

## INFORMATION OPERATIONS INCREASE CIVILIAN SECURITY COOPERATION\*

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Information operations are considered a central element of modern warfare and counter-insurgency, yet there remains little systematic evidence of their effectiveness. Using a geographic quasi-experiment conducted during Operation Enduring Freedom in Afghanistan, we demonstrate that civilians exposed to the government's information campaign resulted in more civilian security cooperation, which in turn increased bomb neutralisations. These results are robust to a number of alternative model specifications that account for troop presence, patrol-based operations, and local military aid allocation. The paper demonstrates that information campaigns can lead to substantive attitudinal and behavioural changes in an adversarial environment and substantially improve battlefield outcomes.

Modern military considers information and influence operations a central element of its strategy (Shapiro *et al.*, 2020). ‘The battlefield is not necessarily a field anymore. It’s in the minds of the people’, noted Admiral Michael Mullen, Chairman of the US Joint Chiefs of Staff, in 2010 (Mullen, 2010). In Afghanistan, these operations have been used to inform civilians about dangers of roadside bombs, political reform and peacebuilding programmes. Yet, despite hundreds of millions of dollars spent on the information operations during the Operation Enduring Freedom, a 2012 RAND study reported that evidence on operational effectiveness is ‘mixed at best’ (Munoz, 2012). In 2018, another RAND report concluded that NATO countries lag behind their adversaries in the use of information operations (Paul *et al.*, 2018). In the absence of a systematic evaluation of information operations’ impact, the prevailing view has been that they do not have the desired effect, especially in the ‘enemy’s territory’.

In this paper, we demonstrate the effectiveness of information operations by conducting a micro-empirical case study of US military operations in a critical region held by Taliban forces until 2010. The operations that we study are concerned with roadside bombs, the improvised explosive devices (IEDs) that remain one of the weapons most widely used by insurgents in

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The data and codes for this paper are available on the Journal repository. They were checked for their ability to reproduce the results presented in the paper. The authors were granted an exemption to publish parts of their data because access to these data is restricted. However, the authors provided the Journal with temporary access to the data, which enabled the Journal to run their codes. The codes for the parts subject to exemption are also available on the Journal repository. The restricted access data and these codes were also checked for their ability to reproduce the results presented in the paper. The replication package for this paper is available at the following address: <https://doi.org/10.5281/zenodo.5721383>.

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Afghanistan, killing thousands of civilians each year.<sup>1</sup> The information campaigns coordinated by international forces were primarily composed of posters, radio addresses and television advertisements detailing the dangers of roadside bombs and how civilians could report potential threats. Following the approach pioneered by Kern and Hainmueller (2009) and Olken (2009), we leverage quasi-random variation in radio signal penetration to estimate the impact of the US Marine's Radio-in-a-box (RIAB) programme in the Garmser district. Using a spatial difference-in-differences design, we find large increases in civilian cooperation and bomb neutralisation after the RIAB transmitter was activated, comparing areas that could have received messaging to those that did not have signal.

Our paper provides direct evidence that government messaging influences civilian behaviours and related battlefield outcomes. This contrasts with prior work, in which propaganda reinforces the existing attitudes, anti-Semitic in Adena *et al.* (2015) and anti-Tutsi in Yanagizawa-Drott (2014) and DellaVigna *et al.* (2014), in which the purpose of propaganda, pro-nationalist among Serbs, was different and triggered a rise in ethnic hatred among affected Croats.<sup>2</sup> The type of messaging that we study, radio broadcasts, and related efforts through television programming, telephone campaigns, posters and printed leaflets resemble a broader strategy used by governments, particularly the United States, globally. Our findings are also relevant to a significant number of ongoing civilian and military operations, currently active in Colombia, El Salvador, Guatemala, Guyana, Honduras, Panama, Peru, Suriname, Trinidad and Tobago, Venezuela as well as the Lake Chad Basin, Horn of Africa, Maghreb, and Gulf of Guinea.<sup>3</sup> These operations use messaging similar to the content shared during the 2010 mission in Garmser.

In our theoretical model, the audience, the receivers of information, is rational about the interaction it participates in, i.e., it knows that it is being influenced. The signal that they receive is sufficiently informative, so they consume information from the channel that contains propaganda, despite knowing that the information is biased. In our case, the Afghan civilians, not necessarily supportive of the government, know that the radio transmission is operated by the government; in the model, they tune in despite the opportunity cost of doing so. Combining these features, our theoretical model of information operations is a version of a Bayesian persuasion model (Kamenica and Gentzkow, 2011; Gehlbach and Sonin, 2014).<sup>4</sup> Naturally, the model predicts that there is a positive effect of radio access on roadside bomb reporting in an environment, in which agents would not report bombs in the absence of messaging. Additional reporting enables government forces to conduct bomb clearance operations.

In line with our theoretical prediction, we find evidence that the radio messaging campaign in Garmser increased civilian collaboration and enabled successful government-led bomb clearance

<sup>1</sup> United Nations Assistance Mission in Afghanistan stated in the October 2019 Quarterly Report: 'Improvised explosive devices (IEDs) claimed 42 per cent of all casualties, while ground engagements were the second leading cause of harm to civilians, at 29 per cent, followed by aerial attacks which caused the majority of civilian deaths, and made up 11 per cent of total casualties'.

<sup>2</sup> Gagliarducci *et al.* (2020) study how radio messaging was used by the Allied Forces to coordinate anti-fascist protests and resistance operations. More recently, rebel defection from the Lord's Resistance Army has been linked to radio broadcasts (Armand *et al.*, 2020).

<sup>3</sup> For more details, see the Operation and Maintenance Overview of the US Department of Defense (<https://bit.ly/3czs8Xe>); information operations conducted by the United States Southern and Africa Commands are described in the SOUTHCOM (<https://bit.ly/3fsGgU0>) and AFRICOM (<https://bit.ly/39vHkD0>) mission descriptions.

<sup>4</sup> For a survey of empirical evidence on persuasion, see DellaVigna and Gentzkow (2010).

missions. We conduct a battery of additional tests to rule out potential confounding factors. We are able to utilise unique features of our military data to track combat operations that occur while troops are on patrol as well as counter-insurgent activity, such as detaining suspected insurgents, that requires security force mobility. We also take advantage of granular data on local development projects allocated under the US military's Commander's Emergency Response Program. This type of data has been used previously by Berman *et al.* (2011) and Sexton (2016) to evaluate the impact of aid programmes in Iraq and Afghanistan. We find no evidence that patrol-based combat operations and detentions and local aid projects significantly influence our main results when we incorporate them as covariates in our main specification (Table 1, columns 2 through 4), even if we allow them to be differentially correlated with our outcomes of interest across pre- versus post-treatment periods (Table 1, column 5). In addition, we are able to account for potential biases from village density, local economic activity (night lights), terrain features, and soil conditions that may influence agricultural activity that vary with the onset of radio messaging (Table 1, columns 6 and 7).

We also develop several novel placebo tests that leverage the spatial extent of radio coverage and timing of the introduction of the tower's two antenna masts. The first placebo test evaluates how the effect of radio messaging decays with radio signal. We demonstrate that the estimated effects of radio messaging are attenuated (indistinguishable from zero) in concentric placebo coverage rings just beyond the spatial extent of radio penetration (Table 3, columns 2 and 5). Next, we leverage the staggered implementation of the radio tower's two antenna masts. The first mast, introduced in September 2010, was too short for radio signals to reach beyond the outpost's walls and was replaced with a taller mast at the end of October 2010. We find no effects during this placebo period—when treatment was initiated but could not yet reach villagers—and large positive effects after the installation of the second, taller mast (Table 3, columns 3 and 6). We implement a third placebo test inspired by the approach taken in Dell and Olken (2019), which leverages a large number of randomly seeded points where radio towers could have been built but were not to estimate counterfactual shifts in civilian behaviour and military outcomes. We estimate the effects of these placebo radio towers and compare them with the main effect of the actual radio tower. We find that the main estimates are substantively large when compared with the distribution of placebo effects (Figure 4).

We use a new approach to estimate radio propagation models, introducing results from a range of plausible technical features. Unlike prior work that uses complete information about the technical capacity of transmitter infrastructure (e.g., mast height, transmitter strength, transmission frequency), we use archival evidence and a field-based description of the tower to identify plausible technical values which we use to implement terrain-based and line-of-sight models. Using these engineering-based measures of radio penetration, we find evidence consistent with the main results (Tables 4 and 5).

Substate conflicts remain a source of substantial economic instability, human loss, and population displacement. Not surprisingly, the recent literature focuses on both origins and means of preventing these episodes of violence (Fearon and Laitin, 2003; Blattman and Miguel, 2010; Dube and Vargas, 2013; Dell and Querubin, 2018). Our research advances this literature by demonstrating that targeted influence campaigns can influence civilian behaviours and improve battlefield outcomes even in an adversarial environment. Our approach is most similar to Bleck and Michelitch (2017) and Blouin and Mukand (2019), though both focus primarily on the impact of localised messaging on the attitudinal changes, and Armand *et al.* (2020), who focus

Table 1. *Estimated Effect of Radio Messaging on Civilian Collaboration and Battlefield Outcomes.*

<i>Panel A: Civilian tips and turn-ins</i>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × radio signal	0.0143*** (0.00447)	0.0150*** (0.00465)	0.0149*** (0.00466)	0.0152*** (0.00465)	0.0150*** (0.00472)	0.0191*** (0.00476)	0.0214*** (0.00506)
SUMMARY STATISTICS							
Outcome mean	0.00655	0.00655	0.00664	0.00664	0.00664	0.00664	0.00664
Outcome SD	0.0852	0.0852	0.0858	0.0858	0.0858	0.0858	0.0858
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
R <sup>2</sup>	0.0399	0.0399	0.0408	0.0408	0.0416	0.0422	0.0426
<i>Panel B: Roadside bomb clearance missions (net detonations)</i>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × radio signal	0.0552** (0.0237)	0.0531** (0.0221)	0.0513** (0.0222)	0.0521** (0.0220)	0.0579*** (0.0208)	0.0744*** (0.0276)	0.0759*** (0.0279)
SUMMARY STATISTICS							
Outcome mean	0.0227	0.0227	0.0230	0.0230	0.0230	0.0230	0.0230
Outcome SD	0.238	0.238	0.239	0.239	0.239	0.239	0.239
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
R <sup>2</sup>	0.0628	0.0628	0.0728	0.0728	0.0806	0.0817	0.0821

Notes: Outcome of interest is civilian tips and turn-ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is specified in the post × radio signal row. Standard errors are clustered at the grid cell level and presented in parentheses; \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

on combatant behaviour. The central contribution of our investigation is that it demonstrates information operations are able to shape civilian attitudes and costly behaviours even in contexts where messaging is least likely to be effective—areas of persistent insurgent control—while reducing civilian and military exposure to security risks.

The rest of the paper is organised as follows. Section 1 presents a simple model of information operations. Section 2 contains the empirical analysis, while Section 3 discusses the results of supplementary investigations. Section 4 concludes.

## 1. A Model of Information Operations

Our theoretical model of information operations is an application of the Bayesian persuasion framework (Kamenica and Gentzkow, 2011; Gehlbach and Sonin, 2014; Bergemann and Morris, 2019). One advantage of Bayesian persuasion is that it provides the upper limit on the amount of persuasion that may be done using any communication protocol. We embed the model in the context we study: a government-led information operation where messages (signals) are transmitted to a civilian audience. We examine the conditions under which civilians (agents) are willing to report information about the location of roadside bombs.

### 1.1. Setup

There is a government that commits to an information design and a unit continuum of rational agents who have heterogeneous costs of listening to radio, and may use the transmitted information to choose whether or not to report IEDs.

For each agent  $i \in [0, 1]$ , the cost of listening to radio,  $\varepsilon_i$ , is uniformly distributed over  $[0, 1]$ . Agent  $i$  is deciding on whether or not to report IEDs to the local government office, and their willingness to do this depends on whether or not they consider the government friendly ( $f$ ), by which we mean ‘willing to and effective at neutralising threats to civilians’, or unfriendly ( $u$ ). If the government is friendly, then reporting IEDs brings the benefit of  $v^R$ ; if unfriendly,  $v^R - c$ , where  $c$  is the cost of reporting to an unfriendly government. Not reporting to the unfriendly government brings the benefit of  $v^N$ , while not reporting to the friendly government,  $v^N - n$ , where  $n$  proxies the willingness to be helpful.

As in any strategic decision-making setup, the particular values of parameters  $v^R$ ,  $v^N$ ,  $c$  and  $n$  are relevant to the extent that they affect relative standing of alternatives in the decision-maker’s eye. Assuming that  $v^R > 0$  represents the notion that agents benefit from a safer environment because of bomb neutralisation, a higher level of  $v^R$  corresponds to a higher benefit. Naturally, the agent who decided to report prefers to report to a friendly, rather than unfriendly government, so  $c > 0$ . At the same time, reporting to the government that is unwilling or not effective at neutralising threats is associated with costs, including the potential for retaliation by rebel forces. Thus,  $v^N > 0$ ; a higher  $v^N$  corresponds to a higher expected cost. Similarly, assuming  $n > 0$  is equivalent to an assumption that the agent who does not report IEDs prefers a friendly government to be in place to an unfriendly one.

Citizens are uncertain about the government’s friendliness; they may have doubts about the government’s intent and its effectiveness. The common prior is  $P(g = f) = \theta$ . We assume that in the absence of any information, people perceive the government as insufficiently friendly and prefer not to report. Formally, this corresponds to the assumption that  $v^R - v^N < (1 - \theta)c - \theta n$ .

(If this assumption fails, the citizens do not need to be persuaded: the expected relative benefits of reporting are so high that they report in the absence of any information.)

The government is interested in neutralising as many IEDs as possible, which in our setup means that it is maximising the expected number of reports about the location of roadside bombs. As it is standard in the Bayesian persuasion literature, the government commits to a signal  $\hat{g}$  that is conditioned on the state of the world. Choosing among all possible information designs, Kamenica and Gentzkow (2011) show that it suffices to focus on signals  $\hat{g}$  such that with  $P(\hat{g} = f|g = f) = 1$ ,  $P(\hat{g} = f|g = u) = \beta$ , where  $\beta \in [0, 1]$  is the signal's *slant*, which is the control parameter of the government.

The timing is as follows. First, the government chooses the signal's slant,  $\beta$ , to maximise the expected number of reports; second, agents decide whether or not to listen to the signal (via radio, for example); and third, upon receiving the public signal, they decide whether or not to report IEDs,  $a_i \in \{R, N\}$ , to maximise their expected utility. We focus on Bayes perfect equilibria.

## 1.2. Analysis

Without turning on the radio, agent  $i$  has the following choice. The expected value of reporting is  $\theta v^R + (1 - \theta)(v^R - c) = v^R - (1 - \theta)c$ ; the expected value of not reporting is  $\theta(v^N - a) + (1 - \theta)v^N = v^N - \theta n$ . Given our assumption that agents choose not to report without any additional information, the expected payoff of an agent that does not have any information is  $v^N - \theta n$ .

As argued above, the signal conveys the information truthfully, if the state of the world is favourable to the government, and randomises with probability  $\beta$  if it is not. Critically for a model of propaganda, the agents know the value of this parameter. Thus, they know that information is slanted in order to influence their behaviour, yet the signal is still sufficiently informative so that they rationally prefer to listen to it, even in the presence of an opportunity cost. For the government, the ability to persuade an agent is limited by two incentives constraints: First, the signal must be informative enough so that the agent listens to the radio broadcast. If there is too much slant ( $\beta$  is too high), then the informativeness of the signal is insufficient to cover the agent's opportunity. Second, it must be optimal, for the agent, to follow the signal that they receive.

If agent  $i$  listens to the radio and the signal is  $\hat{g} = f$ , then their belief that the government is friendly becomes

$$P(g = f|\hat{g} = f) = \theta/(\theta + (1 - \theta)\beta).$$

In equilibrium, agent  $i$ 's actions should correspond to the signals:  $a_i(\hat{g} = f) = R$ ,  $a_i(\hat{g} = u) = N$ . Thus, the incentive compatibility constraint of agent  $i$  implies that the level of bias the government introduces,  $\beta$ , should satisfy

$$\beta \leq \theta(v^R - v^N + n)/((1 - \theta)(c - (v^R - v^N))).$$

The expected payoff of an agent that has access to the signal is

$$(\theta + (1 - \theta)\beta)v^R - (1 - \theta)\beta c + (1 - \theta)(1 - \beta)v^N. \quad (1)$$

For any  $\beta$ , agent  $i$  listens to radio as long as the difference of the expected value of having access to information, (1), and the expected value of not having access,  $v^N - \theta n$ , exceeds  $\varepsilon_i$ .

Given our assumption about the distribution of costs, the number of those who listen to radio is

$$I_G(\beta) = (\theta + (1 - \theta)\beta)(v^R - v^N) - (1 - \theta)\beta c + \theta n.$$

As the government is interested in maximising the expected number of reported IEDs, which is  $P(\hat{g} = f)I_G(\beta)$ , the equilibrium level of propaganda is given by Gehlbach and Sonin (2014).<sup>5</sup>

$$\beta^* = 1/2(\theta/(1 - \theta))((2v^R - c - 2v^N + n)/(c - v^R + v^N)).$$

The envelope theorem gives the following comparative statics results.

**PROPOSITION 1.** *The equilibrium number of reported IEDs increases with an increase in  $n$ , the regret of not reporting to a friendly government, and an increase in  $v^R$ , the value of reporting to a friendly government. It decreases in  $c$ , the cost of reporting to an unfriendly government, and increases in  $v^N$ , the value of not reporting to an unfriendly government.*

In our empirical findings, we establish that the activation of the RIAB transmitter has had a significant positive effect on IED tips and, consequently, bomb neutralisations in those areas in which citizens gained access to the radio signal. This corresponds to the presence of persuasion opportunity in the theoretical model. Without such a mechanism, there would be no IED reporting; with the mechanism in place, agents with low opportunity costs of listening to radio report IEDs to the authorities. In the Online Appendix, we report additional theoretical results that make a distinction between agents who have access to the signal and those who do not. A larger access results in a higher number of IED tips; a previous positive experience with the government (e.g., a higher prior  $\theta$  or a higher benefit  $v^R$ ) further enhances the effect.

## 2. Design and Evidence

In this section, we introduce the research design and main results as well as placebo tests and alternative estimates using engineering-based measures of signal propagation.

### 2.1. Research Design

We study the impact of radio messaging during the operation of Combat Outpost (COP) Rankel in the Garmser district (Helmand province), from 2010 to 2011. COP Rankel was established near Safar Bazaar as a staging point for disrupting Taliban command and weapons trafficking in southern Helmand, which borders Pakistan (Malkasian, 2016).

The study site is presented in Figure 1. On 1 September 2010, US forces established the Radio-in-a-box (RIAB) programme at COP Rankel, which transmitted news about current events in the area as well as messages coordinated with community leaders encouraging civilian cooperation with local security forces. The messages highlighted the dangers of roadside bombs and other threats to civilians. Public data from the Asia Foundation's Survey of the Afghan People as well as proprietary military data suggest radio ownership ( $\geq 95\%$ ) and use ( $\geq 85\%$ ) is extensive in Helmand, though radio signal penetration at the study site was limited prior to the RIAB installation.

Transmission coverage, which decayed at roughly 17.5 kilometres, created a natural set of treatment and control villages for our study. The study site is introduced in Figure 1(a). The

<sup>5</sup> Gehlbach and Sonin (2014) considered a special case of  $v^R = c = 1 - q$ ,  $v^N = n = q$ , and  $\theta < q$ .

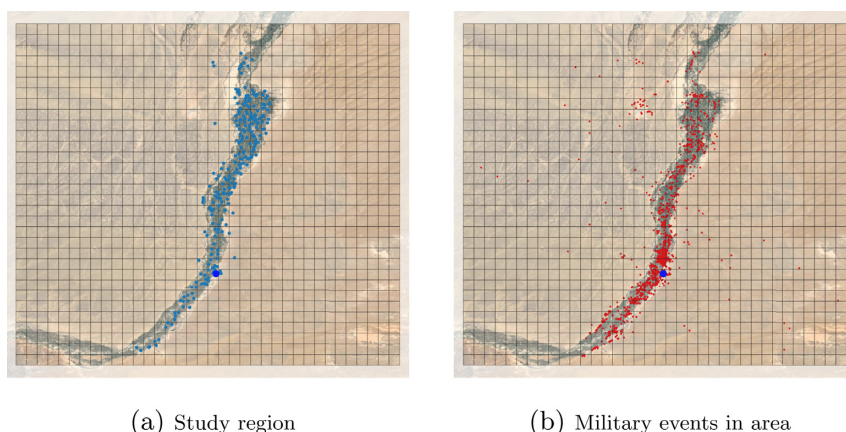


Fig. 1. *Area of Study and Military Data Overlay.* Figure illustrates the location of the study site in Garmser. Panel (a) notes the location of settlements (light blue dots) and combat outpost (COP) Rankel (large dark blue dot). COP Rankel is the site of the Garmser radio-in-a-box (RIAB) tower. Panel (b) overlays the events recorded in the military logs used in the analysis. These red dots indicate combat and intelligence gathering locations during the sample period.

transmission site is noted with a large blue circle. In the main analysis, we leverage the spatial extent of transmission as our primary measure of exposure to radio messaging. We confirmed the geographic limit of the radio signal with a field officer present at the study site when the RIAB was established using a labelled village map. We construct an arbitrary grid matrix, which we use to identify settlements inside and outside of the exposure range of the radio tower. We focus on populated grid cells with at least one village or settlement. We use this populated grid to collapse precisely georeferenced tips and combat activity data (Figure 1(b)).<sup>6</sup>

This approach differs from Yanagizawa-Drott (2014) and Armand *et al.* (2020), which use signal propagation models to estimate radio penetration. After an exhaustive review of archival documents, we have not been able to confirm the exact technical details of the COP Rankel transmitter, including its strength and antenna height. As an additional exercise, we use information about the probable characteristics of the tower and its transmission capacity to estimate a more continuous treatment classification for each gridded area. We discuss these alternative approaches in greater detail below.

## 2.2. Descriptive Evidence

Using the signal cut-off described earlier, Figure 2(a) plots trends in civilian tips and bomb turn-ins for treated (green) and control (black) units for 180 days before and after COP Rankel was established. In line with our theoretical model, we see a significant increase in civilian collaboration following the onset of radio messaging among communities with radio reception. We repeat this exercise for bomb neutralisations (net detonations) in Figure 2(b). Prior to radio transmissions, daily activity in treated and control areas was very similar, with one exception: the August 2010 spearhead mission to clear and hold the location where COP Rankel was built. Although the spearhead mission could have led to a short-term increase in civilian collaboration,

<sup>6</sup> In total, data was logged in 74 grid cells containing 244 villages. See Condra *et al.* (2018) for additional data details.

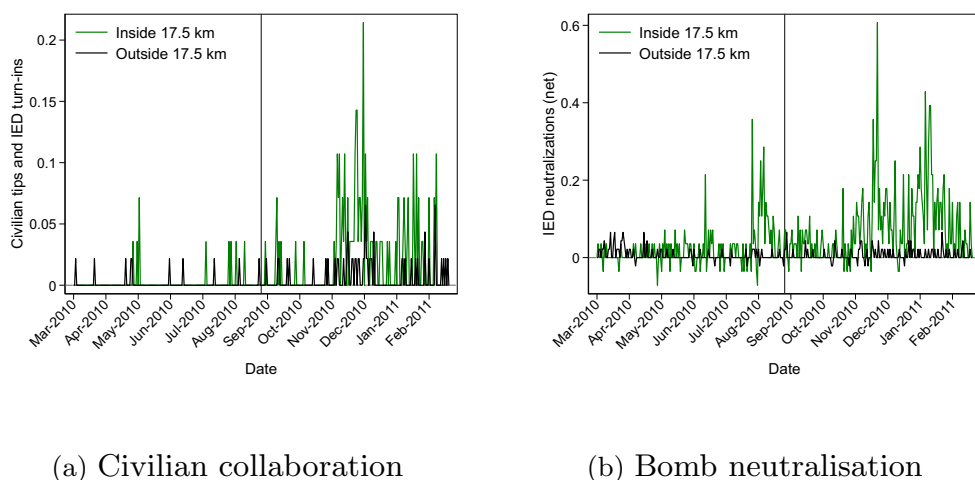


Fig. 2. *Descriptive Evidence of RIAB Messaging Impact on Civilian Cooperation and Bomb Neutralisation.* Figure illustrates the time series of combat and intelligence gathering events during the study period, split into the grid cells classified as exposed to RIAB radio coverage ( $=1$ ) or not. Panel (a) documents daily time series (mean) of civilian tips and bomb turn-ins (by civilians) during 180 days prior to and following introduction of the COP Rankel transmitter. Green trend line indicates cells within radio signal zone (treatment units;  $<17.5$  km); black indicates cells outside the signal zone. Panel (b) presents the equivalent daily time series (mean) of bomb neutralisations (net explosions).

we see no such trend. Overall, the descriptive trends prior to the onset of messaging suggest that civilian security cooperation and bomb neutralisation activities were comparable across areas with and without radio messaging exposure. After radio transmissions begin, however, civilian cooperation and bomb clearances increase substantially in villages with radio access whereas settlements without access remain unaffected. Although the descriptive patterns are quite stark, we introduce regression-based evidence below to more robustly assess the impact of radio messaging on civilian collaboration and bomb neutralisation missions.

### 2.3. Regression-based Evidence

We next produce regression-based estimates of the impact of messaging exposure using a standard difference-in-differences approach. We include grid cell fixed effects to account for local geographic, political and economic characteristics specific to village clusters that remain fixed over time. We also include time fixed effects to account for shocks that are common across the study region and vary over time. We estimate the following equation:

$$y_{gt} = \alpha + \beta_1 Post_t \times Exposure_g + \lambda_g + \gamma_t + \epsilon, \quad (2)$$

where  $y_{gt}$  is (i) the count of civilian tips and IED turn-ins and (ii) the count of bomb neutralisations (net explosions) by grid cell and day.  $\lambda$  and  $\gamma$  represent grid cell and time fixed effects, which absorb the base terms  $Post_t$  and  $Exposure_g$ .  $\beta_1$  captures the change in tips and bomb neutralisations among the grid cells within the radio signal zone after the messaging begins (compared to control units outside the coverage zone).

We present the baseline estimates in Table 1 with summary statistics for the outcomes of interest shown below the coefficient estimates.<sup>7</sup> Results for civilian collaboration are presented in Panel A and results for battlefield outcomes (roadside bomb clearance) are presented in Panel B. Column 1 introduces the result for the two-way fixed effect difference-in-difference model with no additional controls. Following the introduction of the radio messaging platform at COP Rankel, we observe an increase in civilian tips and bomb turn-ins (SD 0.16) as well as a large increase in successful bomb clearance operations (SD 0.23). These effects are large in magnitude and statistically significant.

We next turn to a series of robustness checks that address a number of potential sources of bias in these main estimates. The timing of radio transmissions likely coincided with a broad shift in troop presence and patrol intensity. This shift in troop presence and movement could have led to increased insurgent activity. These factors might have also impacted the ability of military forces to log records of combat engagement. We take several steps to account for these concerns. We georeference data on coalition patrol stations (Malkasian, 2016, p. 218) and calculate the proximity between villages and the nearest patrol station, which we collapse by grid cell. Because this characteristic is fixed, proximity to the nearest patrol station is accounted for in our research design with grid cell fixed effects. However, we can allow the effect of patrol proximity to vary across time with the onset of radio messaging. This parameter ( $post \times patrol\ proximity$ ) accounts for the potential correlation between messaging onset and changes in patrol activity related to the deployment of troops in the study region. We introduce this parameter in column 2 of Table 1. In column 3, we account for another potential source of bias: changes in insurgent tactics. If troop movement coincides with a meaningful shift in insurgent tactics and presence, we would expect a shift in close combat activity (typically insurgent ambush attacks while troops are on patrol) and the number of insurgents detained by security forces (which also involves patrol activity). We gather information on these attacks and detentions and incorporate them into our model using a number of lags (up to seven time periods).<sup>8</sup>

It is also possible that radio transmission onset may have been correlated with changes in the use of military and development aid, in line with the model in Berman *et al.* (2011). Any shift in aid allocation that is correlated with exposure to radio messaging could bias our estimates. *Ex ante*, it is unclear if information operations and aid delivery coincide with one another (complements) or are used as alternative strategies for influencing the civilian population (substitutes). If they are complements, the introduction of radio programming is positively confounded by aid delivery and aid projects trigger civilian collaboration, improving battlefield outcomes (as Berman *et al.*, 2011, argue is likely), then our main estimates overstate the positive impact of the radio campaign. On the contrary, if aid delivery is used to enhance community ties in villages beyond the coverage zone, we are likely to underestimate any positive effects (given that the onset of radio programming influences a positive spatial displacement of programmatic resources). To address this concern, we gather georeferenced data on 293 projects executed as part of the Commander's Emergency Response Program (CERP) that are initiated during our study period (across grid cells). Using this data, we estimate the daily amount of aid delivered to each grid cell. Given that the scale of projects varies considerably, we measure military aid in logs (with one dollar being added to observations with no aid). We introduce this measure in column 4 of Table 1. Again, the main results are largely unaffected.

<sup>7</sup> Additional summary statistics are provided in Table A1.

<sup>8</sup> Our results are unaffected by the number of lagged time periods we incorporate, including 14- and 28-day lags.

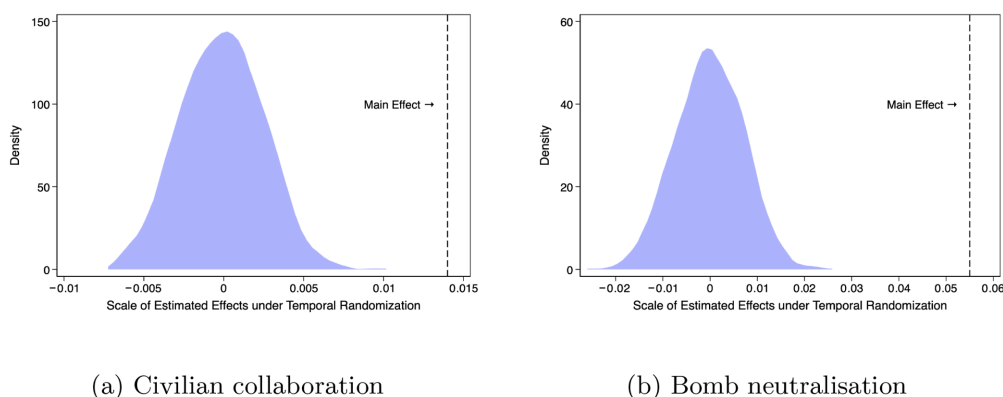


Fig. 3. Distributions of Estimated Effects of Spatially Stratified Randomisation Inference Tests (Temporal Randomisation). Outcome variable is shuffled randomly 1,000 times (for each analysis). Estimates are normally distributed around 0. (a) Analysis of civilian tips and IED turn-ins, with randomly reshuffled data. Dashed line indicates estimated effect from main specification. Distribution indicates main result is highly unlikely to have occurred by random chance ( $p < 0.001$ ). (b) Analysis of bomb neutralisation (net detonations), with randomly reshuffled data. Dashed line indicates estimated effect from main specification. Distribution indicates main result is highly unlikely to have occurred by random chance ( $p < 0.001$ ).

We can push these three approaches even further by allowing the effects of close combat attacks, insurgent detentions, and military aid projects to vary by treatment window. This alternative model specification allows us to account for any systematic shifts between these factors and our outcomes of interest that coincide with the onset of radio messaging in Garmser. These results are presented in column 5. The use of time-varying effects also enables us to dynamically account for cross-sectional features that are otherwise partialled out during estimation (due to the inclusion of grid cell fixed effects). In particular, the estimates may be meaningfully influenced by the number of villages within each grid cell—a proxy for microlevel population density—as well as local economic activity, which we measure using detected light output during 2010. We incorporate these measures using time-varying effects in column 6. In column 7, we incorporate measures of terrain conditions (ruggedness) as well as soil quality using information from the Food and Agriculture Organization's Harmonized World Soil Database (nutrient availability, nutrient retention, and excess soil salts). Even after accounting for these cross-sectional features, the association between radio messaging and civilian collaboration and bomb neutralisation remains robust and substantively significant.

We implement two additional exercises to assess the main result. First, to address potential concerns about spatial correlation in roadside bomb deployment and neutralisation, we conduct a set of spatially stratified randomisation inference tests ( $\times 1,000$ ) for each model. These tests are designed to account for spatial autocorrelation in combat and related activities by randomly shuffling actual realisations of the outcome within each grid cell across days in the study period.<sup>9</sup> The estimate distributions are presented in Figure 3. These results suggest the main results are highly unlikely to have occurred by chance ( $p < 0.001$ ) and yield a measure of statistical precision consistent with our geographically clustered standard errors. Second, we use a Wald

<sup>9</sup> We thank Florence Kondylis and John Loeser for this recommendation.

Table 2. *IV Estimates of Pass-Through Effect of Radio Messaging on Bomb Neutralisations via Civilian IED Tips and Turn-Ins.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Civ. tips/turn ins	3.852* (1.953)	3.540** (1.735)	3.440* (1.740)	3.433** (1.695)	3.863** (1.645)	3.899** (1.687)	3.543** (1.505)
SUMMARY STATISTICS							
Outcome mean	0.0227	0.0227	0.0230	0.0230	0.0230	0.0230	0.0230
Outcome SD	0.238	0.238	0.239	0.239	0.239	0.239	0.239
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
Kleibergen–Paap <i>F</i> statistic	10.30	10.44	10.27	10.67	10.07	16.08	17.91

Notes: Outcome of interest is IED neutralisation (net detonations). Instrument is post × radio signal. Instrumental variable specification follows baseline specification in Table 1. First stage *F* statistic for excluded instrument reported in bottom row of table. Standard errors are clustered at the grid cell level and presented in parentheses; \*\*\**p* < 0.01, \*\**p* < 0.05, \**p* < 0.1.

Estimator to calculate the pass-through effect of information operations on battlefield outcomes via civilian tips and IED turn-ins. To do this, we use the difference-in-differences parameter ( $Post_t \times Exposure_g$ ) to instrument variation in civilian cooperation. We then use this plausibly exogenous messaging-induced variation in civilian behaviour to evaluate the impact of cooperation on bomb neutralisation. These results are introduced in Table 2. These results suggest a large effect via this mechanism, with each additional messaging-related tip associated with roughly four net bomb neutralisations. The pass-through effect is also robust to the various alternative model specifications presented in Table 1. This exercise is useful insofar as it demonstrates that messaging-induced shifts in civilian cooperation are, at least in part, associated with meaningful changes in battlefield outcomes. However, we advise caution in interpreting the magnitude of the pass-through effect because the exclusion restriction could be violated if, for example, radio messaging influenced other forms of civilian cooperation that we do not observe in our data.

2.4. *Using Alternative Placebos to Benchmark Main Estimates*

To further benchmark the main estimates, we use three placebo estimation approaches. We begin by focusing on the spatial extent of coverage. Although we cannot definitively identify which villages have signal access, we use a field-based assessment from an officer deployed to the study region to verify the outer limit of received signal. We can evaluate this assessment by investigating attenuation in the main effects across space. To do this, we construct two 5-kilometre buffers around the treatment zone and classify villages into four bins: within the coverage zone (less than 17.5 kilometres to the mast), in the first exterior buffer (17.5–22.5 kilometres to the mast),

Table 3. *Estimated Effect of Radio Messaging on Civilian Collaboration and Roadside Bomb Clearance (Net Detonations).*

	Civilian tips and turn-ins			IED neutralisations (net detonations)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post × radio signal	0.0143*** (0.00447)	0.0152*** (0.00453)		0.0552** (0.0237)	0.0548** (0.0238)	
Post × 5 km outside		0.00222 (0.00275)			0.00113 (0.00564)	
Post × 10 km outside		0.00345 (0.00621)			−0.00442 (0.00754)	
Post × radio signal (short)			0.00197 (0.00191)			0.00701 (0.0135)
Post × radio signal (tall)			0.0206*** (0.00652)			0.0797** (0.0312)
SUMMARY STATISTICS						
Outcome mean	0.00655	0.00655	0.00655	0.0227	0.0227	0.0227
Outcome SD	0.0852	0.0852	0.0852	0.238	0.238	0.238
MODEL PARAMETERS						
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Concentric buffers	No	Yes	No	No	Yes	No
Pre/post tower upgrade	No	No	Yes	No	No	Yes
MODEL STATISTICS						
No. of observations	26,714	26,714	26,714	26,714	26,714	26,714
No. of clusters	74	74	74	74	74	74
R <sup>2</sup>	0.0399	0.0399	0.0411	0.0628	0.0628	0.0652

Notes: Outcome of interest varies by column. Relevant coefficient estimate is specified in the post × radio signal row. Standard errors are clustered at the grid cell level and presented in parentheses; \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

in the second exterior buffer (22.5–27.5 kilometres to the mast), and beyond 27.5 kilometres. This allows us to examine if villagers just outside of the coverage zone are more or less likely to cooperate with security forces relative to civilians further away. We estimate the following equation in (3):

$$y_{gt} = \alpha + \beta_1 Post_t \times Exposure_g + \beta_2 Post_t \times ExteriorBuffer_g^{17.5-22.5} + \beta_3 Post_t \times ExteriorBuffer_g^{22.5-27.5} + \lambda_g + \gamma_t + \epsilon, \tag{3}$$

where parameters and notation follow (2) and  $\beta_1$  captures the change in tips and bomb neutralisations among the grid cells within the radio signal zone after the messaging begins;  $\beta_2$  and  $\beta_3$  capture the same effects for the first and second exterior buffers. Grid cells outside of the second exterior buffer are the control units in this specification. These results are presented in Table 3 as columns 2 and 5. Notice the coefficients of interest,  $\beta_1$  for grid cells within the coverage zone, remain nearly unaffected while the estimated effects of treatment in the first and second exterior buffers are indistinguishable from zero. This attenuation is what we would expect if messaging exposure decays past the coverage zone for the RIAB tower and suggests that any potential spatial spillovers are likely neither statistically nor substantively meaningful.

We introduce second placebo strategy focusing on the timing of the deployment of a secondary tower at COP Rankel. That is, we exploit the timing of the roll out of the towers of differing heights as a placebo test. The shorter antenna, which came in the RIAB platform as original manufacturing equipment, had effectively no range beyond the immediate vicinity of the Combat

Outpost where the radio was located. Noting this technical issue, forces at the location requested and set up a taller tower approximately two months later. To exploit this staggered introduction of the two radio masts, we split the post-RIAB period and estimate two post-treatment regressors. We estimate the following equation:

$$y_{gt} = \alpha + \beta_1 Post_t^{short} \times Exposure_g + \beta_2 Post_t^{tall} \times Exposure_g + \lambda_g + \gamma_t + \epsilon. \quad (4)$$

We anticipate the timing of increased collaboration and counter-insurgent activity will coincide with the establishment of the second, taller tower. That is, we expect that  $\beta_1$  in (4) will be small and  $\beta_2$  will be large relative to  $\beta_1$  in (2), which pools the post-transmission period. In addition to serving as a placebo check for the primary estimates, this approach also helps us assess whether changes in civilian cooperation and military activity reflect a shift in military presence, which coincided with the deployment of the original tower, or were primarily driven by changes in signal penetration (with the tall mast). These results are presented in Table 3 as columns 3 and 6. Notice that there are no discernible effects of radio messaging after the introduction of the first mast but prior to the installation of the second mast; after the installation of the taller mast, we observe large, positive effects of messaging on civilian collaboration and bomb clearance missions.

We implement a third placebo strategy—following the approach in Dell and Olken (2019)—to estimate the effect of counterfactual radio tower locations. Dell and Olken (2019) identify feasible locations for counterfactual sugar plantations in colonial Java. They restrict the location of randomly seeded counterfactual plantations by considering only sites located along rivers, upstream or downstream from an actual factory, and where the amount of suitable land nearby is similar to actual locations. Then they compare the effects of actual plantation sites to counterfactual effects, which allows them to compute an alternative  $p$ -value. We take a similar approach, randomly seeding 25,000 counterfactual radio tower sites within the study region and identify locations with comparable characteristics as the actual tower site. These constraints include proximity to the road network (approximately 1 kilometre), the type of road access (all roads or military grade roads), location within the geographic corridor of the actual site (a bounding region including potential sites along the Garmser canal), and the density of villages within the radio coverage area of each site (signal reaches at least 71 settlements). We assume the radio penetration would be similar across actual and counterfactual locations and use the radii-based threshold in the main analysis. We then estimate the corresponding difference-in-differences model for all these sites following (2), partialling out any correlation with the true tower site. These results are introduced in Figure 4, with the main sample dark purple. We also introduce a number of permutations to the inclusion thresholds for counterfactual sites (Figure 4, alternative sampling rules). We find robust evidence that the point estimates in the main analysis are in the tail of the distributions of these placebo estimates.

### 2.5. *Alternative Models of Radio Penetration*

In the main analysis, we leverage a radii-based approach to study how the onset of radio messaging by coalition forces influenced civilian collaboration and battlefield outcomes. We take this approach because we lack information about the technical features of the transmitter and tower erected at COP Rankel. Although we cannot be certain about these features, we gathered archival material from the United States Army documenting similar RIAB units in other areas. From this documentation, we can reconstruct a plausible profile of the transmitter and radio antenna used

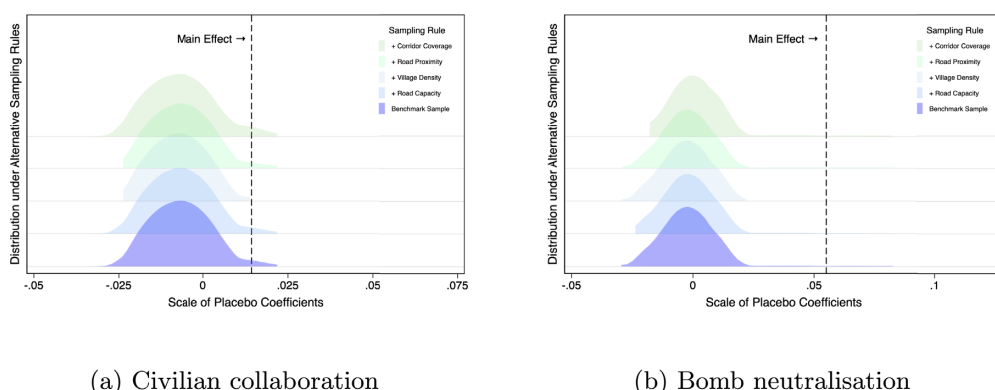


Fig. 4. *Estimated Effects of Randomly Seeded Placebo Radio Towers on Civilian Cooperation and Roadside Bomb Clearance. Main sampling threshold closely reflects characteristics of actual tower site with respect to proximity to the nearest road, density of covered villages (in exposure zone), and geographic region. The legend depicts alternative sampling conditions for identifying relevant placebo locations. This includes: increasing village density in the placebo coverage zones (to 75); raising the road network capacity threshold (to include only military grade roads); constraining the geographic corridor around the actual tower location (by trimming approximately one kilometre along both axes); enhancing the road proximity threshold (to approximately 0.5 kilometre).*

at the COP Rankel location. In particular, we anticipate it was likely a 300 watt unit, similar to the Ramsey Electronics FM transmitter used in Oruzgan Province, with a 10 foot mast. This would be consistent with field reports that the initial antenna only slightly exceeded the height of the HESCO barrier encircling the outpost (a stack of HESCO wall units is approximately 9.2 feet tall). The typical transmission frequency is 30 MHz.

In one of the placebo exercises above, we take advantage of the timing of a secondary tower which was erected near the end of October 2010. One of the officers present at the location noted that the new tower was one of the features of the Garmser skyline, slightly exceeding the height of their surveillance camera system. This description is consistent with a tower approximately the height of an erect ground-based operational surveillance system otherwise known as a G-BOSS. Most G-BOSS units were built by Raytheon Integrated Defense Systems and could operate at several heights, with Cerebus Lite units having a minimum total height of approximately 30 feet and larger units having total heights from 80 feet to approximately 100 feet.

Using this information, we now have three plausible tower height values as well as minimum bound values for transmitter strength and transmission frequency. We then implement the Longley–Rice Irregular Terrain Model (ITM) using the cloud-based platform [cloudf.com](https://cloudf.com). Figure 5(a) presents the baseline ITM result. This generates a raster of estimated radio propagation, which we use to calculate the share of each grid cell that could receive reliable transmissions from the COP Rankel tower.<sup>10</sup> We use these various continuous measures of radio propagation to re-estimate our benchmark difference-in-differences approach above, replicating the specification noted in (2). We present these results in Table 4. The column sequence follows the model specifications described above regarding Table 1. Notice that the primary specification yields

<sup>10</sup> Following advice from Alex Farrant, the lead radio engineer behind Cloud-RF, we set this dBvm threshold at 25 due to a lack of signal jamming devices in the region. Farrant was forward deployed to a patrol base north of the study site in Helmand and is familiar with the study area. We thank him for his detailed feedback.

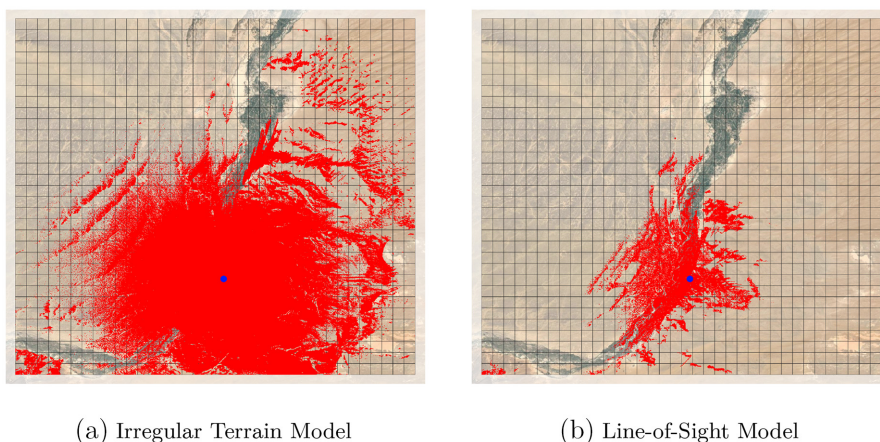


Fig. 5. *Estimation of Latent Irregular Terrain and Line-of-Sight Models from Known and Probable Propagation Parameters. Estimated radio penetration of Garmser RIAB in the study site is illustration presented in red. The location of the RIAB station is plotted with a large blue dot. Latent irregular terrain and line-of-sight models are estimated using Cloud-RF optimising for the known tower location as well as probable tower height, transmitter strength, and transmission frequency. For additional details, see the main text and data and software description (Online Appendix D).*

estimated effects of radio messaging on civilian collaboration and battlefield performance that are highly consistent with the baseline specification using the radii-based measure of radio signal. These results remain robust when we account for patrol proximity, combat activity, insurgent detentions, military aid projects, village density, economic activity, terrain features, and agricultural suitability (soil quality). These results are also robust across various additional latent model parameters for estimating signal propagation (see the Online Appendix, Figure B1), including towers of varying heights (30 feet and 80 feet, reported in the Online Appendix, Tables B2, B3) or varying signal quality thresholds (30 and 35 dBuvm, reported in the Online Appendix, Tables B4, B5).

One important feature of the ITM measures from our study site is geographic normality. That is, the lack of significant terrain variability means the corresponding ITM radio penetration measures will decay more uniformly with distance from the tower location than in more hilly or mountainous areas. An alternative to the ITM approach is the line-of-sight (LOS) model. In the study area, this model produces a measure of propagation that is significantly more heterogeneous geographically. We supplement the ITM measures above with this approach using the benchmark tower and transmitter values. The corresponding measure is illustrated in Figure 5(b). The main results are presented in Table 5 and yield estimates highly consistent with the main effects and larger in magnitude (though not statistically different compared with Table 1).

### 3. Discussion

Evidence from the Garmser radio messaging programme suggests that information operations can effectively increase civilian security cooperation and help thwart security risks. Overall, these findings have important implications for understanding whether information operations can be used to influence attitudes and behaviours even in a potentially adversarial environment, where

Table 4. *Estimated Effect of Radio Messaging on Civilian Cooperation and Roadside Bomb Clearance Using the Longley–Rice Irregular Terrain Model Approach with Known and Latent Parameters.*

<i>Panel A: Civilian tips and turn-ins</i>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × radio penetration	0.0160*** (0.00397)	0.0169*** (0.00416)	0.0170*** (0.00418)	0.0171*** (0.00418)	0.0169*** (0.00420)	0.0233*** (0.00438)	0.0262*** (0.00481)
SUMMARY STATISTICS							
Outcome mean	0.00655	0.00655	0.00664	0.00664	0.00664	0.00664	0.00664
Outcome SD	0.0852	0.0852	0.0858	0.0858	0.0858	0.0858	0.0858
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
R <sup>2</sup>	0.0398	0.0398	0.0407	0.0407	0.0416	0.0423	0.0427
<i>Panel B: Roadside bomb clearance missions (net detonations)</i>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × radio penetration	0.0507** (0.0234)	0.0472** (0.0210)	0.0459** (0.0210)	0.0460** (0.0208)	0.0505** (0.0194)	0.0709** (0.0285)	0.0832** (0.0323)
SUMMARY STATISTICS							
Outcome mean	0.0227	0.0227	0.0230	0.0230	0.0230	0.0230	0.0230
Outcome SD	0.238	0.238	0.239	0.239	0.239	0.239	0.239
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
R <sup>2</sup>	0.0616	0.0617	0.0718	0.0718	0.0793	0.0803	0.0815

Notes: Outcome of interest is civilian tips and turn-ins (Panel A) and Roadside bomb clearance (Panel B). The relevant coefficient estimate is specified in the post × radio signal row. Standard errors are clustered at the grid cell level and presented in parentheses; \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 5. *Estimated Effect of Radio Messaging on Civilian Cooperation and Roadside Bomb Clearance Using a Line-of-Sight Model with Known and Latent Parameters.*Panel A: *Civilian tips and turn-ins*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × radio penetration (LOS)	0.0217*** (0.00590)	0.0224*** (0.00608)	0.0223*** (0.00609)	0.0225*** (0.00607)	0.0227*** (0.00640)	0.0278*** (0.00642)	0.0315*** (0.00677)
SUMMARY STATISTICS							
Outcome mean	0.00655	0.00655	0.00664	0.00664	0.00664	0.00664	0.00664
Outcome SD	0.0852	0.0852	0.0858	0.0858	0.0858	0.0858	0.0858
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
R <sup>2</sup>	0.0405	0.0405	0.0414	0.0414	0.0422	0.0428	0.0434

Panel B: *Roadside bomb clearance missions (net detonations)*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × radio penetration (LOS)	0.0942** (0.0390)	0.0927** (0.0376)	0.0892** (0.0380)	0.0899** (0.0378)	0.103*** (0.0357)	0.127*** (0.0437)	0.132*** (0.0451)
SUMMARY STATISTICS							
Outcome mean	0.0227	0.0227	0.0230	0.0230	0.0230	0.0230	0.0230
Outcome SD	0.238	0.238	0.239	0.239	0.239	0.239	0.239
MODEL PARAMETERS							
Grid cell fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Patrol proximity	No	Yes	Yes	Yes	Yes	Yes	Yes
Close combat activity (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Detained insurgents (lags)	No	No	Yes	Yes	Yes	Yes	Yes
Military Aid (ln)	No	No	No	Yes	Yes	Yes	Yes
Covariates + covariates × post	No	No	No	No	Yes	Yes	Yes
Village density	No	No	No	No	No	Yes	Yes
Night lights	No	No	No	No	No	Yes	Yes
Terrain ruggedness	No	No	No	No	No	No	Yes
Soil quality	No	No	No	No	No	No	Yes
MODEL STATISTICS							
No. of observations	26,714	26,714	26,196	26,196	26,196	26,196	26,196
No. of clusters	74	74	74	74	74	74	74
R <sup>2</sup>	0.0651	0.0652	0.0749	0.0749	0.0834	0.0849	0.0852N

Notes: Outcome of interest is civilian tips and turn-ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is specified in the post × radio signal row. Standard errors are clustered at the grid cell level and presented in parentheses; \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

message receivers may not support or trust the message sender. Importantly, evidence from this quasi-experimental design comes from a ‘hard case’: a remote context that was previously under insurgent control (Malkasian, 2016). Civilian attitudes and behaviours may be particularly difficult to shift in areas where insurgents have been able to establish economic, political and social control previously or remain active. Previous evidence suggests information can be weaponised as a means of reinforcing existing prejudices and inciting violence. The findings of our investigation suggest information campaigns can also be successfully used to engage citizens and reduce exposure to violence. More broadly, these results suggest that cost-effective interventions can be effective even in contexts where the risks associated with information sharing are substantial and the civilian population is distrustful of the intervening actor (in this case, coalition forces).

While the relationship between messaging, civilian collaboration, and battlefield operations in Garmser is robust, it is important to consider whether this evidence extends beyond the specific policy intervention we study and provides insights for other civil conflicts. We evaluate the within-case relevance of the RIAB programme in several ways. First, we gather data from two waves of proprietary nationwide military survey data, which include questions about exposure to counter-IED messaging as well as willingness to report roadside bombs. The survey data are part of the Afghanistan Nationwide Quarterly Assessment Research (ANQAR) platform, coordinated by the North Atlantic Treaty Organization (NATO). The survey is designed and fielded by a local Afghan firm.<sup>11</sup> The evidence suggests survey respondents were 10% more likely to report roadside bombs if they had been exposed to information operations in the prior six months (Online Appendix, Table C6). This finding is robust to a number of alternative specifications and is highly unlikely to be credibly driven by an unknown confounding variable (Online Appendix, Table C8; see Oster, 2017, for bounding methodology). Second, we geographically link the survey data with declassified military records, which include intelligence reports collected about reported threats from roadside bombs as well as combat activity (notably IED detonations, bomb neutralisations, weapons depot seizures, informant killings, and other trends in violence). We collapse the data by administrative district and survey wave period. In line with the main results, we find that civilian security cooperation increases as the percentage of the population exposed to messaging increases (Online Appendix, Figure C3). Finally, we construct a large-scale data set tracking civilian cooperation and counter-insurgent outcomes at the district-by-week level. This approach allows us to examine the impact of cooperation on battlefield outcomes in the same district in the following week. We find strong evidence, consistent with our natural experiment, that more tips about roadside bombs lead to increased bomb neutralisation and weapon cache clearances (Online Appendix, Table C10). Additional evidence suggests a broader class of civilian cooperation, across a range of suspicious activities, also leads to increased safe house raids and detention of suspected insurgents. These additional results suggest the main finding is relevant to counter-IED messaging more broadly and holds beyond Garmser.

As we describe in the introduction, the policy intervention in Garmser is relevant to a range of historical and ongoing civil conflicts. Leaflets and posters were used in Panama during Operation Just Cause and Operation Promote Liberty as well as Iraq during Operations Desert Shield, Desert Storm, and Iraqi Freedom (Goldstein and Findley, 1996; Lamb, 2005). Similar interventions were implemented in Colombia starting in the 1990s, using traditional radio broadcasts as well

<sup>11</sup> See Online Appendix, Figure C2, for an overview of cooperation, refusal, and non-response rates. Also see Online Appendix, Table C9, for an overview of survey instruments. Additional information about ANQAR is described in Condra and Wright (2019).

as field-deployed loudspeakers, wall-sized collector cards, and advertisements during prominent soap operas (Jones, 2006). The US Department of Defense alone has allocated 228 million in the 2021 financial year to information operations like the Garmser programme. These messaging operations take advantage of a broad array of media platforms and are currently active in more than two dozen countries. Our findings provide insight into the likely impact of these information interventions.

#### 4. Conclusion

This paper provides quasi-experimental evidence from Afghanistan linking exposure to government-led information operations and civilian cooperation with security forces. This shift in cooperation coincided with a large increase in roadside bomb neutralisation. These results are robust to a number of alternative model specifications, including various methods for accounting for changing troop presence, movement and operations. These findings advance our understanding of the impact of messaging on civilian attitudes as well as costly behaviours even in a context where rebel forces have maintained consistent control and civilian attitudes towards the message sender are mixed or antagonistic. (In the Online Appendix, we report results of supplemental investigations that yield further evidence consistent with these findings.) Future investigations could take advantage of more precise information about the mechanisms available for disseminating messages in other political contexts, including social media campaigns. This research might also focus on civilian attitudes towards peacebuilding and post-conflict reintegration. Rigorously evaluating these future avenues of research will complement prior work and the evidence presented in this paper, further clarifying the effectiveness of information operations as a means of addressing or even avoiding political violence.

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Additional Supporting Information may be found in the online version of this article:

#### Online Appendix Replication Package

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