Essays on the Economic, Political, and Social Effects of Mass Media

By

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To my mother, Jayanthi; my father, Vasudevan;

and my grandmother, Vedavalli.

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Introduction

Over the last decade there has been an explosion in research on mass media effects, over a whole range of outcomes. The area where the role of mass media has been most studied is perhaps politics and governance, which covers topics such as voter persuasion and mobilization, transparency and corruption, voter education, and media capture and bias. There are a large number of small-scale experiments as well as large-scale quasi-experimental studies, but very few large-scale field experiments studying mass media effects on electoral outcomes. In my first dissertation chapter, I examine the impact of such an anti-vote-buying voter education campaign in India.

During the 2014 Indian general elections, we carried out a large-scale field experiment to evaluate the electoral effects of an education campaign to persuade voters to reject politicians who engage in vote buying. We broadcast ads on randomly selected radio stations, emphasizing the incentives of politicians who distribute "gifts" to voters and the likely economic consequences of electing them. The ads appealed to voters to act in their economic self-interest and urged them to renege on any promises to vote for such politicians. By strategically timing the broadcasts after the prescribed electioneering period but before voters went to the polls, we are able to estimate the electoral effects mainly from educating and persuading voters rather than inducing politicians to react. Prior to the announcement of the election results we interviewed approximately 400 journalists, asking them to identify parties that had engaged in vote buying in different areas. Using official electoral data, we find that exposure to the radio campaign significantly decreased the vote share of the putative vote-buying parties, with estimates ranging from 4 to 7 percentage points. The radio campaign had a small negative but statistically insignificant effect on the voter turnout rate.

In his seminal book on diffusion of innovations, Rogers (2010) argues that mass media can rapidly inform large populations about the existence and merits of a new technology; thus playing an effective role in initiating the technology diffusion process. There is extensive empirical evidence of the role of mass media in the adoption of health behaviors and technologies, and financial products. However there is no systematic, large-scale study of the impact of mass media on the adoption of agricultural innovations. Much of the focus of research on agricultural technology adoption has been on extension services and peers. Anecdotal and case study evidence, however, suggest that local and community mass media sources, such as radio and television, can be quite effective in increasing awareness and adoption of new agricultural technologies. My second dissertation chapter aims to fill this gap in the literature by examining the impact of radio broadcasting on the adoption of a new agricultural technology, improved seeds, in India during the Green Revolution.

After the mass introduction of high yielding varieties (HYV) of wheat and rice in 1966, the Indian government aggressively promoted their adoption on regional radio stations across the country. I estimate the effect of this large informational intervention on HYV adoption by exploiting a natural experiment–the differential time of introduction of radio coverage in different parts of the country. I document a persistent impact of introduction of radio coverage on adoption of HYVs of rice but only a transient effect on adoption of HYVs of wheat. This is consistent with the argument that spatial diffusion of information, a substitute for information from radio, was easier for geographically homogeneous technologies, such as wheat HYVs, than for heterogeneous technologies, such as rice HYVs. This suggests that localized mass communication channels can be quite effective in diffusing geographically heterogeneous technologies. I do not find any impact of introduction of radio coverage on use of modern inputs such as irrigation and fertilizer, and only weak evidence of an increase in rice yield. These results suggest that while mass communication may be an effective means of increasing awareness and adoption of HYVs, constraints on adoption of complementary inputs can restrict the full benefits of technology adoption from being realized.

The first two chapters examined the effects of radio broadcasts, specifically on decisions pertaining to elections and technology adoption, respectively. My third chapter examines the impact of introduction of cable television on women's empowerment, status, and behavior in India. Several ethnographic studies have found that the dramatic expansion of cable TV in India during the 1990s and 2000s has had a "modernizing" influence on Indian villages. There is a large literature studying the effect of TV on aspects of women's status and autonomy, mediated primarily by informational, or attitudinal changes (through exposure to different role models and social norms). Following Putnam (2001), a few empirical studies have found that TV crowds out social participation and has a negative effect on social capital. In my third chapter, I assess the impact of introduction of cable TV to Indian villages on crowding out of women's social participation; in addition to studying its impact on women's health knowledge, fertility preferences and outcomes, and status and autonomy.

To identify the effect, I apply a difference-in-difference strategy using a two rounds of a national household panel dataset of rural households from 2004 and 2011. Unlike previous studies, I do not find any effect of cable TV on women's health knowledge, or fertility preferences and outcomes. While I find that it improved women's status within the household, with a decrease in prevalence of wife-beating, it had little effect on their autonomy related to decision-making or mobility outside the home. There is, however, clear evidence that cable TV significantly decreased women's participation in formal groups in the village, which may have negative implications for women's empowerment and welfare in the long-run.

Mass communication, inter-personal communication, and entertainment are fast converging to the Internet platform, along with people increasingly relying on popular social media platforms to communicate with each other and to access information. While increasing communication and information sharing, it raises the possibility of greater polarization and segregation as people increasingly self-select the information they are exposed to and the people with whom they share information. Further, with decentralization of content creation and dissemination there is much greater scope for motivated agents to manipulate information and associated outcomes. Excessive consumption of Internet-enabled devices has also raised concerns related to crowding out of face-to-face interactions, and various other traditional activities, and importantly, of sleep. Further, the abundance of information that may now be accessed makes the constraints posed by limited attention particularly salient. The agenda for future mass media research is therefore quite large and varied, and particularly exciting with the availability of "big data" and sophisticated econometric techniques to analyze them.

With respect to policy concerns in developing countries, I believe there are three broad areas of focus for future research. The first is the deployment of Internet for greater government transparency and responsiveness. Although Internet has made censorship and government propaganda less feasible in most parts of the world, it has raised concerns of state monitoring and persecution in highly authoritarian countries, motivating the need to study the political economy of Internet. A second area of focus is the use of ICTs and social media-based information dissemination on adoption of new technologies, such as agricultural innovations, health technologies, or financial products. A final area of focus is the use of education-entertainment ("edutainment") to effect socio-economic change by changing norms, attitudes, or just providing new information.

Chapter 1

Diminishing the Effectiveness of Vote Buying: Experimental Evidence from a Persuasive Radio Campaign in India

1.1 Introduction

Vote buying, the practice of bribing voters before elections, is widely prevalent across the developing world.[1] There is ample empirical evidence that poor voters are most likely to be targeted with vote buying (Brusco et al., 2004; Jensen and Justesen, 2014), which undermines the political representation of their interests (Stokes, 2007; Stokes et al., 2013) and diminishes the supply of pro-poor public services (Khemani, 2015). At an aggregate level, vote buying undermines electoral accountability (Stokes, 2005), diverts resources away from provision of public goods (Acemoglu and Robinson, 2001; Coate and Morris, 1995), fosters public corruption (Singer, 2009), and fuels organized crime and criminalization of politics (Schaffer, 2007b). Given the consensus regarding its negative effects (Hicken, 2011), there is

[1] According to the sixth wave (2010-2014) of the World Values Survey, to the question "How often in the country's elections: voters are bribed?", the proportion responding "very often" or "fairly often" in Brazil was 75.8%, in Mexico was 72.7%, in Argentina was 65.4%, and 12% in Germany and 4.3% in Netherlands. Respondents in United States and India were not asked this question.

growing demand from governments, civil-society organizations, and multilateral agencies for cost-effective strategies to diminish the influence of vote buying on elections in developing countries.

Law enforcement agencies already devote significant resources to enforcing ballot secrecy and monitoring electioneering, without much success on curbing vote buying. Voter education campaigns may be a cost-effective complement to these expensive law enforcement efforts. In the long run, diminishing effectiveness could reduce the political incentives to engage in vote buying. In this study, we examine the electoral impacts of educating voters about the incentives of vote-buying politicians and the consequences of electing them. During the 2014 Indian general elections, we conducted a large-scale experiment, using low-cost public radio stations to broadcast ads that dramatized this message. Using official election results, and a survey of journalists to identify vote buying by parties, we find that the radio voter education campaign was effective at persuading a large number of voters to switch to voting for non-vote-buying parties.

Electoral accountability requires voters to be informed about politicians, such as about their qualifications, promises, and performance. Further, in making decisions, voters must be able to meaningfully interpret the information, which requires an understanding of the underlying political processes and incentives. Lack of transparency and low levels of education may limit the ability of voters in developing countries to make such informed decisions and hold their politicians accountable. This study contributes to the growing experimental literature that examines the effect of information provision on voter behavior, particularly in information-scarce contexts.

Past studies have found a high level of voter sophistication in the use of information about incumbent performance (Banerjee et al., 2011; Humphreys and Weinstein, 2010). The evidence, however, is mixed on whether voters punish (exposed) corruption by incumbents (Chong et al., 2015; de Figueiredo et al., 2014; Ferraz and Finan, 2008). Another set of studies that examines the impact of providing information not about candidates per se but about the "policy production function", such as the cost of not voting by women (Gine and Mansuri, 2011), or voting along ethnic lines or for corrupt candidates (Banerjee et al., 2010), suggests that voters need to be aware of why certain politician attributes are undesirable as well as which politicians possess them to be able to take meaningful action on their interest. Following the large voter mobilization/get-out-the-vote literature,[2] which emphasizes the role of personal interaction, several studies have used door-to-door canvassing to persuade voters with appeals, such as urging them to vote their conscience (Hicken et al., 2014; Vicente, 2014), or to organize themselves against violent politicians (Collier and Vicente, 2014).

This study contributes to the broader experimental literature that examines the persuasion effects of political communication,[3] as well as the growing empirical literature on the role of mass media in politics,[4] and more specifically the large-scale electoral effects of mass media, such as newspaper (Besley and Burgess, 2002; Drago et al., 2014; Gentzkow et al., 2011; Oberholzer-Gee and Waldfogel, 2009; Snyder and Strömberg, 2010), television (DellaVigna and Kaplan, 2007; Gentzkow, 2006), and radio (DellaVigna et al., 2014; Ferraz and Finan, 2008; Larreguy et al., 2015; Strömberg, 2004).[5]

What kinds of messages are most likely to be effective at persuading voters to reject vote-buying politicians? Based on a large number of case studies, Schaffer (2007a) argues that moralistic appeals, such as urging voters to vote their conscience, or to not sell their vote, may not be effective among poor voters–those considered most susceptible to vote buying–because they typically do not share the same social norms regarding vote buying as the middle-class reformers that make those appeals. He hypothesizes that convincing poor voters that voting for vote buyers is neither in their own nor their community's economic interest is likely to be far more effective. The voter education campaign we evaluate educates voters about the incentives of politicians who engage in vote buying and the negative economic consequences

[2] See Green and Gerber (2015) for a review.

[3] See DellaVigna and Gentzkow (2010) for a review of this literature.

[4] See Strömberg (2016) for a theoretical framework and a survey of this literature.

[5] Adena et al. (2015) an Yanagizawa-Drott (2014) look at effects of radio on related outcomes–support for pogroms, and sectarian conflict, respectively.

of voting for them, namely under-provision of public services. Because vote buying occurs on such a large scale, voters can easily apply this insight using their knowledge of vote buying by parties.

We selected radio as the mass medium to deliver this message for several reasons: Radio reaches a wider and more economically diverse audience than television. Radio ads can be quickly and cheaply scaled up, and may be readily adapted for use in other developing countries. Importantly, they are less susceptible to interference by vested interests than on-the-ground campaigns (e.g., those that distribute leaflets or posters) and are therefore safer to implement in regions where violence and intimidation are a concern. We strategically timed the campaign just before the elections, when electioneering is prohibited, and it may be too late for parties to change their vote buying strategy.

There is ample evidence that parties react to large-scale anti-vote-buying campaigns. Banerjee et al. (2011) and Vicente (2014) find that their information campaigns reduced the level of vote buying whereas Cruz et al. (2016) find that theirs increased it. Thus the impact of our radio campaign is the sum of the direct effect on voters through changes in attitudes towards vote-buying parties and the indirect effect mediated through parties' reaction to the campaign. While the reaction of parties to the campaign is likely to be transient, the impact on voters is likely to persist beyond one election since it consists of an attitudinal change driven by education. The evidence of a direct effect is therefore generalizable to other interventions that similarly educate voters. However, given the simultaneity of the effect on both voters and parties, it is challenging to empirically identify the direct effect of such campaigns. The strategic timing of our campaign limits the endogenous response of politicians. The estimated effect can therefore be interpreted as arising mainly from changes in voter attitudes rather than mediated though changes in party behavior.

We find that the radio campaign persuaded voters to reject parties engaged in vote buying, reducing their vote share by 4 to 7 pp. We find no evidence that the campaign raised blind anti-establishment or generic anti-corruption sentiments, supporting the argument that the effect was indeed through changes in voter attitudes towards vote-buying parties. Effects of early exposure of some areas to the campaign suggests that parties reacted to the campaign by decreasing vote buying, which led to a large decrease in the voter turnout rate. Ultimately, there was a larger decrease in the vote share of vote-buying parties in these areas. Take together, this suggests that a significant part of vote buying may be mobilization of supporters, as suggested by Nichter (2008).

While our campaign was strictly non-partisan it does negatively portray the class of parties that engages in vote buying. Negative campaigns have been associated with both demobilization (Ansolabehere and Iyengar, 1995) and mobilization (Goldstein and Freedman, 2002) of voters. With respect to corruption information both Chong et al. (2015) and de Figueiredo et al. (2014) find that it significant decreased the voter turnout rate in Mexico and Brazil, respectively. If voters were sufficiently motivated by our campaign to vote for clean parties, it could increase voter turnout. Ultimately, whether campaigns such as ours increase or decrease voter turnout is therefore ex ante ambiguous. We find that the campaign had a small negative (0.16 pp.) effect on voter turnout which is statistically insignificant. A plausible explanation for having no effect on voter turnout is that turnout can be monitored by vote buyers, whereas candidate choices cannot be monitored.

Taken together, the vote share and turnout rate results suggest that the campaign primarily induced voters to switch from vote-buying parties to non-vote-buying parties. Indeed, the campaign was more effective in areas with more non-vote-buying parties. There is also some evidence that campaign may have induced weak coordination effects against prominent vote-buying parties, in addition to the direct effects of education. The estimated effect on vote share and the null effect on turnout rate implies that the radio campaign drew close to two million votes away from the vote-buying parties. Further, with 78 voters persuaded per dollar spent, the campaign may be a cost effective alternative to the more expensive on-the-ground efforts. The persuasion rate of the campaign,[6] i.e., the proportion of the

[6]See DellaVigna and Kaplan (2007) for the persuasion rate framework.

audience persuaded to switch to non-vote-buying parties, is approximately 12%, which is comparable to the persuasion rates reported by other voter information campaigns.[7] Due to the pattern of effects on inter-party performance, the campaign decreased the probability of a vote-buying party getting the most votes by only a statistically insignificant estimate of 4 pp.

Although we provide rigorous evidence on the persuasiveness of messages that educate voters why it is not in their interest to vote for vote buyers, the deeper channels of persuasion remains open to interpretation. Finan and Schechter (2012) argue that vote buying is effective for politicians because it plays on social norms–voters' feelings of moral obligation to reciprocate a "gift" by voting for them.[8] Consequently, changes to social norms surrounding reciprocity could explain the effects estimated in this study. Changing entrenched social norms, however, is no easy task, and unlikely to be achieved by a radio campaign over a few days.[9] Based on the content of the ads and the pattern of the observed effects, the most plausible explanation is that the campaign decreased electoral support for vote-buying parties because it made voters more pessimistic about their post-electoral performance.[10]

The rest of the paper is organized as follows. In Section 1.2 we discuss the setting of the experiment, and the content, timing, and randomization of the radio campaign. Next, in Section 1.3 we present a simple model of voter behavior in the presence of vote buying and formally derive testable predictions of how a voter education campaign might impact it. In Section 1.4 we discuss the data sources, experiment sample, and the journalist survey to identify vote-buying parties. We also lay out the empirical strategy to estimate the average treatment which addresses issues arising from geographically clustered randomization of

[7]See DellaVigna and Gentzkow (2010) for a systematic comparison of persuasion rates of different types of information campaigns.

[8]Using experimental measures of reciprocity and survey data, they find that vote buyers target gifts towards individuals with greater propensity to reciprocate. Lawson and Greene (2014) finds that respondents who were offered larger payments felt a greater obligation to reciprocate to vote buyers.

[9]Though not directly related to electoral politics, an example of a radio intervention changing social norms is by Paluck and Green (2009), who find that over a course of one year, a radio soap opera in Rwanda changed listeners' perception of the community norms surrounding expression of dissent.

[10]There is now growing empirical evidence that candidates use electoral handouts to provide a signal about their electoral viability as well as their future ability to provide targeted goods (Kramon, 2016; Muñoz, 2014).

observations, with overlaps in the clusters. In Section 1.5 we present the results of the experiment, and conclude with Section 1.6.

1.2 The Experiment

1.2.1 Setting

The setting for this experiment was the 2014 Indian general elections, during which 8251 candidates contested elections to 543 seats in the national parliament. Each parliamentary seat represents an electoral district known as a parliamentary constituency (PC).[11] A candidate can either represent a political party or be unaffiliated (commonly referred to as an independent). Party candidates appear on the ballot along with their party name and party symbol. Across the country, 464 parties participated in the elections, out of which six were officially recognized as "national parties" and 39 as "state parties."[12]

The ECI enforced a ban on opinion and exit polling during this entire period. Further, it enforced a three-day ban on electioneering and liquor sales, starting two days before the polling date in each phase.[13] For security reasons, the ECI conducted the election in staggered phases, with polling held on nine different dates.[14] Polling in PCs in the first phase was held on April 10, 2014 and in PCs in the last phase on May 12, 2014.[15] Election results for all phases were released simultaneously on May 16, 2014.[16]

[11] A candidate wins by receiving a plurality of the votes cast.

[12] All parties participating in the election are required to register with the Election Commission of India (ECI), which designates parties as national, state or unrecognized, based on their past performance in national and state elections. National and state parties receive benefits such as subsidized air-time on government-run television and radio stations for election advertisements.

[13] Broadcast of mass media ads, because of their geographically unrestricted nature, was prohibited through out the country during each phase's three-day window. The legality of speeches or statements made in non-restricted PCs that are nevertheless publicized in restricted PCs is ambiguous. Rules governing electioneering practices evolve based on the interpretation of election law in individual cases by the ECI which has quasi-judicial status under the constitution. See Election Commission of India (2014b) for a list of various electoral offenses and corresponding penalties.

[14] This is comparable to the presidential primary elections in the US.

[15] The five phases represented in this study have polling dates approximately a week part.

[16] This is unlike the US presidential primaries where results become available immediately after polling in each phase, potentially affecting voter behavior in subsequent phases. We registered our pre-analysis plan

Approximately 120,000 federal police troops were deployed to prevent the procurement and transportation of resources for vote buying, and to enforce various measures such as bans on sale of liquor, limits on cash withdrawals, checking vehicles at roadblocks, surveillance of airports and railway stations, and even sending videographers to shadow campaigning candidates (Biswas, 2014; Ford, 2014). Working in collaboration with the ECI, the police seized around $50 million in cash and 30 million liters of liquor, and arrested more than two million people in connection with election-related violations (Election Commission of India, 2014a). Despite these efforts, allegations of widespread vote buying were leveled by many media observers (Choudhury, 2014; Ford, 2014; Mandhana and Agarwal, 2014). Cash bribes reportedly ranged from Rupees 1000 ($17) to 2500 ($43) (Chilkoti, 2014). The coalition led by the Bharatiya Janata Party (BJP) won a decisive victory over the long-dominant coalition led by the Indian National Congress (INC). Although rising prices topped voter concerns, corruption scandals were important as well and were cited by one in seven voters (DNA, 2014).

1.2.2 Intervention: The Radio Campaign and Randomization

AIR, also known as *Akashvani*, is the national public radio broadcaster. AIR's transmitters cover 95% of the country by area and 99% by population (Prasar Bharati, 2007). As of 2014, it operated 194 stations that broadcast external advertising, and broadcasts in the 22 nationally recognized languages and several additional languages/dialects recognized by individual states. Compared to other mass media, AIR has the highest audience reach in rural areas, where it has a statutory monopoly on radio broadcasting, television viewership is constrained by unreliable electricity, and newspaper readership is low because of high rates of illiteracy. Regular listenership of AIR comprises 55% of all households in rural areas and 50% in urban areas (Prasar Bharati, 2007).

Of the 194 AIR stations, 57 had high-power transmitters and therefore had large coverage

for the experiment described below at the American Economic Association (AEA) registry on May 15, 2014, before the results were released.

areas that overlapped with those of several neighboring radio stations. In order to minimize such overlap, we eliminated these high-power stations from our sample. Further, for budgetary reasons we excluded 30 radio stations with prohibitively high advertising rates. Since it was feasible to record messages in only a limited number of languages, we restricted our sample to stations broadcasting in five languages that could be understood by the largest listener populations–Hindi, Kannada, Marathi, Oriya, and Telugu. This restriction eliminated 47 additional stations. The selection process resulted in a final list of 60 stations. These radio stations belong to 10 of the major states in India,[17] which contain 67% of the country's population and 62% of the parliamentary constituencies (PC).

We produced three 60-second ads, each consisting of a dramatized vignette that involved a conversation between a "naive" voter who had just received a "gift" from a politician and a "sophisticated" voter who understood the corrupt incentives of vote-buying politicians and the consequences of voting for them. The sophisticated voter conveys the message that politicians give gifts to buy their way into office and that once elected are likely to steal public money in order to recoup their expenditure instead of providing public services like schools and electricity.[18] Further, the sophisticated voter argues that it is quite likely that politicians who trade cash for votes, will expect bribes in the future to perform essential functions required of them. In the vignettes we portrayed the naive voter deciding to no longer honor their promise to vote for the vote-buying politician, having realized that doing so may not be in his or her self-interest. Each ad ended with an appeal by an announcer urging voters to teach vote buyers a lesson by voting instead for an honest candidate. The ads did not name any particular candidate or party, and were not signed off or endorsed by any named individual or entity. English translations of the scripts of the ads are presented in Appendix A.2. The goal in crafting this message was to diminish voter expectation about the post-electoral performance by the vote-buying politicians. The message may have indirectly

[17]A new state of Telangana was carved out of the Andhra Pradesh, one of the states in our sample, after the election.

[18]In the Indian context, there is abundant evidence suggesting that office holders accumulate wealth at an exceptionally high rate (Fisman et al., 2014).

implied that non-vote-buying parties are less likely to be corrupt in the future. The ads were not signed off or endorsed by any personality or entity.

In order to reveal the direct effects of the ads on the behavior of voters, i.e., through changes in their attitudes and expectations, we have to limit the endogenous response of the parties in response to the ads. The ideal strategy for this purpose is to deliver the ads after all the vote buying has already occurred and parties are no longer able to interact or communicate with voters. This suggests broadcasting the ads as close to day of polling as possible. A conflicting goal however is to ensure high voter exposure to the ads, which requires a campaign period that is sufficiently long. Based on these considerations we timed the campaign to occur during the three days of the pre-election window, when electioneering is prohibited by law.[19]

Vote buying is a massive logistical exercise involving transfers of large amounts of resources and coordination of thousands of agents and requires careful planning and execution to evade detection by police, political rivals and anti-corruption activists. Much of the vote buying occurs under the guise of legitimate electioneering–during political rallies, "celebrations", and door-to-door canvassing. Media reports suggest vote buying starts several weeks before the day of elections (Hiddleston, 2011). Party behavior exogeneity would be violated if parties can change their vote buying or electioneering behavior in response to our the ads. By the time our ads aired most of the vote buying would have already taken place and the strategy for any remaining vote buying well in place. Nonetheless, given the reports of vote buying occurring during the 24 hours before the start of polls, we cannot fully rule out an endogenous vote-buying response by parties, nor related responses such as increasing monitoring. Nonetheless, given the short period of time, the magnitude of these endogenous responses is likely to be small.

Prior to the random selection of radio stations, we assigned a schedule for broadcasting the ads to each of the 60 radio stations. The broadcast schedule consisted of a total of

[19] All India Radio found our ads to be exempt from this prohibition on campaigning because they are strictly non-partisan and mentioned neither candidates nor parties, and are therefore not considered electioneering.

48 airings, 24 airings during popular prime-time programs and 24 additional airings during regular non-prime-time programs, spread over three consecutive days.[20] The third day of the scheduled airings coincides with the election date for the town/city where the radio station is based. We divided the 60 radio stations into 4 groups corresponding to the election dates.[21] Exactly half of the radio stations in each group were randomly selected to broadcast the radio campaign according to the pre-assigned schedule. We hired an advertising agency[22] to develop and translate the scripts, produce the ads, and purchase the air-time on the specified radio stations for designated dates.[23] The total cost of the radio campaign, including producing and airing the ads on the 30 stations, was $23,000, or $750 per radio station.

1.3 Model and Hypotheses

In this section, we present a stylized representative agent model to generate testable predictions of the impact of the radio campaign on the two outcome variables of interest–the vote share of politicians that engaged in vote buying and the voter turnout rate. The setup of the model draws on relevant aspects of the institutional setting and experimental design, which we discuss in detail in Section 1.2.

Consider an economy with an electorate and a political regime consisting of two parties, a vote-buying party and a non-vote-buying party. We assume that the electorate is homogeneous and can be modeled by a representative agent. The vote-buying behavior of the two parties is a given feature of the election, occurs before our information campaign is delivered, and is common knowledge. Let the agent be endowed with one unit of time, which can be converted without cost into a vote for the vote-buying party or the non-vote-buying

[20]The distribution of the airings was: 18 on the first day, 18 on the second day, and 12 on the third day.

[21]The stations in our sample had campaign end dates of April 10 (N = 8), April 17 (N = 30), April 24 (N = 12), April 30 (N = 5), and May 7 (N = 5). Henceforth, we will use these end dates to identify campaign timing. We pooled the stations with April 30 and May 7 campaign timing into one group.

[22]Super Ads Pvt. Ltd., New Delhi.

[23]The additional non-prime-time airings were part of a promotional scheme of the AIR that consisted of one free non-prime-time airing for each prime-time airing. We received broadcast certificates from the radio stations only for the paid prime-time ads, not for the free non-prime-time ads. Broadcast certificates are available from the authors on request.

party. Let time and votes be perfectly divisible. The voter turnout rate in the election is $t = v + w$, and the vote share of the vote-buying party is $s = \frac{v}{t}$, where v and w are the votes received by the vote-buying and non-vote-buying parties, respectively. Since there are only two parties, the vote share of the non-vote-buying party is $(1 - s)$. The agent consumes the time remaining after voting as leisure (l).

In this economy, the election represents the political process that produces a composite public good, which we interpret broadly to include both local public goods (e.g., water, electricity, sanitation, health, education, and law and order) and welfare benefits (e.g., subsidies and transfers). The agent has a mental representation of this political process, where the quantity of public good (x) is a function of the voter turnout rate and the vote shares of the two parties as inputs, given by:

$$x(s,t) = t^h s^{h_1} (1-s)^{h_2} \tag{1.1}$$

where $h_1 > 0$ and $h_2 > 0$, are random coefficients that capture the productivity and associated uncertainty of electoral support for the vote-buying and non-vote-buying factions, respectively, and h is the random coefficient associated with voter turnout.[24] Since voter turnout captures the electoral support for the political regime, which is composed of the two parties, for simplicity we assume a basic additive relationship between the turnout coefficient and the vote share coefficients, i.e., $h = h_1 + h_2$.

The agent has preferences over consuming leisure and the public good. Let the agent's preferences be given by the utility function:

$$U(l,x) = \beta \log(l) + \gamma \log(x) \tag{1.2}$$

where $\beta > 0$, and $\gamma > 0$ are preference parameters associated with leisure and public goods,

[24] In this model, we will define only the conditional means of the random coefficients, leaving other moments undefined.

respectively.

Just prior to making the electoral decisions, the agent is exposed to the campaign with intensity m.[25] Further, we assume that all functions in this model are differentiable with respect to m. The timing of campaign relative to vote buying is crucial–in this model all electioneering (including vote buying) has already occurred prior to the campaign and no further action, by either party, is possible.

The campaign changes voter expectations about two parties, i.e, it changes the expectations of the random coefficients, $\mathrm{E}(h_1|m) = h_1(m)$ and $\mathrm{E}(h_2|m) = h_2(m)$. Given the content of our message, discussed in detail in Section 1.2.2, we assume that it can only decrease voter expectation of the parameter associated with electoral support for the vote-buying party, i.e., $h_1'(m) \leq 0$, and increase that associated with the non-vote-buying party, i.e., $h_2'(m) \geq 0$.

The agent maximizes her expected utility, $\mathrm{E}_m\, U(x, l)$ subject to the resource constraint $v + w + l = 1$. The agent's maximization problem in terms of the variables of interest s and t and the parameters is:

$$\underset{1 \leq s,t \leq 0}{\mathrm{Max}} \;\; \beta\log(1-t) + \gamma h(m)\log(t) + \gamma h_1(m)\log(s) + \gamma h_2(m)\log(1-s) \tag{1.3}$$

Assuming that an interior solution exists, the first order conditions of the maximization problem give the following expressions:

$$s(m) = \frac{\gamma h_1(m)}{\gamma h(m)} \tag{1.4}$$

$$t(m) = \frac{\gamma h(m)}{\beta + \gamma h(m)} \tag{1.5}$$

We can now predict the effect of greater exposure to the campaign on the vote share of the vote-buying party and on the voter turnout rate. Differentiating Equation 1.4 with

[25] We parameterize exposure as a continuous rather than a binary variable for ease of mathematical exposition.

respect to m:

$$\underbrace{s'(m)}_{-} = \underbrace{\frac{h_2(m)}{h(m)^2}h_1'(m)}_{-} - \underbrace{\frac{h_1(m)}{h(m)^2}h_2'(m)}_{+} \tag{1.6}$$

The first term represents a decrease in vote share from a decrease in voter expectation about the productivity of electoral support for the vote-buying party; and the second term represents a decrease in vote share from an increase in voter expectation about productivity of electoral support for the non-vote-buying party. Thus, the total effect of greater exposure to the campaign is an unambiguous decrease in the vote share of the vote-buying party.

For turnout results, we differentiate Equation 1.5 with respect to m:

$$\underbrace{t'(m)}_{+/-} = \underbrace{\frac{\gamma\beta}{(\beta+\gamma h(m))^2}h_1'(m)}_{-} + \underbrace{\frac{\gamma\beta}{(\beta+\gamma h(m))^2}h_2'(m)}_{+} \tag{1.7}$$

The first term represents a decrease in voter turnout due to lower support for the vote buying party and the second term represents an increase due to greater support for the non-vote-buying party. We cannot, however, sign the overall effect since the sign of $h'(m) = h_1'(m) + h_2'(m)$ depends on the magnitudes of the changes in the respective expectations. Therefore, the net effect of the campaign on voter turnout rate will be positive only if $h_2(m) > -h_1(m)$, i.e., the increase in optimism about the non-vote-buying party is large enough to counteract the increased pessimism about the vote-buying party. In sum, communication of the type we envision is expected to decrease the vote share of the vote-buying faction but has ambiguous consequences for voter turnout.

1.4 Data and Empirical Strategy

1.4.1 Data and Experiment Sample

Each parliamentary constituency (PC) is divided into several assembly constituencies (AC), typically 5 to 10, each containing 150,000 to 250,000 registered voters. Each AC represents a seat in a state's legislature, known as the Assembly. We chose the AC as the unit of analysis for two reasons: they are typically quite small compared to a station's coverage area and provide the most easily accessible disaggregated official electoral data.

The two main outcome variables of this study are: vote share of the vote-buying parties and the voter turnout rate. To calculate the vote share, in each AC we sum the votes received by all the parties identified as vote-buyers, discussed in Section 1.4.2, and divide this sum by the total votes cast in that AC. Of the ten states in our sample, two states–Andhra Pradesh and Odisha–had state legislative elections simultaneously with the parliamentary elections. In order to maintain consistency in the outcome variable across states, we use votes cast for the parliamentary candidates for all states. The voter turnout rate is calculated by dividing the total votes cast in an AC by the total registered voters in that AC. The electoral data were obtained from the Election Commission of India (2014c). Data on criminal backgrounds of candidates are from their election disclosures, digitized by the Association for Democratic Reforms (ADR).[26]

For robustness checks, we include other covariates–the number of vote-buying parties, demographic variables from the 2011 Census (the percentage of the population that is literate, percentage living in rural areas, and percentage belonging to the Scheduled Caste (SC)/Scheduled Tribe (ST) category), and an indicator of whether the state had simultaneous elections to the state legislature. Data for demographic variables are from the 2011 Census geocoded by ML Infomap (2012).[27]

[26] Available at `www.myneta.info`, accessed May 6, 2017.

[27] The demographic data is at the census block-level. We calculate the demographics of an AC based

We use a simple approach to determine exposure of an AC by a radio station that is based on the distance of the AC from the radio station and the radio station's transmitting power.[28] We obtained the typical radial reach for different levels of transmitter power based on information for a few stations available on the AIR website.[29] We consider an AC to be covered by a radio station if its geographic centroid lies within the radio's radial reach.[30] There are in total 751 ACs that are covered by the 60 radio stations in our sample. However, not all of these are included in the experiment's estimation sample.

The "treatment" in this experiment is defined as receiving the radio campaign during the three-day pre-election window, when the conditions for party behavior exogeneity are most likely to be met. Because of the irregular boundaries of election phases, which often change at state boundaries,[31] and the circular coverage areas of radio stations, the campaign schedule may not match the pre-election window for all ACs covered by a station. The experiment sample therefore consists only of those ACs that are eligible to receive the campaign during their respective pre-election windows,[32] but not before or after.

We exclude 39 ACs that are eligible to receive the campaign only earlier than the three-day window and 11 ACs that are eligible to receive both the early campaign and the regular campaign. We will however re-incorporate these 50 ACs into the analysis to examine the differential impact of early timing of exposure to the campaign. We also exclude 86 ACs that are eligible to receive only post-election ads from the stations covering them,[33] but will use

on those of the census block which contains the AC centroid. Calculations based on the average of block demographics weighted by the proportion of AC area overlapping with the census block yield almost identical values.

[28]We do not have the exact location of the station's transmitter within the city and therefore use distance to the town/city center. This is a minor issue since all the stations in our sample are based in small cities.

[29]`http://www.allindiaradio.gov.in`, accessed 4 April, 2017. The correspondence between transmitter powers and radii reaches are–1 kW: 25 km, 3 kW: 50 km, 5 kW: 65 km, 6 kW: 75 km, 10 kW: 100 km, and 20 kW: 125 km.

[30]An alternate approach might use the proportion of the AC area covered. We use the centroid approach because it is computationally straightforward and ACs are typically small enough to be entirely covered by radio stations.

[31]Recall that an election phase is the set of regions that hold elections on the same day.

[32]An AC is considered eligible if there is some randomization under which it could receive the treatment

[33]The bulk of these ACs are due to incorrect campaign timing for three stations. which would allow delivery of only post-election ads to their covered areas.

them as a sample for placebo tests (henceforth, placebo sample). Our experiment sample therefore comprises of 615 ACs covered by 57 radio stations.[34]

1.4.2 Journalist Survey: Identifying Vote-Buying Parties

In order to estimate the effect of the treatment on electoral support for parties that engaged in vote buying, we need to first identify those parties. Vote buying is an illegal transaction between a bribe giver and a bribe taker that is rarely observed by outsiders in any systematic fashion. There is no direct method for documenting which parties engaged in vote buying, let alone for documenting spatial variation in vote buying by parties.[35] We therefore rely on the impressions of experts in local politics to identify vote-buying parties in different areas.[36]

Our research team conducted phone interviews with journalists covering elections across the 10 states, asking them a standardized set of questions to shed light on which party or parties were engaging in vote buying in regions they were covering. We drew our sample of journalists primarily from names listed in directories of registered reporters in each of the ten states. We also asked respondents to suggest other journalists we could interview. Our sample of journalists is diverse and includes reporters for English, Hindi and local language newspapers, correspondents at national and state-level news channels, and freelancers. Since electoral contests for the *Lok Sabha* elections occur at the parliamentary constituency (PC) level, we asked questions pertaining to specific PCs the journalists were covering. The ACs in our experiment sample belong to 144 PCs, and ACs in the placebo sample belong to 34 PCs.[37]

[34] Although we used 60 stations, only 57 stations are relevant for delivering the treatment ads. The late campaign timing of the 3 stations means it can treat no ACs. Out of the 57 stations, 29 broadcast the ads.

[35] ECI reports statistics related to confiscation of suspected vote-buying resources and police arrests in connection with election-related violations. These reports do not identify the parties connected with the illicit resources or the arrests. This is comparable to the inability of law enforcement authorities in the US to identify mafia bosses with drug busts. This attests to the highly organized nature of vote buying in India. Further, the statistics are only reported at the state level.

[36] Large-scale voter surveys are an alternate approach for identifying vote-buying parties. In our case this was not practically feasible.

[37] There are 21 PCs in common between the two sets of PCs.

In all we received responses from 426 journalists[38] regarding PCs relevant for our experiment and placebo sample, 82% of whom identified at least one vote-buying party in the PC(s) they were covering. Of the 144 PCs relevant for our experiment sample, we obtained at least one journalist response for 138 PCs.[39] The questionnaire (presented in Appendix A.3) made no mention of our radio campaign. Consensus among respondents about which parties were engaging in vote buying is fairly high. In 83% of the PCs with two respondents, both agreed on at least one party.[40] In 97% of PCs with three respondents, two respondents agreed on at least one party, and in 58% all three agreed on at least one party.[41]

In addition to identifying which parties were buying vote, we also asked respondents to describe the kinds of bribes distributed by parties and the categories of voters they typically targeted with such bribes. Of the 426 respondents, 67% identified at least one type of bribe; within this subset, cash (82%), liquor (28%), and food (15%) were the most commonly identified kinds of bribes. Within the subset (63%) of respondents who identified at least one category of voters that was targeted by parties, lower castes and religious minorities (40%), the poor (29%), all voters (19%), slum residents (14%), the youth (14%), and rural voters (14%) were the most commonly stated categories.

We coded the putative vote-buying parties based on journalist responses to the question "Which party/parties seem to be spending the most money secretly (such as on distribution of liquor, cash or other gifts)?"[42] The lowest level at which we can code the vote-buying parties is the PC. Under specification 1, we designate all parties identified by at least one respondent for a PC as vote buyers in that PC. It is our impression that journalists are much more likely to omit reporting one or more vote-buying parties due to incomplete information than to spuriously misreport non-vote-buying parties as vote-buying parties.

[38] All except three journalists were interviewed before elections results were released.

[39] 10% of the 138 PCs had one respondent, 51% had two respondents, 23% had three respondents and 16% had four or more respondents.

[40] 84% of respondents report only 1 party, 14% report 2 parties and 2% of respondents report 3 parties.

[41] 87% of respondents report only 1 party, 12% report 2 parties and 1% of respondents report 3 parties.

[42] Candidates unaffiliated with any party are quite marginal and cannot realistically compete with the vote-buying resources of parties.

By fully incorporating the differences in opinion between journalists in identifying vote-buying parties we are able to minimize the Type I error in their responses. Because we lack respondents for 6 PCs, we are unable to designate vote-buyers for approximately 4% of the ACs using this coding scheme.[43]

In order to designate vote-buying parties for the entire sample and to further reduce the Type I error, we aggregate the journalist responses to the state-election phase (henceforth specification 2). Parties designated as vote buyers in at least one PC are designated as vote-buying parties for the entire state-election phase. Our experiment sample belongs to 21 state-election phases.[44] The assumption underlying this coding scheme is that vote buying by parties is similar among the PCs within a given state and election phase. While aggregation of responses to higher levels further reduces the Type I error, it is likely to also increase Type II error.

To reduce Type II error, we construct 2 additional specifications. Under specification 3, we designate parties identified by at least two respondents for a PC as vote buyers for that PC. We are unable to designate vote-buying parties for 20 PCs with zero or just one respondent. Finally, under specification 4, parties designated as vote buyers in at least two PCs (under specification 1) in a state-election phase are designated as voter buyers for all PCs in that state-election phase. To test the robustness of our results to aggregation of the journalist responses, we present estimates using all four specifications of vote-buying parties.

1.4.3 Empirical Strategy

We seek to estimate the average treatment effect (ATE) of exposure to the radio campaign on the outcome variables of interest–the voter turnout rate and the vote share of the putative vote-buying parties. Ordinarily, one may obtain a consistent estimate of the ATE by

[43] Out of the 34 PCs relevant for our placebo sample, we obtained at least one journalist response for 24 PCs.

[44] Few examples of state-election phases are: Andhra Pradesh-30 April, 2014; Andhra Pradesh-7 May, 2014; Jharkhand-17 April, 2014; and Karnataka-17 April, 2014.

estimating the following regression using OLS.[45]

$$y_i^{2014} = \alpha_1 + \beta_1 T_i + \gamma_1 y_i^{2009} + \delta_1' phase_i + \epsilon_i \tag{1.8}$$

where y_i^{2014} is the outcome variable of interest, T_i is the binary variable indicating the treatment status, and y_i^{2009} is the lagged outcome variable, for AC i, and $phase_i$ is a vector of dummies indicating four of the five election phases. We use the vote share of the putative vote-buying party or parties in the previous general elections (in 2009)[46] as a covariate in the vote-share regression and the voter turnout rate in 2009 as a covariate in the turnout-rate regression.

In our case, overlap among radio coverage areas introduces varying treatment probabilities for different ACs. Although all radio stations have the same probability of being assigned to broadcast the ads, an AC's probability (p_i) of being treated depends on the number of radio stations from which it is eligible to receive the ads during the pre-election window.[47]

Figure 1.1 provides a map of the AC sample, election phases, and the experiment design. Panel (1) provides a map depicting the experiment sample, placebo sample, excluded ACs, and the treatment probabilities for the ACs in the experiment sample. Out of the 615 ACs, 570 ACs belong to the group with probability of 0.5, 44 ACs to that with probability of 0.75, and only 1 AC to the group with probability of 0.875. Panel (2) depicts the broadcast status of the radio stations and the realized treatment status for ACs in the experiment sample. Based on the realization of the random selection of radio stations, 312 ACs were treated

[45] This was the specification envisaged in our pre-analysis plan.

[46] *Illustration for specification 1*: Let parties A and B be the vote-buying parties in a PC. Suppose that only party A contested that PC in 2009. Then for each AC in that PC, the 2014 vote-share is the sum of the 2014 vote-shares of parties A and B in the given AC and the 2009 vote share is the 2009 vote-share of party A in the given AC. Note that this coding scheme is agnostic about whether vote-buying parties in 2014 also bought votes in 2009. *Illustration for specification 2*: Let parties C, D, and E be the vote-buying parties in an election-phase or state. Suppose that parties C and D contested a given PC in 2014, but only parties C and E contested in 2009. Then for each AC in that PC, the 2014 vote-share is the sum of the 2014 vote shares of parties C and D in the given AC, and the 2009 vote-share is the sum of the 2009 vote shares of parties C and E in the given AC.

[47] The probability of assignment of a radio station to broadcast the ads is 0.5. Thus, the treatment probability for an AC which is eligible to receive the ads from one station is 0.5, from two stations is $1 - 0.5 * 0.5 = 0.75$, and from three stations is $1 - 0.5 * 0.5 * 0.5 = 0.875$.

(referred to as treatment ACs) and 303 ACs were untreated (referred to as control ACs).

Our strategy is to estimate Equation 1.8 using weighted least squares (WLS) with inverse-probability weights (IPW), which for an AC is the inverse of the probability of it being treated if treated and the inverse of the probability of it being untreated if untreated. Not only does this approach provide unbiased estimates of the ATE, it is also more efficient than controlling for probability strata fixed effects (Hirano et al., 2003). Further, in our case, there is no possibility of mis-specification of the propensities/probabilities since they are exactly known and not estimated.[48]

Formally, the weight for AC i is $w_i = \frac{T_i}{p_i} + \frac{1-T_i}{1-p_i}$. The weights (% of the sample) are 1.14 (0.15%), 1.33 (7.97%), 2 (91.28%), and 4 (0.60%). The inverse-probability weighted least squares (IPWLS) estimator of β_1 is given by:

$$\hat{\beta}_1^{IPWLS} = \left[\sum_{i=1}^{n} w_i \tilde{T_i}^2\right]^{-1} \left[\sum_{i=1}^{n} w_i \tilde{T_i} \tilde{y_i}^{2014}\right] \tag{1.9}$$

where $\tilde{T}$ and $\tilde{y_i}^{2014}$, are the partialed-out treatment and outcome variables, respectively.

Randomization by radio station means that ACs are assigned to treatment or control groups in geographic clusters. However, because of the overlap in the coverage areas of the radio stations, the error variance-covariance matrix does not have a block-diagonal structure. However, the cross-sectional dependence in the error term has a known structure, where the error term may be correlated between ACs within the same cluster but independent of ACs in other clusters (Barrios et al., 2012). We estimate the standard error robust to multi-way clustering (Cameron et al., 2011), by setting the covariance terms to zero in the residual variance-covariance matrix for ACs that do not belong to the same radio station. This provides consistent estimates of the standard errors. The estimator for standard error of

[48] Results from fixed-effects OLS estimation are quantitatively very close.

$\hat{\beta}_1^{IPWLS}$ is given by:

$$\hat{SE}_{\hat{\beta}_1^{IPWLS}} = \sqrt{\left[\sum_{i=1}^{n} w_i \tilde{T}_i^2\right]^{-1} \left[\sum_{i=1}^{n}\sum_{j=1}^{n} w_i \tilde{T}_i^2 \hat{e}_i \hat{e}_j \mathbf{1}(i,j \text{ in same radio})\right] \left[\sum_{i=1}^{n} w_i \tilde{T}_i^2\right]^{-1}} \tag{1.10}$$

where $\hat{e}_i = \tilde{y}_i^{2014} - \hat{\beta}_1^{IPWLS}\tilde{T}_i$.

Under the sharp null hypothesis of no effect for any AC, the data reveal each AC's treated and untreated potential outcomes. Reproducing the known randomization procedure an arbitrarily large number of times, a procedure known as randomization inference, the distribution of the test statistic under the null can be approximated with a high degree of precision, which in turn can be used to test hypotheses. To address concerns of small number of clusters, we additionally provide p-values estimated using this approach, which are robust to finite sample and distribution issues, and more conservative than the asymptotic p-values calculated from the standard errors (Young, 2016).

1.4.4 Summary Statistics and Balance Check

Table 1.1 presents the summary statistics of electoral and demographic characteristics and differences between the treatment and control ACs. Vote-buying parties are defined for all 615 ACs under specification 2, but only for 481 ACs under specification 3. Under specifications 1 and 3, which aggregate journalist responses by PC, the number of vote-buying parties ranges from one to four with a mean below 2; and under specifications 2 and 4, which aggregate journalist responses by state-election phase, it ranges from one to six with a mean above 2. There are no statistically significant differences in the number of vote-buying parties between the treatment and control groups under any specification. ACs have on average 14.36 candidates (SD = 5.49) out of which 8.77 candidates (SD = 2.42) belong to parties.

According to the Census of India (2011), 73.0% of India's population is literate, 68.8% is rural, and 25.2% belonged to the Scheduled Castes (SC) or Scheduled Tribes (ST) category. By comparison, our sample is on average less literate (59.52%), more rural (79.15%) and has a greater proportion of the population belonging to the SC/ST category (31.77%). The sample is balanced along all observed electoral characteristics. The only demographic variable that differs appreciably between the treatment and control groups is percentage population rural. The mean percentage of population rural in the control group is 76.03, which is 6.30 percentage points lower than the treatment group ($p = 0.04$). The null hypothesis that coefficients from a regression of treatment status on a large set of covariates[49] are jointly equal to zero cannot be rejected (rand. inf. p-value = 0.36).

1.5 Results

Table 1.2 presents the main results of this study–the effect of the treatment (receiving the radio campaign during the three-day pre-election window) on the vote share of vote-buying parties. Electoral support for vote-buying parties is high–the mean for ACs in the control group ranges from 52.01% to 90.73%, depending on vote-buying party specification. Results from the baseline regression of the vote share of vote-buying parties under specification 1, presented in column (1), suggest that the radio campaign decreased the vote share of vote-buying parties by 7.14 percentage points (SE = 3.44). As expected, the p-value from randomization inference (rand. inf.) of 0.07 is slightly larger than the standard or asymptotic p-value of 0.04. Columns (2)-(5) test the robustness of this estimate to inclusion of different covariates. The estimate is robust to inclusion of proportion of parties that are vote buyers, three demographic characteristics, and the state election indicator separately, as reported in columns (2)-(4). However, it decreases considerably in magnitude to 3.46 pp. on inclusion of all five covariates jointly, as reported in column (5). The rand. inf. p-value for the specification that includes the proportion of vote-buying parties is 0.13 and for the specification that includes all covariates is 0.22.

The estimate of the effect on vote share under specification 2, presented in column (6), is a

[49] All variables from 1.1 except the two specification 1 variables are included. The regression is estimated using WLS with IPW.

decrease of 5.99 percentage points (SE = 2.53), with a rand. inf. p-value of 0.04. The estimate is robust to inclusion of covariates, both separately and jointly. The smallest estimate, when all covariates are included, is -4.84 pp. The rand. inf. p-values fall below conventional levels for the specification with the state election indicator (column(9)), and the specification with all covariates (column (10)), at 0.12 and 0.16, respectively. The estimates under specification 3 are about 1 pp. smaller in magnitude than those under specification 2. However, their significance levels fall short of conventional levels, presumably because of the substantially reduced number of observations. The estimates under specification 4 are about 1 pp. larger than those under specification 2 and have comparable statistical significance.

Overall, the results suggest that the vote-share estimates are not sensitive to the level of aggregation at which vote-buying parties are classified (i.e., parliamentary constituency versus state-election phase), or to the degree of certainty about vote buying by parties. The R^2 for all regressions hover around 50%. Estimations using OLS with fixed effects for the treatment probability strata yield similar results, and are given in Table A2 in Appendix A.1. Taken together, these results suggest that the radio campaign decreased the vote share of vote-buying parties by 4 to 7 pp.

Recall that 86 ACs were eligible to receive only post-election ads, i.e, under no random assignment of radio stations could they receive the ads before their election. We utilize this collection of ACs to perform a set of placebo tests. Out of the 86 ACs, 39 ACs received post-election ads whereas the remaining 47 ACs received no ads. The results of the placebo test, i.e., the impact of receiving the radio campaign after the election, are presented in Table 1.3. Some of the coefficients are positive, others are negative, but none are statistically significant.[50]

Table 1.4 presents the estimates of the treatment effect on the voter turnout rate. The baseline result suggests a small decrease in the voter turnout rate of 0.16 pp., on a mean level of 68.20 percent in the control group. The estimated effect, however, is statistically

[50]Out of the 20 estimates one is significant at the 95% level under the standard p-value but insignificant under the rand. inf. p-value.

insignificant, the rand. inf. p-value is 0.95. The results remain weak regardless of whether we control for covariates. The OLS results, given in Table A2 in Appendix A.1, are similar. The placebo tests for turnout rate, presented in Table 1.4, show no impact of post-election radio ads. The magnitude of the effect is negligible compared to the shift in vote share, suggesting that voters primarily responded to the ads by shifting their votes rather than abstaining altogether.

To verify that the radio campaign had an effect by changing voter attitudes towards vote-buying parties rather than by inducing blind anti-incumbent or anti-establishment, or generic anti-corruption sentiments, we estimate the impact of the campaign on the vote share of the incumbent party, the vote share of candidates unaffiliated with any party (independents), the vote share of the "none of the above (NOTA) option"[51], and the vote share of party candidates with criminal backgrounds. The results of these regressions are presented in Table 1.6.

We find that the ads had a negative but statistically insignificant effect (-1.98 percentage points, rand. inf. p-value = 0.43) on the vote share of the incumbent party (control mean = 39.53%). The vote share of candidates unaffiliated with any political party increased by just 0.48 percentage points. Although this estimate is large relative to the control mean of 2.84%, it falls well short of statistical significance (rand. inf. p-value = 0.56). There is similarly only limited evidence of an effect on the NOTA vote share. The effect is an increase of 0.15 percentage points relative to a control mean of 1.01%. In addition to being statistically insignificant (rand. inf. p-value = 0.31), the effect is not robust to inclusion of controls. Finally, there is no statistically significant impact on the vote share of party candidates with criminal backgrounds; the point estimate is 1.26 pp. (rand. inf. p-value = 0.85). Taken together with the impact on the vote share of vote-buying parties, these results suggest that the radio campaign affected voter choices by changing their attitudes towards parties mainly along the dimension of their vote buying behavior and reputation.

[51] The 2014 general elections was the first in which voters were given the option of rejecting all the candidates on the ballot.

To put the magnitude of the estimated effect–a 4 to 7 percentage point reduction in vote share of vote-buying parties–in context, consider the impacts of other voter information campaigns: In municipal elections in Delhi, India, Banerjee et al. (2011) find that disseminating information about incumbent performance, in the form of “report cards”, increased the vote share of the best-performing incumbents by 7 pp. and increased the voter turnout rate by 3.5 pp. Using survey experiments in Uttar Pradesh, India, Banerjee et al. (2010) find that priming voters to vote for the collective development of the community instead of voting along ethnic lines increased voter turnout by 7.6 pp. and decreased the proportion of voters voting along caste lines by 10 pp. Priming voters to not vote for corrupt candidates, however, had no effect, presumably because of lack of accompanying information about who is or has been corrupt. In the case of this study, the identify of vote buying parties is widely known to voters, primarily through personal experience.

In Nigeria, Collier and Vicente (2014) finds that a grass-roots campaign that appealed for collective action against violent politicians increased voter turnout by 11 pp. and decreased levels of electoral violence. In municipal elections in Sorsogon City, Philippines, Hicken et al. (2014) find that inviting voters to “promise not take vote-buying payments at all” reduced vote-switching (relative to initially preferred candidates) by 10.9 pp. in races for certain offices. Invitation to “promise that if they did take vote-buying payments, they would nevertheless vote their conscience” had no effect on any of the races. In São Tomé and Príncipe, Vicente (2014) evaluates a door-to-door campaign urging voters to vote their conscience and finds that the campaign reduced the prevalence of bribes, increased the vote share of the incumbent party by 4 pp., and decreased the voter turnout rate by 3 to 6 pp. It is unclear how much of the effect is from changes in levels of vote buying vs. changes is voter attitudes towards vote buying.

In our case, the estimated effect is mainly attributable to changes in voter attitudes, and is therefore a rigorous estimate of the persuasion effects of mass communication. We calculate the implied persuasion rate using the framework put forth by DellaVigna and Kaplan (2007).

Persuasion rate in their framework is the share of the audience that is convinced to change their behavior because of the message and would not have in its absence, and is calculated as:

$$f = \frac{ATE}{\Delta Exposure} * \frac{1}{\bar{y_c}}, \tag{1.11}$$

where f is the persuasion rate, ATE is the estimated average treatment effect, $\Delta Exposure$ is the difference in exposure to the message between the treatment and control groups, and $\bar{y_c}$ is the proportion of the persuadable voters in the control group.

Assuming no exposure in the control group, 50% exposure in treatment group (the average daily listenership of radio), a proportion of persuadable voter of 68.2 percent (control mean under specification 1), the conservative ATE of 4 pp. implies a persuasion rate of approximately 12%. This persuasion rate is comparable those of other large-scale experimental and quasi-experimental studies of voter effects. E.g., the persuasion rate in DellaVigna and Kaplan (2007) of availability of Fox News on U.S. Republican presidential vote share is 11.6%; in Enikolopov et al. (2011) of exposure to anti-Putin TV station on vote share of anti-Putin parties is 7.7%; in Chiang and Knight (2011) of New York Times endorsements on support for U.S. presidential candidate, Gore is 2%; and in Gerber et al. (2009) of free subscription to the Washington Post on the U.S. Democratic vote share is 19.5%.

Assuming that 150,000 voters cast ballots in a given AC,[52] even the most conservative estimate of 4 percentage points reduction in vote share implies that vote-buying parties received 6000 fewer votes (assuming no effect on turnout). Across the 312 treatment ACs, this estimated effect implies the radio messages drew close to two million votes away from the putative vote-buying parties. Further, the cost of the campaign, of $23,000 ($750/station) implies that 78 voters were persuaded per dollar spent. This cost-effectiveness of this campaign is quite favorable compared to more expensive on-the-ground campaigns, such as door-to-door canvassing.

Unlike vote shares, the impact of the radio campaign on whether a vote-buying party gets

[52]The mean turnout in the control group is 150,807.

the most votes in an AC is not straight-forward. It is mediated by the differential impact of radio campaign on the performance of individual vote-buying and non-vote-buying parties. Under certain patterns of impacts it is possible for it to even increase this probability. We assess the distributional impacts of the campaign by estimating its impact on the highest and second highest vote share of vote-buying parties in an AC, and similarly on the highest and second highest vote share of non-vote-buying parties. Two vote-buying parties are defined for sufficient number of ACs only in specifications 2 and 4, which aggregate responses at the state-election phase level. Table 1.7 presents estimates on the vote shares under these two specifications.

The control mean of the highest vote-buying vote share (specification 2) is 51% and of the second highest vote share is 35%. The impact on the highest vote share is small (-1.40 pp) and statistically insignificant (rand. inf. p-value = 0.44) whereas the impact on the second highest vote share is large (-3.78 pp.) and statistically significant (rand. inf. p-value = 0.05). The control mean of the highest and second-highest vote shares of non-vote-buying parties (specification 2) are 3.39% and 0.89 %, respectively. The campaign increased the highest vote share by 4.14 pp. (rand. inf. p-value = 0.02) and the second-highest vote share by 0.85 pp. (rand. inf. p-value = 0.03), which are substantial and comparable to the control mean levels. Next, we assess the impact of the campaign on the probability of a vote-buying party winning the most votes in an AC. In 99% of the control ACs the vote-buying party won the most votes. The campaign decreased this probability by 4 pp., under both specifications. The point estimates, however, are not statistically significant, at rand. inf. p-values of 0.32 and 0.28 for specifications 2 and 4, respectively.

Voters exposed to the campaign are likely to anticipate its effects on other voters, knowing that they had received the campaign as well. This may induce coordination effects, in addition to the direct effects of voter education. Further, voters have differential abilities to use the information in the campaign, depending on the choices they face on the ballot. To assess the impact of the campaign along these dimensions, we estimate regressions with interactions of the treatment with two vote buying characteristics–the proportion of parties that are engaged in vote buying, and the lagged vote share of vote buying parties. Results of these regressions are presented in Table 1.8.

There is weak evidence that the campaign was more effective in decreasing vote shares of vote-buying parties in areas where they had higher past electoral support. The coefficient is significant in two out of four specifications. The interaction coefficient for turnout rate is 0.04 pp. (p-value = 0.18). Taken together, this suggests that the campaign might have induced some (weak) coordination effects against more prominent vote-buying parties, as captured by their past electoral support. An alternative interpretation is that the past electoral support acts as a proxy for the level of vote buying in an area, with the campaign being more effective in areas with greater vote buying. There is stronger evidence of positive interaction effects for the proportion of vote-buying parties, suggesting that the campaign was less effective in areas where voters were constrained by fewer non-vote-buying alternatives. The coefficient is statistically significant in three out of the four specifications. The corresponding interaction coefficient for turnout rate is -0.05 pp. (p-value = 0.29).

We might reasonably expect the effect of our ads to vary by demographic characteristics of the ACs, which we investigate by estimating the interaction effects of the campaign with key demographic characteristics–proportion of the population literate, rural, and belonging to the SC/ST category, respectively. The results of these regressions are presented in Table 1.9. There is little evidence of heterogeneity along these dimensions. There is suggestive evidence that the campaign may have resonated more with rural voters, possibly because they were set in a rural context. The campaign had a less demobilizing effect in areas with greater proportion of SC/ST population, possibly because SC/ST voters were targeted with greater vote buying (as reported by journalists) and experienced higher levels of associated monitoring of their turnout.

To assess the differential impact of the receiving the campaign during the pre-election window vs. before the window, when parties have greater ability to change their vote-buying and electioneering behavior, we pool together the experiment sample and the sample of 50 ACs that were eligible to receive the campaign before the window. We include three "treatment" variables–whether treated before the window, during the window, or both. To control for the differing treatment selection probabilities we include indicators for the number of stations eligible to broadcast during the window, and for the number of stations eligible to broadcast before the window, respectively. The results of these regressions are presented in Table 1.10.

The coefficient for receiving both the early and regular campaign is very imprecisely estimated since very few ACs fall in this category. The results show a clear pattern: relative to regular campaign, the effect on the vote share of vote-buying parties is much larger for areas receiving the early campaign. However, as is clear from inspecting the standard errors, we cannot statistically reject equality between the coefficients. The stronger effect of the early campaign rules out salience-based explanations for the impact of the campaign. A plausible explanation for the pattern of estimated results is that the campaign caused a change in behavior of the vote-buying parties. To infer whether the campaign increased or decreased the level of vote-buying in response to our campaign, we turn to its impact on the turnout rate. Receiving the early campaign significantly decreased the turnout rate by 4.28 pp (p-value = 0.06) compared to 0.24 (p-value = 0.72) for regular campaign. The null hypothesis of equality of the two coefficients can be rejected at the 90 percent level). These results suggest that the campaign decreased vote buying by parties.

1.6 Conclusion

In many parts of the world, vote buying takes place on such a grand scale that it is difficult to contain solely through law enforcement. Voter education campaigns delivered through mass media represent a cost-effective complement to expensive law enforcement efforts. This study represents the first systematic attempt to evaluate the effects of a mass media voter education campaign against vote buying and one of the few large-scale mass media field experiments of a voter education campaign. This study shows that messages educating voters about the incentives of vote buyers and the negative consequences of voting for them can be quite effective in deflecting electoral support away from parties that engage in vote buying.

Compared to other studies that expose corruption by specific politicians, we evaluate messages that argue against voting for politicians that engage in a particular form of corruption. Because vote buying is so prevalent voters can apply this insight to the information they already have about vote buying by politicians. While other mechanisms such as changes in social norms could have led to the observed effect, one plausible explanation underlying the effect is that voters have a strong preference for receiving public services and the campaign made voters pessimistic about the ability of vote-buying parties to deliver them.

A pertinent question for the future is whether and how vote-buying parties respond to these kinds of media campaigns and to informed voters over time. It might lead to parties to re-allocate resources to developing and disseminating their election platform and to other legitimate electioneering efforts. Alternatively, an (undesirable) possibility might be that as this type of intervention raises the cost-per-vote for vote buyers, parties engaging in this activity will go to greater lengths to monitor voters' compliance (e.g., by having voters use their cell phones to take photos of their ballots inside the voting booth) or perhaps reallocate some of their resources to other forms electoral malpractices, including voter intimidation.

Tables

Table 1.1: Summary Statistics and Balance Check

Variable	Mean	SD	Observations		Mean (C)	Difference	*p*-value	
			Treatment (T)	Control (C)		(T) - (C)	Std.	Rand Inf.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Journalists	2.73	2.06	291	301	2.86	-0.28	0.55	0.69
# Vote-Buying Parties								
Specification 1	1.70	0.71	291	301	1.79	-0.19	0.18	0.17
Specification 2	2.88	0.94	312	303	2.94	-0.12	0.68	0.65
Specification 3	1.26	0.52	223	258	1.28	-0.06	0.64	0.65
Specification 4	2.50	0.82	293	302	2.53	-0.07	0.79	0.79
Lagged Turnout (%)	57.85	12.25	312	303	59.21	-2.74	0.35	0.38
Lagged Vote Share of Vote-Buying Parties (%)								
Specification 1	54.30	25.84	291	301	57.03	-5.72	0.25	0.20
Specification 2	79.00	20.50	312	303	77.88	2.25	0.64	0.61
Specification 3	40.53	24.17	223	258	40.07	1.03	0.86	0.85
Specification 4	74.09	22.80	293	302	74.06	0.07	0.99	0.99
# Registered Voters	235433.76	53230.34	312	303	222737.85	25680.65	0.10	0.15
# All Candidates	14.36	5.49	312	303	14.77	-0.83	0.47	0.47
# Party Candidates	8.77	2.42	312	303	8.73	0.09	0.88	0.86
Election Date								
April 10	0.14	0.35	312	303	0.12	0.04	0.69	0.33
April 17	0.44	0.50	312	303	0.43	0.02	0.90	0.83
April 24	0.20	0.40	312	303	0.21	-0.02	0.87	0.78
April 30	0.10	0.30	312	303	0.14	-0.09	0.32	0.42
May 7	0.12	0.33	312	303	0.10	0.05	0.66	0.63
State Election	0.25	0.44	312	303	0.31	-0.12	0.34	0.30
Pop. Literate (%)	59.52	9.63	312	303	60.69	-2.37	0.24	0.31
Pop. Rural (%)	79.15	23.69	312	303	76.03	6.30	0.02	0.04
Pop. SC/ST (%)	31.77	17.70	312	303	29.83	3.92	0.33	0.34

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Mean, SD, Control Mean, and Difference are weighted using IPW. Randomization inference p-values are obtained from randomization inference with 1000 iterations. Joint F-statistic for all variables is 0.44; p-value (std.)= 0.98, and p-value (rand. inf.) = 0.33. Missing values are coded with value, -9.

Table 1.2: Impact of the Radio Campaign on Vote Share (%) of Vote-Buying Parties

	Specification 1					Specification 2				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean (Control)	67.42	67.42	67.42	67.42	67.42	90.73	90.73	90.73	90.73	90.73
Treatment	-7.14	-4.90	-6.98	-5.37	-3.46	-5.99	-5.72	-5.92	-5.14	-4.84
	(3.44)	(2.55)	(3.37)	(2.57)	(2.04)	(2.53)	(2.26)	(2.52)	(2.13)	(2.00)
p-value										
Standard	0.04	0.05	0.04	0.04	0.09	0.02	0.01	0.02	0.02	0.02
Rand. Inf.	0.07	0.13	0.09	0.10	0.22	0.04	0.07	0.05	0.12	0.15
R^2	0.54	0.66	0.54	0.58	0.69	0.47	0.51	0.49	0.52	0.57
N (Treatment)	301	301	301	301	301	312	312	312	312	312
N (Control)	291	291	291	291	291	303	303	303	303	303
	Specification 3					Specification 4				
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Mean (Control)	52.01	52.01	52.01	52.01	52.01	87.22	87.22	87.22	87.22	87.22
Treatment	-4.90	-3.94	-5.25	-4.81	-3.89	-6.89	-6.64	-6.37	-6.14	-5.33
	(3.47)	(2.62)	(3.44)	(3.00)	(2.5)	(2.78)	(2.49)	(2.81)	(2.45)	(2.19)
p-value										
Standard	0.16	0.13	0.13	0.11	0.12	0.01	0.01	0.02	0.01	0.02
Rand. Inf.	0.24	0.23	0.21	0.17	0.19	0.05	0.06	0.07	0.08	0.14
R^2	0.45	0.58	0.46	0.49	0.60	0.49	0.54	0.49	0.54	0.58
N (Treatment)	223	223	223	223	223	293	293	293	293	293
N (Control)	258	258	258	258	258	302	302	302	302	302
Covariates										
% Parties Vote-Buying		X			X		X			X
Demographics			X		X			X		X
State Election				X	X				X	X

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Mean (Control) is weighted by IPW and the Treatment coefficient is estimated using WLS with IPW. All columns include election phase fixed effects and the lagged vote share. Demographics include percent population rural, SC/ST, and literate, respectively. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference *p*-values obtained from 1000 iterations.

Table 1.3: Impact of Post-Election Radio Campaign on Vote Share (%) of Vote-Buying Parties

	Specification 1					Specification 2				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean (Control)	64.10	64.10	64.10	64.10	64.10	80.34	80.34	80.34	80.34	80.34
Treatment	-0.95	-4.73	5.91	-4.86	0.60	-0.88	-0.35	5.59	-2.64	4.78
	(5.38)	(5.96)	(2.92)	(5.49)	(2.30)	(5.94)	(3.76)	(2.05)	(6.23)	(2.44)
p-value										
Standard	0.86	0.43	0.04	0.38	0.80	0.88	0.92	0.01	0.67	0.05
Rand. Inf.	0.92	0.64	0.38	0.67	0.95	0.96	0.98	0.76	0.88	0.78
R^2	0.83	0.84	0.90	0.86	0.92	0.71	0.78	0.85	0.72	0.85
N (Treatment)	23	23	23	23	23	38	38	38	38	38
N (Control)	42	42	42	42	42	47	47	47	47	47
	Specification 3					Specification 4				
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Mean (Control)	81.40	81.40	81.40	81.40	81.40	84.77	84.77	84.77	84.77	84.77
Treatment	-1.55	-4.48	1.59	-2.53	0.24	3.78	5.18	5.08	3.43	5.50
	(4.46)	(4.17)	(4.07)	(7.09)	(5.28)	(3.84)	(3.93)	(3.93)	(4.11)	(4.33)
p-value										
Standard	0.73	0.28	0.70	0.72	0.96	0.32	0.19	0.20	0.40	0.20
Rand. Inf.	0.75	0.33	0.59	0.63	0.94	0.62	0.50	0.51	0.65	0.47
R^2	0.87	0.88	0.89	0.87	0.90	0.63	0.65	0.67	0.63	0.67
N (Treatment)	37	37	37	37	37	39	39	39	39	39
N (Control)	45	45	45	45	45	47	47	47	47	47
Covariates										
% Parties Vote-Buying		X			X		X			X
Demographics			X		X			X		X
State Election				X	X				X	X

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Mean (Control) is weighted by IPW and the Treatment coefficient is estimated using WLS with IPW. All columns include election phase fixed effects and the lagged vote share. Demographics include percent population rural, SC/ST, and literate, respectively. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference *p*-values obtained from 1000 iterations.

Table 1.4: Impact of the Radio Campaign on Voter Turnout Rate (%)

	(1)	(2)	(3)	(4)	(5)
Mean (Control)	68.20	68.20	68.20	68.20	68.20
Treatment	-0.16	-0.19	-0.37	0.05	-0.21
	(0.87)	(0.82)	(0.70)	(0.86)	(0.63)
p-value					
Standard	0.86	0.82	0.59	0.96	0.75
Rand. Inf.	0.95	0.95	0.90	0.99	0.94
R^2	0.79	0.8	0.81	0.80	0.83
N (Treatment)	312	312	312	312	312
N (Control)	303	303	303	303	303
Covariates					
% Parties Vote-Buying		X			X
Demographics			X		X
State Election				X	X

Notes: Mean(Control) is weighted using IPW and the Treatment coefficient is estimated using WLS with IPW. All columns include election phase fixed effects and the lagged turnout rate. Demographics include percentage population rural, SC/ST, and literate. The proportion of vote-buying parties uses specification 2, which defines vote-buying parties for all ACs. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference p-values obtained from 1000 iterations.

Table 1.5: Impact of Post-Election Radio Campaign on Voter Turnout Rate (%)

	(1)	(2)	(3)	(4)	(5)
Mean (Control)	60.76	60.76	60.76	60.76	60.76
Treatment	-0.59	-0.98	0.25	-1.74	-1.12
	(2.08)	(1.96)	(2.52)	(1.82)	(2.16)
p-value					
Standard	0.78	0.62	0.92	0.34	0.6
Rand. Inf.	0.84	0.77	0.92	0.62	0.74
R^2	0.75	0.75	0.77	0.78	0.81
N (Treatment)	39	38	39	39	38
N (Control)	47	47	47	47	47
Covariates					
% Parties Vote-Buying		X			X
Demographics			X		X
State Election				X	X

Notes: Mean(Control) is weighted using IPW and the Treatment coefficient is estimated using WLS with IPW. All columns include election phase fixed effects and the lagged turnout rate. Demographics include percentage population rural, SC/ST, and literate. The proportion of vote-buying parties uses specification 2, which defines vote-buying parties for all ACs. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference p-values obtained from 1000 iterations.

Table 1.6: Impact of the Radio Campaign on Other Vote Shares (%)

	Incumbent		Independent		NOTA		Criminal	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean (Control)	39.53	39.53	2.84	2.84	1.01	1.01	44.77	44.77
Treatment	-1.98	-2.24	0.48	0.42	0.15	0.03	1.26	0.78
	(2.19)	(2.11)	(0.56)	(0.61)	(0.14)	(0.11)	(3.56)	(3.55)
p-value								
Standard	0.37	0.29	0.39	0.49	0.29	0.77	0.72	0.83
Rand. Inf.	0.43	0.38	0.56	0.62	0.31	0.85	0.85	0.92
R^2	0.40	0.44	0.09	0.10	0.09	0.42	0.68	0.69
N (Treatment)	304	304	312	312	312	312	227	227
N (Control)	292	292	303	303	303	303	261	261
Covariates								
Lagged Dep. Var.	X	X	X	X			X	X
% Parties Vote-Buying		X		X		X		X
Demographics		X		X		X		X
State Election		X		X		X		X

Notes: Mean(Control) is weighted using IPW and the Treatment coefficient is estimated using WLS with IPW. All columns include election phase fixed effects and the lagged turnout rate. Demographics include percentage population rural, SC/ST, and literate. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference *p*-values obtained from 1000 iterations.

Table 1.7: Impact of the Radio Campaign on Inter-Party Electoral Performance

	Vote Share of Vote-Buying Party (%)				Vote Share of Non-Vote-Buying Party (%)				Vote-Buying Party	
	Highest		Second Highest		Highest		Second Highest		Highest	
	Spec. 2	Spec. 4	Spec. 2	Spec. 4	Spec. 2	Spec. 4	Spec. 2	Spec. 4	Spec. 2	Spec. 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean (Control)	51.11	50.91	34.57	33.64	3.39	6.37	0.89	1.18	0.99	0.97
Treatment	-1.40	-1.38	-3.78	-4.52	4.14	4.85	0.85	1.34	-0.04	-0.04
	(1.60)	(1.41)	(1.58)	(1.77)	(1.71)	(1.98)	(0.40)	(0.46)	(0.04)	(0.03)
p-value										
Standard	0.38	0.33	0.02	0.01	0.02	0.01	0.03	0.00	0.31	0.22
Rand. Inf.	0.44	0.42	0.05	0.05	0.02	0.04	0.02	0.01	0.32	0.28
R^2	0.30	0.36	0.09	0.21	0.37	0.47	0.36	0.31	0.25	0.22
N (Treatment)	312	293	296	279	312	293	312	293	312	293
N (Control)	303	302	303	290	303	302	303	302	303	302

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Mean(Control) is weighted using IPW and Treatment coefficient is estimated using WLS with IPW. All columns include election phase fixed effects, lagged outcome variable, demographics (percentage population rural, SC/ST, and literate), and proportion of vote-buying parties. Column (5) includes the proportion of vote-buying parties under specification 2. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference p-values obtained from 1000 iterations.

Table 1.8: Effects of the Radio Campaign Interacted with Vote-Buying Characteristics

	(1)	(2)	(3)	(4)	(5)
	Vote Share of Vote-Buying Parties (%)				Turnout Rate
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	(%)
Treatment	-9.10	-13.07	-19.69	-10.80	-1.23
	(5.62)	(12.38)	(5.13)	(8.20)	(3.12)
p-value	0.11	0.29	0.00	0.19	0.69
Treatment *					
Lagged Vote Share (%)	-0.22	-0.03	-0.21	0.01	0.04
	(0.08)	(0.10)	(0.07)	(0.10)	(0.03)
p-value	0.01	0.77	0.00	0.89	0.18
Treatment *					
% Vote-Buying Parties	0.87	0.31	1.62	0.15	-0.05
	(0.26)	(0.17)	(0.41)	(0.14)	(0.05)
p-value	0.00	0.07	0.00	0.26	0.29
R^2	0.70	0.52	0.66	0.54	0.81
Obs.	592	615	481	595	615

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Regressions estimated using WLS with IPW. All columns include election phase fixed effects, lagged outcome variable, demographics (percentage population rural, SC/ST, and literate), and proportion of vote-buying parties. Column (5) includes the proportion of vote-buying parties and lagged vote share under specification 2, respectively. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses, and corresponding *p*-values reported.

Table 1.9: Effects of the Radio Campaign Interacted with Demographic Characteristics

	(1)	(2)	(3)	(4)	(5)
	Vote Share of Vote-Buying Parties (%)				Turnout Rate
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	(%)
Treatment	7.99	14.37	-0.29	12.50	-4.81
	(14.25)	(15.25)	(26.08)	(16.11)	(4.80)
p-value	0.58	0.35	0.99	0.44	0.32
Treatment*% Pop. Literate	-0.09	-0.23	-0.11	-0.24	0.07
	(0.17)	(0.20)	(0.29)	(0.21)	(0.05)
p-value	0.60	0.24	0.70	0.24	0.21
Treatment*% Pop. SC/ST	0.08	0.12	0.14	0.17	0.09
	(0.11)	(0.08)	(0.13)	(0.10)	(0.04)
	0.46	0.12	0.28	0.08	0.03
Treatment*% Pop. Rural	-0.11	-0.12	-0.02	-0.11	-0.03
	(0.07)	(0.05)	(0.08)	(0.05)	(0.03)
p-value	0.13	0.03	0.83	0.03	0.32
R^2	0.68	0.52	0.61	0.55	0.81
Obs.	592	615	481	595	615

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Regressions estimated using WLS with IPW. All columns include election phase fixed effects, lagged outcome variable, demographics (percentage population rural, SC/ST, and literate), and proportion of vote-buying parties. Column (5) includes the proportion of vote-buying parties under specification 2. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses, and corresponding *p*-values reported.

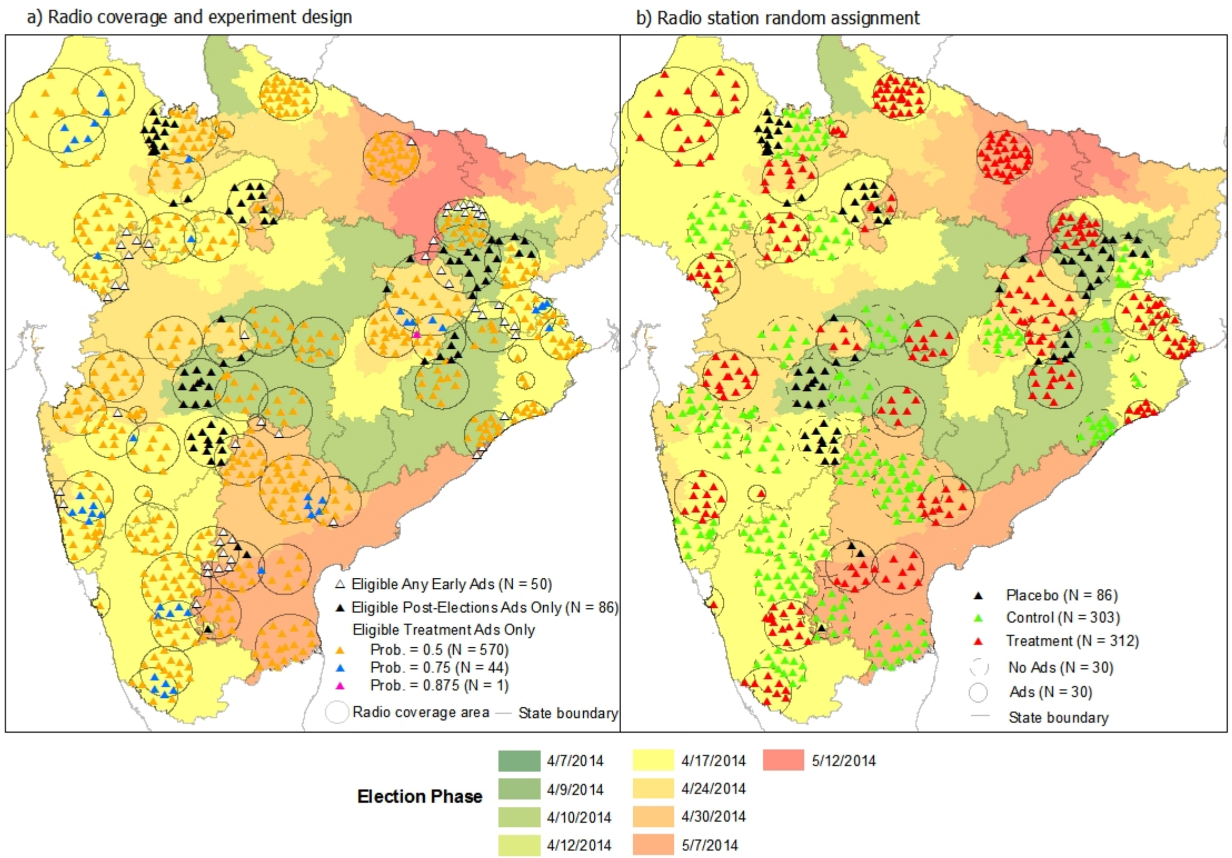
Table 1.10: Timing Effects of the Radio Campaign

	(1)	(2)	(3)	(4)	(5)
	Vote Share of Vote-Buying Parties (%)				Turnout Rate
	Spec. 1	Spec. 2	Spec. 3	Spec. 4	(%)
During Window Only	-4.14	-4.77	-4.09	-5.22	-0.24
	(2.23)	(2.08)	(2.50)	(2.27)	(0.66)
p-value	0.06	0.02	0.10	0.02	0.72
Before Window Only	-6.58	-13.82	-19.39	-10.06	-4.28
	(7.99)	(4.46)	(9.64)	(4.65)	(2.29)
p-value	0.41	0.00	0.04	0.03	0.06
Before and During Window	-7.22	0.36	-12.53	3.59	1.11
	(5.95)	(4.62)	(6.09)	(5.26)	(1.80)
p-value	0.23	0.94	0.04	0.50	0.54
R^2	0.69	0.61	0.61	0.60	0.81
Obs.	628	665	505	641	665

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. Regressions estimated using OLS and includes indicators...All columns include election phase fixed effects, lagged outcome variable, demographics (percentage population rural, SC/ST, and literate), and proportion of vote-buying parties. Column (5) includes the proportion of vote-buying parties under specification 2. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses, and corresponding p-values reported.

Figures

Figure 1.1: Experiment Design and Randomization



Chapter 2

Radio and Technology Adoption During India's Green Revolution: Evidence from a Natural Experiment

2.1 Introduction

High yielding varieties (HYVs) of rice and wheat were introduced on a national scale in India in 1966. Their rapid diffusion led to the Green Revolution, the period of sustained increases in food production that made India self-reliant. In his seminal book on diffusion of innovations, Rogers (2010) argues that mass media can rapidly inform large populations about the existence and merits of a new technology; thus playing an effective role in initiating technology diffusion process.

In this study, I examine the effect of introduction of radio broadcasts on the adoption of improved crop varieties in India during the Green Revolution. Using an annual district-level panel dataset from 1966 to 1978, I find that introduction of radio coverage led to a persistent increase in the adoption of HYVs of rice but only a transient increase in adoption of HYVs of wheat. I find no evidence of a positive impact on use of other inputs, and consequently on crop yields. Overall, the results suggest that radio was effective at providing information about a profitable but rapidly evolving and regionally heterogeneous agricultural innovation (HYV rice) that was otherwise struggling to attain mass adoption due to informational constraints.

The identification strategy I use in this paper, relies on the differential time of introduction of radio coverage in different parts of the country. Resource shortages meant there were gaps of several years between investments in expansion of the radio network. While not random, the expansion of radio coverage followed a predictable pattern to meet population coverage targets under successive five-year plans. To the best of my knowledge this is the first study to exploit such a "natural experiment" to study the effects of radio exposure on technology adoption.

The first set of results estimate the effect of introduction of radio coverage on adoption of the newly introduced HYVs of wheat and rice. I find that introduction of radio had a large impact on adoption of HYVs of rice, as measured by fractions of area cultivated, which persists throughout the entire period. The effect on adoption of HYVs of wheat, however, is transient, rising during initial years and then decaying. The magnitude of the effect on rice is large, and equivalent to approximately 25 percent of the mean level in the final year (1978). The impact was driven by farmers switching from traditional varieties of rice rather than from others crops. Back of the envelope calculations suggest that the nine percentage point expansion of radio coverage was responsible for close to three percent of the adoption of HYVs of rice between 1966 and 1978. Placebo tests confirm the validity of these results– there is no effect of receiving radio coverage in the future on current adoption of wheat or rice HYVs.

What explains the strong and persistent effect on HYVs of rice and weak and transient effect on HYVs of wheat? Initially introduced rice HYVs were not resilient to variations in soil and water conditions. As a result they had to be to tailored to local conditions, and were constantly evolving with new varieties released every year. Wheat HYVs, on the other hand, were a far more homogeneous technology–two of the initial varieties dominated the national market throughout the period. Both the constant change over time and the high geographic heterogeneity of rice HYVs relative to wheat HYVs are likely to have made radio broadcasts more relevant for the former.

Another set of results examines the effect of radio coverage on use of complementary inputs–irrigation and fertilizer–and on crop yields. There is a negative effect on irrigation use, most likely due to supply-side constraints preventing a proportional increase to meet the increased area being cultivated. There is no effect on fertilizer use. There is no effect on wheat yield and some evidence of an increase in rice yield. This suggests that while informational interventions, such as radio broadcasting, can increase adoption of improved seeds, higher crop yield potentials can be realized only if constraints on adoption of complementary inputs are eased as well.

This paper contributes to the growing economics literature that uses natural experiments, by exploiting variation in the timing or intensity of exposure, to estimate mass media effects on various social, political, and economic outcomes.[1] Studies in this strand of the literature have examined outcomes as diverse as voting (DellaVigna et al., 2014; DellaVigna and Kaplan, 2007; Enikolopov et al., 2011; Gentzkow et al., 2011; Larreguy et al., 2015), social capital (Gentzkow, 2006; Olken, 2009), conflict (Adena et al., 2015; Yanagizawa-Drott, 2014), fertility and women's empowerment (Bhavnani and Nellis, 2016; Chong and La Ferrara, 2009; La Ferrara et al., 2012), education (Gentzkow and Shapiro, 2008; Kearney and Levine, 2015a; Keefer and Khemani, 2014), and government responsiveness (Besley and Burgess, 2002; Strömberg, 2004). Out of these, Adena et al. (2015); DellaVigna et al. (2014); Ferraz and Finan (2008); Keefer and Khemani (2014); Larreguy et al. (2015); Olken (2009); Strömberg (2004) examine the impact of radio while the others focus on newspaper or television.

Another strand that this study contributes to is the role of mass media in social marketing,

[1]For a thorough review of this literature, see DellaVigna and Gentzkow (2010); DellaVigna and La Ferrara (2016); La Ferrara (2016); Price and Dahl (2012).

i.e., promoting the adoption of socially desirable attitudes, behaviors, and products. The bulk of the literature focuses on the adoption of healthy behaviors, e.g., smoking cessation, getting children vaccinated, and wearing car seat belts.[2] Exploiting a natural experiment, Vaughan et al. (2000) evaluate the "edutaining" radio soap opera on HIV-related knowledge and behaviors. Recent RCTs have similarly evaluated the effect of edutaining videos on take-up of a public works program (Ravallion et al., 2015), of salt fortified with iron and iodine (Banerjee et al., 2015), both in Bihar, India, and of STD testing in Nigeria (Banerjee et al., 2015).

Finally, this paper also contributes to the large and multi-disciplinary literature on the effect of information on adoption of agricultural innovations. In the 1960s and 1970s, there was lot of enthusiasm for using radio to promote rural development, captured in the highly influential book by Schramm (1964). Dissemination of agricultural information and instruction of farmers was an early focus of development communication. An initiative promoted by the UNESCO involving communal listening of radio farm program, called "Radio Rural Forums", generated a lot of evidence in the form of case studies, e.g., from India (Neurath, 1962), where it was first piloted, and from Ecuador (Spector, 1963), Ghana (Coleman et al., 1968), Tanzania (Hall, 1975), and Thailand (Purnasiri, 1976). The case studies primarily evaluated the effect of radio listenership on farmer knowledge and to lesser extent on their adoption decisions and productivity.

After the worldwide expansion of the "Training and Visit" extension system,[3] the focus of researchers shifted to studying the impact of extension services on productivity (reviewed in Anderson and Feder (2007), Birkhaeuser et al. (1991), and Picciotto and Anderson (1997)) and on social learning by farmers, e.g., Conley and Udry (2010), Foster and Rosenzweig (1995), and Munshi (2004). A newly emerging literature examines the role of information and communication technologies (ICT), especially mobile phones, on the diffusion of agricultural

[2]See Wakefield et al. (2010) for a survey of this literature.

[3]Under the Training and Visit system, promoted by the World Bank, extension agents met with "contact" farmers to disseminate information about improved inputs and practices.

innovations in developing countries (see Aker (2011) for a review of this literature).

The rest of the paper is organized as follows. In Section 2.2, I provide the background for the introduction and diffusion of HYVs, and the the expansion of the radio network, both in the context of India's five-year plans. In Section 2.3, I discuss the agricultural dataset, the radio exposure model, and the empirical strategy. I present the results of this study in Section 2.4 and conclude in Section 2.5.

2.2 Background

2.2.1 High Yielding Varieties

Starting in 1951, the Indian government embarked on a government-driven development agenda through Soviet-style five-year plans. During the first five-year plan (1951-1956) the government focused on agriculture and rural development, making investments in large dams, irrigation networks, setting up a national agricultural research system, and modernizing the British-era agricultural bureaucracy. In the second (1956-1961) and third (1961-1966) five-year plans the government shifted its focus to the industrial sector, at the cost of investments in agriculture. However, successive droughts in the mid-1960s, which brought India to the brink of famine, motivated the Indian government to re-dedicate efforts to attain self-sufficiency in food production.[4]

In 1965, the government decided to introduce semi-dwarf varieties of rice and wheat, imported with assistance from the Ford Foundation, the Rockefeller Foundation and USAID, across the country the following planting season. Because of their lower straw-to-grain ratio and greater responsiveness to fertilizer, these improved varieties had higher yield potential, and came to be known as high yielding varieties (HYVs). Further, their shorter maturation period allowed for multiple cropping using irrigation. The adoption of HYVs, along with

[4]The discussion in the rest of this sub-section is based on Evenson et al. (1998), Munshi (2004), and Parayil (1992).

increased use of fertilizer, pesticide, and irrigation, led to the Green Revolution–the period of rapid increases in production of food. Cereal production increased from 72 million tons in 1966 to 108 million tons in 1971, with corresponding imports declining from 10 million tons to 2 million tons. India became self-reliant in food production by 1978.

Originally, two wheat HYVs–Sonora 64 and Lerma Rojo 64A–which were particularly well suited for Indian conditions, were imported from CIMMYT in Mexico and crossed with local varieties for mass distribution. These HYVs became extremely popular across all major wheat-producing regions of the country. Even in 1978, two of the original crosses, Sonalika and Kalyan Sona, accounted for 65 percent and 20 percent, respectively, of the supply of certified HYV wheat seed in the country. The pattern of development of HYVs of rice by contrast was constant improvement and change, and inter-regional heterogeneity. The first local crosses (Padma and Jaya) of the imported varieties (Taichung Native I and IR8 from IRRI in the Philippines), released for nation-wide adoption were not resilent to floods, droughts or pests, and did not attain widespread popularity. Future varieties that were released had to be tailored to local soil and water conditions. Over the period from 1966 to 1978, 122 varieties were released, only 21 of which were for distribution across the country. However, unlike wheat, no single HYV of rice dominated nationally. Munshi (2004) argues that given these characteristics of wheat and rice HYVs, inter-regional diffusion of information about the new varieties is likely to have been easier for wheat than for rice.

2.2.2 Radio Broadcasting

All India Radio (AIR) is the government-run radio broadcaster in India, which has a monopoly on radio broadcasting in rural areas.[5] Although radio was introduced to India in 1927, before independence its reach was restricted to the major metropolitan areas–in 1947, there were eight radio stations which reached 2.5 percent of the area and 11 percent of the population (Prasar Bharati, 2007). After independence, the Indian government undertook systematic

[5]The following discussion of the expansion of the radio network under subsequent five-year plans draws on Baruah (1983).

efforts, under the five-year plans with the goal of promoting development and national integration, to expand coverage to all regions of the country. Figures 2.1 and 2.2 present the trends in the number of radio stations, and in the area and population covered by them, respectively.

During the first five-year plan (1951-1956) low power transmitters were replaced with high power transmitters, substantially increasing coverage, without increasing the number of radio stations. There was no further upgradation of transmitter power until the 1990s. Future increases in coverage were primarily through investments in new radio stations. The second plan period (1956-1961) saw very limited investments in radio broadcasting–only three new radio stations were added during this period.

AIR's radio stations had production facilities that allowed them to broadcast regionally-tailored public service messages, rural and agricultural programs, and educational programs, as well as national content such as cultural programs and news bulletins. Most of the stations used medium-wave (MW) frequencies that could be received by AM radio receivers, the predominant type of radio receivers at the time, and had limited propagation distances. A handful of radio stations used short-wave (SW) frequencies to broadcast over larger distances to international audiences. These broadcasts were often available to Indian audiences. However, these did not carry regionally-targeted content or farm programs. Starting with the third five-year plan (1961-1966) the government embarked on the so-called "Medium-Wave Expansion Plan" to expand coverage under the MW-based regional radio service to all parts of the country.

Starting 1966, in order to better coordinate the dissemination of agricultural information, particularly about the newly introduced HYVs, AIR coordinated with the Ministry of Agriculture to overhaul the production of agricultural programs and hired dedicated Farm Radio Officers, who were trained or experienced in agricultural extension work. The typical farm content involved a few minutes of "helpful hints" in the morning, a farm program in the evening for around 45 minutes, which consisted of interviews with scientists and farmers, and dramatizations portraying "progressive farmers". The programs were based on centrally issued guidelines but radio stations were responsible for tailoring it to local conditions. They were usually broadcast in colloquial Hindi or a local Hindi dialect for Hindi-speaking states and in the state language, or a regional dialect in non-Hindi-speaking states.

By the end of the fifth five-year plan (1974-1978) there were 86 radio stations that could reach 78 percent of the area and 89 percent of the population. In this study, I restrict the period to the end of the five-year plan when radio was the only medium of mass communication accessible to the rural population as illiteracy limited access to newspapers and before television started taking off in rural areas starting with the sixth five-year plan (1980-1985) (Singhal et al., 1988).[6]

2.3 Data and Empirical Strategy

2.3.1 Agricultural Data

The agricultural data in this paper are from the World Bank's "Indian Agriculture and Climate Dataset", a district-level panel dataset used in Dinar et al. (1998).[7] The variables I use were originally compiled from various reports and statistical abstracts published by the government, by Robert E. Evenson and Mark W. Rosegrant at the Economic Growth Center, Yale University, to estimate the sources of productivity growth in Indian agriculture during the Green Revolution, e.g., in Evenson et al. (1998), and Rosegrant and Evenson (1992). Since then the dataset has been widely used in other applications such as the distributional impacts of dams (Duflo and Pande, 2007), the impact of weather shocks on crop yields and wages (Jayachandran, 2006), and government responsiveness to adverse weather shocks (Cole et al., 2012).

[6] The period from 1978 to 1980 was also a period of political change and instability as the country got its first non-Congress government. Congress was voted back in 1980, which canceled the sixth five-year plan devised by previous government and established an alternate "sixth" plan.

[7] The dataset can be accessed at `http://ipl.econ.duke.edu/dthomas/dev_data/datafiles/india_agric_climate.htm`.

The dataset covers all major agricultural states of the country, with the exception of Assam and Kerala. Also excluded are the agriculturally marginal mountainous states in the north and north-east and the Union Territories. Out of the 271 districts in the dataset, I exclude 5 districts that have little agricultural activity because they consist either of large metropolitan areas, mountains or deserts. The dataset uses consistent district boundaries from 1961. As discussed before I use data over the period from 1966 to 1978.

Table 2.1 presents the summary statistics for the main agricultural variables, for the first and last years of the study period. The first variable is the Gross Cropped Area (GCA), which is the total area cultivated under all crops over a year.[8] From 1966 and 1978, the average GCA increased by 11.6 percent, most of it due to increasing cropping intensity, i.e., the number of times an area is cropped in a year, as implied by the smaller increase of 3.4 percent in the average Net Cropped Area (NCA)[9]. The next set of variables relate to the areas under high yielding varieties (HYVs) of wheat and rice, as a fraction of the GCA. In 1966, the year of introduction of HYVs, the fraction of GCA under HYVs is negligible. By 1978, it is 9.5 percent for wheat and 8.6 percent for rice.

As a proportion of the total wheat area, HYVs went from 3.1 percent to 68.7 percent over the twelve years. The expansion is less impressive for rice, which went from 1.8 percent to 37.2 percent. There is a large increase in the fraction of wheat area that is irrigated, by 19.1 pp., but almost no increase for rice. Fertilizer use (per hectare of NCA) expanded dramatically; close to seven-fold for nitrogen and phosphate, and an even larger increase for potash. Along with HYV adoption, and increased use of irrigation and fertilizers, the yield (output per hectare of gross area planted) of both wheat and rice increased rapidly, close to doubling over the twelve-year period. Table A1 in Appendix B.1 present the summary statistics for additional outcome variables. The fraction of coarse cereals, which includes maize, sorghum, and pearl millet, under HYVs increased to only 23.3 percent by 1978. The average road length in a district increased by 135.9 percent and the number of markets by

[8]Areas are counted as many times as they are cropped over the year.

[9]Areas are counted only once irrespective of the number of times they are cropped.

106.3 percent.

2.3.2 Radio Coverage

A key challenge in studying mass media effects is measuring exposure. Many studies have used signal strength predicted by a radio wave propagation model, called the Irregular Terrain Model (ITM), to measure exposure. This strategy has been used primarily in cross-sectional studies to generate plausible exogenous measures of exposure, e.g., Yanagizawa-Drott (2014), but has also occasionally been used in panel settings, e.g., Olken (2009). The ITM approach requires details about the locations and technical parameters of the transmitters, which are not available in our case. Studies, such as Gentzkow (2006) and La Ferrara et al. (2012), that study historical periods in U.S. and Brazil, respectively, use other measures of exposure. Gentzkow (2006) uses the expansion of television to different Designated Market Areas (DMAs) in the U.S., where a DMA consists of a group of counties which have a majority of measured viewing hours on specific stations. He uses DMA definitions from 2003, and argues that they are valid for the entire period of analysis (1950 to 1970) because the broadcasting strengths of the stations did not change over time. La Ferrara et al. (2012) use the radial reach of the transmitters along with their locations to determine exposure to a soap opera broadcaster, *Globo*, in Brazil.[10]

I use an approach that follows Gentzkow (2006), but modifies it to accommodate changes in transmitter powers. A Primary Service Area (PSA), is a group of districts officially specified by AIR as the target audience for a radio station,[11] to which it tailors language/dialect and content. Like the U.S., it may be possible for viewers to tune into stations from neighboring PSAs. However, the reception from such neighboring stations is potentially of poorer quality and in a different language/dialect. However, we cannot use the current PSA definitions for the period of interest (1966-1978) because broadcasting strengths increased sub-

[10] They, however, do not specify the model or the source of radial reach data.

[11] The current definitions are available on the AIR website, `http://csuair.org.in/Menu/primaryChannel.htm`, accessed on April 7, 2017.

stantially in the 1990s. In 1982, the majority of the transmitters were 10 or 20 KW; the highest power of transmitters was 100 KW. By 2007, 25% of the transmitters were upgraded in strength; the most powerful transmitters were 300 KW.[12] The current coverage is therefore likely to overstate the coverage that existed in the 1960s and 1970s. However, transmitter powers remained relatively unchanged from the early 1960s all the way through the 1980s.

To address this concern, I adjust the coverage areas of radio stations from 2007 for the lower transmitter powers during the 1960s and 1970s using a simple regression approach. I first calculate the area of the PSAs associated with each radio station in 2007. I then regress these areas on a fourth-order polynomial of transmitter power (KW) in 2007.[13] I calculate the areas covered in 1982 using the estimated coefficients and the 1982 transmitter powers.[14] I approximate the coverage area to circle to back out the radial reach of each station.[15]

I create two measures of annual district radio coverage, i.e. district exposure to radio broadcasting. The first measure is a binary indicator of whether a district is covered by broadcasts from any radio station in a given year. I designate a district as covered by a radio station if its centroid is located within the radial reach of that station.[16] I assign the year of introduction of radio coverage for a district as the year of commissioning of its earliest radio station. Formally, I construct the binary indicator of radio coverage for district i in year t as $radio_{it} = \mathbf{1}(t - \tau_i > 0)$, where τ_i is the year of introduction of radio to the district.

The second measure of radio coverage is the fraction of a district's area that is covered by any radio station in a given year. To construct this measure, I first calculate the fraction

[12] The transmitter strengths for 1982 are from Baruah (1983) and for 2007 from Prasar Bharati (2007).

[13] The regression equation I estimate is:

$$Area_{2007} = \alpha_1 KW_{2007} + \alpha_2 KW_{2007}^2 + \alpha_3 KW_{2007}^2 + \alpha_4 KW_{2007}^2 + \epsilon \tag{2.1}$$

[14] The formula is:

$$Area_{1982} = \hat{\alpha}_1 KW_{1982} + \hat{\alpha}_2 KW_{1982}^2 + \hat{\alpha}_3 KW_{1982}^3 + \hat{\alpha}_4 KW_{1982}^4 \tag{2.2}$$

[15] The radius is given by, $radius_{1982} = \sqrt{\frac{Area_{1982}}{\pi}}$.

[16] I use the location of the town/city of a radio station as the center for its radial coverage area.

of a district's area covered by radio as of 1965, the year before the start of the study period. As new radio stations are subsequently commissioned, parts of districts within the radio stations' radial reaches start receiving their broadcasts. In a given year, a district's radio coverage increases only if some previously uncovered part starts receiving broadcasts from a newly commissioned radio station. Since we do not observe any radio station closures, like the binary indicator, the fraction of radio coverage can only increase or remain the same but never decrease. Using the initial fraction and the annual additions, I construct the cumulative annual fraction of district area covered by radio over the period from 1966 to 1978.

As reported in Table 2.2 the proportion of districts covered by radio increased from 72.6 percent to 81.6 percent. The value for 1978 is close to the 78 percent of the area covered by radio reported by AIR (see Figure 2.2) but the value for 1966 is substantially larger than the 52 percent reported by AIR. This can be explained by the fact that AIR's values are for the entire country, including the difficult-to-reach mountain states that received radio much later, whereas our sample excluded these states. Figure 2.3 presents the number of districts newly covered by radio each year based on this approach. Out of the 266 districts, 193 already had radio coverage before 1966, the year of introduction of HYVs, 26 districts received radio coverage some time during the period from 1966 to 1978, and 47 districts did not receive radio coverage as of 1978. Figure 2.3 presents the spatial distribution of districts belonging to these three groups. As is immediately apparent, the districts that received it either during the period 1966-1978 or not before 1978 were typically inland, less densely populated, and less economically and agriculturally developed. The average fraction of a district's area covered by radio increased from 72.6 percent to 82.4 percent. Figures 2.5 and 2.6 present the distribution of the coverage fractions for the first and last years, respectively, showing a clear right-ward shift in distribution.

2.3.3 Empirical Strategy

I use a fixed-effects approach to estimate the impact of introduction of radio on the adoption of HYVs and related outcomes. The effect is identified by variation in radio coverage within a district over time and between districts in a given year. Unobserved district characteristics driving government's expansion of radio, promotion adoption of HYVs, as well as its adoption, could undermine the identification strategy. As is clear from Figure 2.4, the expansion of radio is not random but follows a predictable pattern of covering the denser and easily accessible areas first. To address concerns of spurious correlation, I include fourth-order polynomial interactions of year[17] with several covariates, such as indicators for states, demographic characteristics from the 1961 census(proportion of the population rural, the literacy rate, and population density), to capture economic development level, the daily agricultural wage in 1965 from the agricultural dataset, and to capture the agricultural potential for adoption, the average pre-1966 fractions of GCA under wheat and rice cultivation, respectively. The summary statistics of these variables are given in Table 2.2.

The main specification I estimate is:

$$y_{it} = \alpha radio_{it} + \sum_{q=1}^{4} \gamma_q X_i * y^q + \delta_t + \eta_i + \epsilon_{it} \tag{2.3}$$

where y_{it} is the outcome variable in district i in year t. X_i contains the time-invariant district characteristics described above. $radio_{it}$ is a measure of radio coverage. In some specifications, I will include an interaction term between radio coverage and literacy rate. δ_t is the year fixed effect, η_i is the district fixed effect, and ϵ_{it} is the idiosyncratic error term.

The specification in Equation 2.3 captures only the persistent average effect of radio introduction on adoption. To assess the pattern of adoption over successive years of radio coverage, I regress y_{it} on indicators for each additional year of radio coverage. The number of years of radio coverage a district has had in a given year is $radio_{it}^{years} = \mathbf{1}(t-\tau_i > 0)*(t-\tau_i)$.

[17] The time period $y = 0$ for year 1966, 1 for 1967, so on.

For districts that received radio coverage before 1966, the year of introduction of HYVs, I assign 1965 as their first year of radio coverage. I include indicators for years 1 through 7 and a combined indicator for years 8 though 13. The omitted category is zero years of radio coverage. The estimating equation is:

$$y_{it} = \sum_{m=1}^{8} \beta_m \mathbf{1}(radio_{it}^{years} = m) + \sum_{q=1}^{4} \gamma_q X_i * y^q + \delta_t + \eta_i + \epsilon_{it} \tag{2.4}$$

β_1 through β_8 taken together present the pattern of the impact of introduction of radio, shedding light on both the persistent and transient effects.

2.4 Results

Table 2.3 presents estimates of the impact of radio coverage on the adoption of HYVs of wheat and rice. Columns (1)-(4) pertain to HYV wheat and columns (5)-(8) to HYV rice. In none of specifications is there a statistically significant effect of introduction of radio coverage on adoption of HYVs of wheat. The impact on adoption on HYVs of rice by contrast is quite strong. Column (5) presents the effect on percent of GCA under HYV rice, and column (7) on percent of rice area under HYVs. Receiving radio coverage increased the percent GCA under HYV rice by 2.7 pp., which is equivalent to 0.31 standard deviations, and 27 percent of the mean level in 1978. It also increased the percent of rice area under HYVs by 8.8 pp., which is equivalent to 0.33 standard deviations, and 24 percent of the mean level in 1978. The estimates using the continuous measure of radio coverage, presented in columns (6) and (8) are very close to those using the binary measure. Table 2.4 presents the interaction effects of radio coverage with literacy rate. There is weak evidence of heterogeneity in the impact of radio by literacy rate, the interaction coefficient for HYV rice is negative using both radio measures, suggesting larger effects for areas with lower literacy; however it is not statistically significant in either specification.

How much of the diffusion of rice HYVs from its introduction in 1966 until 1978 can be explained by the expansion of radio? We can do some back-of-the-envelope calculations to answer this question. Between 1966 and 1978, there was a 8.2 pp. increase in fraction of GCA under rice HYVs. The 2.7 pp. effect of radio introduction implies that radio expansion of 9 pp. over this period was responsible for 3 percent of the diffusion of rice HYVs.

To examine whether radio introduction changes the slope of the diffusion curve in addition to parallel shift, I estimate the coefficient for each year after radio introduction, as specified in Equation 2.4. The coefficients, along with the 95 percent confidence intervals, for the percent of GCA under wheat HYVs is plotted in Figure 2.7. There is an upward trend over the first four years after introduction of radio coverage after which it decays. The effect is statistically significant, at the 95 percent level, only between three and five years after getting radio coverage, hovering over 2 pp. The coefficients corresponding to the percent wheat area under HYVs are plotted in Figure 2.9. The pattern is similar. The effect is marginally insignificant at the 95 percent level for year four of having radio coverage, with a point estimate of 7.5 pp. These two effects are equivalent to 0.22 and 0.21 standard deviations of the dependent variable, respectively. To give further context to these effects, the corresponding levels of adoption of HYV wheat in 1978 were 9.5 percent and 68.7 percent, respectively.

Figures 2.8 and 2.10 plot the year-wise effect of radio coverage on adoption of HYVs of rice. The effect on the percent of the GCA under rice HYVs emerges the year following the introduction of radio and persists at the same level of approximately 3 pp. The effect on the fraction of rice area under HYVs similarly emerges starting year one and hovers around 6 pp. Why does the effect decay for wheat HYVs but persist for rice HYVs? A plausible explanation for the estimated pattern may lie in the underlying dynamics and heterogeneity of the technology. Wheat HYVs remained stable throughout the period, with just two varieties dominating the supply of HYV seeds. Rice HYVs, on the other hand, underwent constant change, with new varieties released yearly. Further, the HYVs were region specific, having been tailored to local soil and conditions. Radio kept farmers constantly updated about the the newly released HYVs of rice and their correct use. In the case of wheat such information was not as relevant. Further, as a relatively geographically homogeneous technology, there were fewer barriers to spatial diffusion of information, a substitute to radio, compared to rice HYVs.

Next, I present the results of a placebo test–the impact of getting radio coverage the following year on outcomes this year. The regression includes both whether a district has radio coverage this year, and whether it will get radio coverage next year. The coefficient on the latter captures the effect of *newly* getting radio coverage next year. A non-zero coefficient would imply the existence of spurious correlation, undermining the identification strategy presented in this study. In Table 2.5, I present the results of these regressions. Getting new radio coverage the following year had no effect on any of the measure of adoption of HYVs of wheat or rice and under any specification of the radio coverage.

I additionally estimate a specification of the time trends using 2.4 but expanding it to include both years before as well after introduction of radio coverage. I include indicators for each year from seven years before through seven years after introduction of radio coverage, and for a last category of more than seven years after introduction. The omitted category is more than seven years before introduction. Districts that do not receive any radio coverage by 1978 are excluded from this specification. Figures 2.11 and 2.12 plot these year-wise coefficients for the percent of GCA under wheat and rice HYVs, respectively. Figures 2.13 and 2.14 plot the corresponding coefficients for percent of crop area under HYVs. In all the plots the trend in the outcome variable is relatively flat before introduction of radio.

A key goal of promoting HYVs is to increase crop yields. While the yield potentials of rice and wheat HYVs are higher than that of traditional varieties, it is only possible to realize higher yields with greater use of fertilizers and irrigation. In Table 2.6, I present the results of the impact of radio introduction on irrigation use–the percent of the total wheat and rice area that is irrigated, respectively. There is a negative effect of 3.6 pp. for wheat and 3.6 pp. for rice. This is equivalent to 5.7 percent and 5.9 percent of the mean levels in

1978, respectively. Since irrigation during this period is primarily from public sources such as canals, these results suggest that supply-side constraints prevented a proportional increase in area irrigated. Table 2.7 shows no impact of radio coverage on use (kg per hectare of the NCA) of either of the three types of fertilizers–nitrogen, phosphates, and potash. Taken together, this suggests the existence of constraints in adoption of fertilizer and irrigation relative to adoption of the HYVs. Alternately, radio broadcasts may have promoted HYVs without simultaneously advocating for adequate use of fertilizers to increase yields.

To some extent the estimated effect on input use provides some evidence that government is unlikely to have coordinated efforts, such as allocation of fertilizer or irrigation with the introduction of radio coverage, for the common purpose of boosting HYV adoption. Such coordinated efforts would bias our estimates upward. To test whether the government undertook other infrastructure investments to complement radio in order to increase HYV adoption, I regress outcome variables related to infrastructure stocks necessary for agricultural development–roads and markets, presented in Table A2 in Appendix B.1. There is no correlation between receiving radio coverage and receiving more roads or markets. Table A3 shows that little positive impact of radio coverage on cultivation of HYVs of coarse cereals.

Finally, in Table 2.8, I present the impact of radio coverage on yields (kg per hectare of gross area planted) of wheat and rice. As expected there no effect on wheat yields. In the specification using the binary measure of radio coverage there is no statistically significant effect of radio coverage on rice yield. However, in the specification using the continuous measure there is a 15 percent increase, which is substantial relative to the 70 percent increase in rice yield from 1966 to 1978. There are no heterogeneous effects of radio coverage on rice yields by literacy rate. Overall, the pattern of results suggests radio coverage increased the yield of rice cultivation, presumably by increasing adoption of HYVs.

2.5 Conclusion

There has been a lot of emphasis in the economics literature on studying technology adoption decisions as a function of learning about the optimal use of the new technology. Although relevant to later stages of the diffusion process, what is key at the early stages is raising awareness about the existence and merits of the new technology. Here, the literature has focused primarily on the effect of extension agents and peers, even though mass media are particularly effective in rapidly informing large populations about new technologies (Rogers, 2010). This paper attempts to fill this gap in the literature.

In this paper, I exploit a natural experiment–the differential time of introduction of radio in different parts of the country–to estimate the effect of radio coverage on adoption on HYVs of rice and wheat in India. I find a large and persistent effect of radio on adoption of rice HYVs but only a transient effect on wheat HYVs. The pattern of results is consistent with the argument that as a geographically heterogeneous and rapidly changing technology, there were fewer substitute sources of information about HYVs of rice whereas the opposite is true for HYVs of wheat.

Introduction of radio did not increase use of irrigation or fertilizers. There is no evidence of an impact on wheat yield and some evidence of an increase in rice yield, presumably through increased adoption of HYVs. A policy implication of the pattern of results of input use and yields is that supply-side constraints could restrict the benefits of promoting technology adoption from being fully realized.

As the results on adoption of the two HYVs suggest, the impact of mass communication on adoption depends on characteristics of the underlying technology. Mass media are likely to be effective in promoting technologies that are rapidly changing and about which there are limited alternate sources of information. An implication of this insight is that localized communication can facilitate the diffusion of geographically heterogeneous technologies, such as agricultural innovations.

Convergence of mass communication to the Internet platform increases the scope for targeting audiences, which is likely to incentivize the development of heterogeneous technologies. Future research on the role of information dissemination and targeting in both technology adoption as well as technology change and heterogeneity can improve our understanding of the processes underlying economic growth.

Tables

Table 2.1: Summary Statistics of Outcome Variables

Variable	1966			1978		
	Mean	SD	Obs.	Mean	SD	Obs.
Gross Cropped Area (GCA)	551.797	275.192	266	615.623	294.872	266
Net Cropped Area (NCA)	484.696	258.867	266	501.537	261.346	266
Area/GCA (%)						
HYV Wheat	0.234	0.524	266	9.477	11.345	266
HYV Rice	0.449	1.094	266	8.626	11.611	266
HYV Area/Crop Area (%)						
Wheat	3.093	4.768	235	68.694	31.987	246
Rice	1.800	3.628	248	37.212	32.465	257
Irrigated Area/Crop Area (%)						
Wheat	44.382	34.219	216	63.493	32.254	225
Rice	40.505	37.410	230	41.262	38.165	236
Fertilizer Use/NCA (kg/ha)						
Nitrogen	4.656	5.775	266	26.050	28.230	266
Phosphate	1.167	2.264	266	8.287	10.479	266
Potash	0.361	1.582	266	4.753	11.711	266
Crop Yield (kg/ha)						
Wheat	0.629	0.455	266	1.225	0.673	266
Rice	0.729	0.490	266	1.240	0.666	265

Table 2.2: Summary Statistics of Covariate Variables

Variable	Mean	SD	Obs.
Radio (1966)	0.726	0.447	266
Radio (1978)	0.816	0.388	266
Prop. Radio (1966)	0.726	0.336	266
Prop. Radio (1978)	0.824	0.268	266
Years of Post-HYV Radio (1978)	9.805	5.399	266
Pre-1966 Average (%)			
Wheat Area	9.967	11.378	266
Rice Area	22.582	24.257	266
Daily Male Wage (1965)	2.131	0.884	266
Demographics (Census 1961)			
Literacy Rate (%)	20.701	7.634	266
Pop. Rural (%)	84.329	11.067	266
Pop. Density (persons/sq. km.)	482.188	374.231	266

Table 2.3: Impact of Radio Coverage on Adoption of HYVs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wheat				Rice			
	% HYV Area/GCA		% HYV Area/Crop Area		% HYV Area/GCA		% HYV Area/Crop Area	
Radio	1.006		0.983		2.563**		8.835***	
	(0.687)		(2.843)		(1.055)		(3.061)	
Prop. Radio		0.736		-3.365		2.377**		7.127*
		(1.037)		(3.877)		(1.196)		(3.651)
Adj. R^2	0.742	0.742	0.737	0.737	0.722	0.721	0.690	0.688
Obs.	3458	3458	3125	3125	3458	3458	3262	3262
Dep. var. SD	9.176	9.176	36.356	36.356	8.404	8.404	26.489	26.489

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.4: Heterogeneous Impacts of Radio Coverage on Adoption of HYVs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wheat				Rice			
	% HYV Area/GCA		% HYV Area/Crop Area		% HYV Area/GCA		% HYV Area/Crop Area	
Radio	1.919		-7.419		6.420**		15.470	
	(1.498)		(10.677)		(3.077)		(10.798)	
Radio*Literacy Rate	-0.057		0.530		-0.240		-0.413	
	(0.081)		(0.629)		(0.157)		(0.668)	
Prop. Radio		2.215		21.312		4.965*		15.199
		(1.935)		(17.040)		(2.930)		(10.238)
Prop. Radio*Literacy Rate		-0.096		-1.696		-0.169		-0.526
		(0.106)		(1.130)		(0.167)		(0.605)
Adj. R^2	0.742	0.742	0.737	0.737	0.723	0.721	0.690	0.688
Obs.	3458	3458	3125	3125	3458	3458	3262	3262
Dep. var. SD	9.176	9.176	36.356	36.356	8.404	8.404	26.489	26.489

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.5: Falsification Test: Impact of Next Year's Radio Coverage on Adoption of HYVs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Wheat				Rice			
	% HYV Area/GCA		% HYV Area/Crop Area		% HYV Area/GCA		% HYV Area/Crop Area	
Radio	1.256		5.637		3.085***		6.412*	
	(0.795)		(3.829)		(0.959)		(3.560)	
Radio Next Year	0.520		-2.426		-0.036		3.471	
	(0.862)		(3.552)		(0.622)		(3.561)	
Prop. Radio		0.961		0.120		1.532		5.727*
		(0.958)		(4.095)		(0.951)		(2.976)
Prop. Radio Next Year		0.425		-1.867		1.081		0.916
		(0.961)		(5.189)		(0.862)		(2.830)
Adj. R^2	0.734	0.733	0.741	0.741	0.722	0.720	0.684	0.682
Obs.	3192	3192	2879	2879	3192	3192	3005	3005
Dep. var. SD	8.903	8.903	36.130	36.130	7.984	7.984	25.332	25.332

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.6: Impact of Radio Coverage on Irrigation of Wheat and Rice

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	% Wheat Irrigated Area/Wheat Area				% Rice Irrigated Area/Rice Area			
Radio	-3.575*	-5.046			-2.239*	-1.973		
	(2.045)	(6.388)			(1.214)	(3.565)		
Radio*Literacy Rate		0.093				-0.017		
		(0.400)				(0.216)		
Prop. Radio			-4.854*	10.178			-2.398*	1.925
			(2.630)	(11.850)			(1.325)	(3.940)
Prop. Radio*Literacy Rate				-1.033				-0.282
				(0.817)				(0.265)
Adj. R^2	0.303	0.303	0.303	0.303	0.107	0.107	0.107	0.107
Obs.	2849	2849	2849	2849	2998	2998	2998	2998
Dep. Var. SD	33.482	33.482	33.482	33.482	38.281	38.281	38.281	38.281

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.7: Impact of Radio Coverage on Fertilizer Use

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Nitrogen (kg/ha of NCA)				Phosphate (kg/ha of NCA)				Potash (kg/ha of NCA)			
Radio	-1.821	-5.776			-0.661	-0.196			-0.075	1.173		
	(1.469)	(4.061)			(0.448)	(1.494)			(0.395)	(2.323)		
–*Literacy Rate		0.247				-0.029				-0.078		
		(0.261)				(0.090)				(0.127)		
Prop. Radio			-2.620	-7.721			-0.185	-3.079			1.288	-8.296
			(1.597)	(5.424)			(0.557)	(2.280)			(0.979)	(6.157)
–*Literacy Rate				0.332				0.188				0.624
				(0.372)				(0.153)				(0.427)
Adj. R^2	0.694	0.694	0.694	0.694	0.577	0.577	0.577	0.577	0.255	0.255	0.256	0.263
Obs.	3376	3376	3376	3376	3376	3376	3376	3376	3376	3376	3376	3376
Dep. Var. SD	17.230	17.230	17.230	17.230	5.644	5.644	5.644	5.644	4.687	4.687	4.687	4.687

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 2.8: Impact of Radio Coverage on Crop Yields

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log(Wheat Yield)				Log(Rice Yield)			
Radio	0.042	-0.058			0.019	0.117		
	(0.038)	(0.116)			(0.048)	(0.120)		
Radio*Literacy Rate		0.006				-0.006		
		(0.007)				(0.007)		
Prop. Radio			0.004	0.026			0.150**	0.058
			(0.056)	(0.221)			(0.073)	(0.193)
Prop. Radio*Literacy Rate				-0.002				0.006
				(0.016)				(0.013)
Adj. R^2	0.486	0.486	0.486	0.486	0.321	0.321	0.322	0.322
Obs.	3090	3090	3090	3090	3249	3249	3249	3249

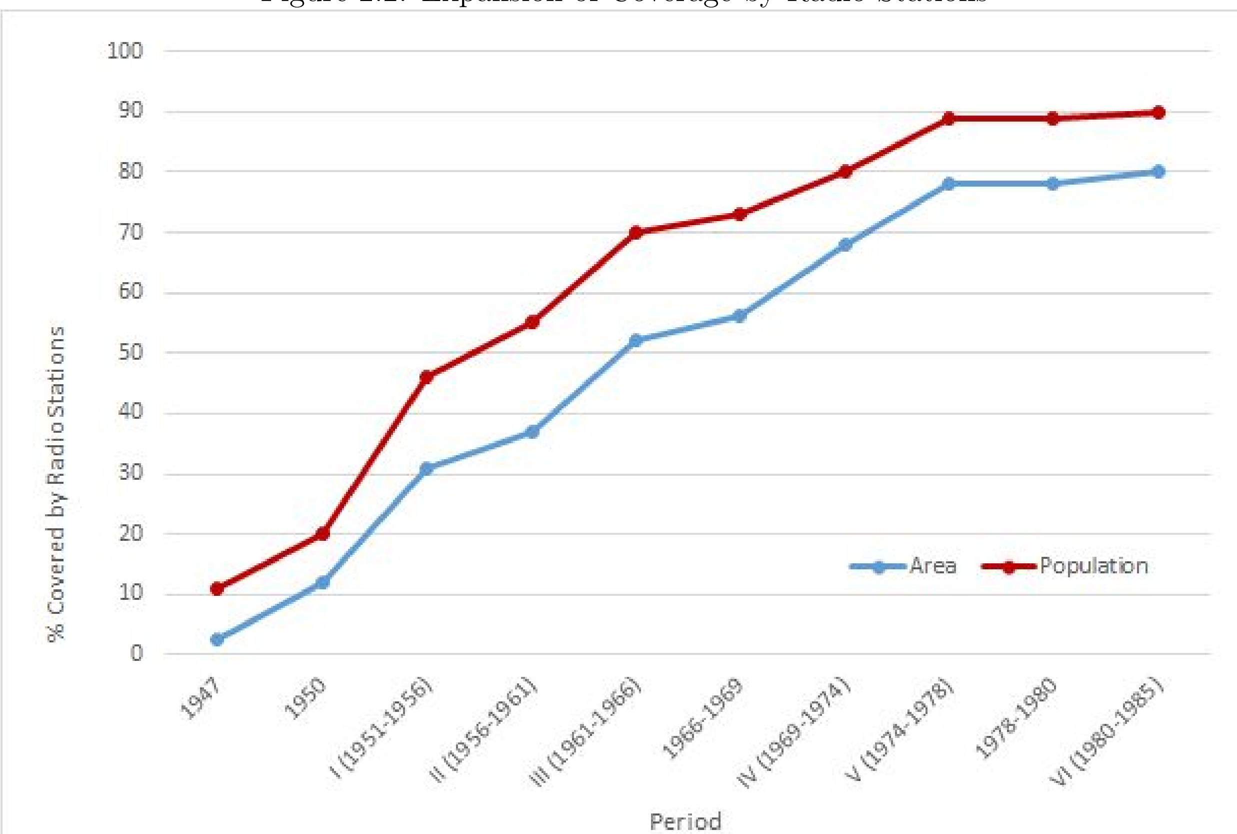
Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Figures

Figure 2.1: Expansion of Radio Stations

Notes: Author's depiction of data from Prasar Bharati (2007).

Figure 2.2: Expansion of Coverage by Radio Stations



Notes: Author's depiction of data from Prasar Bharati (2007).

Figure 2.3: Number of Districts Newly Covered by Radio by Year

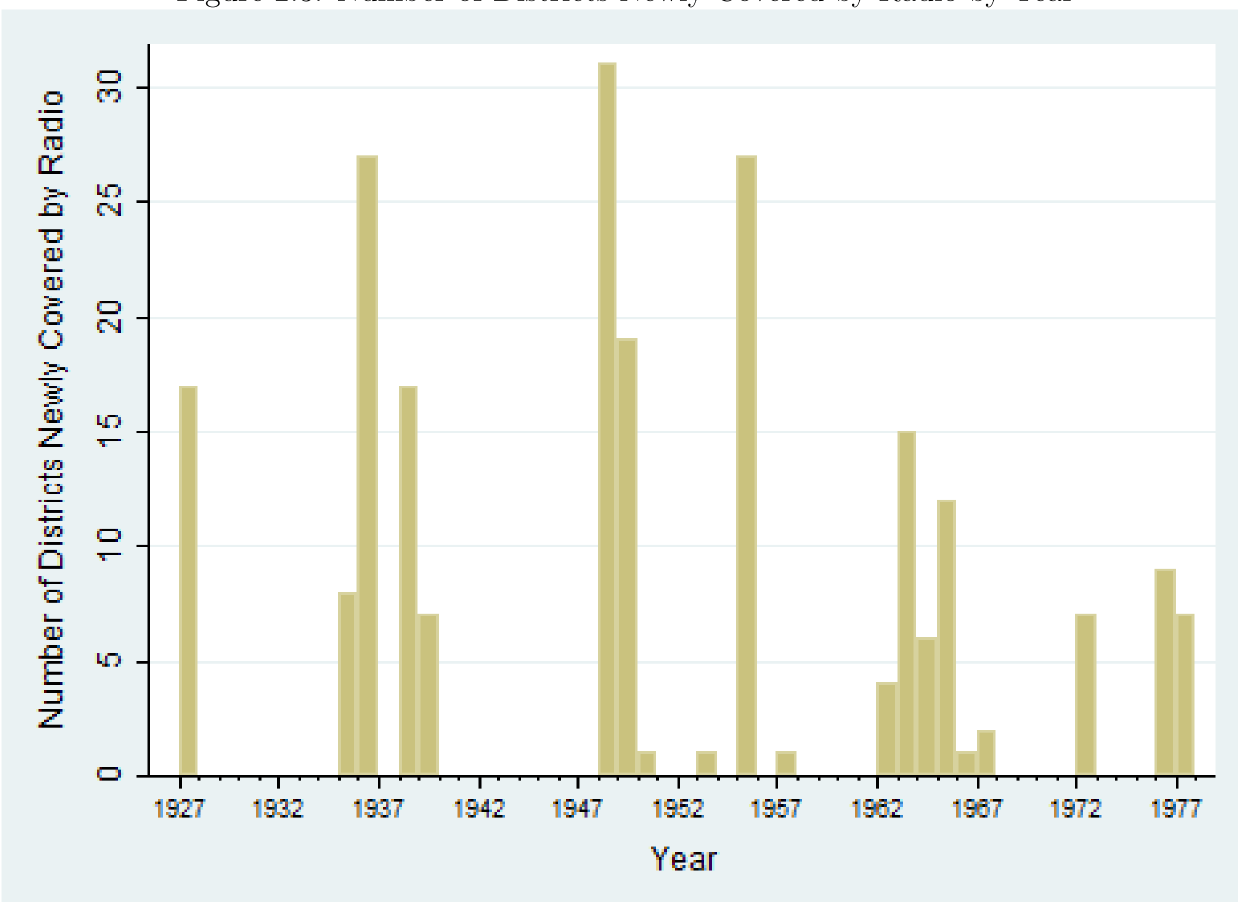


Figure 2.4: Spatial Variation in Period of Introduction of Radio Coverage to Districts

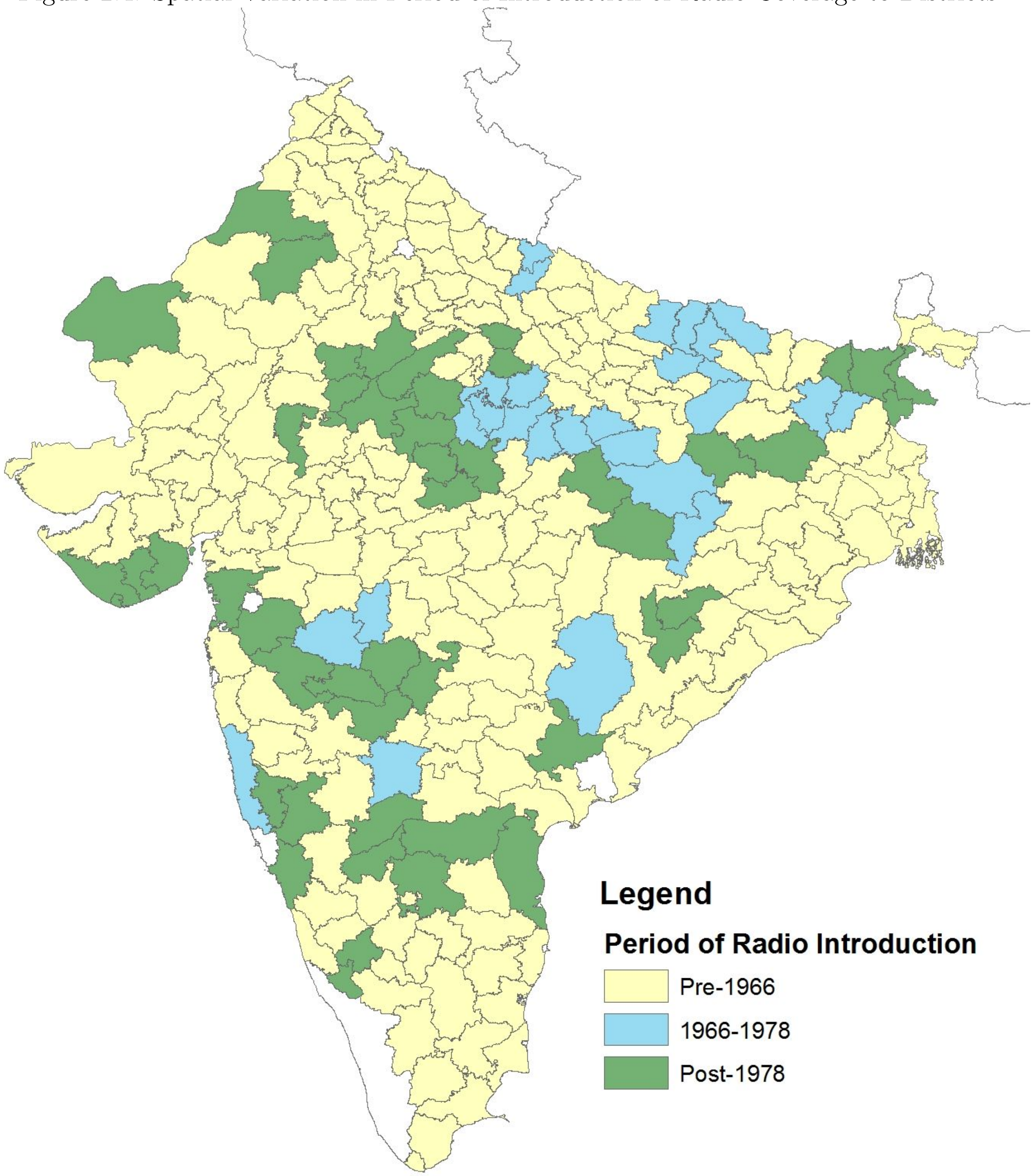


Figure 2.5: Spatial Variation in Period of Introduction of Radio Coverage to Districts

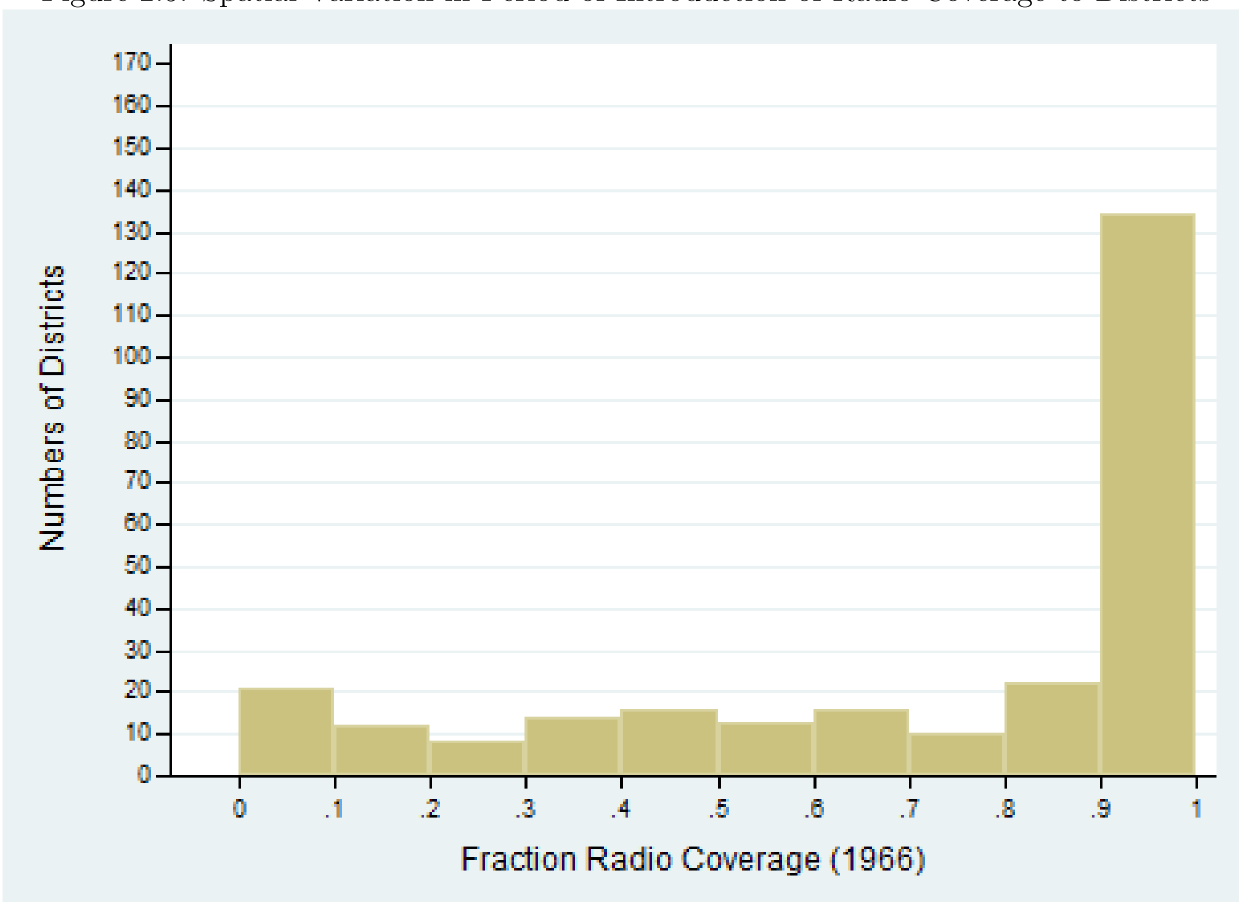


Figure 2.6: Spatial Variation in Period of Introduction of Radio Coverage to Districts

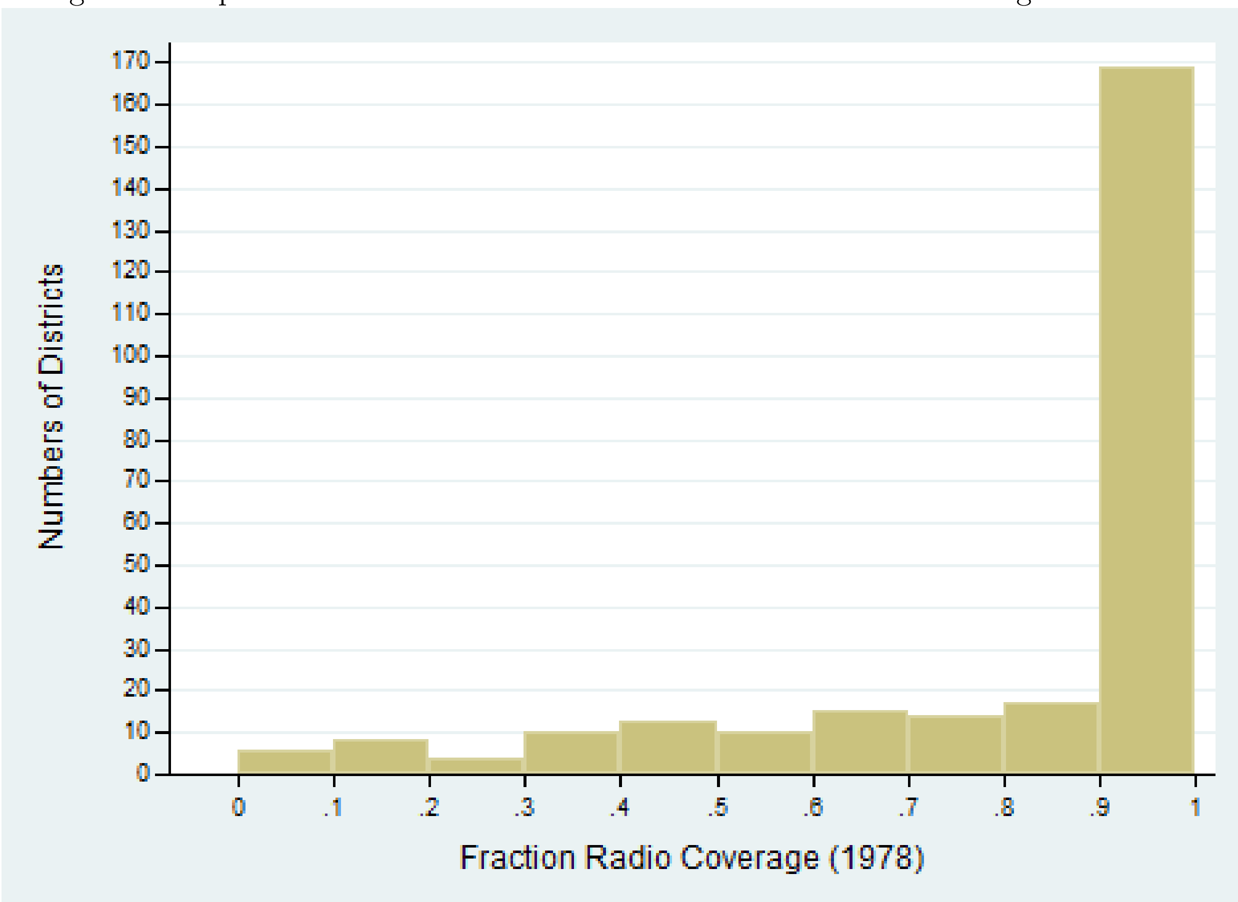
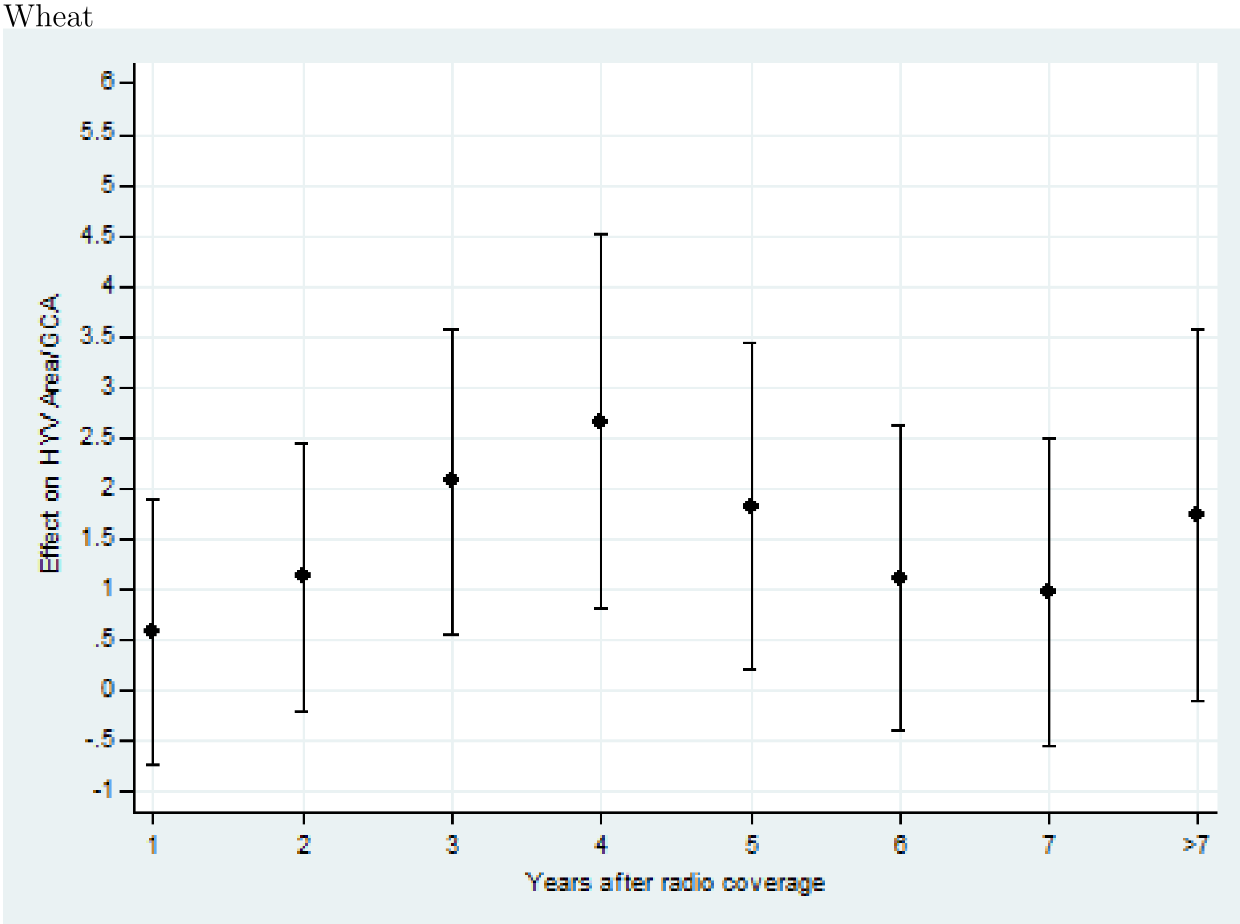
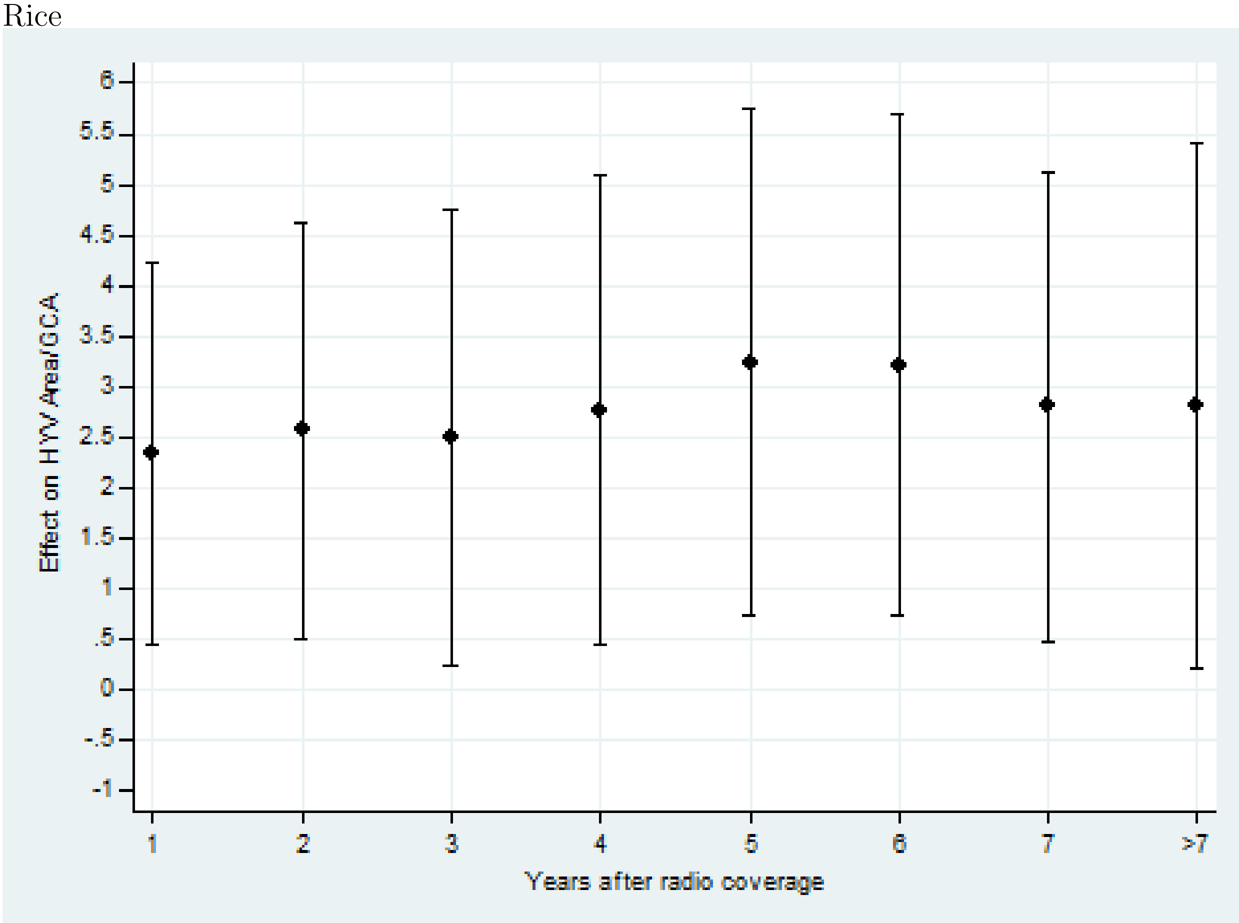


Figure 2.7: Impact of Additional Years of Radio Coverage on Prop. of GCA under HYV Wheat



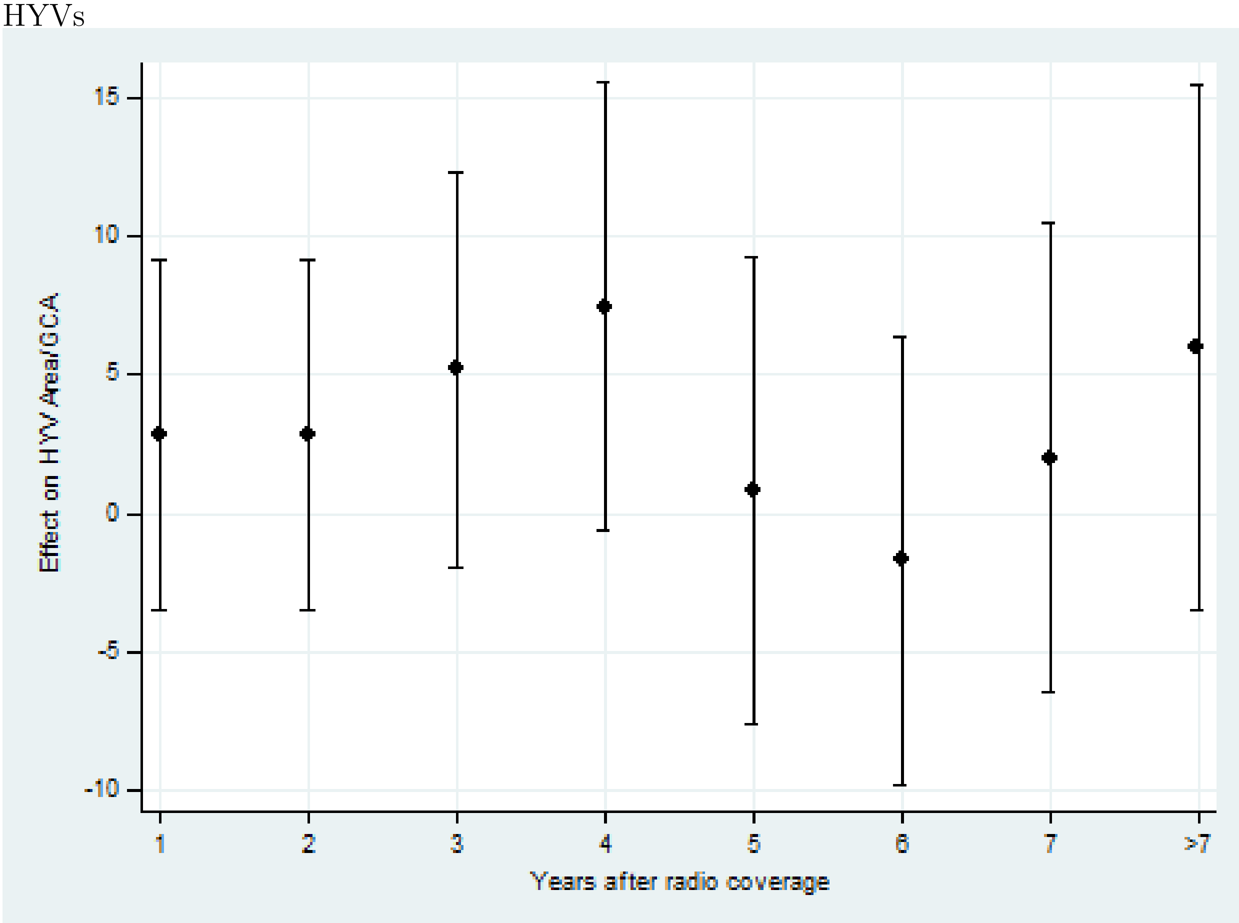
The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.8: Impact of Additional Years of Radio Coverage on Prop. of GCA under HYV Rice



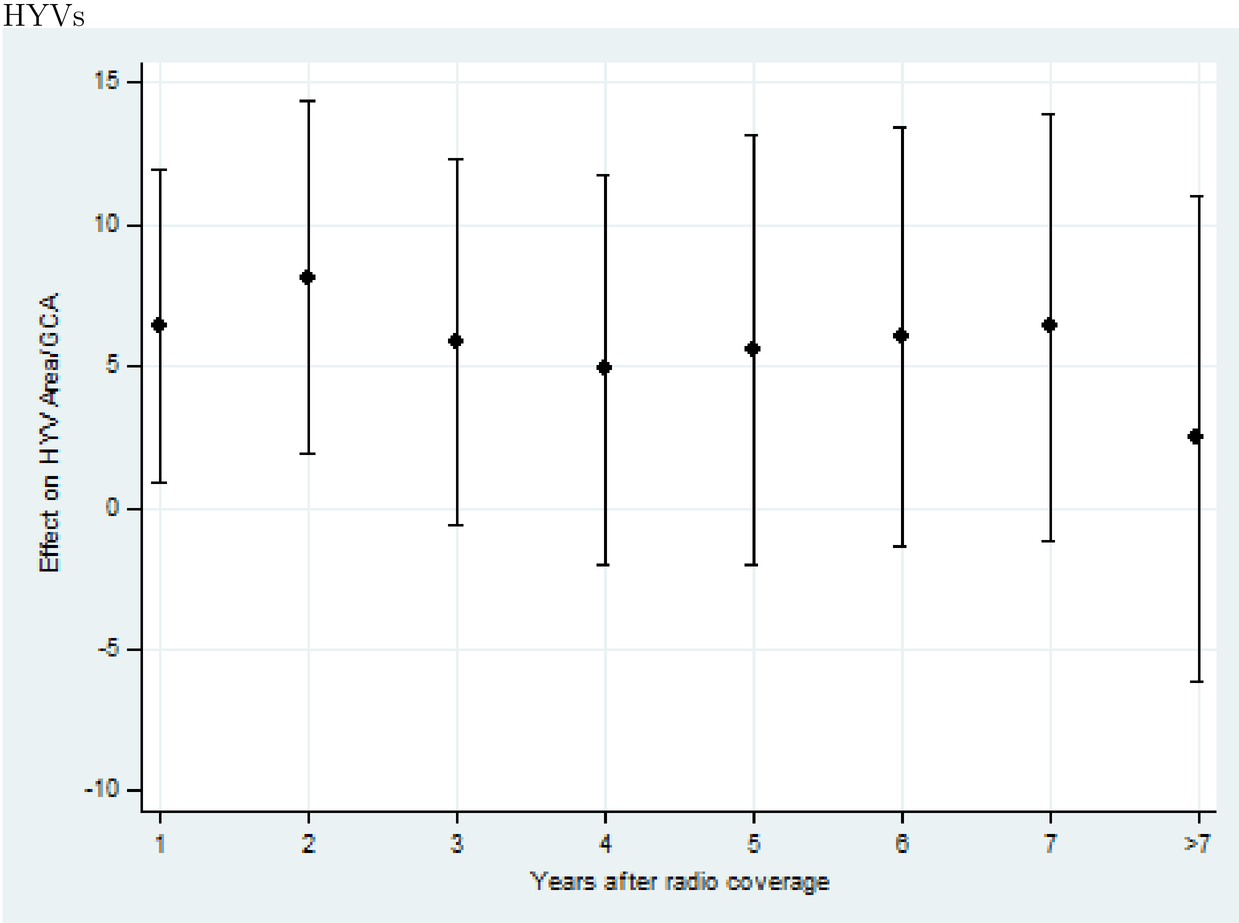
The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.9: Impact of Additional Years of Radio Coverage on Prop. of Wheat Area under HYVs



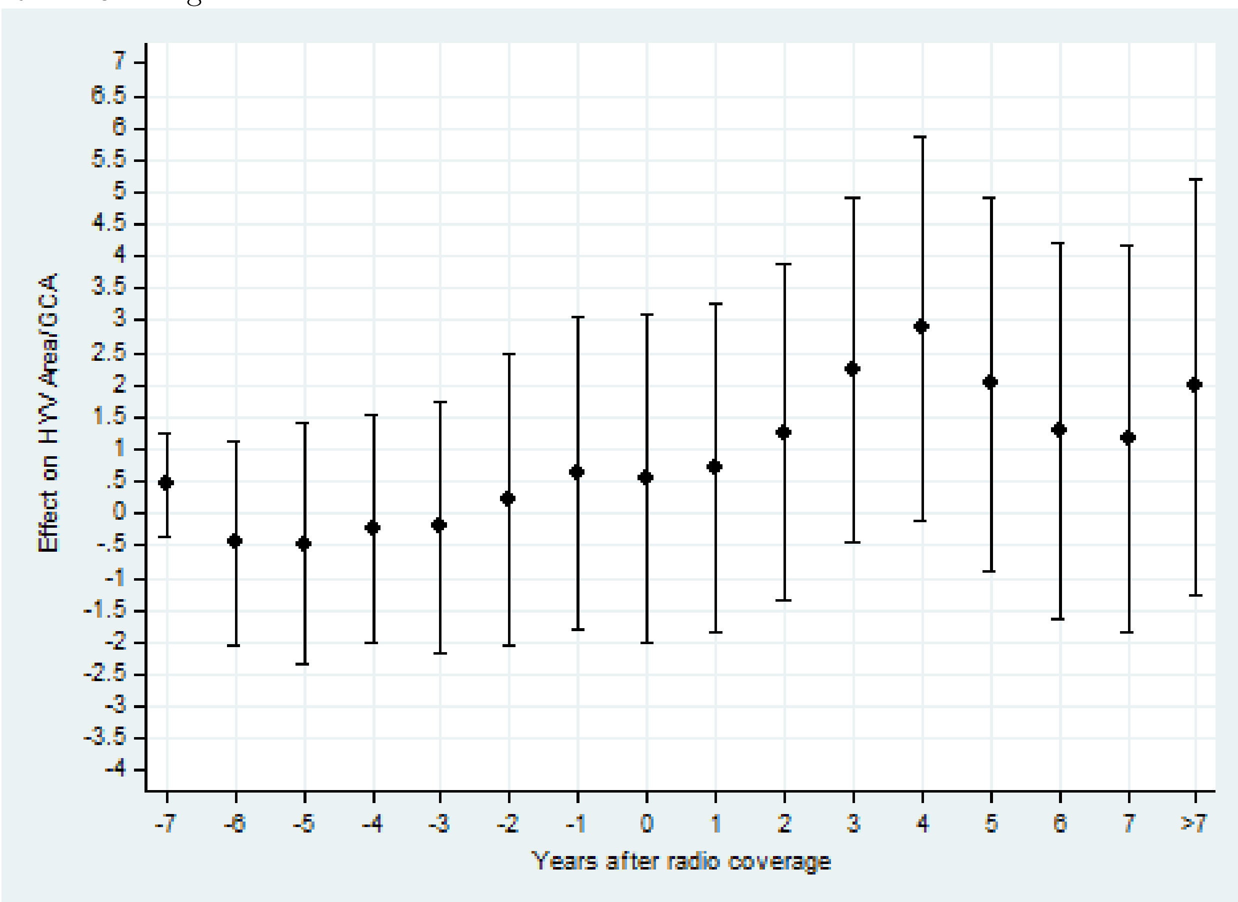
The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.10: Impact of Additional Years of Radio Coverage on Prop. of Rice Area under HYVs



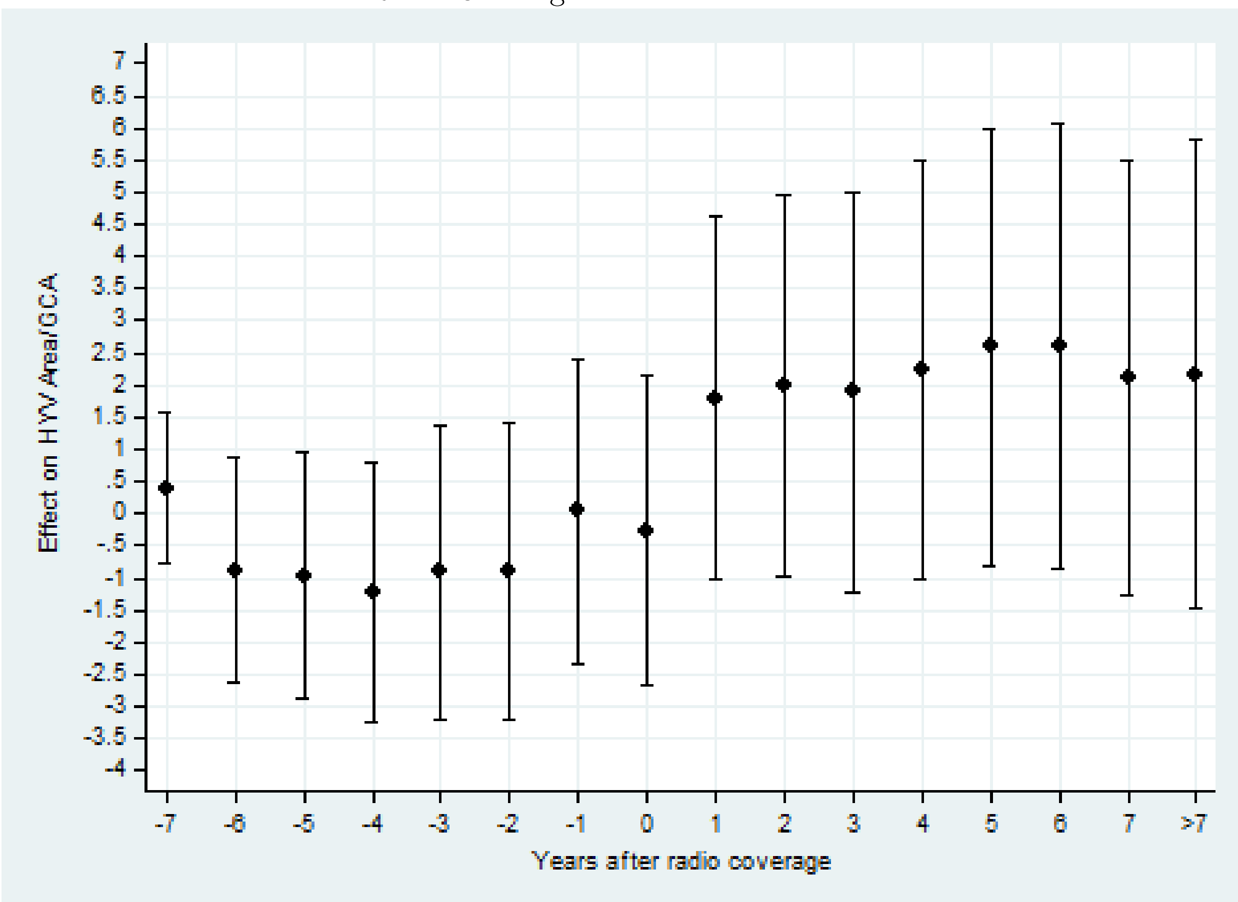
The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.11: Trend of Prop. of GCA under HYV Wheat Relative to Year of Introduction of Radio Coverage



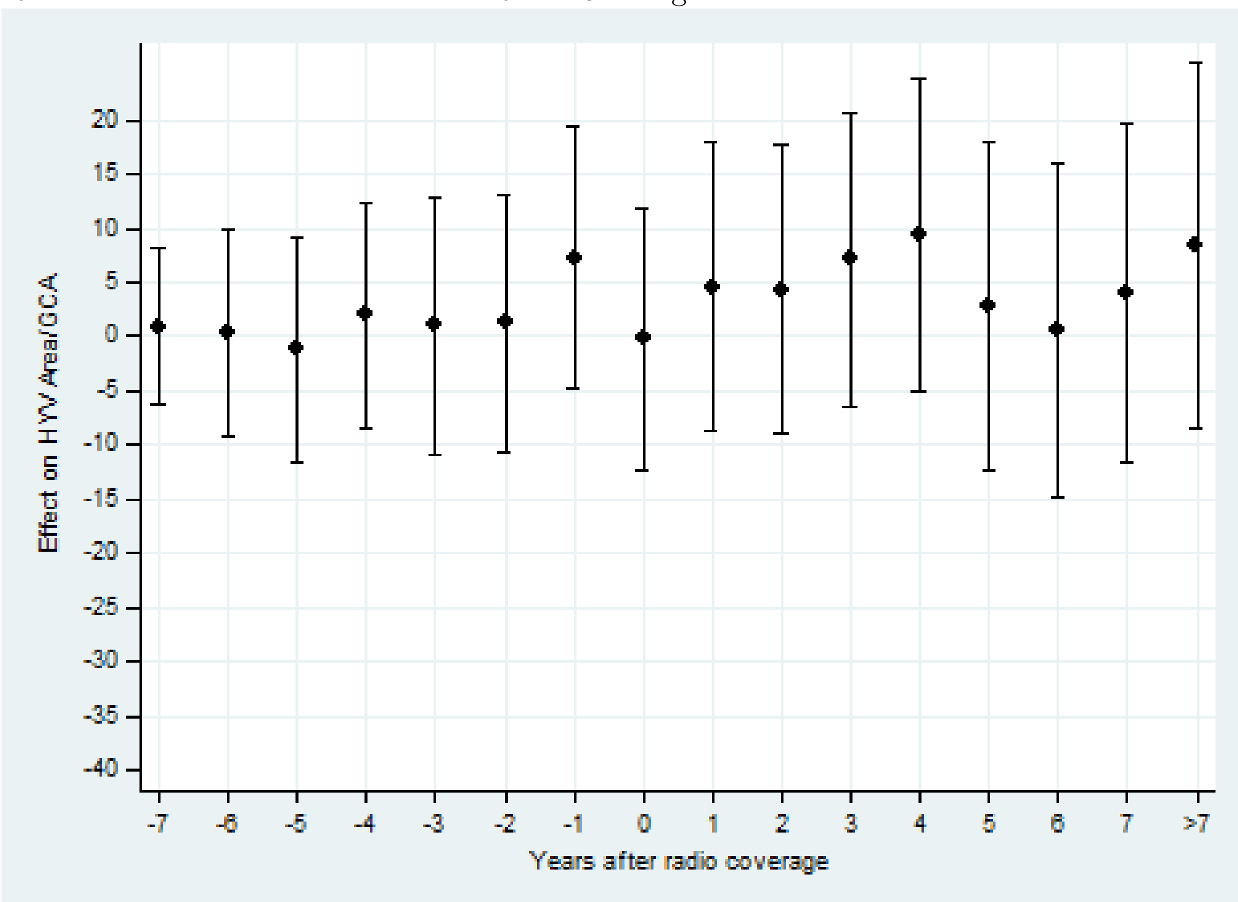
The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. Districts that do no receive radio coverage by 1978 are excluded. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.12: Trend of Impact of Radio Coverage on Prop. of GCA under HYV Rice Relative to Year of Introduction of Radio Coverage



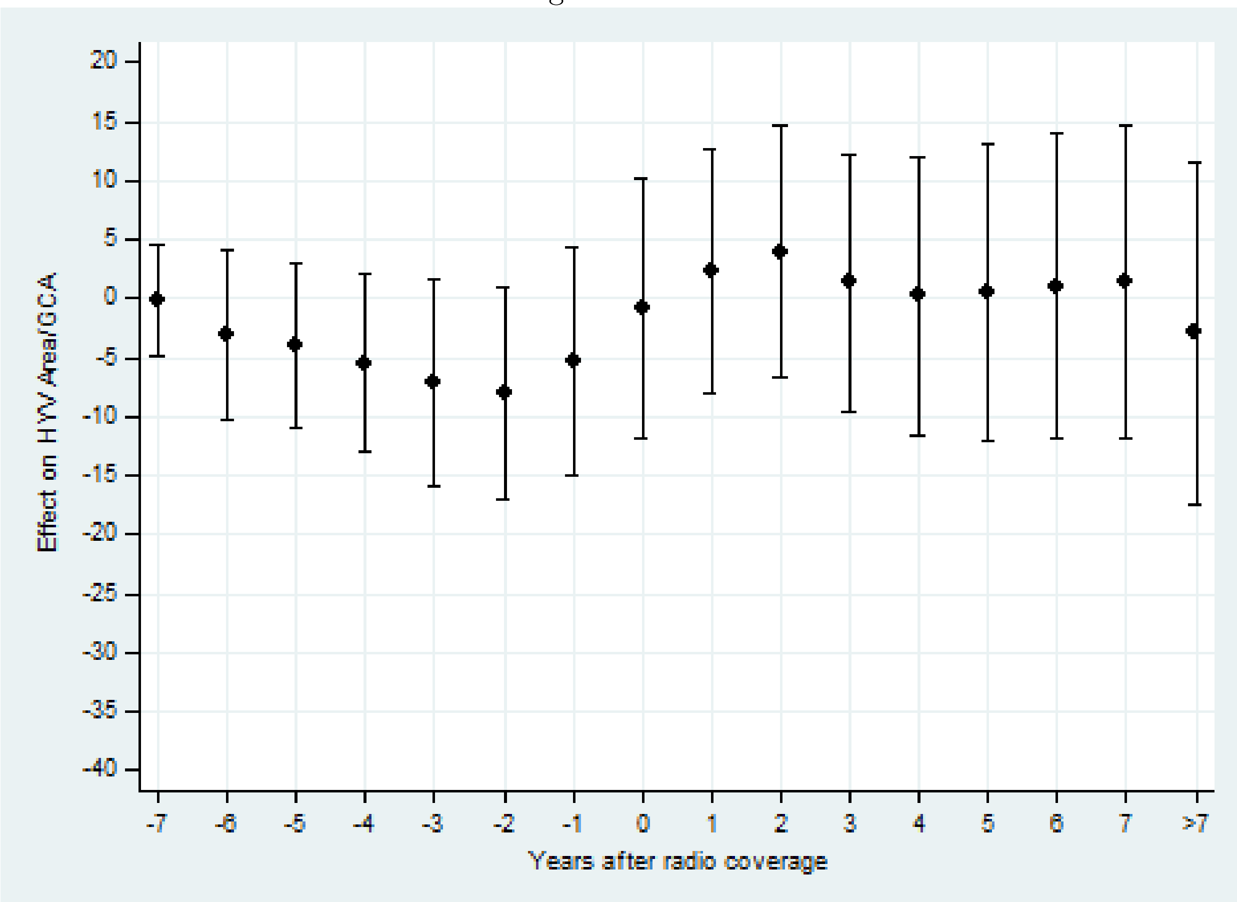
The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. Districts that do no receive radio coverage by 1978 are excluded. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.13: Trend of Impact of Radio Coverage on Prop. of Wheat Area under HYVs Relative to Year of Introduction of Radio Coverage



The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. Districts that do no receive radio coverage by 1978 are excluded. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Figure 2.14: Trend of Impact of Radio Coverage on Prop. of Rice Area under HYVs Relative to Year of Introduction of Radio Coverage



The regression includes district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. The omitted category is more than seven year before radio introduction. Districts that do no receive radio coverage by 1978 are excluded. The 95 percent confidence intervals, calculated using robust standard errors clustered by district, are depicted.

Chapter 3

Impact of Cable Television on Women's Welfare: Evidence from Rural India

3.1 Introduction

There is growing interest in the effect of commercial mass media on families, in both developed and developing countries. Through the information they provide, the norms, attitudes and role models they portray, and the activities they crowd out, mass media affect a range of family choices, behaviors and outcomes.[1] In the case of India, the the introduction of cable/satellite TV led to a dramatic change in the type and quantity of content available to viewers. Indeed, ethnographic studies find that the content of cable TV has had a large "modernizing" influence on Indian villages (Johnson, 2001; Scrase, 2002). Given the significant amount of time households spend watching TV, its crowding-out effects are equally important to study.

[1]See DellaVigna and La Ferrara (2016), and La Ferrara (2016) for a formal model of these mechanisms and a survey of the related literature. Price and Dahl (2012) surveys the literature that uses natural experiments to estimate the effects of mass media on families.

In this study, using two rounds of an Indian national household survey from 2004 and 2011, I examine the impacts of cable TV on women's health knowledge, their fertility preferences and outcomes, their status and autonomy, and their membership in formal groups. Unlike previous studies, I do not find strong impacts on women's fertility preferences or outcomes. It improved women's status within the household to some extent, with a decrease in prevalence of wife-beating but had little effect on their autonomy. There is, however, clear evidence that cable TV decreased women's participation in formal groups.

Television was introduced in India in 1959 but because of the restricted number of terrestrial transmitters of the government-controlled broadcaster, *Doordarshan*, and lack of access to electricity, it remained largely confined to urban areas until the early 1980s. The content was primarily focused towards news, arts, education, and national integration. The introduction of cable TV in the early 1990s increased the number of channels available to viewers from two in 1991 to more than 200 channels in 2005. The new content available covered most genres, including sports, children's programming, news and documentary, international programs and catered to audiences in a range of languages. In 2005, out of the 192 million households in the country (Government of India, 2001), 110 million households had a TV, and 61 million households additionally had cable service, which was growing at a rate of 10 percent per year (National Readership Studies Council, 2006; Thussu, 2007). The most popular TV shows in the 2000s were soap operas that were set in urban areas. Their portrayal of the lifestyle of urban women was markedly different from that of rural women. For example, it was common for female characters on the TV shows to pursue higher education, work professionally, marry later, marry outside of their caste, and have fewer or no children; all of which was quite remarkable to rural viewers.

From a policy perspective, interest in studying the effect of mass media on fertility preferences, family planning, and fertility outcomes, extends to both developed and developing countries. A recent paper by Kearney and Levine (2015b) examines the effect of a popular TV show in the U.S., MTV's *16 and Pregnant*, which portrays the difficulties faced by teenage mothers on the behavior and fertility of teenagers. They find that the show increased Google searches about birth control and abortion, and decreased teen births by 5.7 percent over the 18 months following the introduction of the show.

La Ferrara et al. (2012) examine the effect of soap operas on fertility in Brazil. To identify this effect, they exploit the differential year of introduction of a TV network, *Globo*, that broadcasted the soap operas, over the period from 1979 to 1991. They find that exposure to *Globo* reduced a woman's probability of giving birth in a year by 0.5 pp., which is 5 percent of the mean level and equivalent in magnitude to 1.6 additional years of schooling. To support the argument that the impact of the soap operas was due to the content–the portrayal of role models such as women with fewer or often no children–rather than the crowding out of time spent with their spouse or partner, they provide evidence that exposure to *Globo* increased the naming of children after popular characters from soap operas.

Bhavnani and Nellis (2016) examine the effect of TV ownership (and exposure to the government-controlled monopoly TV network, *Doordarshan*, which emphasized family planning in its programming) on fertility in India. They instrument cross-sectional variation in television ownership, obtained from household data from 1992-1993, with signal loss from *Doordarshan*'s transmitters, calculated using a radio wave propagation model, the Irregular Terrain Model (ITM). They find that TV ownership increased family planning discussions at home and contraceptive use, and decreased the number of children desired. This, however, came at the cost of desiring disproportionately fewer daughters than sons.

This study is closest in terms of context and empirical strategy, although quite different in its conclusions, to Jensen and Oster (2009) who examine the effects of cable TV on women's fertility preferences and outcomes, and their status and empowerment in India. To estimate the effect they exploit the expansion of cable TV to 20 villages over three years from 2001 to 2003 in a sample of 180 villages spread across five states. With respect to fertility, they find that cable TV is associated with a 8.82 pp. (15.47 percent of the mean level) decrease in probability of women desiring the next child to be a boy, and with a 3.79 pp. (52.64 percent of the mean level) decrease in probability of being currently pregnant. I discuss other results they obtain later in this section.

In this study, I find no evidence of impact on fertility preferences and outcomes. There is no impact on desire to have more children or a weak effect on ideal number of children. There is no impact on either contraceptive use or on the probability of current pregnancy. What explain this large difference? Estimation on a sub-sample from the same five states as Jensen and Oster (2009) does not alter this result. The difference in time of the surveys, i.e., 2001-2003 vs. 2004 and 2011 of this study may be associated with different content. The more plausible explanation is that fertility preferences and contraceptive use had already "modernized" with the passage of time, making further reductions in fertility difficult.

There are also several papers that look at the effect of mass media on women's status and empowerment in developing countries. Chong and La Ferrara (2009), investigating the effect of soap operas in Brazil, find that exposure led to increased rates of separation and divorce. Jensen and Oster (2009) find that cable TV reduced the acceptability by wives of beating by husbands. They report a decrease in number of situations in which beating is acceptable by 9.46 percent of the mean level. Finally, Cheung (2012) examines the effect of a popular FM radio station on women's status in Cambodia. Using both a cross-sectional approach that exploits the variation in over-the-air signal strength and a panel approach that exploits the expansion of radio coverage over time, and individual data, she finds that exposure to the radio station significantly raised women's decision-making power within the household and decreased the acceptability of domestic violence.

In terms of women's status, I find that cable TV significantly reduced the (perception of) prevalence of husbands beating wives for going out without permission and for not bringing enough dowry. The number of situations in which women report prevalence of beating decreases by 8.52 percent of the mean level, which is very close to the estimate in Jensen and Oster. Note, however, that the variable in their paper measures acceptability as opposed to the perception of prevalence in this study, although it is often difficult to distinguish between the two. I find no evidence of an impact on any outcome related to women's autonomy–their involvement in making important family decisions or their ability to go outside their home. There is no qualitative change in the results when estimated with the sub-sample of five states from Jensen and Oster (2009)

Introduction of an entertaining mass medium such as cable TV leads naturally to increases in time devoted to watching TV. A direct consequence of the limited amount of time available to individuals is that TV crowds out alternate activities. Overall, the crowding-out effect can lead to unexpected outcomes, whose desirability depends on policy goals. Much of the literature studying such effects has focused on the impact of TV viewing on learning/education outcomes of children. Gentzkow and Shapiro (2008) study the impact of pre-school exposure to TV on school test scores of U.S. children. They exploit the expansion of TV stations across media markets over time and find that the exposure improves English test scores but only for immigrant children. They argue that the mechanism underlying this effect is the crowding out of time spent talking in the native language with family members by the time spent watching TV shows in English. Support for this argument comes from the fact that there is no effect on math scores. Dahl and DellaVigna (2009) find that crime is lower on days with large audiences at theaters for violent movies. They provide suggestive evidence that it is driven by alcohol consumption at bars being crowded out by movie-watching, particularly by those at greater risk of engaging in crimes.

However, not all crowding-out effects are positive. Bjorvatn et al. (2015) conducted an RCT to evaluate the impact of an inspirational TV series on entrepreneurship by secondary school students. Although it increased entrepreneurship rates among the students, it decreased their probability of passing the final school exam and of continuing in school. Following Putnam (2001), the role of TV in crowding out social participation and causing a decline in social capital has been under increased scrutiny.

Gentzkow (2006) examines the impact of TV on voter turnout in the U.S. Using the same identification strategy as Gentzkow and Shapiro (2008), he finds that TV led to a decrease in voter turnout in non-presidential election years. He provides evidence that it is driven by substitution away from reading local newspapers, which tend to carry more information on local politics than national TV news. In the context of a developing country, Olken (2009) examines the effect of expansion of TV and radio on participation in social groups in Indonesian villages. Using both a panel approach and a cross-sectional approach of instrumenting the number of channels available in a village with the predicted signal strength from an ITM model, he finds that additional channels lead to fewer social groups in the village and lower attendance at meetings.

I find that receiving cable TV increases TV viewing for everyone in the household. However, I do not find any evidence of crowding out of newspapers; to the contrary there is a decrease in the probability of men and women reporting that they never read newspapers. However, cable TV decreases the probability of household membership in women-related groups, such as SHGs by 6.6 pp. (36.46 percent of the mean level) and credit/savings associations by 5.4 pp. (47.79 percent of the mean level). These are large effects and driven primarily by the substitution behavior of women who overwhelmingly constitute such groups. The significance on these results is amplified by the fact that there is no impact on membership in other types of groups that do not necessarily cater to women. This may be due to the fact the SHGs and credit/savings associations tend to require regular meetings and interactions among members, imposing larger time burdens compared to other group types.

The rest of the paper is organized as follows. In Section 3.2, I describe the data source and the variables in detail. In Section 3.3, I describe the empirical strategy and in Section 3.4 present the results of the impact of cable TV. Section 3.5 concludes.

3.2 Data

This paper uses the Indian Human Development Survey (IHDS), a national household survey with two rounds, the first in 2004-2005 and second in 2011-2012. The survey covers households in all states and union territories in India with the exception of the islands–Andaman and Nicobar, and Lakshadweep. In round 1, IHDS surveyed households in 1503 villages and 971 urban neighborhoods. In the second round, all the households that remained in the same village or urban neighborhood were re-interviewed. New households that formed due to divisions and resided in the same village or urban neighborhood were also interviewed. In this study, I consider only the rural sample of households. In the first round, 21,627 ever-married women aged 15-49 ("eligible"), one from each household, were interviewed on topics related to health, education, fertility, and gender relations. In the second round, 16,968 of these women were re-interviewed, including 2,747 women who were older than 49.

The data used in this paper are from three questionnaires–the village questionnaire, the household questionnaire, and the women questionnaire. The village questionnaire collected information about various village characteristics, including infrastructure facilities. The household questionnaire, administered to a household member, typically the head of the household, covered a wide variety of topics, including income, employment, educational status, consumption expenditure, and participation in social groups. The estimation sample consists of a panel of 16,440 women (one from each household) from 1348 villages spread across the country with data on village infrastructure, household composition, and the woman's age and schooling, in both rounds. Given the large number of outcomes I study, I do not restrict the sample to include only observations with data for all outcome variables. The number of observations in individual regressions, therefore, will vary depending on the outcome variable.

The summary statistics for the covariates used in estimation are presented in Table 3.1. From 2004-05 to 2011-12, there was rapid expansion of cable TV and mobile phone service in rural areas with coverage by both increasing to almost 100 percent from 48 percent and 62 percent, respectively. There was also a large increase in village access to a paved road. Even in 2004-05, there was almost universal access to electricity at 94 percent, which increased further to 99 percent. The average number of households in a village (from the 2001 census) was 624.10 and the distance to the nearest town was 13.84 km. The next set of covariates are from the household questionnaire and measure changes in household composition. The size of a household was 5.82 members in round 1 and decreased by 8.60 percent in round 2. The proportion of children decreased from 34 percent to 27 percent. The average age of the eligible woman was 32.80 in round 1. As expected for a balanced panel, the average age of women in round 2 is about seven years higher. Unsurprisingly, there has been little change in the years of schooling of the eligible women.

Table A1 in the Appendix C.1 presents the summary statistics for all the outcome variables used in this study. I briefly discuss some key trends revealed by the data. Between the two survey rounds, there is a decrease in proportion of men, women, and children that never watches TV, an increase in proportion that never listens to the radio, and decrease in proportion that never reads newspapers. The household ownership of TV increased from 41 percent to 58 percent and the average amount of TV watched by men increased by 33.79 percent to 1.25 hours/day, by women increased by 25.83 percent to 1.72 hours/day, and by children by 20.22 percent to 1.07 hours/day.

The trends in health beliefs are mixed. The proportion holding the correct health beliefs: "colostrum good for the baby" and "indoor smoke is harmful" increased, and the proportion holding the incorrect belief, "men are weak long after sterilization", decreased. However, the proportions with the incorrect belief: "feed children less water during diarrhea", increased and with the correct belief, "pregnancy most likely to occur mid-way between two periods", decreased. Awareness of AIDS increased marginally by 5 pp. There is very little change in fertility preferences–whether more children desired, and ideal number of sons and daughters–between the two rounds. Contraceptive use increases substantially from 55 percent to 79 percent. The proportion of respondents pregnant decreased from 5 percent to 2 percent, which may at least partially be attributable to the higher average age in the second round given the panel nature of the data.

The next set of variables relate to gender relations within the household including prevalence of wife-beating and discussions between husband and wife on important matters. Women were asked, "In your community is it usual for husbands to beat their wives in each of the following situations?" The situations were, "If she goes out without telling him?", "If he suspects her of having relations with other men?", "If her natal family does not give expected money, jewelry, or other items?", "If she neglects the house or children?", and "If she doesn't cook properly?" Note these questions may not measure the respondent's acceptability of beatings, rather they measure the respondent's perception of the prevalence of beating by husbands in her community, which may or may not be different. Except for suspicion of extra-marital relations, the prevalence of beating increases in all other situations between the two rounds. With respect to discussions with husbands, women report greater likelihood of discussions on topics related to farm or work, to expenditures, and to politics in round 2 compared to round 1.

There is an increase in women being involved in decision-making, either alone or jointly with others, in all areas. The largest increases, of 12 pp., are in "making big purchases" and deciding "who the child marries". There is also a 12 pp. increase in the fraction of women that keep cash on hand. However, more women report needing permission to visit health centers, friend or relative's house, and the market. The largest increase is for markets at 16 pp. There is also a marginal increase in the practice of veiling. More women, however, report that they can go alone to each of these three places. Overall, it appears there is a trend towards greater autonomy for women–in decision-making within the household and to go outside the home, although the latter is accompanied by greater monitoring.

The final set of variables relate to the household participation in groups in the village. The household questionnaire collects information on whether any household member is a member of each of the eight types of social groups. I club three group types (cooperatives, trade union/professional group, and NGOs) under "other". Individually, these groups have negligible membership. The six groups I consider are: Women's Committees (*Mahila Mandals*), Self-Help Groups (SHG), credit/savings associations, social/religious/festival groups, caste associations, and any other groups. Membership in two of six group types decreased between the two rounds. Between the two rounds, proportion of households with members in SHGs more than doubled from 11 percent to 24 percent, and in credit/savings associations from 8 percent to 11 percent. In India, SHGs are formally promoted and supported by the government. A government-controlled agricultural credit bank called NABARD runs a program of SHG-bank linkages to channel microcredit to poor households for non-farm activities. More than 85 percent of the SHGs formed are composed exclusively of women (Guha and Gupta, 2005). Membership in social/religious/festival groups decreased from 15 percent to 10 percent, and in caste associations from 14 percent to 8 percent. Membership in Women's Committees and any other groups remain basically unchanged. Attendance of public meetings increased marginally from 36 percent to 38 percent.

3.3 Empirical Strategy

My empirical strategy follows a difference-in-difference approach that compares changes in outcomes between women (and their households) that live in villages that received cable TV access between the two rounds, and those that live in village that did not. Note that the unit of observation is the individual woman/household whereas the change in cable TV access is at the village level.

A potential source of endogeneity is the non-random timing of introduction of cable TV across the villages. Jensen and Oster (2009) carried out a survey of cable operators to understand the determinants of expansion of cable TV across villages in Tamil Nadu. They find that after electrification, distance of the village is the most important factor influencing an entrepreneur's decision to expand to it. Distances add to the cable operator's costs in the form of regular travel to collect dues, add customers, or make repairs. The main reasons noted for why some villages did not have cable as of 2008 was that they were too far away and that they were too small to justify expansion. Therefore, following Jensen and Oster, I control for these determinants, by including an indicator of whether a village is electrified, and interactions of the village size and distance from the nearest town (where cable operators are typically based) with an indicator for round 2.

$$y_{ivt} = \alpha cable_{vt} + \beta_1 X_{ivt} + \beta_2 W_{vt} + \gamma_{iv} + \delta_t + \epsilon_{ivt} \tag{3.1}$$

where, y_{ivt} is outcome of interest for woman (and her household) i in village v in round t. $cable_{vt}$ is whether village v has cable TV in round t. X_{ivt} contain woman's and household's characteristics. W_{vt} contains indicators of village infrastructure facilities, and interactions of distance from nearest town and number of households in the village (from the 2001 census) with the second round indicator, respectively. All the covariates are listed in Table 3.1. γ_{iv} is the household or woman fixed effect and δ_t is the round fixed effect. ϵ_{ivt} is the idiosyncratic error term. Robust standard errors are computed by clustering by village.

3.4 Results

I begin with an investigation of the impact of receiving cable TV access in a village on media usage by households. In the household questionnaire, households were asked how frequently they watched TV, listened to the radio, and read newspapers, with three options (Never, Sometimes, Regularly). Using Equation 3.1, I estimate the effect of cable TV on never using a medium, separately for men, women, and children in a household. Table 3.2 presents the results of these sets of regressions. After a village gets cable TV, the probability of never watching TV decreases by 3.2 pp. (10.78 percent of the mean level) for men and by 4.1 pp. (12.5 percent of the mean level) for women. There is sizeable effect (-2.7 pp., 7.69 percent of the mean level) for children but it is not statistically significant.

There is no effect of cable TV on frequency of listening to the radio. This is not surprising given the proportion of households that never listen to radio is already very high. Interestingly, a village getting mobile service increases radio listenership for men, women, and children. The plausible explanation for this effect is that most mobile phones have an inbuilt radio receiver, giving users access to popular FM radio stations. Columns (7)-(9) present the effect of cable TV on never reading newspapers. The overwhelming majority of men (57.6 percent), women (80.2 percent), and children (78.3 percent) never read newspapers. In contrast to Gentzkow (2006) who finds a substitution from radio and newspapers in the U.S. after the introduction of broadcast TV, receiving cable TV decreases the probability of never reading newspapers decreases by 3.7 pp. (6.42 percent of the mean level) for men and by 2.7 pp. (3.37 percent of the mean level). There is no statistically significant effect on children.

Table 3.3 presents the impact of cable TV on the daily hours of TV watched by men, women and children. While all the estimates are statistically significant, the magnitudes are modest at 4.5 minutes (6.84 percent of the mean level) for men, 6.24 minutes (7.13 percent of the mean level) for women, and 6.18 minutes (10.5 percent of the mean level) for children. Note that this is the effect on all households in the village, both those with and without television sets. To estimate the effect on TV households, I re-estimate columns (1)-(3) on the sample of households that have a TV in round 1. As expected the effects, presented in columns (4)-(6), are much larger. In levels, the effects are close to twice those estimated for all households. In terms of the mean level, it is 9.60 percent for men and 9.20 percent for women. The increase of 4.54 percent for children is not statistically significant.

Table 3.4 presents the results of the impact of cable TV on women's beliefs pertaining to health. Each of the columns (1)-(6) presents the impact on a specific health belief, whether correct or incorrect. Columns (1) and (2) pertain to the incorrect beliefs: "[it is] harmful to drink 1-2 glasses of milk every day during pregnancy" and "men become physically weak even months after sterilization", respectively. Columns (3) and (4) pertain to correct beliefs: "[colostrum] is good for the baby" and "smoke from a wood/dung burning traditional [stove] is harmful for health". Finally column (5) pertains to the incorrect belief that "when children have diarrhea, they should be given less to drink than usual". Finally, column (6) pertains to the correct belief that "a woman is most likely to get pregnant half-way between two periods". Out of these six beliefs, there is a statistically significant effect only on two. The impact of cable TV on the correct belief regarding probability of pregnancy is an increase of 4.2 pp. (30.22 percent of the mean). Puzzlingly, the impact on the incorrect belief regarding child diarrhea is an increase by 6.1 pp. (34.66 percent of the mean). Column (7) presents the effect on awareness of AIDS which is statistically insignificant. Mobile service has no effect on any of these outcomes.

After "information effect" of cable TV, specifically on health-related issues, I turn next to women's fertility preferences and outcomes. These regressions are estimated on a panel of women that is younger than 49 years in round 2. The results are presented in Table 3.5. The overall impact on these variables is quite weak. There is no statistically significant effect on whether the woman, or her husband, desire more children. There is a weak effect on the ideal number of daughters preferred by the woman–an increase of 0.029 (2.56 percent of the mean level). This coefficient is significant at the 10 percent level. There is no effect on whether the woman is currently using contraception or on the probability of being currently pregnant.

Next I turn to the more multi-dimensional topic of women's status in the household. The first set of outcomes, reported in Table 3.6, are of the prevalence of beating of wives by husbands under different situations. A reduction in the prevalence of beating due to receiving cable TV is statistically significant in two out of five situations–for "going out without telling [husband]" it decreases by 6.4 pp. (13.09 percent of the mean level), and for "not bringing enough dowry" it decreases of 6.0 pp. (19.29 percent of the mean level). The effects for "suspecting relations with other men", "neglects the house or children", and "not cooking properly" are statistically insignificant. Overall, it decreases the number of situations in which it is perceived prevalent by 8.52 percent of the mean level (2.382). Columns (7)-(9) present the results of the impact of cable TV on whether women has discussions with their husbands on topics related to the farm or work, to expenditure, and to politics. There is a statistically significant, albeit small, effect only on discussion about expenditure, of 2.8 pp. (3.1 percent of the mean level).

The next set of outcomes I consider related to women's autonomy. Tables 3.7 and 3.8 present the impact on women's autonomy related to decision-making and mobility outside the households, respectively. Each of the columns (1)-(4), present the effect of cable TV on whether women is involved in making important family decisions (alone or jointly with others) in different domains. Column (6) presents the effect on whether women keep cash on hand for expenses. There is no statistically significant effect on any of these outcomes. In contrast, mobile service has a highly statistically significant effects on all the outcomes, increasing the probability of being involved in decision-making in each case, as well the the probability of keeping cash on hand. The first set of variables in Table 3.8 relate to whether women need permission to visit specific venues–the health center, a friend/relative's house, and the market. The second set of variables relate to whether women can go alone to each of the three venues. The last column presents the effect on the practice of veiling. Similar to decision-making, cable TV has no statistically significant impact of any outcome related to women's autonomy and ability to go outside the home.

Jensen and Oster (2009) find that the number of situations in which beating is reported prevalent decreases by 9.46 percent of the mean level (1.70).[2] In addition to impacts on women's status, in contrast to this study, they also find significant impacts on fertility preferences and outcomes, and autonomy. They report a decrease in likelihood of being currently pregnant by 3.79 pp. (52.64 percent of the mean level), and a lower preference for the next child to be a son by 8.82 pp. (15.47 percent of mean level). Finally, they find a positive effect on women's autonomy, an increase of 4.06 percent of the mean level of the autonomy index.

For a better comparison of the results, I re-estimate the regressions on a sub-sample

[2]The questions in the survey they use ask whether it is acceptable for husbands to beat wives in different situations. In our case the question measures to perceived "commonness" of beating, which is a measure of prevalence as opposed to acceptability, although they are closely related. Further, they use 6 situations compared to 5 in this paper.

from the same five states as Jensen and Oster. These results are presented in the Appendix C.2. Receiving cable TV decreases the ideal number of sons desired by 6.21 percent of the mean level (1.561) and has no effect on preference for daughters. Puzzlingly, compared to no effect in the full sample, in the sub-sample the probability of wanting another child increases by 19.6 pp., which is a staggering 106.52 percent of the mean level. Nonetheless, there is no change in the effect on the probability of being currently pregnant. There is also no qualitative change in the autonomy results. Interestingly, the significance of the gender relations results goes away in the smaller sample. Overall, the results of this paper still remain quite different and weak compared to Jensen and Oster and in some respects moves further away when estimated on the same states.

Tables 3.9 and 3.10 present the effects on household membership in various groups in the village. Columns (1)-(3) of Table 3.9 present the estimates of the effect on membership in three types of women-related groups–Women's Committees (*Mahila Mandals*), Self-Help Groups (SHGs), and credit/savings associations. Note that the membership variable is from household questionnaire and asks whether any person from the household is a member of any such group. However, from the context it is clear that membership in these three groups is primarily if not exclusively comprised by women. There is a highly statistically significant and sizeable effect of cable TV on membership in SHGs and in credit/savings associations. Cable TV decreases the probability of membership in SHGs by 6.6 pp. (36.46 percent of the mean level) and in credit/savings associations by 5.4 pp. (47.79 percent of the mean level). We do not see any such effects for membership in other groups that may have women members but tend to be dominated by men–social/religious/festival groups, caste associations, and any other groups. There is a sizable effect on the probability of attending public meetings of 3.7 pp (10.28 percent of the mean level) but it is not statistically significant.

What explains the stark difference in the effect on household membership in women's groups vs. groups with more general membership? Membership in SHGs and credit/savings associations is very time intensive requiring weekly meetings and regular interaction with other members. While there may be variation across villages and over the year, the time commitment at the other groups is unlikely to be as structured as SHGs and credit/savings associations. By increasing the value of at-home leisure cable TV may have crowded out incentives for women to participate in these groups. This is particularly salient given the potentially increased mobility of women outside the home suggested by the results.

Although, I do not find any overall effects of introduction of cable TV on women's fertility preferences, I assess whether there is any heterogeneity in its impact–decreases for some demographics and increases for others. Table 3.11 presents the results of regressions which include interaction terms of cable access and indicators for religion and caste categories. While there is no evidence of heterogeneous effects on women's desire for more children, relative to Hindu households, it decreased the desire for more children by husbands in Muslim and other religion households. The outcome with the most interesting and statistically significant pattern is for contraceptive use. While there little effect of religion on the impact of cable TV on contraceptive use, the impact of cable TV on contraceptive use by women from Other Backward Castes (OBC) and from Scheduled Castes/Scheduled Tribes (SC/ST) is higher than women from high castes by 13.7 pp. and 10.8 pp., respectively.

Results from similar regressions for household participation in women-related groups are presented in Table 3.12. Cable TV had a negative impact on participation in SHGs for all demographics, however, relative to Hindu women, it was 6.1 pp. lower for Muslim women on a mean level of 17.8 percent. For credit/savings groups, it was 2.9 pp. lower for Muslim women than Hindu women, and 5.6 pp. lower for SC/ST women and 2.4 pp. lower for OBC women, relative to higher-caste women, on a mean level of 10.4 percent. Results for participation in other village groups, presented in Table 3.13, similarly suggest that relative to higher-caste Hindus, cable TV decreased participation for the the most marginalized social groups.

3.5 Conclusion

In this paper, I find that cable TV did not have much of an effect on women's health knowledge, their use of contraception or their fertility outcomes. I also do not find any evidence that it increased women's autonomy–decision-making authority or ability to go outside the home. I find evidence that it had some "modernizing" effects on attitudes: a decrease in prevalence/acceptability of domestic violence, and a small increase in women's preference for daughters. However, I also find that cable TV is associated with a significant decrease in participation of women in formal groups in the village.

Opportunities for social participation by rural women is quite restricted, particularly in India. Participation in groups related to credit/entrepreneurship provide financial security for economically vulnerable women and families (Banerjee et al., 2015). Additionally, regular interaction among members also increases social capital among women (Feigenberg et al., 2013) that promotes collective action (Sanyal, 2009). Decreased social participation by women due to cable TV, therefore, may have negative implications for women's empowerment in India.

The literature evaluating the effect of mass media on women's status and empowerment has emphasized studying behaviors that are responsive to changes in attitudes. Ultimately, to assess the welfare impact of mass media, especially for policy purposes, it is also important to study behaviors and choices that are likely to be crowded out by mass media consumption. Future research could enrich our understanding of the multi-dimensional impacts of mass media, especially its crowding-out effects, by collecting and analyzing time-use data.

Even in developing countries, the delivery of media content is increasingly taking place over the Internet, which will provide a greater quantity and variety of content to viewers. The interactive nature of the Internet, allows for greater degree of self-selection of content, which has the potential for inducing larger heterogeneous effects, by gender, ethnicity, age, education, and so on. Further, given the rapid diffusion of social media platforms, that the effect of social network-mediated content on social participation is particularly ambiguous.

Tables

Table 3.1: Summary Statistics of Regression Covariates

	Round 1 (2004-2005)			Round 2 (2011-2012)		
Variable	Mean	SD	N	Mean	SD	N
Has Cable TV Access	0.48	0.50	1348	1.00	0.05	1348
Panel A: Covariates from Village Questionnaire						
Has Mobile Service	0.62	0.49	1348	0.99	0.08	1348
Has Paved Road	0.66	0.47	1348	0.87	0.34	1348
Has Electricity	0.94	0.25	1348	0.99	0.11	1348
# HHs	624.1	842.05	1348			
Dist. to Town (km)	13.84	11.17	1348			
Panel B: Covariates from HH Questionnaire						
HH Size	5.82	2.56	16165	5.33	2.36	16165
Adult Male (%)	0.26	0.12	16165	0.28	0.15	16165
Adult Female (%)	0.26	0.12	16165	0.31	0.14	16165
Teen Male (%)	0.07	0.12	16165	0.07	0.12	16165
Teen Female (%)	0.07	0.11	16165	0.06	0.11	16165
Child Male (%)	0.18	0.16	16165	0.14	0.16	16165
Child Female (%)	0.16	0.16	16165	0.13	0.16	16165
Panel C: Covariates from Women's Questionnaire						
Age	32.80	7.98	16165	40.11	8.49	16165
Years Schooling	3.13	4.03	16165	3.22	4.05	16165

Table 3.2: Effect of Cable TV on Mass Media Use

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Never Watch TV:			Never Listen to Radio:			Never Read Newpaper:		
	Men	Women	Children	Men	Women	Children	Men	Women	Children
Village Cable	-0.032**	-0.041***	-0.027	0.002	-0.002	0.019	-0.037***	-0.027***	0.013
	(0.016)	(0.016)	(0.018)	(0.018)	(0.018)	(0.018)	(0.014)	(0.010)	(0.014)
Village Mobile	-0.015	-0.020	-0.007	0.057***	0.040**	0.057***	-0.006	0.030***	0.044***
	(0.018)	(0.018)	(0.020)	(0.020)	(0.020)	(0.020)	(0.015)	(0.011)	(0.016)
Adj. R^2	0.062	0.078	0.152	0.139	0.110	0.034	0.026	0.024	0.126
Obs.	31216	31895	27357	31263	31923	27541	31214	31837	27397
Dep. var. mean	0.297	0.328	0.351	0.629	0.715	0.755	0.576	0.802	0.783

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.3: Effect of Cable TV on TV Consumption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All Households			Owns	TV Households in Round 1		
	Men	Women	Children	TV	Men	Women	Children
Village Cable	0.075**	0.104**	0.103***	-0.016	0.148***	0.201***	0.062
	(0.033)	(0.045)	(0.036)	-0.012	(0.052)	(0.074)	(0.057)
Village Mobile	-0.044	-0.065	-0.005	0.009	-0.059	-0.118	-0.022
	(0.035)	(0.048)	(0.038)	-0.013	(0.061)	(0.083)	(0.066)
Adj. R^2	0.083	0.107	0.166	0.125	0.027	0.028	0.270
Obs.	31760	31810	31272	32326	13042	13080	12793
Dep. var. mean	1.097	1.458	0.980	0.496	1.540	2.187	1.365

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.4: Effect of Cable TV on Women's Health Beliefs

	(1) Milk During Pregnancy Harmful	(2) Men Weak After Sterilization	(3) Colostrum Good For Baby	(4) Indoor Smoke Harmful	(5) Less Water For Child Diarrhea	(6) Pregnancy Most Likely Mid-Way Cycle	(7) Aware of AIDS
Village Cable	-0.004	-0.042	-0.010	0.021	0.061***	0.042**	-0.014
	(0.022)	(0.026)	(0.018)	(0.018)	(0.018)	(0.019)	(0.016)
Village Mobile	0.028	-0.034	0.023	0.027	-0.023	-0.003	0.019
	(0.024)	(0.028)	(0.019)	(0.020)	(0.020)	(0.021)	(0.017)
Adj. R^2	0.002	0.005	0.020	0.010	0.009	0.013	0.014
Obs.	30855	24218	32330	32330	30152	23937	32159
Dep. var. mean	0.236	0.631	0.771	0.820	0.176	0.139	0.483

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.5: Effect of Cable TV on Fertility Preferences and Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	More Children Desired By:		Ideal Number of Children		Currently Using	Currently
	Woman	Husband	Sons	Daughters	Contraception	Pregnant
Village Cable	-0.020	-0.028	-0.009	0.029*	0.022	-0.001
	(0.038)	(0.086)	(0.021)	(0.017)	(0.018)	(0.005)
Village Mobile	-0.060	-0.136	-0.005	-0.019	-0.012	-0.001
	(0.040)	(0.090)	(0.023)	(0.018)	(0.020)	(0.005)
Adj. R^2	0.167	0.124	0.005	0.022	0.212	0.070
Obs.	23576	13856	23956	23765	24730	25906
Dep. var. mean	0.940	0.396	1.437	1.131	0.677	0.042

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.6: Effect of Cable TV on Gender Relations Within the Household

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Beating by Husband if:						Discuss with Husband about:		
	Go Out	Suspect Extra-marit.	Dowry	Neglect Home/Child.	Cook	# Situations	Work	Expenditure	Politics
Village Cable	-0.064**	-0.021	-0.060**	-0.041	-0.026	-0.203**	-0.014	0.010	0.027
	(0.026)	(0.018)	(0.023)	(0.025)	(0.024)	(0.093)	(0.015)	(0.011)	(0.025)
Village Mobile	-0.095***	0.045**	-0.062**	-0.053**	-0.059**	-0.225**	-0.015	-0.011	-0.038
	(0.028)	(0.020)	(0.025)	(0.027)	(0.026)	(0.098)	(0.016)	(0.013)	(0.027)
Adj. R^2	0.039	0.015	0.011	0.023	0.007	0.020	0.009	0.012	0.015
Obs.	32233	32205	32229	32238	32224	32330	31393	31403	31394
Dep. var. mean	0.489	0.867	0.311	0.400	0.323	2.382	0.831	0.899	0.674

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.7: Effect of Cable TV on Women's Autonomy: Involvement in Household Decision-Making

	(1)	(2)	(3)	(4)	(5)
	Involved in Decisions Related to:				
		Children			
	Big Purchases	Num.	Illness	Marriage	Keeps Cash
Village Cable	0.031	-0.013	-0.000	-0.013	-0.003
	(0.022)	(0.018)	(0.016)	(0.020)	(0.014)
Village Mobile	0.097***	0.067***	0.049***	0.062***	0.045***
	(0.024)	(0.020)	(0.018)	(0.022)	(0.016)
Adj. R^2	0.052	0.081	0.036	0.059	0.078
Obs.	32195	31567	31283	30952	32264
Dep. var. mean	0.752	0.860	0.883	0.839	0.872

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.8: Effect of Cable TV on Women's Autonomy: Ability to Go Outside the Home

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Need Permission to Visit:			Can Go Alone			Practice Veiling
	Health Center	Friend/Relative	Market	Health Center	Friend/Relative	Market	
Village Cable	0.013	-0.004	0.014	0.001	0.018	-0.008	0.027
	(0.014)	(0.019)	(0.024)	(0.017)	(0.019)	(0.018)	(0.016)
Village Mobile	-0.047***	0.002	-0.006	0.005	0.008	0.016	0.047***
	(0.016)	(0.021)	(0.026)	(0.018)	(0.021)	(0.019)	(0.018)
Adj. R^2	0.068	0.026	0.073	0.030	0.049	0.038	0.008
Obs.	32162	31985	26662	31634	31286	28760	32266
Dep. var. mean	0.844	0.809	0.661	0.691	0.748	0.775	0.608

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.9: Effect of Cable TV on Household Membership in Women-Related Groups

	(1)	(2)	(3)
	Member in:		
	Women's Cmte.	SHG	Credit/Savings
Village Cable	0.005	-0.034**	-0.040***
	(0.011)	(0.014)	(0.012)
Village Mobile	-0.001	0.038**	0.011
	(0.012)	(0.015)	(0.012)
Adj. R^2	0.004	0.079	0.020
Obs.	32295	32297	32298
Dep. var. mean	0.093	0.178	0.104

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.10: Effect of Cable TV on Household Membership in Social and Other Groups

	(1)	(2)	(3)	(4)
	Member in:			
	Social/ Religious	Caste Assoc.	Other Group	Attends Public Meetings
Village Cable	-0.003	0.017	0.011	-0.015
	-0.016	-0.015	-0.011	-0.02
Village Mobile	-0.024	-0.024	0.018	0.006
	-0.017	-0.016	-0.012	-0.022
Adj. R^2	0.017	0.024	0.005	0.003
Obs.	32299	32293	32330	32254
Dep. var. mean	0.122	0.106	0.082	0.371

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.11: Heterogeneous Effects of Cable TV on Fertility Preferences and Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	More Children Desired By:		Ideal Number of Children		Currently Using	Currently
	Woman	Husband	Sons	Daughters	Contraception	Pregnant
Village Cable	-0.059	0.084	-0.007	0.031	-0.070***	-0.002
	(0.060)	(0.101)	(0.028)	(0.023)	(0.025)	(0.008)
∗ Religion = Muslim	-0.096	-0.359**	0.037	0.056	-0.020	0.013
	(0.086)	(0.167)	(0.063)	(0.050)	(0.042)	(0.014)
∗ Religion = Other	-0.042	-0.335*	-0.026	-0.068*	0.047	-0.026*
	(0.084)	(0.181)	(0.070)	(0.041)	(0.036)	(0.015)
∗ Caste = OBC	0.103*	-0.012	-0.026	-0.011	0.137***	-0.000
	(0.061)	(0.107)	(0.032)	(0.023)	(0.026)	(0.009)
∗ Caste = SC/ST	0.026	-0.038	0.015	0.006	0.108***	0.005
	(0.061)	(0.092)	(0.028)	(0.025)	(0.025)	(0.009)
Adj. R^2	0.167	0.129	0.005	0.022	0.216	0.070
Obs.	23561	13846	23945	23754	24716	25890
Dep. var. mean	0.940	0.396	1.437	1.131	0.677	0.041

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. The omitted categories are, "Religion = Hindu", and "Caste = Brahmin/General/Forward". Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.12: Heterogeneous Effects of Cable TV on Household Membership in Women-Related Groups

	(1)	(2)	(3)
	Member in:		
	Women's Cmte.	SHG	Credit/Savings
Village Cable	0.019	-0.027	-0.01
	-0.015	-0.02	-0.016
∗ Religion = Muslim	0.01	-0.061***	-0.029**
	-0.017	-0.02	-0.012
∗ Religion = Other	0.022	-0.033	0.02
	-0.019	-0.026	-0.018
∗ Caste = OBC	-0.021*	0.007	-0.024*
	-0.013	-0.019	-0.013
∗ Caste = SC/ST	-0.021	-0.005	-0.056***
	-0.016	-0.021	-0.014
Adj. R^2	0.004	0.08	0.022
Obs.	32275	32277	32278
Dep. var. mean	0.093	0.178	0.104

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. The omitted categories are, "Religion = Hindu", and "Caste = Brahmin/General/Forward". Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table 3.13: Heterogeneous Effects of Cable TV on Household Membership in Social and Other Groups

	(1)	(2)	(3)	(4)
	Member in:			
	Social/ Religious	Caste Assoc.	Other Group	Attends Public Meetings
Village Cable	0.033	0.054***	0.052***	-0.032
	(0.021)	(0.018)	(0.018)	(0.027)
∗ Religion = Muslim	-0.060*	-0.107***	-0.022	-0.061
	(0.031)	(0.034)	(0.015)	(0.038)
∗ Religion = Other	-0.027	-0.011	0.024	0.045
	(0.037)	(0.034)	(0.018)	(0.042)
∗ Caste = OBC	-0.043**	-0.032*	-0.049***	0.024
	(0.020)	(0.018)	(0.016)	(0.025)
∗ Caste = SC/ST	-0.030	-0.035**	-0.058***	0.031
	(0.020)	(0.018)	(0.017)	(0.027)
Adj. R^2	0.019	0.027	0.007	0.004
Obs.	32279	32273	32310	32234
Dep. var. mean	0.122	0.106	0.082	0.371

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. The omitted categories are, "Religion = Hindu", and "Caste = Brahmin/General/Forward". Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix A: Chapter 1

A.1 Treatment Effects for Main Outcome Variables using OLS with Fixed Effects

Table A1: Impact of the Radio Campaign on Vote Share (%) of Vote-Buying Parties

	Specification 1					Specification 2				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean (Control)	67.32	67.32	67.32	67.32	67.32	90.72	90.72	90.72	90.72	90.72
Treatment	-7.31	-5.19	-7.17	-5.56	-3.76	-4.90	-4.77	-4.84	-4.17	-3.99
	(3.54)	(2.58)	(3.47)	(2.65)	(2.09)	(2.16)	(1.98)	(2.23)	(1.88)	(1.85)
p-value										
Standard	0.04	0.04	0.04	0.04	0.07	0.02	0.02	0.03	0.03	0.03
Rand. Inf.	0.07	0.12	0.08	0.09	0.18	0.14	0.16	0.15	0.25	0.27
R^2	0.53	0.65	0.54	0.58	0.68	0.40	0.44	0.43	0.46	0.51
N (Treatment)	301	301	301	301	301	312	312	312	312	312
N (Control)	291	291	291	291	291	303	303	303	303	303
	Specification 3					Specification 4				
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Mean (Control)	52.04	52.04	52.04	52.04	52.04	87.20	87.20	87.20	87.20	87.20
Treatment	-3.37	-2.72	-3.53	-3.21	-2.96	-6.52	-6.39	-6.04	-5.80	-5.13
	(3.66)	(3.65)	(3.78)	(3.31)	(3.68)	(2.83)	(2.53)	(2.86)	(2.49)	(2.22)
p-value										
Standard	0.36	0.46	0.35	0.33	0.42	0.02	0.01	0.03	0.02	0.02
Rand. Inf.	0.45	0.52	0.44	0.44	0.47	0.06	0.06	0.08	0.10	0.15
R^2	0.22	0.23	0.23	0.24	0.25	0.42	0.47	0.42	0.47	0.52
N (Treatment)	223	223	223	223	223	293	293	293	293	293
N (Control)	258	258	258	258	258	302	302	302	302	302
Covariates										
% Parties Vote-Buying		X			X		X			X
Demographics			X		X			X		X
State Election				X	X				X	X

Notes: See Section 1.4.2 for a description of the four specifications of vote-buying parties. The Treatment coefficient is estimated using OLS with probability strata fixed effects. All columns include election phase fixed effects and the lagged vote share. Demographics include percent population rural, SC/ST, and literate, respectively. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference p-values obtained from 1000 iterations.

Table A2: Impact of the Radio Campaign on Voter Turnout Rate (%)

	(1)	(2)	(3)	(4)	(5)
Mean (Control)	68.21	68.21	68.21	68.21	68.21
Treatment	-0.11	-0.10	-0.33	0.09	-0.14
	(0.89)	(0.82)	(0.71)	(0.87)	(0.63)
p-value					
Standard	0.91	0.90	0.64	0.92	0.82
Rand. Inf.	0.97	0.97	0.91	0.97	0.96
R^2	0.77	0.78	0.79	0.78	0.81
N (Treatment)	312	312	312	312	312
N (Control)	303	303	303	303	303
Covariates					
% Parties Vote-Buying		X			X
Demographics			X		X
State Election				X	X

Notes: The Treatment coefficient is estimated using OLS with probability strata fixed effects. All columns include election phase fixed effects and the lagged turnout rate. Demographics include percentage population rural, SC/ST, and literate. Standard errors robust to heteroskedasticity and cross-sectional dependence given in parentheses. Randomization inference *p*-values obtained from 1000 iterations.

A.2 Radio Campaign Advertisements

A.2.1 Script 1

It is a village setting. We hear birds chirping, the distant rumble of a motorbike and the faint noise of distant conversations. Kamala (grandmother, around 70 years old) comes to Ramesh's (male, around 50 years old) shop to make a purchase.

Kamala: Namaste, Ramesh Bhaiyya!

Ramesh: Namaste! How are you Amma?

Kamala: I am really happy today. Give me three of your best school bags. I am buying them as gifts for my grandchildren.

Ramesh: School bags (puzzled)? But our area doesn't even have a school!

Kamala: Then we'll get one soon (laughing). I was just at an election rally where the candidate promised to build a school if he wins.

Ramesh: Oh, really?

Kamala: Yes, and he was handing out cash as well. And all we have to do in return is to vote for him. That's it!

Ramesh: That's it (rhetorical)? Don't you get it? He is trying to buy your vote with money.

Kamala: I don't quite follow.

Ramesh: Amma, if he wins, then in order to recoup his election expenditure, he could siphon off government funds.

Kamala: Really (surprised)?

Ramesh: Yes Amma! And the school–it will remain only in the books.

Kamala: Oh! I hadn't thought of that. In that case, there is no way I am voting for him.

End scene.

Announcer: Teach vote buying leaders a lesson–use your secret ballot to vote for an honest candidate.

A.2.2 Script2

It is a village setting. We hear birds chirping, the distant rumble of a motorbike and the faint noise of distant conversations. Ram (male, around 40 years old) is a customer with a *happy-go-lucky personality and Ramesh (male, around 50 years old) is the shopkeeper. Ram comes to Ramesh's shop to make a purchase.*

Ram: Ramesh Bhai, show me the best pair of clothes you have on sale.

Ramesh: Of course. Looks like you had a good harvest.

Ram: My harvest was good. But that's not why I am buying new clothes?

Ramesh: What's the reason then?

Ram: Actually, an acquaintance of mine is contesting in the upcoming elections. He has fattened my wallet so I vote for him.

Ramesh: I see. And if he wins do you think he will fulfill his responsibilities?

Ram: Why won't he?

Ramesh: Well, why would anyone who trades notes for votes do anything for free?

Ram: Oh, I hadn't thought of that. In that case, there is no way I am voting for him.

End scene.

Announcer: Teach vote-buying leaders a lesson–use your secret ballot to vote for an honest candidate.

A.2.3 Script 3

It is a village setting. We hear birds chirping, the distant rumble of a motorbike and the faint noise of distant conversations. Mohan (male, around 40 years old) is a passerby and Ramesh (male, around 50 years old) is a shopkeeper. Mohan happens to walk past Ramesh's shop holding an electric fan.

Ramesh: Mohan Babu, where did you buy this electric fan?

Mohan: I didn't buy it! A candidate is handing them out for free at the election rally.

Ramesh: But our village doesn't even get power.

Mohan: The candidate has promised to bring power to our village if he wins.

Ramesh: If this corrupt candidate wins then in order to recoup his election expenditure he could siphon off government funds.

Mohan: What (shocked)!

Ramesh: Yes and the promise will remain just that–a promise.

Mohan: Oh, I hadn't thought of that. In that case, there is no way I am voting for him then.

End scene.

Announcer: Teach vote-buying leaders a lesson–use your secret ballot to vote for an honest candidate.

A.3 Journalist Interview Questions

1. Which *Lok Sabha* constituencies you are covering?

   Interviewer Note: Ask the remaining questions for each constituency mentioned.

2. Which three parties have the biggest presence and what is the name of the candidate contesting from each party?

3. How are parties spending money to gain publicity and increase their vote share?

   Interviewer Note: Examples used to prompt can be rallies, parades, and posters.

4. Which party/parties seem to be spending the most on campaigning?

5. Which party/parties have held the most public events (such as rallies, speeches, parades, etc.)?

6. Which party/parties have had the most visits by party leaders or "star campaigners" (such as celebrities or other well-known individuals lending support to the candidate)?

7. Which party/parties have the most volunteers or workers (largest party cadre)?

8. Which party/parties seem to be spending the most money secretly (such as on distribution of liquor, cash or other gifts)?

9. What are they spending this money on?

10. What class of voters are they trying to win by distributing gifts?

11. Which party do you think will get the largest vote share?

Appendix B: Chapter 2

B.1 Additional Tables

Table A1: Summary Statistics of Additional Outcome Variables

Variable	1966			1978		
	Mean	SD	Obs.	Mean	SD	Obs.
Area/GCA (%)						
HYV Coarse Cereals	0.154	0.280	266	3.770	4.962	266
Sugarcane	1.598	2.934	266	1.890	3.889	266
Cotton	4.330	9.349	266	3.942	8.555	266
Groundnut	4.486	8.173	266	4.139	8.629	266
Area/Crop Area (%)						
HYV Coarse Cereals	1.926	6.596	266	23.320	22.277	266
Road Length (km)	1408.770	747.687	76	3323.746	2933.488	260
Num. Markets	8.158	8.441	19	16.829	14.409	245

Table A2: Impact of Radio Coverage on Infrastructure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log(Road Length)				Log(Num. Markets)			
Radio	-0.013	0.016			-0.054	0.219		
	(0.054)	(0.155)			(0.078)	(0.214)		
Radio*Literacy Rate		-0.002				-0.018		
		(0.010)				(0.016)		
Prop. Radio			-0.009	0.103			0.111	0.535***
			(0.060)	(0.192)			(0.096)	(0.179)
Prop. Radio*Literacy Rate				-0.007				-0.029**
				(0.012)				(0.011)
Adj. R^2	0.777	0.777	0.777	0.777	0.508	0.509	0.509	0.510
Obs.	2723	2723	2723	2723	2106	2106	2106	2106

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table A3: Impact of Radio Coverage on Adoption of HYVs of Coarse Cereals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	% Coarse Cer. HYV Area/GCA				% Coarse Cer. HYV Area/Coarse Cer. Area			
Radio	-0.292	-1.540			0.811	-17.416**		
	(0.384)	(1.820)			(1.738)	(7.861)		
Radio*Literacy Rate		0.078				1.134**		
		(0.124)				(0.505)		
Prop. Radio			-0.715*	-0.984			-2.035	0.447
			(0.373)	(1.356)			(3.057)	(22.904)
Prop. Radio*Literacy Rate				0.018				-0.162
				(0.091)				(1.649)
Adj. R^2	0.424	0.424	0.424	0.424	0.444	0.446	0.444	0.444
Obs.	3458	3458	3458	3458	3458	3458	3458	3458
Dep. var. SD	3.732	3.732	3.732	3.732	18.765	18.765	18.765	18.765

Notes: All columns include district fixed effects, year fixed effects, interactions of a fourth-order polynomial of time period with covariates listed in Table 2.2 and with indicators for states, respectively. Robust standard errors clustered by district reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Appendix C: Chapter 3

C.1 Additional Tables

Table A1: Summary Statistics of Outcome Variables

	Round 1 (2004-2005)			Round 2 (2011-2012)		
Variable	Mean	SD	N	Mean	SD	N
Panel A: Household Media Usage						
Never watches TV:						
Men	0.36	0.48	15665	0.24	0.42	15551
Women	0.40	0.49	15859	0.26	0.44	16036
Children	0.46	0.50	13764	0.24	0.43	13593
Never listens to radio:						
Men	0.51	0.50	15715	0.75	0.43	15548
Women	0.61	0.49	15894	0.81	0.39	16029
Children	0.71	0.45	13938	0.80	0.40	13603
Never reads newspaper:						
Men	0.60	0.49	15665	0.55	0.50	15549
Women	0.82	0.38	15810	0.78	0.41	16027

Continued on next page

Table A1 – continued from previous page

	Round 1 (2004-2005)			Round 2 (2011-2012)		
Variable	Mean	SD	N	Mean	SD	N
Children	0.86	0.35	13807	0.71	0.46	13590
Daily hours TV watched:						
Men	0.94	0.85	15787	1.25	1.16	15973
Women	1.20	1.16	15785	1.72	1.50	16025
Children	0.89	1.06	15555	1.07	1.35	15717
Has TV	0.41	0.49	16165	0.58	0.49	16161
Panel B: Women's Health Beliefs, Status, Autonomy, and Fertility						
Milk during pregnancy harmful	0.23	0.42	15271	0.24	0.43	15584
Men weak long after sterilization	0.64	0.48	11527	0.62	0.49	12691
Colostrum good for baby	0.73	0.44	16165	0.81	0.39	16165
Indoor smoke harmful	0.80	0.40	16165	0.84	0.37	16165
Feed less water for child diarrhea	0.16	0.37	14792	0.19	0.39	15360
Pregnancy most likely mid-way in cycle	0.16	0.37	10518	0.12	0.33	13419
Aware of AIDS	0.46	0.50	16004	0.51	0.50	16155
Beating by husband common if:						
Go out without permission	0.43	0.49	16107	0.55	0.50	16126
Suspect relations with men	0.88	0.32	16083	0.85	0.35	16122
Not enough dowry	0.29	0.45	16106	0.33	0.47	16123
Neglecting home or children	0.36	0.48	16119	0.44	0.50	16119
Cooking not properly	0.31	0.46	16123	0.34	0.47	16101
# Stituations	2.25	1.69	16165	2.51	1.65	16165
Discusses with husband about:						

Continued on next page

Table A1 – continued from previous page

	Round 1 (2004-2005)			Round 2 (2011-2012)		
Variable	Mean	SD	N	Mean	SD	N
Farm/work	0.82	0.39	15856	0.84	0.36	15537
Expenditures	0.88	0.32	15884	0.91	0.28	15519
Politics	0.64	0.48	15876	0.71	0.45	15518
Involved in deciding:						
Making big purchases	0.69	0.46	16165	0.81	0.39	16030
Num. of children to have	0.80	0.40	16165	0.93	0.26	15402
Treating child illness	0.85	0.36	15444	0.92	0.27	15839
Who child marries	0.78	0.41	15189	0.90	0.31	15763
Keeps cash on hand	0.81	0.39	16122	0.93	0.25	16142
Need permission to visit:						
Health center	0.79	0.41	16149	0.90	0.30	16013
Friend/relative's house	0.78	0.42	15897	0.84	0.37	16088
Market	0.58	0.49	13087	0.74	0.44	13575
Can go alone to:						
Health center	0.66	0.48	15651	0.73	0.45	15983
Friend/relative's house	0.69	0.46	15338	0.80	0.40	15948
Market	0.72	0.45	13445	0.82	0.38	15315
Practices veiling	0.60	0.49	16113	0.62	0.49	16153
More children desired by:						
Woman	0.79	1.18	13517	1.02	0.82	14109
Husband	0.43	1.29	11268	0.19	0.39	4564
Ideal num. desired:						

Continued on next page

Table A1 – continued from previous page

	Round 1 (2004-2005)			Round 2 (2011-2012)		
Variable	Mean	SD	N	Mean	SD	N
Sons	1.46	0.66	13991	1.47	0.65	14439
Daughters	1.11	0.49	13878	1.19	0.51	14340
Currently using contraception	0.55	0.50	14619	0.79	0.41	14656
Total num. children born	3.10	1.85	15923	3.54	1.87	16144
Currently pregnant	0.05	0.23	15642	0.02	0.12	14964
Panel C: Household Membership in Groups in the Village						
Member in:						
Women's Committee	0.09	0.28	16148	0.10	0.30	16147
Self-Help Group (SHG)	0.11	0.32	16150	0.24	0.43	16147
Credit/Savings Assoc.	0.08	0.27	16151	0.13	0.33	16147
Social/Religious/Festival Group	0.15	0.35	16151	0.10	0.30	16148
Caste Assoc.	0.14	0.34	16146	0.08	0.27	16147
Any other group	0.08	0.28	16165	0.08	0.27	16165
Attends public neetings	0.36	0.48	16137	0.38	0.49	16117

C.2 Results using Sub-Sample of Five States from Jensen and Oster (2009)

Table A2: Effect of Cable TV on Fertility Preferences and Outcomes (Sub-Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	More Children Desired By:		Ideal Number of Children		Currently Using	Currently
	Woman	Husband	Sons	Daughters	Contraception	Pregnant
Village Cable	0.196*	-0.018	-0.097*	0.005	-0.072	-0.015
	-0.103	-0.261	-0.055	-0.037	-0.055	-0.013
Village Mobile	-0.038	-0.306	0.015	0.015	-0.064	-0.021
	-0.115	-0.403	-0.081	-0.059	-0.09	-0.019
Adj. R^2	0.184	0.156	0.015	0.025	0.293	0.064
Obs.	3586	2256	3676	3653	3671	3962
Dep. var. mean	0.929	0.464	1.561	1.168	0.55	0.052

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table A3: Effect of Cable TV on Fertility Preferences and Outcomes (Sub-Sample)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Beating by Husband if:						Discuss with Husband about:		
	Go Out	Suspect Extra-marit.	Dowry	Neglect Home/Child.	Cook	# Situations	Work	Expenditure	Politics
Village Cable	0.008	0.030	0.012	0.012	-0.001	0.070	-0.004	-0.043	-0.038
	-0.073	-0.048	-0.058	-0.066	-0.060	-0.243	-0.039	-0.029	-0.060
Village Mobile	-0.201**	-0.031	-0.112	-0.097	-0.083	-0.513	-0.018	0.066	0.040
	-0.089	-0.077	-0.090	-0.080	-0.068	-0.327	-0.062	-0.049	-0.095
Adj. R^2	0.044	0.080	0.030	0.034	0.065	0.056	0.027	0.031	0.024
Obs.	4902	4902	4901	4901	4893	4918	4774	4804	4804
Dep. var. mean	0.446	0.833	0.311	0.380	0.354	2.315	0.835	0.904	0.730

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively.Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table A4: Effect of Cable TV on Women's Autonomy: Involvement in Household Decision-Making (Sub-Sample)

	(1)	(2)	(3)	(4)	(5)
	Involved in Decisions Related to:				
		Children			
	Big Purchases	Num.	Illness	Marriage	Keeps Cash
Village Cable	-0.041	-0.052	-0.064*	-0.052	-0.012
	(0.052)	(0.038)	(0.037)	(0.044)	(0.025)
Village Mobile	0.230**	0.144**	0.159**	0.255***	0.050
	(0.090)	(0.059)	(0.066)	(0.082)	(0.039)
Adj. R^2	0.047	0.052	0.060	0.083	0.027
Obs.	4889	4847	4766	4686	4900
Dep. var. mean	0.791	0.893	0.912	0.879	0.920

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

Table A5: Effect of Cable TV on Women's Autonomy: Ability to Go Outside the Home (Sub-Sample)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Need Permission to Visit:			Can Go Alone			Practice Veiling
	Health Center	Friend/Relative	Market	Health Center	Friend/Relative	Market	
Village Cable	-0.015	-0.061	-0.100	-0.018	0.053	-0.002	0.041
	(0.042)	(0.050)	(0.071)	(0.046)	(0.047)	(0.044)	(0.027)
Village Mobile	-0.045	0.017	0.145*	0.086	0.018	0.040	-0.021
	(0.051)	(0.054)	(0.077)	(0.054)	(0.075)	(0.061)	(0.044)
Adj. R^2	0.177	0.058	0.139	0.068	0.114	0.062	0.007
Obs.	4886	4878	4271	4837	4834	4430	4902
Dep. var. mean	0.811	0.803	0.653	0.673	0.707	0.770	0.701

Notes: All columns include household fixed effects, round fixed effects, covariates listed in Table 3.1, and interactions of number of households in the village (in 2001) and distance to nearest town with an indicator for round 2, respectively. Robust standard errors clustered by village reported in parentheses. Significance level indicated by * at the 10% level, ** at the 5% level, and *** at the 1% level.

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