Local Media and the Shaping of Social Norms:
Evidence from the Ebola outbreak

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Abstract

Media around the world is disseminated at the national level as well as at the local level. While the capacity of media to shape preferences and behavior has been widely recognized, less is known about the differential impacts of local media. Local media may have particularly important effects on social norms due to the provision of locally relevant information that becomes common knowledge in a community. I examine this possibility in a high-stakes context: the Ebola epidemic in Guinea. I exploit quasi-random variation in access to distinct media outlets and the timing of a public-health campaign on community radio. I find that 13% of Ebola cases would have been prevented if places with access to neighboring community radio stations had instead their own. This is driven by radio stations’ locality, not ethno-linguistic boundaries, and by coordination in social behaviors sanctioned locally.

JEL codes: O12, D71, L82, P16, I18, H12, D81, H41

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There is a great interest in economics on the impacts of mass media. Media helps coordinating people, and is a powerful tool to affect behaviors attached to social norms.\footnote{For example Paluck and Green (2009), La Ferrara, Chong and Duryea (2012), Yanagizawa-Drott (2014). See Strömberg (2015), DellaVigna and La Ferrara (2015) for a review of literature on media.} Less is known, however, about the role played by media being local. Local media, being more disaggregated than other types of mass media, could in theory make coordination more difficult. Local information however, has the ability to be more relatable and specific to a locality, ethnicity or language group, and thus persuasive. Is there a value to a media source being local? If so, why? Is it more relevant information, ethno-linguistic belonging, or, locality per se, which may be important in coordinating behavior?

This paper studies the impacts of local media in the context of an epidemic. Identifying the impacts of media being local is not straightforward. It requires variation in access to local media outlets, holding other things constant: informational content and access to a similar media outlet that is not local. Further, decoupling the effect of locality from ethnic group or language is difficult. It necessitates enough variation in ethno-linguistic composition of media outlets and within geographic locations. Finally, we need to observe behaviors and outcomes attached to social norms.

The devastating 2014-16 Ebola epidemic in West Africa provides a relevant high-stakes context to study this. In response to the health crisis, Guinea launched a major public health campaign, designed and coordinated from the capital, yet aired in local languages across the country’s community radio stations. The campaign aimed at convincing the population to change health behaviors attached to cultural practices and prevalent conspiracy theories that facilitated the spread of Ebola.

I evaluate the impacts of local media on changing health behavior and the resulting spread of disease, exploiting novel data collected on-site. The reach of radio can go beyond administrative boundaries. I can therefore differentiate between places with access to a community radio station that is located within their prefecture, compared to neighboring places reached by the same radio station, but for whom it is not local. I compare the evolution of the epidemic in places with more or less access to the radio signal of a local community radio station (based in their prefecture), before and after the launch of the public health campaign, controlling for overall access to community radio (regardless of the location of the radio transmitter), as well as to private and national radio. Importantly, I construct the measure of radio access based on geographic features of the terrain and technical attributes of radio transmitters, using the Irregular Terrain Model (ITM), developed by engineers and standard in the economics literature since Olken (2009). Guinea’s geography in particular provides a relevant set-up for exploiting this quasi-random variation in access to radio due to the ruggedness of its terrain.\footnote{Guinea’s elevation spans from 0 to 1752 meters (5,748 feet) above sea level. The ruggedness index developed by Nunn and Puga (2012) shows that Guinea’s ruggedness is among the top half of African countries, not as high as in Rwanda, but similar to Indonesia, and twice the ruggedness of Congo, where the ITM has also been applied to study impacts of media (e.g. Olken, 2009, Yanagizawa-Drott, 2014, Armand, Atwell and Gomes, 2020).}
Further, given high levels of diversity within a prefecture, I also study whether the effects of local radio are driven by the ethno-linguistic makeup of its listeners. In contexts of ethno-linguistic diversity, media along ethnic or linguistic lines has been shown to be important for civic engagement of the targeted group; e.g. Spanish-language news or ‘Black radio’ in the US (Oberholzer-Gee and Waldfogel, 2009, Wang, 2020). To understand whether locality matters beyond other group belonging, I test whether the effect of local radio is different in places with the same majority group as the local media outlet, compared to places with a different majority group.

The results indicate that the public health campaign aired on community radio led to an earlier drop and a greater reduction in Ebola cases in places with a local radio station, compared to places with access the same radio station, but for whom it is not local. The main result is perceptible from raw data (Figure 1). During the initial months of the epidemic the growth in Ebola cases evolves similarly in places with and without access to a community radio station that is local to them, when both places have above-average access to the signal from any community radio, which may be located outside their prefecture. This validates the design, as it indicates that these places would have evolved similarly in the absence of the public health campaign. Following the launch of the campaign, the number of Ebola infections drops in places with local community radio. A back-of-the-envelope calculation suggests that 470-500 infections, 13% of total Ebola cases in Guinea, would have been prevented if all places with above-average access to community radio had their own local radio station.  

Perhaps surprisingly, the impact of community radio is not driven by ethno-linguistic belonging alone. Local radio has a similar effect in places which share the majority language of the community radio station located in its prefecture, and those who do not. Further, since ethno-linguistic groups cross administrative boundaries, I can define “local” media differently. I can compare places with and without access to the radio signal from a community radio station speaking their own majority language, regardless of the location of the radio transmitter. I do not find that defining radio access by shared ethno-linguistic group has a significant impact on the evolution of the epidemic. The results imply that local media has an impact on the epidemic, and that this is driven by media being local, beyond ethno-linguistic considerations.

Next I lay out a mechanism through which local media affects the spread of Ebola. Media creates common knowledge: everybody knows that others have heard the same information as themselves. This characteristic of media is important for achieving a coordinated shift in behavior (Morris and Shin, 2001). It should matter for socially-sanctioned behaviors, as one’s own behavior depends on what

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3Increasing the share of a territory covered by radio signal to local community by 10 percentage points (from a baseline of 28%) is associated with a drop of 13-18% in Ebola infections per month. The effect kicks in seven months after the launch of the campaign (or five months after it was reinforced), and lasts for five months, until the outbreak effectively ends. I condition on access to other radio stations, distance to the closest radio transmitter for each media outlet, demographics, and deployment of public health facilities.
the community sanctions. Anthropological research, however, suggests that more proximate sources of information led by community groups are more effective than mass media campaigns at changing socially-entrenched behaviors (Richards, 2016). I hypothesize that local media solves this trade-off, as it provides locally relevant information and achieves coordination with a relevant group: one’s own community, who observes and sanctions this behavior. To formalize this mechanism I extend Morris and Shin (2002) and Cornand and Heinemann (2008) to a model with multiple public signals. I consider a game of incomplete information in which individuals’ payoffs depend their own behavior, other peoples’ behavior when it is attached to a social norm, and the true state of the world. The degree of protective behavior in equilibrium then affects the transmission rate of Ebola and hence the number of infected cases. The model leads to two predictions: Firstly, public information has a greater impact on actions associated to social norms, compared to private information; and secondly, the radio providing more precise information has a greater weight in individuals’ protective behavior taken in equilibrium. This can explain the greater impacts of local community radio, as opposed a radio station that is not local.

Further, whether radio from a distinct locality but with shared ethnic identity provides more relevant or precise information than a local community radio, regardless of ethnic belonging, is an empirical question. Since health behavior affects others through physical contact, the finding of this paper that impacts are driven by the locality of the media outlet, is intuitive: the relevant community for affecting social health behavior is the community one has contact with, and hence the importance of the locality of media. Prefectures are a substantive regional entity, since although administrative divisions were to a certain extent imposed by the French colonizing power, their origins predate the colonial period (Goerg, 2011, McGovern, 2012). They are related to ethno-linguistic groups, but a prefecture still harbors important diversity, and thus opportunity for close contact between groups.

The evidence presented next is consistent with local media facilitating a coordinated shift in behaviors attached to social norms. First, the impacts take time to materialize — the drop in Ebola infections occurs seven months after the official launch of the campaign in June 2014, or five months if counting from September 2014, when community radio raised its capacity, air-time and quality of its contents with international donor support. This is consistent with media serving as coordination device — it takes time to realize that others have heard the same information as oneself.

Second, I find that places with or without local community radio start out with similar levels of adherence to public health measures, but they diverge after the public health campaign is launched, concurrently with the drop in infections. This is of utmost importance, since the decline in epidemic cases is directly linked to a change in socially-sanctioned behaviors, such as seeking health treatment in new ad-hoc Ebola Treatment Units (ETUs), and adhering to newly-imposed safe burial practices. This

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4I do not find a concurrent change in the supply in public health facilities, ruling out a political accountability channel as the main driver in this context (Besley and Burgess, 2002, Eisensee and Strömberg, 2007).
means that, over time, people in places with local community radio refrain from taking care of sick family members, counter prevalent conspiracy theories surrounding ETUs, and leave behind traditional funeral practices, which involve washing the deceased before burial.

Third, I observe that individuals who learned about Ebola through media hold a stronger belief that others in their locality are more likely to seek medical treatment when sick. So media affects what they think their neighbors believe and do. This, in turn, affects what an individual believes is acceptable in their locality and can explain a change in ones’ own behavior, and the overall treatment uptake and social resistance observed. The magnitude of this effect increases with the proportion of people in one’s own locality who learned about the disease from the media. This means that media helps people coordinate and that its common knowledge aspect is important for seeking health treatment, a socially-sanctioned behavior in this context. In contrast, media is no more effective than other information sources when behavior is private or not socially costly, such as washing one’s hands or clothes with chlorine.

The main contribution of this paper is to identify the impacts of local media, unpacking the role of the locality of media, and its effects on shaping social norms. In contrast to previous studies, I hold the information source and contents of a campaign constant and show that impacts are driven by a media outlet being local. I am also able to differentiate the locality of media from ethno-linguistic groupings. Further, I am able to distinguish impacts on socially-sanctioned behavior, from private behavior. The paper links the political economy of media with our understanding of cultural change, its intricacies with ethnic belonging, and helps reconcile mixed evidence of media impacts on health behavior.

I add to a body of work studying the impacts of mass media exposure on a variety of socio-economic behaviors, including civic engagement, gender norms, violence, and demonetization (e.g. Strömberg, 2004, DellaVigna and Kaplan, 2007, Ferraz and Finan, 2008, Jensen and Oster, 2009, Olken, 2009, Paluck and Green, 2009, Enikolopov, Petrova and Zhuravskaya, 2011, Card and Dahl, 2011, La Ferrara, Chong and Duryea, 2012, DellaVigna et al., 2014, Yanagizawa-Drott, 2014, Adena et al., 2015, Banerjee et al., 2018, Green, Wilke and Cooper, 2019, Armand, Atwell and Gomes, 2020). While there is evidence of community radio influencing demand for public services (Keefer and Khemani, 2011, 2014) and more recently contraception (Glennnerster, Murray and Poulquien, 2021), I show that holding access to community radio constant there is an additional value to the particular location a radio station is based in. In relation to evidence on Spanish-language news or ‘Black radio’ in the US (Oberholzer-Gee and Waldfogel, 2009, Wang, 2020), I show that there is an impact of local information which goes beyond ethno-linguistic groupings. The paper is also related to recent work showing a role for non-national private media in affecting religious behavior (Grosfeld et al., 2021).

\[5\] This holds in an OLS framework, controlling for other information sources, as well as in a 2SLS framework, using access to local community radio as an IV to address selection into information sources.
This paper adds to a literature on social norms and cultural change (Bisin and Verdier, 2011, Gershman, 2017, Bursztyn, González and Yanagizawa-Drott, 2018), and on the role of information in facilitating these shifts (Karing, 2018, Gulzar and Khan, 2021). I find a rapid change in cultural practices facilitated via local media. I add to research on ethnic divides and economic performance (Alesina and La Ferrara, 2005, Alesina, Michalopoulos and Papaioannou, 2016). My results underscore the importance of cultural diversity beyond ethnicity (Desmet, Ortuño-Ortín and Wacziarg, 2017). I also relate to a theoretical literature on global games, most closely to Morris and Shin (2001, 2002), Cornand and Heinemann (2008), Kuznetsova (2016), Shadmehr and de Mesquita (2020).

I provide novel evidence of media impacts on the actual spread of disease. Distinguishing between social and private health behaviors reconciles mixed evidence on the effects of information on health behavior. These range from no effect (Kremer and Miguel, 2007, Duflo, Dupas and Kremer, 2015), to an effect depending on context and type of information provided (Dupas, 2011, Galiani et al., 2016, Banerjee, La Ferrara and Orozco, 2019, Banerjee et al., 2020, Breza et al., 2021). The results also add to our understanding of social and institutional factors behind the spread of infectious diseases (Adda, 2016), including Ebola (Richards et al., 2015, Christensen et al., 2018, Van der Windt and Voors, 2020, González-Torres and Esposito, 2020) and Covid-19 (Brodeur et al., 2021).

Next, Section 1 describes the background and data on the Ebola epidemic, Guinea’s media landscape and the public health campaigns. The main empirical set-up and results are presented in Section 3. I elaborate on the hypothesized mechanism in Section 4, showing also suggestive evidence for it, followed by evidence against alternative explanations. Section 5 concludes.

1 Background and Data

I combine a rich amount of data on the Ebola outbreak and the public health response in Guinea, including own-conducted surveys, and data on demographic characteristics, and on other diseases. Most of the data spans the entire epidemic, starting from January 2014 and coming to an end in May 2016, a total of 29 months, and is at monthly-level per sub-prefecture. Guinea has a total of 341 sub-prefectures, with an average population of 33,000, and belonging to a total of 34 prefectures.

Direct-messaging is more effective than media for hand-washing (Galiani et al., 2016, Banerjee et al., 2020). An experiment showing a TV edutainment-series in some community centers affects HIV-knowledge and testing, but not social norms (Banerjee, La Ferrara and Orozco, 2019). The results are consistent with the common-knowledge aspect of media being key for social norms, since this characteristic of media may be difficult to mimic in an experiment. Allcott et al. (2020), Bursztyn et al. (2020), Ajzenman, Cavalcanti and Da Mata (2020), Ash et al. (2020) study the reverse, effects of misinformation during Covid-19.

While the first case was recorded end of December 2013, it was localized in Gueckedou, and we also observe the first Ebola infections in that area in January 2014.
FIGURE 1: Ebola infections by access to local community radio

Notes: Average log-Ebola in places (sub-prefectures) with above- and below-median access to a local community radio station, conditioning on sub-prefectures with above-average access to some community radio station. The log is taken over the number of infections+1 (for alternative definitions see Figure ??). Vertical lines indicate when the public health campaign was launched on community radio (gray dashed line), and the actual start by most community radio stations, as significant international aid arrived, helping community radio to boost capacity, increase the number of hours aired and improve the quality of the sensitization campaign (red solid line).

### 1.1 Outcome variables: epidemic disease and social health behavior

**Ebola infections**  The main outcome is Ebola infections, obtained from patient records collected by the WHO, spanning from January 2014 to May 2016. There were a total of 3,814 (2,544) Ebola infections (deaths) in Guinea (Table ??, and Supplementary Online Appendix (SOA) Figure ??). My baseline measure is the log-number of Ebola cases per 100,000 people in a sub-prefecture over a month (adjusted by +0.01). Infections is a more complete measure than deaths. The Ebola virus disease is short-lived, with people typically dying within four weeks since contagion, and has a fatality-rate that widely varies from 25-90%, depending on treatment-uptake. The virus is transmitted through body fluids and contagion occurs only with advanced symptoms. This helps keep under-reporting is low, especially in Guinea according to WHO, due to the surveillance set in place. It also means that changing health behavior can significantly affect death rates and reduce infections. Ebola survivors suffer from persistent medical conditions after recovery, including loss of sight, mental illness, and increased mortality risk (James et al., 2020).

**Social health behavior**  As secondary outcomes, I use two measures of socially-sanctioned health behaviors. One is an aggregate measure of “social resistance”, which includes attacks against public health authorities, refusing treatment or opposition to safe burials for family members. These were

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8Treatment-uptake and improved public health systems lowered Ebola death rates (Garske et al., 2017).
opposed as they countered cultural practices and prevalent beliefs about the disease.\textsuperscript{9} This data was published in daily or weekly situation reports by the Guinean Ministry of Health, which I digitized using data-scraping algorithms (see Figure ??). I compute the number of weeks in a month with at least one such resistance behavior for a given sub-prefecture (thus taking values between 0 and 4).

Another outcome is the number of people who die from Ebola in their own community divided by the total number of individuals who die from it, including those dying in an Ebola treatment unit (ETU). This is a proxy for low treatment-uptake or opposition to public health measures, proposed by the WHO in Guinea, who provided this data. Individuals who oppose treatment refrain from going to an ETU; if they die, they are more likely to do so within the community than in an ETU.

1.2 Treatment: public health campaign on community radio

The main treatment variable is the share of a sub-prefecture that has access to a pre-existing community radio station located in their prefecture interacted with the timing of the start of the public health campaign on community radio.

**Public health campaigns** I collected information about public health information delivered through different media outlets during in-person and phone interviews, and surveys issued with radio stations across the country. The most comprehensive public health campaign was launched six months after the start of the Ebola outbreak, by the community radio, known as the *Radios Rurales de Guinée (RRG)*. The campaign aimed at convincing the population to avoid taking care of sick family members, seek health treatment instead, and change traditional funeral practices, the main causes for the disease spreading. Other media outlets provided some public health information, but this was either late and limited in time (private radio), or it gave only descriptive information about the state of the epidemic (national radio).

The campaign was a coordinated effort from the headquarters in the capital, Conakry, but it was delivered by local hosts in local languages. Although it was officially launched end of June 2014, most community radio stations started the program around September 2014, when the non-governmental organization *Fondation Hirondelle* provided technical assistance and created content in multiple local languages, which community radio stations would directly upload into their programs. I therefore show two main dates as post-treatment period, June and September 2014. We expect the effects to take time, since the program evolved as more comprehensive and persuasive content was included, by having Ebola survivors, traditional or religious leaders in their talk shows, and by directly addressing rumors. The focus shifted from a descriptive account of the disease, at times contradictory as medical knowledge

\textsuperscript{9}Reported attacks against Red Cross volunteers, who were in charge of burials, averaged ten per month in the second half of 2014 (IFRC website). Interviews with social workers in Guinea reveal that ETUs were a source of conspiracy theories. These were established ad-hoc, as Ebola patients need to be isolated to avoid contagion. People had to refrain from taking care of sick family members, and saw them dying in ETUs at high rates.
evolved, to focusing on high-risk habits, such as traditional burial practices and low treatment-uptake.\textsuperscript{10}

**Local community radio** There were 23 community radio stations in Guinea before the outbreak started, located in 23 out of the 34 prefectures. Since each community radio is established to serve a given prefecture, I define community radio as *local* to all sub-prefectures belonging to the prefecture where its radio transmitter is located. Note that since the radio signal can reach beyond administrative borders, some sub-prefectures have access to a community radio station that is not local to them (those situated in 11 out of 34 prefectures).\textsuperscript{11}

**Ethno-linguistic groups of community radio** Since each community radio is established to serve a given prefecture, they aim to represent the prefecture, both in terms of contents and languages spoken. For the analysis based on ethno-linguistic belonging, I define the majority ethno-linguistic group of a community radio by the ethnic majority in the prefecture it serves. This also coincides with the main languages reported by the radio stations I surveyed. Additional details are provided in Section 3.2.

**Radio signal reception** I use data from the National Telecommunications Agency of Guinea (ARPT) on a total of 155 radio transmitters, including information on their technical characteristics. With this data and geographic terrain features I calculate the radio signal reception using a radio propagation tool employed by engineers, based on the Irregular Terrain Model (ITM) / Longley-Rice, standard in the economics literature since Olken (2009). I group radio transmitters by type of media outlet, namely community, national, private and international radio, as well as other relevant features, notably whether it is a local community radio station or not. I then obtain the share of a given sub-prefecture with access to a given radio station with a signal strength of at least 43 dBµV/m. The cross-sectional treatment variable \(\text{RadioSignal}_k^s\) used in the analysis is the share of a given sub-prefecture \(s\) covered by a signal strength of at least 43 dBµV/m from a given radio station \(k\).

I find that most sub-prefectures have at least half of their territory covered with a media outlet (Table ??). The most common type of media outlet is community radio, followed by national radio. Access to a local community station is less common, however. The median (mean) share of a sub-prefecture with an own community radio is 14% (28%) (see details in Figures ??-??).

**1.3 Other data**

Demographics are from the 2014 Guinean census and Afrobarometer rounds 5 (2013) and 6 (2015). Containment policies are the WHO, UNOCHA/UNMEER. Data on prevalence of other infectious dise-
cases are by prefecture for 2013 and 2014 from the Guinean Ministry of Health. To track other health behaviors and beliefs about Ebola, I use a representative survey on 2,466 individuals conducted by the Guinean Institute of National Statistics in September 2015. Table ?? has summary statistics.

2 Conceptual Framework

I introduce a stylized model to describe the role of public radio on behavior attached to social norms, and how this affects the number of infections (Section 2.1). Different types of public radio provide different levels of precision or relevant information on the local epidemic conditions. This is essentially an empirical question, and I describe my approach to test alternative hypotheses in Section 2.2.

2.1 Stylized model

I model the impact of a public information campaign on behavior as a game of incomplete information in which individuals’ payoffs depend their own behavior, other peoples’ behavior and the true state of the world. The degree of protective behavior in equilibrium then affects the transmission rate of Ebola and hence the number of infected cases.

A model of incomplete information I extend Morris and Shin (2002) model of public and private signals to a model with one private and two or more public signals. Consider a continuum of individuals, indexed by the unit interval $[0, 1]$. Each individual $i$ chooses an action $a_i \in \mathbb{R}$, which corresponds to their degree of protective behavior towards the disease. For instance, they can choose between a traditional burial and a safe burial for a deceased family member, they can choose whether to bring their child to an ETU when sick, and take or not take social distancing measures. There is incomplete information about the true state of nature $\theta$, which captures the existence, gravity, and costs associated with the new epidemic disease. If they do not take protective measures, they may increase their likelihood of contagion, incurring cost $\theta$. If they take too many protective measures, they may incur economic costs, or risk their lives if the reality is that Ebola does not exist and individuals die in ETUs. Further, individuals may incur costs from not conforming to the social norm, and may want to match the average action taken by others, $\bar{A} = \int a_i \, di$. This introduces strategic complementarity in individuals’ actions. We expect this for actions that are observable and sanctioned by others, such as engaging in traditional burials or sending ones’ child to an ETU, but not for actions that are not observed or reprimanded by others, such as hand-washing. The degree of strategic complementarity is captured by $r \in (0, 1)$.$^{12}$

$^{12}$Strategic complementarity in individuals’ actions can be defined as $r = r_0 - c$, where $r_0$ captures the marginal social benefit of abiding with the norm and $c \geq 0$ is the cost due to an increased transmission rate, as others perform the risky action. If hand-washing does not violate any norm, but has a positive externality, $r = -c < 0$, introducing strategic substitutability (derivations and predictions not shown, but available upon request).
The utility of individual $i$ is given by the following loss function:

$$u_i(a, \theta) \equiv -(1 - r) (a_i - \theta)^2 - r (a_i - \bar{A})^2$$  \hspace{1cm} (1)$$

where $a$ is the action profile over all individuals.

Individual utility has two components. The first component captures the private cost of taking an action $a_i$ that is far from the state of nature $\theta$. The second component captures the cost from taking an action that differs from the average action taken by others $\bar{A}$. The weight on the social norm component increases with the degree of strategic complementarity $r$.

An individual chooses the action $a_i$ that maximizes utility (1). The first order condition is given by:

$$a_i = (1 - r) E_i(\theta) + r E_i(\bar{A})$$

where $E_i(\cdot)$ is the expectation operator for player $i$. In the presence of strategic complementarities ($r > 0$), individuals care both about the costs of contagion, as well as the social norm. Therefore, they put positive weight on the expected state and the expected actions of others.

If $\theta$ is common knowledge, the equilibrium is $a_i = \theta$ for all $i$. Next consider the case in which individuals face uncertainty concerning $\theta$. Assume $\theta$ is drawn from an improper uniform prior over the real line, $\theta \sim \mathcal{N}(0, \infty)$. Individuals receive one private signal and one or multiple public signals indexed by $k = \{L, N, F\}$. The local radio $k = L$ gives relatively accurate information about the local epidemic $\theta$ with some noise. The national radio $k = N$ gives information about the epidemic at national level which provides a proxy for the local epidemic, with some additional noise. The non-local or foreign radio $k = F$ provides information about the epidemic in a different location, and this provides even noisier information about the local epidemic conditions. Formally:

**Public signal** $k = \{L, N, F\}$:  
$$y_k = \theta + \eta_k \quad \text{with} \quad \eta \sim \mathcal{N}(0, 1/\alpha_k)$$

**Private signal**:  
$$x_i = \theta + \epsilon_i \quad \text{with} \quad \epsilon_i \sim \mathcal{N}(0, 1/\beta)$$

Signals $y_k$ are “public” in the sense that the realizations of $y_k$ are common knowledge. Signal $x_i$ is private in the sense that it is not observable by others. Denote by $\alpha_k, \beta$ the precisions of the public and the private signals, respectively. The noise terms $\eta_k$ are independent of $\theta$, and independent of each other conditional on $\theta$. The noise terms $\epsilon_i$ are independent of $\theta$ and $\eta_k$, so $E(\epsilon_i \epsilon_j) = 0$ for $i \neq j$.

To conceptualize that only a share of a sub-prefecture is covered by radio, I allow for a share of individuals to be informed by the public signals, following Cornand and Heinemann (2008). For simplicity, I assume that individuals either receive the private signal only, or all of the available public signals, fixing the share of individuals informed by all of the public signals to $P \in [0, 1]$.

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11 With a standard welfare function, social welfare is maximized when individuals’ actions match the reality of the spread of disease. When $\theta$ is common knowledge social welfare is maximized at equilibrium. The analysis is not central here and equivalent to Morris and Shin (2002).
The optimal strategy for an individual who receives a public signal is a linear function of each of the signals (Morris and Shin, 2002, Cornand and Heinemann, 2008):

$$a_i(I_i) = \sum_k \kappa_y^P y_k + \kappa_x^P x_i \quad \text{for } P \in [0, 1]$$

(2)

where $I_i$ is the information set of the individual $i$, namely $(y_k, x_i)$.

The equilibrium weights are given by (see SOA Section ??):

$$\kappa_y^P = \frac{\alpha_k}{(1 - rP)\beta + \sum_j \alpha_j} \quad \forall k$$

(3)

$$\kappa_x^P = \frac{(1 - rP)\beta + \sum_j \alpha_j}{(1 - rP)\beta + \sum_j \alpha_j}$$

(4)

In equilibrium, individuals with public information choose:

$$a_i^P(I_i) = \frac{\sum_k \alpha_k y_k + (1 - rP)\beta x_i}{(1 - rP)\beta + \sum_j \alpha_j}$$

(5)

Individuals with private information only, choose $a_i^0 = x_i$.

Equations (3) and (4) imply that the relative weight of the private information in equilibrium depends on the level of strategic complementarity $r$, and the proportion of individuals with access to public radio $P$; i.e. $\kappa_y^P > \kappa_x^P \iff \alpha_k > (1 - rP)\beta$. The larger the externalities or social norm aspect of a given action (higher $r$), the higher weight public information has in equilibrium, as coordination motives rise. Further, the more individuals with access to public information (higher $P$), the greater importance of this coordination effect, and also the higher the weight of public information. These results are identical to Morris and Shin (2002) and Cornand and Heinemann (2008), respectively.

In addition, this framework allows me to compare the public signals. Equation (3) shows that public information with a more precise signal has a higher weight in the equilibrium action (2), i.e. $\alpha_L > \alpha_N \iff \kappa_y^L > \kappa_y^N$. If a foreign or non-local radio gives no information on the local epidemic ($\alpha_F = 0$), it has zero weight in the equilibrium action $\kappa_y^F$.

The model leads to two predictions:

Prediction #1: Public radio has a greater impact on actions associated to social norms, compared to private information, which in this context may take the form of door-to-door campaigns. This difference is smaller for actions that are private or not socially sanctioned ($r = 0$), and absent if in addition everybody has access to the public information ($r = 0, P = 1$).

Prediction #2: Local community radio, as long as it provides more relevant or precise information about the actions needed to match the local epidemic conditions, leads to a faster change in equilibrium actions, compared to a community radio station that is not local and provides more noisy information about the local epidemic conditions and advised protective behavior.
Note that prediction #2 hinges on local radio providing more precise information than non-local radio. Whether community radio from one’s own locality or non-local community radio with shared ethnicity provides more relevant information is an empirical question, which I discuss in Section 2.2.

**Epidemiological model** New Ebola infections in each sub-prefecture $s$ at time $t$ follow exponential growth with transmission rate $\beta_{s,t}$ on a fraction $\rho \in [0, 1]$ of past cases (Lekone and Finkenstädt, 2006, Fang et al., 2016). The public information campaign affects the degree of protective behavior adopted in equilibrium, which in turn impacts the transmission rate $\beta_{s,t}$ (Funk et al., 2009, Kiss et al., 2010). This is summarized by the following model of exponential growth in Ebola infections:

$$Ebola_{s,t} = Ebola_{s,t-1}^\rho e^{f(\beta_0, b(P_{s,t}), X_{s,t})}$$

(6)

The transmission rate $\beta_{s,t} = f(\beta_0, b(P_{s,t}), X_{s,t})$ is a function of baseline transmission rate $\beta_0$, the equilibrium strategies $b(P_{s,t})$ and baseline covariates $X_{s,t}$. As described above, the equilibrium strategies depend on the access to the public health campaign $P_{s,t}$, which I measure as the interaction between two terms: radio signal exposure, i.e. the share of a sub-prefecture’s territory with access to a community radio, and the timing of the launch of a particular radio campaign $k$ throughout the country ($\tau_k$):

$$P_{s,t} = \begin{cases} 
0 & \text{if } t < \tau_k \\
RadioSignal_s & \text{if } t \geq \tau_k 
\end{cases}$$

I further simplify the model above by approximating the transmission rate $\beta_{s,t}$ with a linear function $\beta_0 + \beta_1 P_{s,t} + \beta_2 X_{s,t}$ and taking logs in (6):

$$\log Ebola_{s,t} = \log Ebola_{s,t-1}^\rho + \beta_0 + \beta_1 P_{s,t} + \beta_2 X_{s,t} + u_{s,t}$$

(7)

$u_{s,t}$ captures the probability that new cases are generated from contagion with distant communities or animal-to-human transmission. Equation (7) guides the main empirical strategy.

### 2.2 Hypotheses

Next I lay out the different hypotheses comparing different public radio signals, and the approach to test them. I describe these with the help of the sylized map shown in Figure 2. Assume there are at least two prefectures, two ethnic groups, and at most one community radio station in a given prefecture. Focusing on the community radio station located in prefecture A (in sub-prefecture A0), I ask which sub-prefectures are expected to see an earlier drop in infections, depending on the hypothesis at hand.

The estimating strategies are detailed in Section 3. The overarching approach is to examine whether sub-prefectures with a greater share of their territory covered by the signal of a given radio station see a similar evolution of the epidemic before the start of the public health campaign, compared to other sub-prefectures with less access to it, followed by an earlier drop in infections a few months thereafter.
FIGURE 2: Sylized map illustrating reach of community radio and working hypotheses

Notes: The Figure presents a stylized map of Guinea. To illustrate the hypotheses tested, I assume there are at least two prefectures, two ethnic groups, and at most one community radio station in a given prefecture. The interior of the dashed ellipse depicts the areas covered by the radio signal from prefecture A’s community radio station. It covers some sub-prefectures in prefecture A (A0, A1, A0), and some sub-prefectures in prefecture B (B1, B0). It covers sub-prefectures that have the same ethnic majority as the prefecture where the radio station is located (A0, A1, B1), and it also covers sub-prefectures with a different ethnic majority (A2, B2). Depending on the hypothesis at hand, we expect different sub-prefectures to see a relatively earlier drop in infections; i.e. whether what helps curb the epidemic is receiving information from any community radio (H1: A0, A1, A2, B1, B2), mostly local information (H1a: A0, A1, A2), mostly information from a radio station located in a sub-prefecture with a shared ethnic majority (H1b: A0, A1, B1), or a combination of H1a & H1b (H1c: A0, A1).

Hypothesis 1: Access to any community radio provides public information relevant to individuals across the country, and this leads to lower infections over several months.

- Empirical test: Test whether sub-prefectures with a greater share of their territory covered by any community radio signal (A0, A1, A2, B1, B2) see an earlier drop in infections, compared to others.

Hypothesis 1a: Access to community radio provides public information especially relevant to individuals in the locality (prefecture) it serves.

- Empirical test: Test whether sub-prefectures with a greater share of their territory covered by the radio signal from their own community radio (A0, A1, A2) see an earlier drop in infections, compared to others, including those with access to community radio from other prefectures (B1, B2).

Hypothesis 1b: Access to community radio provides public information especially relevant to individuals from any locality but with shared ethnic identity as the majority in the prefecture that the community radio serves.
Empirical test: Test whether sub-prefectures with a greater share of their territory covered by the radio signal of the community radio of any prefecture with whom they share the same ethnic majority (A0, A1, B1) see an earlier drop in infections, compared to other sub-prefectures, including those with access to community radio from prefectures with a different ethnic majority (A2, B2).

Hypothesis 1c: Access to community radio provides public information relevant to individuals in the locality (prefecture) it serves, especially for those who share the ethnic identity of the majority in the prefecture that the community radio serves.

Empirical test: Test whether sub-prefectures with a greater share of their territory covered by the radio signal from their own community radio (A0, A1, A2) see an earlier drop in infections, compared to other sub-prefectures, including those with access to community radio from other prefectures (B1, B2), and test whether this earlier drop is driven by sub-prefectures that share the ethnic majority of the radio stations' prefecture (i.e. driven by A0, A1, as opposed to A2).

The main hypothesis tested in this paper is Hypothesis 1a, and the rest of the Sections are organized around testing whether the locality of community radio has an additional impact. The other hypotheses are tested as possible alternatives. Note that to study the impact of a given radio station, as opposed to general radio access, I condition on overall access to radio. Turning to the role of local community radio or of ethnic-belonging, my baseline specification conditions on overall community radio access, and on access to other radio stations, including including national radio.14

3 Empirical Strategy

I begin by motivating the main hypothesis and empirical strategy with Figure 3. The upper panels show the total number of Ebola cases over two periods, before and after September 2014, when most community radio stations launched the public health campaign. The lower panel depicts access to a local (solid purple) and to a non-local (dashed) community radio station. The clearest example is seen in the south-west of Guinea. Although neither Forecariah nor Kindia were hit by Ebola before October 2014, they had very different trajectories thereafter. Kindia, which had a local community radio station, saw a much lower epidemic burden, compared to Forecariah, which despite having a similar access

14 Baseline results are confirmed also without conditioning on other radio stations (see Figure ??). Note that other types of radio stations could have similar effects, such as national radio. This additional Hypothesis 2 is falsified in the Figures ??-??:

Hypothesis 2: Access to any radio (e.g. national radio) provides public information relevant to individuals across the country, and this leads to lower infections over several months.

Empirical test: Test whether sub-prefectures with a greater share of their territory covered by the national signal see an earlier drop in infections, compared to other sub-prefectures.
to a community radio signal, did not have its own. Further, Forcariah has no less access to health facilities and is more populated than Kindia (shown in Figure ??). Another example is perceptible in the south-east of Guinea. Although Lola and Nzérékoré are close to the epicenter, sub-prefectures in Lola experience a higher per capita epidemic burden, compared to sub-prefectures in Nzérékoré. Nzérékoré had its own local community radio, while Lola did not.

The empirical design will systematically look at the differential change in the epidemic in places like those located in Kindia and Forcariah. All of them have access to community radio, but only for places situated in Kindia is this a local community radio station.

3.1 Local radio impacts on the spread of Ebola

The main empirical strategy follows the same logic as a standard difference-in-differences strategy with continuous treatment. I study the evolution of the epidemic in places with varying access to a community radio station that is local to a community, several periods before and after the start of a major public health campaign, conditional on access to other radio stations.

Identifying assumptions and design

The cross-sectional treatment variable is the share of a sub-prefecture with access to a community radio that is local, i.e. based in one’s own prefecture, as opposed to one from neighboring prefectures. The design builds on previous media literature seeking to identify the impact of broadcast information on a relevant economic outcome (e.g. Olken, 2009). The number of radio listeners and other measures of information uptake, is plausibly endogenous to willingness to abide with public health measures. Instead, I follow this literature and construct a measure of radio signal exposure, based on characteristics of the radio transmitter, combined with features of the geographic terrain. This measure could still be correlated with socio-economic outcomes affecting the spread of disease. I add two additional elements that strengthen the design: Firstly, I use a time dimension, since I observe Ebola spreading for at least six months before the public health campaign is officially launched by the directorate of community radios. Secondly, I control for access to any community radio and other radio, interacted with time dummies. This ensures I compare the evolution of the virus in places with similar radio access.

Identification relies on a parallel-trends assumption: in the absence of an information campaign, places with greater access to a local community radio station would have behaved similarly to other places, conditional on access to other radio stations. I provide evidence supporting this assumption in three ways. Firstly, I find that Ebola infections do not only evolve in parallel, but have similar levels in places with varying access to a local radio station, conditional on other radio stations, during the months before the campaign is officially launched. Secondly, on average, socio-economic characteristics appear to be similar in places with varying access to a local radio station, conditional on access to other radio
FIGURE 3: Ebola burden and access to community radio

Notes: Cumulative number of Ebola infections per 100,000 people in a sub-prefecture before (panel A) and after (panel B) the public health campaign on community radios. Share of a sub-prefecture with access to a community or to a local community radio station, i.e. one based in their own prefecture (panel C). For health facilities and population see Figure ??.
stations. Thirdly, these places also appear to have a similar burden of other infectious diseases on average, in the years prior to the Ebola outbreak. Details are given in SOA Section ??.

**Main estimating equation**

The main empirical strategy is a fully flexible difference-in-differences strategy with time dummies for each month before and after launch of the public health campaign, as summarized in equation (8):

\[
\log\text{Ebola}_{s,t} = \sum_{\tau} \beta_{\tau} \text{RadioSignal}_{s}^{Local} \times 1(t(\tau)) + \sum_{\tau} \sum_{k \neq Local} \gamma_{\tau}^{k} \text{RadioSignal}_{s}^{k} \times 1(t(\tau)) + X_{s,t} \Gamma + \alpha_s + \lambda_t + u_{s,t} \tag{8}
\]

This specification tests the main Hypothesis 1a, that the locality of the community radio matters. Section 3.2 describes alternative hypotheses.

The outcome \(\log\text{Ebola}_{s,t}\) is the log-number of Ebola infected cases per 100,000 people in sub-prefecture \(s\) at month \(t\). The strategy is motivated by the theory in Section 2.1.\(^{15}\) The model is identical to a standard difference-in-differences equation, but instead of a typical post-treatment dummy I use time dummies \(1(t(\tau))\), for each month \(\tau\), where \(\tau = 0\) is the month in which the campaign started.\(^{16}\)

The treatment variable of interest is the interaction between the share of a sub-prefecture \(s\) with access to a local community radio station \(\text{RadioSignal}_{s}^{Local} \in [0, 1]\), and the time dummies \(1(t(\tau))\), for each month \(\tau > 0\) after the start of the campaign. I control for access to other radio stations interacted with the post-treatment dummies. This includes overall access to radio stations, to any community radio station, and to private and national radio stations, which pre-date the Ebola outbreak.

The coefficients of interest are \(\{\beta_{\tau}\}_{\tau \geq 0}\). They measure the marginal effect on the growth of Ebola infections of the public health campaign aired from local radio stations \(\tau\) months after it is launched, conditional on access to other radio stations and controls.

This specification allows me to plot each coefficient \(\beta_{\tau}\) and test the parallel-trends assumption. I test whether \(\beta_{\tau} = \beta\) constant for all \(\tau < 0\) before the official launch of the public health campaign in June 2014, and potentially also until its effective adoption after September 2014.

\(^{15}\)See equation (7), where \(\text{RadioSignal}_{s}^{Local} \times 1(t(\tau))\); \(\forall \tau > 0\) corresponds to \(P_{s,t}\). The preferred specification uses \(\log\text{(Ebola + 0.01)}\), as this allows us to interpret the coefficient \(\beta\) as the \% change in the number of Ebola cases as a result of a 1 \% increase in access to local radio. Results are similar with alternative specifications. For robustness I show that the effect does not change when I add a dummy variable for each zero observation.

\(^{16}\)The omitted category is \(\tau = -1\), the period immediately following the start of the campaign in June 2014. A simple difference-in-differences exercise summarized in equation (9) illustrates the design:

\[
\log\text{Ebola}_{s,t} = \beta \text{RadioSignal}_{s}^{Local} \times Post_{t} + \sum_{k \neq Local} \gamma^{k} \text{RadioSignal}_{s}^{k} \times Post_{t} + X_{s,t} \Gamma + \alpha_s + \lambda_t + u_{s,t} \tag{9}
\]

Since one expects public health information to take time to affect health behavior and the spread of disease, the flexible difference-in-difference is the preferred specification.
I include location fixed-effects $\alpha_s$ and time fixed-effects $\lambda_t$ to capture time-invariant differences across locations, as well as common changes over time. In the main specification I do not include a lagged dependent variable, assuming that the additional impact of past Ebola cases on the effect of interest will be largely covered by the fixed-effects. Given that we are dealing with one single epidemic outbreak, the assumption seems reasonable, since the initial spread of Ebola is largely driven by fixed characteristics, namely the distance to the first case and population density. The results are also confirmed in a lagged dependent variable specification (shown in SOA Section ??). Standard errors are clustered at prefecture-level, to account for spatial and serial dependence.

$X_{s,t}$ includes a set of time-varying or time-invariant controls interacted with the post-treatment dummy. To account for factors that may facilitate the spread of disease, as well as socio-economic confounders, I control for population level and density, geographic area, distance to the epicenter, i.e. the location of the first Ebola case. I control for the shortest distance to public health facilities at each point in time, to ensure that impacts are not driven by a change in their supply.\(^{17}\) To address a potential concern that impacts are driven by the proximity to the radio tower (i.e. possibly wealthier areas), I include the distance to the closest radio transmitter for each type of media outlet.

As a robustness check I also add a dummy variable \(Radio_{s,local}^{Local} \in \{0, 1\}\) which is equal to 1 if a sub-prefecture \(s\) has its own local radio station in its prefecture and 0 otherwise, interacted with the time dummies. This way I ensure that the impact of local radio is not driven by unobserved characteristics that fundamentally differentiate prefectures that have a local radio station from those that do not.

### 3.1.1 Results on the effect of local radio stations on the spread of Ebola

The results from estimating equation (8) are shown in Figure 4. First, they support the parallel-trends assumption. There is no difference in the spread of Ebola between areas with varying levels of access to a local community radio station, controlling for access to other radio stations, prior to the launch of the public health campaign and at least until its effective adoption by community radio stations throughout the country, i.e. \(\hat{\beta}_\tau = 0\) for all \(\tau \leq 2\), or September 2014. This also holds conditional on a number of controls correlated with the spread of disease detailed above. Second, we see the impacts of the campaign were not immediate: the transmission rate of Ebola in places with access to local radios sank seven months after the intended starting date, four months after most of the community radio stations adopted the intense sensitization campaign (see Section 3.1.3 for an interpretation on this lagged effect).

Third, results indicate that 10 percentage point (pp) increase in access to a local radio station (from a baseline of 28%) lowers Ebola infections per 100,000 people by 13-18% each month after the seventh

\(^{17}\)A potential concern of this strategy is that the increasing influx of international aid may also have affected other public health measures, notably the opening of Ebola treatment units and laboratories for rapid testing. This would be an issue if their provision was linearly correlated with pre-existing access to local radio stations. SOA Section ?? provides evidence refuting this, as discussed under Robustness checks section 3.1.4.
FIGURE 4: Event study: Ebola infections, social resistance and treatment-uptake pre/post public health campaign, by access to a local community radio station

A. Ebola Infections

B. Social resistance

C. Treatment-uptake: ratio of Ebola deaths in-community over total deaths

With 95% confidence intervals; Bootstrap standard errors clustered by prefecture; Omitted category: 1-1.

Notes: Coefficients estimates of equation (8), with omitted category -1 (May 2014). Interpreted as the percentage difference in Ebola infections (panel A), the difference in social resistance (panel B) and in treatment-uptake (panel C) per 100,000 people, for sub-prefectures with 1 pp. greater access to a local community radio station, each month before and after the public health campaign was launched. The vertical lines indicate the launch campaign (gray dashed line), and the actual start by most community radio stations, as significant international aid arrived (red solid line). I condition on access to community radio, and to other radio stations. Controls include population, population-density, distance to epicenter, to the closest radio transmitter from any radio, from national, private, local and non-local community radio, interacted with time-dummies, and distance to the closest ETU, CCC and laboratory at each time. See also Table ??.
month following the start of the campaign.\textsuperscript{18} The treatment effect subsides a year into the campaign, in June 2015, as the epidemic is coming to an end, due to the combination of public health measures put in place.\textsuperscript{19} The difference-in-differences results based on equation (9) are smaller and less precisely estimated, but they show a similar pattern. A 10\textit{pp} increase in access to local radio stations leads to a 3-5\% drop in Ebola infections per 100,000 people over the entire period since the launch of the campaign.

I do back-of-the-envelope calculations of how many Ebola cases could have been prevented with greater access to local radio stations. I focus on places with above-median access to community radio (which have on average 75\% of the sub-prefecture covered by some community radio station). I first note that places with local radio have an average of 62\% of their territory covered with the signal from their local radio station. Next, I observe that places without local radio saw a total of 1451 people infected with Ebola, counting from the official launch of the campaign. I then multiply each event-study estimate with the corresponding number of new Ebola cases each month after the launch of the campaign $\times 62\text{pp}$. This suggests that around 470-500 infections or 13\% of the total Ebola epidemic in Guinea could have been prevented if places with above-median access to some community radio had had a local one.\textsuperscript{20}

**3.1.2 Local radio impacts on social health behavior**

I use the same empirical strategy described above to study whether the way in which public health campaigns halted the spread of Ebola was through affecting socially-sanctioned health behaviors.

Firstly, I look at “social resistance”, namely collective acts expressing a refusal to abide with public health measures, including safe burials. There is a contemporaneous drop in social resistance in the same month as the drop in the transmission rate of Ebola (Figure 4). This is consistent with social resistance behavior and the spread of the virus reinforcing each other. Most of the impacts arise seven months after the public health campaign commenced, starting from a 34\% drop in social resistance in the seventh months and stabilizing at 13\% per month thereafter, for 10\textit{pp} greater access to a local radio station.

Secondly, I examine at a measure of treatment-uptake: the ratio of deaths in the community over the total number of deaths, including those that die in an ETU, adjusted by population. I observe a gradual decrease in the relative number of Ebola deaths in-community, by 25\% in the seventh month, up to 41\% in the eighth month, with 10\textit{pp} greater access to a local radio station.\textsuperscript{21}

\textsuperscript{18}Regression results are in Table ?? for the fully-flexible model and ?? for differences-in-differences results. Coefficients give the percentage change in Ebola cases due to a 1\textit{pp} increase access to a local radio station.
\textsuperscript{19}Partly this can be due to new sensitization campaigns in the second half of 2015 (Table ??), and new local radio stations, but only one is launched in March 2015, two in May 2015, the others earliest in August 2015.
\textsuperscript{20}Difference-in-differences estimates imply 360-450 fewer Ebola cases, or 9-10\% of the total epidemic burden.
\textsuperscript{21}The outcome is the percentage of Ebola deaths in-community over total deaths + 1.
3.1.3 Interpretation of lagged effect

Next I discuss how to interpret the fact that it takes time to detect impacts of the public awareness campaign on the epidemic outbreak: about seven months since the official launch of the campaign, or four months since the campaign improved its contents and as community radio stations received significant reinforced capacity. I interpret the results as intention-to-treat effects, given that the effective and more complete adoption of the sensitization campaign by different community radio stations takes more time with respect to its official launch (for details see Table ??). In addition, the lagged effect is consistent with a mechanism of coordination in behaviors attached to social norms. Insights from game theory imply that it takes time to adjust behaviors that depend on others’ beliefs and actions, based on changes in information that are common knowledge (Geanakoplos, 1992): it takes time to adjust actions, based on observing others, given what others know and what they know that others know. Epidemiological models consider the role of information on shortening epidemics (Funk et al., 2009, Kiss et al., 2010). There is little robust empirical evidence, however, on how fast public information actually spreads and impacts social health behavior and disease. Individual health behavior, such as choosing whether to travel in the next days during the Covid-19 pandemic or not, can change rapidly due to targeted advertising on social media (Breza et al., 2021). Socially-entrenched behaviors, however, may take more time to change. For example Wakefield et al. (2011) find that a media campaign impacted smoking behavior three months after the campaign started. Public health literature highlights the need for widespread, frequent and prolonged exposure for a campaign’s success (e.g. Flay, 1987, Hornik, 2002, Wakefield, Loken and Hornik, 2010). Communications research also advise that most campaigns take anywhere from 90 days to a year to complete (Blakeman, 2011). The results are in line with this body of evidence. Future research is advised to learn more about the pace at which different behaviors change as a function of distinct types of information.

3.1.4 Robustness checks

In SOA Section ??, I conduct a number of validity checks to the main specification, and additional discussion on study limitations. The key identifying assumption is that in the absence of the public health campaign, the epidemic burden would have grown at the same rate in places with varying levels of access to a local radio. I conduct several checks to support this assumption. We saw that the epidemic evolves similarly in areas with varying levels of access to a local radio, prior to the start of the campaign, and this holds unconditionally, as well as conditional on other radios, and on wide set of controls. Next, a potential concern is that the epidemic spreads faster depending on underlying socio-economic characteristics correlated with access to local radio. I address this concern in several ways. First, I show that access to local radio is not systematically correlated with a set of covariates that could influence
the spread of disease, including population, wealth, education, infrastructure, trust, and public health facilities, when conditioning on overall access to community radio (Tables ??-??). Second, I find no evidence that other infectious diseases are systematically related to access to local radios (Table ??). Third, I do not find similar impacts of other radio stations, which did not launch this public health campaign (Figure ??). Fourth, I study the possibility that the impact of local radio is mediated through trust in national institutions, and find that the baseline results are confirmed when controlling for trust in president, interacted with time dummies (Figure ??). More generally, the baseline results also hold at the intensive margin, that is, when looking at the impact of greater access to a local radio signal, conditional having a local radio station (Figure ??). This addresses the concern that prefectures with a local radio station have unobservable characteristics that make them fundamentally different from those that do not. Moreover, I study whether the Ebola response changes over time differentially for places with greater access to local radio. I find that access to ETUs and laboratories is not correlated with local media, nor does their access change at the time when observe the main effect on Ebola (Figure ??). This also suggests that the impacts of local media are not driven by a change in the provision of public health facilities, through a government accountability channel (Besley and Burgess, 2002, Eisensee and Strömberg, 2007). Further, results are not very sensitive to different specifications, such as a lagged-dependent variable model and alternative counts of Ebola cases (Figure ??), or different ways of measuring social resistance and treatment uptake (Figures ??-??). I also show that the results also hold with more parsimonious specifications, not conditioning on other radio signals nor controls. I show this in Figure ??, which adds each radio signal and controls separately.

3.2 The role of local information, beyond ethno-linguistic belonging

The results show that the public health campaign lead to an earlier drop in infected cases, accompanied by a change in social health behavior, in places with access to a community radio station that is local. I test alternative hypotheses described in Section 2.2.

Overall community radio access (Hypothesis 1) To test whether places with any community radio saw an earlier drop in Ebola infections (Hypothesis 1), I replace the main treatment variable in equation (8) with $\text{RadioSignal}_{s}^{\text{Community}} \in [0, 1]$, which measures the share of a sub-prefecture $s$ with access to a community radio station from any locality. I condition on access to other radio stations.

Results presented in Figure 5, Panel A, show no statistically significant impacts, suggesting that having access to any community radio is not sufficient to drive a change in behavior.22 Further, impacts of national radio are rejected (Hypothesis 1c, Figures ??-??).

22In some specifications, depending on controls, there is a significant drop in infections about 10 months from the start of the campaign, about three months later than the effects seen in locations with local community radio, but these results and the parallel trends are not robust (Figures ??-??).
FIGURE 5: Event study: Ebola infections, for alternative Hypotheses 1 & 1b.

A. Treatment: access to any community radio (H1)
B. Treatment: access to a community radio with shared majority language (H1b)

With 95% confidence intervals; Bootstrap standard errors clustered by prefecture; Omitted category: t-1.
Notes: Coefficients are interpreted as the percentage difference in Ebola infections per 100,000 people in sub-prefectures with 1pp. greater access to a community radio each month before and after the public health campaign was launched. The estimating equation is (8), but with alternative treatment variables. In Panel A treatment is $\text{RadioSignal}^{Comm.}$, the share of a sub-prefecture with access to any community radio, regardless of language or location (Hypothesis 1). I condition on access to other radio stations. In Panel B treatment is $\text{RadioSignal}^{Ethn.}$, the share of a sub-prefecture with shared ethnic language I compute the largest share of a sub-prefecture covered by a community radio station sharing the sub-prefecture’s majority language (Hypothesis 1b). I condition on access to community radio, and to other radio stations. Controls are as in Figure 4.

Ethno-linguistic belonging Next, I explore whether the importance of local information is due to ethno-linguistic belonging. Since there are at least 24 distinct languages spoken in Guinea, it could be that the importance of local radio is simply due to citizens’ inability to understand the radio from a neighboring community. Note however, that major language groups are somewhat clustered across Guinea’s four main regions. This means that there are neighboring prefectures, which have access to each others’ community radio signal and whose populations largely share a language (Figure ??). Therefore the results presented above are unlikely to be entirely driven by language.

At the same time, Guinea exhibits diversity both within and across prefectures. In any given sub-prefecture an average of one-fourth of the population does not share the same mother tongue as the majority of the prefecture, and in some cases this is up to two-thirds (Table ??). However, Guineans are often able to understand several languages. Moreover, community radio stations take existing diversity into account and transmit radio programs in a number of languages. They report airing in one or two main languages, which coincide empirically with the prefectures’ majority groups. To study the possibility of ethno-linguistic belonging being behind the impact of local radio more deeply, I do two empirical exercises, described next (Hypotheses 1b and 1c).

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23 I use ethnicity and language indistinctively, as they are analogous in this context.

24 In addition to the main language, they may use French and other local languages. E.g. the community radio of Bokè reports using mainly Susu and Fulla, but also sometimes Landuma, Diakanke, Nalou, Mikhifore and French.
Ethno-linguistic belonging, instead of locality (Hypothesis 1b) To study whether ethno-linguistic belonging is driving the impacts of local community radio, I define what “local” media is differently. In particular, I test whether places with access to a community radio speaking their own majority language, saw an earlier drop in Ebola infections (Hypothesis 1b), compared to other places with access to community radio or to other radio stations. In other words, I replace the main treatment variable in equation (8) with $\text{RadioSignal}_{s}^{\text{Ethnic}} \in [0, 1]$, which measures the largest share of sub-prefecture $s$ covered by a community radio station sharing the sub-prefecture’s majority language. I condition on access to other radio stations. Results presented in Figure 5, Panel B, show no statistically significant impacts, suggesting that having access to a community radio with shared language is not sufficient to drive a change in behavior.

FIGURE 6: Event study on Ebola infections for alternative Hypothesis 1c.

Treatment: access to local community radio, interacted with a dummy variable indicating whether a sub-prefecture shares the majority language of the local community radio (left), or does not not (right) × Shared Ethno-linguistic group × Different Ethno-linguistic group

Conditional on community radio & other radio stations & controls

With 95% confidence intervals; Bootstrap standard errors clustered by prefecture; Omitted category: t-1.

Notes: Coefficients are interpreted as the percentage difference in Ebola infections per 100,000 people in sub-prefectures with 1pp. greater access to local community radio, in places with/without shared ethno-linguistic group, each month before and after the public health campaign was launched. I study heterogeneous effects of local community radios, in sub-prefectures sharing the majority language of the community radio, i.e. the majority language in the prefecture (left panel), and for those that do not (right panel) (Hypothesis 1c, equation (10)).

Ethno-linguistic belonging on top of locality (Hypothesis 1c) To test whether local radio has different impacts in sub-prefectures sharing the majority-group of their prefecture (and thus the radio station’s main language), compared to sub-prefectures with a different majority, I estimate equation (10):

$$\log Ebola_{s,t} = \sum_{\tau} \beta_{\tau}^{1} \times \text{RadioSignal}_{s}^{\text{Local}} \times \text{Lang}_{s}^{1} \times 1_{t}(\tau) + \sum_{\tau} \beta_{\tau}^{0} \times \text{RadioSignal}_{s}^{\text{Local}} \times \text{Lang}_{s}^{0} \times 1_{t}(\tau)$$

$$+ \sum_{\tau} \sum_{\tau \neq \text{Local}} \gamma_{\tau}^{k} \times \text{RadioSignal}_{s}^{k} \times 1_{t}(\tau) + X_{s,t} \Gamma + \alpha_{s} + \lambda_{t} + u_{s,t}$$

(10)
The dummy variable $\text{Lang}_s^1$ ($\text{Lang}_s^0$) takes value 1 if sub-prefecture $s$ shares (does not share) the majority language of the prefecture it is located in. Everything is identical to the flexible difference-in-differences strategy above (8), except that here I look at heterogeneous effects of local radio, splitting by whether the sub-prefecture shares the majority language of its local community radio or not.

If the importance of local information were due to language, we would expect to see no effect or a significantly smaller effect in sub-prefectures whose majority language is distinct from its community radio, compared to places which share the same majority language (Hypothesis 1c). Figure 6 shows that this is not the case. On the contrary, the impact of a local community radio is present both in sub-prefectures sharing the main language as the local community radio, and those that do not.25

4 Mechanisms

In this Section I discuss role of local media more deeply. First, I delve into the role of inter-personal contact in sanctioning social behavior (Section 4.1). Second, I provide a deeper overview of ethnic and religious fractionalization across Guinea’s regions (Section 4.2). I then present suggestive evidence that the common-knowledge aspect of media is playing out at the local level, and is key for affecting social health behaviors, but not for private health behaviors (Section 4.3). I also discuss and provide evidence against alternative channels through which local media could affect the spread of Ebola, other than through the impacts of the locality of information (Section 4.4). An additional discussion on the interpretation of findings and study limitations is given in SOA Section ??.

4.1 Locally-sanctioned behavior

I hypothesize that local media helps halt contagion as it facilitates coordination in socially-sanctioned behaviors, which are observed and sanctioned locally. Whether the locality of media matters responds to the question of who is the relevant ‘other’, whose behavior and beliefs influence one’s own behavior. Since health behavior affects others through physical contact, the finding that impacts are driven by the locality of media, is intuitive: the relevant ‘other’ are people one has physical contact with, and hence the importance of locality. While ethnic ties may matter in multiple ways, a co-ethnic potentially located across a large region or area is less able to transmit the disease and observe one’s own health behavior.

Consider that someone living in Forécariah, but originally from the majority ethnic group in Kindia, hears the information that conducting safe burials or not shaking hands are now the new social norm in Kindia. One still needs to encounter other people in Forécariah and tell them that they are not conducting traditional burials or shaking hands anymore and doing this may be socially costly. The information provided is the same, but if these are socially-entrenched behaviors, the media outlet located elsewhere may not be as effective in changing the norm.

25Results are similar when using the first two majority groups, or other specifications (SOA Section ??).
### TABLE 1: Descriptive evidence of ethnic diversity and multiplicity of identities

#### A. Ethnic and religious diversity

| Variable                  | Mean / (Std. Dev.) | (1) | (2) | (3) | (4) |
|---------------------------|--------------------|-----|-----|-----|-----|
| Ethnic fractionalization  | 0.75 (0.02)        | 0.26| 0.20|     |     |
| Religious fractionalization| 0.23 (0.01)       | 0.12| 0.11|     |     |

#### B. Multiple identities and languages spoken

| Variable                                              | Mean     | Std. Dev. | Min | Max |
|-------------------------------------------------------|----------|-----------|-----|-----|
| Number of languages (implied in interview)            | 1.92 (0.59) | 1.00 | 4.00 |
| More than one ethnicity or language spoken             | 0.79 (0.41) | 0.00 | 1.00 |
| Feels more national than ethnic identity               | 0.78 (0.42) | 0.00 | 1.00 |
| Feels more ethnic than national identity               | 0.11 (0.31) | 0.00 | 1.00 |
| Feels equally national and ethnic identity             | 0.11 (0.32) | 0.00 | 1.00 |

Notes: Panel A reports the mean values of ethnic and religious diversity in the country, region, prefecture, or sub-prefecture, based on the fractionalization index from Alesina et al. (2003). This index computes the probability that two individuals from a given location belong to different ethnic or religious groups. The fractionalization index in location \( j \) is defined as \( F(j) = 1 - \sum_{i}^{m(j)} \pi(j)_i^2 \), where \( \pi(j)_i = n_i(j)/N(j) \) is the population share of each group in location \( j \), and \( m(j) \) is the number of groups. An index takes values from 0 (all individuals belong to the same group), to 1 (total diversity). Panel B reports mean values in key variables measuring interactions between individuals of different ethnicities. This is based on the entire sample of individuals surveyed in Guinea in Afrobarometer rounds 5 (2013) and 6 (2015). The number of language or ethnicities spoken refers to the minimum number of languages spoken as implied by the survey (ethnicities reported, languages reported and language(s) in which the interview took place).

The importance of physical contact in changing social norms related to health behavior is consistent with evidence from the Covid-19 pandemic, where conformity in mask-wearing behavior was observed as a function of close contacts (Woodcock and Schultz, 2021). The role of local media in changing health behavior is consistent both with social science research, which highlights the importance of community-based awareness campaigns to affect behavior (e.g. Katz and Lazarsfeld, 1966, Richards, 2016), as well as with epidemiological models, which consider the overlap of social networks through which information is transmitted, and the epidemic spreads as a result (e.g. Funk et al., 2009).

#### 4.2 Regional fractionalization in Guinea

When considering the role of a prefecture as a relevant location, note that administrative divisions were to a certain extent imposed by the French colonizing power, but their origins predate the colonial period (Goerg, 2011, McGovern, 2012). They are related to ethno-linguistic groups, but a given prefecture and sub-prefecture still harbors important diversity. Panel A in Table 1, which presents ethnic and religious fractionalization across the country, regions, prefectures and sub-prefectures, illustrates...
this. The probability that two people belong to different ethnic groups is approximately 0.26 (0.2) at the
prefecture (sub-prefecture) level, compared to 0.75 (0.43) at the country (regional) level. This suggests
that people are in close contact with other ethnicities, even within a prefecture or sub-prefecture. It also
suggests that prefectures are not much more diverse than sub-prefectures, but that both have more ho-
mogeneous groupings, compared to regions or the country. This point is also illustrated by the fact that
75% (83%) of individuals in a prefecture (sub-prefecture) share the prefecture’s majority language (see
Tables ?? and Figure ??). Finally, while there is high ethnic diversity in countries like Guinea, people
speak multiple languages and identify with multiple identities (Panel B in Table 1).

4.3 Coordination in socially-sanctioned behaviors

I explore the hypothesis that the common-knowledge aspect of media plays a role, especially for
social health behaviors, as opposed to private health behaviors, and that it is driven by beliefs related
to people in one’s own locality. The first part of this hypothesis is essentially Prediction #1 above, that
public media is especially relevant for behaviors attached to social norms. The second part provides an
additional element to explain the role of local media, consistent with Prediction #2.

I provide suggestive evidence for this, using cross-sectional household survey data collected at the
day of the outbreak. The treatment is having heard about Ebola on the media (mostly radio), or the
proportion of people in one’s sub-prefecture who have heard about it on the radio. I study two outcomes:
First, the belief that neighbors seek treatment when sick. This is a proxy for second-order beliefs about
socially-sanctioned behavior. Second, the use of chlorine for hand-washing, clothes and other personal
items. This behavior is either private or not socially-costly. I first estimate equation (11) by OLS:

\[
\text{Behavior}_i = \alpha + \beta \text{EbolaInfo}_{i,\text{OnMedia}} + \gamma \text{EbolaInfo}_{i} + \mathbf{X}_{i,s} \Gamma + \mu_r + u_{i,s}
\]

The outcome is the behavior or belief reported by individual \(i\). \(\text{EbolaInfo}_{i,\text{OnMedia}}\) is a dummy variable
taking value 1 if individual \(i\) has heard about Ebola in the media and zero otherwise.\(^{26}\) Importantly, I
control include dummy variable \(\text{EbolaInfo}_{i}\), which takes value 1 if the individual has received informa-
tion about Ebola through other means. The omitted category is people who have not heard about Ebola
or who have heard about it from their family. The main coefficient of interest is \(\beta\), the effect of hearing
about Ebola in the media, compared to other information sources. \(\mathbf{X}_{i,s}\) controls for characteristics at
individual-level or by sub-prefecture \(s\). I add region fixed-effects \(\mu_r\), as well as capital-of-the-prefecture
fixed-effects, to allow for the possibility that big agglomerations evolve differently. Standard errors are
clustered at the level of a sub-prefecture to account for clustering of individuals responses to at that level.

I use an instrumental variables strategy to address the plausible concern that people who seek health

\(^{26}\)The media source is predominantly radio, but it may include TV in few cases. Other means of information
include social mobilization (door-to-door) campaigns, from NGOs or being informed by a doctor.
information are also more likely to know more about Ebola and take protective measures. As an instrument for having heard about Ebola in the media, I use access to local community radio. The exclusion restriction is that the radio signal reception for a local community radio does not drive the observed behavior other than through its effect on hearing about Ebola in the media. To keep the design close to the main empirical analysis and compare individuals with similar access to radio overall, I focus on the sub-sample of areas with above-median access to any community radio station.27

Next, I study the effect of having a proportion k of people in one’s own sub-prefecture who have heard about Ebola in the media, except oneself. I replace the treatment variables in (11) with $EbolaInfo^{OnMedia}_{-i,s}$ and $EbolaInfo_{-i,s}$, where $-i$ denotes individuals other than oneself. To uncover the common-knowledge aspect of media, I examine the presence of non-linearities in k. If coordination between people is important, we expect effects to be larger, as more people are informed. I test whether the effect varies for different values of k, with $k = \{< 50\%, 50 - 70\%, > 70\%\}$, as shown in equation (12).

$$Behavior_i = \alpha + \sum_k \beta_k EbolaInfo^{OnMedia}_{-i,s} + \gamma EbolaInfo_i + X_{i,s} \Gamma + \mu_r + u_{i,s} \quad (12)$$

The main results, interpreted as suggestive, are shown in Figure 7. People who heard about Ebola in the media are about a third of-a-standard-deviation more likely to think their neighbors are more willing to seek treatment, compared to people who learned about the disease from other sources. 2SLS implies an effect of 2 standard deviations, when conditioning on access to other information sources. While the difference is large compared to the OLS result, it is similar when we look at the effect of neighbors learning about Ebola from the media. The first stage is strong (F-Stat>17, Table ??). The reduced form effect indicates that as a sub-prefecture increases its territory covered by local radio by 10 pp., individuals are 20% of-a-standard-deviation more likely to believe their neighbors seek treatment. Local media helps people predict their neighbors’ actions, which may affect what an individual believes is socially acceptable in their community, and eventually may impact their own behavior. In fact, there is a reduction in social resistance and an increase treatment-uptake (Section 3.1.2). There is evidence of non-linearity, which suggests coordination: people are increasingly more likely to believe their neighbors seek more health treatment, as more people in their sub-prefecture hear about Ebola in the media.

On the other hand, I find that local media has either no additional impact, or only a marginal impact on the use of chlorine, compared to other types of information. This is in line with the coordination effects of media being key for socially-sanctioned behaviors, but not necessarily for behaviors that are private or not socially costly. Note that the nuanced effect shown in one of the estimates of Panel B is in line with the model above where public information is smaller for actions that are private or not socially sanctioned, when not everybody has access to the public information ($r = 0, P < 1$).

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27 This is motivated by Figure 1. SOA Section ?? shows that covariates are balanced around access to local radios, conditional on access to other community radio stations.
FIGURE 7: Relationship between having heard about Ebola in the media, conditional on receiving some information about Ebola, and second order beliefs (left) or own private health behavior (right)

A. Belief about a socially-sanctioned behavior:  
Belief that neighbors seek more health treatment

B. Private or not socially-costly action:  
Chlorine use for hand-washing/clothes

With 95% confidence intervals; Robust standard errors clustered by sub-prefecture.

Notes: Coefficients are interpreted as the effect of having heard about Ebola in the media, compared to other information sources (door-to-door campaigns, doctors, NGOs). They are conditional on above-median access to an own community radio signal and controlling for access to other radio stations. Outcomes are standardized variables. Seeking treatment takes three values (less/same/more than before). I plot coefficients on five different regressions: (1) reduced form effect of percent of a sub-prefecture with access to a local community radio; (2) OLS effect of having heard about Ebola in the media; (3) the 2SLS effect of (2) instrumented with (1); (4) the effect of others in the sub-prefecture having heard about Ebola in the media, except oneself; and (5) this effect depending on the percentage of others having heard about Ebola in the media. I condition on access to community radio, as well as other radio stations. Controls are as in Figures 4-6, as well as age, education, wealth, gender, whether the location is an urban area, access to electricity, health facilities. Tables ?? show regression estimates. Data sources: Post-Ebola survey (2015), Guinean National Institute of Statistics (INS).

4.4 Alternative channels

I discuss alternative possible explanations for the impacts of local media on the spread of Ebola.

Political accountability: Local media could affect an epidemic through its impact on the provision of public goods, due to a government accountability channel (Besley and Burgess, 2002, Eiseensee and Strömberg, 2007). Better access to information could lead governments to provide more public goods because citizens are more able to hold them accountable. I study this by looking at the provision of public health facilities. However, I find that ETUs and laboratories are no more likely to open in places with local radio stations (Figure ??).

Radio listening patterns: It is possible that in places with greater access to a local radio people are more likely to listen to radio overall, compared to other places. I find that in areas with higher access to a radio signal (from any radio) more people own radio devices and listen to news on the radio (Table ??). Conditional on access to any radio station, however, it is not the case that people with access to a
local community radio station have more radio devices or listen more to news on the radio.

**Unobserved characteristics correlated with radio transmitter location:** Places with a local community radio transmitter could have unobserved characteristics that differentiate them from other places, which turn out to be important for responding to the epidemic over time. In Section 3.1.4, we saw that access to local radio, conditional on overall access to community radio, is not systematically correlated covariates important for the spread of epidemics (Tables ??-??). To explore this possibility further, however, I do three exercises, which confirm the baseline results: First, I simply exclude sub-prefectures where the community radio transmitter is located (Figure ??, Panel A). Second, I control for the location of the community radio transmitter by including a dummy variable indicating whether the sub-prefecture has a community radio transmitter or not, interacted with each event-study time dummy (Figure ??, Panel B). Third, prefectures, as opposed to sub-prefectures, with a radio transmitter could be different to begin with. To address this I confirm that results are robust to controlling for a prefecture’s access to any local community radio, that is, they also hold at the intensive margin of greater access to a local community radio (Figure ??, Panel B).

5 Conclusion

This paper provides novel evidence on the role of local media in affecting important development outcomes, such as a major epidemic outbreak, through a coordinated change in behaviors attached to social norms. My findings show that a public health campaign aired on radio led to a significant reduction and an earlier drop in Ebola infections in places with access to local community radio station. This drop in infections is accompanied by a change in socially-sanctioned health behaviors, and the effects are driven by the information source being local. A back-of-the-envelope calculation implies that 13% of the total number of Ebola cases would have been prevented if places with access to a community radio station had their own.

This research contributes with key findings: Firstly, the source of information being local, holding its contents constant, is an important characteristic of media for affecting important socio-economic outcomes. Secondly, the results suggest that the locality of media, together with its common-knowledge aspect, is key for affecting socially-sanctioned behaviors and cultural practices observed and sanctioned locally. Finally, the impacts are driven by information being local, beyond ethno-linguistic belonging. This contributes to our understanding of cultural change in diverse settings. It has important policy implications. It supports the use of local media as an effective means to reach populations during crises that require a coordinated shift in behavior. More generally, it underscores the value of local public information in driving rapid change in behaviors attached to social norms.
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