Tuning in to Change:
Fertility Transition and Female Empowerment*

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PRELIMINARY - PLEASE DO NOT CIRCULATE

Abstract

This paper investigates the impact of family planning mass media content on fertility outcomes and female empowerment in Malawi. We exploit topography-induced random spatial variation in radio coverage and temporal variation from a sharp content policy shift by Malawi's dominant national radio network in the 1990s. We find that women with higher exposure to family planning radio programs experienced a significant reduction in fertility rates, driven primarily by changes in fertility preferences and increased contraceptive use. Beyond fertility outcomes, we document meaningful improvements in women's agency, including increased decision-making power, reductions in the acceptance of intimate partner violence and increased labor market participation. The effects are strongest for younger cohorts who were exposed to the programs during school-age years, suggesting that access to family planning information reinforced human capital investments and expanded economic opportunities. (*JEL* D7, D83, J13, L82, Z18)

Keywords: Mass media; Radio; Family planning; Malawi; Fertility; Female empowerment; Female agency.

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1 Introduction

Fertility transition is a key driver of demographic and economic transformation. Nevertheless, the broader consequences of reduced fertility, particularly for women, remain poorly understood. In particular, the relationship between declining fertility and female empowerment is largely unexplored, although it has the potential to reshape gender roles, increase women's participation in the labor force and influence household decision making. Understanding these consequences is crucial in the poorest nations in the world. Rapid population growth in Africa continues to be a major concern for policymakers, yet progress in reproductive health and family planning has been slow. Between 2022 and 2050, half of all global population growth will be concentrated in sub-Saharan Africa. By the end of the century, the region is projected to account for roughly a third of the world's population, up from just 14 percent in 2019 (United Nations, 2024).

This paper studies the consequences of reducing fertility on female empowerment. We focus on this relationship by exploiting a unique natural experiment that occurred in Malawi in the mid-1990s, and stimulated a decrease in fertility. Starting in 1995, the national radio network–Malawi Broadcasting Corporation (MBC)– started broadcasting an extensive series of programs promoting family planning, mixing different formats including edutainment and educational. This represented a sudden and stark shift in broadcasting policies, as such topics were previously banned from the public media and discourse. The decision to begin this operation followed the intention of the government and other international donors to respond to high fertility and, in particular, to poor reproductive and maternal health.

Up until the 1990s, Malawi showed a slow adoption of contraception use and a high prevalence of HIV/AIDS among the younger generations (Lema et al., 2002). Directly addressing the lack of mass media coverage of such messages before the mid-1990s, the campaign was a major success, reaching an average listenership across the country of more than 70% of women and 90% of men (Meekers et al., 2007; USAID et al., 2012). National radio content remained relatively stable for roughly 15 years, and family planning content has remained popular until today. Qualitative evidence highlights how such promotion of family planning played a crucial role in transforming social norms.

For identification, we combine variation in radio exposure, arising from the spatially heterogeneous reach of the national radio network MBC, with temporal variation originating either from the timing of fertility or from the survey period. Random exposure to radio coverage induced by topography, estimated using the Longley-Rice Irregular Terrain Model (Olken, 2009), allows us to isolate variation that is plausibly exogenous to individual characteristics and decisions. Building on this cross-sectional variation,

we employ an event study approach to estimate the impact on fertility decisions. This method leverages differences in radio signal strength and changes in birth probabilities before and after exposure to the new radio content. In addition, to examine broader behavioral and attitudinal changes, we complement this strategy with a pooled cross-sectional approach. Unlike the event study, which tracks fertility outcomes over time, this method relies on single-period analysis to estimate the effects of radio exposure on knowledge, attitudes, contraceptive behavior, and, importantly, female empowerment.

We find that exposure to family planning radio campaigns significantly reduced fertility. Women living in areas with strong radio coverage experienced a substantial decline in birth rates after the launch of the campaign as compared to those living in areas with weaker signals. The impact is most pronounced among younger cohorts who were exposed throughout their reproductive years. The reduction in fertility appears to be driven by increased contraceptive uptake and shifting fertility preferences, rather than by improvements in explicit knowledge about reproductive health. Notably, the findings indicate a lagged effect, with fertility declines becoming evident only a few years after the campaigns began, suggesting that mass media can gradually reshape norms around ideal family size and reproductive behavior.

Beyond fertility, the study provides robust evidence that declining birth rates translated into meaningful gains in female empowerment. Women exposed to the campaign reported higher levels of household decision-making power, reduced acceptance of intimate partner violence, and increased participation in non-agricultural employment. These effects are particularly strong for younger women, who also experienced higher educational attainment, suggesting that lower fertility facilitated greater investments in human capital.

Our findings highlight a crucial link between fertility transition and gender dynamics, contributing to different branches of the literature.

First, we provide novel evidence on the consequences of reducing fertility rates on female empowerment. Lower fertility is often associated with increased educational attainment, labor market participation, and decision-making power for women, as having fewer children reduces time constraints and caregiving burdens, enabling greater investments in human capital and economic opportunities (Goldin and Katz, 2002). Experimental and quasi-experimental studies on mass media interventions have shown that shifts in fertility preferences, facilitated by information diffusion, can lead to broader gender norm changes, including increased spousal communication and reduced tolerance of intimate partner violence (Jensen and Oster, 2009; Ferrara et al., 2012). Despite evidence on the link between fertility and female empowerment, several important gaps remain. First, while numerous studies document a correlation between

fertility decline and women's economic and social advancement, the mechanisms driving this relationship remain underexplored. Specifically, we lack rigorous evidence on whether fertility reductions primarily empower women by increasing their labor market participation, enhancing their decision-making power within households, or shifting broader gender norms. Second, most existing research focuses on short-term effects, leaving open the question of whether these empowerment gains persist over time and across generations. Third, the role of structural constraints in moderating the fertility-empowerment relationship remains unclear. In contexts where formal labor markets are weak, or where traditional gender norms persist, do reductions in fertility still translate into greater female agency? Fourth, while the literature has largely focused on settings where family planning programs or education policies have driven fertility decline, we know relatively little about how media-driven fertility transitions, such as those facilitated by mass communication campaigns, impact empowerment differently from more direct policy interventions.

Second, we highlight the effectiveness of promoting family planning. Family planning is widely recognized as a key tool for improving child and maternal health and for fostering sustainable development (World Health Organization, 2005; United Nations, 2015). Numerous studies have documented the benefits of greater reproductive control for women, including improved educational and labor market outcomes (Goldin and Katz, 2002; Field, 2003; Miller, 2010; Duflo et al., 2015; Ruthbah, 2020). However, demand-side constraints, including social norms, misinformation, and partner dynamics, remain substantial barriers to contraceptive adoption. These factors highlight the importance of targeted interventions that address not just access, but also knowledge, attitudes, and social influences on reproductive behavior.

Finally, we provide new evidence on the potential of mass media to play a transformative role in shifting reproductive behaviors and norms. Glennerster et al. (2021) experimentally evaluated the role of radio messaging on contraception by distributing radio devices to randomly selected participants. Beyond reproductive health, radio campaigns have been found to significantly influence a range of social and economic behaviors, including violence (DellaVigna et al., 2014; Yanagizawa-Drott, 2014; Adena et al., 2015; Armand et al., 2020), political engagement (Besley and Burgess, 2002; Strömberg, 2004; DellaVigna and Kaplan, 2007), crime (Dahl and DellaVigna, 2009), social capital (Olken, 2009), women's agency (Jensen and Oster, 2009; La Ferrara et al., 2012), and broader social attitudes (Paluck and Green, 2009; Blouin and Mukand, 2019).

2 Background

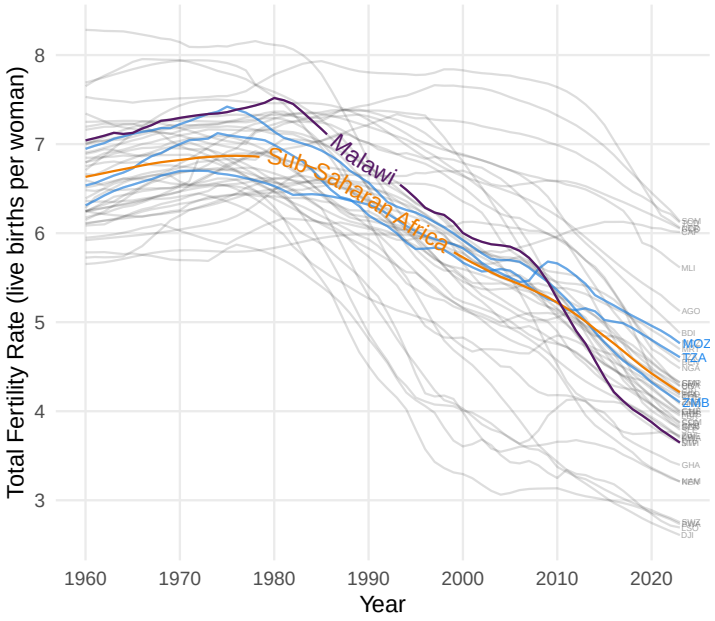
Malawi's family planning policies underwent a profound transformation, particularly in the 1990s, marking a shift from strong opposition under President Hastings Kamuzu Banda to widespread acceptance and integration into national development plans. Under Banda's authoritarian rule, family planning was largely dismissed as a Western imposition that contradicted Malawian cultural values. Contraceptive use was discouraged, and family planning programs remained underdeveloped. The few available family planning services that existed, were provided by private organizations, but their reach remained limited.

The government also imposed strict censorship across all media platforms. The Malawi Censorship Board reviewed and controlled content to align with the regime's conservative values and political objectives, effectively prohibiting discussions on topics such as family planning. This suppression extended to public discourse, discouraging citizens from engaging in conversations about reproductive health. The only available radio station, the state-controlled Malawi Broadcasting Corporation (MBC), aired only government-approved content. Consequently, radio did not feature any programming related to family planning during this period (Cammack, 2000; Robinson, 2017).

A paradigm shift occurred in the early 1990s, particularly after Malawi transitioned to multiparty democracy in 1994. With this political change came greater openness in discussing reproductive health. Recognizing the challenges linked to rapid population growth and the increasing spread of HIV, the new government adopted a National Population Policy, rebranding the Malawi National Child Spacing Program as the Malawi Family Planning Program. This new approach framed family planning as a strategy to improve maternal and child health rather than merely a population control measure, leading to the expansion of health services, increased contraceptive supply, and extensive, targeted communication campaigns (John Snow, Inc., 1998; Robinson, 2017). While Malawi had one of the highest fertility rates in Sub-Saharan Africa in 1980, it experienced one of the region's most rapid fertility declines by 2020 (Figure 1). Malawian officials attribute much of this success to a growing cultural acceptance of family planning at the community level, emphasizing that *"Family planning is increasingly becoming a social norm in Malawi"* (USAID, 2012).

Although empirical evidence remains limited, we suspect that the national radio network, the Malawi Broadcasting Corporation (MBC), played a pivotal role in reshaping reproductive health behaviors and norms. As the dominant mass medium in Malawi, with extensive reach across both rural and urban populations, MBC served as a key platform for promoting contraceptive awareness and challenging cultural resistance, particularly in communities where such discourse was previously scarce.

Figure 1: Fertility transition across Sub-Saharan Africa



Note. Average number of children per woman by year and country across Sub-Saharan Africa. Malawi's direct neighboring countries are highlighted in blue. Data stems from the 2024 World Population Prospects provided by the U.N. population division.

The impacts were potentially magnified by the dominance of MBC radio in the national media market. Between 1994 and 2000, the government granted only two private radio broadcasting licenses. The first television station was established only in 1999, with uptake remaining low.Patrick Mbewe, then Malawi's tourism minister, stated in 1996 that private radio licenses would not be granted because the new government did not want a "flourishment of casual sex on radio in the country" (cited in Cammack (2000), p.13). This emphasizes MBC's enduring monopoly in spreading FP messages throughout the country. Meanwhile written news media are circulating only in the most urban areas with higher literacy rates (Cammack, 2000; MACRA, 2023).

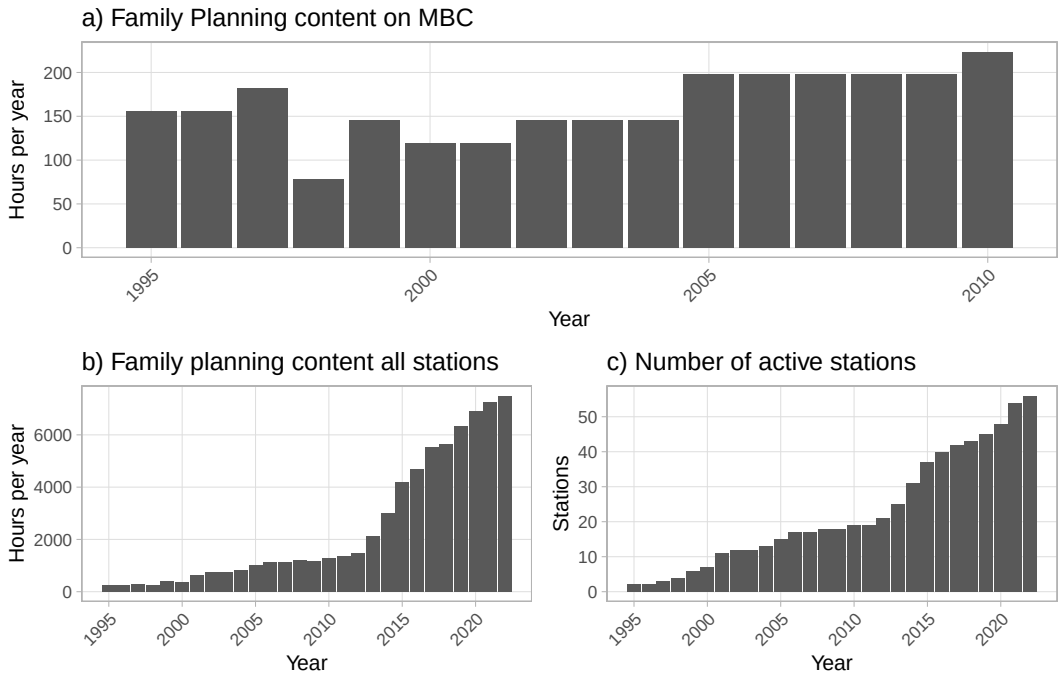
Between 1995 and 2010, Malawi MBC broadcasted an average of 2.9 hours of family planning content per week, spread across various formats (Figure 2a). With a sudden shift of broadcasting content from 1995 onward, radio jingles and public service announcements countered common myths about contraceptives, while storytelling formats such as radio dramas addressed topics like HIV prevention, contraceptive use, birth spacing, and maternal health in an engaging and relatable manner. Programs such as "Straight Talk" (sponsored by UNICEF), "Tinkanena", "Tikuferanji" ("Why Are We Dying?"), "Kulera" ("Family Planning"), and "Radio Doctor" integrated dramatized storytelling and expert medical advice to normalize discussions about contraception, increase spousal communication, empower women

in fertility decisions, and encourage the adoption of modern contraceptive methods. In a 2001 survey of high school students, 87% of males and 73% of females identified radio as their primary source of sexual health information (Kadzamira et al., 2001). By 2010, 56% of Malawian women and 76% of men reported having heard a radio program about family planning (NSO and Macro, 2011).

The abrupt shift in content policy, combined with the intensity, consistency, and widespread reach of family planning messaging, makes Malawi a unique case for studying the long-term impacts of mass media on fertility patterns and broader cultural norms.

We limit our analysis to the period up to 2010, as FP content rapidly expanded nationwide through additional networks thereafter (Figure 2b). This expansion was driven in part by the rise of new radio stations, which challenged the dominance of the public MBC network (Figure 2c)[1]. The widespread dissemination of content across various formats and overlapping time periods makes it difficult to isolate the effects of individual broadcasts. Instead, we treat the new broadcasting policy as a comprehensive shift in MBC radio content.

Figure 2: Annual family planning content and active radio staions



Note. Panel a) and b) show the hours of family planning content broadcast on MBC, and, respectively, the aggregate across all networks per year. We sum up broadcast time of all FP related formats. No such content was aired before 1995 due to strict media censorship. Panel c) illustrates the number of active radio stations by year. Calculations are based on the author's own survey of radio stations. See section 3.1.

[1] In our core analysis, we utilize DHS waves from 2000, 2004, and 2010. Although the radio landscape remained relatively stable from 1995 to 2010, the number of radio stations doubled between 2010 and 2015, and the volume of FP content roughly tripled.

3 Data

3.1 Radio exposure

The data on radio exposure to family planning (FP) content originates from an original retrospective survey covering an exhaustive set of active radio stations in Malawi. In collaboration with the Malawi Communications Regulatory Authority (MACRA), we identified the universe of radio stations operating during our study period. We then designed and administered a structured questionnaire targeted at radio station managers, collecting detailed information on FP-related broadcasting, including content type and broadcast frequency.

From this survey, we construct a panel dataset that captures each station's FP-related messaging over time, including the volume, timing, and nature of broadcasts. Additionally, we collect time-varying technical data on each station, including the exact geographic coordinates of transmitters, antenna heights, and transmitter power. Using these technical characteristics, we compute the geographical reach of each station's broadcasts, enabling us to map exposure to FP content across Malawi.

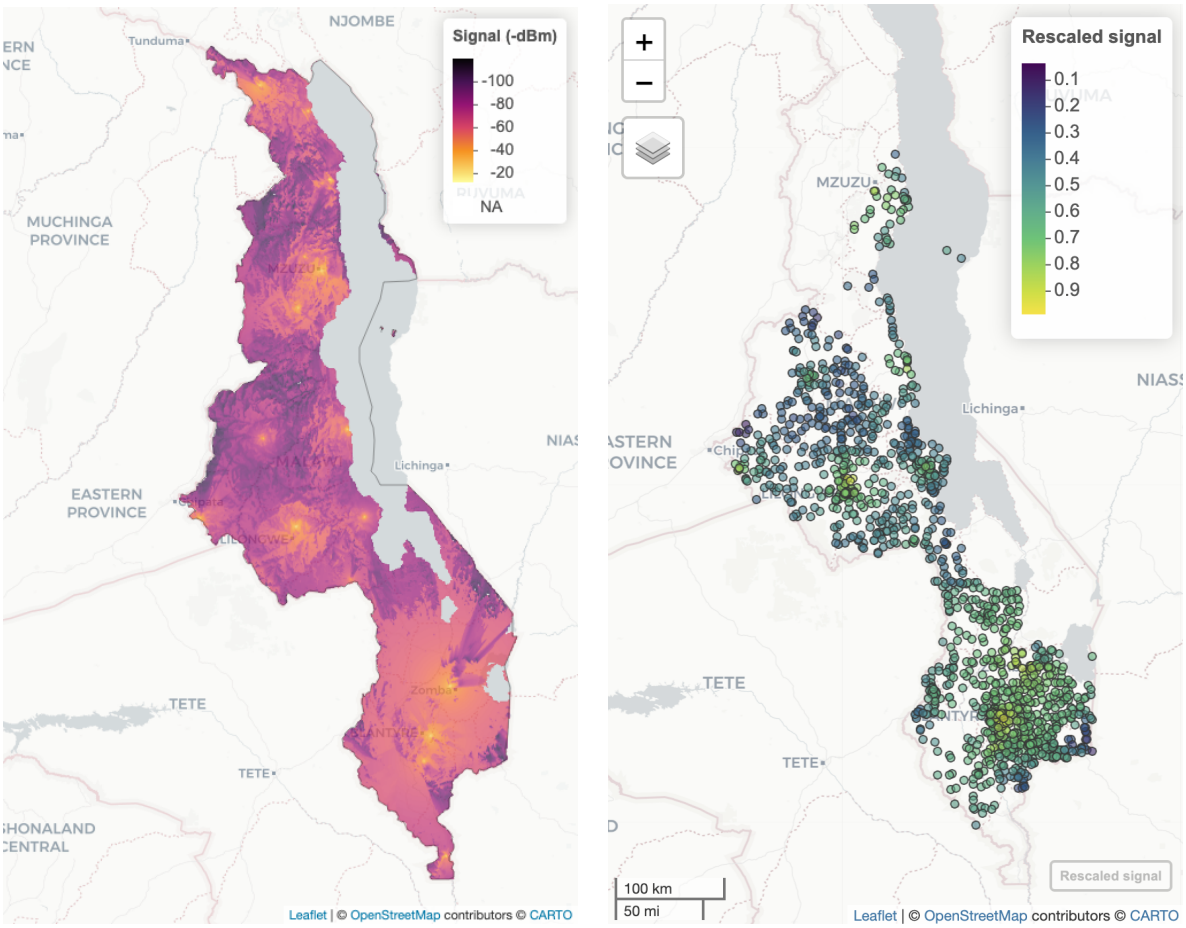
Our core analysis examines the impact of the sudden, large-scale family planning campaigns broadcast on the national network MBC (see Section 2). We restrict our study to the period 1995 to 2010, during which MBC maintained a dominant market position, providing a compelling empirical setting for assessing the impact of national-level media campaigning. Notably, MBC's network extension halted in 1972 and coverage remained stable throughout the study period (1995–2010). After 2010, however, MBC's market dominance declined due to the proliferation of private radio operators who increasingly broadcast original, independent programming, fragmenting the national audience.

While the reach of the radio network may be endogenous to fertility trends, we leverage exogenous variation in radio signal exposure arising from the randomness of topography, as part of our identification strategy (detailed in Section 4). Consistent with prior literature, we construct topography-corrected radio coverage using the Longley-Rice/Irregular Terrain Model (ITM) (Olken, 2009; Enikolopov et al., 2011; Yanagizawa-Drott, 2014; Armand et al., 2020). This model incorporates station parameters and topographic features to predict signal strength at the cell level, achieving a spatial resolution of 300 meters. Figures 3 present the coverage map of FP broadcasts aired on MBC during the period 1995–2010 at cell level (a) and at survey cluster level (b).

Figure 3: MBC signal strength across Malawi 1972–2010

a. MBC signal strength at cell level in -dBm

b. [0,1] Rescaled signal strength at DHS cluster level



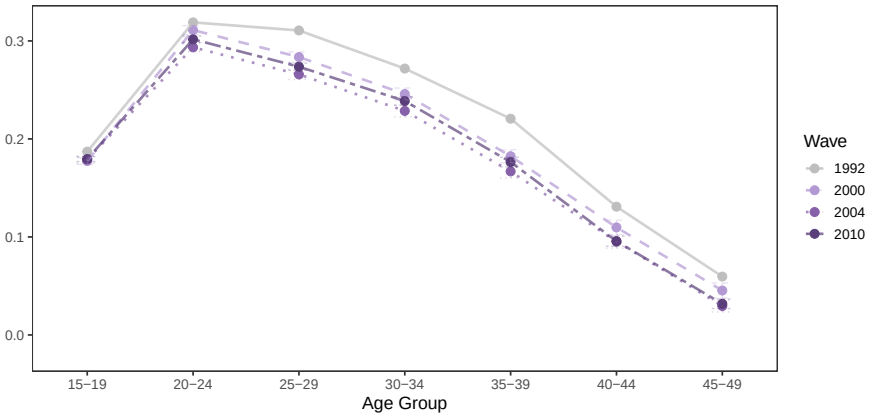
Note. Panel A plots the topography corrected signal loss at the 300m resolution cell level, estimated by the ITM model (Olken, 2009). High values, represented by yellow, indicate strong radio signals, while low values, depicted in purple, signify poor signal quality. Panel B plots the signal at the level of our estimation sample DHS clusters from DHS survey waves 2000, 2004 and 2010. We exclude clusters in areas where chichewa is not the majority language. For ease of interpretation, we rescale signal to values between 0 and 1 in our estimations.

3.2 Fertility, reproductive health and female empowerment

We obtain reproductive health-related outcomes from three geo-referenced waves of the Demographic and Health Surveys (DHS; Croft et al., 2018), collected in 2000, 2004, and 2010. Individual surveys provide nationally representative data on health and population, with a particular focus on maternal and child health, and they have been widely used to calculate mortality rates among children. The program surveys women aged 15–49 and includes information about their demographics, including wealth and human capital accumulation. Each surveyed woman's birth history is recorded and includes information on their children's year and month of birth, sex, birth order, whether they are twins, and the date of death when applicable. The primary sampling unit is a community (or cluster), representing a village or neighbourhood.

We use information from the DHS surveys to build three different sets of outcomes. First, we focus on fertility. Based on retrospective birth history, we create a yearly panel for women aged 15 to 49 that spanned the years 1990 and 2009. We exclude the year of survey to address censoring and limit retrospective panel of each woman to maximum ten years before the survey to minimize recall bias. A binary dummy indicates whether women gave birth in a given year. Figure 4 displays the age-specific probability of giving birth per year, by age group and wave of data collection. This figure includes the 1992 DHS wave that cannot be used for analysis due to lack of geo-spatial data, but allows to observe the large drop in fertility rate for women between 25 and 40 years old between 1992 and and 2000. We focus our analysis on a subsample of women aged 15 to 35 years old, married, co-residing with their partner or sexually active, as these have the highest probability of giving birth in a given year.

Figure 4: Probability of giving birth, by age



*Note.*The graph shows age-specific probability of giving birth by wave. The age-specific probability of giving birth measures the average probability of giving birth in a given year by age-group. Data: DHS. Sample: women aged 15 to 50.

Second, we capture outcomes related to family planning and reproductive health, including the use of modern contraceptives (MC), approval of MC, desired fertility, and reported listenership of FP related radio programs for each survey wave. We condense listenership outcomes into one binary variable, taking the value 1 if the survey respondent has listened to any of the FP programs, and 0 otherwise. Table 1 displays summary statistics for key variables across the three DHS waves.

Finally, we make use of the survey to gather information about female empowerment, focusing on attitudes toward domestic violence, female autonomy in decision making, and direct measure of female income, such as education and labor supply. We supplement information collected from the DHS surveys, thus measuring shorter-term impacts, with comparable information using the geo-referenced Afrobarometer waves 2017 and 2022, and capturing longer-term effects.

Table 1: Summary Statistics by Wave

	DHS 2000	DHS 2004	DHS 2010
Age Distribution			
Age 15-19	0.217	0.205	0.218
Age 20-24	0.224	0.245	0.197
Age 25-29	0.182	0.184	0.190
Age 30-34	0.118	0.127	0.141
Age 35-39	0.108	0.095	0.109
Age 40-44	0.080	0.080	0.076
Age 45-49	0.072	0.064	0.068
Sample Selection Variables			
Coresiding	0.013	0.043	0.088
Married	0.702	0.668	0.586
Sexually Active	0.558	0.554	0.546
Married or Coresiding or Sexually Active	0.739	0.734	0.697
Control Variables			
Matrilineal Ethnic Group	0.763	0.757	0.755
Number of Siblings	5.998	5.547	5.950
Urban	0.159	0.178	0.183
Education Years	3.991	4.715	5.360
Selected Outcome Variables			
Completed Primary	0.191	0.255	0.293
Completed Secondary	0.039	0.060	0.075
Listened to Family Planning Program	0.757	0.732	0.673
Children Ever Born	3.132	3.032	3.070
Ideal Number of Children	4.206	4.058	3.987
Paid Employment	0.267	0.199	0.420
Uses Any Contraceptive Method	0.250	0.257	0.354
Observations	*13220*	*11689*	*22480*

Notes: The table displays the mean of important variables used for sample definition, as control or outcomes, separately for each DHS wave. The variables are constructed as follows: sexually active is a dummy equal to 1 if the woman reports any sexual intercourse in the last 30 days; urban areas are defined by the Malawi National Statistics Office (NSO); any contraceptive method is a dummy equal to 1 if the woman report currently using any modern or traditional contraceptive method. Data: DHS. Sample: women aged 15 to 50. Statistics are weighted using survey weights.

4 Empirical strategy

Identifying causal effects of radio coverage on fertility outcomes requires variation in radio coverage to be uncorrelated with all other determinants of fertility. Although the MBC network remained stable after 1972, it's initial roll-out arguably followed population density and economic development, maximizing the reach of radio broadcasting. Consequently, an endogeneity concern arises from antennas being situated in regions characterized by particular fertility dynamics. In our core specification we combine two

complementary empirical strategies to tackle this issue.

First, we exploit the sudden and sharp shift in broadcasting policy in 1995, when the national radio network (MBC) began airing previously banned family planning (FP) content. This policy change created cohort-based variation in exposure, as women of different ages experienced differential exposure to FP messaging across their reproductive years. Further, despite substantial network penetration, we observe significant spatial variation in signal strength and hence exposure across Malawi, which results in unequal exposure to FP content across localities. We argue that these sources of temporal and spatial variation provide a clean difference-in-differences design. Identification then rests on the assumption of parallel trends, after controlling for cohort-specific and location-specific effects.

Secondly, we strengthen this approach exploiting random patterns of radio exposure due to topographic obstacles on the radio transmission path. The propagation of FM radio signal depends primarily on the height and power of each antenna, and the respective distance to between transmitter and receiver. Since transmitters may have been placed strategically, distance to the antenna is likely correlated with other determinants of fertility. In the presence of physical obstacles such as hills or mountains, the signal can be blocked or diffracted, creating patterns in the local coverage of the radio signal which are exogenous to local socio-economic characteristics. In the Malawian context, the large mountain chains of the East African Rift System traverse the country from north to south, generating large topographic obstacles for radio transmission and inducing severe difficulties for network planning (see Figure A1 in the Appendix.).

Building on previous literature, we construct topography-corrected radio coverage using the Longley–Rice Irregular Terrain Model (ITM). To isolate the effect of topography, we also compute free-field radio coverage, which represents the theoretical signal reach in the absence of obstacles. Conditional on free-field coverage–which captures both distance and the technical characteristics of the nearest antenna–residual variation in radio exposure arises solely from topographic interference, rendering it exogenous to listener behavior. We additionally include controls for terrain ruggedness and elevation, which may correlate with unobserved cluster characteristics and influence radio signal propagation (Olken, 2009; Yanagizawa-Drott, 2014; DellaVigna et al., 2014; Adena et al., 2015; Armand et al., 2020)[2]. In the next section, we will formerly test this assumption.

[2]We will hereafter refer to the set of topographic and free field radio coverage control variables as *propagation controls*.

Exogeneity check If the identification strategy is valid and residual radio coverage, after controlling for free field radio coverage, is random, there should be no correlation between the variation in radio coverage and other socio-demographic determinants of future fertility decisions. To test this, we assess the exogeneity assumption using observable individual and cluster outcomes through a series of simple regressions:

$$y_{i(c)} = \beta_1 S_{c(i)} + \beta_2 S_{c(i)}^{free} + \overline{X}\lambda + \mu_w + \mu_{district} + \epsilon_{ic,t}, \tag{1}$$

where $y_{i(c)}$ are (predetermined) characteristics of individual i or cluster c. μ_w and $\mu_{district}$ are sets of survey wave and district fixed effects. $\overline{X}$ incldues a vector of geographic controls. $S_{c(i)}$ and $S_{c(i)}^{free}$ are, respectively, MBC signal strength and theoretical free field signal strength in the absence of topographic obstacles.Under the exogeneity assumption, residual variation in signal quality is random, and we expect $\beta_1 = 0$. When analyzing individual level outcomes, we limit the sample to women aged 18 and above in 1995 to rule out any direct impacts by our treatment.

Table 4 presents the results. Column 2 shows that radio coverage indeed correlates with specific individual and cluster-level characteristics. After inclusion of the free field signal, none of the individual characteristics remains significant. For cluster level characteristics, we find only a weakly significant coefficient for the number of livestock. Further, comparing columns 1 and 4 reveals that coefficients are consistently driven towards 0. These findings validate to our identification strategy and support exogeneity in residual radio exposure.

Event study specification To assess the impact of family planning (FP) content on radio broadcasts on fertility decisions in Malawi, we begin by estimating a difference-in-differences (DiD) model. The outcome is measured at the mother-year level, utilizing quasi-panel data constructed from retrospective birth histories in the DHS. This approach leverages spatial variation in radio coverage and temporal variation in birth probabilities within women over time, comparing birth probabilities before and after being exposed to FP radio content:

$$birth_{i,t} = \sum_{\tau=-a}^{a} \gamma_\tau D_\tau \cdot S_{c(i)} + \sum_{\tau=-a}^{a} \gamma_\tau D_\tau \cdot S_{c(i)}^{free} + X'_{i(c),t}\lambda + \mu_i + \mu_t + \mu_w + \epsilon_{i,t} \tag{2}$$

where the outcome variable $birth_{i,t}$ is a dummy equal to 1 if woman i, surveyed in cluster c, in survey wave w, gave birth in year t, and 0 otherwise. μ_i are individual level fixed effects capturing potential

Table 2: Exogeneity check

	Signal			*Signal and free field*			
Dependent	Coefficient	SE	R^2	Coefficient	SE	R^2	N
Individual-level outcomes	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Years of education	2.311***	0.527	0.098	-0.074	0.69	0.103	14243
Highest education level	0.635***	0.144	0.088	0.041	0.184	0.092	14243
Chewa ethnicity	-0.014	0.07	0.233	-0.02	0.12	0.233	25354
Tumbuka ethnicity	-0.038	0.029	0.097	0.054	0.037	0.102	25354
Age	-1.755***	0.419	0.003	-0.583	0.628	0.003	34959
Age squared	-107.97***	26.434	0.003	-35.194	40.235	0.004	34959
Age at first marriage	0.421	0.332	0.012	0.623	0.474	0.012	14121
Age at first intercourse	-0.343	0.315	0.036	-0.451	0.496	0.036	14188
Years at place	-25.559***	4.132	0.107	1.722	6.093	0.111	34948
Number of Siblings	0.018	0.285	0.025	-0.282	0.413	0.025	14243
Cluster-level outcomes							
ln population 2000	-0.359	0.217	0.294	-0.034	0.399	0.296	1403
ln under 5 population 2000	2.488***	0.607	0.578	0.28	0.636	0.631	1403
ln population density 2000	2.649***	0.619	0.604	0.386	0.66	0.651	1403
Urban status (DHS)	0.968***	0.234	0.382	0.144	0.192	0.434	1404
ln distance to urban center	-3.341***	0.831	0.443	-0.866	1.027	0.492	1404
Built-up area	-24.422	26.542	0.501	-56.047	59.709	0.501	1404
Nightlights 1994	11.423	7.088	0.503	4.498	6.692	0.51	1404
Nightlights 2010	20.613*	9.974	0.58	6.123	9.029	0.595	1404
Share of agriculture	-0.555***	0.157	0.279	-0.105	0.169	0.303	1404
Irrigated area	46.605	73.418	0.255	1.375	83.732	0.255	1404
ln livestock	-1.168*	0.595	0.183	-1.125*	0.623	0.183	1403
FLFP	-0.084	0.055	0.146	-0.036	0.078	0.146	1404
Malaria prevalence 2000	-24.542	26.54	0.501	-56.033	59.709	0.501	1404
Growing season length	-0.18	0.41	0.807	-0.253	0.461	0.807	1404
Drought episodes	0.022	0.388	0.659	0.404	0.326	0.661	1403
Propagation controls	✓			✓			
District FE	✓			✓			
Survey wave FE	✓			✓			

Note: This table shows the correlation between individual-level characteristics (top) and cluster-level characteristics (bottom) with exposure to the radio program. Column 1 reports the coefficients from ordinary least squares (OLS) regressions of each variable on actual signal strength. Column 4 adds controls for hypothetical signal strength in free space. All models include controls for elevation, terrain ruggedness, survey wave, and district fixed effects. The sample consists of women from the DHS survey waves of 2000, 2004, and 2010 (top), and, respectively, the surveyed clusters from these waves (bottom). For individual outcomes of education, first marriage, first intercourse and number of siblings we limit the sample to women aged 18 and above in 1995. Standard errors are clustered at the DHS cluster level for individual outcomes and district level for cluster level outcomes. Significance levels are denoted as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

sources of unobserved heterogeneity across women. μ_t, μ_w represent fixed effects for birth year, and survey wave, respectively. $X'_{i(c),t}$ denotes a vector of individual and cluster-level controls, including a set of dummies for age at time t.

$S_{c(i)}$ is the actual signal strength of MBC at woman i's cluster of residence c; $S^{free}_{c(i)}$ is the hypothetical signal strength in free space, that is, without any topographic interference. Crucially, this variable accounts for a cluster's proximity to a transmitter and the transmitter's power, capturing, for example, the components linked to the degree of urbanization. Although radio coverage may correlate with unobserved cluster characteristics, our identification strategy exploits random residual variation in radio propagation induced by topographic obstacles (see the previous section for validation of this assumption).

To analyze the time-profile of effects, our coefficients of interest, γ_τ, vary on a yearly basis to capture the dynamic impact of the treatment over time. Specifically, $\tau = 0$ marks the initiation year of family planning (FP) radio campaigning by MBC in 1995. The variables D_τ is a set of year indicators that define each year in relation to the treatment initiation. We use survey weights and cluster standard errors at the level of DHS clusters. This analysis can only be performed with the 2000 and 2004 DHS waves to keep only women with variation in exposure to the MBC programs within their last ten fertile years (we censor birth history to the past ten years to minimize recall bias).

Pooled cross-section Second, we investigate impacts on further behavioral outcomes and attitudes, notably self-reported radio listenership, the use of modern contraceptives (MC), approval of MC and desired fertility. While DHS data on retrospective birth histories allow us to control for women specific fixed effects and exploit only the timing of birth, effects on these outcomes are identified based on a pooled cross-section of surveyed women. This specification derives causal identification from conditionally random exposure to radio signal, after controlling for free field radio propagation.

$$Y_i = \beta_1 S_{c(i)} + \beta_2 S^{free}_{c(i)} + X'_{i,t}\lambda + \mu_{district} + \mu_w + \epsilon_{ic,t} \tag{3}$$

We control for a large set of individual and cluster-level characteristics $X'_{i,t}$, and add survey and district fixed effects, μ_w and $\mu_{district}$.

5 Results

5.1 Radio coverage and listenership

First, we present evidence that supports our empirical first stage analysis, assessing the impact of exposure to the MBC signal on the likelihood of listening to family planning (FP) content on the radio. We construct a binary variable, indicating whether a woman reported to have listened at least to 1 of the 15 specific programs broadcasted on MBC and surveyed by the respective DHS wave.

Table 3 demonstrates how access to a high-quality MBC radio signal at the cluster of residence influences the probability of listening to FP programs for women but not for men. Estimating equation 3 on reported FP listenership, we find that the impact of signal quality on FP listenership is statistically highly significant at the 5% level for women only. Controlling for the full set of fixed effects and individual and cluster-specific controls, our results suggest that transitioning from low to high signal quality increases the likelihood of listenership by 11.2 percentage points for women, whose overall listenership averages 72%.

Men's listenership, by contrast, averages approximately 90% and appears unaffected by signal quality. This difference may reflect men's greater mobility, which allows them to access radio broadcasts away from their residential clusters. Table B1 in Appendix supports this interpretation: the listenership of women currently working—hence potentially more mobile—is higher on average but also more weakly correlated with signal quality.

Table 3: MBC signal strength and listenership

	Listened to any MBC family planning program							
	Women		Men		Women (married)		Men (married)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MBC signal	0.139***	0.112**	-0.033	-0.055	0.185***	0.162***	-0.053	-0.068
	(0.051)	(0.054)	(0.051)	(0.054)	(0.052)	(0.056)	(0.062)	(0.065)
Adjusted R^2	0.0312	0.0352	0.0221	0.0228	0.0250	0.0271	0.0144	0.0155
Observations	34,950	34,950	9,971	9,971	18,566	18,566	3,884	3,884
Dependent variable mean	0.7196	0.7196	0.9049	0.9049	0.7479	0.7479	0.9199	0.9199
District fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Wave fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Cluster Controls		✓		✓		✓		✓
Free Field	✓	✓	✓	✓	✓	✓	✓	✓

Notes: Estimates based on Equation 3. The main sample includes women and men aged 15 to 50 from three DHS waves of data collected in 2000, 2004 and 2010. The sample of married women includes women 15-35 years old reported as married, living with their partner or sexually active (last 30 days). The dependent variable takes the value 1 if the respondent reports having listened to any of the 15 specific family planning programs broadcasted by MBC in the last few months. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We reproduce our analysis for our main sample of interest, women 15 to 35 years old, married, co-

residing with their partner or sexually active, in column 5 and 6, and find an increased probability of listenership of 16.2 percentage points for women with high signal quality. By contrast, we find no significant effect for men in the same age range who meet the same criteria.

These results are crucial for interpreting our later analysis on the effect of MBC signal quality on family planning and empowerment outcomes. Specifically, we leverage variation in women's direct exposure to the program in a context where men's exposure is nearly universal.

5.2 Fertility decisions

Table 4 displays the estimates of the event study specification with two periods, before and after MBC started broadcasting family planning programs. As explained in Equation 2, the coefficient of MBC signal x post identifies the effect of the radio campaign on the annual probability of giving birth. The third column presents our preferred estimates with the women fixed effects controlling for any time invariant differences between women residing in areas with low and high signal quality. The coefficient is however stable across specifications with less demanding district and cluster fixed effects, suggesting that controlling for free field radio propagation addresses potential bias. Our results suggest that women exposed to the highest signal quality were 6.1 percentage point less likely to give birth in a given year than women exposed to the lowest signal quality. Such a reduction is quite large in comparison to the sample average probability to give birth in a given year, 27.7%, and corresponds to 1.5 children over 25 years of reproductive life.[3] The cohort analysis in Table B3 in Appendix shows that these annual reduction in probability of giving birth lead to cumulated reduction in the number of children : younger cohorts exposed more of their reproductive years after the launch of the radio campaigns have less children on average.

Figure 5 illustrates the effect of MBC signal quality on the annual probability of giving birth by year, based on the specification in column 3 of Table 4 , along with a 90% confidence interval. The omitted category is the year 1995, when MBC launched its family planning radio campaign. We show the event study for our main sample of women aged 15 to 35 years old using 10 years of retrospective data, and we extend to 15 years as a robustness check to allow more years prior to 1995, but observe no evidence of a pre-trend. The results are broadly similar with the two specifications: starting three years after the campaign began broadcasting, in 1998, high signal quality is associated with a 0.10 percentage point

[3] In comparison, Rossi and Godard (2022) find a 12 percentage point reduction in annual probability of giving birth associated with a pension reform in Namibia, corresponding to 3 children over 25 years.

Table 4: Impact of MBC Signal on Probability of Birth

	Child birth (dummy)					
	(1)	(2)	(3)	(4)	(5)	(6)
MBC signal x post	-0.044*	-0.052**	-0.045*	-0.053**	-0.058**	-0.061**
	(0.024)	(0.025)	(0.025)	(0.026)	(0.026)	(0.027)
MBC signal	0.026	0.029				
	(0.025)	(0.025)				
R^2	0.0219	0.0260	0.0289	0.0329	0.0945	0.0980
Observations	76,337	76,337	76,337	76,337	76,337	76,337
Dependent variable mean	0.2729	0.2729	0.2729	0.2729	0.2729	0.2729
Wave fixed effects	✓	✓	✓	✓	✓	✓
Year and Age fixed effects	✓		✓		✓	
District fixed effects	✓	✓				
Year-Age fixed effects		✓		✓		✓
Cluster fixed effects			✓	✓		
Woman ID fixed effects					✓	✓

Notes: Estimates based on Equation 2, all regressions include wave fixed effects and individuals controls for education years, number of siblings and whether woman belongs to a matrilineal ethnic group. Columns 1 and 2 include cluster controls for urban, elevation and rugedness. Post refers to years post 1995, when MBC started broadcasting family planning programs. The sample includes married, coresiding or sexually active women aged 15 to 35 in year t, and 10 years of retrospective data from three waves of data collected in 2000 and 2004, covering the period 1990 to 2003. The year of data collection is excluded from the sample for each of the two waves. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

decrease in the annual probability of giving birth. The effect becomes more pronounced in subsequent years, reaching -0.13 percentage points in 2000, before stabilizing around -0.12 percentage points in the following years. These dynamics suggest some delay before exposure to the radio programs messages translates into fertility outcomes, even accounting for a 9-month pregnancy lag, indicating that changes in norms around ideal family size and reproductive health have occurred gradually. We investigate these mechanisms in the next section.

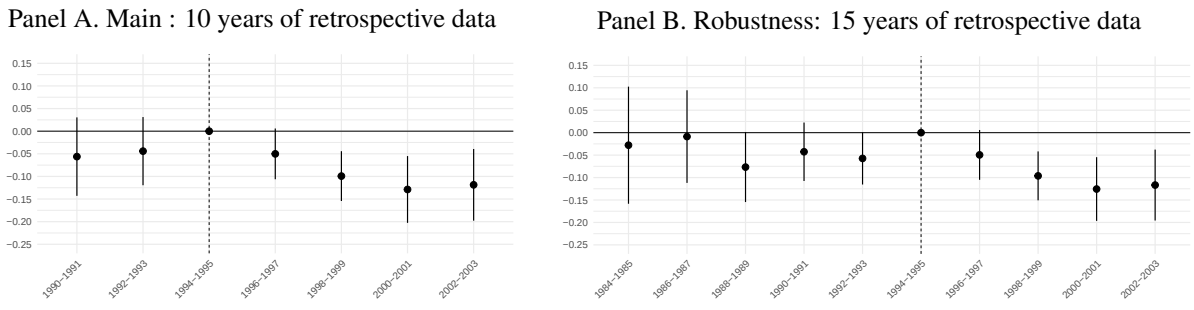


Figure 5: Impact of MBC signal on probability of birth by year.

Note. Estimates based on Equation 2, controlling for age, woman, and wave fixed effects. We pool together years t and $t-1$ to increase precision. The omitted category is 1994–1995, the last period in which fertility decisions were made before MBC started broadcasting family planning programs. The graph plots 90 percent confidence intervals. The sample includes married, co-residing, and sexually active women aged 15 to 35 in year t, and uses retrospective data from two waves collected in 2000 and 2004. The year of data collection is excluded from the sample for each wave.

5.3 Mechanisms

In this section, we investigate the channels through which the family planning programs broadcasted on MBC radio may have contributed to reduced fertility among female listeners.

On one hand, programs such as *Radio Doctor* disseminated information about sexual and reproductive health, potentially increasing listeners' awareness of available contraception methods, ways to prevent STIs (including HIV), and reducing misconceptions about the side effects of modern contraception that may otherwise constrain adoption. Additionally, these programs provided practical guidance on how to procure contraceptive methods. On the other hand, radio soap operas such as *Tinkanena* contained less direct informational content but instead sought to influence social norms and attitudes through edutainment, promoting family planning in a relatable, narrative-driven format.

While we cannot disentangle the causal effect of listenership to each program separately—since they were all broadcast simultaneously on the main radio channel—we analyze the overall impact of exposure to this bundle of programs on knowledge and norm-related outcomes to unpack the potential mechanisms of impact. To explore these mechanisms, we leverage random cross-sectional variation in exposure to radio signal, as specified in Equation 3, where identification is achieved from exogenous variation in radio signal strength, controlling for free-field radio propagation.

Table 5 examines the impact of exposure to the family planning radio programs on reproductive and sexual health knowledge.

The first column reports the effect on a standardized index of knowledge, constructed from multiple components: the share of modern contraceptive methods the respondent reports knowing (out of 12 modern methods explicitly listed by DHS enumerators), the total number of scientifically valid methods spontaneously cited by the respondent to prevent HIV (out of 11 possible answers, including using condoms and limiting the number of sexual partners), the number of misconceptions about HIV prevention mentioned by the respondent (out of three common misconceptions, such as avoiding mosquito bites or not sharing food with HIV-positive individuals), and whether the respondent knows where to get tested for HIV. Due to a high percentage of missing values, we separately analyze knowledge of where to obtain condoms.

The results indicate that exposure to the program had no statistically significant effect on the overall knowledge index or on any of its individual components. Likewise, exposure does not appear to improve knowledge of where to obtain condoms. While the estimated coefficients consistently suggest an

increase in knowledge or a reduction in misconceptions, their magnitudes are small and not statistically significant. These findings suggest that information provision alone may have been insufficient to substantially improve knowledge or that baseline knowledge levels were already relatively high among the target population.

Table 5: Knowledge outcomes

	Knowledge index (1)	Known mCMs (share) (2)	AIDS knowledge (3)	AIDS misconceptions (4)	HIV test where (5)	Get condoms where (6)
MBC signal	0.078	0.028	0.066	-0.009	0.010	0.045
	(0.107)	(0.029)	(0.123)	(0.008)	(0.047)	(0.057)
Adjusted R^2	0.4337	0.1524	0.6453	0.0112	0.1383	0.0254
Observations	18,470	18,470	18,470	18,470	18,470	15,843
Dependent variable mean	0.0076	0.6152	1.127	0.0083	0.8868	0.7967
Age fixed effects	✓	✓	✓	✓	✓	✓
Wave fixed effects	✓	✓	✓	✓	✓	✓
District fixed effects	✓	✓	✓	✓	✓	✓

Notes: Estimates based on Equation 3. All regressions include wave, age and district fixed effects and individuals controls for education years, number of siblings and whether woman belongs to a matrilineal ethnic group as well as cluster controls for urban, elevation and rugedness. The sample includes married, co-residing and sexually active women aged 15 to 35 from three DHS waves of data collected in 2000, 2004 and 2010. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Despite the limited impact on knowledge, Table 6 reveals meaningful shifts in attitudes toward family planning and contraceptive behavior. Women exposed to strong radio signal are 9.9 percentage points more likely to have discussed family planning with their partners, a critical step toward joint fertility decision-making. Moreover, they report wanting 0.42 fewer children on average, a significant reduction in ideal family size.

Interestingly, this decrease in desired fertility is primarily driven by a decline in the preferred number of sons, suggesting that the program may have not only influenced overall fertility preferences but also weakened existing son preference norms. Baseline statistics indicate that respondents did not exhibit strong son preference prior to the program—on average, women reported wanting 45% of their children to be boys, with the remainder either girls or no preferred sex. However, the program's effect on reducing the ideal number of boys suggests that its influence extended beyond fertility limitation to gender composition preferences.

These attitudinal changes appear to have translated into concrete contraceptive behaviors. Women exposed to the program were significantly more likely to have used a condom during their last sexual intercourse and to be currently using any form of contraception (including modern and traditional methods).

Table 6: Family planning outcomes

	Discussed FP with partner (1)	Children ideal number (2)	Boys ideal share (3)	Used condom last intercourse (4)	Uses any CM (5)
MBC signal	0.099**	-0.420***	-0.047**	0.056***	0.093*
	(0.050)	(0.149)	(0.019)	(0.021)	(0.051)
Adjusted R^2	0.0092	0.1689	0.0144	0.0315	0.0663
Observations	10,134	18,288	18,194	18,074	18,571
Dependent variable mean	0.1200	3.922	0.4497	0.0507	0.3683
Age fixed effects	✓	✓	✓	✓	✓
Wave fixed effects	✓	✓	✓	✓	✓
District fixed effects	✓	✓	✓	✓	✓

Notes: Estimates based on Equation 3. All regressions include wave, age and district fixed effects and individuals controls for education years, number of siblings and whether woman belongs to a matrilineal ethnic group as well as cluster controls for urban, elevation and rugedness. The sample includes married women aged 15 to 35 from three DHS waves of data collected in 2000, 2004 and 2010. The family planning discussion variable is collected only in the 2000 and 2004 survey waves. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Taken together, these results suggest that while the family planning radio programs did not dramatically improve explicit knowledge of reproductive health, they played a key role in shaping fertility preferences and increasing contraceptive uptake, primarily through changing attitudes and facilitating discussions about family planning.

5.4 Effect of fertility reduction on women empowerment

Our results on fertility suggest that the radio programs broadcast on MBC accelerated the fertility transition in Malawi, triggering an exogenous shift in fertility. This setting allows us to study how reductions in fertility affect women's empowerment through two main channels: education and human capital accumulation, and labor force participation and economic empowerment.

From a theoretical perspective, reduced fertility can directly impact women's education by lowering the time burden of childcare, enabling young women to remain in school longer. Empirical evidence suggests that access to contraception and lower fertility rates are associated with higher female educational attainment, as girls face fewer interruptions to their schooling due to early childbearing (Miller, 2010). A secondary, indirect channel operates through reduced dependency ratios at the household level, as smaller families allow greater per-child investments in nutrition, health, and education, leading to higher overall human capital accumulation (Becker and Lewis, 1973). Higher educational attainment, in turn, strengthens women's bargaining power through enhanced cognitive skills (Mckelway, 2018) and greater

labor market opportunities.

Lower fertility also facilitates women's entry and retention in the labor market, increasing their economic independence. The opportunity cost of childbearing declines, making formal employment more feasible for women. Empirical studies have found that reductions in fertility, particularly through access to family planning, are associated with increased female labor force participation (Goldin and Katz, 2002). Higher participation in the labor force not only improves women's financial security but also increases their contributions to household income, enhancing their bargaining power in household decision-making (Heath and Mobarak, 2015; Majlesi, 2016).

Table 7: Women empowerment outcomes

	IPV score (1)	Decision making score (2)	Completed primary (3)	Currently working (4)	Paid employment (5)	Work outside agriculture (6)
Panel A : Married women a 15-35						
MBC signal	0.234**	0.254***	0.053	0.011	0.094	0.104*
	(0.105)	(0.071)	(0.059)	(0.072)	(0.071)	(0.060)
R^2	0.0906	0.1544	0.0851	0.0398	0.0915	0.0596
Observations	18,566	18,568	18,571	18,571	18,542	18,570
Dependent variable mean	-0.0295	-0.0786	0.2340	0.5551	0.3122	0.2515
Panel B : Married women below 15 in 1995						
MBC signal	0.202	0.306***	0.125*	-0.004	0.192**	0.246***
	(0.131)	(0.091)	(0.074)	(0.089)	(0.090)	(0.075)
R^2	0.0994	0.1709	0.0716	0.0514	0.1182	0.0639
Observations	8,917	8,917	8,918	8,918	8,899	8,917
Dependent variable mean	0.0423	-0.0253	0.2733	0.5318	0.3162	0.2428
Panel C : Married women above 15 in 1995						
MBC signal	0.125	0.127	0.017	0.098	-0.0005	0.020
	(0.110)	(0.079)	(0.060)	(0.076)	(0.077)	(0.070)
R^2	0.0852	0.1445	0.0723	0.0312	0.0860	0.0660
Observations	14,723	14,725	14,728	14,728	14,715	14,728
Dependent variable mean	-0.0473	-0.0755	0.1561	0.6124	0.3327	0.2686

Notes: Estimates based on Equation 3. All regressions include wave, age and district fixed effects and cluster controls for urban, elevation and ruggedness. Individuals controls for education years and number of siblings are not included in these regressions. The sample includes married women aged 15 to 49 from three DHS waves of data collected in 2000, 2004 and 2010. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7 presents the effects of program exposure on women's empowerment outcomes, disaggregated by age groups. Panel A examines the effects on married women aged 15-35, the group most directly affected by reduced fertility. We find a significant increase in empowerment, as measured by a 0.234 standard deviation decrease in acceptance of intimate partner violence (IPV) and a 0.254 standard deviation increase in decision-making power within the household. While we do not observe significant effects on primary education completion or overall employment, we do find a 10.4 percentage point increase in the probability of working outside of agriculture. These results suggest that fertility reductions may have enabled young women to engage in non-agricultural labor, consistent with a decline in the opportunity costs of childbearing.

To further explore whether education played a role in empowerment gains, we split the sample into two groups based on whether they were of primary school age when the program started. Panel B focuses on women who were younger than 15 in 1995 and therefore still of schooling age. For this group, we find a 12.5 percentage point increase in the probability of completing primary education, consistent with the hypothesis that reduced fertility allowed for greater schooling investments. This higher human capital accumulation translates into significant labor market improvements, with a 19.2 percentage point increase in paid employment and a 24.6 percentage point increase in working outside agriculture. Importantly, decision-making power within the household increases by 0.306 standard deviations, consistent with greater economic autonomy reinforcing bargaining power. The effect on IPV acceptance, while similar in magnitude to Panel A, is not statistically significant, potentially due to the younger age profile of this group.

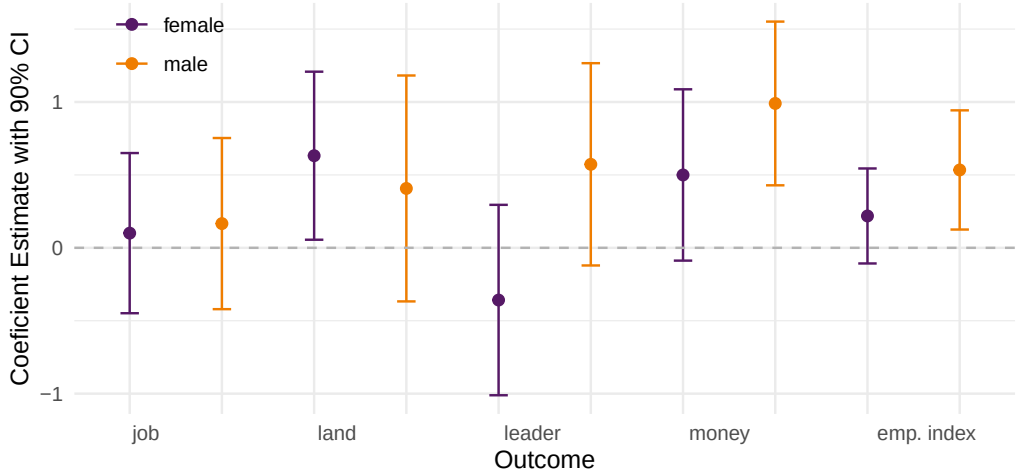
By contrast, Panel C examines women who were already older than 15 in 1995 and unlikely to have benefited from any direct schooling effects. For this group, we do not detect significant effects on education, labor market outcomes, or decision-making power, reinforcing the interpretation that the observed empowerment effects stem from increased schooling among younger women.

To further validate this interpretation, we conduct a cohort analysis with district and cluster fixed effects (Table B4), confirming that exposure to the program during school years significantly increases primary school completion rates but does not affect secondary school attainment. Together, these results suggest that improved human capital accumulation through a quantity-quality trade-off is a key driver of women's empowerment gains, largely operating through greater labor market opportunities.

Finally, we turn our attention to potential long-run effects of the fertility transition on empowerment. We combine data from the two available Afrobarometer waves 2017 and 2022 which include precise spatial encoding and information on attitudes towards female empowerment. We focus on 5 core dimensions which jointly capture female empowerment. These item measure (i) whether women should have equal access to jobs; (ii) whether women should have equal rights to inherit land; (iii) whether women are equally suited for leadership roles; and (iv) whether women should have equal say when it comes to financial decisions. Measures are standardized around their respective means. We combine these five dimensions to compute a general empowerment indicator as the average across their z-scores. Positive values represent attitudes that reflect stronger female empowerment.

We then proceed to estimate equation 3 separately for women and men. Figure 6 plots the coefficients of broadcasting exposure (along with 90 percent confidence intervals) across the four distinct dimensions

Figure 6: Impact of MBC signal on probability on long-run female empowerment outcomes



Note. Estimates of FP broadcasting exposure on attitudes toward female empowerment by male and female sub-samples, based on Afrobarometer waves 2017 and 2022. Higher values indicate greater support for female empowerment. Estimates derive from equation 3, controlling for wave and district fixed effects, propagation parameters, and individual characteristics. Standard errors are clustered at the district level.

of attitudes toward female empowerment, as well as the composite index.[4] Overall, the results suggest that exposure to the MBC signal produced shifts in empowerment-related attitudes, with only the point estimate of women's attitudes toward female leadership being negative but not statistically significant. Notably, men exhibit an increase in the composite attitudes towards empowerment index of 0.53 standard deviations, significant at the 5 percent level. For women, we find an increase of 0.22 standard deviations, although not significant at conventional levels. Polling both groups together we find an average increase of 0.32 significant at the 5 percent level.

Both men and women show positive coefficients for women's right to inherit land, with women being 0.63 standard deviations more supportive. Likewise, attitudes about women's influence over household financial decisions register large positive effect–roughly a one standard deviation increase among men, significant at the 1 percent level. By contrast, changes in attitudes toward women's right to access jobs remain smaller and indistinguishable from zero for both genders, possibly reflecting entrenched family arrangements and labor market norms.

Taken together, these findings suggest that the fertility transition spurred by MBC's family planning programs not only affected women's beliefs and behaviors but also led men to adopt more progressive views regarding female autonomy and rights over the long run.

[4] See table B2 in the appendix for the corresponding regression table.

6 Conclusion

This paper provides novel evidence on the impact of mass media-driven family planning campaigns on fertility transition and female empowerment in a developing country context. Using exogenous variation in radio signal strength induced by topography, we show that exposure to family planning programs broadcast on Malawi's national radio station significantly reduced fertility rates among women of reproductive age. This decline was primarily driven by shifts in fertility preferences and increased contraceptive uptake, rather than improved explicit knowledge of reproductive health.

The ability of mass media to drive fertility decline and enhance women's empowerment highlights its potential as a powerful policy tool in high-fertility settings. Policymakers should consider leveraging media-based interventions as a complementary strategy to traditional supply-side reproductive health programs, which have often struggled to produce meaningful reductions in fertility (Dupas et al., 2024).

Beyond fertility, the observed decline in childbearing provides a unique opportunity to study its broader implications for women's empowerment. We find that this fertility reduction translated into meaningful improvements in women's agency, including greater participation in household decision-making, lower acceptance of intimate partner violence, and increased engagement in non-agricultural employment. These effects were most pronounced for younger cohorts, suggesting that reductions in fertility facilitated increased schooling investments and, in turn, greater labor market opportunities. Our results highlight the crucial role of human capital accumulation in translating fertility declines into long-term gains in female agency and economic participation.

ONLINE APPENDIX

Fertility Transition and Female Empowerment

Alex Armand, Marion Richard and Yannik Schenk

A Topography of Malawi **2**

B Additional Results **4**

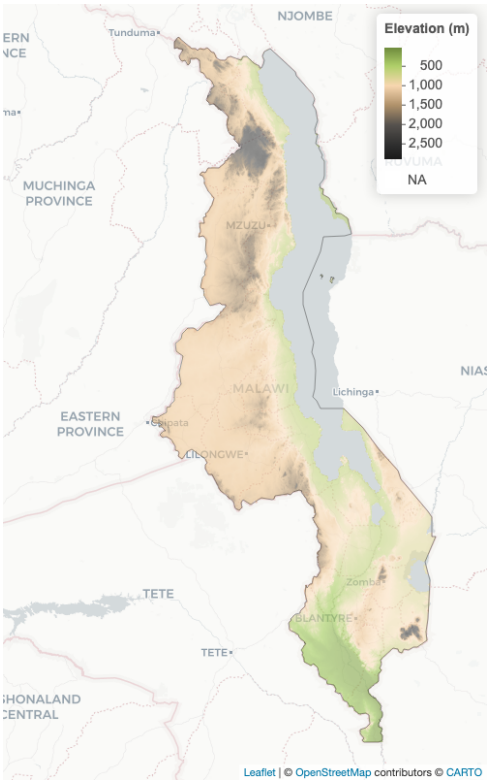
B.1 Signal strength and listenership by work status 4

B.2 Signal strength and lon-run female empowerment 4

B.3 Exposure model 6

A Topography of Malawi

Figure A1: Topography of Malawi



Note. Elevation in meters. Data stems from the OpenTopography API global datasets.

B Additional Results

B.1 Signal strength and listenership by work status

Table B1: MBC signal strength and listenership by working status

	Listened to any MBC family planning program (1)
MBC signal	0.181***
	(0.058)
MBC signal (free)	0.081
	(0.067)
Elevation	0.010
	(0.029)
Rugedness	-0.105
	(0.116)
Currently working	0.083***
	(0.024)
MBC signal × Currently working	-0.090**
	(0.041)
R^2	0.0332
Observations	34,950
Dependent variable mean	0.7196
District fixed effects	✓
Wave fixed effects	✓

Notes: Estimates based on Equation 3. The sample includes women and men aged 15 to 50 from three DHS waves of data collected in 2000, 2004 and 2010. The dependent variable takes the value 1 if the respondent reports having listened to any of the 15 specific family planning programs broadcasted by MBC in the last few months. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B.2 Signal strength and lon-run female empowerment

Table B2: Signal strength and lon-run female empowerment

	Attitudes to empowerment index (1)	job (2)	land (3)	leader (4)	money (5)
Panel A : all					
signal	0.324**	0.069	0.409	0.098	0.720***
	(0.155)	(0.237)	(0.281)	(0.266)	(0.261)
R^2	0.1460	0.1297	0.1200	0.1255	0.1582
Observations	2,388	2,388	2,388	2,388	2,388
Panel B : men					
signal	0.534**	0.166	0.407	0.573	0.990***
	(0.248)	(0.356)	(0.470)	(0.421)	(0.341)
R^2	0.2117	0.2050	0.1489	0.2244	0.2450
Observations	1,192	1,192	1,192	1,192	1,192
Panel C: women					
signal	0.218	0.101	0.632*	-0.358	0.500
	(0.198)	(0.333)	(0.350)	(0.396)	(0.356)
R^2	0.2491	0.2019	0.2350	0.2024	0.2339
Observations	1,196	1,196	1,196	1,196	1,196

Notes: Estimates of FP broadcasting exposure on attitudes toward female empowerment by male and female sub-samples, based on Afrobarometer waves 2017 and 2022. Higher values indicate greater support for female empowerment. Estimates derive from equation 3, controlling for wave and district fixed effects and propagation controls. Additional we control for age, education, and religion and main language to capture ethnic differences. Standard errors clustered by year and afrobarometer locality are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B.3 Exposure model

Empirical approach In this section, we suggest an alternative estimation strategy, exploiting the cumulative exposure to FP broadcasting to estimate impacts on realized fertility and education outcomes. This approach leverages cohort level variation in exposure to radio programs within clusters. Depending on the year of birth, the number of fertile years during which a woman has been exposed to this kind of novel content varies largely.

Figure B2 illustrates the variation we exploit with the three different DHS surveys used. Women surveyed in 2010 (2000) could have been exposed to a maximum of 15 (5) fertile years to the family planning programs, which began in 1995. However, women under 30 (20) at the time of the 2010 (2000) DHS survey had fewer years of exposure, as they had not yet completed 15 (5) fertile years at the time of survey. Similarly, women over 45 in the 2010 (2000) survey also had fewer years of exposure, as they were already older than 30 (45) when the program began, leaving them with less than 15 (5) remaining fertile years.

Similarly, to study the effect of the program on education outcomes, we define primary (secondary) schooling years exposure, as the cumulative number of school years, aged between 6–14 (18), after MBC started broadcasting family planning programs. Figure B3 illustrates the variation we exploit with the three different DHS surveys used. In this setting, all women surveyed are old enough to have completed primary school years, and all surveys have been conducted more than 8 years after the MBC program started, so that the maximum number of primary school years with MBC Family Planning Programs is 8 for all three waves. Women over 20 (10, so all) years old at the time of the 2010 (2000) DHS survey have been exposed to the MBC FP Program for only some of their primary school years and women over 29

Figure B2: Age in 1995 and Fertile Years with MBC Family Planning Programs

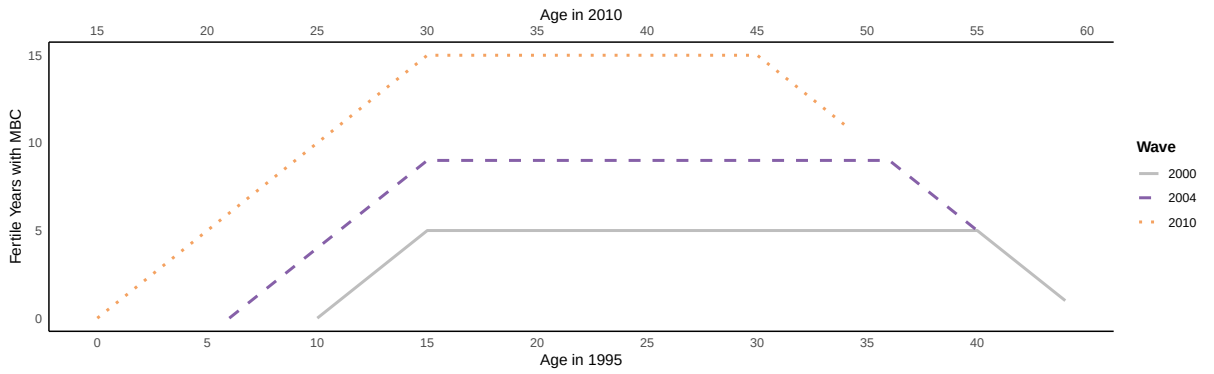
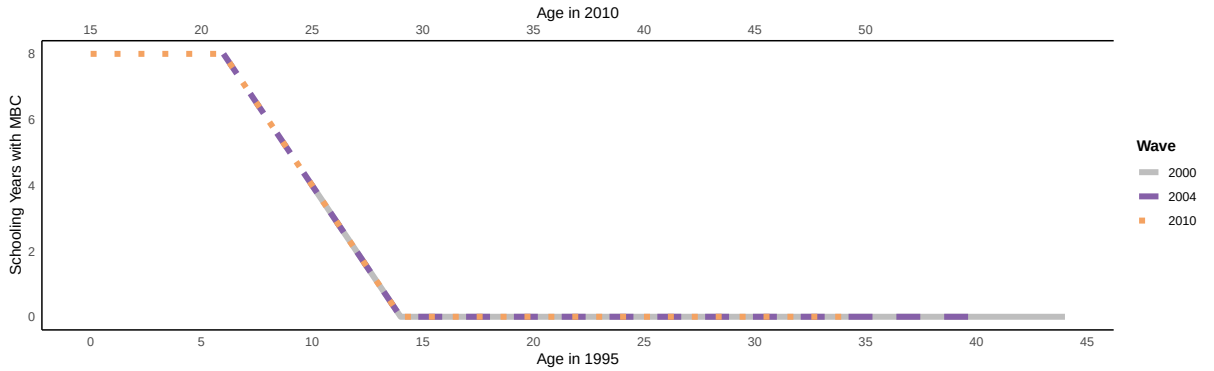


Figure B3: Age in 1995 and Primary School Years with MBC Family Planning Programs



(19) years old at the time of the 2010 (2000) DHS survey have not have been exposed at all during their primary school years.

We proceed to estimate the cumulative impact of exposure to the radio campaign on fertility and education outcomes based on the following equation:

$$children_i = \beta_1 S_{c(i)} \times E_{k(i)} + \beta_2 S_{c(i)}^{free} \times E_{k(i)} + X_i'\lambda + \mu_c + \mu_w + \mu_k + \epsilon_i \quad (4)$$

We define exposure $E_{k(i)}$ as the cumulative number of fertile (education) years of woman i from age cohort k, occurring after the beginning of FP radio broadcasting in 1995. X_i' represents a vector of individual controls. We include μ_c and μ_w, cluster and wave fixed effects. μ_k represents a set of dummies for age cohorts.

Results

Table B3: Cohort Analysis : Impact of MBC Signal on Total Number of Children Ever Born

	Children ever born		Any child	
	(1)	(2)	(3)	(4)
MBC signal x fertile years	-0.083***	-0.139***	-0.010***	-0.014***
	(0.019)	(0.019)	(0.003)	(0.004)
Adjusted R^2	0.6816	0.6870	0.5840	0.5903
Observations	34,959	34,959	34,959	34,959
Dependent variable mean	3.094	3.094	0.7841	0.7841
Age fixed effects	✓	✓	✓	✓
Wave fixed effects	✓	✓	✓	✓
District fixed effects	✓		✓	
Cluster fixed effects		✓		✓

Notes: Estimates based on Equation 4. All regressions include wave fixed effects and individuals controls for education years, number of siblings and whether woman belongs to a matrilineal ethnic group. Columns without cluster fixed effects include cluster controls for urban, elevation and rugedness. Exposure is defined as the number of years during the fertile period of women, between 15 and 45 years old, after MBC started to broadcast family planning programs. The sample includes women aged 15 to 50 at the time of survey using data from the waves of data collected in 2000, 2004 and 2010 , covering the period 1990 to 2010. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table B4: Cohort Analysis : Impact of MBC Signal on Education

	Primary years		Completed primary		Secondary years		Completed secondary	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MBC signal x primary years	0.136***	0.067	0.021***	0.020***				
	(0.047)	(0.045)	(0.008)	(0.007)				
MBC signal x all school years					0.052	0.035	0.002	0.001
					(0.033)	(0.025)	(0.006)	(0.006)
Adjusted R^2	0.2526	0.3341	0.1510	0.2243	0.1705	0.2920	0.1104	0.1891
Observations	34,959	34,959	34,959	34,959	34,959	34,959	34,959	34,959
Dependent variable mean	4.318	4.318	0.2439	0.2439	0.4207	0.4207	0.0566	0.0566
Age fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Wave fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
District fixed effects	✓		✓		✓		✓	
Cluster fixed effects		✓		✓		✓		✓

Notes: Estimates based on Equation 4. All regressions include wave fixed effects and individuals controls for education years, number of siblings and whether woman belongs to a matrilineal ethnic group. Columns without cluster fixed effects include cluster controls for urban, elevation and rugedness.. Exposure is defined as the number of years during the primary school years of women, between 6 and 15 years old, after MBC started to broadcast family planning programs. The sample includes women aged 15 to 50 at the time of survey using data from the waves of data collected in 2000, 2004 and 2010 , covering the period 1990 to 2010. Standard errors clustered by year and cluster are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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