Did Radio RTLM Really Contribute Meaningfully to the Rwandan Genocide?:

Using Qualitative Information to Improve Causal Inference

From Measures of Media Availability

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Did Radio RTLM Really Contribute Meaningfully to the Rwandan Genocide?: Using Qualitative Information to Improve Causal Inference From Measures of Media Availability

Abstract

The scholarly literature on the relationship between media and communication technology and social behaviour is as vast as it is fascinating, and is as consequential as it is vast. In this article, I focus on a subset of that research, one which examines the relationship between information which is disseminated "from above" and political violence, and which employs estimates of media exposure to explore that relationship. I argue that, while these methods hold enormous potential for addressing some of the limitations that have long plagued conflict research, they involve a potential pitfall, i.e., the possibility that the variable that they measure, media availability, is an inadequate proxy for media consumption, which is the actual variable of interest. I further argue that researchers often cannot be confident that that proxy is a valid one unless they have a deep qualitative understanding of media consumption habits of the population under study. I illustrate that concern by examining the findings of Yanagizawa-Drott (2014), which estimated that roughly ten percent of the violence which took place in the course of the Rwandan genocide can be attributed to broadcast of the so-called "hate radio" station, Radio Télévision Libre des Mille Collines (RTLM).

Introduction

The scholarly literature on the relationship between media and communication technology and social behaviour is as vast as it is fascinating, and is as consequential as it is vast. Researchers have argued that those technologies can, among other things, destroy social capital (Olkean 2009), alter the political trajectories of fragile democracies (Adena *et al*. 2015; Enikolopov *et al*. 2011), affect levels of political violence (Pierskalla and Hollenbach 2013; Shapiro and Weidmann 2015; Warren 2015), and alter both patterns and levels of participation in political protest (Little 2016; Reuter and Szakonyi 2015; Kern and Hainmueller 2009).

In this article, I focus on the subset of this research, one that examines the relationship between information which is disseminated "from above" and political violence, and which employs estimates of media exposure to explore that relationship. I argue that, while these methods hold enormous potential for addressing some of the limitations that have long plagued conflict research, they involve a potential pitfall, i.e., the possibility that the variable that they measure, media availability, is an inadequate proxy for media consumption, which is the actual variable of interest. I further argue that researchers often cannot be confident that that proxy is a valid one unless they have a deep qualitative understanding of the media consumption habits of the population under study. I illustrate that concern by examining the findings of Yanagizawa-Drott (2014), which estimated that roughly ten percent of the violence which took place in the course of the Rwandan genocide can be attributed to broadcasts of the so-called "hate radio" station, Radio Télévision Libre des Mille Collines (RTLM). I find that qualitative evidence regarding radio consumption habits indeed undermines confidence in those findings, and employ a cross-validation exercise to determine that inclusion of the radio reception variable in Yanagizawa-Drott's model does not improve its out-of-sample predictive performance.

Background

The international community has proclaimed that the prevention of mass atrocities is a central responsibility of states, and has endorsed the concept of the Responsibility to Protect, which mandates that states take steps to prevent atrocities, including intervening militarily as a last resort (Petty 2013). However, some states have arguably used that responsibility as an excuse for interfering in the internal affairs of their neighbors (Mohamed, 2012; Evans 2008). If the international community is to navigate between the Scylla of under-intervention and the Charybdis of over-intervention, understanding the causes of violent substate conflict, especially mass atrocities, is exceptionally important.

Unfortunately, if there is any truism in the field of conflict studies, it is that precise and accurate understandings of causal processes and other phenomena are exceedingly hard to come by, in large part because of the difficulty of obtaining data that is sufficiently accurate and complete (Weidmann 2016, Klayvas 2008; Davenport and Ball 2002). This issue has become particularly problematic as scholars have come to realise that microanalysis, and hence micro-level data, is essential to understanding violent conflict (Kalyvas 2008).

The problem of causal inference in conflict studies is perhaps especially acute when examining the causal role of persuasive media. Recent research indicates that propaganda and other persuasive techniques are much less effective than policymaker and even some scholars have long presumed (Mercier 2017). In particular, those techniques have often been found to be effective in motivating behaviour only among those who are already predisposed to believe the viewpoints being espoused. For example, Adena *et al*. (2015) found that the effect of Nazi anti-Semitic propaganda varied according to the predisposition of listeners, in that it was most

effective in engendering denunciations of Jews to authorities and anti-Semitic letters to *Der Sturmer* in areas where anti-Semitism was historically high, but had a negative effect in places where anti-Semitism was historically low. Similarly, Chan *et al*. (2015) found that broadband internet availability increases racial hate crimes in the United States only in those areas with higher levels of racism; Weeraratne (2010) found that elite-orchestrated campaigns in Indonesia which scapegoated minorities resulted in anti-Chinese riots only when the rhetoric employed therein was rendered salient by local conditions; and Wilson (2011) employed process tracing to determine that participants in violent ethno-religious conflicts in Indonesia tended to be acting out of their own self-interest, rather than being incited by elite propaganda.

However, there are reasons to question whether these findings regarding the effect of persuasive media hold as strongly in circumstances involving violent conflict or the risk thereof. First, in those circumstances, propaganda or other persuasive media might operate to increase violence through some mechanism other than changing listeners' underlying beliefs, such as by signaling to those inclined to violence that they will not be punished by authorities (Horowitz 2001).

Second, in conditions of ongoing or incipient political violence, the salience of certain types of propagandistic appeals might be enhanced; for example, appeals to ethnic identity might be more persuasive in times of conflict, because identity is often endogenous to ongoing conflict, as violence often causes individuals to adopt oppositional identities by increasing the salience of those identities. (Balcells and Steele, 2016; Kalyvas and Kocher 2007; Fearon and Laitin 2000).

Finally, during ongoing violence, even the most extreme appeal to "destroy them to save us" (Straus 2012; De Forges 1999) might appear to be reasonable, and compliance therewith might be perceived as rational, because the potential cost of being wrong — i.e., in refusing to

believe that the threat is real and therefore declining to engage in violence — is too high (De Figueiredo and Weingast 1999).

That is one reason why the recent advances in the analysis of information communication technology are so exciting. By analyzing variations in the exposure of subsets of the populations under study to information communication technologies, scholars have been able to make inferences about the relationship between exposure to information and outcomes of interest. For example, Olkean (2009) employed the fact that Indonesia's mountainous terrain creates variations in radio and television signal strength in local villages to analyze the association between access to signals and villagers' participation in village governance and self-reported levels of trust. Similarly, Enikolopov *et al*. (2011) used temporal and geographic variation in the availability of the sole independent television station in Russia to estimate its influence on the electoral fortunes of major opposition parties; Adena *et al*. (2015) found that variation in radio exposure in pre-war Germany, as measured in part by radio signal strength, was associated with variation both in electoral support for the NSDAP and in anti-Semitic acts, conditioned on listeners' predispositions toward anti-Semitism; Durante *et al*. (2017) found that early access to Silvio Berlusconi's commercial TV network was associated with greater electoral support for Mr. Berlusconi's party; Yanagizawa-Drott (2014) found that variations in radio reception among local Rwandan cells was associated with variations in levels of participation in the genocide of 1994; DellaVigna *et al*. (2014) found that residents of Croatian villages which had better reception of Serbian radio broadcasts were more supportive of extreme nationalist parties; and Gagliarducci *et al*. (2017) found that variation in reception of BBC broadcast, engendered by sunspot activity, was associated with variations in levels of resistance activity in Italy in the late stages of World War II. In contrast, Crabtree *et al*. (2015) found that there was no association

between the availability of West German television broadcasts and the incidence of anti-regime protests in East Germany, and Warren (2015) found a negative association between radio ownership and collective violence in Africa.

Scholars of political violence and collective action have also analyzed more contemporary forms of information communication technology. For example, Bailard (2015), Warren (2015), and Pierskalla and Hollenbach (2013) each found that greater availability of cellular phone coverage is associated with a greater probability of violent collective action in Africa, while Bergren and Bailard (2017) found that an increased availability of cellular phones is associated with less violent contention in Myanmar, and Shapiro and Weidmann (2015) found that cellular coverage in Iraq was negatively associated with attacks on government and Coalition troops. Finally, there is a burgeoning literature on the role of the Internet on violent contention (Gohdes 2018).

Thus, it is clear that analysis of media and communication technology has the potential to greatly expand our understanding of the role that communication plays in conflict, a potential which can only expand as communication technology grows more ubiquitous, and the data it generates becomes more voluminous. However, a possible pitfall exists in this literature. The primary independent variable employed in most of these studies is some measure of the availability of the technology at issue. However, media availability is merely a proxy for the true variable of interest, which is actual consumption of the medium under study, whether that medium takes the form of radio broadcasts, television broadcasts, cellular phone usage, or social media. If media availability is an inadequate proxy for media consumption, then our confidence in the results of analyses of media and communication technology must perforce be reduced.

That problem is, of course, not unique to this particular set of studies; Hegre *et al*. (2017, 117) note that "many of the 'usual suspect' variables [in peace and conflict research] are proxies that on their own cannot exert causal effects[,]" and Kalyvas (2008, 397) identifies the "considerable distance between theoretical constructs and proxies" as a "well known" problem of econometric studies of civil war. Nevertheless, it is a problem that must be addressed, and most of the above-cited studies attempt to do so by including some direct measures of technology usage and demonstrating that those direct measures correlate with the measures of availability which constitute each study's primary independent variable. For example, Olkean (2009) included a survey which found that respondents with better television reception tended to spend more time listening to radio and and watching television; Enikolopov *et al*. (2011) constructed a dummy variable from a survey of media consumption habits and determined that increased availability of television was indeed associated with greater consumption thereof; Adena *et al*. (2015) used local radio subscription rates to determine the levels at which predicted signal strength, which was their primary main explanatory variable, actually resulted in greater levels of listenership; DellaVigna *et al*. (2014) conducted a survey and determined that large numbers of Croats in areas where Serbian radio signals are strong in fact listen to Serbian radio with some regularity; and Durante *et al*. (2017) examined survey data on television consumption and political attitudes, and found that support for Mr. Berlusconi's party was higher among age cohorts who tend to watch the most television.

In each of these cases, the author or authors were able to present evidence indicating that their primary proxy variables, measures of availability of the media in question, were correlated with more direct measures of their actual dependent variable, consumption of that medium.

Hence, in these cases, we have high confidence that the studies are really examining what they purport to examine.

However, there are many cases in which it is not possible to employ that strategy. It is the central claim of this article that, in such cases, even the most sophisticated analysis of media availability is of limited utility, unless the author can draw upon a deep qualitative understanding of the culture of media use of the population under study in order to increase confidence in the validity of the proxy variable. I test that claim by examining Yanagizawa-Drott's (2014) study of the role of radio in the Rwandan genocide, which found that greater availability of RTLM "hate radio" broadcasts was associated with greater levels of participation in the 1994 genocide.

Case Study - Yanagizawa-Drott (2014)'s Findings Regarding RTLM and Rwanda

Yanagizawa-Drott (2014) examined the role played by Radio Télévision Libre des Mille Collines (RTLM) in the Rwandan genocide. That issue has been of particular interest to both scholars and policymakers because, as Nyseth Brehm (2017) observes, "[a]lthough the genocide was orchestrated by the state, hundreds of thousands of civilians implemented the killing, and viewing the violence strictly as a top-down endeavor ignores the other factors that influenced their participation" (23). Hence, understanding who participated in the Rwandan genocide, and why, is clearly a significant question.

Background – Radio and the Rwandan genocide

Until the Summer of 1993, Rwanda had only one radio station, the government-operated Radio Rwanda (Des Forges 1999, 58). RTLM, which began broadcasting to the entire country in

July of 1993 (Mironko 2007, 126), was created by Hutu hard-liners; although the station was officially distinct from the government, it used many of the same staff and much of the same equipment as Radio Rwanda, and many of its founders had close connections with high government officials (Des Forges 1999, 59). Unlike Radio Rwanda, RTLM was designed to be highly entertaining, featuring popular music, call-in talk shows, and gossip, and it quickly became extremely popular (Des Forges 1999, 60; Petrova and Yanagizawa-Drott 2016).

Prior to the 6 April 1994, downing of the aircraft carrying Rwandan President Juvénal Habyarimana, RTLM broadcasts included statements by radio personalities and political figures which, among other things, framed Rwandan history as the oppression of the Hutu majority by the Tutsi minority; often used the terms "Inyenzi" (cockroach) to refer to members of the ongoing Tutsi insurgency and even to Tutsis in general; conflated Tutsi rebels with Tutsis in general; depicted the Tutsi insurgency and the Tutsi in general as existential threats to the Hutu; engaged in ethnic stereotyping; and accused specific Tutsi civilians and their families as being in league with the insurgents (The Prosecutor v. Ferdinand Nahimana 2003, 118-133). After the death of President Habyarimana and the subsequent initiation of the genocide, RTLM broadcasts began to explicitly define as enemies the Tutsis as a whole, rather than just the rebels; increasingly referred to Tutsis as Inyenzi; began calling for the killing or "extermination" of Tutsi civilians; and specifically named as enemies particular persons, many of whom were subsequently killed (The Prosecutor v. Ferdinand Nahimana 2003, 133-158). In some instances after the killing began, RTLM gave specific directions regarding where to find particular targets (Des Forges 1999, 158), and even broadcast the license plate numbers of those attempting to escape (Kirschke 1996).

Yanagizawa-Drott's Findings

As noted by Wilson (2015), in comparison to most studies of RTLM's role in the genocide, Yanagizawa-Drott's (2014) is a relative outlier. Yanagizawa-Drott tested the hypothesis that higher levels of consumption of RTLM broadcasts were associated with higher levels of participation in the genocide. He measured participation in genocide by the number of prosecutions in each of the local cell-level Gacaca courts, which were established by the Rwandan government in 1997 to prosecute genocide participants (Schabas 2005). The Gacaca courts divided suspects into three categories: Category 1 suspects were those accused of being planners or organizers, government officials, leaders who participated or who urged, coerced, or incited others to participate, and those accused of rape or sexual torture; Category 2 suspects were "notorious murderers," individuals accused of murder, torture or the defilement of bodies, and their accomplices; and Category 3 suspects were those accused of property crimes (Nyseth Brehm *et al*. 2014). Although most killers acted in groups (Fujii 2009, 7), Yanagizawa-Drott maintains that most Category 1 offenders at the cell level were members of local militia members (Yanagizawa-Drott 2014, 1959), and hence for convenience he denominates Category 1 killings as "militia" killings, and Category 2 killings as "individual" killings (Yanagizawa-Drott 2010, 1960).

Yanagizawa-Drott's data included a total of roughly 77,000 persons who were prosecuted for Category 1 ("milita") violence, and approximately 432,000 persons who were prosecuted for Category 2 ("individual") violence. In order to measure cell-level consumption of RTLM broadcasts, Yanagizawa-Drott employed a proxy variable, a measure of radio reception in each of the cells. Because of the very hilly topography of Rwanda, which is known colloquially as the

"land of a thousand hills" (Carr and Halsey 2000), levels of reception varied greatly from village to cell. According to Yanagizawa-Drott's data, in the median cell[1] only ten percent of the cell received radio signals; the mean was .19 and the standard deviation was .23. Just over twenty percent of the cells had no reception at all, and in only 104 of 1065 cells did at least fifty percent of the cell have reception. Yanagizawa-Drott employed a fixed-effects model with controls for various potential determinants of violence in order to test his hypothesis that higher levels of radio reception were associated with higher levels of participation in the genocide.

Yanagizawa-Drott found that levels of participation were indeed higher in cells with greater radio reception. He estimated that RTLM broadcasts increased overall participation by approximately ten percent; that it increased the incidence of Category 1 ("militia") violence participation by almost a third; and that there was a "spillover" effect for militia violence, but not individual violence, in that the likelihood of a person in a given cell engaging in militia violence was significantly higher when radio reception in neighboring cells was higher.

Potential weaknesses in Yanagizawa-Drott's proxy for radio consumption

Yanagizawa-Drott's findings are broadly consistent with what we know about RTLM broadcasts during the genocide, in that on several occasions the station broadcast specific instructions regarding exactly where to find particular victims (Des Forges 1999, 158; Kirschke 1996). Specifically, the fact that RTLM sometimes broadcast such specific instructions is very consistent with Yanagizawa-Drott's finding that spillover effects were confined to Category 1 violence, if Yanagizawa-Drott is correct in stating that most Category 1 participants were militia

[1] Yanagizawa-Drott uses the term, "village," but the administrative level at which Gacaca courts were established is denominated the "cell" in Rwanda (Government of Rwanda 2001, Article 3; Government of Rwanda 2004, Article 3) .

members, because militia members might have gone to neighboring cells in search of particular named victims, and committed the crimes there, which would have subjected them to Gacaca prosecution in that cell.[2] In addition, militia members who traveled to neighboring cells in search of named victims might have recruited or coerced residents there to participate.

However, there are some reasons to be wary of Yanagizawa-Drott's findings.

First, as noted previously, his findings are a bit of an outlier, as other studies have struggled to find a significant connection between RTLM broadcasts and participation in the genocide.

Second, Yanagizawa-Drott uses cell-level data on radio reception. As Warren (2015) notes, analyses of the same phenomenon that are based on different geographical units of analysis can sometimes yield different empirical inferences (299). And, indeed, Nyseth Brehm (2017) analyzed Yanagizawa-Drott's data at the commune level[3], and found no significant association with the level of killing.

Third, data on radio ownership in Rwanda indicates that radio consumption might have been greater than implied by Yanagizawa-Drott's data on radio reception. The 1991 Rwandan census found that 34% of households owned radios (IPUMS International 2012), yet Yanagizawa-Drott's data indicates that only 19.8% percent of the population had radio reception. While radio ownership is not a perfect proxy for radio consumption — Spitulinik (2002) found that eight percent of radios owned by Zambians are broken at any given time, and that an additional four percent are inoperative because they lack batteries — nevertheless a wide discrepancy between ownership and reception raises a suspicion that radio reception data does

[2] The jurisdiction of the Gacaca courts was based on where the crimes were committed, rather than where the defendants resided. (Organic Law 2004, Art. 44-45).

[3] The commune was a now-defunct administrative unit, each of which was subdivided into several sectors; each sector was divided into several cells.

not fully capture actual levels of radio consumption. The fact that Warren (2015) found a negative association between radio ownership and collective violence in Africa at the country level of course reinforces that suspicion to some degree.

Finally, unlike many of the studies discussed herein, Yanagizawa-Drott was unable to investigate whether his measure of radio reception is correlated with measures of radio consumption.

Qualitative studies of radio consumption habits in Sub-Saharan Africa cast additional doubt on the validity of Yanagizawa-Drott's proxy for radio consumption

Therefore, there is some doubt whether radio reception is a sufficiently valid proxy for Yanagizawa-Drott's variable of interest, radio consumption. That doubt might well be dispelled if there is qualitative evidence regarding Rwandan media consumption patterns indicating that radio reception is likely to be closely correlated with radio consumption; however, if anything, the evidence trends in the opposite direction. There was little specific research on Rwandan radio listening habits in the pre-genocide period, but research conducted in analogous regions indicates that radio reception data might seriously underestimate levels of radio consumption, because it appears that that radio consumption in Sub-Saharan Africa is very much both a social and a mobile activity.

The leading exploration of radio consumption habits in Sub-Saharan Africa is Spitulinik's (2002) study of 1990s Zambia. Spitulinik found, among other things, that Zambian radio consumption practices were shaped by "the sociality of domestic space. … In situations where there are portable radios and batteries people listen outside during daylight. Such listening occurs in an outdoor workspace, under a shade tree, on the stoop of the home, at the

marketplace, or on the road" (313). She also noted that "... the tendency is for most daytime social activity and a great deal of domestic labor to take place outdoors; thus, the portable radio moves as people move" (313), and that "[p]eople carry radios to the office when presidential press conferences or football matches are to be broadcast, and they are sometimes brought into the field to listen to while farming" (314). In addition, "[r]adios are on in public spaces such as bus stops, minibuses, shops, foodstands, bars and markets" (314), and when a visitor brings a radio to an area where radios are scarce, it "temporarily becomes a collective asset within his wider kin and friendship networks" (315). Finally, Spitulinik found that "... rural men were 1.5 times more likely to listen to radio than rural women …" (312).

Spitulinik's findings are echoed by those of Ambler (2002), who notes that, again in Zambia, radio listening became "less of a conscious leisure activity and more an accompaniment to work or socializing" (131), and also that radio listening became popular during World War Two, when "concern about global warfare once again impinging on Northern Rhodesia created a substantial audience for world news" (133).

Gathigi (2009) studied radio listening habits in rural Kenya and also found that "[m]ost men in Kieni West used radio as a companion in their places of work" (142) and that men were more likely to carry the radio when going to work in the fields than were women (142). Indeed, he quotes one 68-year-old male respondent as claiming that his portable radio "has become a part of me" (142).

These findings tend to further undermine confidence in the utility of a measure of radio reception as a proxy for radio consumption in Rwanda. If radio owners in Rwanda, like radio owners in Zambia and Kenya, carried their radios to work in the fields in the period during which RTLM was broadcasting, then variation in consumption of those broadcasts from cell to cell

might be much less than is implied by levels of radio reception. For example, Yanagizawa-Drott's data indicates that only about five percent of the cell of Vumbi in the Runyinya commune had radio reception; in contrast, radio reached 13% of the cell of Kibingo, which was in the same commune. Yet, if residents of both cells spent their days tending fields at relatively high altitude areas, where radio reception is at its best, then they might in fact have had roughly equivalent levels of consumption RTLM broadcasts. The evidence that men are more likely than women to listen to radio at work in rural occupations is significant as well, since the majority of the participants in the genocide were male (Adler *et al*. 2007). Hence, radio consumption by the actual participants in the genocide might vary less than is implied by measures of radio reception.

In addition, because radio consumption is often a social activity in Sub-Saharan Africa, residents might have tended to gather in the evenings in those few locations with good radio reception, as has historically often been the case in rural areas worldwide when media becomes available (Opt 1992; Roberts 1995; Leguy 2007). If so, then this again implies that residents' consumption of radio broadcasts might vary less among cells than is indicated by data on reception.

This evidence regarding media consumption patterns in other sub-Saharan African countries is of course not dispositive of those habits in Rwanda. Because the primary crops in Rwanda during the period before the genocide were not necessarily the same as those in Zambia and Kenya – for example, in Rwanda the primary cash crops were coffee and bananas (Verwimp 2003, 173-174), while in Zambia in the 1990s and early 2000s they were cotton and groundnuts (FAO/WPP 2002, 3), and in Kenya major crops included maize, sugarcane, tea and also coffee (Kibaara et al. 2008) –work patterns and hence media consumption habits during working hours

in Rwanda might differ from those in Zambia and Kenya. Moreover, unlike Zambia and Kenya during the years covered by the studies thereof cited herein, Rwanda was experiencing serious internal armed conflict in the years before the genocide, which of course is likely to have been disruptive of all manner of settled patterns of residents' social and economic life, including media consumption habits related thereto. However, such disruption would not have been either uniform nor universal, as noted by Sperling (1997), who reports that "[t]ime spent away from the homestead . . . was on average, four months, although this varied greatly by region (from 3-4 weeks in the southwest to 54.6 in the northwest) . . . [and] 30% of those still farming in Rwanda at the end 1995 had not been displaced at all, not even for a single day" (21).

However, there is evidence from Rwanda which indicates that the general patterns of media consumption observed in Zambia and Kenya were common in Rwanda as well. First, as was the case elsewhere in Africa, Rwandans listened to radio "in bars and at work, and . . . you could hear it in taxis and at the market" (The Prosecutor v. Ferdinand Nahimana 2003, 117). Indeed, as elsewhere, in Rwanda "[r]adio bookend[ed] and punctuate[d] the daily routine of many ordinary Rwandans" (Li 2004, 20), and "'people who did not have radios went to someone else's house to listen to the radio'" (Bonnier *et al*. 2016, 25 n. 33).

Second, many crops in Rwanda are cultivated on slopes — as of 2007, 77 percent of cultivated land in Rwanda had slopes between 13% and 55% (Republic of Rwanda 2007) — which implies that agricultural labor took place not in valley bottoms but rather higher up, where radio reception is generally better. Hence, a cell that has low radio reception by Yanagizawa-Drott's measure might actually have a relatively large percentage of its populace living in the small areas where reception is good.

Third, Rwanda experienced a crash in commodity prices and a serious drought in the early 1990s (Newbury 1998). Rural residents in such circumstances are likely to be driven to travel further afield in search of land to cultivate or other income activities. This implies that radio reception in participants' home cells might not accurately estimate their actual exposure to radio broadcasts. Moreover, Verwimp (2005) found that Hutu households with at least one participant in genocide averaged twice the number of days worked off the farm than did Hutu households with no participants. It is of course possible that the factors which caused Hutu individuals to seek work off the farm also caused such individuals to be more likely to participate in genocide. But, it is also possible that the experiences of those who worked off the farm had an independent effect on genocide participation rates. If exposure to RTLM broadcasts was one such factor, then the effects of that exposure cannot be estimated by a measure of home cell reception.

Fourth, in the two decades before the initiation of the genocide, the Rwandan government had implemented a resettlement policy, the Payasannat program, in which rural residents were encouraged to move either to hillsides or to valley bottoms; by the early 1990s, an estimated 76% of rural households had done so (Niazi 2002). Valley bottoms, of course, have poorer radio reception than hillsides. That is not problematic if the percentage of households located in valley bottoms in each cell is randomly distributed vis-a-vis estimates of radio reception. In other words, variation in cell-wide radio reception is a good proxy for variation in household consumption only if the proportion of the households living in valley bottom is unrelated to radio reception patterns. However, the Longley-Rice propagation model employed by Yanagizawa-Drott includes local terrain profiles, including terrain slope (Kasampalis *et al*. 2013; Weiner 2005). Hence, if residents' decisions on whether to locate their households in valley bottoms

rather than hillsides is also related to the nature of the local hillside terrain, which seems plausible, then there might be systematic biases in the variation between the propagation model's estimate of reception and actual reception, and hence consumption, of broadcasts.

Finally, the years before the genocide had of course been marked by an ongoing insurgency; in such periods of instability and potential threat, it is likely that those without radio reception at home would make a special effort to listen to news by finding neighbors or local gathering places that had reception (Bratić 2005, 4).

For all of these reasons it is entirely possible that variation in radio consumption among Rwandan cells is less than the estimated variation in radio reception which is generated by the propagation model employed by Yanagizawa-Drott. That raises the very real possibility that Yanagizawa-Drott's findings are somewhat less convincing than they appear. That possibility is all the more likely because previous studies of the Rwandan genocide tend not to support Yanagizawa-Drott's findings.

Previous studies of the Rwandan genocide have generally downplayed the role of RTLM

Although the popular media has blamed RTLM for causing or at least greatly exacerbating the genocide by generating hatred against the Tutsi (Smith 2003; Dalliare 2003, 272; Melvern 2000, 71), most researchers have found little direct evidence to support that claim.

First, qualitative studies of participation in the Rwandan genocide generally minimize the role of RTLM in causing the violence, and find that face-to-face interactions with peers and community members were key to catalyzing participation. For example, Straus (2007) interviewed 210 sentenced and self-confessed perpetrators, and found that most were mobilized by local actors (626). Similarly, Fujii (2009) found that social ties were the primary

determinants of how individuals responded to the genocide, which social ties "were the product of talking, gossiping, greetings, visiting, sharing beers, and participating in *umuganda* [the obligatory communal labor system]" (128); and McDoom's (2013) study of Category 2 participants in one sector of Rwanda found that participants often resided in neighbourhoods, and were members of households, with high concentrations of other participants. He concluded that "horizontal pressure" from peers was the primary determinant of participation; in contrast, he found that the evidence for pressure from above was merely "tentative" (462). Straus (2007) also notes that the most extreme RTLM broadcasts did not take place until the later stage of the genocide, after the bulk of the killing had already taken place (622)

McDoom (2013) also discusses the onset of violence in the Tare section, which at the time of the genocide was part of the Maraba commune (458). He notes that the violence in the Maraba commune, which was the focus of his study, did not begin until nearly two weeks after the assassination of President Habyarimana, but only the day after Rwanda's new president visited the commune; within four days, most of the local Tutsi population had been eliminated (459). That implies that the RTLM broadcasts had little effect in Maraba, and that instead it was in-person organizing that was the driving force of participation.

Finally, Nyseth Brehm (2017) examined variation in killing at the commune level and found that neither RTLM coverage nor an interaction between radio coverage and radio ownership was significantly associated therewith, but instead that higher levels of violence were associated with lower levels of social control and cohesion. However, Nyseth Brehm did note that an earlier study (Nyseth Brehm 2014) had found that greater Radio RTLM coverage was associated with earlier onsets of violence at the commune level.

Qualitative studies of the genocide also cast more direct doubt on the assumption that reception of RTLM is a valid proxy for consumption thereof. For example, Mironko (2007) interviewed 100 perpetrators of genocide and found that although many did not listen to RTLM broadcasts, nevertheless oftentimes "[t]hey heard the messages from others" (134), and Li (2004) notes that "[b]roadcasts were often reincarnated elsewhere as rumour," and relates the story of a militia member who "used to spend mornings on the roof of his shop with a radio clutched to his ear, listening to RTLM" and who would subsequently "climb down and gather people to tell them what he had heard" (19). That final anecdote is a particular telling example of the dangers of assuming that radio reception is a valid proxy for radio consumption; the individual in question presumably spent hours on his roof because radio reception in his area was poor, yet he and his neighbors were nevertheless able to consume the broadcasts and the contents thereof. However, it is possible to overstate the extent to which these studies are inconsistent with Yanagizawa-Drott. For example, McDoom's (2013) finding that participants tended to be concentrated in certain neighborhoods and households is perfectly consistent with Yanagizawa-Drott's finding that variation in radio reception helps explain variation in rates of participation, since the neighborhoods and households with many participants could easily be those with better radio reception. In addition, according to Yanagizawa-Drott's data, the commune in which McDoom conducted his research had rather poor radio reception. Hence, the fact that residents thereof did not engage in killing until prompted by a visit by the President does little to undermine Yanagizawa-Drott's argument. Finally, Yanagizawa-Drott's broad findings are consistent with Mironko's (2007) finding that any impact of RTLM was likely far greater in Kigali than in rural areas, in that Kigali had more broad radio reception than most rural areas.

Most importantly, Yanagizawa-Drott's findings are relatively modest – he estimates that ten percent of the overall violence can be attributed to the RTLM broadcasts – and most of the qualitative work on the genocide concludes that radio probably had at least some effect on participation. For example, although Straus (2007) "conclude[s] that radio alone cannot account for either the onset of most genocidal violence or the participation of most perpetrators[,]" he nevertheless "find[s] some evidence of conditional media effects" (611), especially among more hard-core participants, although he notes that "[t]he causal arrows remain unclear" (628). Similarly, Mironko (2007) concludes only that RTLM and other government-sponsored messages "*alone* did not cause them to kill" (134, emphasis in original), and Li (2004) maintains that RTLM broadcasts probably increased listeners' tendencies toward participation by "appropriate[ing] and transform[ing] elements of three of the dominant public discourses of post-colonial Rwandan modernity" (12-13), and by "implicat[ing] ordinary listeners in the activities of the genocide" (18).

Hence, Yanagizawa-Drott's findings are not entirely inconsistent with prior research.

Quantitative analysis of the predictive ability of Yanagizawa-Drott's proxy for radio consumption

It appears that, while Yanagizawa-Drott's findings are not necessarily inconsistent with previous research, nevertheless there is reason to question the validity of his proxy for radio consumption. As a result, his data might misstate the variation in radio consumption among cells, and hence his estimates of the effect of RTLM broadcasts on participation might be inaccurate. Had Yanagizawa-Drott been able to gather qualitative evidence regarding radio consumption habits in Rwanda, we could be more confident that his proxy captures the true

variation in RTLM consumption among cells. In the absence of that qualitative evidence, it is useful to conduct an additional quantitative analysis of his data, in order to determine whether higher levels of radio reception predict higher levels of participation in the genocide.

If radio reception is, in fact, a valid proxy for radio consumption, and if consumption or RTLM broadcasts did, indeed, cause increased participation in the genocide, then higher levels of radio reception should predict increased genocide participation. If, on the other hand, measures of radio reception are poor proxies for radio consumption, as I hypothesise, or if radio consumption had no causal effect on genocide participation, then higher levels of radio reception should not predict higher levels of genocide participation. This is because, although there is an important distinction between prediction and causal inference (Cederman and Weidmann 2017; Shmueli 2010), and of course some predictive variables are not causal (Gohdes and Carey 2017), a variable's failure to increase the predictive power of a model does reduce confidence in its role as a causal factor (Chenoweth and Ulfelder 2017; Hegre *et al*. 2017; Muchlinski *et al*. 2015; Wischnath and Buhaug 2014; Schneider *et al*. 2011).

An analysis of the predictive power of RTLM reception in Yanagizawa-Drott's model is also important because Ward *et al*. (2010) found that statistically significant variables in models of conflict onset are often poor predictors of onset. Hence, it cannot be assumed that RTLM reception in fact has predictive power, merely because Yanagizawa-Drott found it to be a statistically significant independent variable.

Therefore, following Ward *et al*. (2010), I assessed the predictive power of radio reception on genocide participation by employing Yanagizawa-Drott's fixed effects model. The dependent variable (Gacaca court prosecutions), the primary independent variable (radio

reception) and all control variables are those employed by Yanagizawa-Drott, who graciously provided his replication data and code.

Ward *et al*. (2010) measured the predictive power of conflict models using a calculation of the area under the Receiver Operating Characteristic (ROC) curve for the test set. The ROC curve was developed during World War II to assess the effectiveness of radar, and was subsequently applied to the field of medical diagnostics (Streiner and Cairney 2007). In both radar detection and medical diagnostics, there is a tradeoff between false positives (for example, a medical test which indicates the presence of disease when the patient is healthy) and false negatives (for example, a medical test that fails to detect disease in a patient who in fact has the disease). The ROC curve is a graph of the predictor's true positive rate (the number of correctly predicted events divided by the total number of cases where the event in fact occurred) against the false positive rate (the number of incorrect predictions divided by the total number of cases where the event did not occur) (Ward et. al 2010, 366). The area under the ROC curve is frequently used to assess the overall predictive accuracy of a model. The area's value ranges from 0.5 to 1.0, and it is a calculation of how much better the model does at predicting outcomes than does random chance; for example, an area of 0.5 indicates that the model only outperforms a random guess fifty percent of the time, and hence that it performs no better than a random guess (Ward *et al*. 2010, 266-267).

Because ROC analysis requires a binary dependent variable, I instead employed the method developed by Obuchowski (2005, 2006) for conducting ROC-style analysis on models with a continuous dependent variable, using the NonbinROC package in R (Nguyen 2007). Following Ward *et al*., I first assessed the predictive power of Yanagizawa-Drott's full model, and then dropped the radio reception variable from the model and reran the analysis. If the

predictive power of the truncated model dropped substantially, that would imply that radio reception improves the model's predictive ability, and hence that high levels of radio reception in a given cell (in Yanagizawa-Drott's parlance, village) predicts high levels of Gacaca prosecutions in that cell; if the truncated model performed just as well as the new model, then that implies that high levels of radio reception does not predict high levels of prosecution, which thus implies either that radio reception is a poor proxy for radio consumption, or that radio consumption did not increase genocide participation.

A common challenge in assessing the predictive accuracy of models is that, often, all of the available data is used to generate the model, leaving no data which can be used to test the ability of the model to predict outcomes based on out-of-sample data. The solution to this dilemma is to use K-fold cross-validation, in which the data is randomly divided into *k* equal sized subsamples. One subset is withheld, and the remaining *k-1* subsets are combined into a single training set. The training set is used to train the model, and then the model's predictive ability is then assessed using the remaining data, i.e., the test set. The procedure is then repeated *k* times, with a different subset being used each time as test set. As Ward *et al*. (2010) note, the results of that process can sometimes be dependent on the initial random partition; hence, the best practice is to repeat the entire process numerous times, and to then average the results (370).

Following Ward *et al*. (2010), I employed 4-fold cross-validation;[4] however, while Ward *et al*. repeated the process ten times, I found that repeated iterations of ten repeats yielded slightly different outcomes, so I instead repeated the process on one hundred different random partitions of the Yanagizawa-Drott data, and averaged the results.

[4] Increasing the number of folds to ten did not meaningfully change the results, which were the same within two decimal places.

I compared the results of the continuous ROC analysis on models with and without the radio reception variable by dividing the four hundred outcomes from the continuous ROC analysis into ten sets of forty each, and employing the paired t-test to calculate a p-value for each set. I repeated that analysis on ten different random sorts of the continuous ROC outcomes, and averaged the results. I chose the paired t-test because it is the most conservative of many options; that is, it has high power but also high rates of Type I error (Dietterich 1998), and hence is unlikely to underestimate any improvement in prediction from including the RTLM variable in the model.

The results of that analysis are set forth in Table 1.

Table 1
Results of Continuous ROC analysis

	Y-D Model	Model w/o RTLM	Paired t-test p-value
All violence	0.644	0.645	0.202
Category 1 violence	0.637	0.637	0.456
Category 2 violence	0.641	0.635	0.143

These results are interpreted as follows (Nguyen 2007, 5):

Regarding total violence, of two randomly chosen cells, a) there is a 64.4% chance that the cell with greater total participation in violence will have a larger predicted participation from the full model than the cell with less total participation in violence; b) there is a 64.5% chance that the cell with greater total participation in violence will have a larger predicted participation from the model that omits radio reception than the cell with less total participation in violence; and c) the difference between the two results is not statistically significant.

Regarding Category 1 violence, of two randomly chosen cells, a) there is a 63.7% chance that the cell with greater participation in Category 1 violence will have a larger predicted participation in Category 1 violence from the full model than the cell with less participation in Category 1 violence; b) there is a 63.7% chance that the cell with greater participation in Category 1 violence will have a larger predicted participation in Category 1 violence from the model that omits radio reception than the cell with less participation in Category 1 violence; and c) the difference between the two results is not statistically significant.

Regarding Category 2 violence, of two randomly chosen cells, a) there is a 64.1% chance that the cell with greater participation in Category 2 violence will have a larger predicted participation in Category 2 violence from the full model than the cell with less participation in Category 2 violence; b) there is a 63.5% chance that the cell with greater participation in Category 2 violence will have a larger predicted participation in Category 2 violence from the model that omits radio reception than the cell with less participation in Category 2 violence; and c) the difference between the two results is not statistically significant.

The results indicate that the out-of-sample predictive power of the model without radio reception is virtually the same as the the out-of-sample predictive power of the full model with radio reception included.

As Ward *et al*. (2010) note, the fact that statistically significant variables do not improve the model's ability to make correct predictions indicates that "something is amiss" (Ward *et al*. 2010, 372). Given the qualitative evidence discussed herein regarding the culture of radio consumption in Sub-Saharan Africa in general and in Rwanda in particular, it seems likely that what is "amiss" is that radio reception is an insufficiently precise proxy for radio consumption in period before and during the Rwandan genocide.

Conclusion

The findings herein do not, of course, mean that the RTLM broadcasts had no effect on the genocide. Indeed, there is good reason to think that they had some effect on specific instances of killing, given that there is evidence that the broadcasts were used explicitly to coordinate the actions of some of the *genocidaires* (Des Forges 1999; Kirschke 1996). In addition, because, as Straus (2015) notes, elites do not need large scale popular participation for genocide to take place but rather only need "popular compliance — they need citizens not to mobilise to resist violence" (66), it is certainly plausible that exposure to anti-Tutsi propaganda might have made implementation of the genocide easier, such as by reminding listeners of the founding, exclusionary ideology of the country (Straus 2015), by causing civilians to internalise norms that legitimised the killing (Smeulers and Hoex 2010), or by spurring the adoption of oppositional identities (Balcells and Steele, 2016; Kalyvas and Kocher 2007; Mandami 2001; Fearon and Laitin 2000).

What the findings do imply, however, is that quantifying the effect of media and communications technologies is even more challenging than previously thought. New methodologies such as the use of radio propagation models and the analysis of "big data" generated by social media platforms hold great promise, but their use must be coupled with a qualitative understanding of the society and the medium in question.

That understanding can help researchers choose the best tools and methods for their task. For example, because televisions are less mobile than radios, an analysis of television broadcasting reception is likely to be a better proxy for television program consumption than is an analysis of radio reception. Similarly, because people obviously have greater ability to move

through space than through time, an analysis that relies on temporal variation in media availability is likely to yield a more precise measure of media consumption than is an analysis that relies on geographic variation in media availability.

Moreover, scholars who employ measures of media availability should make every effort to also employ surveys or other instruments which can help to verify that media availability is indeed closely correlated with media consumption; the ability of Adena *et al*. (2015), DellaVigna *et al*. (2014), Durante *et al*. (2017), Enikolopov *et al*. (2011), and Olkean (2009) to do so greatly enhances DellaVigna *et al*. (2014) conducted a survey and determined that large numbers of Croats in areas where Serbian radio signals are strong in fact listen to Serbian radio with some regularity; and Durante *et al*. (2017) the reader's confidence in their findings.

Attention to the need for a qualitative understanding of media consumption habits is also likely to enhance the ability of future studies which employ analysis of information communication technology to contribute to the burgeoning literature on the role in political violence of such factors as social ties, McDoom (2014); communication networks, Larson and Lewis (2018); norm diffusion, Fujii (2004); and framing, Luft (2015), Shaikh (2016).

Finally, understanding the predictive power of models of political violence and of the variables included therein has important implications for public policy, including policies concerning prevention of mass atrocities, the limits of humanitarian intervention, and in the case of the role of the media in engendering violence, freedom of speech. (Nanlohy *et al*. 2017; Petrova and Yanagizawa-Drott. 2016; Dafoe and Lyall 2015; Muchlinski *et al*. 2015; Buhaug *et al*. 2014; Ward *et al*. 2010).

Moreover, the media, including social media, has been hypothesized to play important roles both in exacerbating violence and in advancing respect democracy and human rights. As

an example of the former, rumour has long been recognized as playing a role in sparking violence (Bhavnani *et al.* 2009; Horowitz 2001), and authorities have sometimes claimed that media can exacerbate that tendency (Polianskaya 2018; Ngdona 2017). On the other hand, many activists argue that social media can be a valuable tool for atrocity response, mitigation, and documentation (Tuckwood 2014), and that it can enhance citizens' political engagement (Gil de Zúñiga and Valenzuela 2011).

Therefore, understanding the precise role of communication technologies has the potential to improve policy, including policies designed to intervene in order to forestall violence (Kogen 2013). Research on communication technologies which is attentive to local media consumption habits therefore both improve our understanding of past events, and assist policymakers to design more effective policies.

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