-0.003 [0.985]	0.093 (0.134)	-0.023 [1.012]	0.078 (0.065)	0.08 [0.966]	-0.092 (0.059)
N total	6,728		3,877		1,473		1,378	
N in-person survey	5,860		3,314		1,202		1,307	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. α: information only available in the in-person survey. See appendix 2 for the definition of indexes. ***, **, * indicate statistical significance at 1, 5 and 10%.

Table 6: Heterogeneity: Which Women Were the Most and Least Impacted?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	No radio Mean	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
Impact on mCPR by baseline status with respect to contraception:								
mCPR if using contraception at baseline (N=1,591)	0.48 [0.5]	0.129*** (0.036)	0.47 [0.5]	0.136*** (0.026)	0.491 [0.501]	-0.038 (0.076)	0.606 [0.49]	0.025 (0.07)
mCPR if declared unmet needs for contraception at baseline (N=3,082)	0.272 [0.445]	0.054*** (0.019)	0.263 [0.441]	0.068*** (0.026)	0.327 [0.47]	-0.094** (0.037)	0.304 [0.461]	0.059 (0.042)
mCPR if declared no unmet needs for contraception at baseline (N=2,075	0.195 [0.396]	0.012 (0.039)	0.188 [0.391]	0.041 (0.044)	0.22 [0.415]	0.022 (0.044)	0.178 [0.383]	0.085* (0.049)
Impact on mCPR by baseline age group :								
mCPR if [15-22[years old at baseline (N=1,457)	0.25 [0.433]	-0.008 (0.043)	0.248 [0.432]	0.017 (0.046)	0.222 [0.417]	0.036 (0.067)	0.224 [0.419]	0.042 (0.096)
mCPR if [22-29[years old at baseline (N=1,615)	0.347 [0.476]	0.08* (0.043)	0.341 [0.475]	0.09*** (0.035)	0.374 [0.485]	-0.098 (0.086)	0.444 [0.498]	0.112 (0.078)
mCPR if [29-37[years old at baseline (N=1,770)	0.362 [0.481]	0.107*** (0.033)	0.35 [0.477]	0.144*** (0.03)	0.432 [0.497]	-0.138* (0.079)	0.447 [0.498]	-0.007 (0.081)
mCPR if [37-49[years old at baseline (N=1,886)	0.225 [0.418]	0.047 (0.043)	0.228 [0.42]	0.059 (0.049)	0.259 [0.439]	-0.08 (0.053)	0.194 [0.396]	0.072 (0.053)
Impact on mCPR by baseline knowledge of contraception :								
mCPR if Index of knowledge of contraception **below median**	0.238 [0.426]	0.014 (0.031)	0.237 [0.425]	0.028 (0.038)	0.262 [0.44]	-0.032 (0.036)	0.225 [0.418]	0.127*** (0.045)
mCPR if Index of knowledge of contraception **above median**	0.352 [0.478]	0.078* (0.044)	0.337 [0.473]	0.098** (0.038)	0.404 [0.491]	-0.087* (0.046)	0.417 [0.494]	0.023 (0.042)
Impact on mCPR by baseline perceptions of fertility and birth spacing								
mCPR if Index of Women's perceptions of fertility and birth spacing **below median**	0.29 [0.454]	0.046* (0.025)	0.29 [0.454]	0.063** (0.023)	0.306 [0.462]	-0.048 (0.04)	0.275 [0.447]	0.081* (0.045)
mCPR if Index of Women's perceptions of fertility and birth spacing **above median**	0.321 [0.467]	0.09*** (0.036)	0.317 [0.466]	0.118*** (0.034)	0.364 [0.482]	-0.103** (0.048)	0.42 [0.494]	0.021 (0.045)
N total	6,728		3,877		1,473		1,378	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. α: information only available in the in-person survey. See appendix 2 for the definition of indexes. ***, **, * indicate statistical significance at 1, 5 and 10%.

Table 7: Impact on Fertility and Well-being

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Treat. Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
Gave birth in the last year	0.174 [0.379]	-0.013 (0.011)	0.177 [0.382]	-0.013 (0.014)	0.171 [0.377]	-0.011 (0.025)	0.171 [0.377]	-0.006 (0.022)
Gave birth in the last year. Women [29-49[only	0.157 [0.364]	-0.015* (0.009)	0.162 [0.368]	-0.014 (0.015)	0.142 [0.35]	0.008 (0.027)	0.142 [0.349]	0.002 (0.023)
Had sex in the last 3 months$^{\alpha}$	0.502 [0.5]	0.086 (0.069)	0.499 [0.5]	0.1 (0.069)	0.506 [0.5]	-0.005 (0.031)	0.587 [0.493]	0.006 (0.03)
Had sex in the last 3 months$^{\alpha.}$ Women [29-49[only	0.506 [0.5]	0.104 (0.066)	0.508 [0.5]	0.11* (0.066)	0.505 [0.5]	-0.029 (0.035)	0.617 [0.486]	0.017 (0.034)
Index of self-assessed health and well being	-0.088 [0.961]	0.258*** (0.109)	0.014 [0.916]	0.218** (0.103)	-0.214 [1.002]	-0.001 (0.048)	0.254 [0.862]	-0.05 (0.047)
N total	6,728		3,877		1,473		1,378	
N in-person survey	5,860		3,314		1,202		1,307	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. α: information only available in the in-person survey. See appendix 2 for the definition of indexes. ***, **, * indicate statistical significance at 1, 5 and 10%.

Table 8: Program Cost-Effectiveness

	(1)	(2)	(3)	(4)
	Pilot program (8 radio stations)		**Program scaled-up in all Burkina Faso**	
	Population similar to survey data	Other pop. reached in Treat. areas	Population similar to survey data	Other population
Program Costs: (in US$ in 2018)				
Total program Costs	$3,132,883		$3,454,392	
Incl. fixed costs	$2,794,959		$3,081,789	
Incl. variable costs	$337,924		$372,603	
Total population reached by the media campaign:				
Population in 2018 (projections using 2006 census)	760,834	1,923,448	5,082,070	11,311,704
Women of reproductive age (15-49) (23.3% of total)	177,274	448,163	1,184,122	2,635,627
Impact and Program Cost-effectiveness:				
Assumption 1: Same impact everywhere	5.9%	5.9%	5.9%	5.9%
Number of additional women using contraception	10,459	26,442	69,863	155,502
Additional women using contraception	36,901		225,365	
Total cost per extra women using modern contraception	$84.9		$15.3	
Anual cost per extra women using modern contraception	$42.5		$7.7	
Assumption 2: No impact in other population	5.9%	0.0%	5.9%	0.0%
Number of additional women using contraception	10,459	0	69,863	0
Additional women using contraception	10,459		69,863	
Total cost per extra women using modern contraception	$299.5		$49.4	
Anual cost per extra women using modern contraception	$149.8		$24.7	

Note: Cost data from DMI in 2018 US$. Population data from 2006 national census using projection calculated by the national statistical agency.

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Appendices Figures

Figure A1: Study Timeline

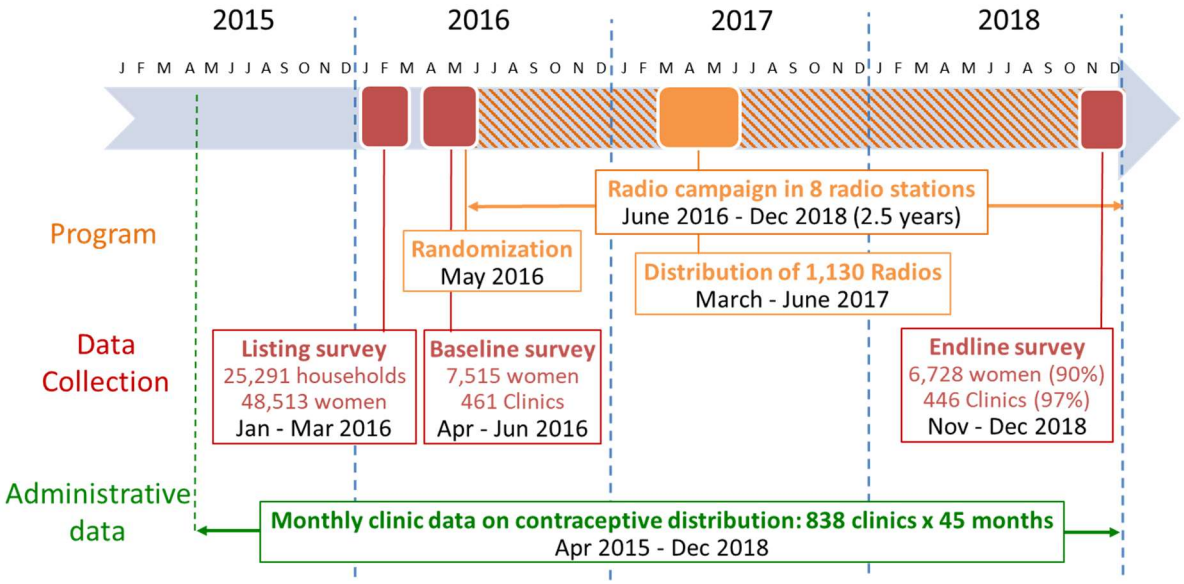
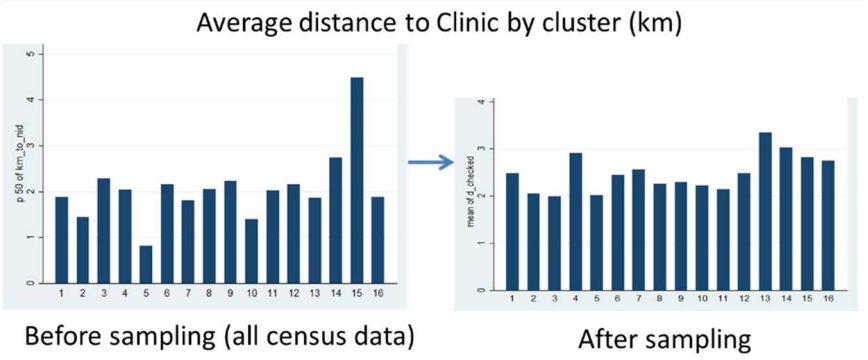
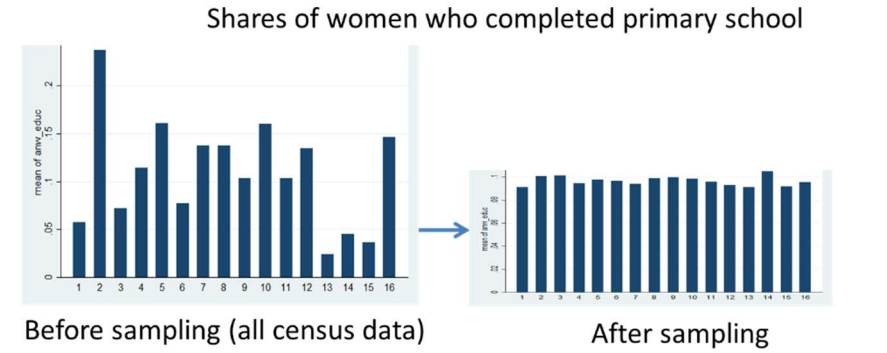


Figure A2: Sampling Strategy





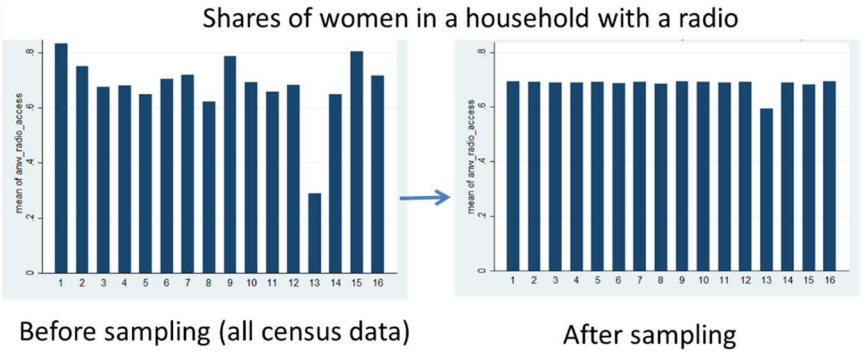
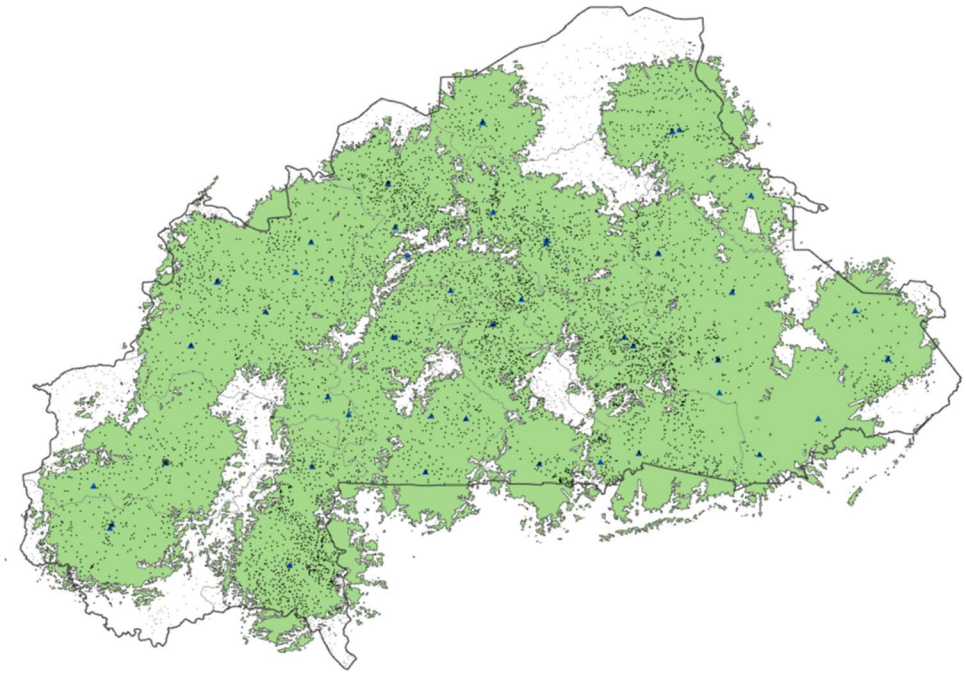
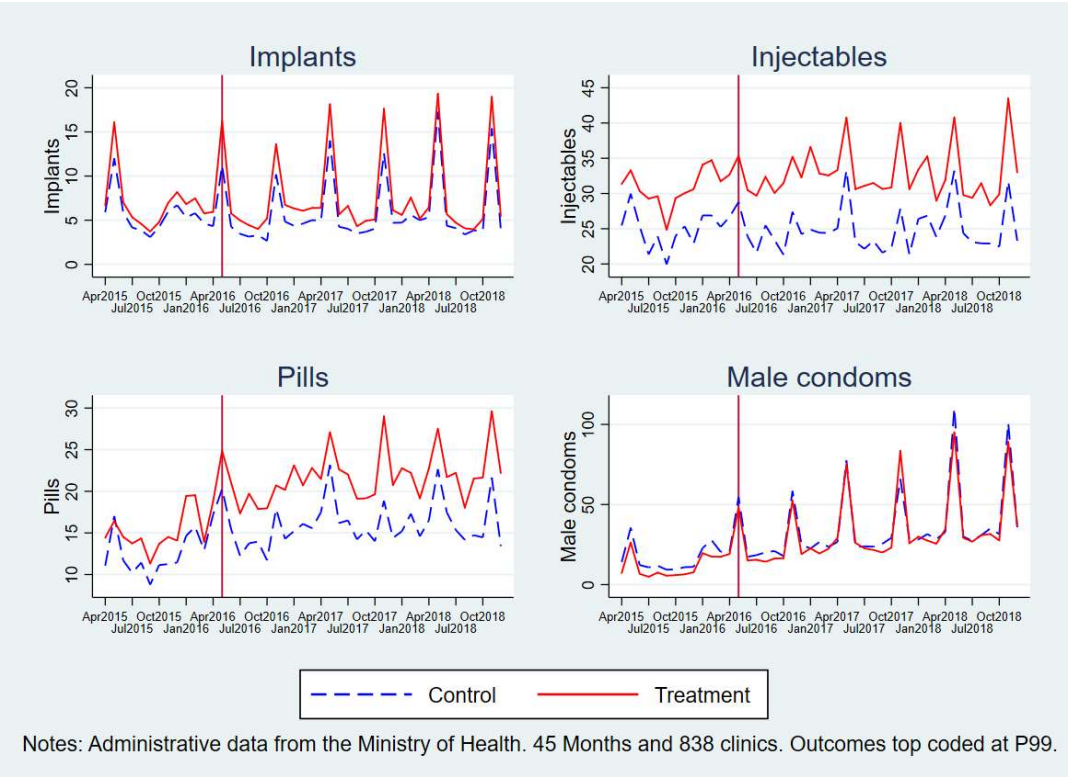


Figure A3: Areas Reached by Radio Stations Involved in Program Scale-Up



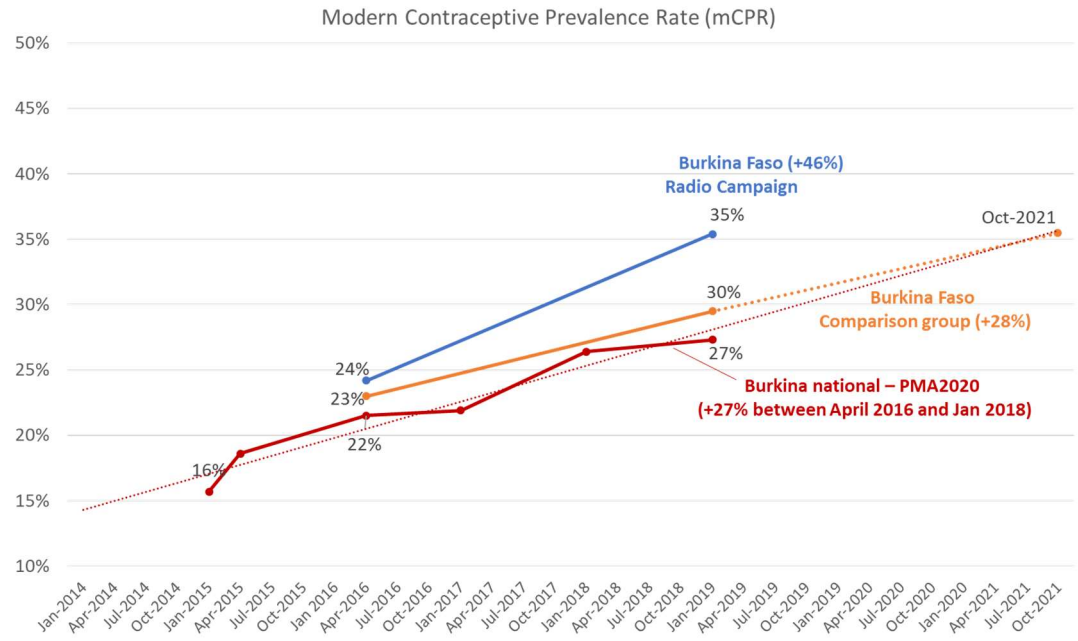
Note: We estimate that 83% of the population is reached by a radio involved in the program scale-up

Figure A4: Monthly Administrative Data in Control and Treatment Areas



Notes: Administrative data from the Ministry of Health. 45 Months and 838 clinics. Outcomes top coded at P99.

Figure A5: mCPR trends in Burkina Faso



Notes: Survey data and data from PMA 2020

Appendices Tables

Table A1: Attrition at Follow up Survey

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		Radio at baseline		In control areas		In treatment areas	
	Control Mean	Treat. Mean P-value	Control Mean	Treat. Mean P-value	No radio Mean	Radio Mean P-value	No radio Mean	Radio Mean P-value
Surveyed	90.6%	88.5%	90.8%	89.3%	89.8%	90.6%	90.6%	92.6%
		0.783		0.773		0.877		0.384
Including:								
Surveyed in person	78.9%	77.1%	82.9%	78.7%	73.6%	73.7%	84.9%	88.8%
		0.943		0.768		0.993		0.056*
Surveyed by phone	11.7%	11.4%	7.9%	10.6%	16.3%	16.9%	5.6%	3.8%
		0.986		0.806		0.784		0.09*
If not surveyed reason:								
Refused	0.2%	0%	0.3%	0%	0.1%	0%	0%	0%
Deseased or sick	1%	0.9%	1%	0.8%	1%	1%	1.8%	0.3%
Absent during the survey	2.9%	2.1%	2.8%	2.3%	3.3%	2.9%	2.1%	2.3%
Moved	4%	2.9%	4.3%	3%	3.8%	3.6%	4.1%	2.6%
Unknow	0.9%	1.5%	0.5%	1%	1.3%	1.5%	0.3%	0.9%
N total	3,675	3,840	2,015	2,090	817	816	764	741

Note: Endline survey data, December 2018. Columns (1), (3), (5) and (8): p-values calculated from OLS regressions of attrition variables on a treatment dummy, controlling for strata fixed-effects and with standard errors clustered at the radio station level and p-values computed using the wild boostrap procedure as described in Cameron et al. (2008). Columns (7) and (8): p-values calculated from OLS regressions of attrition variables on a treatment dummy, controlling for strata fixed-effects and with standard errors clustered at the household level. ***, **, * indicate statistical significance at 1, 5 and 10%

Table A2: Robustness of Main Results to the Inclusion of Sampling Weigts

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Coef. (SE) P-value	Control Mean [SD]	Coef. (SE) P-value	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
Impact on primary outcome								
Currently using modern contraception (mCPR)	0.289 [0.453]	0.066*** (0.019)	0.297 [0.457]	0.077*** (0.025)	0.314 [0.464]	-0.067* (0.037)	0.324 [0.468]	0.113** (0.049)
Wants to use contracept. in the future	0.731 [0.443]	0.085* (0.051)	0.76 [0.427]	0.078** (0.032)	0.724 [0.447]	-0.08* (0.041)	0.782 [0.413]	0.064 (0.042)
Used contraception at last sexual intercourse	0.284 [0.451]	0.089*** (0.031)	0.305 [0.46]	0.099** (0.039)	0.277 [0.448]	-0.034 (0.037)	0.369 [0.483]	0.064 (0.054)
Impact on information and knowledge:								
Index of knowledge of family planning$^{\alpha}$	0 [1]	0.036 (0.157)	0.036 [0.98]	0.017 (0.131)	-0.072 [1.039]	0.025 (0.091)	-0.091 [0.978]	0.262** (0.111)
Index of Knowledge of contraceptive methods	0 [1]	0.283*** (0.102)	-0.001 [1.006]	0.273*** (0.096)	0.016 [0.987]	-0.087 (0.084)	0.173 [0.945]	0.199* (0.109)
Impact on norms and attitudes:								
Index of attitudes towards family planning$^{\alpha}$	0 [1]	0.14 (0.082)	-0.005 [1.026]	0.16** (0.072)	0.003 [0.947]	0.000 (0.094)	0.09 [0.89]	0.029 (0.088)
Index of Attitudes towards contraceptive methods	0 [1]	-0.083 (0.082)	0.031 [0.971]	-0.143 (0.131)	-0.028 [1.014]	-0.01 (0.107)	-0.065 [1.025]	0.116 (0.115)
Index of women's perceptions of fertility and birth spacing	0 [1]	0.125 (0.206)	0.037 [0.995]	0.106 (0.234)	-0.003 [1.03]	-0.093 (0.089)	-0.131 [0.997]	0.264*** (0.095)
Index of Husband's perceptions of fertility and birth spacing$^{\alpha}$	0 [1]	0.266 (0.231)	-0.013 [0.965]	0.23 (0.302)	0.149 [1.106]	-0.211* (0.118)	0.057 [1.055]	0.326*** (0.126)
Impact on secondary outcomes:								
Index of self-assessed health and well being	0 [1]	0.147 (0.107)	0.077 [0.968]	0.065 (0.075)	-0.056 [0.996]	-0.041 (0.084)	-0.118 [1.031]	0.105 (0.12)
Index of gender attitudes (higher values for more positive attitudes)	0 [1]	-0.492 (0.176)	0.029 [1.002]	-0.457** (0.155)	0.005 [0.984]	-0.108 (0.077)	-0.322 [1.115]	0.096 (0.136)
Index of women empowerment$^{\alpha}$	0 [1]	0.187 (0.341)	-0.094 [0.888]	0.133 (0.202)	0.068 [1.075]	0.108 (0.098)	0.409 [1.255]	0.361** (0.153)
Index of domestic violence (higher values for less domestic violence) $^{\alpha}$	0 [1]	0.035 (0.171)	0.037 [0.944]	0.071 (0.132)	-0.126 [1.108]	0.151 (0.104)	-0.245 [1.144]	-0.073 (0.133)
N total	6,728		3,877		1,473		1,378	
N in-person survey	5,860		3,314		1,202		1,307	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. α: information only available in the in-person survey. See appendix 2 for the definition of indexes. ***, **, * indicate statistical significance at 1, 5 and 10%.

Table A3: Robustness of Main Results to Controlling for Baseline Value of the Outcome

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of Mass Media Campaign				**Impact of Radio Distribution**			
	Overall sample		A radio at baseline		In control areas		In treatment areas	
	Control Mean [SD]	Coef. (SE) P-value	Control Mean [SD]	Coef. (SE) P-value	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)
Impact on primary outcome								
Currently using modern contraception (mCPR)	0.295 [0.456]	0.056** (0.027)	0.291 [0.454]	0.074*** (0.027)	0.327 [0.469]	-0.052** (0.025)	0.331 [0.471]	0.058** (0.027)
Wants to use contracept. in the future	0.739 [0.439]	0.055** (0.023)	0.74 [0.439]	0.059*** (0.022)	0.756 [0.43]	-0.026 (0.024)	0.788 [0.409]	0.009 (0.023)
Used contraception at last sexual intercourse	0.282 [0.45]	0.067** (0.029)	0.284 [0.451]	0.083*** (0.032)	0.296 [0.457]	-0.038 (0.025)	0.336 [0.473]	0.02 (0.027)
Impact on information and knowledge:								
Index of knowledge of family planning[α]	0 [1]	0.161 (0.149)	0.019 [1.009]	0.128 (0.134)	-0.01 [0.997]	0.003 (0.059)	0.114 [1.081]	0.084 (0.06)
Index of Knowledge of contraceptive methods	0 [1]	0.256*** (0.04)	-0.003 [1.02]	0.29*** (0.061)	0.024 [0.968]	-0.021 (0.053)	0.207 [0.893]	0.125*** (0.048)
Impact on norms and attitudes:								
Index of attitudes towards family planning[α]	0 [1]	0.11** (0.05)	0.014 [0.98]	0.081** (0.035)	0.015 [0.922]	-0.046 (0.07)	0.13 [0.801]	0.024 (0.046)
Index of Attitudes towards contraceptive methods	0 [1]	0.091 (0.111)	0.008 [0.988]	0.097 (0.118)	0.021 [0.989]	0.023 (0.056)	0.052 [0.964]	0.043 (0.055)
Index of women's perceptions of fertility and birth spacing	0 [1]	-0.078 (0.119)	0.028 [0.997]	-0.093 (0.133)	-0.024 [1.016]	-0.02 (0.052)	-0.087 [0.982]	0.131** (0.052)
Index of Husband's perceptions of fertility and birth spacing[α]	0 [1]	0.099 (0.121)	0.004 [0.986]	0.035 (0.131)	0.063 [1.031]	-0.102 (0.07)	0.063 [1.04]	0.121* (0.063)
Impact on secondary outcomes:								
Index of self-assessed health and well being	0 [1]	0.264** (0.122)	0.106 [0.953]	0.222* (0.114)	-0.131 [1.042]	0.001 (0.049)	0.355 [0.896]	-0.056 (0.049)
Index of gender attitudes (higher values for more positive attitudes)	0 [1]	-0.185 (0.212)	0.031 [0.996]	-0.182 (0.188)	0.01 [0.998]	-0.109** (0.051)	-0.243 [1.018]	0.023 (0.057)
Index of women empowerment[α]	0 [1]	-0.055 (0.131)	-0.07 [0.924]	-0.082 (0.101)	0.078 [1.07]	0.042 (0.061)	-0.038 [0.985]	0.049 (0.053)
Index of domestic violence (higher values for less domestic violence) [α]	0 [1]	0.043 (0.127)	-0.003 [0.985]	0.055 (0.14)	-0.023 [1.012]	0.08 (0.063)	0.08 [0.966]	-0.082 (0.054)
N total	6,728		3,877		1,473		1,378	
N in-person survey	5,860		3,314		1,202		1,307	

Note: Endline women survey data, December 2018. Columns (1), (3), (5) and (7): Standard deviations in brackets. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). Columns (6) and (8): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the household level. α: information only available in the in-person survey. See appendix 2 for the definition of indexes. ***, **, * indicate statistical significance at 1, 5 and 10%.

Table A4: Correction for Multiple Hypothesis Testing on Ten Pre-specified Indexes

	(1)	(2)	(3)	(4)
	Impact of Mass Media Campaign			
	Overall sample			
	Control Mean [SD]	Coef. (SE)	P-values (wild-bootsrap)	**Sharpened two stage q-values**
Impact on information and knowledge:				
Index of knowledge of family planning[α]	0 [1]	0.157 (0.122)	0.508	1
Index of Knowledge of contraceptive methods	0 [1]	0.288*** (0.032)	0.000	0.001
Impact on norms and attitudes:				
Index of attitudes towards family planning[α]	0 [1]	0.128** (0.036)	0.013	0.041
Index of Attitudes towards contraceptive methods	0 [1]	0.106 (0.068)	0.364	1
Index of women's perceptions of fertility and birth spacing	0 [1]	-0.047 (0.102)	0.834	1
Index of Husband's perceptions of fertility and birth spacing[α]	0 [1]	0.106 (0.093)	0.639	1
Impact on other outcomes:				
Index of self-assessed health and well-being	0 [1]	0.269*** (0.074)	0.008	0.038
Index of gender attitudes (higher values = more positive attitudes)	0 [1]	-0.186 (0.116)	0.415	1
Index of women empowermentα	0 [1]	-0.054 (0.099)	0.74	1
Index of domestic violence (higher values = less domestic violence)[α]	0 [1]	0.078 (0.087)	0.626	1
N total	6,728			
N in-person survey	5,860			

Note: Endline women survey data, December 2018. Column (1): Standard deviations in brackets. Column (2) : coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controlling for strata fixed-effects. Standard errors are clustered at the radio station level. Column (3): p-values are computed using wild boostrap procedure as described in Cameron et al. (2008). Column (4): sharpened two-stage q-values corrected for multiple hypothesis testing as described in Anderson (2008). See appendix 2 for the definition of indexes. α: information only available in the in-person survey. ***, **, * indicate statistical significance at 1, 5 and 10%

Table A5: Impact in Areas Not Surveyed Using Administrative Data

	(1)	(2)	(3)	(4)	(5)	(6)
	Implants distributed		**Injectables distributed**		**Oral Pills distributed**	
	Control Mean [SD]	Coef. (SE) P-value	Control Mean [SD]	Coef. (SE) P-value	Control Mean [SD]	Coef. (SE) P-value
Administrative Clinic Data: Only Clinics not in Survey Sample						
Monthly Data: top codded at P99 (N= 10,575)	3.89	0.03	17.03	2.82	10.71	4.11*
	[8.62]	(0.54)	[29.4]	(1.88)	[27.63]	(2.45)
Monthly Data: IHS Transformation (N= 10,575)	1.04	0.05	2.1	0.13	1.39	0.16
	[1.34]	(0.12)	[1.92]	(0.22)	[1.75]	(0.18)
Quarterly Data: top codded at P99 (N= 3,760)	3.86	-0.07	17.01	3.03*	10.64	4.42*
	[7]	(0.54)	[27.8]	(1.83)	[24.87]	(2.56)
Six-Months Data: top codded at P99 (N= 2,115)	3.88	-0.3	17.01	3.32*	10.55	4.93*
	[6.8]	(0.63)	[27.58]	(1.83)	[24.08]	(2.72)

Note: Administrative data from the Ministry of Health on 838 health centers and 45 months. Columns (2), (4) and (6): coefficients and standard errors from OLS regressions of the outcome variables on a treatment dummy, controling for strata fixed-effects and with time and clinic fixed-effects. Standard errors are clustered and the radio station level and computed using wild boostrap procedure as described in Cameron et al. (2008). ***, **, * indicate statistical significance at 1, 5 and 10%.

Appendix 1: Additional information on the sampling strategy

Our sampling strategy had two steps: selection of villages and selection of women within these villages.

Village selection:
The survey was conducted in a random sample of villages located between 5 and 50 kilometers from our sample radio stations, with less than 1,500 inhabitants, not on the electricity grid and within 5 kilometers from a health center. The objective was to identify villages where television access is limited (no electricity) and thus radio listenership high, and where supply of modern contraceptive was not a major barrier to use. Villages that met these criteria were initially identified by combining data from the 2006 National Census (for village population and electricity access), National Geographic Institute (for GPS coordinates and distance mapping) and Ministry of Health (for lists and locations of clinics). A total of 320 villages were randomly sampled from this list for a household listing. In total 48,513 women between the ages of 15 and 49 and living in 25,291 households were listed between January-March 2016. Using information from these surveys, we dropped 68 additional villages because we found they did not conform to our sampling criteria (49 villages were more than 5 km from a health clinic, 13 could access more than one of the study radio stations and 6 had very few inhabitants listening to the study radio station).

A household listing was conducted in a random 320 of these villages between January-March 2016. We ended up with a final study sample of 252 villages representative of around 1,400 villages where 1 million inhabitants were living in 2006 according to the national census (1.4 million in 2018 according to the national statistics agency projections). Thus, while we lost some external validity by selecting rural villages near clinics our survey data is still representative of a large population (around 7.5% of the total population of Burkina Faso).

Women selection:
We selected 7,515 women in these 252 villages in a way that makes our 16 clusters as similar as possible on key characteristics. We used listing survey data to create strata of women with and without education and with and without radio access and then sampled women within each cluster proportionally to their share in the overall sample population. Intuitively, this involved over-sampling educated women in clusters where there are few educated women and under-sampling educated women in clusters where many women are educated. Similarly, we harmonized average distances to a health center across clusters by taking different numbers of women

from villages with different distances to clinics. As a result, we ended up with 16 clusters that look more similar in our final women sample than in our initial listing survey sample. Appendix Figure (A2) shows graphically how averages of three key characteristics (distance to clinic, education and radio access) were *smoothed* by this strategy.

Appendix 2: Outcomes Definition

This appendix describes the variables included in the indexes used in this paper, following the order in which they appear in the paper.

Standardized index of knowledge of family planning: percentage of women who know benefits of spacing births, percentage who know benefits of delaying the age of marriage for young girls.

Standardized index of knowledge of contraceptive methods: knowledge of the existence of different methods, rejection of misconceptions such as contraception causing sterility or sickness.

Standardized index of attitudes towards family planning: percentage of women who think it is acceptable to talk about family planning in public (radio, schools, posters, etc.), percentage who think that a woman should be able to control the number of children she has during her lifetime.

Standardized index of attitudes towards contraception: percentage of women who think that it is embarrassing to buy a contraceptive method, percentage who think that using contraceptive methods is a sign of not trusting their partner.

Standardized index of women's perceptions of fertility and birth spacing: Perception on the ideal age at first birth, perception on the ideal time lapse between first and second birth, perception on the ideal number of children in total.

Standardized index of partners' perceptions of fertility and birth spacing (as reported by women): Partners' perception on the ideal time lapse between first and second birth, partners' perception on the ideal number of children in total.

Standardized index of women's subjective health and well-being: percentage of women satisfied with their lives, percentage of women considering themselves healthy compared to other women in the village.

Standardized index of perceptions on gender norms: percentage of women who think that it is better to be a man than a woman, percentage who think that boys should have better access to resources in education, percentage who think that men

must be more educated than their wives, percentage who think that men should have better access to consumption of meat and imported products.

Standardized index of women empowerment: percentage of women working or participating in a productive activity, percentage participating in decision-making when it comes to different household expenditures.

Standardized index of domestic violence and sexual harassment: percentage of women whose husbands get jealous when they walk to other men, don't allow them to see their female friends, insist on knowing where they are at any time of the day, ever threatened to harm them or their families, ever destroyed their personal objects, ever physically hurt them.