Propaganda and Conflict: Theory and Evidence From the Rwandan Genocide

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Abstract

This paper investigates the impact of propaganda on violent conflict. It examines the effects of the infamous "hate radio" station RTLM that before and during the 1994 Rwanda Genocide called for the extermination of the Tutsi ethnic minority population. It develops a simple model of participation in ethnic violence, where ethnic majority members with radio receive a noisy public signal about the net benefits of violence. It then tests a set of empirical predictions using a nation-wide village-level dataset on Radio RTLM coverage and prosecutions for genocide violence. To identify causal effects, it exploits arguably exogeneous variation in radio coverage generated by hills in the line-of-sight between radio transmitters and villages. The results show that the broadcasts increased participation in the violence and that the effects were: decreasing in ethnic polarization; highly non-linear in radio coverage; and decreasing in literacy rates. The results are consistent with the model under strategic complementarities in conflict, but inconsistent under strategic substitutes. They suggest that the radio station caused more violence partly because it functioned as a coordination device. Finally, the estimated effects are substantial. Full village radio coverage increased participation in violence by 65 to 77 percent, and approximately 9.3 percent of the genocide is explained by the radio station.

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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 of approximately 75% of the country's Tutsi population (des Forges, 1999).[1] While much of the violence was organized by the army and local militia groups, the high intensity of the killings was largely achieved by mass participation by hundreds of thousands ethnic majority Hutu citizens (des Forges, 1999; Straus, 2004) using mainly machetes and clubs as weapons (Verwimp, 2006). Given the large-scale participation and human lives lost, understanding the determinants of the genocide is of great importance. The principal aim of this paper is to examine one factor widely believed (BBC, 2003; Thompson, 2007) to have played a crucial role in the genocide: propaganda.

Specifically, the paper estimates the impact of the propaganda spread by the infamous "hate radio" station Radio Télévision Libre des Mille Collines (RTLM). Founded as a semi-private station by extremist Hutu politicians, it was viewed as an important tool by the government as it was publicly announced by the Prime Minister as "one of the key weapons in the war" (Kimani, 2007). Starting the broadcasts ten months before the genocide, the station claimed that pre-emptive violence was a necessary response of self-defense to Tutsi political domination, and explicitly called for the extermination of the Tutsi ethnic group (ICTR, 2003). Despite common claims that the radio station was one of the key factors contributing to the mass violence (Chrétien et al., 2005; Thompson, 2007), no study has quantitatively estimated the effects of Radio RTLM broadcasts on participation in the genocide.[2] Therefore,

[1] There were also a significant amount of moderate Hutus that were killed. The total number of deaths in respective ethnic group, as well as the population levels of the ethnic groups are not uncontroversial. For discussions on the death tolls, see des Forges (1999) and Verpoorten (2005).

[2] Straus (2007) interviewed 210 sentenced and self-confessed perpetrators, sampled from fifteen prisons nationwide. On the question "Did the radio lead you to take part in the attacks?", 85 percent of respondents

the main questions asked in this paper are: Did Radio RTLM have a causal impact on participation in the genocidal violence? If so, what were the mechanisms? How much of genocidal violence can be explained by the broadcasts?

In order to understand the determinants of participation in violence and the mechanisms by which propaganda can affect an individual's willingsness to participate, the paper first sets up a simple model of participation in ethnic violence. The model adopts the global games framework (Carlsson and van Damme, 1993; Morris and Shin, 1998) and has three basic features. First, ethnic majority members considering whether to participate in the violent attack face some uncertainty about the fundamental value of conflict, but each member has access to independent information that is used to form beliefs about it. Second, a fraction of the ethnic majority members have access to radio broadcasting a noisy signal about the benefits. A key feature of the radio broadcasts is that they are *public* among those that receive them. That is, there is common knowledge about the broadcasts among them, which implies that everybody with access to the radio station knows that everybody else that are receiving the broadcasts are receiving the same broadcasts. Third, there are potential strategic aspects of participation in violence. In particular, participation in violence may be subject to either strategic complementarities or strategic substitutes.[3] Under strategic complementarities, the benefits of participation increases in the number of participants joining the attack, so that the more members in the village that participate, the more willing is each individual to participate in the violence. Under strategic substitutes, the opposite relationship holds, where participation is less beneficial if many others participate.

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 expectations individuals hold about the fundamental value of conflict. Second, and more interestingly, by changing the expectations individuals hold about whether others will participate. This mechanism implies that if there are significant strategic complementarities in violence, such that most individuals only participate if they expect that many others also will, then propaganda will function as a *coordination device.* The insight

said "no" and 15 percent said "yes". He finds that the perpetrators who said "yes" were significantly more likely to commit more violence and to be leaders of the killings than those who said "no".

[3]Due to the global games framework, the equilibrium is unique under some regularities conditions. A novel deviation from the standard framework is that is that only a fraction of the population receives the (semi) public signal. This requires some additional restrictions on what individuals without the public signal know.

is that this can lead to large-scale participation if sufficiently many individuals are receiving the propaganda.

The model delivers a set of testable predictions where the degree of village radio coverage will affect the village participation rate. In particular, it delivers predictions that allows the data to disentangle whether participation in ethnic violence is free from strategic considerations, subject to strategic complementarities, or subject to strategic substitutes. A contribution of the paper, in addition to estimating the impact of Radio RTLM on participation in the genocide violence, is therefore to shed light on the mechanisms driving ethnic violence.

In order to measure the main variables of the model, the paper combines data from several sources. First, as a proxy for participation rate, it uses a nation-wide village-level dataset on prosection rates for violence during the genocide. The prosecution data has two judicial categories; organized violence (mainly militia) and civilian violence.[4]

Second, the paper uses village-level data on predicted Radio RTLM coverage. The variable is constructed in several steps. First, it uses information on locations and technical specifications of Radio RTLM transmitters. It then predicts the radio coverage across the country by using digital topographic maps and radio propagation software developed by engineers.[5] The software produces a radio coverage map at a 90 meter cell resolution, indicating whether each cell has radio coverage or not. Using a digital map of village boundaries, the radio coverage variable is then defined as the share of the village area predicted to have radio coverage.[6] Additional data on village covariates is collected from the 1991 Rwanda Census and the Africover database. The matched dataset contains data on 1105 villages.[7]

To identify causal effects of radio coverage, the empirical strategy exploits arguably ex-

[4]The prosecution data comes from the local level *Gacaca* courts. The court system was set up in 2001 to process the hundreds of thousands of individuals accused for crimes committed during the genocide. Since the prosecution rate is used as a proxy for the participation rate, there will be measurement error in the dependent variable. It is worth noting that this will not lead to biased estimates unless the measurement error is correlated with the exploited variation in radio coverage.

[5]The algoritm is called ITM/Longley-Rice, and is typically used by radio and TV engineers assessing the signal strength of broadcasts.

[6]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. Also, as there is no available nation-wide village-level data on Radio RTLM listening rates, the paper estimates the reduced form effect of RTLM radio coverage on the participation rate.

[7]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.

ogenous variation generated by Rwanda's highly varying topography of hills and valleys. By using highly 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.[8] In order to examine the validity of the identification strategy, the paper first tests whether a set of pre-genocide village characteristics are correlated with the exploited variation in radio coverage. The tests find no significant correlations, which lends credibility to the identification strategy.

The results show substantial effects of the Radio RTLM broadcasts on violence participation. The estimates imply that when a village has full radio coverage, compared zero radio coverage, civilian violence increased by 65 percent and organized militia violence by 77 percent. Furthermore, the paper presents evidence of strategic complementarities. First, the effects are driven entirely by villages where the Hutu ethnic group was large relative to the Tutsi ethnic minority, which is only consistent with the model under strategic complementarities. Second, as predicted by the model under strategic complementarities, the estimated effects are highly nonlinear in the degree of radio coverage as violence increases sharply 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 by which the broadcasts increased violence was in part because it functioned as a *coordination device*.

Furthermore, the model predicts that access to independent information can mitigate the propaganda effects. It tests this prediction by 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 higher ability to access independent information mitigated the propaganda effects, as there is no effect of radio coverage in villages in the tertile with the highest literacy rates and highest levels of primary education.

To assess how much of the genocide that can be explained by the violence, it conducts

[8]There are 129 communes in the sample. The use of this method to examine media effects in social science 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.

a simple counter-factual calculation implying that the Radio RTLM cause approximately 9.3% of the genocidal violence.[9] The results therefore suggest that Radio RTLM was a quantitatively important causal factor in the genocide.

This project makes several contributions to the existing literature. First, it contributes to the literature on the determinants of the genocide (e.g., Verwimp 2005; 2006, Straus, 2007). It adds to this literature by presenting novel evidence on the causal effects of Radio RTLM. Second, the Rwanda genocide may be extraordinaty grim, but forms only part of the wider phenomenon of civil war and conflict. Since 1960, one third of all nations have experience civil war and one fifth have seen episodes of more than 10 years of civil war (Blattman and Miguel, 2009). This paper adds an important piece to the understanding of why people participate in civil conflict in general. A large share the existing literature focuses on the economic determinants of conflict (For an overview, see Blattman and Miguel, 2009). Within this literature, this paper is most closely related to the study of ethnic mobilization and violence (Bates, 1986; Fearon and Laitin, 1996).

The contribution is two-folded. On the theoretical side, it contributes by allowing for a micro-founded model with both strategic complementarities as well as strategic substitutes. The work-horse model to study determinants of group violence (including ethnic) is the contest model (Haavelmo, 1954; Hirshleifer, 1988). By assuming unitary actors, the contest model ignores the participation problem at the individual level. Although the model presented in this paper is simple, it derives a unique equilbrium under both forms of strategic considerations and adds some key insights into how information can affect beliefs as well as participation. Importantly, the empirical results are consistent with strategic complementarities in violence, and inconsistent with strategic substitutes. To the best of the author's knowledge, this is a novel finding.

On the empirical side, robust micro-evidence on the causal determinants of civil conflict is scarce. 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. A small but growing literature has used within-country regional data to identify factors that determine the intensity of civil violence (e.g., Murshed and Gates, 2005; Dube and Vargas ,2007; Do and Iyer, 2007; Jha 2008). This

[9]This is substantial considering that the radio signal was only receivable in about 20 percent of the country.

paper sheds light on the importance of information and beliefs, which so far has been poorly understood.

Finally, the paper adds to the literature on media effects within political economy. 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 has been studied at least since Lazarfeld et al. (1954). This literature concluded "minimal effects" of mass media, but a recent literature using modern methods to address endogeneity concerns finds significant effects. This includes effects on voting behavior (Gentzkow, 2006; Della Vigna and Kaplan, 2007; Gerber et al., 2009; Chang and Knight, 2008), accountability and policy (Besley and Burgess, 2002; Stromberg, 2004; Eisensee and Stromberg, 2005), and political knowledge and beliefs (Gentzkow and Shapiro, 2004; Snyder and Stromberg, 2008). This paper adds to the media literature in political economy by presenting novel evidence showing that severly biased mass media can persuade individuals into what is arguably the most extreme political acts of them all: killing members the political opposition.

The paper is organized as follows. Section 2 provides the background to the genocide and RTLM propaganda; section 3 present the model; section 4 explains the empirical strategy; section 5 describes the data and the specifications; section 6 presents results; and section 7 concludes.

2 Background

2.1 A Brief History of the 1994 Rwanda Genocide

In order to understand the historical relationship between the two ethnic groups and the pre-existing political tensions before the genocide, this section is aimed at giving a brief background of the genocide.[10]

When Belgium received control of Rwanda after the First World War (previously a German colony) on a mandate by the UN, existing ethnic cleavages were reinforced by a range

[10]The United Nations definition of genocide is "any of the following acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group, as such: killing members of the group; causing serious bodily or mental harm to members of the group; deliberately inflicting on the group conditions of life, calculated to bring about its physical destruction in whole or in part; imposing measures intended to prevent births within the group; [and] forcibly transferring children of the group to another group."

of policies favoring the ethnic minority Tutsi group that lasted until the years before independence (Prunier, 1995). Between 1959 and 1961 there was a complete reversal of power, supported by the Belgians, called the "Hutu Revolution", where the monarchy was abolished, and a series of killings of Tutsis lead to approximately 10,000 deaths and 120,000 fleeing to neighboring countries (Waller, 1993). Independence followed in 1962 with Hutu elites in power. Some Tutsi refugees tried to reclaim power by unsuccessfully doing raids into Rwanda in 1963, but this was followed by persecutions of Tutsis where practically all Tutsis in political positions in Rwanda were killed and some 236,000 fled the country as refugees.

A period of relative stability then followed, but in 1972 large-scale killings of approximately 200,000 Hutus took place in neighboring Tutsi-ruled Burundi, leading to reprisal killings of Tutsis in Rwandan schools and another wave of Tutsi emigration. In the middle of this period of violence and instability, the young and brutal military leader Juvénal Habyarimana managed to seize power in a coup in July 1973. Violence against Tutsis came to a halt, and promises of uniting the nation had the Tutsis welcoming Habyarimana as a saviour. However, the uniting took a form of a one-party state, ethnically segregated with a system of quotas for education an all public positions, built on the 90 percent majority of Hutus, leading to one of the most rigidly controlled countries in the world at the time.

In October 1990, a rebel army invaded Rwanda from Uganda. The rebels, of the Rwandan Patriotic Front (RPF), was representing the refugees that had fled during the "Hutu Revolution" and demanded amongst several things an end to the ethnically unbalanced policies and presented itself internationally as a democratic multi-ethnic movement trying to overthrow a corrupt regime. The rebel army of about four thousand well-trained troops consisted mostly of second-generation Rwandan refugees that had gained experience from having been in Uganda's National Resistance Army (NRA) that seized power in Uganda in 1986. It was after it had been decided that Rwandan refugees were to be excluded from owning land in Uganda, that the decision to invade Rwanda and to regain the right of citizenship was taken.

In April 1992 a transitional multi-party government was formed and after periods of negotiations and unrest with the RPF, a peace agreement was finally signed in Arusha on August 4th, 1993. With sparse resources and a weak mandate, United National peacekeeping forces were to facilitate the installation of the transitional government, but after periods of violence and unrest, postponed installations, President Habyarimana's jet was

shot down (still unknown who did it) on April 6th 1994. Within days, extremists within Hutu-dominated political parties had managed to take over the most important positions of government, and the genocide started through out the country shortly thereafter.

The killings were in no way spontaneous. Due to a highly organized command structure and that Hutu extremists who had been talking and planning for the "final solution" for years seized political power in a coup d'etat, the killings started within hours where the regime were active in all parts of the government branches, 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, as well as ordinary civilians (Prunier, 1995).

The genocide ended in late July 1994 when the RPF defeated the Rwandan army and militias forces, after approximately 800,000 Tutsis had been killed, and where about 130,000 had managed to survive by hiding and taking refuge (Prunier, 1995).

2.2 Radio RTLM

Radio RTLM started broadcasting in July 1993, and was set up as a private company by a group of Hutu politicians, while receiving strong support by President Habyarimana (Des Forges, in Thomson). The broadcasts continued throughout the genocide, and it was only after the RPF rebels manage to take control of the country in mid-July that broadcast and Tutsi killings ended. Two radio transmitters were installed in 1993, one placed in the middle of the capital Kigali, and the other one in the Northwestern part of the country on one of the country's highest mountain, Mount Muhe. Compared to the only other national radio station in the country, the government owned Radio Rwanda, it quickly became popular as it aired western-style talk shows and played the latest music, especially popular Congolese songs, while Radio Rwanda was still broadcasting old standard songs. However, it did not only play music. It also engaged in ethnic stereotyping that promoted hatred against the Tutsi population, such as highlighting inherent differences between Hutu and Tutsi, that Tutsis were not to be considered Rwandan citizens, stressing the disproportionate share of wealth held by Tutsis, and the horrors of past Tutsi rule before independence. Both official authorities such as politicians as well as journalists would be heard on the talk shows.

Moreover, the main enemy in the broadcasts was identifying as the RPF rebel group and their accomplices. Most importantly,.RPF accomplices were effectively equated with

all members of the Tutsi ethnic groups (ICTR, 2005). The radio station systematically called upon Hutus to be aware of Tutsi plots and forecoming attacks, and encourage Hutus to prepare to defend themselves against the Tutsi enemy (Des Forges, in Thomson). The general message before the genocide was therefore to promote fear and an expectation of an armed insurrection by Tutsi members.

Once the genocide had started after the Hutu President Habyarimana was killed on April 6th, the intensity of the inflammatory propaganda increased as broadcasts during the genocide explicitly called for the extermination of the Tutsi ethnic group. In some occasions the station directly named specific targets and families to be attacked, and after receiving reports of successful killings the station would congratulated the killers (Des Forges, in Thomson) Moreover, Kimani (Thomson, eds) estimates that approximately 24 percent of the airtime dedicated to inflammatory statements consisted of allegations that Tutsis in the region were involved in conspiring in the war. The United Nations International Criminal Tribunal for Rwanda later convicted the individual responsible for the RTLM broadcasts, and summarized its role by the following statement:

> *"The radio explicitly and repeatedly, in fact relentlessly, targeted the Tutsi population for destruction... the media called for the extermination of the Tutsi ethnic group as a response to the political threat that they associated with Tutsi ethnicity"*

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 try 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 that listened to the radio station, 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 broadcasts 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. Second, we find the equilibrium and show how propaganda can affect it. 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 individuals is a member of one of two ethnic groups, ethnic majority group H and ethnic minority group T. The population size of group H is normalized to 1, and the size of group T in the village is t. The following 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 excluded from the analysis in order to keep things simple. Therefore, in what follows we focus exclusively on group H members behavior.

The payoff from participating in the attack depends on a fundamental value, θ, which is possibly negative. We may think about θ as the net benefit that depend on a range of factors independent of how many other group H members that participate in the attack, as well as the size of group T. For example, a factor determining θ could be the amount of wealth a group H member would appropriate if he attacked alone, or how much defensive weapons each group T member possesses. In the context of a pre-emptive attack, it would the value associated with the advantage of attacking group T first, compared to the alternative of being attacked by group T and defend.

In addition to the fundamental value, we allow the payoff from participating in violence to exhibit strategic complementarities or strategic substitutes. Under strategic complementarities, 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 complementarities 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, which lowers the individual opportunity cost; or, other members' participation is a substitute to investment in costly weapons. 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

would be strategic substitutes in violence.

Similarly, we allow the payoff from the having more members participate in the attack h to depend on the group size of the defending group, t. Specifically, to get a simple 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 complemenetarities in violence, $\alpha > 0$. If there are strategic substitutes in violence, $\alpha < 0$. When there are no strategic considerations to participation, $\alpha = 0$. 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 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 know with complete certainty in most cases of violent conflict. In this section, we decribe 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 think of 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 think of a lower σ_x representing having access to multiple sources of information, or access to information sources of high quality.

Furthermore, 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 $p = \theta + b$ is broadcasted through the radio,

where b is distributed normally with mean zero and variance σ_p^2.[11] Key to the model is that 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 the fraction r of the other village members listens to the radio and receives signal y, 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. In order to focus on the choices of majority members that receive the radio broadcasts and keep the analysis tractable, we make the simplifying assumption that members without radio are unaware about 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 receive 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

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

where $j = N$ labels the strategy for members without radio and $j = R$ for members with radio. That is, a member participates if the expectation of the fundamental value of violence

[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. For a model with endogenous information manipulation in a civil war context, see Edmond (2009).

[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 $\frac{\sigma_x^2 \sigma_p^2}{\sigma_x^2 + \sigma_p^2}$.

is sufficiently high, above some threshold κ^j. Following Morris and Shin (1998, 2005), this strategy is unique under some regularity conditions (see 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

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

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. 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 sure about how many other members that 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 that are likely to hold expectations of θ above the participation threshold κ^N. The higher expectation a member holds of the fundamental value of conflict, $\bar{\theta}_i^N$, the more other members he therefore expects to participate. The equilibrium condition of equation 1 pins down the expectation $\bar{\theta}_i^N$ where a member is indifferent between participating or 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 intution 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-folded. 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

[14]The regularity conditions require that α is bounded from above and below. The bounds are found in the Appendix.

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 to participate or not. 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 received p too, which can dramatically changes his expectations about how others will behave, and therefore 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.

3.3.1 Equilibrium Participation in Violence

Having pinned down the equilibrium lower bounds on the expectation members must hold in order to participate in violence, 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 member 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 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 only if radio broadcasts a*

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

signal that the fundamental value is sufficiently high, does ; $\partial h/\partial r > 0$ for all r, only if $p > \tilde{p} \equiv -\frac{\alpha}{2t}$. Radio coverage affects participation through two effects. First, through a direct "fundamentals effect" that changes the share of the population with beliefs about the fundamental 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

See Appendix A for the proof. First, 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 radio broadcasts that the fundamental value of conflict is sufficiently high (above the participation thresholds) will a larger fraction of the members with radio will 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 knows that everybody with radio listens to the same broadcasts. When radio coverage increases, 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 depends crucially on whether participation in conflict is subject to strategic complementarities or strategic substitutes. Under strategic complementarities the effect is positive, whereas under strategic substitutes the effect is negative. Under strategic complementarities, 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 compared to when radio coverage 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.

Moreover, as long as radio broadcasts a signal that the value is sufficiently high, participation increases inititally with radio coverage regardless of strategic complementarities or strategic substitutes. This is because the fundamentals effect is always positive when radio coverage approaches zero, while the strategic effect becomes negligable. How participation is affected at high levels of radio coverage, however, depends crucially on whether participation in conflict is subject to strategic complements or strategic substitutes. Next, we derive the properties of participation in violence in the three cases possible: no strategic considerations, strategic complementarities, and strategic substitutes.

3.3.2 Benchmark Case: $a = 0$

In this section, we derive the properties for the benchmark case when α is zero and participation in violence is free from no strategic considerations.

Proposition 1 ***No Strategic Components*** *($\alpha = 0$): If $p > \tilde{p}$, then $\partial h/\partial r = \bar{c} > 0$ and $\partial h/\partial r \partial t = 0$, where $\bar{c}$ is a constant.*

See Appendix for the proof. 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, an member participates if his expectation of the fundamental value of participation is positive. Therefore, radio coverage affects participation only through the *fundamentals effect* by increasing the share of the population holding expectations of the fundamental value of conflict above zero. As this fraction is constant within the group of membera that have radio coverage, the fundamentals effect of radio coverage is linear and positive.[16]

3.3.3 Strategic Complementarities Case: $a > 0$

In this section, we derive the properties for the case when α is positive and participation in violence is subject to strategic complementarities.

Proposition 2 ***Strategic Complementarities*** *($\alpha > 0$): If $p > \tilde{p}$, radio coverage exhibits increasing scale effects; $\partial h/\partial r > 0$ for all r, $\partial^2 h/\partial r^2 > 0$ for $r \in [0, \tilde{r}]$ and $\partial^2 h/\partial r^2 < 0$*

[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 result go in the opposite direction, so that participation is decreasing in radio coverage if $p < \tilde{p}$.

for $r \in (\tilde{r}, 1]$, *where* $0 < \tilde{r} \leq 1$. *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.*

For the proof, see Appendix A. The reason why radio coverage exhibits increasing scale effects under strategic complementarities is due to the combination of *fundamentals effect* and the *strategic effect*. In particular, both of the effects are positive. As radio coverage increases, the fundamentals effect imply 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 partipation threshold. This effect, therefore, 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 complementarities.[17] To clearly see the importance of the strategic effects, the parameter values are set such that 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 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 knows that many has received the radio broadcasts and therefore 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 importantly 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

[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.

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, as the marginal benefit of more participants is lower when the ethnic minority is large (e.g. because the expected defense is higher 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.

3.3.4 Strategic Substitutes Case: $a < 0$

In this section, we derive the properties for the case when α is negative and participation in violence is subject to strategic substitutes.

Proposition 3 ***Strategic Substitutes*** *($\alpha < 0$):* *If $p > \tilde{p}$, the participation rate increases initially with radio coverage; $\partial h/\partial r > 0$ for $r \in [0, \tilde{r}]$, where $0 < \tilde{r} \leq 1$. Radio coverage exhibits decreasing scale effects; $\partial^2 h/\partial r^2 < 0$ for $r \in [0, \hat{r}]$, where $0 < \hat{r} \leq 1$. 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 $0 < \hat{r} \leq 1$. If $\hat{r} < 1$, the sign of $\partial h/\partial r \partial t$ for $r > \hat{r}$ is ambiguous.*

For the proof, see Appendix A. When radio coverage is low, the positive fundamentals effect dominates the negative strategic effect. The participation rate therefore increases initially with radio coverage. However, due to the negative strategic effect, the increase in participation is lower when radio coverage is high which gives rise to decreasing scale effects. Under strategic substitutes, the total payoff of participation is lower the more that participates. At low levels of radio coverage, members with radio hold high expectations about the fundamental value of conflict (fundamentals effect), but since not very many others have receives the radio broadcasts, members with radio do not believe that many others will participate. When radio coverage is high, however, members with radio knows that many have receive the radio broadcasts and therefore expect higher participation. Expecting many others to participate, each member finds it less worthwhile to participate.

Figure 1A graphically shows the importance of negative strategic effects. The figure shows how the participation rate changes as a function of radio coverage, for the benchmark

case and three different levels of strategic substitutes.[18] The figure plots the benchmark case where the increase is participation is due to fundamental effects only. When the degree of strategic substitutes is low, we see that the effect is close the the benchmark case and nearly linear. When the degree of strategic substitutes is high, participation increases initially but the effects are close to zero at higher levels of radio coverage. The intuition behind this result is that at when radio coverage increases to higher levels, most individuals with radio expect knows that many others have received the broadcasts and therefore expects many others to participate. Since strategic substitutes imply that the total payoff of participation is lower when many participate, individuals with radio are not very willing to participate. These strategic effects therefore results 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 effect of more participants is higher when the ethnic minority is large, e.g because a larger ethnic minority implies that there are more total wealth that ethnic majority members are fighting for. Therefore, even though members with radio coverage expect relatively many others to participateat at high levels of radio coverage, since the there is relatively much wealth of the ethnic minority still available to fight for, increases in radio coverage increases participation.

3.3.5 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 precise fundamental value of conflict, he uses his independent information to form expectations about it.[19]. Importantly, the effect of radio coverage will crucially depend on how much independent information members have.

Proposition 4 *For any α, when members have access to independent information, the effect*

[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.

of radio coverage disappears; $\partial h/\partial r \to 0$ *for all* r*, when* $\sigma_x \to 0$.

For the proof, see Appendix A. The first results is relatively straightforward. The expectation a members holds about the value of conflict θ, will be a weighted average between independent information, x_i, and the information broadcasted on the radio, p. As members have better independent information about the fundamental value of conflict, the less weight will be put on the radio broadcasts. Therefore, when members through other information sources have very precise expectations about the fundamental value of conflict, they stop believing in the radio broadcast. Consequently, propaganda will in that case not affect participation in the violence.

3.4 Empirical Predictions

We now summarize the results from the previous section and formulate 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 the radio broadcasted 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 the following predictions:

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

a) *decreasing* in ethnic polarization t, only if there are *strategic complementarities,* $\alpha > 0$. (Figure 1B).

b) *increasing* in ethnic polarization t, only if there are *strategic substitutes,* $\alpha < 0$ (Figure 2B).

3. Scale Effects: Radio coverage r exhibits

a) *increasing* scale effects on participation h, only if there are *strategic complementarities,* $\alpha > 0$. (Figure 1A).

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

b) *decreasing* scale effects on participation h, only if there are *strategic substitutes,* $\alpha < 0$ (Figure 2A).

4. Independent information, σ_x: 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 that the data will allow us to disentangle whether α is positive or negative.

4 Data and Empirical Strategy

This section describes the data used for measuring the key variables of interest in the empirical predictions (h, r, t, σ_x). Several sources of data are combined to construct a village-level cross-sectional dataset. The final dataset consists of 1105 matched villages.[21] Figure 3 shows are map of village boundaries.

4.1 Measuring the participation rate, *h*

Unfortunately, there is no dataset available that measures h explicitly. Instead, this paper uses a nation-wide village-level dataset on prosections 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 thousands of individuals accused for crimes committed during the genocide.

There are two violent crime categories. First, 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, this is typically prosecutions committed by local militias such as the Interahamwe and Impuzamugambi. Furthermore, category 2 prosecutions are for civilian violence, defined as:

- Authors, coauthors, accomplices of deliberate homicides, or of serious attacks that caused someone's death.
- The person who - with intention of killing - caused injuries or committed other serious violence, but without actually causing death.
- The person who committed criminal acts or became 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. Figure 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, there is likely some measurement error in the dependent variable. This will not lead to biased estimates unless the measurement error is correlated with the exploited variation in radio coverage.

4.2 Measuring the 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. It then predicts the radio coverage across the country by using digital topographic maps and radio propagation software developed by engineers.[25] The algoritm is called Longley-Rice, and is typically used by radio and TV engineers assessing the signal strength of broadcasts. The software (ArcGIS) uses a digital topographic map of Rwanda, provided by Shuttle Radar Topography Mission (SRTM), and it lets the software run the 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 the predicted radio coverage.[26]

Using the digital map of village boundaries, the measure of r is the share of the village area with radio coverage is calculated. The measured for r is therefore the share of the village area with Radio RTLM 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]

4.3 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 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

[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).

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 households divided by the number of Hutu households in the commune.[30]

Since there are two ethnic groups (98% of the population is 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). We therefore use t and *ethnic polarization* interchangeably hereafter.

4.4 Measuring access to independent information, σ_x

We want to test Prediction 4. However, we cannot measure access to independent information (σ_x) directly, as this is naturally unobservable to the researcher. Instead, we proxy for the access to independent information. Specifically, we proxy with the *ability* to access independent information, by exploiting variation in literacy rates and education.

Access to independent information can of course come from a range of sources. Within the context of the Rwanda genocide this was to a large extent through newspapers. 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 were not aligned with the parties associated with the government, typically political opposition newspapers, during this period was between 30 to 60 (Alexis and Mpambara, 2003; Higiro, 2005). Arguably, a necessary requirement for having access to newspapers is literacy and basic primary education. In addition, Des Forges (1999) reports that in practive not only the literate would read the newspapers, but also that those who knew how to read were accustomed to reading newspapers for others.[31].

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

[30]There are 129 communes in the sample.

[31]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.

household heads that have some primary education.[32] Both variables are only available at the commune level.

4.5 Measuring covariates

The SRTM topography data and ArcGIS software maps allows us to calculate 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 of are presented in Table 1.

4.6 Identification strategy

In this section, the identification strategy is presented.

To identify the causal effects of radio coverage on the participation rate requires that the exploited variation in radio coverage is uncorrelated with all the other determinants of participation. In the model the radio coverage is exogeneous, 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 watts) was placed on Mount Muhe in the northwestern part of the country.[33] 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 the radio coverage and the participation rate would then violate the identifying assumption. Importantly, since both θ and σ_x are unobservable, we cannot controlled for them in a regression.

The following identification strategy addresses this problem in several steps.[34] First, Rwanda is a very hilly country and without any really flat regions. Nick-named "The Land of the Thousand Hills", figure 2 shows a map with the topography of Rwanda. The are literally hill tops and valleys everywhere in the country and the topographic variation shown

[32]The 1991 Census reports "last grade completed" for each household head.

[33]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.

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

in Figure 2 provides the basic foundation for the identification strategy. In particular, the main idea is to exploie variation in radio coverage due to whether there happens to be 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 the transmitter height and transmission power, the two main determinants of the signal strength is: 1) The distance to the transmitter; 2) Whether receiver is in the line-of-sight of the transmitter[35] First, 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 controlling for a second order polynomial in the distance to the transmitter.[36] This will therefore leave variation in signal strength caused by variation in the line-of-sight between the transmitter and the receiver.

Figure 6 graphically shows how radio coverage due to variation in the line-of-sight is determined. Whether receiver is in the line-of-sight of the transmitter will mainly depend on two factors: The topography at the receiver (the higher altitude of the receiver, the higher is the likelihood of 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.

Third, 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*.[37] The exploited variation is radio

[35]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).

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

[37]Commune fixed effects alone explain 82 percent of the variation in village mean altitude, and 72 percent

coverage will therefore be highly local variation across village within communes.[38] This variation is arguably uncorrelated with other determinants of conflict, as radio coverage with be determined by whether a hilltop randomly happens to be in the line-of-sight between the transmitter and the village.

Figure 7 graphically shows 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 that is located approximately 30 km to west, outside the figure. The figures show that within each commune, villages that happen to be situated to the east of hill tops have low radio coverage, while villages that happen to be situated to the east of hill tops have high radio coverage. This is because is this case the signal comes in from the west, and the hilltops are in the line-of-sight to the transmitter. This arguably provides a credible identification strategy, as there is no apparent reason why other unobserved determinants of participation in violence are different across the directions of the hilltops.[39]

4.7 Exogeneity check

If the identification strategy is valid and radio coverage is "as good as randomly assigned", there should be no correlation between the exploited 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.[40] Instead, we test the validity of the exogeneity assumption by using observable village characteristics that are potentially correlated with θ and σ_x. The variables used are the 1991 population density; the 1991 population levels; the distance to the nearest major town; the distance to the nearest major road; the distance to the nearest

of the variation in radio coverage.

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

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

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

border point; and the village area.[41]. 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; 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 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 show the results. None of the village characteristics are significant, and the highest p-value is 0.235. This lends credibility to the identification strategy. In the 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.

4.8 Econometric Specifications

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

4.8.1 Prediction 1: Main Effects

Prediction 1 states: *If radio coverage r increases the participation rate h, then the radio broadcasted 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, it implies that the ethnic majority members perceived the Radio RTLM broadcasts as information that the fundmental value of conflict was high. To test this, we run the following regression[42]

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

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

[42]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.

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.[43] We will also run separate regressions where $h_{c,i}$ is either civilian violence only, or organized violence only. The vector 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; 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 the distance to the neareast border point. According to Prediction 1, if $\beta > 0$ then this is consistent with $p > \tilde{p}$.

4.8.2 Prediction 2: Ethnic Polarization

Prediction 2 states: *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 allows us to separate whether there are *strategic complementarities ($\alpha > 0$)* 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 ethnic minority population in commune c is large, and the other variables are the same as before. 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 $\delta < 0$, then this is only consistent with $\alpha > 0$. If $\delta < 0$, then this is only consistent with $\alpha > 0$.

4.8.3 Prediction 3: Scale Effects

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

[43] 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.

This provides an additional test that allows us to separate whether there are *strategic complementarities* ($\alpha > 0$) 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.

4.8.4 Prediction 4: Independent Information

Prediction 4 states: *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 by 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 the tertile j in the distribution of Hutu literacy rates (or the Hutu primary education level). If η_3 is a sufficiently good proxy for σ_x close to zero, by Prediction 4 we expect $\eta_3 = 0$.

5 Results

In this 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 the genocide violence. The effect is significant at the 5 percent level. Column 3 shows that the point estimate is almost identical when adding additional village covariates. Column 4 shows that RTLM reception has a positive and significant impact on civilian violence, and columns 6 shows significant effects also on organized violence.[44] 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 [45].

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 in violence for villages with full radio coverage ($r = 1$), 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) [46]

Interpreting these results within the framework of the model and Prediction 1, they imply that Radio RTLM broadcasted messages that the value of conflict was high, *and* that Rwandan citizens believed in them. However, the results are consistent with both *fundamentals effects* as well as *strategic effects*. That is, the results presented in Table 3 are not informative about whether the participation increased only due to Hutu citizens updating their beliefs about the fundamental value of participation, or whether it was also because it changed the expectations about how many others that were likely to participate in the killings. In other words, the estimated effects do not necessarily imply either strategic complementarities, or strategic substitutes, in the decision to participate in ethnic violence. Next, we present results that allow us to further understand the underlying mechanisms that can explain why Radio RTLM caused more violence.

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

[45]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.

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

5.2 Ethnic Polarization

The results for the test of Prediction 2 are presented in Table 4. Column 1 and 2 and 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.[47] Interestingly, the estimated coefficients imply that the broadscasts 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.[48]

As given by Prediction 2, the results are only consistent with the model under *strategic complementarities*. Figure 1B graphically shows the how the model, under strategic complementarities, predicts the effects of radio coverage depending on the relative size of the ethnic minority group. The empirical results not only show that the RTLM propaganda was uneffective when the Tutsi population was relatively large, they also suggest that the reason was due to strategic complementarities 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 because of fear that Tutsi villagers would be able to better defend themselves as a group. Therefore, even though radio broadcasted a message about the value of conflict was high in general, the results show that the broadcasts were not sufficient to pursuade Hutu citizens to partipicate 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 significant 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

[47] 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.

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

95 percent confidence intervals. The figure shows that the effects are highly non-linear. We see that for the range up to 60-70 percent radio coverage, the point estimates are small not significantly different from zero. Most importantly, they are non-increasing in the range. When radio coverage reaches approximately 70 percent, however, we see a sharp estimated increase in the participation rate. The effects are substantial. The point estimates increase almost three-folded. They imply that participation increased by approximately 70 percent when radio coverage reached above 70 percent. The coefficients are significant at the 5 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. Figure 10 shows increasing scale effects. This is only consistent with the model under strategic complementarities 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 also only consistent with the model under strategic complementarities. Both results therefore suggest that the Radio RTLM caused more violence due to strategic effects. Figure 1B graphically shows how the estimated effects in Figure 10 can be interpreted. Figure 1B shows that 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 due to strategic effects. 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 complementarities in violence, individuals are more willing to participate when they expect others to participate too. When the radio was received by sufficiently many people, then people to a larger extent held expectations that others would participate too. And this caused a large-scale, 70 percent, increases in participation. The evidence therefore suggests that there were important strategic complementarities 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. The estimated effect is very large. 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. In villages with medium literacy rates, the coefficients imply a 71 percent (0.535 log points) increase in participation when 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 including additional controls.

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 the most primary education. The coefficients in both column 3 and 4 are very close to zero.

Interpreting relatively high literacy rates and 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 suggest 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 didn't put much weight into the RTLM broadcasts because on relative terms, RTLM didn't contain much information. Therefore, they didn't believe much in the messages, and they were consequently not pursuaded 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[49]. Since the 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 9.3% 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.[50]

Finally, we can make same calculations for civilian violence and organized violence separately. Using Table 5 column 2 for civilian violence and column 3 for organized violence, the counterfactual calculation suggest 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 suggest that approximately 9.3% of the organized violence and 11% of the civilian violence can be explained by Radio RTLM.

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. It then derives a set of testable predictions that are consequently taken to the data. To identify causal effects

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

[50]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 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 radio coverage, compared zero radio coverage, civilian violence increased by 65 percent and organized militia violence by 77 percent. Furthermore, the paper presents evidence of strategic complementarities. First, the effects are driven entirely by villages where the Hutu ethnic group was large relative to the Tutsi ethnic minority, which is only consistent with the model under strategic complementarities. Second, as predicted by the model under strategic complementarities, the estimated effects are highly nonlinear in the degree of radio coverage as violence increases sharply 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 by which the broadcasts increased violence was in part because it functioned as a *coordination device*.

Furthermore, the model predicts that access to independent information can mitigate the propaganda effects. It tests this prediction by 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, it conducts a simple counter-factual calculation implying that the Radio RTLM cause approximately 9.3% of the genocidal violence. The results therefore suggest that Radio RTLM was a quantitatively important causal factor in the genocide.

Finally, finding that the propaganda was partly effective because of strategic complementarities in violence opens up further questions. Why are there strategic complementarities 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 complementarities generally present in civil conflicts? If so, what are the other devices used for coordination? These are important questions left for future reaserch.

References

[1] Bates, Robert H. (1986). "Modernization, Ethnic Competition, and the Rationality of Politics in Contemporary Africa." *Governing in Black Africa*, 6:4, pp. 457-84.

[2] BBC (2003). "The impact of hate media in Rwanda", BBC article from 3 December, 2003, http://news.bbc.co.uk/2/hi/africa/3257748.stm, Available (2009-11-06)

[3] Besley, Timothy and Burgess, R. (2002). "The political economy of government responsiveness: Theory and evidence from india". *Quarterly Journal of Economics*, 117(4):1415-51

[4] Besley, Timothy and Persson, Torsten (2008). "The Incidence of Civil War: Theory and Evidence", mimeo

[5] Bethany, Lacina and Gleditsch, Nils Petter, 2005). "Monitoring Trends in Global Combat: A New Dataset of Battle Deaths", *European Journal of Population* 21(2–3): 145–166

[6] Blattman, Chris and Miguel, Edward (2009). "Civil War", *NBER Working Paper,* 14801, March

[7] Boesche, Roger (2003). "Kautilya's Arthaśāstra on War and Diplomacy in Ancient India". *The Journal of Military History* 67 (1): 9–37

[8] Carlsson, Hans and van Damme, Eric (1993). "Global Games and Equilibrium Selection," *Econometrica*, vol. 61(5), pages 989-1018, Sept

[9] Chang, Chun-Fang and Knight, Brian (2008). "Media Bias and Influence: Evidence from Newspaper Endorsements", *NBER Working Paper,* 14445

[10] Chretien, J., Dupaquier, J., Kabanda, M., Ngarambe, J., and Reporters Sans Frontieres. (1995). Rwanda: Les medias du genocide [Rwanda: The media of the genocide]. Paris: Karthala.

[11] Collier, Paul and Hoeffler, Anke (1998). "On economic causes of civil war." *Oxford Economic Papers*, 50:4, pp. 563-73

[12] Collier, Paul and Hoeffler, Anke (2004) "Greed and Grievance in Civil War." *Oxford Economic Papers*, 56:4, pp. 563-95

[13] Della Vigna, Stefano and Kaplan, Ethan (2007). "The Fox News Effect: Media Bias and Voting" *Quarterly Journal of Economics,* 122(3):1187-234

[14] Diamond, Jared (2005). *Collapse: How Societies Choose to Fail or Succeed*, New York: Penguin.

[15] Do, Quy-Toan and Lakshmi Iyer (2007). "Poverty, Social Divisions and Conflict in Nepal." Unpublished working paper, Harvard Business School.

[16] Dube, Oeindrila and Juan F. Vargas. (2007). "Commodity Price Shocks and Civil Conflict: Evidence From Colombia." Unpublished working paper, Harvard University and UCLA

[17] Edmond, Chris (2008). "Information manipulation, coordination and regime change." Stern School of Business, mimeo

[18] Eisensee Tomas and Strömberg, David (2007). "News droughts, news floods, and U.S. disaster relief". *Quarterly Journal of Economics*, 122(2):693-728

[19] Fearon, James D. and David D. Laitin (2003). "Ethnicity, Insurgency and Civil War." *American Political Science Review*, 97:1, pp. 75-90

[20] Fearon, James D. and David D. Laitin.(1996). "Explaining Interethnic Cooperation." *The American Political Science Review*, 90:4, pp. 715-35

[21] Gentzkow, Matthew and Shapiro, Jesse (2004). "Media, education and anti-americanism in the muslim world." *The Journal of Economic Perspectives*, 18(3):117-33

[22] Gentzkow, Matthew (2006) "Television and Voter Turnout" *Quarterly Journal of Economics*, CXXI (3).

[23] Gerber A, Karlan D, Bergan, D. (2009). "Does the media matter? A field experiment measuring the effect of newspapers on voting behavior and political opinions." *American Economic Journal: Applied Economics*, 1(2):35-52

[24] Glaeser, Edward (2005). "The Political Economy of Hatred", *Quarterly Journal of Economics,* 120(1): pp. 45-86.

[25] International Criminal Tribunal for Rwanda (ICTR) 2003, Case No. ICTR-99-52-T Judgement. http://www.ictr.org/ENGLISH/cases/Barayagwiza/judgement/Summary-Media.pdf (Available 2009-09-05)

[26] Jensen, Robert and Oster, Emily (2008). "The Power of TV: Cable Television and Women's Status in India", *Quarterly Journal of Economics*, Forthcoming

[27] Jha, Saumitra (2008). "Trade, Institutions and Religious Tolerance: Evidence from India." Stanford GSB Working Paper No. 2004, January

[28] Knight, Brian, and Chiang, CF (2008). "Media bias and influence: Evidence from newspaper endorsements." Mimeo

[29] Berelson, Bernard R., Lazarsfeld, Paul F., and William M. McPhee (1954). *Voting: A Study of Opinion Formation in a Presidential Campaign*. University of Chicago Press.

[30] Miguel, Edward, Satyanath, Shanker and Sergenti, Ernest (2004). "Economic Shocks and Civil Conflict: An Instrumental Variables Approach." *Journal of Political Economy*, 112:4, pp. 725-53

[31] Montalvo, J.G., and Reynal-Querol, Marta, (2005). "Ethnic polarization, potential conflict and civil war", *American Economic Review*, 95 (3), 796-816.

[32] Morris, Stephen and Shin, Hyun Song (1998). "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks," American Economic Review, American Economic Association, vol. 88(3), pages 587-97, June.

[33] Mullainathan, Sendhil and Shleifer, Andrei (2005). "The Market for News." *American Economic Review*, 95(4): 1031–53.

[34] Murshed, S. Mansoob and Gates, Scott (2005). "Spatial-Horizontal Inequality and the Maoist Insurgency in Nepal," *Review of Development Economics* 9, 1: 121-134.

[35] Olken, Ben (2009). "Do TV and Radio Destroy Social Capital? Evidence from Indonesian Villages", *American Economic Journal: Applied Economics*, forthcoming

[36] Paluck, Elizabeth L. (2009). "Reducing Intergroup Prejudice and Conflict Using the Media: A Field Experiment in Rwanda." *Journal of Personality and Social Psychology* 96 (March): 574-587

[37] Prat, Andrea and Strömberg, David (2005). "Commercial Television and Voter Information.", CEPR Discussion Papers 4989.

[38] Prunier, Gérard. (1995). *The Rwanda Crisis: History of a Genocide.* New York: Columbia University Press.

[39] Verpoorten, Marijke (2005). "The death toll of the Rwandan genocide: a detailed analysis for Gikongoro Province", *Population* 60(4): 331-368.

[40] Verwimp, Philip (2005). "An economic profile of peasant perpetrators of genocide: Micro-level evidence from Rwanda," *Journal of Development Economics*, vol. 77(2), pp. 297-323, August.

[41] Verwimp, Philip (2006). "Machetes and Firearms: the Organisation of Massacres in Rwanda", *Journal of Peace Research*, vol. 43, 1, 5-22, January

[42] Straus, Scott (2004). "How Many Perpetrators Were There in the Rwandan Genocide? An Estimate", *Journal of Genocide Research*

[43] Straus, Scott (2007). "What Is the Relationship between Hate Radio and Violence? Rethinking Rwanda's "Radio Machete", *Politics & Society* 2007; 35; 609

[44] Strömberg, David (2004) "Radio's Impact on Public Spending", *Quarterly Journal of Economics*, 119(1)

[45] Strömberg D, and Snyder, Jim (2008). "Press coverage and political accountability.", Mimeo

[46] Thompson, Allan (eds). (2007). *The media and the Rwandan genocide.* London: Pluto Press.

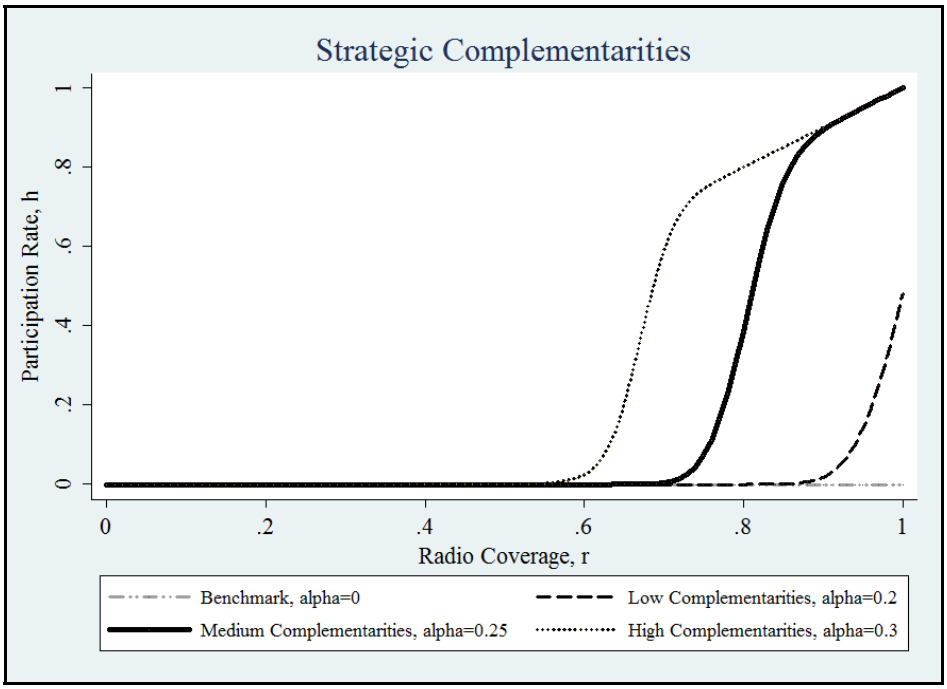

Figure 1A. The figure plots the participation rate as a function of the radio coverage. It shows the importance of strategic effects due to strategic complementarities. Under the benchmark case (fundamentals effects only), there is essentially no effect. For higher degrees of complementarities, the larger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

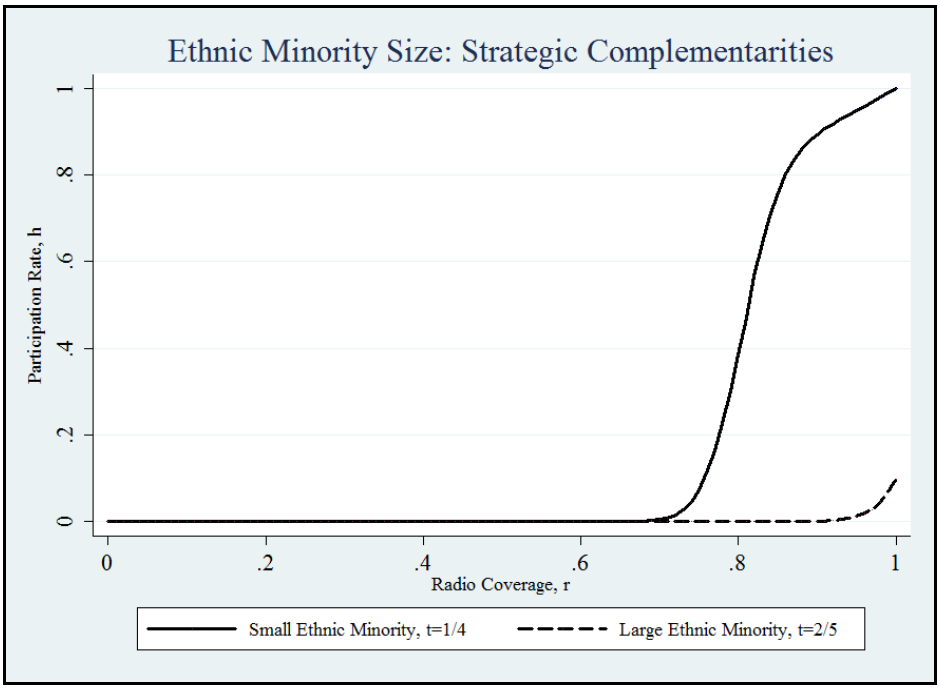

Figure 1B. The figure plots the participation rate as a function of the radio coverage for two levels of ethnic minority size. It shows that the effect of radio coverage is smaller, and can disappear, when the ethnic minority is relatively large.

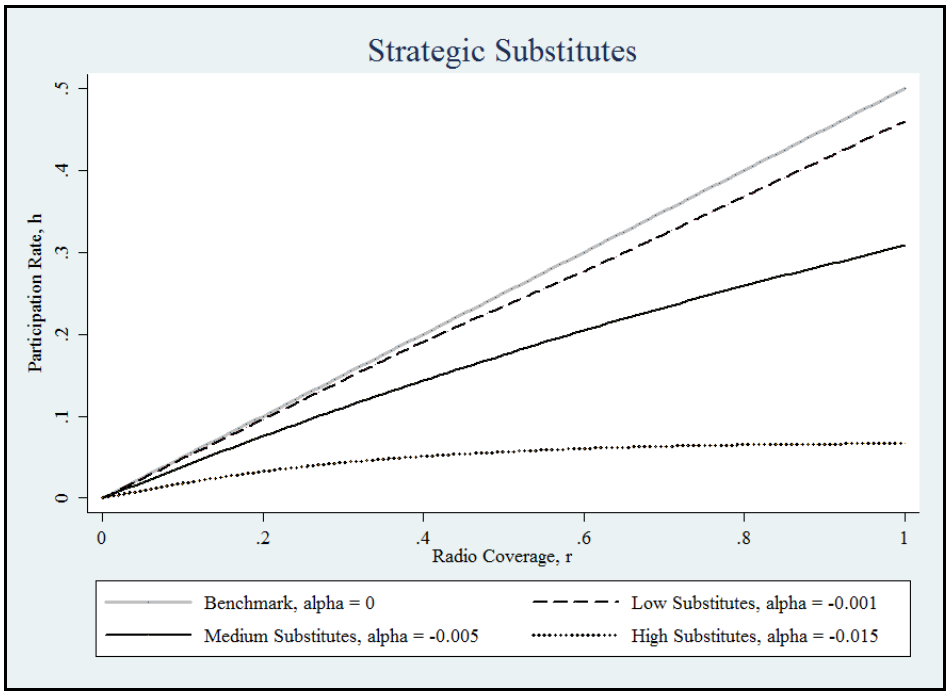

Figure 2A. The figure plots the participation rate as a function of the radio coverage. It shows the importance of strategic effects due to strategic substitutes. Under the benchmark case (fundamentals effects only), the effect is linear. The effects of radio coverage decrease with higher degrees of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

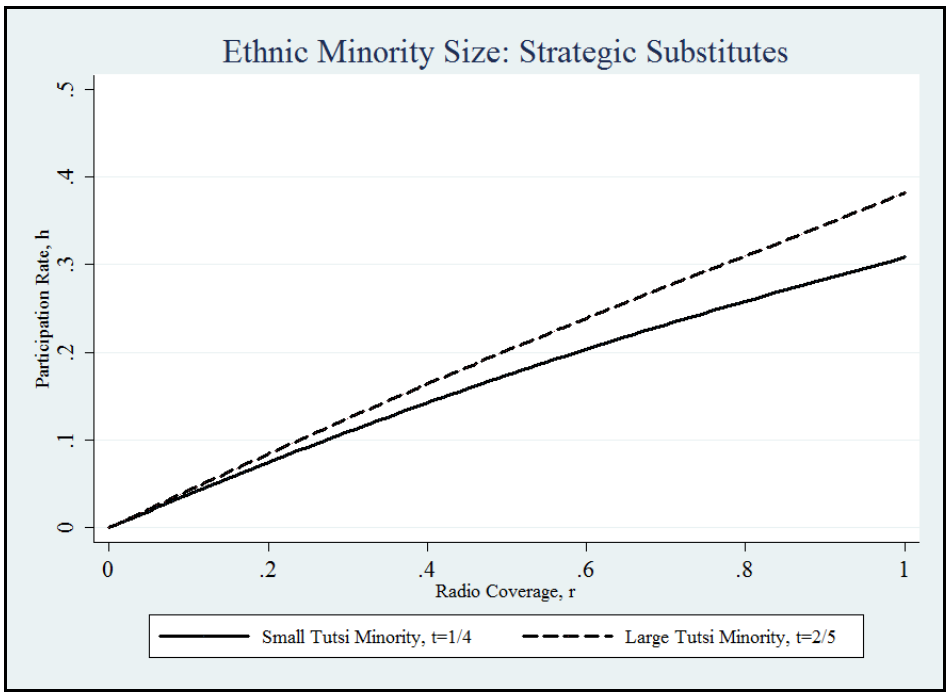

Figure 2B. The figure shows the participation rate as a function of the radio coverage for two levels of ethnic minority size. It shows that the effect of radio coverage is larger when the ethnic minority is large.

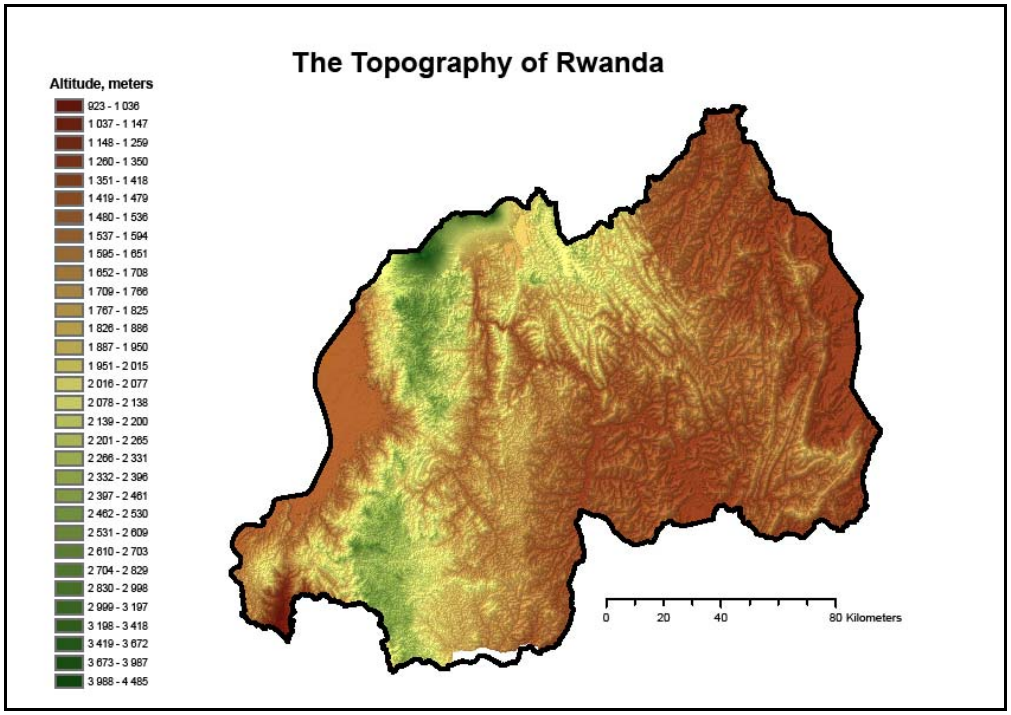

Figure 3. The Topography of Rwanda
Source: Shuttle Radar Topography Mission

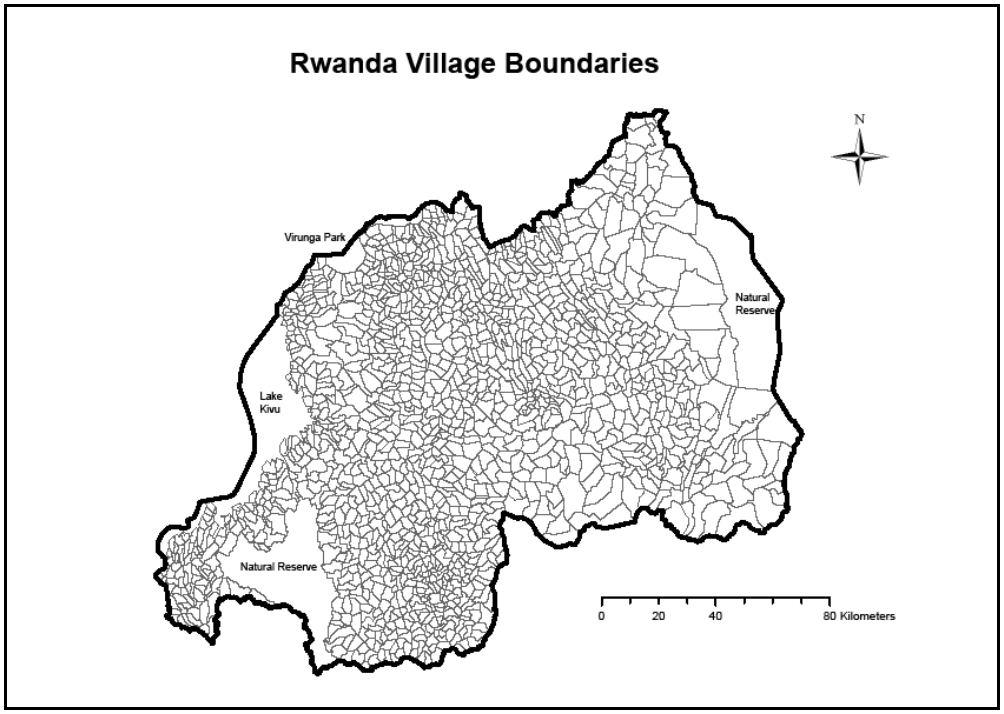

Figure 4. Rwandan Village Boundaries
Source: Analog map by Organisation Administrative du territorie de la Republic Rwandaise, digitized by the author.

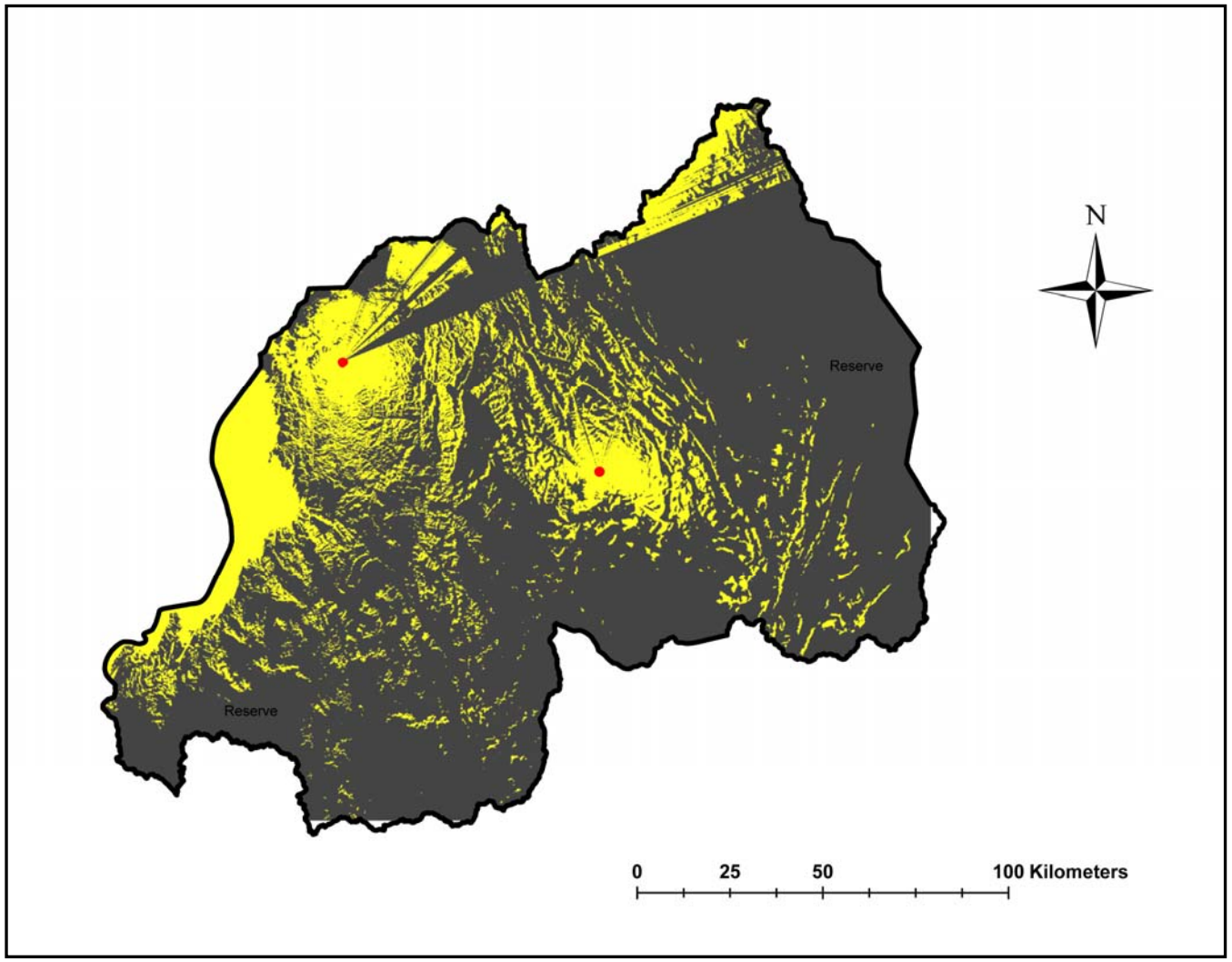

Figure 5. RTLM Radio Coverage

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 watts transmitter is on Mount Muhe. The central 100 watts 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.

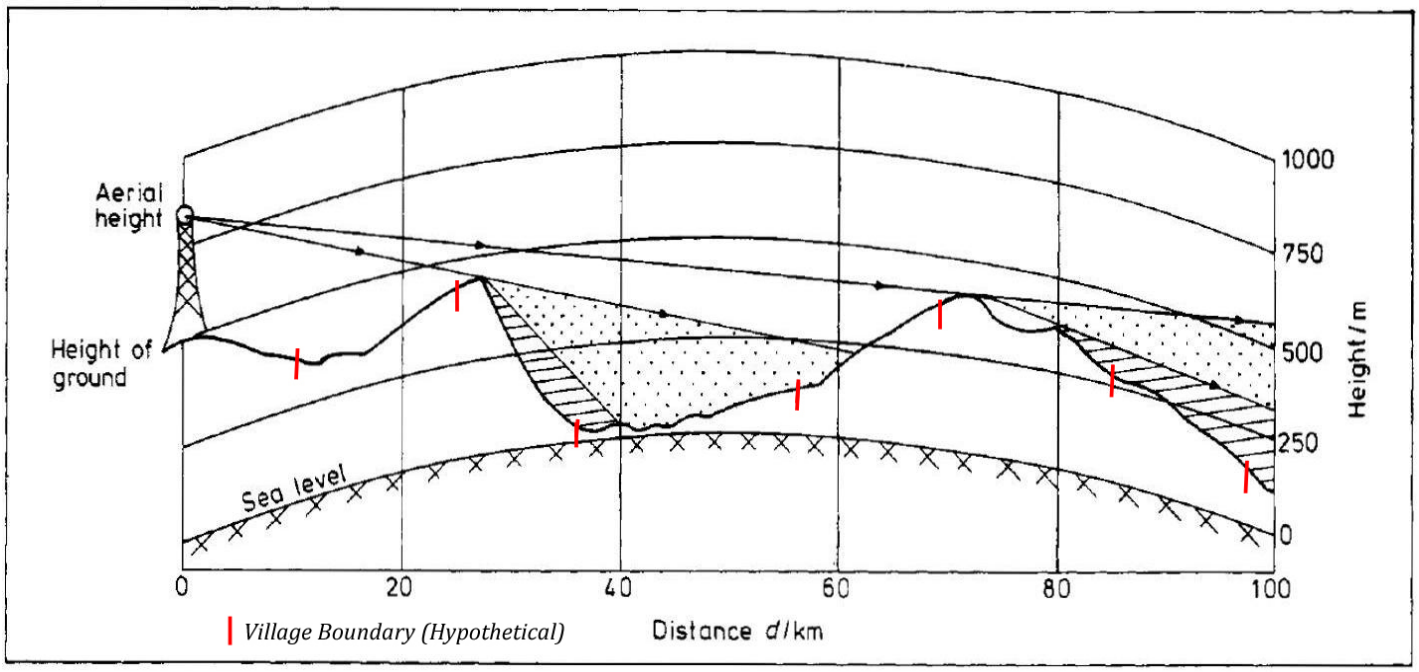

Figure 6. Theoretical Radio Coverage
Dotted space marks low signal strength, and striped space marks even lower signal strength. The figure shows that the signal strength for a point on the ground is lower when there is a hilltop in the line-of-sight between the transmitter and a point on the ground.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

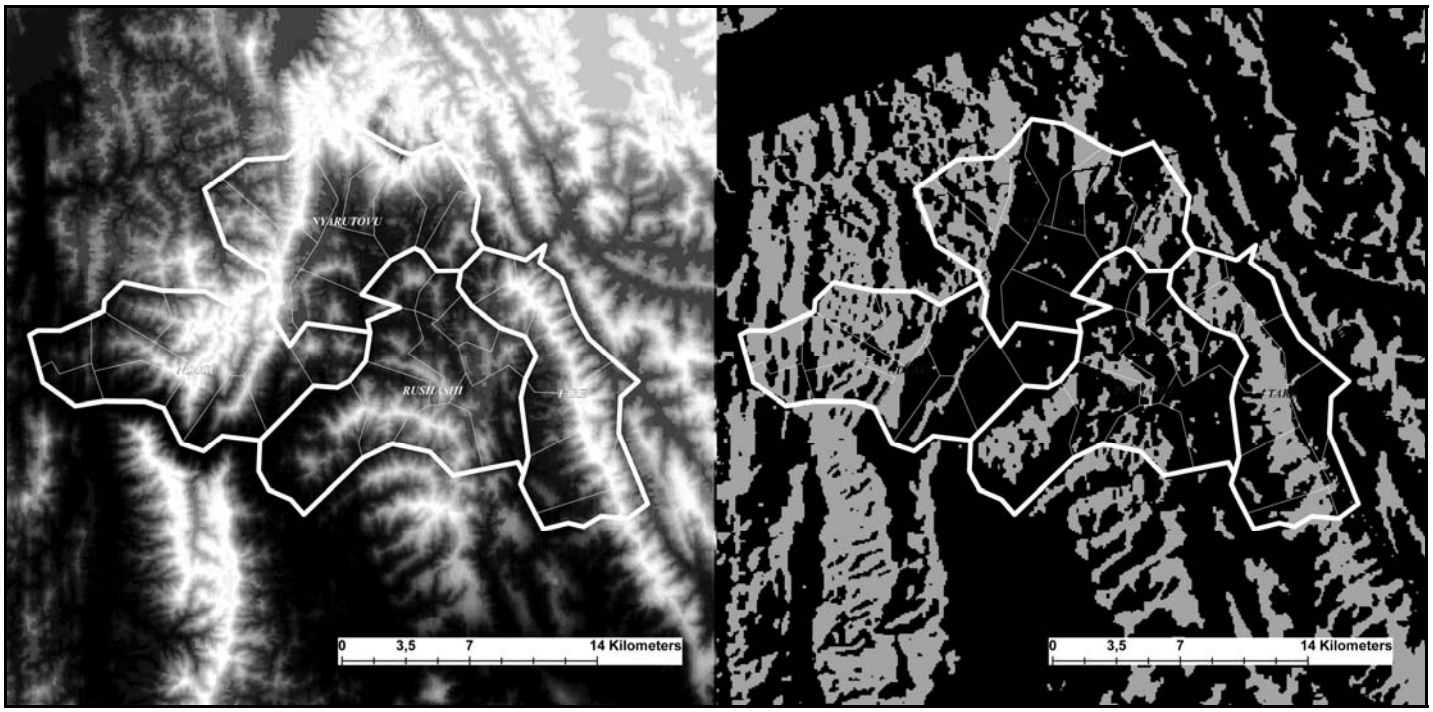

Figure 7. Predicted Radio Coverage, 4 communes example
This left picture shows the height of ground, where brighter marks higher altitude. The right picture shows the shows the empirical radio coverage, where grey marks radio coverage. The signal comes from the Mount Muhe transmitter located 30 km to 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.

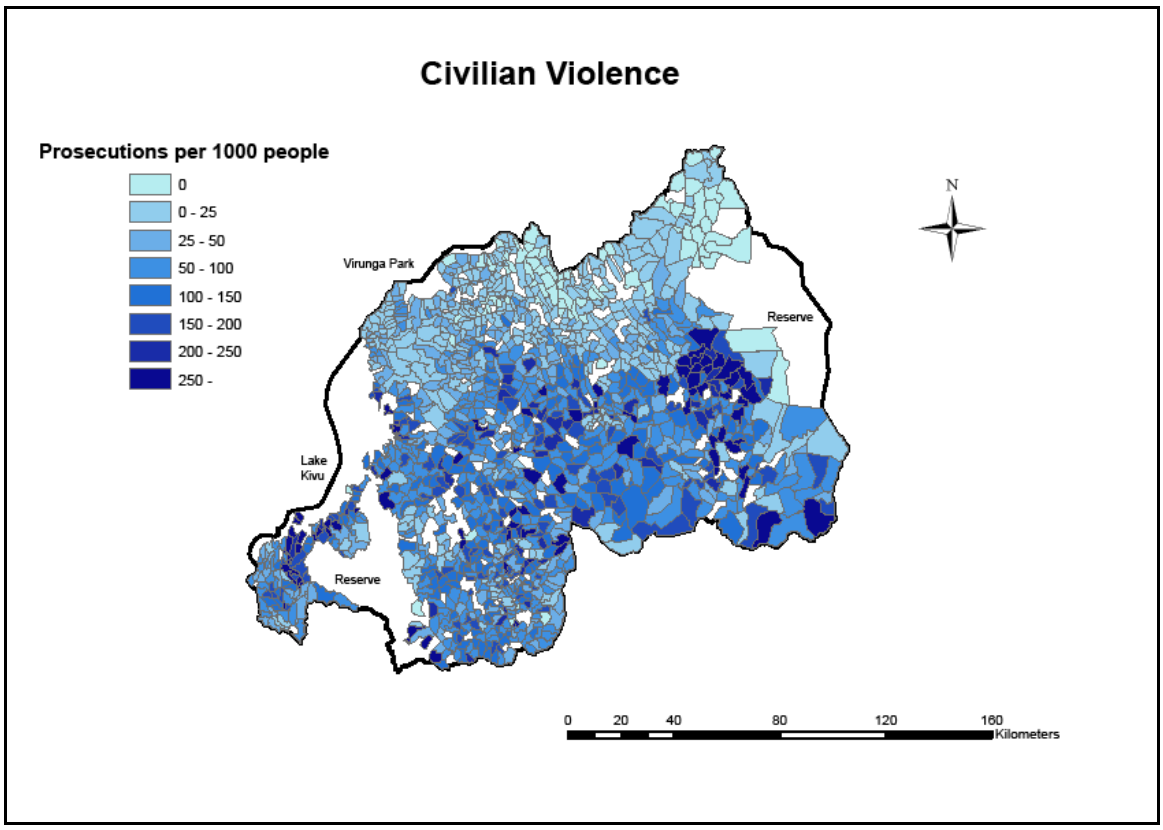

Figure 8. Civilian Violence. White areas are no data areas, either because of Lake Kivu, Natural Reserves, or villages that are missing due to unmatchable data issues.

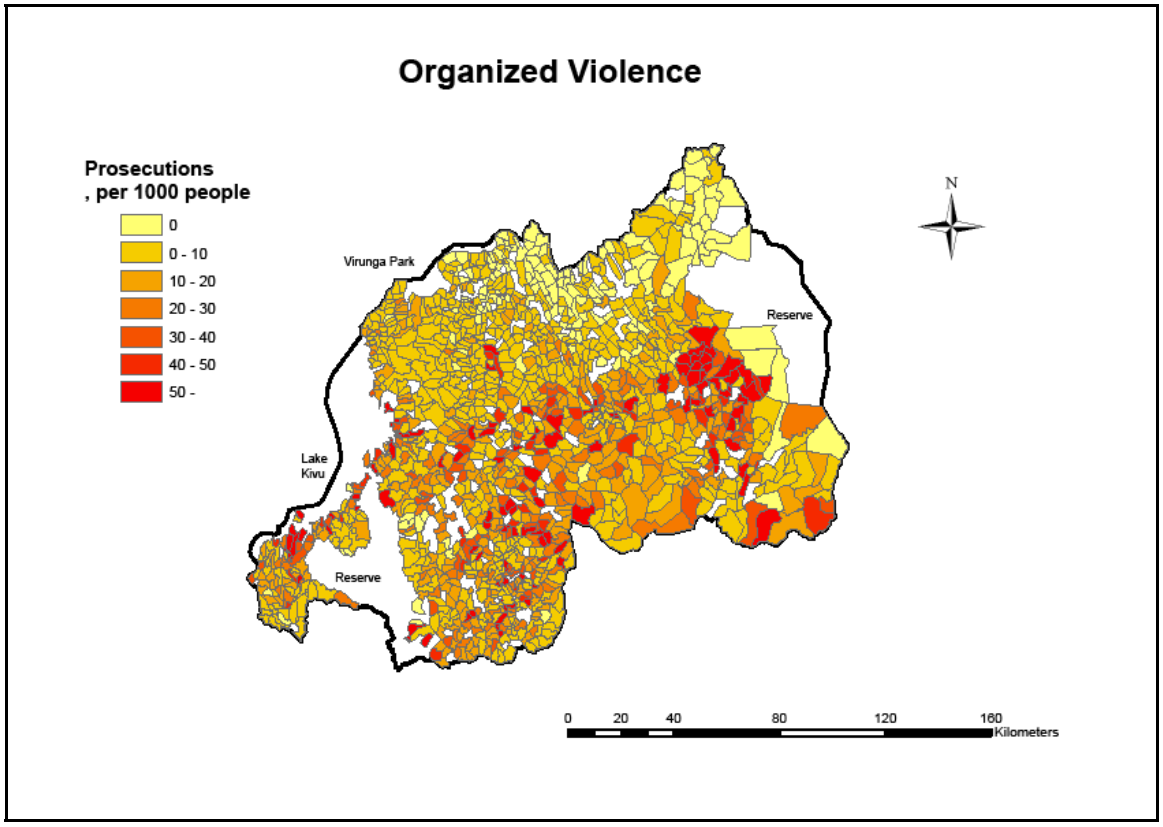

Figure 9. Organized Violence. White areas are no data areas, either because of Lake Kivu, Natural Reserves, or villages that are missing due to unmatchable data issues.

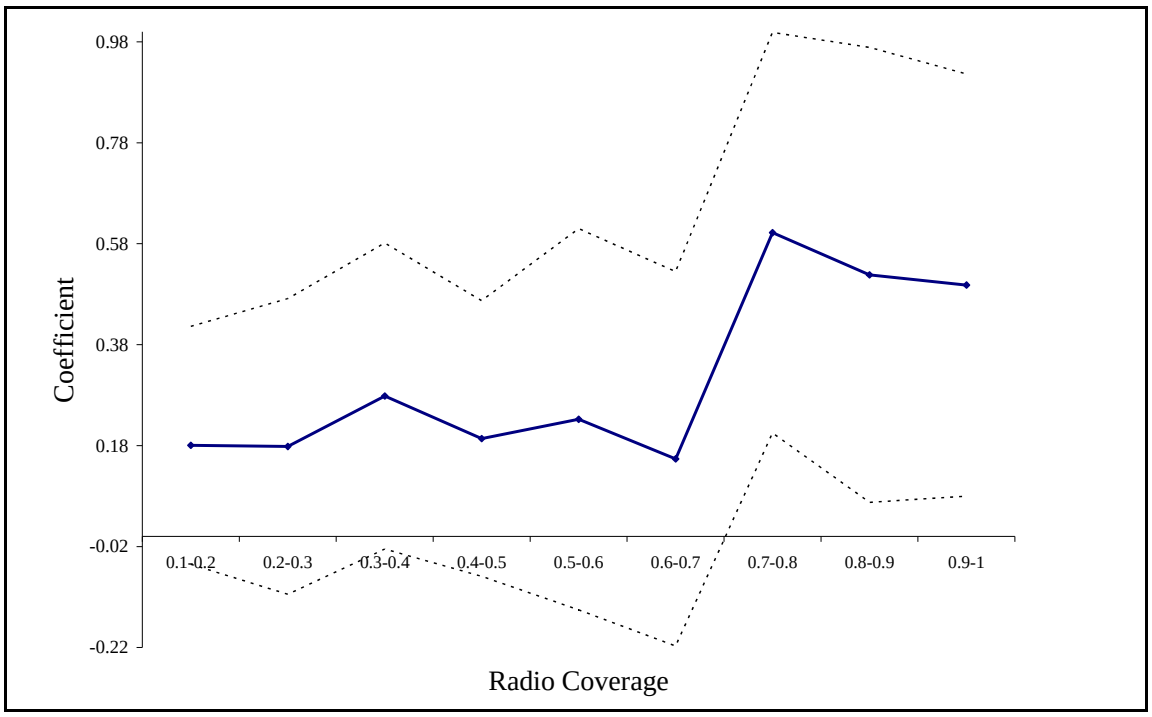

Figure 10. Scale Effects, Total Violence

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, square km	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 organisers, 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 kilometres. *Altitude, Variance* is the village variance in altitude in meters, *Distance to Transmitter* is the distance in kilometres 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 is 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 kilometres, 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	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
COMMUNE FIXED EFFECTS	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	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 RTLM	**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 reception. The controls are: A second order polynomial in village mean altitude, the 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	NO	YES	YES	YES	YES	YES	YES
COMMUNE FE	NO	YES	YES	YES	YES	YES	YES
Observations	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 organisers, 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 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	YES	YES	YES	YES	YES	YES
COMMUNE FE	YES	YES	YES	YES	YES	YES
Observations	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 organisers, 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	YES	YES	1105
COMMUNE FE	YES	YES	0.52
Observations	1105	1105	1105
R-squared	0.62	0.61	0.52

Radio Coverage is the share of the village area that has RTLM radio coverage.
Robust standard errors in parentheses, clustered at the commune level. There are 128 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	YES	YES	YES	YES
COMMUNE FE	YES	YES	YES	YES
Observations	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 organisers, 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. The other variables are described in the data section. Robust standard errors in parentheses, clustered at the commune level. There are 128 communes in the sample.
* significant at 10%; ** significant at 5%; *** significant at 1%