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Mass Media and Contraception Use: An Experimental Test of Modernization Theory in Burkina Faso

Rachel Glennerster, Joanna Murray, Victor Pouliquen

Abstract

This paper tests whether the arrival of mass media triggers a decline in fertility, a central prediction of modernization theory. Using a field experiment, we vary exposure to mass media and its content in a quarter of Burkina Faso. We provide radios to 1,600 women without previous access to mass media. Half live in status quo areas and half in areas where the local radio station was randomly selected to air a science-based family planning campaign. Contrary to modernization theory and previous literature, gaining access to status quo mass media decreases contraception use by 14 percent and reinforces traditional gender norms. In contrast, receiving a radio in campaign areas boosts contraception use by 16 percent. The campaign also led to a 9 percent reduction in births and a 0.3 standard deviation increase in reported welfare. Reduced belief in misinformation rather than shifts in attitudes and preferences drives the result.

KEYWORDS

Mass media campaign, radio, modern contraception, family planning

JEL CODES

L82, J13, J16

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1 Introduction

Mass media is considered an accelerator of the transition from traditional to modern societies and as a result demographic transition. According to modernization theory, it plays this role not by advocating a specific agenda, but by broadening horizons. By exposing audiences to diverse lifestyles and perspectives, mass media fosters greater understanding of people beyond one's immediate community, shifts social orientation from kin-based to non-kin networks, and diminishes the role of family and clan as primary sources of status (Lerner, 1958). Key indicators of modernization are 1) declining fertility and 2) convergence towards global values (Newson and Richerson, 2009).

While modernization theory has its critics, it is one of the most persistent theories of development (Marsh 2014) and its fertility and gender values predictions are in line with global trends (Hornik and McAnany, 2001). Previous studies on the impact of mass media are consistent with the theory: communities with access to mass media are less community (i.e., kin and clan) focused in Indonesia (Olken, 2009), and the arrival of more engaging media reduced fertility and led rural areas to converge with urban gender norms in India and Brazil (Jensen and Oster 2009, La Ferrara et al. 2012).[1]

We present a counterexample to mass media modernization theory and much of the previous empirical economics literature on mass media's impact on fertility. We separately vary both access to mass media and its content using a two-level randomized experiment that covers 5 million people in rural Burkina Faso. To vary access, women in 1,400 households without a radio were randomly selected to receive a radio.[2] To vary content, 8 out of 16 geographically and linguistically distinct community FM radio stations were randomly selected to broadcast a science-based family planning campaign for two and a half years. The rest continued regular programming. Surveys of 7,500 women and 461 clinics, and monthly administrative data on contraceptive distribution for all clinics in study areas allow us to tease out mechanisms.

We find two main results, both inconsistent with media modernization theory. First, providing radios to women in status quo areas reduces the use of contraception (our primary pre-specified outcome) by 4.6 percentage points (-14%, p-value=0.042) and if anything leads to divergence of gender attitudes from the global mode. This de-

[1] While the arrival of cable TV in India and soap operas in Brazil changed the content of media consumed not access, the mechanism presented (new forms of media effectively broadened horizons and built empathy of other lifestyles) are precisely those hypothesized in modernization theory.

[2] TV, newspapers and social media are almost nonexistent in these communities.

modernizing impact is not due to an explicit agenda of the radio station (all stations were willing to run the campaign) nor an increase in belief in contraception misinformation. Mass media access did increase women's exposure to views and events outside their community a key mechanism by which media accelerates modernization. However, some coverage reinforced local norms: it was male dominated (women speak 17% of peak listening time) and call-in shows (17% of peak time) provided a platform for locally predominant views. This mix of national and local programming is common especially when mass media is first introduced (Sterling and Kittross, 1978). We conjecture the arrival of mass media in households puts pressure on women to align with the modal behavior in their media market (the modal woman does not use contraception). Learning about, or making more salient, the views and behavior of others can change behavior without changing preferences (Bursztyn et al. 2020). Women vulnerable to social pressure, i.e. who don't want more children but are not using contraception at baseline, experience particularly large falls in contraception use at endline (-8.7 percentage points), without changing desired fertility.

Second, we show this de-modernizing impact of receiving a radio in status quo areas can be more than offset by a science-based mass media campaign. Receiving a radio in campaign areas increased contraception use by 5.3 percentage points (+16%, p-value=0.026). Contrary to modernization theory, this effect was driven by improved knowledge rather than shifts in values or preferences. There was no change in gender norms or ideal number of children. Instead, our index of family planning knowledge rose 0.12 standard deviations (p-value=0.005), and women who wished to control their pregnancies were more likely to act on that preference.

The campaign implemented by the NGO *Development Media International* (DMI) lasted two and a half years and was intensive (three one-hour interactive phone-in shows a week and ten short spots a day). It used strategies found to be effective in the health behavior literature by: using trusted voices to fill specific knowledge gaps (Dupas, 2011), presenting messages in an entertaining way (Bernard et al. 2015, Banerjee et al. 2019) and ensuring family planning was salient (Alsan and Eichmeyer 2021, Kumkale et al. 2010). The campaign replaced 17% of peak listening time with new (often female presented) content, mainly crowding-out debates and call-in shows.

Overall, women in campaign areas were 5.1 percentage points more likely to use modern contraception (+17%, p-value=0.011) than in noncampaign areas. Clinics provided 37% more family planning consultations and distributed 10 to 20% more

contraceptives. Increased knowledge and a decline in misconceptions about the side effects of modern methods appear to explain the result.

The media campaign was most effective among women already using contraception before the campaign (many use it inconsistently) and those who don't want children but are not using contraception (have "unmet need"). This aligns with a model in which women near the adoption margin use information to update beliefs on costs and benefits (Kremer and Glennerster, 2011), and with a behavioral model in which women inclined to adopt pay closer attention. We find no support for models that predict the least informed would be most responsive (Ackerberg, 2003).

As the campaign changed beliefs not preferences, corrected misinformation, and mainly changed behavior for women with unmet need, it is likely welfare improving (DellaVigna and Gentzkow, 2010). Our index of self-assessed health and well-being rose 0.25 standard deviations. Finally, we find some evidence that increased contraception use reduced fertility, despite more sexual activity from the campaign.

Understanding the impact of mass media and media campaigns on contraception is not only a test of modernization theory, it is an important practical question for the millions of women who want to stop or delay childbirth but do not use contraception (one in four women in sub-Saharan Arica, Family Planning, 2020). 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), but "side-effects and health concerns" is the most common reason for not using contraception across sub-Saharan Africa. Evidence on how to reduce unmet need remains scarce (Zakiyah et al. 2016). Our paper identifies a cost-effective, scalable intervention, and suggests addressing misinformation rather than attempting to shift norms may be particularly effective. We estimate that the campaign implemented nationwide[3] led to 200,000 additional women using contraception and 10,000 fewer (mostly unwanted) births a year, at a cost of US$7 per woman and $139 per birth. While rigorous data on the cost per woman using contraception achieved through other approaches is limited, estimates range from US$30 to US$60 (IRC 2016, Shade et al. 2013, Dulli et al., 2016).

In addition to the literature on media access, our paper adds to a substantial literature on how the content of mass media changes behavior (see Cheung 2012, Bengtsson et al. 2013, and Kearney and Levine 2015 for examples on family planning). Most closely related are Kasteng et al. (2018) and Alatas et al. (2022),[4] the only other

[3]The campaign was scaled up in 2019 when initial results from this study became available.

[4]Kasteng et al. (2018) randomize 14 radio stations into a DMI child survival campaign. They find

randomized experiments to our knowledge which test the impact of a health behavior mass media campaign under conditions representative of how people typically access media.[5] Uniquely, our paper simultaneously cross randomizes exposure to mass media at a micro (household) level and the content of mass media at a macro (radio station) level, allowing us to separately identify each effect. The two-level randomization provides two independent sources of variation for testing the impact of a mass media campaign when the number of radio stations that can be randomized is small. This methodology shows promise for future mass media studies.

2 Background

2.1 Modernization and Fertility in Burkina Faso

Rural Burkina Faso is at an early stage of modernization. In a band of high poverty and fertility countries in West Africa its GDP per capital in 2017 was US$1,978. "Modern" drivers of status (education and occupation) are not key differentiators of an individual's status: 81% of rural adults are subsistence farmers (DHS, 2010) and 20% had any formal education. Clan is a key source of status and authority: 69% of the rural population have a great deal of confidence in traditional leaders (Afrobarometer, 2017).

This focus on kin and clan is reflected in a total fertility rate of 6.7 children per woman in 2010 and desired fertility of 5.9 (DHS, 2010). Nationally, in 2017, 21.5% of women of childbearing age used modern contraception and 24.2% did not want to get pregnant but were not using contraception, the definition of "unmet need" (PMA2020, 2016). Women primarily used implants (42% of users in 2016), injectables (29%) and pills (11%).[6] Similar rates are found in most countries in Africa,[7] though they vary starkly from global averages: 2.3 births per woman, 46% using a contraceptive method and 15% with an unmet need for family planning (WHO, 2021).

Authors debate whether high fertility in Sub-Saharan Africa contradicts modernization theory by falling unusually slowly due to Africa uniquely pronatatist belief systems such as the cult of the ancestors (Caldwell and Caldwell, 1987) or whether

a significant effect in clinic but not household data on care-seeking and no impact on their primary outcome child mortality. Alatas et al. (2022) randomize celebrity tweets promoting vaccination.

[5] 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.

[6] Only 10% of users, mainly in urban areas, use male condoms.

[7] For example Ivory-Coast (fertility rate of 4.8, modern contraception prevalence rate of 21.8%, and unmet need of 25.1%), Ethiopia (4.5, 27% and 16%), Ghana (4, 21.7% and 23.5%) (PMA2020, 2016).

Africa's fertility reflects its level of modernization. Both perspective see preferences as the main driver suggesting mass media would need to change these to influence fertility.

Gender values and practices in Burkina Faso are "pre-modern" in that they have not yet converged to global averages: 36% of people live in polygamous households (the highest in the world), compared to 2% globally (Pew Research Center, 2020). In 2016, the prevalence of female genital cutting was 68% compared to 6% globally (World Bank, 2024). Only 61% believe women should have an equal right to own land compared to the average across Africa of 73% (Afrobarometer, 2017).

2.2 Mass media and community radio in Burkina Fasso

Community radio is the dominant mass media in Burkina Faso. Nationally, 68% of households own a radio and 56% of the population listens at least once a week (66% and 41% respectively in rural areas). Only 7% of rural households watch TV at least once a week (DHS, 2010). In our study sample, the average woman listens to 3.2 hours of radio a week. National stations primarily broadcast in French (spoken by less than 20% of people in rural areas). Community radios broadcast in local languages and have the largest audience. While especially important in Burkina Faso, community radio is a major source of mass media across the developing world (La Ferrara 2016).

Unlike much of the existing literature on media (e.g. DellaVigna and Gentzkow, 2010), the radio stations studied here did not have explicit social agendas. Before the campaign, news shows, music, and debate and call-in shows, each represent around a quarter of total airtime. The remaining quarter is split between behavior change programs (mainly on health and education) (13%), programs from national stations (11%), and religious shows (3%). Our survey suggests women's radio consumption follows a similar pattern.

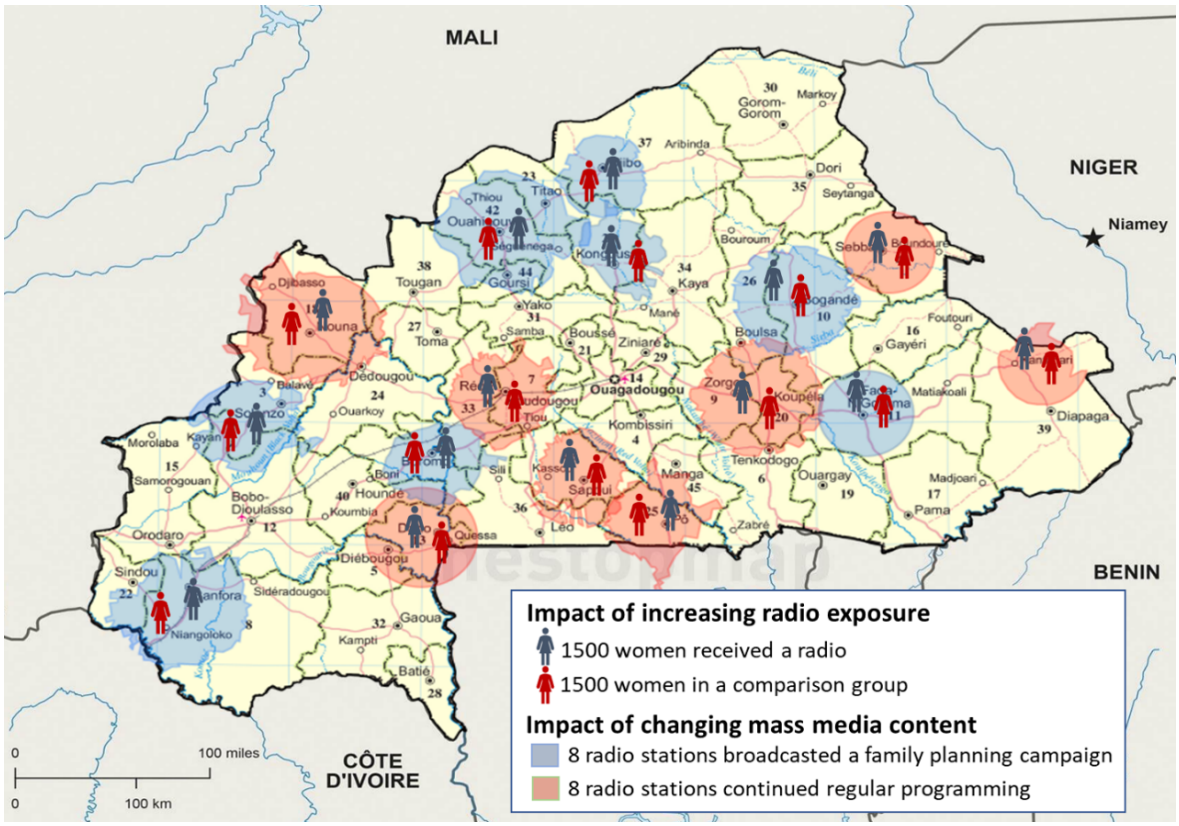
Thus, over two-thirds of community radio programming could be seen as "modernizing" i.e. linking households to a wider world (news, music, national programming), or explicitly calling for a move towards global norms, such as girls' education and family planning (behavioral change programs). The last third (debates, call-in, and religious programs) reflects the social attitudes of the local community, which can be conservative according to radio station directors. If mass media provides a mechanism for learning about or emphasizing with others' preferences and actions, it could lead to a reduction or increase in contraception use depending on the reference group.

3 Experimental design

3.1 A two-level randomized experiment

To estimate the impact of access to status quo mass media, we used our baseline to identify 1,444 households (1,633 women) in noncampaign areas who had no radio in the household and randomly allocated 50% to receive a radio.[8]

Figure 1: Research Design: a Two-level Randomized Experiment



Note: Broadcasting areas of the 16 local radio stations included in the study.

To measure the impact of the radio campaign on those with and without a radio at baseline, we ran a two-level randomized experiment at the radio station and household levels. Of 16 local radio stations, half were randomly assigned to treatment (broadcast the campaign) or control (regular programming). Stations were selected for their large audiences and highly localized coverage areas (Figure 1), which minimized the risk people heard treatment stations in control areas. The small areas with overlapping coverage were excluded from surveys to avoid contamination. Sixteen stations had

[8]The randomization was stratified by village, modern contraception use, and any formal education.

sufficiently distinct reach and strong market penetration (Head et al., 2015). To reduce the probability of imbalance across treatment and control clusters (Kasteng et al., 2018, who ran a previous radio station RCT in Burkina Faso encountered this problem), we used pairwise randomization stratified by baseline levels of our primary outcome (modern contraceptive prevalence rate). Of the 1,343 households in campaign areas without a radio at baseline, half received radios for all their women.

3.2 Testing Modernization Theory

Most premodern communities are kin-based, but economic development (through urbanization, occupational diversification, and mobility) reduces the proportion of kin in social networks (Newson and Richerson, 2009) with two key implications: traditional family institutions (marriage, children, kinship obligations) lose centrality, while education, professional success, and property gain importance (Hypothesis 1) and; while kin-based societies foster locally distinct values and traditions, greater exposure to non-kin leads to value convergence across groups (Hypothesis 2). Declining fertility is the common indicator of H1 and convergence with globally modal values the common indicator for H2 (Marsh, 2014).

Mass media is hypothesized to accelerate this process by creating exposure to and empathy for non-kin groups and their values and generating aspirations of modern forms of status (Lerner, 1958).[9] The mechanism behind the fall in fertility is a fall in *desired* fertility (as kin are less important and norms converge with global norms), (Mechanism 1). This is not a result of media being pro family planning, but because media weakens the influence of kin and community ties as in Olken (2009). Thus the impact of mass media on fertility, in the standard modernization mass media theory, is independent of its specific content (Hypothesis 3).

We test these predictions using our two-level RCT. As a validity check we verify community radio in Burkina Faso provides a window to a world outside the clan. We test H1 (does access to mass media alone decrease fertility) by comparing mCPR for women randomly given and not given radios in status quo areas. For H2 (convergence of gender norms) and M1 (fall in desired fertility), we make the same comparison but with gender norms and preferences over number of children as the outcomes. For H3 (media's

[9]Note that the broader (non-mass media related) modernization theory includes many other hypotheses including about the direct effect of modernization on fertility (e.g. that girls' education reduces the opportunity cost of children) that we are not set up to test.

impact is independent of content) we compare mCPR for women in campaign and status quo radio areas and (as an independent identification strategy) those randomly chosen to receive or not receive radios in campaign areas.

The existing literature is not well suited to testing these predictions: it either varies access (inevitably tied to specific content) or content. Several seminal studies of media access intentionally test programming with a social agenda. Adena et al.(2015) examine access to explicitly anti or pro Nazi party radio while La Ferrara et al. (2012) discuss how the Novelas (access to which they evaluate) provided an opportunity for otherwise censored writers in Brazil to advocate for their liberal values. The community radios we studied did not have a particular social agenda and covered a mixture of national, international, and local content similar to early radio in the US (Sterling and Kittross, 1978). We can thus separate the impact of access to status quo media from the impact of a specific pro family planning campaign.

4 Program implementation

4.1 Radio distribution

In households without radios at baseline, 1,557 women (in 1,397 households) were randomly selected to receive a solar powered radio across both campaign and noncampaign areas. 1,130 (72%) were found by DMI and given a radio between March and June 2017 (track rates were similar in campaign and noncampaign areas). Absence from the village was mainly due to seasonal travel to distant fields. The radios cost US$13, not a meaningful direct income effect at endline, one-and-a-half years after distribution.

Nearly all women (95%) who received a radio and were successfully interviewed at endline still had their radio, and 62% were still functioning.[10] While the radio distribution targeted women, radios can also be listened to by men.

4.2 The radio mass media campaign

The mass media campaign was implemented by DMI, an international NGO specialized in TV and radio campaigns. It ran from June 2016 until December 2018[11] and followed

[10]Women were told that if they still had their radios when DMI came back (at endline) they would be eligible for a lottery for a small cash prize (around US$ 3.5).

[11]In one cluster in the north, the campaign had to be stopped after 6 months for security reasons. This cluster was kept in the study sample and all analysis was intent to treat.

the *"Saturation +"* approach developed by DMI (Murray et al. 2015):

- Saturation: Messages ran 10 times per day, using 90-second spots in local languages plus one-hour phone-in programs 3 times a week for a total of 195 hours per year (4% of total content but 17% of peak listening time). This compared to 31 hours of family planning content on control stations annually.
- Science: Qualitative research identified the following information gaps and barriers in the target audience: information on the different methods available, concerns about side effects, the benefits of birth spacing, and gender norms.
- Stories: stories craft the emotional climax of the moment of decision where protagonists must either overcome the obstacles or revise their goals.

The campaign thus reflected key findings from behavior science: saturation ensured high salience; programming provided information not known to listeners on which they could act; and the stories presented information in an entertaining way which helps information to be absorbed (Banerjee et al. 2019).

Comparing station logs before and after the campaign shows airtime on behavior change programs focusing on women's health and family planning more than tripled from 3% to 11% of total peak airtime. The DMI campaign primarily crowded out debates and call-in shows which decreased from 19% to 11%. The proportion of peak time during which women present increased from 21% to 27% with the campaign. Appendix A provides more details on radio content with and without the campaign.

5 Data and empirical strategy

We use four sources of quantitative data: radio station logs; baseline and endline surveys of women; surveys of clinics located near the surveyed women; and administrative data on all clinics in the study areas from 2016 to 2018. Appendix B provides further details on these data sources and the definition of the outcome variables, while Figure A1 presents a flow diagram describing our sample.

5.1 Survey data and sampling strategy

Our women's survey sample sacrificed representativeness to achieve balance and statistical power (given the radio station RCT had only 16 randomization units). First, we randomly selected 16 villages per radio station cluster (252 total) from a list of villages where local radio would be the dominant mass media (i.e. fewer than 1,500

inhabitants, located within 50 kilometers of our sample radio stations, and off the electricity grid and thus little access to TV), and where contraceptive supply would not be a barrier (within 5 kilometers of a health center). While this reduced external validity, the sample still represents 1.4 million people or 8% of Burkina Faso's population. Our administrative data is more representative.

Second, we selected 7,515 women in a way that makes our 16 clusters more similar across key characteristics and thus helped ensure balance. We used household listing data to create strata by education, radio access, and distance to a health center, and sampled women within each cluster proportionally to their share in the overall sample. This meant over-sampling certain subgroups in some clusters (e.g., educated women in low-education clusters) and under-sampling in others. Our 16 clusters thus look more similar in our final women sample than in our listing (Appendix C). Importantly, our results are similar when we reweight to account for this strategy (appendix Table A4). This sampling strategy does not apply to our administrative and clinic data.

We surveyed all 461 clinics serving the selected villages, as reported by women respondents or local leaders. This sample is more representative and includes clinics serving women in urban areas and villages located more than 5km from a clinic.

Baseline surveys of women and clinics were conducted in April-June 2016, with follow-ups in November-December 2018. Attrition was low at 10.5% in the women's survey and 2.4% in the clinic survey, and balanced across treatment groups (appendix Table A2). Due to security issues, 11.5% of women and 5% of clinic follow-up surveys were conducted by phone using shorter instruments (balanced by treatment arms).

At baseline, women in our sample were on average 30 years old, 83% were married and 20% had ever been to school (Table 1, column 5). Women lived on average 4.5 kilometers from a health center and 23% were using modern contraception (close to the 21.5% found in the 2015 nationally representative PMA2020 survey). Women using a modern contraceptive relied primarily on implants (11%), injectables (8%) and oral pills (2%). Women with no radio in their household at baseline have similar age, marital status, number of pregnancies and distance to the nearest clinic to those with radio access. They are slightly less likely to use contraception (22% vs. 25%) and to have attended formal school (17.5% vs. 20%). Observable characteristics are well balanced on the post-attrition sample across all treatment and control groups (Table 1).

Table 1: Baseline Characteristics of Post-Attrition Women Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Women with no radio at baseline				**All women**		**Women with a radio at baseline**	
	Noncampaign areas		Campaign areas					
	No radio Mean	Radio Mean P-value	No radio Mean	Radio Mean P-value	Control Mean	Treat. Mean P-value	Control Mean	Treat. Mean P-value
Currently using contraception$^{\alpha}$	21.7%	19.6%	22.4%	22.7%	23%	24.2%	24.8%	26%
		-		-		0.52		0.621
Unmet need for contraception for spacing	36.5%	36.9%	32.8%	33.7%	34.3%	33.1%	32.5%	31.8%
		0.869		0.673		0.727		0.871
Unmet need for contraception for limiting	10.6%	11.9%	13.3%	14.6%	11.8%	12.4%	12.2%	11.7%
		0.657		0.418		0.655		0.226
Husband makes contraception decisions	24.7%	23.2%	20.4%	23.1%	24%	21.7%	24%	22.1%
		0.993		0.749		0.682		0.769
Distance to nearest Clinic	4.4	4.2	4.4	4.6	4.5	4.6	4.6	4.6
		0.214		0.959		0.686		0.931
Age	30.7	30.1	30.5	30.3	30.5	30.1	30.5	30
		0.273		0.786		0.63		0.288
Married	84.3%	81.5%	82.9%	82.2%	83.2%	84%	83.5%	84.7%
		0.087		0.807		0.821		0.697
Total number of pregnancy	4.4	4	4.5	4.3	4.2	4.3	4.2	4.3
		0.003		0.392		0.491		0.819
Ever attended formal school$^{\alpha}$	17.5%	19.6%	14.9%	15.9%	20%	18.3%	21.4%	20.3%
		-		-		0.381		0.751
Generate income	43.3%	43.4%	42.3%	41.5%	47.1%	45.1%	50.1%	48.4%
		0.985		0.727		0.865		0.822
Muslim	43.9%	43.6%	59.1%	54.1%	44%	59.2%	44.2%	58%
		0.781		0.02		0.47		0.238
Has access to a radio in her household	0%	0%	0%	0%	55%	54.9%	100%	100%
		-		-		0.992		-
N total	734	739	692	686	3,328	3,400	1,829	1,866

Note: Baseline survey data, April 2016. Columns (2) and (4): P-values from OLS regressions of the outcome variables on a tequal to one for women randomly selected to receive a radio, controlling for strata fixed-effects with standards errors clustered at the household level. Columns (6) and (8): Pvalues computed using wild boostrap procedure from OLS regressions of the outcome variables on a dummy equal to one in campaign areas, controlling for strata fixed-effects and with standard errors clustered at the radio station level. α: variables used for stratifying the randomization of the radio distribution intervention.

5.2 Administrative data

We use monthly administrative data from the Ministry of Health in Burkina Faso from January 2014 to December 2018. These data compile reports of contraceptives distributed by the 838 health centers located within 50 km of a study radio station, (461 of which are also in our clinic survey). This sample is representative, covering 5.1 million people in both urban and rural areas, or 27% of Burkina Faso's population.

Following our pre-analysis plan, we present results for implants, injectables, and pills (less than 1% of women report using other methods).

To account for outliers and the large number of zeros, we implement three (preregistered) strategies: we top-code the outcomes at the 99th percentile; we use logarithmic and inverse hyperbolic sine (IHS) transformations in some specifications;[12] and we smooth by pooling monthly data into quarterly periods. This last mitigates concerns that clinics report several months of contraceptives at once, leaving zeros in other months. Some zeros may reflect missing data, which would attenuate our results.

Before the program started, health centers in our sample were distributing an average of 25 injectables, 15 packs of oral pills and 6 implants every month.

5.3 Empirical strategy

We have three estimating equations: one for the distribution of radios randomized by household (SE clustered by household), one for the radio station RCT (SE clustered by radio station), and one for panel administrative data (SE clustered by radio station). While our primary outcome (mCPR) was prespecified, we collect other outcomes into prespecified families and adjust for multiple hypotheses when testing mechanisms.

We estimate the impact of being given a radio using the following equation on the sample of women eligible to receive a radio (i.e. women with no radio at baseline):

$$Y_{ih} = b_0 + b_1 Radio_h + X_i' + \varepsilon_{ih} \tag{1}$$

where Y_{ih} is the outcome of woman i in household h measured at endline, $Radio_i$ is an indicator for being assigned to receive a radio, and X_i' is a vector of control variables selected using post-double selection lasso (Belloni et al., 2014).[13] Standard errors are clustered at the household-level (the level of randomization). b_1 gives the impact of being assigned to receive a radio. We estimate equation (1) separately for women living in noncampaign and campaign areas so that in noncampaign areas b_1 estimates the impact of gaining access to status quo mass media while in campaign areas, b_1 estimates the combined impact of access to mass media and the campaign. A comparison between the two shows the marginal impact of the campaign.

[12] The IHS transformation is defined as $\log(y + \sqrt{y^2 + 1})$ and can be interpreted as a logarithmic transformation. It has become less popular since we pre-registered the study, due to difficulties in interpreting the results. We include it for completeness.

[13] Post-double lasso is a disciplined way of selecting baseline control variables that are strong predictors of future outcomes and treatment status. It can improve precision and help account for imbalances due to chance or caused by selective attrition.

Next we estimate the impact of the media campaign on a broader population (including those with and without radios) by exploiting our radio station level randomization. The specification for our women and clinics survey samples, is as follows:

$$Y_{ij} = \beta_0 + \beta_1 Treat_j + X_i' + \varepsilon_{ij} \tag{2}$$

where $Y_{i,j}$ is the outcome variable of women (or clinic) i in cluster j measured at the follow-up survey, $Treat_j$ is an indicator equal to one in treatment areas, and X_i' is a vector of covariates selected using post-double selection lasso.[14] ε_{ij} is the error term clustered at the radio station level. To account for the small number of clusters, we calculate p-values using the clustered wild bootstrap procedure proposed by Cameron et al. (2008) with 2,000 replications. β_1, our coefficient of interest, captures the effect of living in an area assigned to receive the mass media campaign, including any spillover effects on those without radios or who do not listen to the campaign station.

Finally, we estimate the impact of the media campaign on contraceptive distribution using administrative clinic data and a difference-in-differences strategy with clinic and time fixed effects. This approach leverages the high-frequency dimension of the dataset, which spans 60 months and begins 2.5 years before program start:

$$Y_{ijt} = \alpha_0 + \alpha_1 Treat_j * Post_t + c_j + \tau_t + \varepsilon_{ijt} \tag{3}$$

where $Y_{i,j,t}$ is the outcome for clinic i in time t in cluster j. $Treat_j$ takes the value 1 if the clinic is located within 50 km of a treatment radio station and 0 if the clinic is within 50 km of a control radio station. $Post_t$ takes the value 1 in all periods after the start of the campaign (April 2016 onward), c_i and τ_i are clinic and time-period fixed effects. The standard errors, ε_{ijt} are clustered at the radio station level and p-values are calculated using wild bootstrap with 2000 replications. α_1, our coefficient of interest, provides the intent-to-treat estimate of the average treatment effect.

Given the large number of outcomes in our women's survey, we pre-registered a single primary outcome (mCPR) and ten families of mechanism outcomes measuring knowledge, attitudes and perception of family planning, norms, and well being. We calculated z-scores for each family following Kling et al. (2007).[15] Coefficients are measured in percentage of the control group (noncampaign areas) standard deviation.

[14] As a robustness check, we also estimate equations (1) and (2) that control only for strata fixed effects. We find virtually identical (slightly less precise) results (available on request).

[15] Indices are constructed from pre-specified variables coded so that higher values reflect greater knowledge or more positive attitudes. Each variable is standardized using the control group's mean and standard deviation, and the index is calculated as the standardized average of these variables.

Appendix B defines all variables in the indices. Results for components of indices, subpopulations (except radio ownership) and descriptive statistics are exploratory.

α_1 from equation (3), β_1 from equation (2), and the difference between b_1 estimated in treatment vs control areas all provide independent estimates of the impact of the radio campaign on different populations, using different data sources, and two different sources of random variation.

6 Results

6.1 Did the radios and campaign reach women?

As a validity check we confirm the radio distribution increased exposure to mass media (not its content) while the campaign change the content (but not quantity) (Table 2).

In noncampaign 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.[16] The radio distribution doubled the chance there was a radio in the household from 32 to 66% in noncampaign areas and from 33 to 67% in campaign areas. The share of woman with their own radio rose from 4 to 60% in noncampaign areas and from 1 to 64% in campaign areas. On average, women who received radios reported listening to the radio over an hour more per week in both campaign and noncampaign areas roughly doubling their exposure to mass media.

The media campaign changed the content of media but not the quantity consumed. For those not receiving a radio as part of the experiment, the campaign had no effect on radio access and ownership, amount of time spent listening to the radio, or the likelihood a woman listened regularly to the study radio station (Table 2, column 6).

The media campaign changed the type of programs women listened to. The share of women who listened to a behavior change program in the last week increased from 13% to 23% in campaign areas (p-value=0.000[17]), the share who heard of family planning in the last month rose from 63% to 80% (p-value=0.003). The share that listened in the last week to debates and call-in shows fell an insignificant 3 percentage points and to religious programs an insignificant 2 percentage points. Even in noncampaign areas, most 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 to

[16] Many women could not name the stations they listened to suggesting this is a lower bound.
[17] When applicable, all reported p-values are computed using the wild bootstrap procedure.

family planning content) as well as the quality of the programming (discussed below).

Table 2: Impact on Radio Ownership, Listenership and Content

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
At least a radio in the household	0.324	0.333	0.335	0.336	0.553	0.003
	[0.468]	(0.025)	[0.472]	(0.026)	[0.497]	(0.039)
Has her own personal radio	0.044	0.553	0.012	0.625	0.179	-0.021
	[0.204]	(0.019)	[0.107]	(0.019)	[0.383]	(0.015)
Often listen to the radio	0.79	0.142	0.819	0.134	0.872	0.018
	[0.407]	(0.018)	[0.385]	(0.017)	[0.334]	(0.027)
Often listen to the cluster radio station	0.532	0.097	0.552	0.124	0.601	0.002
	[0.499]	(0.027)	[0.498]	(0.024)	[0.49]	(0.154)
Amount of time listened to the radio in the last 7 days (hours)	1.368	0.991	1.135	1.979	2.006	-0.092
	[3.945]	(0.244)	[3.932]	(0.259)	[5.163]	(0.285)
Listen at least once in the last week to :						
News shows	0.104	0.077	0.1	0.147	0.166	0.001
	[0.305]	(0.018)	[0.3]	(0.02)	[0.372]	(0.023)
Behavior change programs	0.079	0.079	0.149	0.207	0.133	0.1
	[0.27]	(0.016)	[0.356]	(0.022)	[0.34]	(0.01)
Religious programs	0.04	0.043	0.025	0.048	0.065	-0.02
	[0.195]	(0.012)	[0.155]	(0.012)	[0.246]	(0.016)
Debates and call-in shows	0.095	0.099	0.092	0.132	0.165	-0.025
	[0.294]	(0.017)	[0.29]	(0.019)	[0.371]	(0.046)
Music	0.124	0.068	0.072	0.099	0.167	-0.048
	[0.33]	(0.017)	[0.259]	(0.017)	[0.373]	(0.061)
Ever heard of family planning on the radio	0.653	0.187	0.821	0.115	0.759	0.11
	[0.476]	(0.023)	[0.384]	(0.017)	[0.428]	(0.039)
Heard of FP on the radio in the last month	0.529	0.219	0.725	0.137	0.633	0.162
	[0.499]	(0.025)	[0.447]	(0.022)	[0.482]	(0.054)
N total	1,473		1,378		6,728	

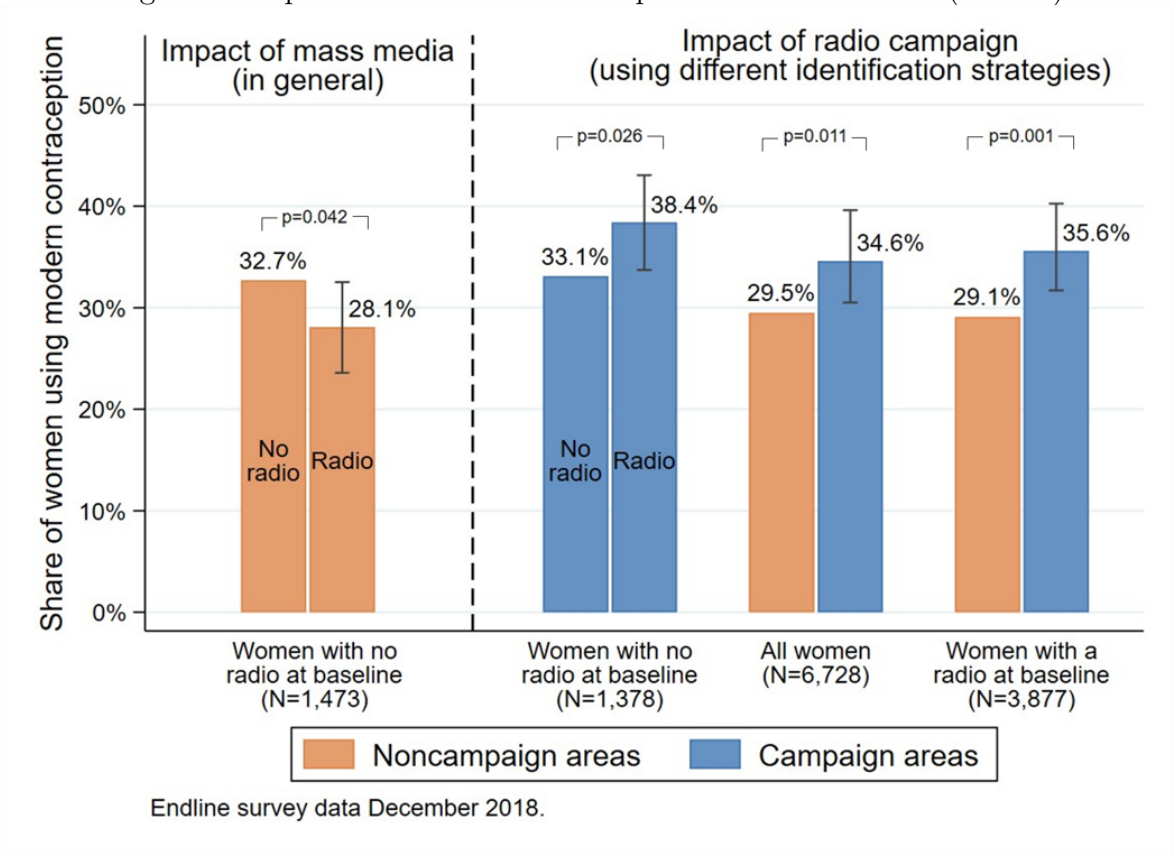
Note: Endline women survey data. Columns (2) and (4): OLS regressions of the outcome variables on a dummy for the radio distribution intervention. Standard errors clustered at the household level. Column (6): OLS regressions of the outcome variables on a dummy for campaign areas. Wild bootstrapped standard errors, clustered at the radio-station level. Regressions include baseline covariates from post-double selection lasso.

6.2 Impact of mass media on knowledge, behavior and preferences

Contrary to modernization theory, those who were introduced to mass media in non-campaign areas reduced their modern contraceptive prevalence rate (mCPR, our pri-

mary prespecified outcome[18]) by 4.6 percentage points (p-value=0.042, Figure 2) compared to women who did not receive a radio (H1). Despite greater exposure to national and international programming, we find no evidence for the main mechanism posited by modernization theory and prior economic literature, namely that mass media reduces the desired number of children (M1) (Table 3, column 2). Nor did it change an index of family planning attitudes or attitudes to birth spacing.

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



Status quo mass media did not change information or misinformation on contraception. Women who received a radio were more likely to have heard about family planning on the radio (19 percentage points, Table 2) and listened to behavior change programs (8 points). However, knowledge about family planning and different methods was unaffected by receiving a radio (Table 3) potentially because it did not use effective behavior change strategies. They did not use entertainment, provide new information,

[18]Our primary pre-specified outcomes are mCPR and total contraceptive use (modern and effective traditional methods). We focus on mCPR as it is more commonly used and only few women report using traditional methods. Results for total contraceptive use are similar (Appendix Table A3).

or tackle misperceptions.[19] According to station directors it mainly advertised the weeks when contraception was free, information most women already knew. Note that increased exposure to family planning messaging is not a key mechanism hypothesized in modernization theory by which mass media changes fertility.

Access to status quo mass media did not lead to a convergence with globally modal gender attitudes (H2), if anything it led to a divergence. Women who received radios in noncampaign areas reported less liberal gender attitudes (-0.086 standard deviations, Table 3). For example, women were 3.6 percentage points more likely to agree that "a man is superior to a woman," and 4.6 percentage points more likely to agree that "boys should have more opportunities and resources for education than girls." However, these gender results do not survive multiple hypothesis testing (Appendix Table A6).

6.3 Why did giving radios in noncampaign areas reduce contraception use?

Exposure to mass media did not change fertility preferences, yet contraceptive use declined. Unlike the Catholic radio stations in Bengtsson et al. (2013) or *Fox News* in DellaVigna and Kaplan (2007), community radio stations in this study had no conservative agenda: all agreed to air the DMI program. Nor did media exposure increase misinformation about family planning (views about contraception causing sterility were unchanged).

However, 17% of peak time content in control stations consisted of debates and call-in shows in which the norms and views of the local community were voiced. Qualitative interviews with station managers revealed contraception was frequently discussed in these shows, and hosts felt unprepared to contradict local views. Previous literature has stressed the role of norm convergence whereby rural women are exposed to more progressive urban values (La Ferrara et al., 2012) or progressive content (Cheung, 2012). Yet if local radio reflects the norms of the society it serves, it may promote convergence with local norms (e.g. through second order beliefs). With 68% of the community not using contraception, convergence to the local mode means a decline in mCPR. Thus convergence to the modal behavior of the media market could explain the increases in contraception observed in previous studies and our results.

[19]The Government of Burkina Faso at the time was a strong proponent of access to family planning as outlined in the Ouagadougou Partnership https://partenariatouaga.org.

Table 3: Mechanisms: Impact on Knowledge, Attitudes and Norms

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Index of knowledge of contraceptive methods	0.024	-0.031	0.207	0.122	0	0.26
	[0.968]	(0.051)	[0.893]	(0.044)	[1]	(0.042)
Modern contraceptive methods can make a woman sterile	0.258	-0.005	0.163	-0.001	0.259	-0.086
	[0.438]	(0.022)	[0.37]	(0.019)	[0.438]	(0.034)
Modern contraceptive methods can cause sickness	0.343	0.037	0.301	-0.03	0.38	-0.079
	[0.475]	(0.025)	[0.459]	(0.024)	[0.486]	(0.035)
Ever heard of implants$^{\alpha}$	0.867	-0.02	0.864	0.033	0.863	0.006
	[0.34]	(0.02)	[0.343]	(0.017)	[0.344]	(0.023)
Ever heard of injectables$^{\alpha}$	0.791	-0.007	0.85	0.037	0.789	0.076
	[0.407]	(0.024)	[0.357]	(0.019)	[0.408]	(0.03)
Ever heard of oral pills$^{\alpha}$	0.741	-0.001	0.815	0.016	0.751	0.07
	[0.439]	(0.025)	[0.389]	(0.02)	[0.432]	(0.034)
Index of attitudes towards family planning$^{\alpha}$	0.015	-0.075	0.13	0.03	0	0.108
	[0.922]	(0.059)	[0.801]	(0.043)	[1]	(0.045)
Women should control the number of children they have during their lifetime$^{\alpha}$	0.506	0.008	0.634	0.035	0.547	0.066
	[0.5]	(0.024)	[0.482]	(0.025)	[0.498]	(0.039)
Index of women's perceptions of fertility and birth spacing	-0.024	-0.028	-0.087	0.094	0	-0.078
	[1.016]	(0.048)	[0.982]	(0.048)	[1]	(0.115)
Ideal number of children	6.168	0.054	6.044	-0.075	6.116	-0.062
	[1.959]	(0.089)	[1.804]	(0.092)	[1.872]	(0.119)
Index of husband's perceptions of fertility and birth spacing$^{\alpha}$	0.063	-0.109	0.063	0.053	0	0.063
	[1.031]	(0.06)	[1.04]	(0.056)	[1]	(0.093)
Perceived husband ideal number of children	7.22	0.139	7.085	-0.019	7.302	-0.361
	[2.67]	(0.186)	[3.004]	(0.192)	[2.7]	(0.405)
Index of positive gender attitudes	0.01	-0.086	-0.243	0.025	0	-0.19
	[0.998]	(0.05)	[1.018]	(0.053)	[1]	(0.211)
N total	1,473		1,378		6,728	
N in-person survey	1,202		1,307		5,860	

Note: Endline women survey data. Columns (2) and (4): OLS regressions of outcome variables on a dummy for the radio distribution treatment. Standard errors clustered at the household level. Column (6): OLS regressions of outcome variables on a dummy for campaign areas. Wild bootstrapped standard errors clustered at the radio-station level. All regressions include baseline covariates from post-double selection lasso. α: only in the in-person survey

Women with an unmet need for contraception at baseline (i.e. whose desire, if acted on, is out of line with modal behavior) see the biggest change when receiving a radio i.e. an 8.7 percentage point fall in contraception use (Appendix Table A4).

The (nonrobust) decline in gender attitudes discussed above would go beyond convergence. This could be explained by the male dominance of radio content with 83%

of peak airtime hosted by men (this falls to 73% in campaign areas) and call-in shows where listeners condemned family planning and expressed patriarchal views.[20]

Thus, while radio stations did not have an explicit conservative agenda, they appear to have reinforced patriarchal views common in the community. This may have reinforced the pressure on women who wanted to control their fertility not to act on this preference, and on men not to allow them to.

6.4 Impact of mass media campaign

6.4.1 Impact on contraception use from women survey data

We assess the impact of changing the content of mass media on mCPR by comparing those who did and did not receive a radio in campaign areas (individual RCT); and all women in campaign vs all women in noncampaign areas (station level RCT). Despite relying on independent identification strategies, both methods yield similar results (Figure 2), providing evidence against H3 (media effects are independent of content).

Women living in campaign areas who received a radio, were 5.3 percentage points (p-value=0.026) more likely to adopt a modern method relative to women who did not. The DMI campaign was therefore able to overcome the negative impact of mass media in general and generate an increase in contraceptive use.[21]

The station level RCT suggests the mass media campaign increased mCPR, by 5.1 percentage points (intention to treat estimate, p-value=0.011). This corresponds to a 17% increase relative to the control group mCPR of 29.5%. 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 away from other forms of contraception (Appendix Table A3).

The impact is larger (though not significantly so) on women who had a radio at baseline (Figure 2) for whom mCPR increased from 29.1% to 36.1% (p-value=0.001).

[20] In all qualitative interviews, station managers described calls expressing anti-family planning and patriarchal views. For example: "*listeners often call during interactive shows to condemn family planning*"; *listeners opposed offering implants, arguing it could ... encourage women's infidelity*; "*a woman cannot adopt a method without her husband's consent*; "*listeners stated that women's bodies are sacred in Dagara country, no one has the right to touch them, even for contraceptive methods.*"

[21] Receiving a radio in noncampaign areas reduces mCPR by 4.6 percentage points. The campaign increases mCPR for those with a radio at baseline by 7 percentage points. The implied combined effect of a radio in campaign areas is +2.4 percentage points. This is within the confidence interval of the experimentally estimated effect of the combined intervention (giving a radio and the campaign).

Those who did not receive a radio in campaign and status quo areas have identical mCPR, suggesting limited spillovers (bars 1 and 3 of Figure 2).

There was an upward trend in mCPR from baseline (23%) to endline (29.5%) similar to that in the nationally representative PMA2020 survey and in other countries in sub-Saharan Africa (Appendix D).

6.4.2 Clinic survey and administrative data

Clinic surveys and administrative data are an independent check on women's self-reported contraception use and also suggest a large impact of the mass media campaign on modern contraceptive uptake (Table 4). All point estimates have confidence intervals that include the 17% increase from the women's survey. The campaign increased the average number of: family planning consultations from 31 to 43 (p-value=0.09, Panel A), implants distributed from 3.6 to 5.5 (p-value=0.056), injectables distributed from 27.5 to 34 (p-value=0.2) and pills distributed from 16.3 to 33 (p-value=0.007).

Table 4: Impact of Media Campaign on Contraceptives Distribution: 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 2018: top coded at P99 (N= 401)	30.97 [35.2]	11.79 (6.77)	3.61 [5.41]	1.9 (0.99)	27.52 [27.4]	6.54 (4.74)	16.31 [25.38]	12.54 (3.48)
October 2018: log/IHS Transformation (N= 401)	3.01 [0.97]	0.35 (0.21)	1.4 [1.11]	0.21 (0.27)	3.53 [1.1]	0.32 (0.16)	2.42 [1.69]	0.72 (0.33)
Panel B: Administrative clinic panel data								
Monthly data: top coded at P99 (N= 50,280)			5.59 [10]	0.57 (0.7)	24.36 [30.57]	2.5 (1.15)	14.23 [28.4]	2.86 (2.31)
Monthly data: IHS Transformation (N= 50,280)			1.45 [1.41]	0.12 (0.12)	2.87 [1.78]	0.1 (0.1)	1.94 [1.79]	0.1 (0.08)
Quarterly data: top coded at P99 (N=17,598)			5.53 [7.74]	0.61 (0.67)	24.3 [28.37]	2.6 (1.12)	14.17 [25.22]	3.03 (2.39)

Note: Panel A: clinic survey data. OLS regressions of the outcome variables on a dummy for campaign areas, controlling for baseline covariates selected using post-double selection lasso. Panel B: administrative data on 838 health centers and 60 months. Difference-in-differences regressions with time and clinic fixed effects. All standard errors are clustered at the radio station level and computed using wild boostrap procedure.

We find similar results using the large sample, representative administrative data (Panel B). Health centers located in treatment areas distributed on average 2.6 more injectables (+11%, p-value=0.02) and 3 more oral pill packages (+21%, p-value=0.2) per

month in our preferred specification using data aggregated quarterly. Appendix Figure A2 provides graphical evidence supporting the parallel trends assumption, and tests that pre-treatment period dummies are jointly equal to zero and are not significant.

Finally, increased demand rather than supply drives our results as very few clinics in our survey sample were out of stock of contraceptives in the two months before the survey (1.2% were out of pills, 1.7% of injectables and 2.7% of implants)[22] with no significant difference between campaign and noncampaign areas.

6.4.3 Does the campaign change preferences or knowledge?

Contrary to modernization theory, the campaign changed knowledge not preferences (Table 3, columns 6 and 4). Behavior change due to corrected misinformation is likely welfare increasing while the welfare implications of preferences shifts are less clear (DellaVigna and Gentzkow, 2010). We cannot rule out that knowledge changed due to less status quo content rather than more DMI content but find the latter more likely as status quo content alone did not change knowledge.

Unlike general media access, campaign exposure significantly improved the index on contraception knowledge: 0.26 standard deviations (p=0.000) in the radio station RCT and 0.12 in the individual-level RCT. This was driven by a decline in the belief that modern contraception causes sterility (26% to 17%, p=0.007) or sickness (38% to 30%, p=0.032), and greater awareness of contraceptive methods available. The campaign shifted information sources: the share of women citing radio as their source rose by 24.3 percentage points, while reliance on other women fell by 9.8 points (Table A5). Attitudes toward family planning also improved, with the share agreeing that "women should control the number of children they have" rising from 55% to 62%.

In contrast, fertility and stigma-related attitudes (e.g., embarrassment buying contraceptives) showed no significant change, nor did ideal number of children or birth spacing preferences.

Finally, we find no effect of the campaign on gender attitudes. Women given radios in campaign areas did not become more (or less) conservative—possibly because DMI programming displaced call-in shows where conservative views were often voiced.

6.4.4 Who changes behavior and models of persuasion

We find strong evidence for inconsistent use of contraception (Appendix Table A4). Nearly half (48%) of women using modern contraception at baseline were no longer

[22] This is consistent with PMA2020 which finds supply is not a major issue in Burkina Faso.

using it at endline.[23] The media campaign was especially effective on these women, increasing mCPR from 48% to 59% (p-value=0.003). We find lower but sizable impacts on women who declared unmet need for contraception at baseline (increased from 27% to 33%, p-value=0.002) but no effect on women who declared no unmet needs at baseline. Evidence of inconsistent contraceptive use and stronger effects among baseline users aligns with limited attention models where women intend to use contraception but may forget, and the campaign boosts salience. Its design with frequent, engaging messages over 2.5 years, was well suited to affect behavior through this channel.

The campaign also had greater impacts on women who were already better informed (mCPR rose from 35% to 43%, p=0.005) and those wanting fewer children (31% to 37%, p=0.047). This is consistent with models in which campaigns alter behavior by changing knowledge of expected benefits or costs (e.g. the risk of side effects). Those most likely to change are closest to the margin of adoption pre-campaign (e.g. those already informed, those with unmet need, and inconsistent users).

These (exploratory) patterns contrast with models predicting that information campaigns are most effective among those with weaker priors, such as those least informed or who had never used contraception (Ackerberg 2003, Dupas 2014).

6.4.5 Does contraception change fertility and well-being?

We examine the impact of the campaign on fertility (Table 5). 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 (for this reason we did not pre-specify it as an outcome). 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).

We find a negative impact of the campaign on the share of women who gave birth in the 12 months preceding the endline (from 17.4% to 15.9%, p-value=0.069). This 9% reduction in fertility is consistent with the magnitude of correlation between contraceptive prevalence and fertility identified in the demographic literature (Bongaarts 2017).[24] We also find a positive impact on the share of women who had sex in the last 3 months from 50% to 58%, (p-value=0.28, not prespecified).

[23] 62% of these women have unmet need for contraception, 32% stopped because they want to get pregnant or gave birth recently and 6% are infertile or not sexually active.

[24] 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 34.6% should correlate with a reduction in total fertility rate from 4.8 to 4.4 children per woman, a 8.3% reduction.

The campaign increased our pre-specified index of self-assessed health and well-being by 0.252 standard deviation (p-value =0.026), further suggesting it was welfare improving. Reduced fertility among those wanting to avoid childbirth and increased sexual activity could explain this. We find no significant impact on other pre-specified secondary endpoints (indices of women's empowerment and domestic violence).

Table 5: Impact on Fertility, Sexual Activity and Well-being

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Gave birth in the last year	0.171	-0.005	0.171	-0.016	0.174	-0.015
	[0.377]	(0.021)	[0.377]	(0.02)	[0.379]	(0.009)
Had sex in the last 3 months	0.506	-0.003	0.587	0.007	0.502	0.075
	[0.5]	(0.028)	[0.493]	(0.026)	[0.5]	(0.058)
Index of self-assessed health and well being	-0.131	0.005	0.355	-0.06	0	0.252
	[1.042]	(0.045)	[0.896]	(0.043)	[1]	(0.119)
N total	1,473		1,378		6,728	

Note: Endline women survey data. Columns (2) and (4): OLS regressions of outcome variables on a dummy for the radio distribution intervention. Standard errors clustered at the household level. Column (6): OLS regressions of outcome variables on a dummy for campaign areas. Wild bootstrapped standard errors, clustered at the radio-station level. Regressions include baseline covariates from post-double selection lasso.

6.4.6 Cost-effectiveness

We examine the cost-effectiveness of the pilot campaign (which reached 5 million people) and a nationwide scale-up to 39 local radio stations. The scale-up started in January 2019 after preliminary results of this study became available. Our estimates are based on actual program expenses (in 2018 dollars), data on radio broadcasting areas computed by DMI, and population estimates from the national census.

We estimate that 625,000 women of reproductive age lived in a village reached by the pilot campaign, including 177,000 in villages for which our survey data is representative. The national campaign reached 83% of Burkina Faso's population (Figure A3), or 3.8 million women of reproductive age (1.2 million in areas similar to our survey data).

Under our preferred assumption that the program has the same impact everywhere,[25] the pilot campaign led to 32,000 more women using contraception and 1,600

[25]Two pieces of data support this assumption: we find larger impacts on women with characteristics closer to urban population (with access to a radio, using contraception, and with more information);

fewer (likely undesired) births at an annual cost of US$39 per women and US$770 per birth. The nationwide campaign led to about 200,000 additional contraception users and 10,000 fewer birth at cost of US$7 per women per year and US$139 per birth averted.

Under our most conservative assumption that the program had no impact in areas for which our survey sample is not representative, these costs would increase to $23 per additional contraceptive user and $447 per birth averted.

This is more cost-effective than alternative approaches to promote mCPR for which data is available. Integrating mCPR into other health services (e.g., HIV or immunization) which is considered among the most promising costs US$30 to US$60 per additional user (Shade et al., 2013, Dulli et al., 2016, Rosen et al., 2019).

These results are also economically significant. The campaign's "persuasion rate"—the share of recipients who changed behavior among those exposed to the message and not already persuaded (DellaVigna and Gentzkow, 2010)—is 8.1%,[26] which is large, but not out of line with other studies on the impact of mass media.[27]

Appendix D provides additional details on cost-effectiveness, including program costs, justification of assumptions, and benchmark comparisons.

6.5 Robustness to multiple hypothesis adjustment

To guard against p-hacking (and imprecision from multiple hypothesis testing), we prespecified a single primary outcome (mCPR). However, in examining mechanisms and secondary outcomes we simultaneously examine the impact of the mass media campaign on 10 pre-specified indices. 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). Results for our indices of contraceptive methods knowledge, attitudes towards family planning and self-assessed health and well-being are robust to false discovery rate adjustment with q-values equal to 0.001, 0.038 and 0.075 respectively (Appendix Table A6).

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and administrative data from urban clinics reached by the pilot (but not in our woman sample) suggests the program had at least similar impacts in urban areas (appendix Table A7 vs Table 4).

[26] The persuation rate is defined as the ratio of (a) the treatment effect (5.1%) and the product of (b) the share who haven't already adopted the behavior (ie. the share not using contraception: 70.5%) and (c) the difference in exposure to the campaign between treatment and control (i.e. the share often listening to the radio in campaign areas: 89.5%).

[27] DellaVigna and Kaplan (2007) find a persuasion rate of 11.6% for access to *Fox News* on Republican vote share, Enikolopov et al. (2011) a rate of 7.7% for the availability of an anti-Putin TV station on votes against Putin, and Gerber et al. (2009) report 19.5% for a 10-week subscription to *The Washington Post* on Democratic vote share.

7 Conclusion

We provide large-scale experimental evidence that access to mass media can sharply reduce the use of contraception despite increasing exposure to national and international programming (including on family planning). This finding is contrary to modernization theory, which suggests mass media accelerates modernization by broadening horizons and thus undermines the traditional primary focus on family and kin. It is also in opposition to much of the previous economic literature.

The change in contraception use does not appear to work through changes in family size preference (the key mechanism hypothesized in previous economics literature and modernization theory). Instead, women with unmet need at baseline who receive a radio are less likely to use contraception at endline than their equivalents without radios, while their preferences remain unchanged.

Our finding and that in the previous economic literature can be reconciled if access to mass media works by making more salient, and creating pressure to conform to, the behavior of the modal media consumer. Previous studies examined the impact on rural and poor populations of being incorporated into national mass media markets (cable TV and soap operas) where the modal viewer had smaller families than the new media consumers. In our case, status quo mass media appears to put pressure on women who don't want more children to conform to the behavior around them.

This negative effect of mass media on contraception can be offset by a high-quality mass media public health campaign based on the lessons from behavioral science. Again, mass media did not work through changing preferences (contrary to modernization theory). Instead, the intensive, two-and-a-half-year campaign, delivered at scale, effectively challenged misconceptions about contraception including that contraception can make a woman sterile. This is important given the high prevalence of misinformation about contraception in low-income countries. We show such campaigns can be many times more cost-effective than other effective family planning interventions.

Methodologically, we demonstrate that the challenge of studying the impact of mass media campaigns can be overcome (in some settings) with a multi-layered experiment combining individual-level randomization of radio access with station-level randomization. This design effectively embeds an at-scale replication within a single study. It yielded consistent estimates from two independent sources of random variation and three data sources (women's survey, clinic survey, and administrative records).

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Conflict of interest

Rachel Glennerster and Victor Pouliquen do not have any relevant or material financial interests that relate to the research described in this paper. Joanna Murray is permanently employed by Development Media International, the organization implementing the media campaign studied in this paper. She contributed to the study design, campaign implementation and writing of this paper, but she did not directly handle or analyze the data presented at any stage. She does not have any other relevant or material financial interests that relate to the research described in this paper.

Appendix Figures

Figure A.1: Randomization and Sampling Flow Diagram

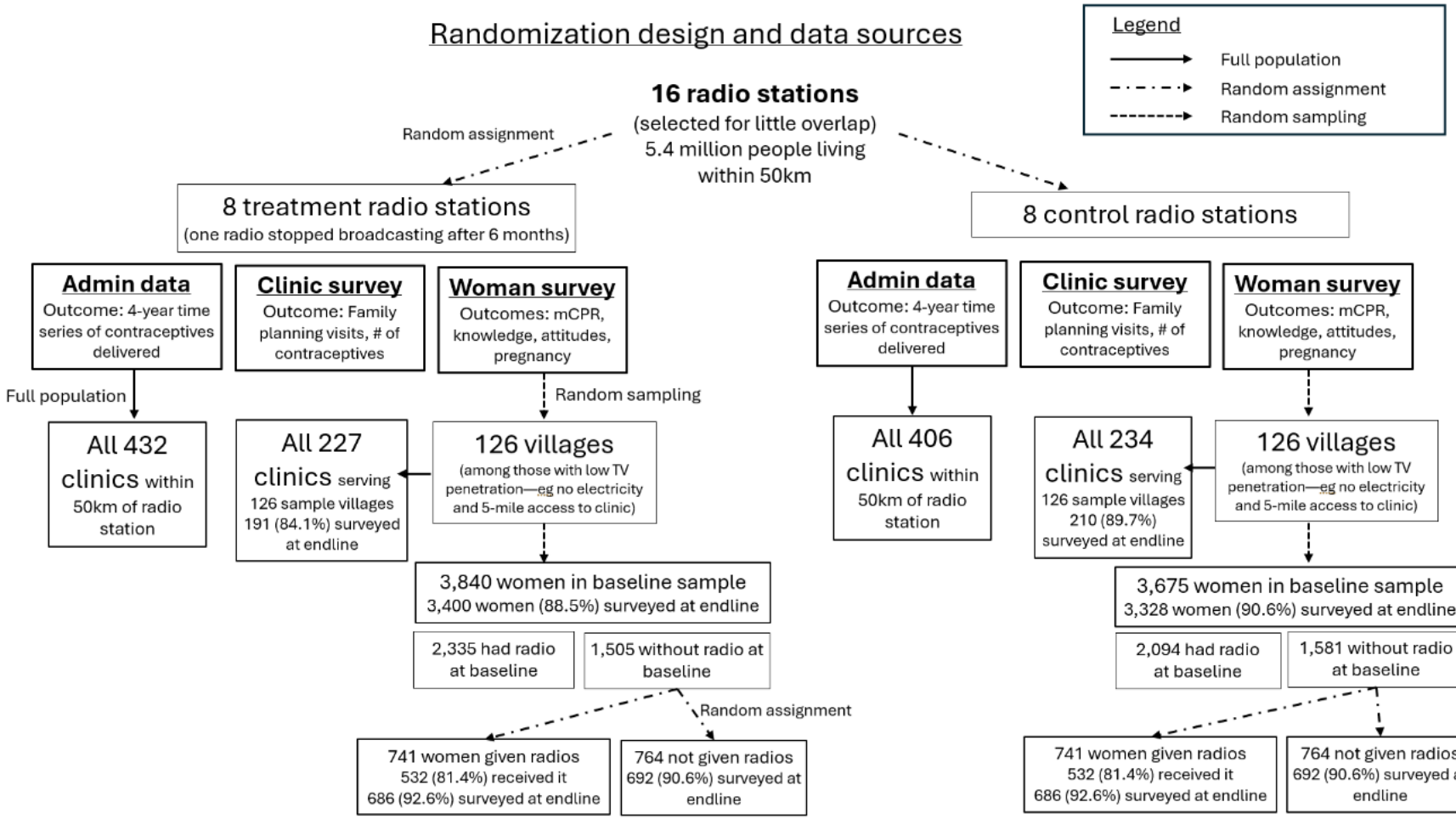


Figure A.2: Impact on Injectables and Oral Pills Distribution

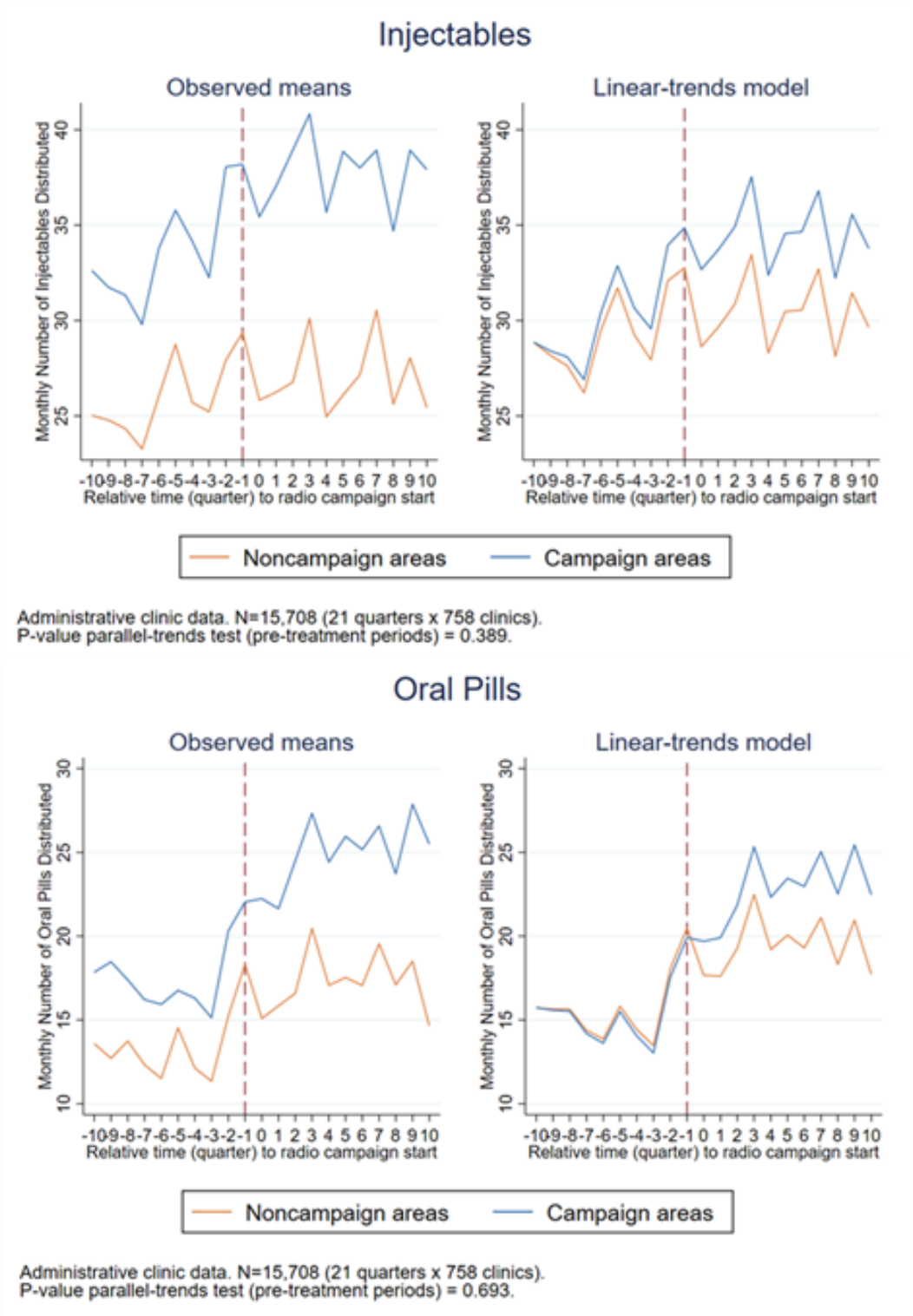
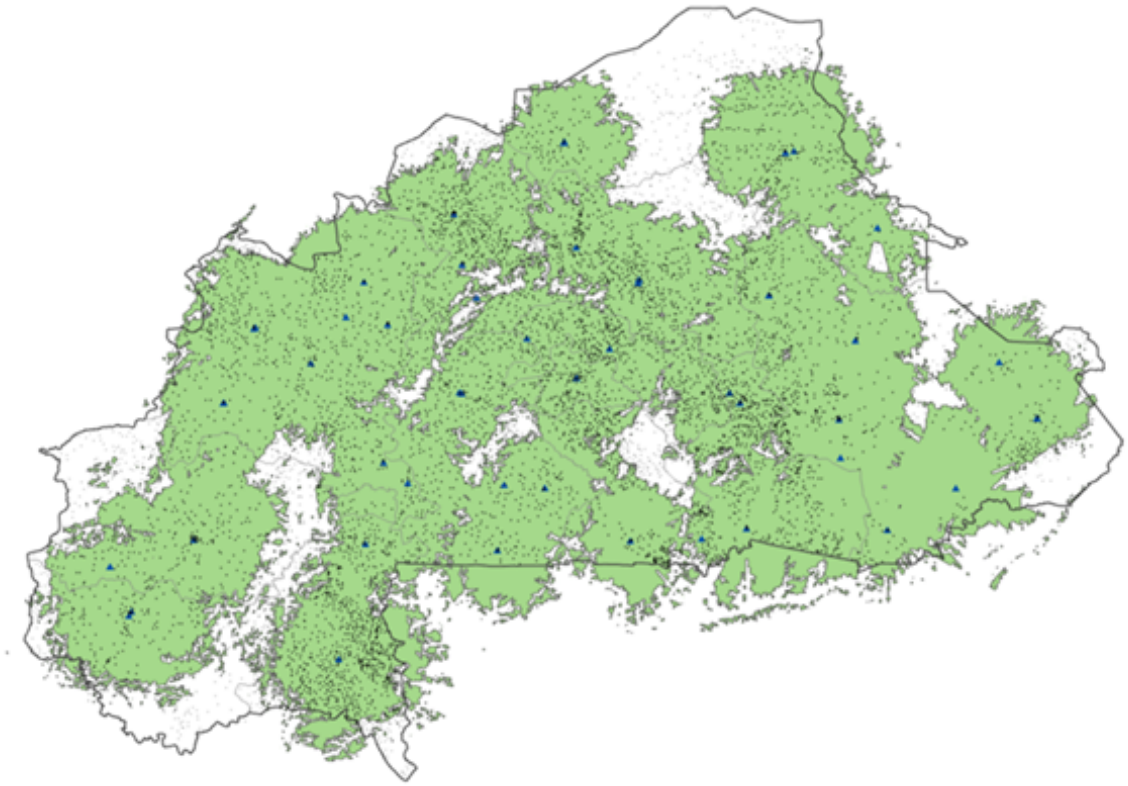


Figure A.3: Areas Reached by Radio Stations Involved in Program Scale-Up



Note: Using population census data we estimate that 83% of the population is reached by a radio station involved in the program scale-up.

Appendix Tables

Table A.1: Robustness of Main Results to the Inclusion of Sampling Weights

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Impact on primary outcome:						
Currently using modern contraception (mCPR)	0.314 [0.464]	-0.058 (0.035)	0.324 [0.468]	0.09 (0.047)	0.289 [0.453]	0.056 (0.027)
Impact on information and knowledge:						
Index of knowledge of family planning[α]	-0.072 [1.039]	0.043 (0.111)	-0.091 [0.978]	0.27 (0.102)	0 [1]	-0.048 (0.061)
Index of knowledge of contraceptive methods	0.016 [0.987]	0.007 (0.084)	0.173 [0.945]	0.186 (0.078)	0 [1]	0.276 (0.047)
Impact on norms and attitudes:						
Index of attitudes towards family planning[α]	0.003 [0.947]	0.008 (0.076)	0.09 [0.89]	0.03 (0.088)	0 [1]	0.087 (0.054)
Index of attitudes towards contraceptive methods	-0.028 [1.014]	0.001 (0.089)	-0.065 [1.025]	0.078 (0.094)	0 [1]	-0.08 (0.025)
Index of women's perceptions of fertility and birth spacing	-0.003 [1.03]	-0.082 (0.085)	-0.131 [0.997]	0.317 (0.1)	0 [1]	0.06 (0.198)
Index of husband's perceptions of fertility and birth spacing[α]	0.149 [1.106]	-0.22 (0.102)	0.057 [1.055]	0.324 (0.113)	0 [1]	0.191 (0.172)
Index of gender attitudes	0.005 [0.984]	-0.094 (0.074)	-0.322 [1.115]	0.058 (0.122)	0 [1]	-0.485 (0.06)
Impact on fertitity, well-being and secondary outcomes:						
Gave birth in the last year	0.148 [0.355]	0.025 (0.033)	0.16 [0.367]	-0.002 (0.044)	0.162 [0.369]	-0.003 (0.015)
Index of self-assessed health and well being	-0.056 [0.996]	-0.045 (0.075)	-0.118 [1.031]	0.094 (0.099)	0 [1]	0.155 (0.065)
Index of women empowerment[α]	0.068 [1.075]	0.044 (0.074)	0.409 [1.255]	0.239 (0.109)	0 [1]	0.043 (0.166)
Index of domestic violence [α]	-0.126 [1.108]	0.139 (0.102)	-0.245 [1.144]	0.086 (0.116)	0 [1]	0.000 (0.114)
N total	1,473		1,378		6,728	
N in-person survey	1,202		1,307		5,860	

Note: Endline women survey data. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a dummy for the radio distribution intervention. Standard errors clustered at the household level. Columns (6): OLS regressions of the outcome variables on a dummy equal to one in campaign areas. Wild bootstrapped standard errors, clustered at the radio-station level. All regressions include baseline covariates selected using post-double selection lasso. See appendix B for the indexes definition.

Table A.2: Attrition at Follow-up Survey

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Impact of mass media		**Impact of mass media campaign**					
	Radio distribution in noncompaign areas		Radio distribution in campaign areas		All women		A radio at baseline	
	No radio Mean	Radio Mean P-value	No radio Mean	Radio Mean P-value	Control Mean	Treat. Mean P-value	Control Mean	Treat. Mean P-value
Surveyed	89.8%	90.6%	90.6%	92.6%	90.6%	88.5%	90.8%	89.3%
		0.877		0.384		0.783		0.773
Including:								
Surveyed in person	73.6%	73.7%	84.9%	88.8%	78.9%	77.1%	82.9%	78.7%
		0.993		0.056*		0.943		0.768
Surveyed by phone	16.3%	16.9%	5.6%	3.8%	11.7%	11.4%	7.9%	10.6%
		0.784		0.09*		0.986		0.806
N total	817	816	764	741	3 675	3 840	2 015	2 090

Note: Endline survey data, December 2018. Columns (2) and (4): P-values from OLS regressions of the outcome variables on a dummy for the radio distribution intervention, controlling for strata fixed-effects with standards errors clustered at the household level. Columns (6) and (8): Pvalues computed using wild boostrap procedure from OLS regressions of the outcome variables on a dummy equal to one in campaign areas, controlling for strata fixed-effects and with standard errors clustered at the radio station level.

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

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Currently using modern contraception (mCPR)	0.327 [0.469]	-0.046 (0.023)	0.331 [0.471]	0.053 (0.024)	0.295 [0.456]	0.051 (0.021)
Method used:						
Implant	0.199 [0.399]	-0.044 (0.019)	0.169 [0.375]	0.052 (0.021)	0.165 [0.371]	0.024 (0.02)
Injection	0.097 [0.296]	0.005 (0.015)	0.132 [0.338]	-0.008 (0.018)	0.107 [0.31]	0.019 (0.011)
Oral pills	0.031 [0.174]	-0.008 (0.009)	0.023 [0.15]	0.005 (0.008)	0.022 [0.146]	0.009 (0.007)
Wants to use contracept. in the future	0.756 [0.43]	-0.033 (0.019)	0.788 [0.409]	-0.006 (0.019)	0.739 [0.439]	0.049 (0.018)
Used contraception at last sexual intercourse	0.296 [0.457]	-0.034 (0.023)	0.336 [0.473]	0.016 (0.024)	0.282 [0.45]	0.061 (0.026)
Currently using contraception incl. abstinence, rhythm and withdrawal	0.338 [0.473]	-0.049 (0.023)	0.331 [0.471]	0.055 (0.024)	0.304 [0.46]	0.045 (0.02)
N total	1,473		1,378		6,728	

Note: Endline women survey data. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a dummy for the radio distribution intervention. Standard errors clustered at the household level. Columns (6): OLS regressions of the outcome variables on a dummy equal to one in campaign areas. Wild bootstrapped standard errors, clustered at the radio-station level. All regressions include baseline covariates selected using post-double selection lasso.

Table A.4: Heterogeneity: Which Women Were the Most and Least Impacted?

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Impact on mCPR by baseline status with respect to contraception:						
mCPR if using contraception at baseline (N=1,591)	0.491 [0.501]	0.015 (0.057)	0.606 [0.49]	0.035 (0.054)	0.48 [0.5]	0.112 (0.034)
mCPR if unmet needs for contraception at baseline (N=3,082)	0.327 [0.47]	-0.087 (0.033)	0.304 [0.461]	0.054 (0.036)	0.272 [0.445]	0.054 (0.014)
mCPR if no unmet needs for contraception at baseline (N=2,075)	0.22 [0.415]	-0.021 (0.038)	0.178 [0.383]	0.056 (0.036)	0.195 [0.396]	0.007 (0.035)
Impact on mCPR by baseline knowledge of contraception :						
mCPR if index of knowledge of contraception **below median**	0.262 [0.44]	-0.035 (0.03)	0.225 [0.418]	0.059 (0.033)	0.238 [0.426]	0.023 (0.026)
mCPR if index of knowledge of contraception **above median**	0.404 [0.491]	-0.059 (0.035)	0.417 [0.494]	0.045 (0.033)	0.352 [0.478]	0.073 (0.024)
Impact on mCPR by baseline fertility preferences						
mCPR if women's ideal number of children **above median**	0.31 [0.463]	-0.041 (0.04)	0.275 [0.448]	0.042 (0.04)	0.278 [0.448]	0.033 (0.028)
mCPR if women's ideal number of children **below median**	0.337 [0.473]	-0.042 (0.028)	0.365 [0.482]	0.057 (0.03)	0.306 [0.461]	0.062 (0.031)
N total	1,473		1,378		6,728	

Note: Endline women survey data. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a dummy for the radio distribution intervention. Standard errors clustered at the household level. Columns (6): OLS regressions of the outcome variables on a dummy equal to one in campaign areas. Wild bootstrapped standard errors, clustered at the radio-station level. All regressions include baseline covariates selected using post-double selection lasso. See appendix B for the indexes definition.

Table A.5: Impact on Other Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	Radio Coef. (SE)	No radio Mean [SD]	Radio Coef. (SE)	Control Mean [SD]	Treat. Coef. (SE)
Persons from whom or places where the women have heard of the contraceptive methods she knows:						
Women in the same family and/or cowives	0.192 [0.395]	-0.025 (0.022)	0.09 [0.287]	-0.018 (0.015)	0.181 [0.385]	-0.12 (0.023)
Women from the same village	0.179 [0.383]	-0.06 (0.021)	0.087 [0.282]	-0.029 (0.014)	0.144 [0.351]	-0.098 (0.03)
Men from the same household	0.009 [0.092]	0.000 (0.005)	0.011 [0.105]	-0.008 (0.005)	0.006 [0.078]	-0.002 (0.003)
Health workers	0.813 [0.39]	0.011 (0.022)	0.829 [0.377]	-0.018 (0.02)	0.833 [0.373]	-0.011 (0.031)
Radio	0.316 [0.465]	0.072 (0.028)	0.56 [0.497]	0.14 (0.026)	0.364 [0.481]	0.243 (0.036)
NGO	0.033 [0.179]	0.011 (0.009)	0.033 [0.178]	0.017 (0.01)	0.038 [0.191]	-0.002 (0.008)
At school / with a teacher	0.01 [0.101]	0.009 (0.006)	0.014 [0.119]	-0.002 (0.005)	0.024 [0.154]	-0.006 (0.004)
Who decides whether or not to use contraception:						
Respondent	0.213 [0.41]	0.009 (0.023)	0.181 [0.386]	0.029 (0.021)	0.206 [0.405]	-0.011 (0.081)
Husband	0.336 [0.473]	-0.04 (0.026)	0.452 [0.498]	0.009 (0.026)	0.338 [0.473]	0.136 (0.095)
Both decide together	0.25 [0.433]	0.000 (0.025)	0.244 [0.43]	-0.027 (0.022)	0.248 [0.432]	-0.044 (0.053)
Both never thought about it	0.201 [0.401]	0.02 (0.023)	0.119 [0.324]	-0.009 (0.017)	0.205 [0.404]	-0.085 (0.045)
N in-person survey	1,202		1,307		5,860	

Note: Endline women survey data. Columns (2) and (4): coefficients and standard errors from OLS regressions of the outcome variables on a dummy for the radio distribution intervention. Standard errors clustered at the household level. Columns (6): OLS regressions of the outcome variables on a dummy equal to one in campaign areas. Wild bootstrapped standard errors, clustered at the radio-station level. All regressions include baseline covariates selected using post-double selection lasso.

Table A.6: Correction for Multiple Hypothesis Testing on Ten Pre-specified Indices

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of radio distribution in noncampaign areas		Impact of radio distribution in campaign areas		Impact of mass media campaign (all women)	
	No radio Mean [SD]	No Radio Coef. (SE) **Sharpened two-stage q-values**	No radio Mean [SD]	Radio Coef. (SE) **Sharpened two-stage q-values**	Control Mean [SD]	Coef. (SE) **Sharpened two-stage q-values**
Impact on information and knowledge:						
Index of knowledge of family planning[α]	-0.01 [0.997]	-0.021 (0.057) **1**	0.114 [1.081]	0.086 (0.056) **0.489**	0 [1]	0.085 (0.136) **1**
Index of knowledge of contraceptive methods	0.024 [0.968]	-0.031 (0.051) **1**	0.207 [0.893]	0.122 (0.044) **0.055**	0 [1]	0.26 (0.042) **0.001**
Impact on norms and attitudes:						
Index of attitudes towards family planning[α]	0.015 [0.922]	-0.075 (0.059) **1**	0.13 [0.801]	0.03 (0.043) **0.697**	0 [1]	0.108 (0.045) **0.038**
Index of attitudes towards contraceptive methods	0.021 [0.989]	-0.052 (0.053) **1**	0.052 [0.964]	0.029 (0.049) **0.697**	0 [1]	0.076 (0.107) **1**
Index of women's perceptions of fertility and birth spacing	-0.024 [1.016]	-0.028 (0.048) **1**	-0.087 [0.982]	0.094 (0.048) **0.288**	0 [1]	-0.078 (0.115) **1**
Index of husband's perceptions of fertility and birth spacing[α]	0.063 [1.031]	-0.109 (0.06) **0.744**	0.063 [1.04]	0.053 (0.056) **0.697**	0 [1]	0.063 (0.093) **1**
Index of gender attitudes	0.01 [0.998]	-0.086 (0.05) **0.744**	-0.243 [1.018]	0.025 (0.053) **0.697**	0 [1]	-0.19 (0.211) **1**
Impact on secondary outcomes:						
Index of self-assessed health and well being	-0.131 [1.042]	0.005 (0.045) **1**	0.355 [0.896]	-0.06 (0.043) **0.489**	0 [1]	0.252 (0.119) **0.075**
Index of women empowerment[α]	0.078 [1.07]	0.026 (0.051) **1**	-0.038 [0.985]	0.036 (0.045) **0.697**	0 [1]	-0.026 (0.134) **1**
Index of domestic violence [α]	-0.023 [1.012]	0.051 (0.057) **1**	0.08 [0.966]	-0.022 (0.051) **0.697**	0 [1]	0.029 (0.119) **1**

Note: Endline women survey data, December 2018. Sharpened two-stage q-values corrected for multiple hypothesis testing as described in Anderson (2008). α: information only available in the in-person survey. See Appendix B for indexes definition.

Table A.7: Impact of Media Campaign 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)	Control Mean [SD]	Coef. (SE)	Control Mean [SD]	Coef. (SE)
Administrative clinic data: only clinics not in survey sample						
Monthly data: top codded at P99 (N= 22,620)	3.74 [8.46]	0.24 (0.62)	16.29 [28.76]	2.33 (2.48)	10.04 [26.54]	3.44 (2.55)
Monthly data: IHS Transformation (N= 22,620)	1 [1.33]	0.03 (0.17)	2.01 [1.93]	0.04 (0.3)	1.34 [1.72]	0.1 (0.18)
Quarterly data: top codded at P99 (N= 9,917)	3.68 [6.81]	0.27 (0.6)	16.24 [27.13]	2.49 (2.51)	9.96 [23.87]	3.54 (2.68)
Six-Months data: top codded at P99 (N= 4,147)	3.64 [6.37]	0.3 (0.56)	16.23 [26.83]	2.78 (2.54)	9.92 [23.1]	3.82 (2.77)

Note: Administrative data from the Ministry of Health on 377 health centers and 60 months. Columns (2), (4) and (6): coefficients and standard errors from OLS regressions of the outcome variables on a dummy equal to one in campaign areas, controlling for strata, time and clinic fixed effects. Standard errors are clustered at the radio station level and computed using wild boostrap procedure.

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Appendix H Additional Information on Radio Content and DMI Media Campaign

This appendix provides supplementary details on the programming of community radio stations in Burkina Faso and on the media campaign implemented by *Development Media International* (DMI). All 16 community radio stations contacted by DMI agreed to participate in the study and to broadcast the campaign if randomly selected.

H.1 Family Planning Content Broadcast by Control Stations

To document existing family planning coverage, we asked staff at control radio stations to report all content related to family planning aired over the course of a typical year. Across the eight control stations, this amounts to an average of 31 hours per year, of which approximately 13 hours are concentrated during the biannual "free contraception weeks." In comparison, the DMI campaign alone accounted for approximately 195 broadcast hours per year.

Based on these reports, we estimate that over 50% of family planning programming in control stations focuses on providing information about the timing and location of contraceptive services offered by clinics and NGOs. The costs and benefits of family planning and different contraceptive methods are rarely discussed. Table I provides a station-level breakdown of family planning content for each control radio station.

H.2 Additional Details on the DMI Campaign

Radio stations participating in the DMI campaign were closely monitored by DMI staff, who systematically recorded all short audio spots and provided detailed scripts for the interactive programs. These programs were implemented collaboratively between station personnel and one professional actor (typically a woman) hired by DMI.

Most radio stations broadcast daily from 6:00 a.m. to 11:00 p.m., corresponding to roughly 119 hours of airtime per week. The DMI campaign accounted for approximately 4 hours and 45 minutes of broadcasting time per week, or about 4% of total weekly content. Importantly, DMI programming was concentrated during peak listening periods in the morning and evening, which together capture the majority of radio audience time. Baseline survey data indicate that 73% of women who regularly listen

to the radio do so in the evening, 29% in the early morning, and only 12% in the afternoon. Consequently, the DMI campaign was broadcast during approximately 17% of total peak listening hours, ensuring high exposure despite its relatively small share of total airtime.

Table I: Annual Family Planning Content on Control Radio Stations

	Total family planning content (hrs)	**Family planning annual content during the two weeks of free contraception (twice a year)**		**Family planning annual content during the rest of the year**	
		Content description	Total time (hrs)	Content description	Total time (hrs)
Radio station 1	44	Two programs by a NGO with information on where to find contraceptives and activities during these two weeks	9	Nine special programs by NGOs broadcasted once or twice a year. Marie Strope International's communication on where and when they offer contraception. One weekly 15 min show with a discussion with a contraception expert.	35
Radio station 2	44	Micro programs from the government every day during 14 days. Two interactive shows twice a year.	20	One weekly 30min shows with an Imam on household's life (in favor of some types of family planning)	24
Radio station 3	18	One interactive show with midwives and one with pro family planning religious leaders. One show organized by the ministry of health (district) providing information on where and when to find free contraceptives.	6	Marie Strope International's communication on where and when they offer contraception.	12
Radio station 4	28	Communication from the ministry of health on where and whento find free contraceptives.	8	Marie Strope International's communication on where and when they offer contraception. Theater on the radio (twice a year). Different spots by local NGOs.	20
Radio station 5	9	Five minute interviews with local health workers five times. Communication from the ministry of health on where and when to find free contraceptives.	9		0
Radio station 6	40	Communication from the ministry of health on where and when to find free contraceptives. Interactive shows with local health workers. Daily spots and information shows on the free contraception weeks.	20	Weekly one hour show open to different associations (20% of them on family planning). Interactive shows by a NGO on family planning, female genital cutting and forced marriage.	20
Radio station 7	12	Communication from the ministry of health on where and when to find free contraceptives. 30 min Interviews of local health workers broadcasted twice.	10	One show by a NGO broadcasted twice a year.	2
Radio station 8	53	Communication from the ministry of health on where and when to find free contraceptives. Interactive shows with local health workers. Interactive game with midwives (once) Information shows with midwives on the free contraception weeks. Interactive shows with local NGO.	18	Interactive shows and spots on family planning broadcasted by a local NGO. Marie Strope International's communication on where and when they offer contraception. Weekly interactive show "life and society" with some debates on family planning.	35
Mean	**31**		**13**		**19**

The main potential barriers to modern contraception uptake identified by DMI's formative research included information on the different available modern methods (implants, injectables, condoms and pills), concerns about side effects including infertility, information on the benefits of birth spacing, gender norms and the idea that family planning is a joint responsibility.

The DMI campaign targeted particularly misinformation. For instance, DMI used a recurring fictitious person played by an actor and called "Commandant Zabra" who regularly called to express prevalent misinformation about contraception. This started a discussion and combatted the misinformation in a structured way.

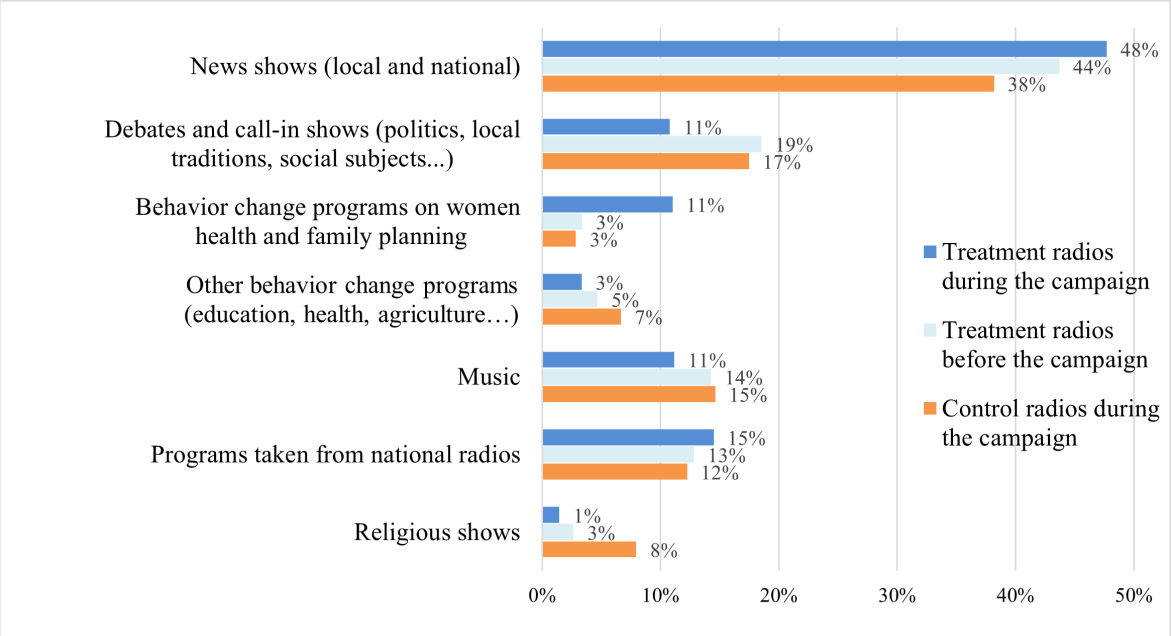
To limit the incidence of power outages, the 8 treatment radio stations also received solar systems so that they could broadcast without interruption. However, power outages were rare in noncampaign areas, and we show that radio listenership was similar in campaign and noncampaign areas suggesting limited overall effect of these solar systems.

More information on DMI approach and on the campaign is available on its website: https://www.developmentmedia.net/

H.3 Content of community radio stations before and after DMI media campaign

Figure I and Table II provide descriptive statistics on the content of radio stations before and during the radio campaign by treatment status. This data comes from radio station logs. The description of how this data was collected and coded, and the definition of each category is provided in the Appendix B on data collection and outcomes. Besides the different effects described in the main paper, these data shows that noncampaign stations aired more religious content (8% vs. 1%), but this is driven by a single station (38% religious content). Its treatment effect is near zero and statistically insignificant.

Figure I: Radio Content during Peak Listening Time



Notes: 7 radio stations in campaign areas and 8 radio stations in noncampaign areas. Peak listening time includes one hour in the morning (7-8am) and 3 hours in the evening (6-9pm) when most people listen to the radio. It corresponds to a quarter of total airtime. Data on behavior change programs does not include DMI's short spots (1h45min per week) broadcast in-between programs.

Table II: Radio Content Before and During the Campaign

	Control group (8 stations)				**Treatment group (7 radio stations)**							
	During the campaign				**Before the campaign**				**During the campaign**			
	Total airtime		Peak time		Total airtime		Peak time		Total airtime		Peak time	
	All	Share women	All	Share women	All	Share women	All	Share women	All	Share women	All	Share women
All programs	**100%**	**17%**	**26%**	**17%**	**100%**	**22%**	**25%**	**21%**	**100%**	**21%**	**24%**	**27%**
News shows	**31%**	**7%**	**38%**	**11%**	**27%**	**8%**	**44%**	**14%**	**31%**	**8%**	**48%**	**17%**
Incl. national and international news	*18%*	*2%*	*17%*	*2%*	*14%*	*2%*	*19%*	*3%*	*18%*	*2%*	*21%*	*4%*
Incl. local news and events	*13%*	*5%*	*21%*	*9%*	*13%*	*6%*	*24%*	*11%*	*14%*	*5%*	*27%*	*13%*
Music	**22%**	**4%**	**15%**	**1%**	**24%**	**5%**	**14%**	**1%**	**22%**	**4%**	**11%**	**0%**
Debate and call-in shows	**19%**	**1%**	**17%**	**0%**	**23%**	**5%**	**19%**	**3%**	**19%**	**3%**	**11%**	**2%**
Behavior change programs	**12%**	**4%**	**10%**	**3%**	**13%**	**4%**	**8%**	**4%**	**16%**	**6%**	**14%**	**8%**
Incl. on women health and fam. plan.	*2%*	*1%*	*3%*	*2%*	*2%*	*1%*	*3%*	*2%*	*5%*	*3%*	*11%*	*7%*
Incl. programs on other topics	*10%*	*3%*	*7%*	*1%*	*11%*	*3%*	*5%*	*2%*	*11%*	*3%*	*3%*	*1%*
Programs from national radios	**2%**	**1%**	**12%**	**2%**	**11%**	**0%**	**13%**	**0%**	**10%**	**0%**	**15%**	**0%**
Religious shows	**6%**	**0%**	**8%**	**0%**	**3%**	**0%**	**3%**	**0%**	**3%**	**0%**	**1%**	**0%**

Note: Data source: averages over all radio stations included in the study (except one) for normal weeks of broadcasting. DMI short (1.5 min) spots broadcasted 10 times a day are not classified as behavior change programs (but long format programs are). Data before the campaign are from 2015 and during the campaign for 2016-2018. Data before the campaign were not available in the control group.

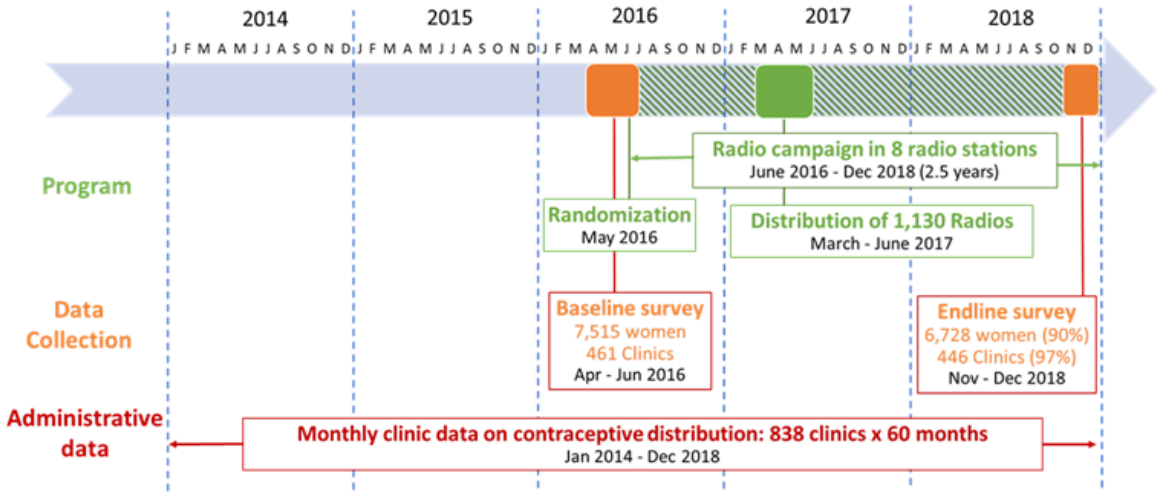
Appendix I Data, and Outcomes Definition

This appendix provides additional information on the data used in this paper and on outcome and indices definition.

I.1 Data and program timeline

Four sources of quantitative data are used to assess impact: radio station logs, surveys of women, surveys of clinics close to surveyed women, and administrative data on all clinics in the study areas. In addition, qualitative data were regularly collected before and during the program for monitoring purposes and to inform quantitative questionnaire design.

Figure II: Study Timeline



I.2 Radio station logs

Study radio stations provided detailed logs on programming during a typical week, before and during the DMI campaign. Noncampaign stations provided similar information for the study period. All study radio stations provided data except one which stopped working with DMI for security reasons. We classified all content into the following categories:

- Local information shows: information and communications on local news and events. Examples of programs: regional news, communications and timeline of local events...

- National and international information shows: programs with national or international informational content. Examples of programs: Daily or weekly journals, press reviews, sport information.

- Music: Examples of programs: Zouk Machine, Saturday night, live los salseros...

- Debate and call-in shows: programs on politics, local traditions, social subjects, games, or sport with some interactions with auditors or local people (calls-in, direct interviews...). Examples of programs: debate on current affairs, talk shows, radio theatre, traditions among the Mooré...

- Behavior change programs on women's health and family planning: programs designed explicitly to change behaviors related to women's health or family planning. Some of these programs are often created in partnership with the ministry of health, local health centers or NGOs. Examples of programs: Gender and development, mother and child health, DMI family planning program...

- Other behavior change programs: mainly on education (targeted on students), health, agriculture, and conflict prevention. Most of these programs are created in partnership with NGOs or government agencies. Examples of programs: health magazine, student time, program on road safety, program on agricultural transformation...

- Program from national radios: these programs can be on any topic covered by national radios. According to our local partner, most content taken from national radio is information and debate shows.

- Religious shows: Examples of programs: Friday's call to prayer for Muslim, Sunday worship service, programs discussing the Koran or the Bible, religious preach.

For two thirds of the programs, the classification was done by the research team using description of the program content provided by radio stations. For the remaining third, the classification was done by radio staff. For programs belonging to two categories, each category was allocated 50% of the duration. Radio stations also provided information on the gender of the person presenting each program.

I.3 Indices used 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.

Appendix J Additional information on sampling strategy

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

J.1 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 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 household listing was conducted in a random 320 of these villages between January-March 2016. In total, 48,513 women between the ages of 15 and 49 and living in 25,291 households were listed. 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 5km 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).

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 8% of Burkina Faso's population).

See Appendix Figure A1 for a sampling flow diagram of the experiment.

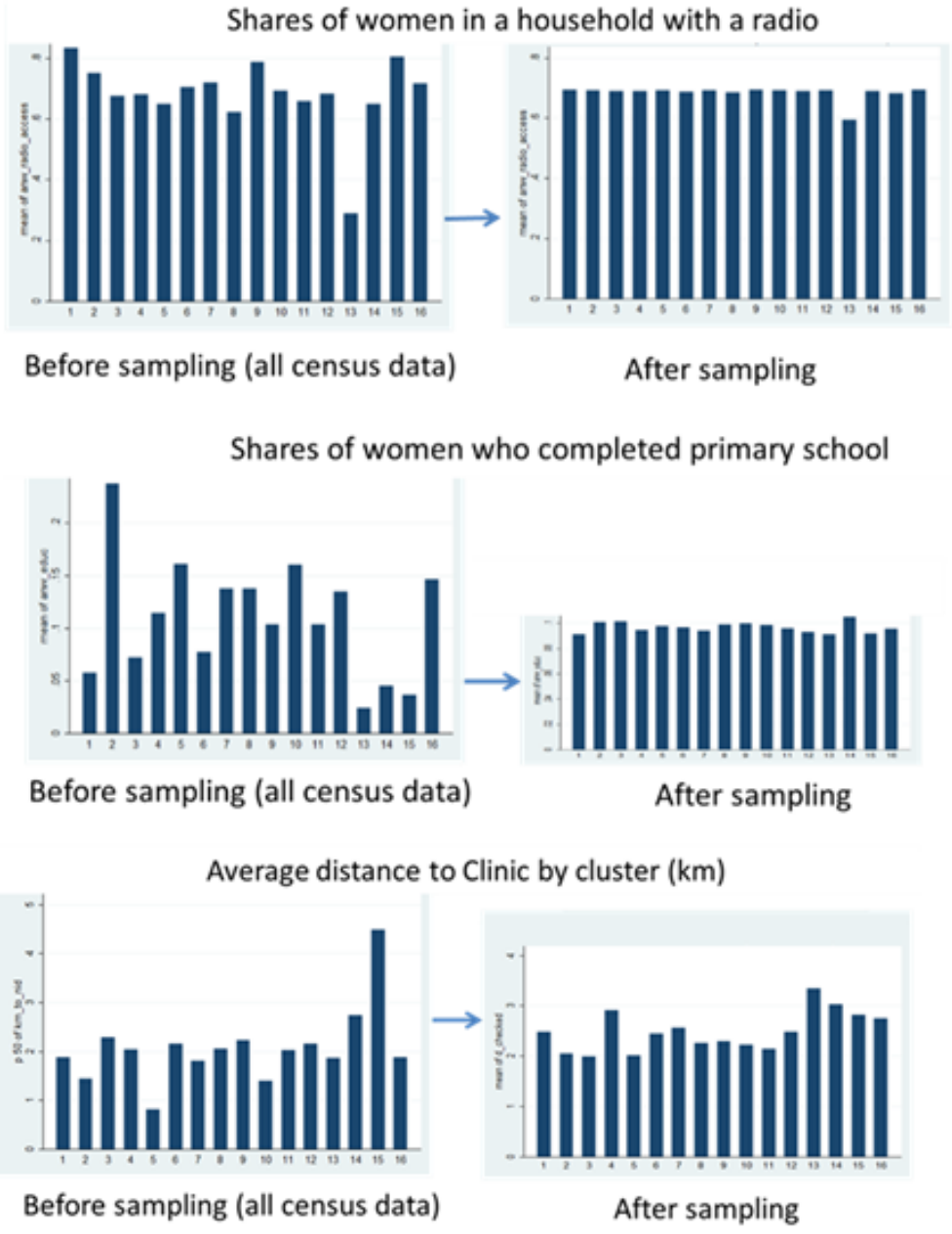
J.2 Women selection

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.

J.3 Effects of this smoothing strategy

Figure III shows graphically how averages of three key characteristics (radio access, education, and distance to clinic) were smoothed by this strategy.

Figure III: Smoothing strategy



Appendix K Cost-effectiveness

We examine the cost-effectiveness of the pilot campaign (which reached 5 million people) and estimate the cost-effectiveness of a nationwide scale-up to 39 local radio stations under various assumptions. The scale-up started in January 2019 after preliminary results of this study became available. All monetary estimates are in 2018 dollars.

Under our preferred assumption, the pilot campaign led to 32,000 additional women using contraception and 1,600 fewer births at an annual cost of US$39 per women and US$770 per birth. The nationwide campaign led to approximately 200,000 additional women using contraception and 10,000 fewer birth at an annual cost of US$7 per women and US$139 per birth averted (Table III).

K.1 Annual cost per additional woman using contraception

Campaign implementation costs are calculated using data on actual total expenses provided by DMI: 3.1 million for the 2.5 year pilot program and US$ 3.4 million for the national scale up. [28] We add the marginal cost to the Burkinabe Ministry of Health for additional contraceptives of $3.5 per additional woman using contraceptives (Guttmacher Institute (2017)). We do not include the cost of additional time of health workers counseling women as rural health workers usually have space capacity.[29]

Using the national population census[30] and data on radio broadcasting areas computed by DMI, we estimate that 625,000 women of reproductive age were living in a village reached by the pilot campaign, including 177,000 women in villages for which our survey data is representative. For the national campaign, we estimate that 83% of Burkina Faso's population was reached (Figure A3), or 3.8 million women of reproductive age (1.2 million in areas similar to our survey data). For women living in areas for which our survey data is representative, we use our overall estimate of the program impact (+5.1 percentage point increase in mCPR). For other areas reached by the campaign, we must make additional assumptions. We consider two:

- Assumption 1: the program had the same impact everywhere (+5.1 percentage points). Under this assumption, the program increased the number of women

[28] See https://www.povertyactionlab.org/research-resources/cost-effectiveness for more details on our cost-effectiveness methodology.

[29] According to the Guttmacher Institute (2017), the Ministry of Health in Burkina Faso spend US$ 18 million on family planning services annually, or US$ 14 per woman using modern contraception.

[30] We use projections of the 2018 population calculated using the 2006 national census.

using modern contraception by 32,000 in areas targeted by the pilot and by 195,000 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 60,000 with the national campaign. This is the most conservative assumption possible and a lower bound of the program cost-effectiveness.

Table III: Cost-Effectiveness of Media Campaign

	(1)	(2)	(3)	(4)
	Pilot program (8 radio stations)		**Nationwide campain (39 radio stations)**	
	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
Number of births per year (from survey data)	30 846	77 980	206 037	458 599
Assumption 1 (preferred assumption): Same impact everywhere				
Cost per additional women using contraception				
Impact on contraception adoption	5,1%	5,1%	5,1%	5,1%
Number of additional women using contraception	9 041	22 856	60 390	134 417
Anual cost per extra women using modern contraception	$39		$7	
Cost per (most likely undesired) birth averted				
Impact on birth rate	-1,5%	-1,5%	-1,5%	-1,5%
Number of births averted	463	1 170	3 091	6 879
Anual cost per birth averted	$768		$139	
Assumption 2 (most concervative assumption): No impact elsewhere				
Cost per additional women using contraception				
Impact on contraception adoption	5,1%	0,0%	5,1%	0,0%
Number of additional women using contraception	9 041	0	60 390	0
Anual cost per extra women using modern contraception	$139		$23	
Cost per (most likely undesired) birth averted				
Impact on birth rate	-1,5%	0,0%	-1,5%	0,0%
Number of births averted	463	0	3 091	0
Anual cost per birth averted	$2 708		$447	

Note: Cost data from DMI in 2018 US$. Population data from United Nations, World Population Prospects (2022) and 2006 national census using projection calculated by the national statistical agency.

Two pieces of data suggest assumption 1 is the most valid (and 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 we seek to extrapolate to, have a greater share of women who: have access to a radio (56% of women in urban areas listen weekly to the radio vs 41% in rural areas, DHS, 2010), use modern contraception (44% in urban vs 21% in rural, PMA2020, 2016), and have information on contraception (72% in urban vs 62% in rural have good information on modern methods, PMA2020, 2016).

Second, administrative data suggests the program had at least as large impacts in urban than rural clinics. We have monthly data on contraceptive distribution for 235 clinics which are within 50km of (and thus reached by) study radio station but were excluded from our initial study area. The treatment effect, among these more urban clinics is slightly larger than the results for the clinics in our study area (appendix Table A7 vs table 4), again supporting assumption 1.

Using total program costs, population data, impact estimates, and assuming that the impact was sustained through the 2.5 years program duration,[31] we derive the annual cost per additional woman using contraception during the pilot study and nationwide scale up. Under our preferred assumption (assumption 1), this cost was US$ 39 per women for the pilot and US$ 7 for the national scale-up ($42 and $10 respectively if we include the cost of additional supply).

K.2 Annual cost per (most likely undesired) births averted

Our estimated impact of the program on fertility (-1.5 percentage points) translates into 1,630 (most likely undesired) births averted annually during the pilot and 10,000 for the nationwide campaign at a cost of US$ 770 and US$140 per birth averted respectively.

K.3 How economically significant are the results?

We benchmark our results against those from other evaluations, trends in the use of contraception in Burkina Faso and other African economies, and the cost of other family planning spending in Burkina Faso .

[31] This assumption is motivated by administrative data showing the number of contraceptives distributed rose rapidly within a few months of the campaign start and was relatively constant across the two-and-a-half years (appendix figure A2).

Evidence on the cost-effectiveness of alternative approaches to promote mCPR, especially 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 increased contraception use at a cost of US$65 per new user per year. Dulli et al. (2016) find integrating family planning into immunization services in 7 clinics in Rwanda increased contraception use at a cost of US$32 per new user (although this study also has a small number of clusters). The IRC (2016) estimated the average cost of providing a year of protection to couples across four programs was $47 (this study did not calculate impact).

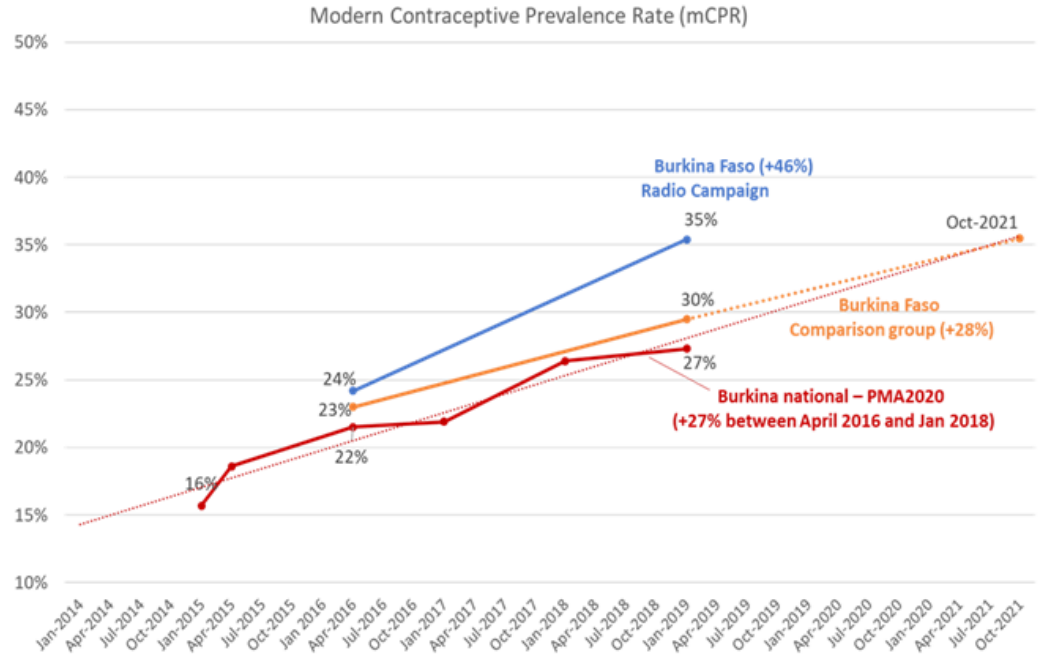
DMI's campaign is considerably more cost-effective at scale with US$7 per new user. Even the pilot with US$ 39 per new use is more cost-effective.

We also benchmark the magnitude of this intervention against trends in mCPR in Burkina Faso (Figure IV) and from various sub-Saharan African countries (Figure V) using PMA 2020 data. MCPR increased 5.1 percentage points each year in DMI campaign areas. The treatment effect of the campaign is equivalent to 2.5 years of the rising trend in Burkina Faso (Figure V). Moreover, Figure V shows the average annual increase in mCPR during the same period ranged between 0.4 and 2.8 percentage points in other sub-Saharan countries, illustrating how an effective demand side intervention can complement and accelerate the impact of supply side provision.

Finally, we benchmark the cost-effectiveness of this intervention against the cost of other (primarily supply side) family planning spending in Burkina Faso. Guttmacher Institute (2017)[32] estimates 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 per year. In comparison, the campaign increased contraception use (under our preferred assumption) at a cost of US$10 per year including the cost of contraceptives. This "marginal" cost is 29% lower than the above estimated average cost of US$14 (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.

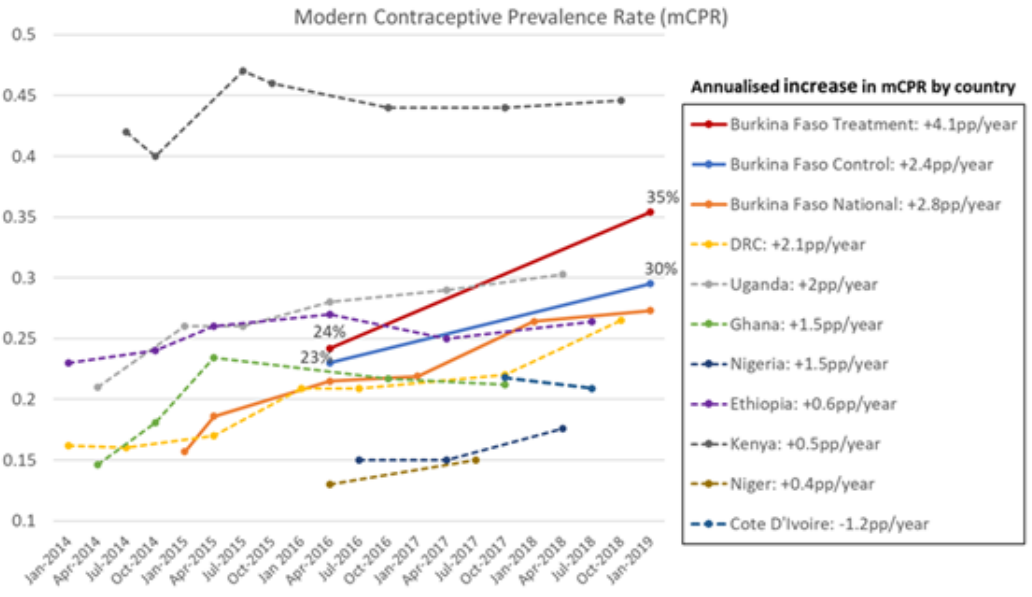
[32]See https://www.guttmacher.org/fact-sheet/adding-it-up-contraception-mnh-2017

Figure IV: Trends in Modern Contraception Prevalence Rate in Burkina Faso



Notes: Survey data and data from PMA 2020.

Figure V: Trends in Modern Contraception Prevalence Rate (mCPR)



Notes: Survey data and data from PMA 2020.