Propaganda and Conflict: Theory and Evidence From the Rwandan Genocide

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November 21, 2009

Abstract

This paper investigates the impact of propaganda on participation in violent conflict. I examine the effects of the infamous "hate radio" station Radio RTLM that called for the extermination of the Tutsi ethnic minority population before and during the 1994 Rwanda Genocide. I develop a model of participation in ethnic violence where radio broadcasts a noisy public signal about the value of violence. I then test the model's predictions using a nation-wide village-level dataset on radio coverage and prosecutions for genocide violence. To identify causal effects, I exploit arguably exogenous variation in radio coverage generated by hills in the line-of-sight between radio transmitters and villages. Consistent with the model under strategic complements in violence, I find that Radio RTLM increased participation in violence, that the effects were decreasing in ethnic polarization, highly non-linear in radio coverage, and decreasing in literacy rates. Finally, the estimated effects are substantial. Complete village radio coverage increased violence by 65 to 77 percent, and a simple counter-factual calculation suggests that approximately 9 percent of the genocide, corresponding to at least 45 000 Tutsi deaths, can be explained by the radio station.

*[JOB MARKET PAPER] Contact: yana@iies.su.se. I thank Robert H. Bates, Ethan Kaplan, Masayuki Kudamatsu, Rocco Macchiavello, Nancy Qian, Torsten Persson, David Stromberg and, especially Jakob Svensson for their comments; the participants at Harvard Development Lunch, Econometric Society European Winter Meeting 09, the CIFAR IOG 09, and the EUDN Workshop at Oxford. I would also like to thank Giovanni Zambotti at the Center for Geographic Analysis at Harvard University for ArcGIS assistance. All mistakes are my own.

1 Introduction

> "The radio encouraged people to participate because it said 'the enemy is the Tutsi'. If the radio had not declared things, people would not have gone into the attacks."
>
> -Genocide perpetrator, interviewed by Straus (2007)

Among all historical episodes of civil conflict the 1994 Rwanda Genocide is an extraordinary event. During a period of only three months, a nation-wide extermination campaign led by the Rwandan government against the Tutsi ethnic minority population resulted in at least 500 000 Tutsi civilian deaths and a reduction by approximately 75% of the country's Tutsi population (des Forges, 1999).[1] In addition to the violence organized by the army and militias, the high intensity killings were achieved by mass participation by hundreds of thousand ethnic majority Hutu citizens using their machetes and clubs (des Forges, 1999; Straus, 2004; Verwimp, 2006). Given the large-scale participation and the human lives lost, understanding the determinants of participation in the genocide is of great importance. The principal aim of this paper is to estimate the impact of one factor widely believed (BBC, 2003; Thompson, 2007) to have played a significant role in the genocide: propaganda spread by the infamous "hate radio" station Radio Télévision Libre des Mille Collines (RTLM).

In order to understand the determinants of participation in violence, and the mechanisms through which propaganda can affect participation, the paper first sets up a simple model of propaganda and participation in ethnic violence. The model adopts the global games framework (Carlsson and van Damme, 1993; Morris and Shin, 1998; 2005) and considers a situation where individuals face some uncertainty about the value of conflict, but may receive a noisy public signal about the value through the radio. The key insight of the model is that propaganda, defined as radio broadcasts signalling that the value of conflict is high, will affect participation through two mechanisms. First, by increasing the expected value of conflict, independent of how many others that participate. Second, and potentially more importantly, by changing the expectations individuals hold about whether others will participate. If there are strategic complements in violence, the second mechanism implies

[1] There was also a significant amount of moderate Hutus that were killed. For discussions on the death tolls, see des Forges (1999), Verpoorten (2005), as well as Davenport and Stam's analysis at www.genodynamics.com (Available 2009-11-05).

that propaganda will function as a coordination device and lead to large-scale increases in participation if a sufficiently large number of people receives the propaganda.

The predictions of the model are taken to a unique nation-wide village-level dataset that combines data from several sources. First, as a proxy for participation rate, the paper uses data on prosecution rates for violence during the genocide, provided by Rwanda's National Service of Gacaca Jurisdictions. Second, it uses information on locations and technical specifications of Radio RTLM transmitters, and produces a nation-wide radio coverage map at a 90 meter cell resolution. Using a digital map of village boundaries, the radio coverage of each village is then calculated. Additional data on village characteristics is collected from the 1991 Rwanda Census and the Africover database. The matched dataset contains data on 1105 villages.[2]

The identification strategy exploits arguably exogenous variation generated by Rwanda's highly varying topography consisting of hills and valleys. Using local *within-commune* village variation in radio coverage, the variation exploited will be due to whether there happens to be hills in the line-of-sight between radio transmitters and villages.[3]

Radio RTLM broadcasts had a substantial effect on violence. The estimates imply that going from no to full village radio coverage, increased civilian violence 65 percent and organized violence by 77 percent. Furthermore, the effects are entirely driven by villages where the Hutu ethnic majority was large relative to the Tutsi ethnic minority, and they are highly nonlinear in the degree of radio coverage as there is a sharp increase in violence when the radio coverage is sufficiently high. These results are consistent with the model under strategic complements, and suggest that the broadcasts were most effective when people knew that many other village members were also listening to the same broadcasts. The propaganda, therefore, appears to have functioned as a coordination device.

Moreover, and consistent with the model, the paper finds evidence that the ability to access independent information can mitigate the propaganda effects. In fact, there is no effect of radio coverage in villages in the upper literacy rate tertile, whereas the effects are large in villages in the lower literacy rate tertile. The results therefore suggest that the

[2]The villages are formally called "administrative sectors". The term village is used for simplicity, highlighting that the units are relatively small. The median village area is 10.6 square kilometers.

[3]The use of this method to examine media effects in the social sciences is not new. Olken (2009) employs a closely related but not identical approach in his study of the effects of television and radio on social capital in Indonesia.

propaganda caused more violence because there was a lack of alternative information sources that could contest the content broadcasted by Radio RTLM.

To assess the extent to which the propaganda can explain the degree of violence in the genocide, the paper presents a simple counter-factual calculation. The results suggest that Radio RTLM caused approximately 9% of the genocidal violence, which corresponds to at least 45 000 Tutsi deaths.[4] Therefore, Radio RTLM was a quantitatively important causal factor in the genocide.

This project is related and adds to several strands of literature. First, it contributes to the literature on the determinants of the genocide (Verwimp, 2005, 2006; Straus, 2007), by presenting novel evidence on the causal effects of Radio RTLM.

Second, the Rwanda genocide may be extraordinarily grim, but it forms part of the wider phenomenon of civil war and conflict. Since 1960, one third of all nations has experienced civil war and one fifth has seen episodes of more than 10 years of civil war (for an overview, see Blattman and Miguel, 2009). Cross-country studies (Collier and Hoeffler 1998, 2004; Fearon and Laitin 2003; Miguel et al. 2004; Besley and Persson 2008) have focused on the macro determinants of conflict onset, incidence and duration. There is also a small but growing literature has used within-country regional data to identify factors determining the intensity of civil violence (e.g., Murshed and Gates, 2005; Dube and Vargas ,2007; Do and Iyer, 2007; Jha 2008). By presenting robust micro evidence on the role of information and beliefs, this paper adds an important piece to the understanding of why people participate in civil war and conflict, as well as how ethnic mobilization is achieved (e.g., Bates, 1986; Fearon and Laitin, 1996). In their overview of the literature, Blattman and Miguel (2009) conclude that the existing theory is incomplete. They argue that although the individual participation choice should be a natural starting point for the analysis of civil conflict, the literature lacks an understanding of the roots of individual participation. The work-horse model used to study determinants of group violence (including ethnic) is the contest model (Haavelmo, 1954; Hirshleifer, 1988). By assuming unitary groups, the contest model therefore typically ignores the participation problem at the individual level. In addition, Blattman and Miguel argue that theories seldom specify the empirical predictions that can test between competing accounts, and there is a lack of studies with convincing econometric

[4]This is substantial considering that the radio signal was only receivable in about 19 percent of the country.

identification. The model proposed in this paper analyzes the individual participation choice, and delivers predictions that allow the data to disentangle whether participation in ethnic violence is subject to strategic complements or strategic substitutes.[5] A contribution of the paper, in addition to estimating the causal effects of Radio RTLM on participation in the genocide, is therefore to shed light on the mechanisms driving ethnic violence. Specifically, the empirical results are consistent with strategic complements in violence, and inconsistent with strategic substitutes. To the best of the author's knowledge, this is a novel finding.

Finally, the paper adds to the literature on media effects (for an overview, see Della Vigna and Gentzkow, 2009). Theoretically, self-interested politicians may supply biased mass media in order to reduce the likelihood of regime change (Edmond, 2009) as well as to induce hatred (Glaeser, 2005). The empirical effects of mass media on political behavior have been studied at least since Lazarfeld et al. (1954). A recent literature has found significant effects. This includes effects on voting behavior (Gentzkow, 2006; Della Vigna and Kaplan, 2007; Chang and Knight, 2008; Enikolopov et al., 2008; Gerber et al., 2009); accountability and policy (Besley and Burgess, 2002; Strömberg, 2004; Eisensee and Strömberg, 2005); political knowledge and beliefs (Gentzkow and Shapiro, 2004; Snyder and Strömberg, 2008); and social capital (Paluck, 2009; Olken, 2009). This paper adds to the literature by presenting novel evidence showing that mass media can persuade individuals into what is arguably the most extreme political acts of them all: killing members the political opposition.

Below, section 2 provides the background to the genocide and Radio RTLM; section 3 presents the model and derives empirical predictions; section 4 explains the data and the empirical strategy; section 5 presents the results; and section 6 concludes the paper.

2 Background

This section provides a brief background in order to understand the pre-existing political tensions leading up to the genocide, as well as the structure and content of Radio RTLM broadcasts.

[5]Under strategic interactions and complete information, multiple equilibria are typically present. However, under incomplete information (Carlsson and van Damme, 1993; Morris and Shin, 1998; 2005), there is a unique equilibrium that allows one to derive testable predictions.

2.1 Political and ethnic tensions

After World War I, Belgium took control of Rwanda (previously a German colony) on a mandate by the League of Nations. The Belgian rule reinforced pre-existing ethnic cleavages by a range of policies favoring the ethnic minority Tutsi group (Prunier, 1995). However, with the "Hutu Revolution" and the independence from Belgium in 1962, there was a complete reversal of power. After 1962, Rwanda became a Hutu-dominated one-party state.

In connection with the independence, there were several episodes of ethnic violence between the two ethnic groups that led to several hundreds of thousand ethnic Tutsi refugees in neighboring countries (Prunier, 1995). A period of relative stability followed but in 1973, there was more violence as ethnic clashes between Hutus and Tutsis in Burundi spilled over into Rwanda. The unrest eventually led to the young Hutu military leader Juvénal Habyarimana seizing power in a coup in 1973.

In October 1990, a rebel army invaded Rwanda from Uganda. The rebels, of the Rwandan Patriotic Front (RPF), represented the refugees that had fled during the Hutu Revolution and demanded an end to the ethnically unbalanced policies. Internationally, they presented themselves as a democratic multi-ethnic movement trying to overthrow a corrupt regime.[6]

In April 1992, a transitional multi-party government was formed. After periods of negotiations and unrest, a peace agreement was finally signed in Arusha in August 1993. With sparse resources and a weak mandate, United Nations' peace-keeping forces were to facilitate the installation of the transitional government. After periods of violence, unrest, and postponed installations, the Hutu president Habyarimana was assassinated when his jet was shot down on April 6th 1994. Within days, extremists within Hutu-dominated political parties managed to take over key positions of government, and an ethnic cleansing campaign spread throughout the country shortly thereafter.

The branches of government took an active role in the killings, from Presidential Guards, the regular army FAR, national gendarmes, via the civil administration down to the mobilization and supply of resources to the Interahamwe and Impuzamugambi militias (Prunier, 1995). In addition, there was large-scale civilian participation as several hundreds of thousands citizens participated in the attacks (Straus, 2004).

[6]The rebel army of about four thousand well-trained troops mainly consisted of second-generation Rwandan refugees. They had gained military experience from Uganda's National Resistance Army which seized power in Uganda in 1986.

The genocide ended in late July 1994 when the Tutsi RPF rebels defeated the Rwandan army and militia groups, and managed to seize the capital Kigali. At that point, at least 500 000 Tutsis had been killed (des Forges, 1999).

2.2 Media and Radio RTLM

Radio RTLM started broadcasting in July 1993. The station was set up as a private company by a group of Hutu politicians, but with strong support from President Habyarimana (Thompson, 2007). The broadcasts continued throughout the genocide, and did not end until RPF rebels manage to take control of the country in mid-July.

Two radio transmitters were installed. One 100 watt transmitter was placed in Kigali, the capital, and another 1000 watt transmitter was placed on Mount Muhe, one of the country's highest mountains. Compared to the only other national radio station in the country, government owned Radio Rwanda, RTLM quickly became popular by airing western-style talk shows and playing the latest music, especially popular Congolese songs.[7]

Importantly, the radio station called for the extermination of the Tutsi ethnic group and claimed that preemptive violence against the Tutsi population was a necessary response of "self-defense" (ICTR, 2003; Thompson, 2007).[8] In her study of RTLM airtime content, Kimani (2007) reports that the most common inflammatory statements consisted of 1) Reports of Tutsi RPF rebel atrocities (33%); 2) Allegations that Tutsis in the region were involved in the war or a conspiracy (24%); and 3) Allegations that RPF wanted power and control over Hutus (16%).

Although the radio station systematically called upon Hutus to be aware of Tutsi plots and forthcoming attacks, it is still unclear to what extent Hutu citizens believed in the RTLM broadcasts and viewed them as informative about the ongoing conflict between Hutus and Tutsis, and to what extent citizens discredited the broadcasts as being biased. However, the fact that there was a demand for the broadcasts suggests that citizens at least viewed the broadcasts as bringing important information. For example, Des Forges described the high demand of RTLM as "people listened to the radio all the time, and people who didn't have

[7]There was also a station owned by the Tutsi RPF rebels, Radio Muhabura, that broadcast into Rwandan territories from Uganda.

[8]A common definition of propaganda is "the spreading of ideas, information, or rumor for the purpose of helping or injuring an institution, a cause, or a person". <www.merriam-webster.com/dictionary/> (Available 2009-11-15)

radios went to someone else's house to listen to the radio. I remember one witness describing how in part of Rwanda, it was difficult to receive RTLM, and so he had to climb up on the roof of his house in order to get a clear signal, and he would stand up there on the roof of his house with his radio to his ear listening to it".[9]

Furthermore, as alternative information sources were limited in the rural areas, it was arguably difficult to verify the content in the broadcasts. Alternative media sources did exist. In particular, the number of independent newspapers, including political opposition newspapers, at the time of the genocide was between 30 to 60 (Alexis and Mpambara, 2003; Higiro, 2005). However, the circulation and readership of these newspapers in the rural areas, however, was naturally limited due to relatively low literacy rates in the country.[10] Therefore, the radio became the sole source of news for most people (des Forges, 1999).

3 A Model of Ethnic Violence

Given their content, it is quite clear that one of the main motives for the RTLM broadcasts was to affect the beliefs among the Hutu population that a nondiscriminatory, preemptive, attack against conspiring Tutsis was the appropriate course of action. We now turn to a simple model that allows us to analyze how these broadcast might have affected the beliefs among the Hutu population, and how it could have influenced the level of violence in Rwandan villages. Albeit relatively simple, the model sheds light on some interesting channels through which propaganda might translate into violence. Most importantly, the model delivers a set of testable predictions that will be taken to the data in the subsequent sections of the paper.

We proceed in several steps. First, we explain the basic setup and second, we find the equilibrium and show how it can be affected by propaganda. Third, we present the empirical predictions that will be taken to the data.

3.1 Basic setup

Consider a village with a continuum of individuals, where each individual is a member of one of two ethnic groups, ethnic majority group H and ethnic minority group T. The

[9]Interview with Alison des Forges, available (2009-11-16) at <www.carleton.ca/jmc/mediagenocide>
[10]The literacy rate was 66 percent (des Forges, 1999).

population size of group H is normalized to 1, and the size of group T in the village is t. The analysis focuses on the discrete decision by group H members to participate in an attack against minority group T in the village. Strategic behavior by minority group members is not studied in order to keep things simple. Therefore, in what follows we exclusively focus on the behavior of group H members.

The payoff from participating in the attack depends on some fundamental value, θ, which is possibly negative. We may consider θ as the net benefit that depends on a range of factors independently of how many other group H members participate in the attack, as well as the size of group T. For example, factors determining θ could be the amount of wealth of group H, the opportunity cost of attacking group T, or the value associated with being the first side to attack the opposite group

In addition to the fundamental value, we allow the payoff from participating in violence to exhibit strategic complements or strategic substitutes. Under strategic complements, the payoff depends positively on how many other members of group H that participate in the attack, h. Under strategic substitutes, the payoff depends negatively on how many other members that participate. On the one hand, violence is a dangerous and costly activity, and there are good reasons to think that there exists strategic complements in violence. For example, the larger is the group attacking, the smaller is the likelihood of being injured, or the shorter is the duration of fighting required for success. On the other hand, if the appropriable resources are limited and the participating members fight over the same resources, then there would be less appropriable resources per participating member the more members that participate. Under such conditions, there could be strategic substitutes in violence.

Similarly, we allow the payoff from having more members participate in the attack h to depend on the (relative) size of the defending group, t. Specifically, to get a convenient formalization, let the payoff structure be the following

$$u = \begin{cases} \theta + \alpha\frac{h}{t} & \text{if the member participates in the attack} \\ 0 & \text{if the member does not participate in the attack} \end{cases}$$

If there are strategic complements (substitutes) in violence, $\alpha > 0$ ($\alpha < 0$). When there are no strategic interactions, $\alpha = 0$. We are interested in the equilibrium number of ethnic majority members participating in the attack, h, and how h can be affected by propaganda.

3.2 Information and beliefs

In reality, participating in conflict is a risky project. We formalize this by assuming that members face uncertainty about the fundamental value of participating in violence, such that there is incomplete information about θ. It is reasonable to believe that θ cannot be known with complete certainty in most cases of violent conflict. In this section, we describe how members form their beliefs about θ.

Following the literature on global games, members do not observe θ but receive information about the value that allows them to form beliefs. We make the standard assumption that members have a diffuse prior distribution of θ on the real line. Each member i observes an independent private signal $x_i = \theta + \varepsilon_i$, where ε_i is independently and normally distributed with mean zero and variance σ_x^2. We can consider x_i as all the independent private information a member has from different sources that are relevant for the fundamental value of conflict. Furthermore, we can consider a lower σ_x representing having access to multiple sources of information, or access to information sources of high quality.

Furthermore, the radio broadcasts a signal p about the value of θ. A fraction r of the village population has radio coverage. Having radio coverage implies receiving the signal p. For simplicity, we do not consider strategic behavior on behalf of whomever sends out the radio signal. Instead, agents view the signal p as informative about the underlying fundamental value of conflict, θ. The signal has the structure $p = \theta + b$. To keep the analysis simple, we assume that b is exogenous, unobservable, and distributed normally with mean zero and variance σ_p^2.[11] Key to the model is that the radio signal is a *public* signal among members with radio, i.e. there is common knowledge about the radio signal among majority members with radio. Therefore, a member with radio will not only use the signal to update his belief about θ, he also knows that a fraction r of the other village members listens to the radio and receives signal p, and everybody with radio knows that everybody else with radio knows this, and everybody knows that everybody knows... ad infinitum. Individuals without radio access do not receive the public signal. To focus on the choices of majority members that receive the radio broadcasts and keep the analysis tractable, we make the simplifying

[11] The key assumption about p is that σ_p^2 is finite, so that the broadcasts are informative. The zero mean is not a binding assumption. If the radio signal is biased on average, individuals will adjust for this when they form beliefs about θ. However, treating the signal as exogenous and without manipulation is clearly a unrealistic simplication, made to keep the analysis simple. For a model with endogenous information manipulation in a civil war context, see Edmond (2009).

assumption that members without radio are unaware of others receiving the radio signal.[12]

Individuals use Bayes' rule to update their beliefs about the fundamental value of violence. Consider first a member without radio. The private posterior distribution for member i that receives private signal x_i is normally distributed with mean $\bar{\theta}_i^N = x_i$ and variance σ_x^2. For members with radio, the posterior expectation of θ given public information alone is normal with mean[13]

$$\bar{\theta}_i^R = \frac{\sigma_x^2 p + \sigma_p^2 x_i}{\sigma_p^2 + \sigma_x^2}.$$

3.3 Equilibrium

We are interested in the equilibrium level of participation, h. Consider a strategy where each member follows a simple switching rule

$$a(\bar{\theta}_i^j) \quad = \quad \begin{cases} \text{participate} & \text{if} \quad \bar{\theta}_i^j \geq \kappa^j \\ \text{do not participate} & \text{if} \quad \bar{\theta}_i^j < \kappa^j \end{cases}$$

where $j = N$ labels the strategy for members without radio and $j = R$ for members with radio. That is, members participate if and only if their beliefs about the fundamental value of violence is sufficiently high, above some threshold κ^j. Following Morris and Shin (1998, 2005), this strategy is unique under some regularity conditions (see the web appendix for the regularity conditions and the derivation of the equilibrium).[14] For members without radio coverage, the Bayes-Nash equilibrium threshold κ^N is

$$\kappa^N = -\frac{\alpha}{2t}. \tag{1}$$

[12]The key assumption is that a fraction $1 - r$ of the members do not receive the signal p. One could in principle allow $1 - r$ members to not receive the signal p, but still be aware of the distribution of p, and that some fraction r receives the signal p. This would complicate the analysis, but would most likely not change the main results.

[13]The posterior variance is $\frac{\sigma_x^2 \sigma_p^2}{\sigma_x^2 + \sigma_p^2}$.

[14]The regularity conditions require that α is bounded from above and below. The exact bounds are found in the web appendix available at http://people.su.se/~daya0852/.

For members with radio coverage, the equilibrium participation threshold κ^R is the solution to the equilibrium condition

$$\kappa^R + \frac{\alpha}{t}\left(r\Phi\left[\gamma(p-\kappa^R)\sigma_x^2/\sigma_y^2\right] + (1-r)\Phi\left[\gamma\left(\frac{\alpha}{2t}+\kappa^R\right)\right]\right) = 0. \tag{2}$$

where $\gamma \equiv (2\sigma_x^2\sigma_p^2 + \sigma_x^4)^{-1/2}(\sigma_x^2 + \sigma_p^2)^{1/2}$. The intuition behind equation 1 is relatively straightforward. A member without radio coverage faces two forms of uncertainty. First, there is uncertainty about θ and second, there is also uncertainty about how many others that will participate, h. This is because given the switching strategy, since the member is uncertain about θ, he is also not certain about how many other members have expectations of θ above the threshold κ^N. However, since he has independent information about θ, he forms beliefs about the distribution of θ. In turn, this means that he holds beliefs about how many other members are likely to hold expectations of θ above the participation threshold, κ^N. The higher expectation is the expectation of a member of the value of conflict, $\bar{\theta}_i^N$, the more other members he expects to participate. The equilibrium condition of equation 1 pins down the expectation $\bar{\theta}_i^N$ where a member is indifferent between participating and not participating. Importantly, since members without radio do not receive the radio signal p and are also unaware of the existence of the broadcasts, p and r do not change the participation threshold whereby members are willing to participate.

The intuition behind equation 2 follows a similar logic. However, the important distinction between a member with radio coverage and a member without radio coverage is two-fold. First, a member with radio receives the additional signal p about the value of conflict θ. This will cause him to update his beliefs $\bar{\theta}_i^R$ by the same logic as in equation 1. Second, and most importantly, due to the publicity of the signal he knows that everybody else with radio coverage also has received the same signal p.[15] This is important because it will change his beliefs about how likely it is that other members with radio will participate, h. For this reason, the fraction r that has received the broadcasts is therefore a key variable in his decision of whether to participate. When r is low, he knows that not too many have received p, so he reasons similarly as someone without radio. When r is high, however, he knows that most members have also received p too, which can dramatically change his expectations about

[15]He also knows that everybody with radio knows that everybody with radio knows this, and that everybody... ad infinitum.

how others will behave, and can thus change his own willingness to participate. Therefore, the fraction of the population with radio coverage, r, is a key variable for the equilibrium participation in violence.

3.4 Participation

Having pinned down the equilibrium thresholds, κ^N and κ^R, we can investigate the equilibrium participation, h. Given a fundamental value of violence θ, we can calculate the proportion of non-radio members with beliefs $\bar{\theta}_i^N \geq \kappa^N$, given by equation 1, and the proportion of radio members with beliefs $\bar{\theta}_i^R \geq \kappa^R$, given by equation 2. Using the distributions for the private signal and the radio signal, conditional on θ, the total share of the majority population participating that is a function of village radio coverage r

$$h = rh^R + (1-r)h^N \ , \tag{3}$$

where h^N is the proportion of members without radio coverage participating

$$h^N = \Phi\left(\frac{\frac{\alpha}{2t} + \theta}{\sigma_x}\right) \ , \tag{4}$$

and h^R is the proportion of members with radio coverage participating

$$h^R = \Phi\left[\frac{\frac{\sigma_x^2}{\sigma_p^2}p + \theta - \frac{\sigma_x^2+\sigma_p^2}{\sigma_p^2}\kappa^R}{\sigma_x}\right] \ . \tag{5}$$

Lemma 1 *The participation rate increases with radio coverage ($\partial h/\partial r > 0$, for all r) only if radio broadcasts a signal that the fundamental value is sufficiently high ($p > \tilde{p} \equiv -\frac{\alpha}{2t}$). Defining propaganda as a signal that the value of conflict is high ($p > \tilde{p}$), increasing radio coverage affects participation through two propaganda effects. First, through a direct "fundamentals effect" that changes the share of the population with beliefs about the value of conflict above the equilibrium participation threshold, κ^R. Second, through an indirect "strategic effect" that affects the expectations individuals hold about how many other individuals that will participate, which changes the equilibrium participation threshold κ^R.*

Proof: see the web appendix. The equilibrium implies that members only participate if their beliefs about the fundamental value of conflict is sufficiently high. Given participation thresholds for radio members and no-radio members, only if the radio broadcasts that the fundamental value of conflict is sufficiently high (above the participation thresholds) will a larger fraction of the members with radio hold expectations of the fundamental value of conflict above the participation threshold. This is the *fundamentals effect*.

Furthermore, due the publicity of the radio signal, members with radio know that everybody with radio listens to the same broadcasts. When there is an increase in the radio coverage, members with radio realize that more people now hold high expectations of the fundamental value of conflict, which for each member with radio increases the expected number of participants. This, in turn, changes the equilibrium participation threshold κ^R whereby somebody with radio is willing to participate. This is the *strategic effect*.

Importantly, the direction of the strategic effect on participation crucially depends on whether participation in conflict is subject to strategic complements or strategic substitutes. Under strategic complements, the effect is positive, whereas under strategic substitutes the effect is negative. Under strategic complements, the total payoff of participation in conflict is always higher the more people that participate. Therefore, when radio coverage increases, each member with radio expects more people to participate, which makes each member with radio more willing to participate by lowering the participation threshold. Individuals therefore participate at lower beliefs about the fundamental value of conflict when radio coverage is high as compared to when it is low. Under strategic substitutes, on the other hand, the total payoff of participation in conflict is always lower the more people that participate. Therefore, when radio coverage increases, each member with radio expects more people to participate, which makes each member with radio less willing to participate by increasing the participation threshold, κ^R.

Next, we derive the properties of participation in violence in the three possible cases: no strategic interactions, strategic complements, and strategic substitutes. Since we are interested in how propaganda may increase participation, from now on we assume that $p > \tilde{p}$.[16]

[16]Since the focus of this paper is when $p > \tilde{p}$, results are not presented for $p < \tilde{p}$. It is worth noting that in general the results go in the opposite directions when $p < \tilde{p}$.

Benchmark case: $a = 0$

We first state the properties for the benchmark case when α is zero and participation in violence is free from any strategic interactions.

Proposition 1 *($\alpha = 0$) : If there are no strategic interactions, then participation increases linearly in radio coverage ($\partial h/\partial r = \bar{c} > 0$) and the effect is the same regardless of the size of the ethnic minority ($\partial h/\partial r \partial t = 0$).*

Proof: see the web appendix. The intuition behind this result is relatively straightforward. When there are no strategic components, the individual choice of participation does not depend on how many others that participate. Instead, a member participates if his expectation of the fundamental value of participation is positive. Therefore, radio coverage only affects participation through the *fundamentals effect*. As the fraction holding positive expectations of the value of conflict is constant within the group of members with radio coverage, the fundamentals effect of radio coverage is linear and positive.

Strategic complements case: $a > 0$

Next, consider the case when α is positive and participation in violence is subject to strategic complements.

Proposition 2 *($\alpha > 0$) : If participation is subject to strategic complements, then radio coverage exhibits increasing scale effects ($\partial^2 h/\partial r^2 > 0$ for $r \in [0, \tilde{r}]$, and $\partial^2 h/\partial r^2 < 0$ for $r \in (\tilde{r}, 1]$, where $0 < \tilde{r} \leq 1$). Furthermore, the effect of radio coverage is decreasing in the size of the ethnic minority ($\partial h/\partial r \partial t < 0$ for $r \in [0, \hat{r}]$, where $\hat{r} = 1$ as long as $h^R < 1/2$. If $\hat{r} < 1$, the sign of $\partial h/\partial r \partial t$ for $r > \hat{r}$ is ambiguous).*

Proof: see the web appendix. The reason why radio coverage exhibits increasing scale effects under strategic complements is due to the combination of the *fundamentals effect* and the *strategic effect.* In particular, both effects are positive. As radio coverage increases, the fundamentals effect implies that more members with radio will hold beliefs about the fundamental value of conflict above the participation threshold, which increases participation. In addition, when radio coverage increases, the strategic effect implies that members with radio expect more people to participate which, in turn, lowers the equilibrium participation threshold, an effect which further increases participation.

Figure 1A graphically shows equation 3 after solving equations 2, 4 and 5. The figure shows how the participation rate changes as a function of radio coverage, for the benchmark case and three different levels of strategic complements.[17] To clearly see the importance of the strategic effects, the parameter values are set such that the fundamentals effect of radio coverage is essentially zero (i.e. very small and positive). We see that although the fundamentals effects are essentially zero (so that almost no members believe that the fundamental value is sufficiently high for participation), there are important positive strategic effects when radio coverage is sufficiently high. The main insight is that the effects of radio coverage can be highly non-linear. The intuition behind this result is that at low levels of radio coverage, most members with radio expect do not expect many others to participate since only a small fraction of the population has received the radio broadcasts. At high levels of radio coverage, however, members with radio know that many have received the radio broadcasts and therefore, they expect many others to participate. Consequently, due to these strategic effects, increasing the radio coverage to high levels of radio coverage can have dramatic effects on participation.

Furthermore, the effect of radio coverage on participation depends considerably on the size of the ethnic minority group. Figure 1B graphically shows the effect of radio coverage for two different levels of ethnic minority size (keeping the other parameter values the same as in Figure 1A). When the size of the ethnic minority is relatively small ($t = 1/4$), there is a strong and positive strategic effect of radio coverage. However, when the size of the ethnic minority is relatively large ($t = 2/5$), the effect of radio coverage almost completely goes away as there is only a small increase in participation at very high levels of radio coverage. The reason is relatively straightforward, since the marginal benefit of more participants is lower when the ethnic minority is large. Therefore, even at high levels of radio coverage, most members with radio coverage do not expect many others to participate and, consequently, not many members are willing to participate.

Strategic substitutes case: $a < 0$

Finally, we treat the case when α is negative and participation in violence is subject to strategic substitutes.

[17] The other parameter values are: $p = 0$, $t = 1/4$, $\theta = -1$, and the variances of private information ($\sigma_x = 0.05$) and radio information ($\sigma_p = 0.1$) are set such that the conditions for a unique equilibrium is satisfied.

Proposition 3 *($\alpha < 0$) : If participation is subject to strategic substitutes, then radio coverage exhibits decreasing scale effects ($\partial^2 h/\partial r^2 < 0$ for $r \in [0, \tilde{r}]$, where $0 < \tilde{r} \leq 1$). Furthermore, the effect of radio coverage is increasing in the size of the ethnic minority ($\partial h/\partial r \partial t > 0$ for $r \in [0, \hat{r}]$, where $\hat{r} = 1$ as long as $h^R < 1/2$. If $\hat{r} < 1$, the signs of $\partial^2 h/\partial r^2$ and $\partial h/\partial r \partial t$ for $r > \hat{r}$ are ambiguous).*

Proof: see the web appendix. Under strategic substitutes, the strategic effects are negative. Figure 2A graphically shows the importance of negative strategic effects.[18] When radio coverage is low, the positive fundamentals effect dominates the negative strategic effect. The participation rate therefore initially increases with radio coverage. When radio coverage is high, however, members with the radio know that many people will have received the radio broadcasts and thus expect higher participation. Expecting many others to participate, each member finds it less worthwhile to participate. Strategic substitutes therefore result in decreasing scale effects of radio coverage.

Furthermore, the effect of radio coverage on participation depends importantly on the size of the ethnic minority group. Figure 2B graphically shows the effect of radio coverage for two different levels of ethnic minority size (keeping the other parameter values the same as in Figure 2A). We see that the effect of radio coverage is larger when the size of the ethnic minority is relatively large. The reason is relatively straightforward, as the marginal payoff of more participants is higher when the ethnic minority is relatively large. Therefore, even though members with radio coverage expect a relatively large number of other people to participate at high levels of radio coverage, since the ethnic minority is relatively large, increases in radio coverage increase participation.

Independent information

In this section, we investigate how the effects of radio coverage are related to the access to independent information, σ_x. First, even though each member does not know the exact fundamental value of conflict, he uses his independent information to form expectations about it.[19]. Therefore, the effect of radio coverage will crucially depend on how much independent information members have.

[18]Compared to Figures 1A and 1B, the value of the radio signal is now set higher ($y = 4$ instead of $y = 0$) so that the benchmark case exhibits visible positive effects.

[19]Recall that the independent private information is equal to $x_i = \theta + \varepsilon_i$, where ε_i is independently and normally distributed with mean zero and variance σ_x^2.

Proposition 4 *When members have sufficiently good access to independent information ($\sigma_x \to 0$), the effect of radio coverage disappears ($\partial h/\partial r \to 0$).*

Proof: see the web appendix. Intuitively, the expectation a member holds about the value of conflict, θ, will be a weighted average between independent information, x_i, and the information broadcast on the radio, p. The better independent information about the fundamental value of conflict that members have, the less weight will be put on the radio broadcasts. Therefore, when members have very precise expectations about the fundamental value of conflict through other information sources, they stop believing in the radio broadcast. Consequently, propaganda will not affect participation in the violence in that case.

3.5 Empirical predictions

We now summarize the results from the previous section into testable predictions.[20] Lemma 1 and Propositions 1 to 4 imply the following predictions:

1. Main Effects: If radio coverage r increases the participation rate h, then radio broadcasts a signal that the fundamental value of conflict was high, $p > \tilde{p}$. This prediction follows from Lemma 1.

Moreover, if $p > \tilde{p}$, then Propositions 1-4 imply:

2. Ethnic Polarization: The effect of radio coverage r on the participation rate is

a) *decreasing* in ethnic polarization t, only with *strategic complements* in violence (Figure 1B).

b) *increasing* in ethnic polarization t, only with *strategic substitutes* in violence (Figure 2B).

3. Scale Effects of r: Radio coverage r exhibits

a) *increasing* scale effects on participation h, only with *strategic complements* (Figure 1A).

b) *decreasing* scale effects on participation h, only with *strategic substitutes* (Figure 2A).

[20] We focus on the unambiguous effects derived in the previous section. That is, we assume that the additional conditions needed for the unambiguous effects are fulfilled. It is worth noting that the additional condition $h < 1/2$ is fulfilled in all the observations in the data.

4. **Independent information**: Radio coverage r does not affect the participation rate h when ethnic majority members have sufficiently good access to independent information ($\sigma_x \to 0$).

Importantly, Predictions 2 and 3 imply to the extent we get consistent results, the data will allow us to disentangle whether α is zero, positive, or negative.

4 Data and Empirical Strategy

This section describes the data, identification strategy, and econometric specifications.

4.1 Measurement

The variables of interest are h, r, t, and σ_x. Here, we present how they are measured. Several sources of data are combined to construct a village-level cross-sectional dataset. Figure 3 shows a map of village boundaries in Rwanda. The final dataset consists of 1105 matched villages.[21]

Measuring the participation rate, *h*

Unfortunately, there is no dataset available that measures h directly. Instead, this paper uses an indirect measure from a nation-wide village-level dataset on prosecutions for violent crimes committed during the genocide. The data is provided from the government agency National Service of Gacaca Jurisdictions. The proxy used for the participation rate h is therefore the prosecution rate.[22]

The prosecution data for each village comes from local level Gacaca courts.[23] The national court system was set up in 2001 to process the hundreds of thousand of individuals accused for crimes committed during the genocide.

There are two violent crime categories. Category 1 includes prosecutions for organized violence, legally defined as:

[21]The term village is used for simplicity reasons, highlighting that the units are relatively small. The correct term is "administrative sector". The median administrative sector in the dataset is 10.6 square kilometers and has a population of 4336. There are some problems matching data across data sources, see each section below.

[22]The data used for village population and ethnicity is described below.

[23]To see the laws governing the courts, see the National Service of Gacaca Jurisdictions homepage, http://www.inkiko-gacaca.gov.rw/En/EnLaw.htm (Available 2009-11-05).

- Planners, organizers, instigators, supervisors of the genocide.
- Leaders at the national, provincial or district level, within political parties, army, religious denominations or militia.

At the village level, these are typically prosecutions committed by local militias such as the Interahamwe and Impuzamugambi. Category 2 prosecutions concern civilian violence, defined as:

- Authors, coauthors, accomplices of deliberate homicides, or of serious attacks that caused someone's death.
- The person who - with the intention of killing - caused injuries or committed other serious violence, but without actually causing death.
- The person who committed criminal acts or became the accomplice of serious attacks, without the intention of causing death.

The data specifies the number of prosecutions for each village in Rwanda. In the sample, there are approximately 64 000 category 1 prosecution cases, and 362 000 category 2 cases. Unfortunately, there is no data available on ethnicity at the village level (it is available only at higher levels), only population numbers in 1991 (see below). The proxy used for the participation rate h is therefore the prosecution rate, measured as prosecutions per capita. Figures 6 and 7 show the prosecution rates in villages.[24]

Since we do not observe actual participation but prosecutions, and per capita rather than per Hutu, we have some measurement error in the dependent variable. This will not lead to any biased estimates unless the measurement error is correlated with the measured variation in radio coverage.

Measuring radio coverage, r

The paper uses village-level data on predicted Radio RTLM coverage. The variable is constructed in several steps. First, it uses data on Radio RTLM transmitter locations and

[24]White areas on the map indicate no data. This is either because of national parks or Lake Kivu (to the west), or because of matching problems. The data is matched on village names. There are two types of matching problems. First, names have changed across data sources. Second, two villages within communes sometimes have identical names.

technical specifications, provided by the government agency Office Rwandais d'Information. Then, it predicts the radio coverage across the country by using digital topographic maps and radio propagation software developed by engineers.[25] The software (ArcGIS) uses an algoritm called ITM/Longley-Rice, which is typically used by radio and TV engineers assessing the signal strength of broadcasts. The software uses a digital topographic map of Rwanda, provided by Shuttle Radar Topography Mission (SRTM), and it lets the software run the ITM/Longley-Rice algoritm and predict the signal strength across the country. The software produces a radio coverage map at a 90 meter cell resolution, indicating whether each cell has radio coverage or not. Figure 5 shows predicted radio coverage.[26]

Using the digital map of village boundaries, the measure of r is calculated as the share of the village area with coverage.[27] As there is no available dataset on Radio RTLM listening rates, the paper will estimate the reduced form effect of RTLM radio coverage on the participation rate.[28]

Measuring ethnic polarization, t

Population and ethnic data is retrieved from the Rwanda 1991 population census, provided by IPUMS International and GenoDynamics.[29] The GenoDynamics data is used for the population in each village. It does not contain any data on ethnicity. However, the 1991 census from IPUMS International reports the number of Tutsi and Hutu households in the commune. The ethnicity of the household is defined as the ethnicity of the household head. The data is only available at the commune level, which is one administrative level above the village (i.e., administrative sector). The measure used for t is therefore the number of Tutsi

[25]The transmitter parameters are GPS position; transmitter height; transmission power; frequency; polarization.

[26]The software requires topography data in order to predict the radio signal. The digital map has complete topography data of Rwanda. However, the software runs into a missing data problem for a small section of villages in the very north and northeast, for signals radiation from the Mount Muhe antenna. This is because the radio signal need to travel across Uganda in the north before reaching the northeastern Rwanda. Therefore, the predicted radio signal is incorrect for those areas. The 205 villages affected by this data problem are dropped from the sample.

[27]As the measure is predicted radio coverage rather than actual radio coverage, there could be some random measurement error in the data. In that case, this will lead to attenuation bias and an underestimation of the true effects.

[28]The commune average radio ownership rate in the sample is 34%, taken from the 1991 Census. Radio ownership data is not available at the village level.

[29]The data is available at https://international.ipums.org/international/, (Available 2008-06-08), and http://www.genodynamics.com/, (Available 2009-05-11).

households divided by the number of Hutu households in the commune.

Since there are only two ethnic groups (98% of the population are either Hutu or Tutsi) where the Tutsi population is all the villages (the maximum t in the data is 0.44), this measure is equal to the commonly used measures of "ethnolinguistic fractionalization" and "ethnic polarization", up to a scalar (see Montalvo and Reynal-Querol, 2005). Therefore, we use t and *ethnic polarization* interchangeably.

Measuring access to independent information, σ_x

Ideally, we would want to test Prediction 4 directly through a measure of independent information (σ_x). But this is naturally unobservable to the researcher. Instead, we proxy for the access to independent information with the *ability* to access independent information, by exploiting variation in literacy rates and education.

Independent information can, of course, come from a range of sources. Within the context of the Rwanda genocide, newspapers are particularly relevant. In the years preceding the genocide, the independent press quickly expanded with multi-party politics and the legalization of opposition parties in June 1991. The number of independent newspapers that not aligned with the government parties was between 30 to 60 during this period (Alexis and Mpambara, 2003; Higiro, 2005). Arguably, a necessary requirement for access to newspapers is literacy and basic primary education. In addition, Des Forges (1999) reports that, in practice, not only the literate would read the newspapers, but those who knew how to read were accustomed to reading newspapers to others.[30].

The data on literacy rates and primary education also comes from the 1991 Census provided by IPUMS International. For the literacy rate, the fraction of Hutu household heads that are literate is used. For primary education, the variable is the fraction of Hutu household heads that have some primary education.[31] Both variables are only available at the commune level.

[30]The model assumes that independent information is unbiased on average. However, since the newspapers in Rwanda were typically aligned with political parties, each newspaper most likely supplied biased information. This does not necessarily mean that the newspapers were biased on average. In fact, Mullainathan and Shleifer (2005) argues that with sufficient political divisions the information will be unbiased on average.

[31]The 1991 Census reports "last grade completed" for each household head. Since we would like to directly measure σ_x, but use the proxy variables, there is measurement error. This will also lead to attenuation bias if the error is classical.

Covariates

The SRTM topography data and ArcGIS software maps allow us to calculate the village mean altitude, the village variance in altitude, and the min and max altitude of the village, distance to the border, and village area. Using data from Africover, we can also measure the village centroid distance to the nearest major town and the distance to the nearest major road.

The summary statistics are presented in Table 1.

4.2 Identification strategy

To identify the causal effects of radio coverage on the participation rate requires variation in radio coverage to be uncorrelated with all other determinants of participation. In the model radio coverage is exogenous, while in reality the placement of the two RTLM transmitters was not random. One 100 watt transmitter was placed in the capital Kigali. The other transmitter (1000 watt) was placed on Mount Muhe in the northwestern part of the country.[32] The main endogeneity concern is that the transmitters could have been placed in areas with high fundamental value of conflict θ, little independent information σ_x, or ethnic polarization t. The simple correlation between radio coverage and participation rate would then violate the identifying assumption. Importantly, since both θ and σ_x are unobservable, they cannot be controlled for in a regression.

The following identification strategy addresses the problem in steps.[33] Rwanda is a very hilly country without any really flat regions. Nick-named "The Land of the Thousand Hills", Figure 2 shows a map with the topography of Rwanda. There are literally hilltops and valleys everywhere in the country and the topographic variation shown in Figure 2 provides the basic foundation for the identification strategy. In particular, the main idea is to exploit variation in radio coverage due to hills in the line-of-sight between radio transmitters and villages *in between* radio transmitters and villages.

Radio propagation follows the laws of physics for electromagnetic propagation. Given

[32]The highest mountain, Mount Karisimbi, is right on the border to DR Congo and Uganda. Mount Muhe is the second highest mountain in the country, but the highest one that is well within the country's border. Together with the Kigali transmitter, the placement strongly suggest to have been driven by a maximizing of listeners.

[33]The strategy was pioneered by Olken (2009). The approach in this paper is similar but not identical to Olken's.

transmitter height and power, the two main determinants of the signal strength are: distance to the transmitter; and whether the receiver is in the line-of-sight of the transmitter[34] In free space, the power density of the radio signal decreases in the square distance from the transmitter. Since the transmitter may have been placed strategically, the distance to the transmitter most likely correlates with either θ or σ_x. The first step is therefore to control for a second-order polynomial in the distance to the transmitter.[35] This will leave variation in signal strength caused by variation in the line-of-sight between the transmitter and the receiver.

Figure 6 shows graphically how radio coverage due to variation in the line-of-sight is determined. Whether the receiver is in the line-of-sight of the transmitter will depend on two factors: the topography where the receiver is located (the higher the altitude of the receiver, the higher is the likelihood of its being in the line-of-sight) and the topography between the transmitter and the receiver. Since the topography of a village may be correlated with the other unobservable determinants of participation in conflict (θ and σ_x), it will be controlled for. The second step is therefore to control for the topography of the village. The control variables consist of a second order polynomial in the mean altitude of the village and the altitude variance. This will leave variation in radio coverage due to the topography between the transmitter and the receiver.

Since the two Radio RTLM transmitters may have been strategically placed in parts of the country with certain topography, the variation left (after controlling for the distance to the transmitter and the topography of the village) may still be correlated with θ and σ_x. Therefore, in order to control for broad regional difference in topography, the third and last step is to include *commune fixed effects*.[36] The variation in radio coverage exploited for identification will therefore be highly local variation across villages within communes.[37] This variation is arguably uncorrelated with other determinants of conflict, as radio coverage is determined by whether a hilltop randomly happens to be in the line-of-sight between the

[34]If there are sharp edges that the electromagnetic signal encounters, there can also be some diffraction. The exact formula, and the Longley-Rice model, can be found at http://flattop.its.bldrdoc.gov/itm.html (Available 2009-11-03).

[35]The 2-order polynomial in the distance to the transmitter explains alone 44 percent of the variation in radio coverage.

[36]Commune fixed effects alone explain 82 percent of the variation in village mean altitude, and 72 percent of the variation in radio coverage.

[37]There are 129 communes in the sample and 8.6 villages per commune.

transmitter and the village.

Figure 7 shows graphically the topography and radio coverage variation within four communes in the northern part of the country. The radio signal in these communes comes from the Mount Muhe transmitter located approximately 30 km west, outside the figure. The figures show that within each commune, villages that happen to be situated to the east of hilltops have low radio coverage, while villages that happen to be situated to the west of hilltops have high radio coverage. This is because the signal comes in from the west, and the hilltops are in line of sight to the transmitter. This arguably provides a credible identification strategy, as there is no plausible reason why other determinants of participation in violence shoule be different across the eastern and western sides of the hilltops.[38]

Exogeneity check

If the identification strategy is valid and radio coverage is as good as randomly assigned, there should be no correlation between the variation in radio coverage and the other determinants of participation in violence. In particular, there should be no correlation between radio coverage and the fundamental value of participation in conflict θ, or the access to independent information, σ_x. Since these variables are unobservable, it it not feasible to directly test this assumption.[39] Instead, we test the validity of the exogeneity assumption by using observable village characteristics that are likely correlated with θ and σ_x, namely 1991 population density; 1991 population levels; distance to the nearest major town; distance to the nearest major road; distance to the nearest border point; and village area.[40]. The regression specification is

$$y_{c,i} = \beta r_{c,i} + X_{c,i}\pi + \gamma_c + \varepsilon_{c,i} \ , \tag{6}$$

where $y_{c,i}$ is a characteristic of village i in commune c; $r_{c,i}$ is the radio coverage of village i in commune c; $X_{c,i}$ is the vector of village i controls and γ_c is the commune fixed effects. For completeness, we test using both levels and logs for each y.

The vector of standard village controls are: a second order polynomial in the kilometer

[38]Note that in this particular case, the variation comes from the east-west relationship to the hilltops. In other communes it will, of course, be in other directions.

[39]Since there is no available data on ethnic polarization t at the village level, t is also an unobserved determinant of participation.

[40]The analogy used in randomized experiments is to check whether the treatment and control group is balanced on observable pre-treatment characteristics.

distance to the nearest transmitter; a second order polynomial in the average village altitude in kilometers; the variance in altitude within the village. If the exogeneity assumption is correct, we expect $\beta = 0$.

Table 2 shows the results. None of the village characteristics are significant, and the lowest p-value is 0.234. This lends credibility to the identification strategy. In the main regressions, results will be presented both without and with village characteristics. The results are similar with and without the inclusion of these characteristics.

4.3 Econometric specifications

In this section, we present the econometric specifications used to test each prediction.

Main Effects (Prediction 1): *If radio coverage r increases the participation rate h, then radio broadcast a signal that the fundamental value of conflict was high, $p > \tilde{p}$.*

That is, if we find that radio coverage increased the participation rate, ethnic majority members perceived the Radio RTLM broadcasts as information that the fundamental value of conflict being high. To test this, we run the following regression[41]

$$\log(h_{c,i}) = \beta r_{c,i} + X_{c,i}\pi + \gamma_c + \varepsilon_{c,i} \ , \tag{7}$$

where the dependent variable is the logged total number of prosecutions per capita, $h_{c,i}$, of village i in commune c; $r_{c,i}$ is the RTLM radio coverage of village i in commune c; $X_{c,i}$ is the vector of village i controls; and γ_c is the commune fixed effects.[42] We will also run separate regressions where $h_{c,i}$ is either civilian violence only or organized violence only. The vectors of standard village controls are: a second-order polynomial in the kilometer distance to the nearest transmitter; a second-order polynomial in the average village altitude in kilometers and the variance in altitude within the village. In additional specifications, we also add controls for population density, distance to nearest major town, distance to nearest road, and distance to the nearest border point. According to Prediction 1, if $\beta > 0$ then this is

[41] Since the true conditional expectations function $E[h_i \mid r_i]$ depends on the unobservable parameters in the model, it is unknown. We use a standard OLS regression model with a logged outcome variable. The regression will provide a linear approximation of the true relationship.

[42] Of the 1105 villages, 20 have zero prosecutions. Since the outcome variable is logged, we use log[(prosecutions+1)/population] to deal with the problem of undefined log function.

consistent with $p > \tilde{p}$.

Ethnic Polarization (Prediction 2): *The effect of radio coverage r on the participation rate is decreasing in ethnic polarization t, only if $\alpha > 0$; and decreasing in t only if $\alpha < 0$.*

Therefore, testing for differential effects of radio coverage depending on ethnic polarization gives one method to separate whether there are *strategic complements ($\alpha > 0$)* or *strategic substitutes ($\alpha < 0$)* in participation. We test for this using the following specification

$$\log(h_{c,i}) = \beta r_{c,i} + \delta r_{c,i} \times t_c + X_{c,i}\pi + \gamma_c + \varepsilon_{c,i} \ , \tag{8}$$

where t_c is a dummy variable indicating whether the size of the ethnic minority population in commune c is large and the other variables are the same as previously. Specifically, t_c is equal to one if the ethnic minority size is above the median (7.53%) commune. The main parameter of interest is δ. According to Prediction 2, if $\delta < 0$, this is only consistent with $\alpha > 0$. If $\delta < 0$, then this is only consistent with $\alpha > 0$.

Scale Effects (Prediction 3): *Radio coverage r exhibits increasing scale effects, only if $\alpha > 0$; and decreasing scale effects, only if $\alpha < 0$.*

This provides an additional test that allows us to separate whether there are *strategic complements ($\alpha > 0$)* or *strategic substitutes ($\alpha < 0$)* in participation. To investigate Prediction 3, we use the following flexible non-linear specification

$$\log(h_{c,i}) = \sum_{s=0.1}^{1} \beta^s r^s_{c,i} + X_{c,i}\pi + \gamma_c + \varepsilon_{c,i} \ , \tag{9}$$

where ${r^s}_{c,i}$ is a dummy variable equal to one if $s - 0.1 \leq r_{c,i} < s$, and zero otherwise. The other variables are the same as before. We estimate the β^s in order to investigate the scale effects.

Independent Information (Prediction 4): *Radio coverage r does not affect the participation rate h when ethnic majority members have sufficiently good access to independent information ($\sigma_x \to 0$).*

As described in section 4.4, we test this prediction using literacy rates and primary education as proxy variables for access to independent information, σ_x. We use the following

specification

$$\log(h_{c,i}) = \eta_1 r_{c,i} \times \sigma_{1,c} + \eta_2 r_{c,i} \times \sigma_{2,c} + \eta_3 r_{c,i} \times \sigma_{3,c} + X_{c,i}\pi + \gamma_c + \varepsilon_{c,i} \ , \tag{10}$$

where $\sigma_{j,c}$ is a dummy variable indicating whether the Hutu literacy rate (or the Hutu primary education level) commune c belongs to tertile j in the distribution of Hutu literacy rates (or the Hutu primary education level). If $\sigma_{3,c}$ is a sufficiently good proxy for σ_x close to zero, by Prediction 4 we expect $\eta_3 = 0$.

5 Results

In the following sections, we present the results for each tested prediction.

5.1 Main effects

The results for the test of Prediction 1 are presented in Table 3. Column 1 presents the simple correlation between radio coverage and the participation rate, and shows a negative correlation for total violence. However, this is unlikely to be a causal effect of RTLM radio coverage for a number of reasons mentioned in the empirical strategy section. Applying the identification strategy by controlling for the main set of variables that determine radio propagation and commune fixed effects, Column 2 shows that radio coverage increased participation in genocide violence. The effect is significant at the 5 percent level. Column 3 shows that the point estimate is almost identical when additional village covariates are added. Column 4 shows that RTLM reception has a positive and significant impact on civilian violence, and Column 6 shows significant effects also on organized violence.[43] Columns 5 and 7 show that adding covariates does little in the way of changing the point estimates, which is not surprising given the identification strategy and the results in Table 2.[44]

The estimated effects from the full specifications in Table 3 are substantial. For overall violence, Radio RTLM propaganda caused 71 percent (0.561 log points) more participation

[43] Residual plots show that the results are not driven by outliers (not shown).

[44] The estimates assume no spillover across villages, which might be unrealistic. If the violence increased in villages with good radio coverage, which caused further violence in neighboring villages with low radio coverage, this will lead to an underestimation of the true effects. If this is the case, the estimates could be interpreted as providing the lower bounds of the true effects.

in violence for villages with full radio coverage ($r = 1$), as compared to villages unable to receive the propaganda ($r = 0$). Looking at the two types of violence separately, civilian violence increased by 65 percent (0.501 log points) and for organized violence, the increase was 77 percent (0.572 log points).[45]

Interpreting these results within the framework of the model and Prediction 1, they imply that Radio RTLM did indeed broadcast messages that the value of conflict was high, *and* Rwandan citizens believed in them. Furthermore, the results are consistent with the model under strategic interactions in violence, as well as without such interactions. That is, the results presented in Table 3 are not informative about whether the participation increased because Hutu citizens updated their beliefs about the fundamental value of violence, or whether the broadcasts also changed the beliefs how many others were likely to participate in the killings. Next, we present results that allow us to further understand the underlying mechanisms that can explain why Radio RTLM caused more violence.

5.2 Ethnic polarization

The results for the test of Prediction 2 are presented in Table 4. Column 1 and 2 show the estimated effects for total violence. The interaction effect between radio coverage and ethnic polarization is negative with and without additional controls. Both coefficients are significant at the 5 percent level. Columns 3 to 6 show that the interaction coefficients are similar for civilian and organized violence. The coefficients for civilian violence are significant at the 5 percent level, and insignificant for organized violence.[46] Interestingly, the estimated coefficients imply that the broadcasts only had an effect in areas with low ethnic polarization (i.e., where the ethnic minority population is small), as the point estimate for the interaction with high ethnic polarization is almost identical, but of the opposite sign, as the coefficient when ethnic polarization is low.[47]

As stated in Prediction 2, the results are only consistent with the model under *strategic complements*. Figure 1B graphically shows how the model, under strategic complements, predicts the effects of radio coverage depending on the relative size of the ethnic minority

[45]Due to the specification, these are linear approximations of the causal effects.

[46]Strictly speaking, we cannot reject the null hypothesis for organized violence. Note, however, that this is due to large standars errors. The coefficients for organized violence are very similar to those for civilian violence.

[47]The p-value for the test of effects when ethnic polarization is high is 0.89.

group. The empirical results not only show that RTLM propaganda was ineffective when the Tutsi population was relatively large, they also suggest that this was due to strategic complements in ethnic violence. That is, Hutu citizens were more reluctant to participate in the attacks against Tutsi citizens when the Hutu majority population was relatively small, perhaps due to a fear that Tutsi villagers would be able to better defend themselves as a group. Therefore, even though radio broadcast a message about the value of conflict was high in general, the results show that the broadcasts were not sufficient to persuade Hutu citizens to participate in areas with high ethnic polarization.

5.3 Scale effects

The results for the test of Prediction 3 are presented in Table 5. Column 1 shows that the estimated coefficients are generally small and not significantly different from zero for low levels of radio coverage, while for high levels of radio coverage, the coefficients are large and statistically significant at the 1 or 5 percent level. Figure 10 graphically plots the coefficients and the 95 percent confidence intervals. The figure shows that the effects are highly non-linear. For the range of up to 60-70 percent radio coverage, the point estimates are small but not significantly different from zero. Most importantly, they are non-increasing in the range. When radio coverage reaches approximately 70 percent, we see a sharp estimated increase in the participation rate, however. The effects are substantial. The increase in the point estimates is almost three-fold. They imply that participation increased by approximately 70 percent when radio coverage reached above 70 percent. The coefficients are significant at the five-percent level.

Figure 10 suggests that the broadcasts were effective only when people knew that many other village members were also listening to the same broadcasts. The model allows us to further interpret the results. By Prediction 3, under strategic substitutes there should be decreasing scale effects, whereas Figure 10 shows increasing scale effects. This is only consistent with the model under strategic complements in violence. Furthermore, the results from the previous section showed that all of the effects of radio coverage on participation rates comes from villages where the Tutsi population was relatively small (i.e., low ethnic polarization). This is also only consistent with the model under strategic complements. Both results therefore suggest that Radio RTLM caused more violence due to strategic coordination.

Figure 1B shows how the estimated effects in Figure 10 can be interpreted. For low levels of radio coverage, even though the ethnic minority is small, there is essentially no effects on participation in violence. When radio coverage reaches critically high levels, however, there is a sharp increase in participation. In particular, when sufficiently many receives the broadcast, then everybody that listens to the radio knows that almost everybody else are also listening to the same broadcasts. Under strategic complements in violence, individuals are more willing to participate when they expect others to participate too. And this caused a large-scale, 70 percent, increases in participation. The evidence therefore suggests that there were important strategic complements in violence, and that Radio RTLM functioned as a coordination device.

5.4 Access to independent information

The results for the test of Prediction 4 are presented in Table 6. Column 1 shows that there is a significant effect of radio coverage when the literacy rate is low. The coefficient is large and significant at the 5 percent level. It implies that in villages with low literacy rates (bottom tertile), complete radio coverage ($r = 1$) increased participation by 347 percent (1.499 log points), compared to villages unable to receive the propaganda ($r = 0$). Column 1 also shows that in villages with medium literacy rates (middle tertile), radio coverage had a significant effect on participation. The coefficient is significant at the 10 percent level and implies a 71 percent (0.535 log points) increase in participation when the radio coverage was complete. Importantly, there is no effect of radio coverage in the villages with the highest literacy rates (upper tertile). The coefficient is negative and very close to zero. Column 2 shows that the effects are similar when additional controls are included.

Columns 3 and 4 estimate the effects of radio coverage for different levels of primary education. The estimated coefficients show a similar pattern as literacy rates. Importantly, there is no effect in villages where the Hutu household heads have most primary education. The coefficients in both columns 3 and 4 are very close to zero.

Interpreting relatively high literacy rates and a relatively high level of primary education as better access to independent sources of information, the results confirm Prediction 4. Moreover, the model allows us to interpret why literacy rates and primary education were important and suggests why they mitigated the propaganda effects. When people had better access to independent information, for example through the 30-60 independent newspapers

available at the time, they did not put much weight on the RTLM broadcasts because, in relative terms, RTLM did not contain much information. Therefore, they did not put much belief in the messages and, consequently, they were not persuaded to participate in the killings.

5.5 How much of the genocide is explained by Radio RTLM?

This section performs a simple counterfactual calculation to assess how much of the genocide that can be explained by Radio RTLM. Specifically, we use the estimated coefficients of Table 5 and calculate the participation in the absence of the radio station.

For each village i, we first calculate the counterfactual ($r = 0$) participation

$$\hat{h}_{i,c}(r=0) = \exp\left[\log\left(h_{c,i}\right) - \hat{\beta}^{s}_{c,i}\right] \ ,$$

where $\hat{h}_{i,c}$ is the counterfactual participation rate (prosecution rate) of village i in commune c, and $\hat{\beta}^{s}_{c,i}$ is the coefficient estimate from Table 5, column 1, for the radio coverage indicator variable equal to 1 for village i[48]. Since participation is defined as the number of village prosecutions divided by the 1991 village population, we multiply with 1991 population in order to the get counterfactual number of prosecutions. Summing over all villages, we find that Radio RTLM caused approximately 39 700 of the total 425 900 prosecution cases for genocidal violence in the sample. The estimates therefore suggest that approximately 9% of the genocide can be explained by Radio RTLM. This is non-trivial considering that only about 20 percent of the population had radio coverage to receive the broadcasts.[49]

We can make the same calculations for civilian violence and organized violence, respectively. Using Table 5 column 2 for civilian violence and column 3 for organized violence, the counterfactual calculation suggests that Radio RTLM caused approximately 32 000 more civilian prosecution cases (the sample total is approximately 361 700 category 2 crimes) and 5 200 more prosecution cases for organized violence (category 1 crimes). Therefore, using the separate estimates suggests that approximately 9% of the organized violence and 11%

[48]We use the point estimates. Naturally, since there is uncertainty in the estimated coefficients, the resulting numbers should be taken as approximate estimates.

[49]We calculate the number by village radio coverage multiplied by the population number in each village, given by the 1991 Census. Therefore, the number refers to the share of the population calculated to have had radio coverage. Since only 34% of the households in the 1991 Census owned a radio (in the communes in the sample), the number of listeners is most likely lower.

of the civilian violence can be explained by Radio RTLM.

Finally, we can use the numbers to assess how many in the Tutsi population were killed due to Radio RTLM. According to des Forges (1999), at least 500 000 Tutsis were killed in the genocide. Making the additional assumption that the number of Tutsi deaths is proportional to the number of prosecutions, the estimated effects therefore suggest that Radio RTLM caused 45 000 Tutsi deaths.

6 Conclusion

This paper investigates the impact of propaganda on participation in civil conflict. Specifically, the paper examines the impact of the propaganda spread by the infamous "hate radio" station Radio Télévision Libre des Mille Collines before and during the 1994 Rwanda Genocide.

The paper first sets up a simple model of participation in ethnic violence. Then, it derives a set of testable predictions that are consequently taken to the data. To identify the causal effects of the broadcasts, the empirical strategy exploits arguably exogenous variation generated by Rwanda's highly varying topography consisting of hills and valleys.

The paper presents novel evidence on the effects of propaganda. The results show substantial effects of the Radio RTLM broadcasts on violence participation. The estimates imply that when a village has full rather than zero radio coverage, civilian violence increased by 65 percent and organized violence by 77 percent.

Furthermore, the paper presents evidence of strategic complements. First, the effects are entirely driven by villages where the Hutu ethnic group was large relative to the Tutsi ethnic minority, which is only consistent with the model under strategic complements. Second, as predicted by the model under strategic complements, the estimated effects are highly nonlinear in the degree of radio coverage as the is a sharp increase in violence when the village radio coverage is sufficiently high. This suggests that the broadcasts were effective only when people knew that many other village members were also listening to the same broadcasts. Together, the evidence therefore suggests that the mechanism through which the broadcasts increased violence was in part because it functioned as a coordination device.

The model also predicts that access to independent information can mitigate the propaganda effects. It tests this prediction using variables associated with the ability to access

independent information, such as the 30-60 independent newspapers available in Rwanda at the time of the genocide, by estimating whether the broadcasts had smaller effects in villages with higher levels of literacy and primary education. The empirical results show that more education decreased the propaganda effects, as there is no effect of radio coverage in villages in the tertile with the highest literacy rates and primary education.

To assess how much of the genocide that can be explained by the violence, the paper conducts a simple counter-factual calculation implying that Radio RTLM caused approximately 9.3% of the genocidal violence, corresponding to at least 45 000 deaths. The results therefore suggest that Radio RTLM was a quantitatively important causal factor in the genocide.

Finding that the propaganda caused more violence, and was partly effective because of strategic complements in violence, opens up further questions. Why are there strategic complements in violence? Is it because attacking in numbers is less risky? Or is it because *not* participating is dangerous when many others participate? Are strategic complements generally present in civil conflicts? If so, what are the other devices used for coordination? These are important questions left for future research.

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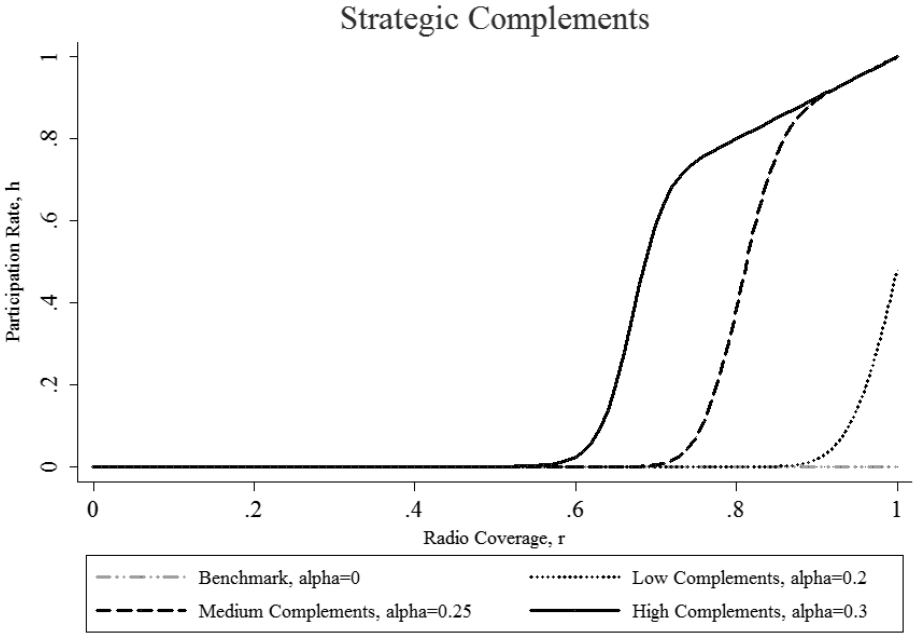

Figure 1A. The figure plots the participation rate as a function of the radio coverage. It shows the importance of strategic effects due to strategic complements. Under the benchmark case (fundamentals effects only), there is essentially no effect. The higher are the degrees of complements, the larger are the strategic effects.

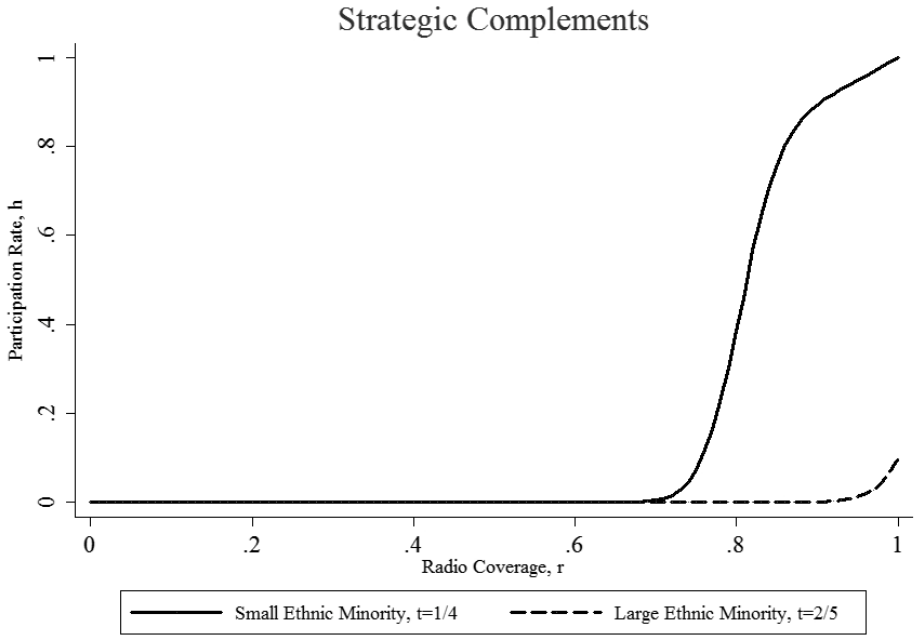

Figure 1B. The figure plots the participation rate as a function of the radio coverage for two levels of ethnic minority size. It shows that the effect of radio coverage is smaller, and can disappear, when the ethnic minority is relatively large.

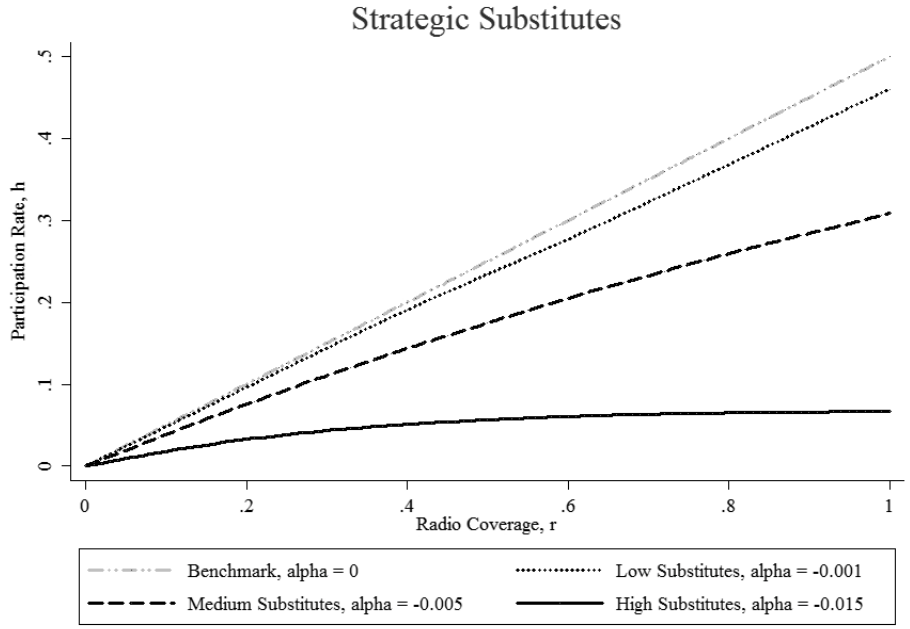

Figure 2A. The figure plots the participation rate as a function of the radio coverage. It shows the importance of strategic effects due to strategic substitutes. Under the benchmark case (fundamentals effects only), the effect is linear. The effects of radio coverage decrease with higher degrees of substitutes.

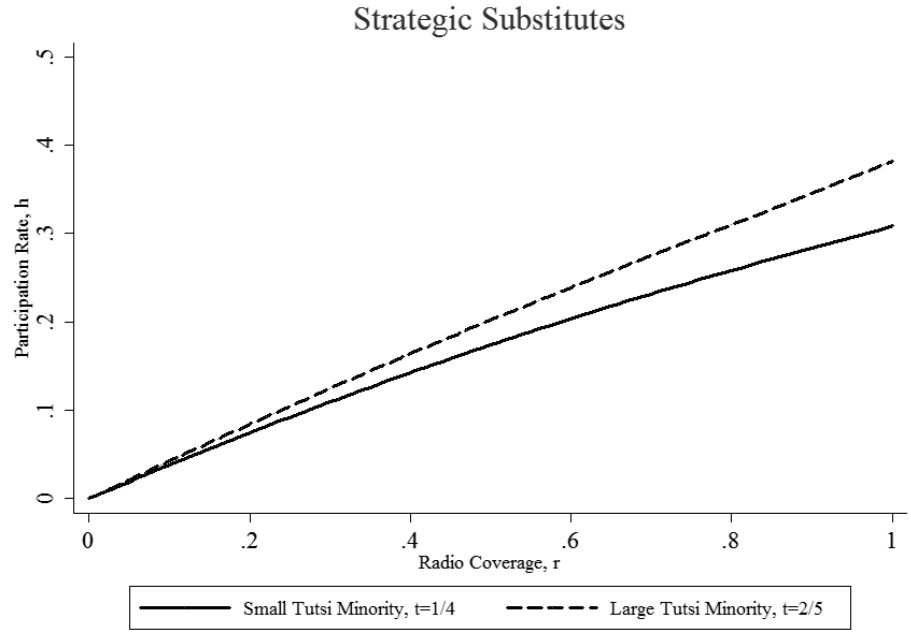

Figure 2B. The figure shows the participation rate as a function of the radio coverage for two levels of ethnic minority size. It shows that the effect of radio coverage is larger when the ethnic minority is large.

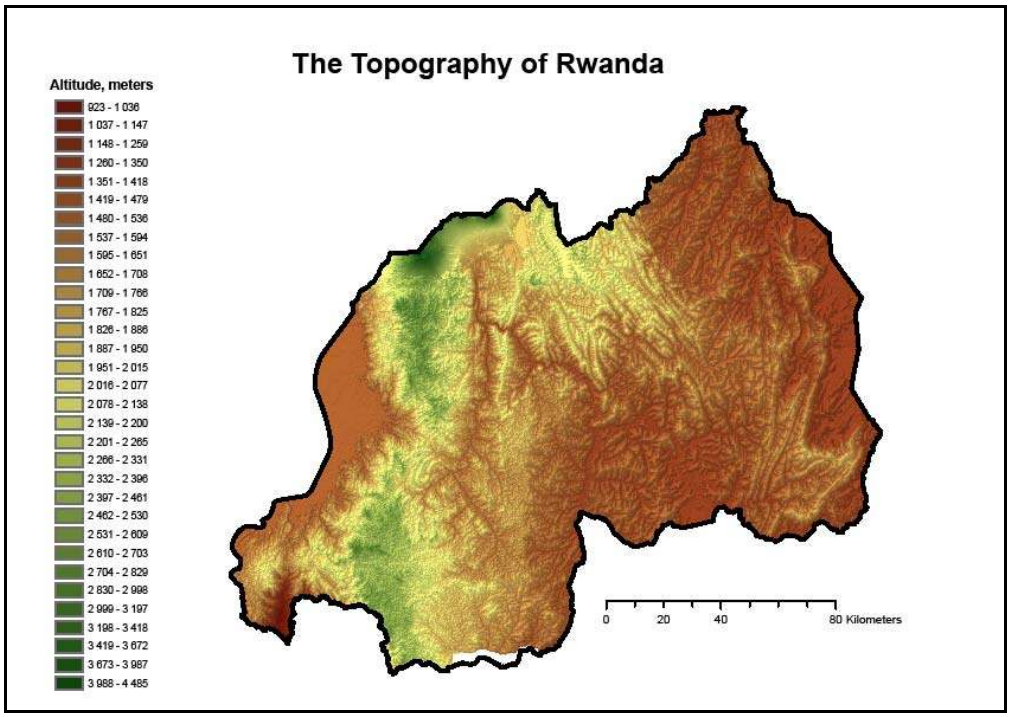

Figure 3. The Topography of Rwanda
Source: Shuttle Radar Topography Mission

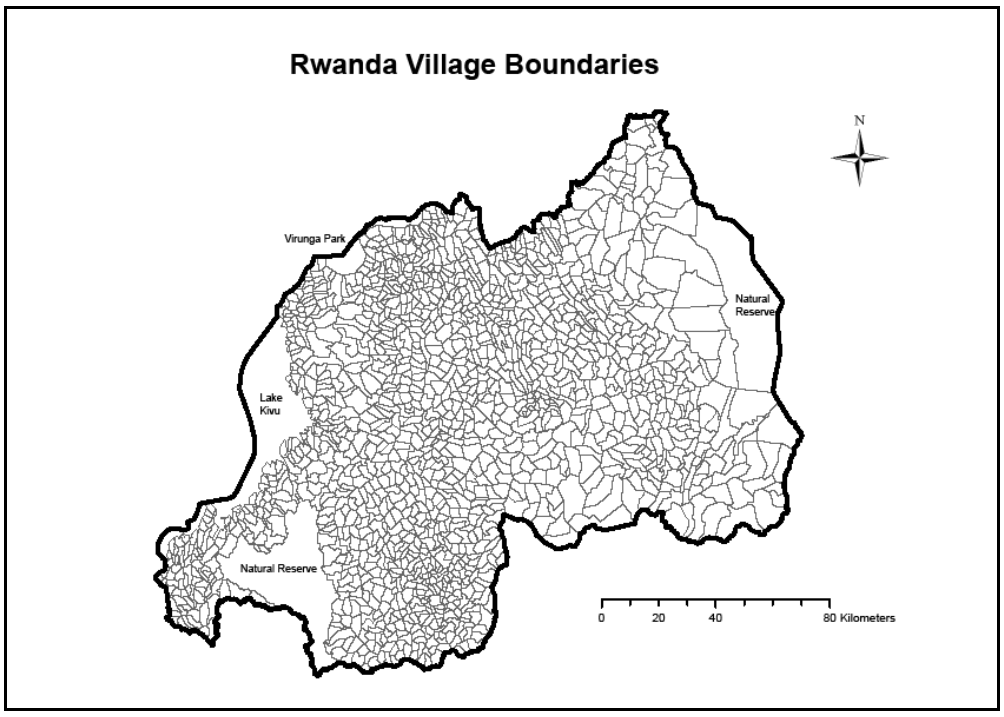

Figure 4. Rwandan Village Boundaries
Source: Analog map by Organisation Administrative du territorie de la Republic Rwandaise, digitized by the author.

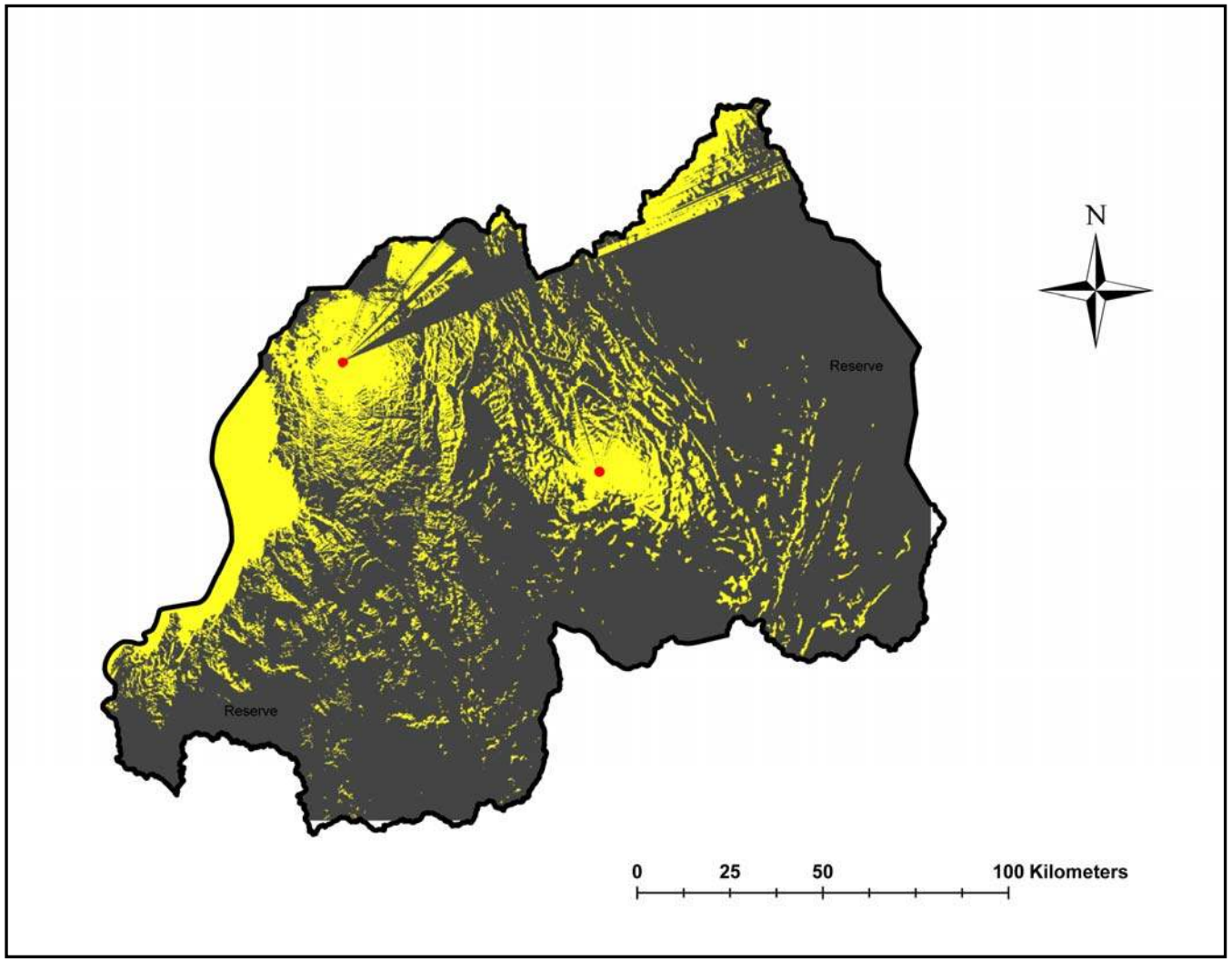

Figure 5. RTLM Radio Coverage

The figure shows the predicted radio coverage based on SRTM 90 meter digital topography maps and ArcGIS radio propagation software. The two red dots mark the transmitters. The north-western 1000 watt transmitter is on Mount Muhe. The central 100 watt transmitter is in the capital Kigali. Yellow indicates radio coverage. The map also shows a software calculation error in the north due to missing topography data (see the data section for the details). Villages affected by this error are excluded from the sample. Source: Author's calculations in ArcGIS using the Longley-Rice Propagation Model.

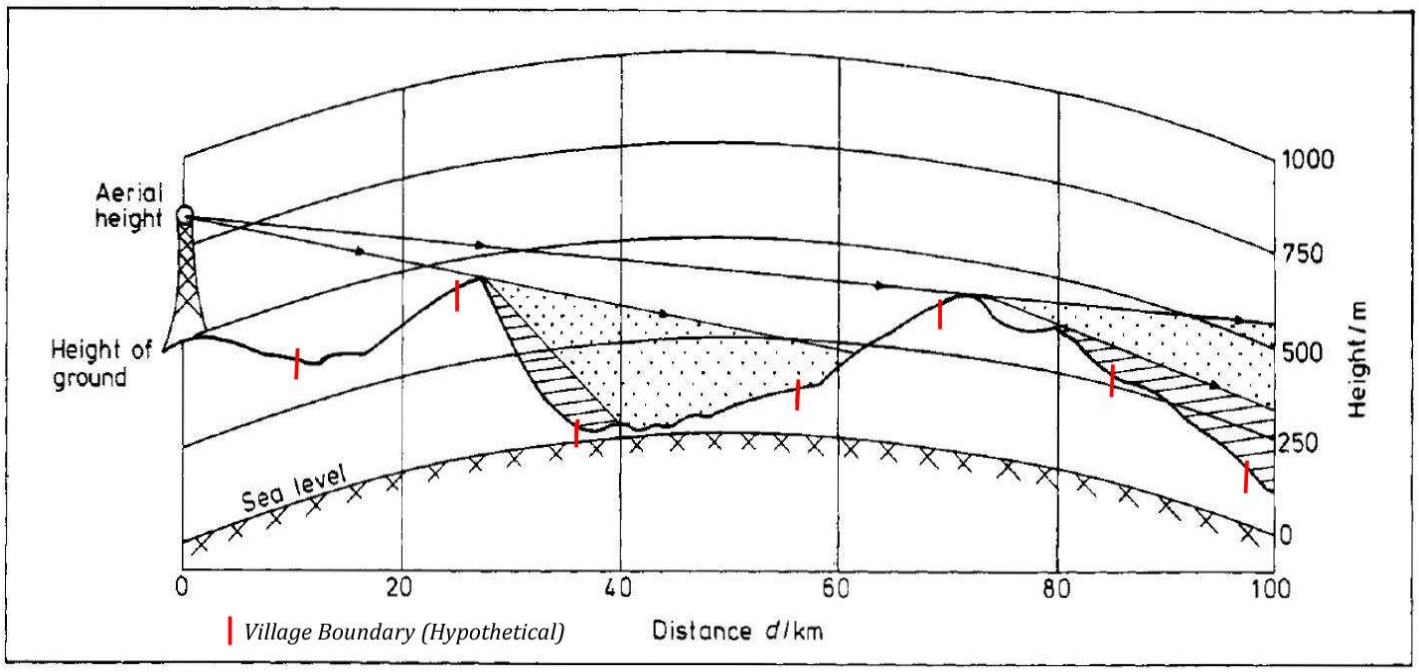

Figure 6. Theoretical Radio Coverage
Dotted space marks low signal strength, and striped space marks even lower signal strength. The figure shows that the signal strength for a point on the ground is lower when there is a hilltop in the line-of-sight between the transmitter and a point on the ground. The red bars mark hypothetical village boundaries.

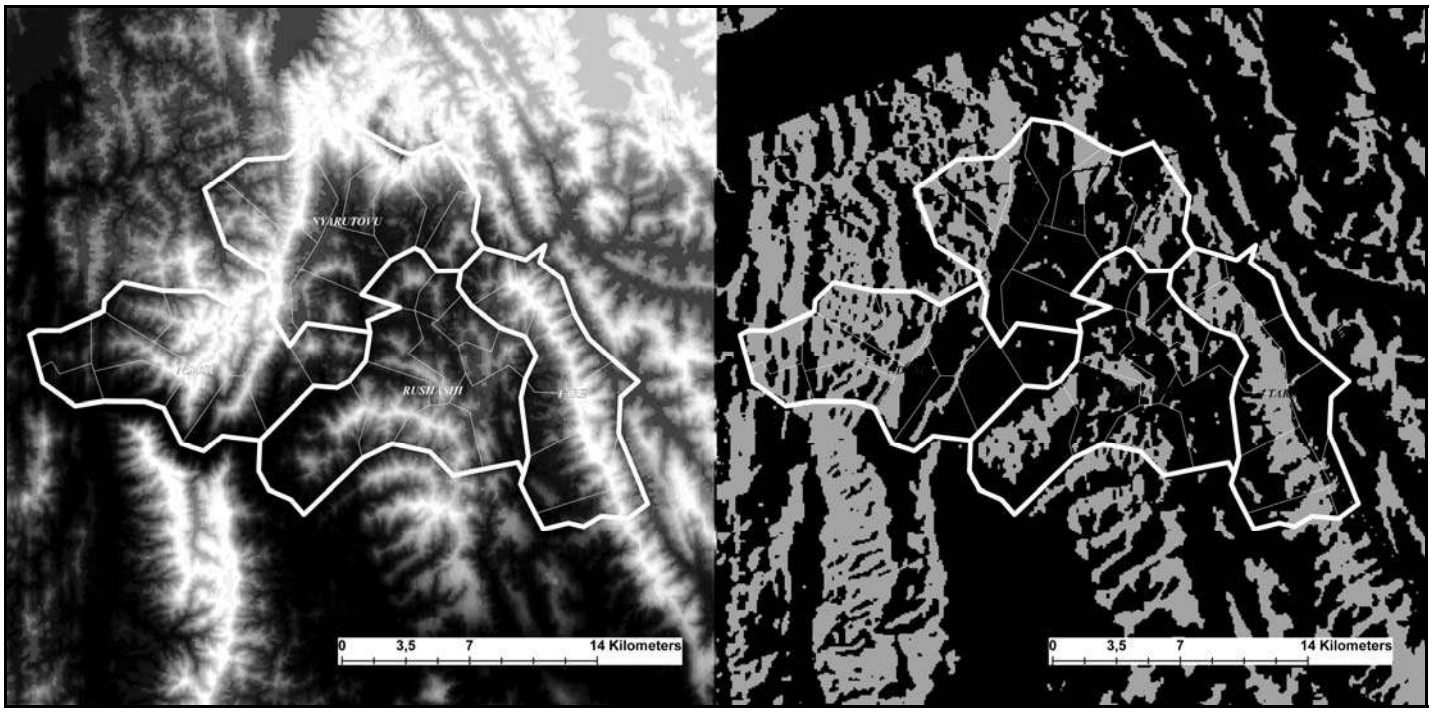

Figure 7. Predicted Radio Coverage, 4 communes example
This left picture shows the height of ground, where brighter marks higher altitude. The right picture shows the empirical radio coverage, where grey marks radio coverage. The signal comes from the Mount Muhe transmitter located 30 km to the west (outside the figure). The figures show that within each commune (boundaries in thick white lines), villages (boundaries in thin white lines) to the east of hill tops have low radio coverage due the hilltops in the line-of-sight to the transmitter.
Source: SRTM topography data, Author's own calculations of radio coverage in ArcGIS software.

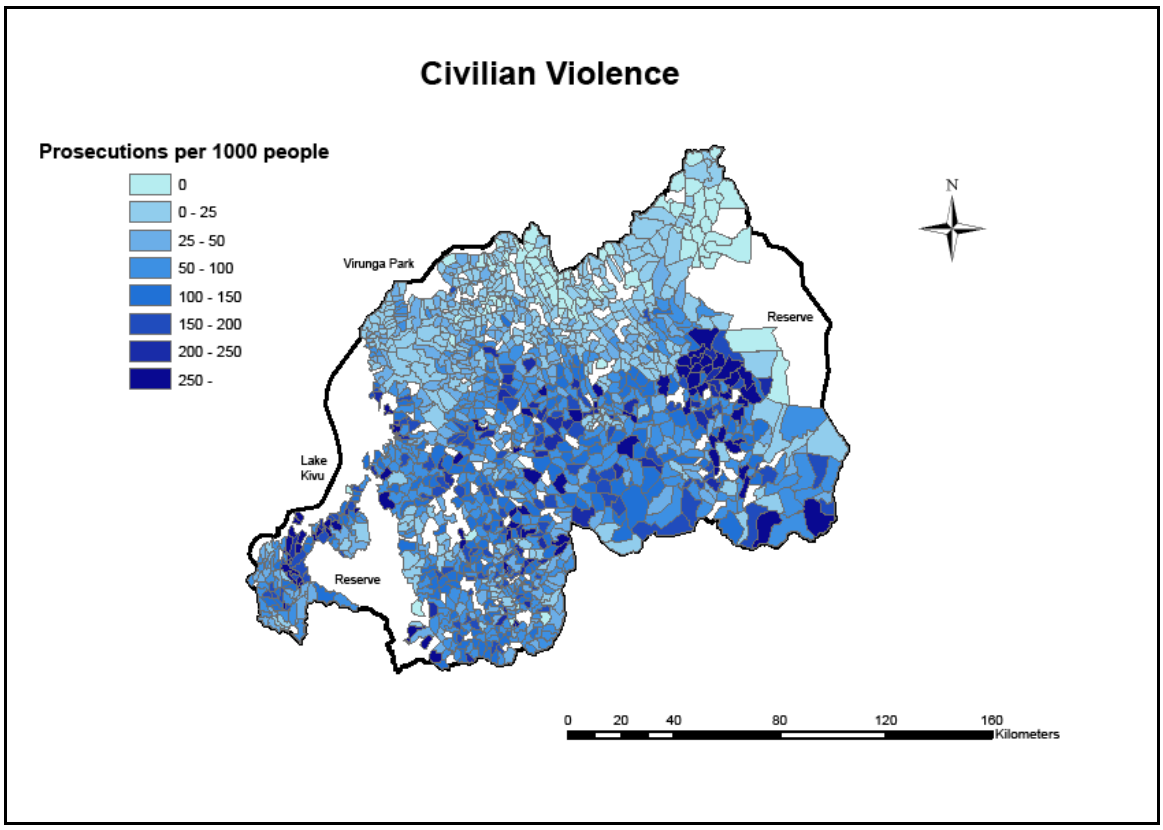

Figure 8. Civilian Violence. White areas are no data areas, either because of Lake Kivu, Natural Reserves, or villages that are missing due to unmatchable data issues.

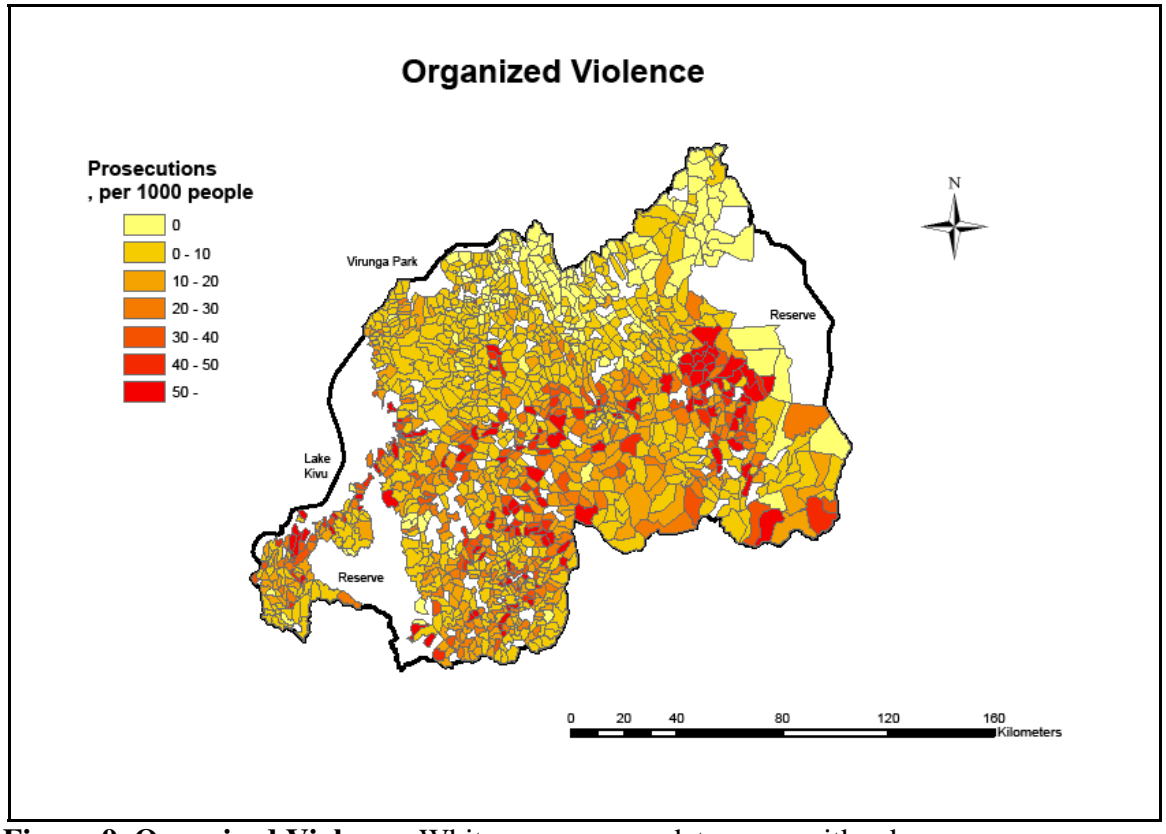

Figure 9. Organized Violence. White areas are no data areas, either because of Lake Kivu, Natural Reserves, or villages that are missing due to unmatchable data issues.

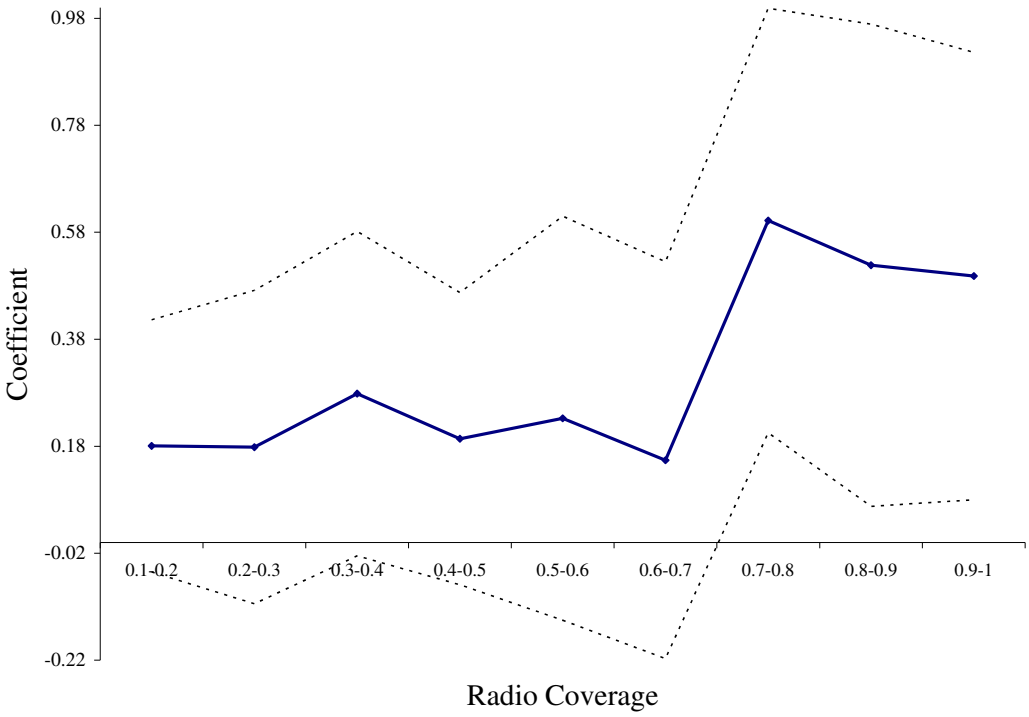

Figure 10. Scale Effects, Total Violence

Table 1. Summary Statistics

Variable	Observations	Mean	Std. Dev.
Dependent Variables			
Participation Rate, Total	1105	.084	.070
Participation Rate, Civilian	1105	.072	.060
Participation Rate, Organized	1105	.013	.016
Independent Variables			
Radio Coverage	1105	.189	.226
Altitude, Mean	1105	1.713	.229
Altitude, Variance	1105	9208.3	10531.6
Distance to Transmitter	1105	5.171	2.841
Distance to Major Town	1067	.200	.120
Distance to Major Road	1071	.058	.052
Distance to the Border	1074	.217	.127
Village Area	1105	15.07	44.6
Hutu Literacy Rate	1105	.503	.056
Hutu Primary Education	1105	.579	.060
Tutsi Minority Size	1105	.098	.085
Population	1105	4846.7	2456.5
Population Density	1105	.528	.868

The dependent variables are violent crimes prosecutions divided by the village population in 1991; *Organized Violence* is crime category 1 prosecutions against organizers, leaders, army and militia; *Civilian Violence* is crime category 2 prosecutions for homicides, attempted homicides and serious violence. *Total* is the combined Civilian and Organized. *Radio Coverage* is the share of the village area that has RTLM reception. *Altitude, Mean* is the mean altitude in the village in kilometers. *Altitude, Variance* is the village variance in altitude in meters, *Distance to Transmitter* is the distance in kilometers to the nearest RTLM transmitter. The other distance variables are measured in decimal degrees. *Hutu Literacy Rate* is the fraction of Hutu household heads in the commune that are literate. *Hutu Primary Education* is the fraction of Hutu household heads in the commune that have at least some primary education. Education and literacy data are taken from the 1991 Census, available only at the commune level. There are 129 communes in the sample, and approximately 8.6 villages per commune. *Population* is the population number in the village and *Population Density* is 1000 people per square kilometers, also from the 1991 Census.

Table 2. Exogeneity Check

Dependent Variable	Population Density, 1991		Population, 1991		Village Area, km^2		Distance to Major Town		Distance to Major Road		Distance to the Border	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	level	log	level	log	level	log	level	log	level	log	level	log
Radio Coverage	0.240	0.177	-557.32	-0.047	-28.484	-0.224	0.006	0.096	-0.012	-0.233	0.001	0.091
	[0.352]	[0.205]	[766.21]	[0.094]	[31.305]	[0.191]	[0.010]	[0.112]	[0.010]	[0.212]	[0.011]	[0.146]
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Commune FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	1105	1105	1105	1105	1105	1105	1067	1067	1071	1071	1074	1074
R-squared	0.44	0.42	0.42	0.45	0.18	0.56	0.95	0.90	0.81	0.70	0.96	0.92
P-value of Radio Coverage	0.496	0.389	0.468	0.618	0.365	0.243	0.528	0.390	0.234	0.275	0.957	0.535

Radio Coverage is the share of the village area that has RTLM radio coverage. The controls are: A second-order polynomial in village mean altitude, altitude variance, and a second-order polynomial in the distance to the nearest transmitter.
Robust standard errors in parentheses, clustered at the commune level. There are 129 communes in the sample. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Main Effects

Dependent Variable	*Log(Participation Rate) Total Violence*			*Log(Participation Rate) Civilian Violence*		*Log(Participation Rate) Organized Violence*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Radio Coverage	-0.717 [0.260]***	0.571 [0.229]**	0.561 [0.244]**	0.520 [0.229]**	0.501 [0.246]**	0.559 [0.294]*	0.572 [0.288]**
Log(Population Density)			-0.127 [0.071]*		-0.120 [0.071]*		-0.101 [0.082]
Distance to Major Town			1.019 [1.534]		1.224 [1.526]		-0.518 [1.768]
Distance to Major Road			-2.791 [1.548]*		-2.646 [1.554]*		-4.527 [1.810]**
Distance to the Border			1.910 [1.317]		2.150 [1.366]		0.198 [1.625]
Controls	N	Y	Y	Y	Y	Y	Y
Commune FE	N	Y	Y	Y	Y	Y	Y
N	1105	1105	1066	1105	1066	1105	1066
R-squared	0.02	0.62	0.63	0.61	0.62	0.51	0.52

Participation Rate is the number of violent crimes prosecutions per capita; *Total Violence* is the sum of *Civilian* and *Organized Violence*, *Organized Violence* is crime category 1 prosecutions against organizers, leaders, army and militia; *Civilian Violence* is crime category 2 prosecutions for homicides, attempted homicides and serious violence. *Radio Coverage* is the share of the village area that has RTLM radio coverage. The radio propagation controls are: A second-order polynomial in village mean altitude, village altitude variance, and a second-order polynomial in the distance to the nearest transmitter. Robust standard errors in parentheses, clustered at the commune level. There are 129 communes in the sample.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Ethnic Polarization

Dependent Variable	*Log(Participation Rate) Total Violence*		*Log(Participation Rate) Civilian Violence*		*Log(Participation Rate) Organized Violence*	
	(1)	(2)	(4)	(5)	(6)	(7)
Radio Coverage	0.932 [0.303]***	0.936 [0.325]***	0.849 [0.301]***	0.834 [0.325]**	0.870 [0.379]**	0.922 [0.369]**
Radio Coverage x High Ethnic Polarization	-0.972 [0.411]**	-0.972 [0.427]**	-0.884 [0.412]**	-0.864 [0.430]**	-0.839 [0.619]	-0.907 [0.614]
Log(Population Density)		-0.126 [0.070]*		-0.118 [0.070]*		-0.100 [0.081]
Distance to Major Town		0.845 [1.509]		1.069 [1.504]		-0.681 [1.738]
Distance to Major Road		-2.736 [1.528]*		-2.598 [1.537]*		-4.475 [1.789]**
Distance to the Border		1.824 [1.296]		2.073 [1.346]		0.118 [1.613]
Controls	Y	Y	Y	Y	Y	Y
Commune FE	Y	Y	Y	Y	Y	Y
N	1105	1066	1105	1066	1105	1066
R-squared	0.62	0.63	0.61	0.62	0.51	0.52

Participation Rate is the number of violent crimes prosecutions per capita; *Total Violence* is the sum of *Civilian* and *Organized Violence*, *Organized Violence* is crime category 1 prosecutions against organizers, leaders, army and militia; *Civilian Violence* is crime category 2 prosecutions for homicides, attempted homicides and serious violence. *Radio Coverage* is the share of the village area that has RTLM radio coverage. The radio propagation controls are: A second-order polynomial in village mean altitude, the village altitude variance, and a second-order polynomial in the distance to the nearest transmitter. Robust standard errors in parentheses, clustered at the commune level. There are 129 communes in the sample.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Scale Effects

Dependent Variable	*Log(Participation Rate) Total Violence*	*Log(Participation Rate) Civilian Violence*	*Log(Participation Rate) Organized Violence*
	(1)	(2)	(3)
Radio Coverage, 0.1 - 0.2	0.181	0.163	0.346
	[0.119]	[0.119]	[0.121]***
Radio Coverage, 0.2 - 0.3	0.178	0.180	-0.004
	[0.148]	[0.143]	[0.145]
Radio Coverage, 0.3 - 0.4	0.278	0.281	0.147
	[0.153]*	[0.158]*	[0.149]
Radio Coverage, 0.4 - 0.5	0.194	0.196	0.115
	[0.138]	[0.137]	[0.216]
Radio Coverage, 0.5 - 0.6	0.232	0.227	-0.005
	[0.191]	[0.199]	[0.199]
Radio Coverage, 0.6 - 0.7	0.154	0.169	0.171
	[0.187]	[0.178]	[0.320]
Radio Coverage, 0.7 - 0.8	0.602	0.559	0.594
	[0.201]***	[0.205]***	[0.285]**
Radio Coverage, 0.8 - 0.9	0.518	0.429	0.855
	[0.228]**	[0.239]*	[0.288]***
Radio Coverage, 0.9 – 1	0.498	0.381	0.810
	[0.211]**	[0.189]**	[0.390]**
Controls	Y	Y	Y
Commune FE	Y	Y	Y
N	1105	1105	1105
R-squared	0.62	0.61	0.52

Participation Rate is the number of violent crimes prosecutions per capita; *Total Violence* is the sum of *Civilian* and *Organized violence*, *Organized Violence* is crime category 1 prosecutions against organizers, leaders, army and militia; *Civilian Violence* is crime category 2 prosecutions for homicides, attempted homicides and serious violence. *Radio Coverage* is the share of the village area that has RTLM radio coverage. The radio propagation controls are: A second-order polynomial in village mean altitude, village altitude variance, and a second-order polynomial in the distance to the nearest transmitter.
Robust standard errors in parentheses, clustered at the commune level. There are 129 communes in the sample.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6. Ability to Access Independent Information

Dependent Variable	*Log(Participation Rate) Total Violence*			
	(1)	(2)	(3)	(4)
Radio Coverage x Low Hutu Literacy	1.499	1.549		
	[0.582]**	[0.602]**		
Radio Coverage x Medium Hutu Literacy	0.535	0.484		
	[0.323]*	[0.355]		
Radio Coverage x High Hutu Literacy	-0.013	-0.042		
	[0.308]	[0.321]		
Radio Coverage x Low Hutu Education			0.855	0.811
			[0.473]*	[0.480]*
Radio Coverage x Medium Hutu Education			0.824	0.980
			[0.329]**	[0.366]***
Radio Coverage x High Hutu Education			0.015	-0.139
			[0.337]	[0.364]
Log(Population Density)		-0.122		-0.128
		[0.071]*		[0.070]*
Distance to Major Town		0.963		0.971
		[1.513]		[1.536]
Distance to Major Road		-2.592		-2.821
		[1.526]*		[1.541]*
Distance to the Border		2.178		2.011
		[1.299]*		[1.304]
Controls	Y	Y	Y	Y
Commune FE	Y	Y	Y	Y
N	1105	1066	1105	1066
R-squared	0.62	0.63	0.62	0.63

Participation Rate is the number of violent crimes prosecutions per capita; *Total Violence* is the sum of *Civilian* and *Organized violence*, *Organized Violence* is crime category 1 prosecutions against organizers, leaders, army and militia; *Civilian Violence* is crime category 2 prosecutions for homicides, attempted homicides and serious violence. *Radio Coverage* is the share of the village area that has RTLM radio coverage. The radio propagation controls are: A second-order polynomial in village mean altitude, village altitude variance, and a second-order polynomial in the distance to the nearest transmitter. The other variables are described in the data section. Robust standard errors in parentheses, clustered at the commune level. There are 129 communes in the sample.
* significant at 10%; ** significant at 5%; *** significant at 1%