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JEL Classification: O1, D74, D82

Keywords: Propaganda, Bayesian persuasion, conflict

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Information Operations Increase Civilian Security Cooperation*

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May 27, 2021

Abstract

Information operations are considered a central element of modern warfare and counterinsurgency, 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 neutralizations. These results are robust to a number of alternative model specifications that account for troop presence, patrol-based operations, and local military aid allocation as well as a series of novel placebo tests and latent radio signal propagation approaches. The paper demonstrates that information campaigns can lead to substantive attitudinal and behavioral changes in an adversarial environment and substantially improve battlefield outcomes.

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1 Introduction

Modern military considers information and influence operations a central element of its strategy (Shapiro, Berman and Felter, 2020). "The battlefield is not necessarily a field anymore. It's in the minds of the people," noted Admiral Michael Mullen, Chairman of the U.S. 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 programs. 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, Clarke 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 Afghanistan, killing thousands of civilians each year.[1] 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 Olken (2009) and Kern and Hainmueller (2009), we leverage quasi-random variation in radio signal penetration to esti-

[1] 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."

mate the impact of the US Marine's Radio-In-A-Box (RIAB) program in Garmser district. Using a spatial difference-in-differences design, we find large increases in civilian cooperation and bomb neutralization 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 behaviors 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 Croatians.[2] 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, Venezeula as well as the Lake Chad Basin, Horn of Africa, Maghreb, and Gulf of Guinea.[3] 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

[2] 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, Atwell and Gomes, 2020).

[3] For more details, see the Operation and Maintenance Overview of the U.S. Department of Defense; information operations conducted by the United States Southern and Africa Commands are described in the SOUTHCOM and AFRICOM mission descriptions.

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).[4] 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 radio messaging campaign in Garmser increased civilian collaboration and enabled successful government-led bomb clearance missions. We conduct a battery of additional tests to rule out potential confounding factors. We are able to utilize unique features of our military data to track combat operations that occur while troops are on patrol as well as counterinsurgent 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 U.S. military's Commander's Emergency Response Program. This type of data has been used previously by Berman, Shapiro and Felter (2011) and Sexton (2016) to evaluate the impact of aid programs 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

[4] For a survey of empirical evidence on persuasion, see DellaVigna and Gentzkow (2010).

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 behavior 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 behaviors 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 localized messaging on the attitudinal changes, and Armand, Atwell and Gomes (2020), which focuses on combatant behavior. The central contribution of our investigation is that it demonstrates information operations are able to shape civilian attitudes and costly behaviors 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 organized as follows. Section 2 presents a simple model of information operations. Section 3 contains the empirical analysis, while Section 4 discusses the results of supplementary investigations. Section 5 concludes.

2 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.

2.1 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, ε_i, is uniformly distributed over $[0,1]$. Agent i is deciding on whether or not to report IEDs to the local government office, and her willingness to do this depends on whether or not she considers the government friendly (f), by which we mean "willing to and effective at neutralizing 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 neutralization; 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 neutralizing 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 neutralizing as many IEDs as possible, which in our setup means that it is maximizing 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 $\widehat{g}$ 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 $\widehat{g}$ such that with $P(\widehat{g} = f|g = f) = 1$, $P(\widehat{g} = f|g = u) = \beta$, 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, β, to maximize 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 maximize their expected utility. We focus on Bayes perfect equilibria.

2.2 Analysis

Without turning on radio, agent i has the following choice. The expected value of reporting is $\theta v^R + (1-\theta)\left(v^R - c\right) = v^R - (1-\theta)\,c$; the expected value of not reporting is $\theta\left(v^N - a\right) + (1-\theta)\,v^N = v^N - \theta n$. 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 favorable to the government, and randomizes with probability β 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 behavior, 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 (β 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 she receives.

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

$$P(g = f|\widehat{g} = f) = \frac{\theta}{\theta + (1-\theta)\,\beta}.$$

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

$$\beta \leq \frac{\theta\left(v^R - v^N + n\right)}{(1-\theta)\left(c - \left(v^R - v^N\right)\right)}.$$

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

$$(\theta + (1-\theta)\,\beta)\,v^R - (1-\theta)\,\beta c + (1-\theta)\,(1-\beta)v^N. \tag{1}$$

For any β, 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 ε_i. Given our assumption about the distribution of costs, the number of those who listen to radio is

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

As the government is interested in maximizing the expected number of reported IEDs, which is $P(\widehat{g} = f) I_G(\beta)$, the equilibrium level of propaganda is given by[5]

$$\beta^* = \frac{1}{2} \frac{\theta}{1-\theta} \frac{2v^R - c - 2v^N + n}{c - v^R + v^N}.$$

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 neutralizations 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 radio report IEDs to the authorities. In the 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 θ or a higher benefit v^R) further enhances the effect.

3 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.

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

3.1 Research Design

We study the impact of radio messaging during the operation of Combat Outpost (COP) Rankel in 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).

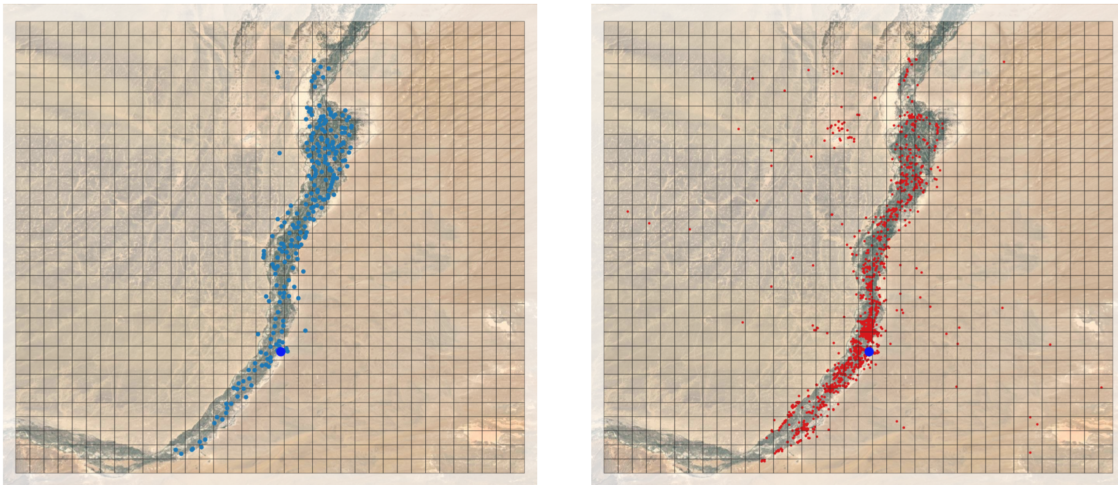
The study site is presented in Figure 1. On September 1, 2010, US forces established the Radio In A Box (RIAB) program at COP Rankel, which transmitted news about current events in the area as well as messages coordinated with community leaders encouraging civilian cooperation with local security forces. 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 kilometers, created a natural set of treatment and control villages for our study. The study site is introduced in Panel A of Figure 1. The 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 labeled 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 (Panel B).[6]

This approach differs from Yanagizawa-Drott (2014) and Armand, Atwell and Gomes

[6] In total, data was logged in 74 grid cells containing 244 villages. See Condra et al. (2018) for additional data details.

Figure 1: Area of Study and Military Data Overlay



(a) Study region (b) Military events in area

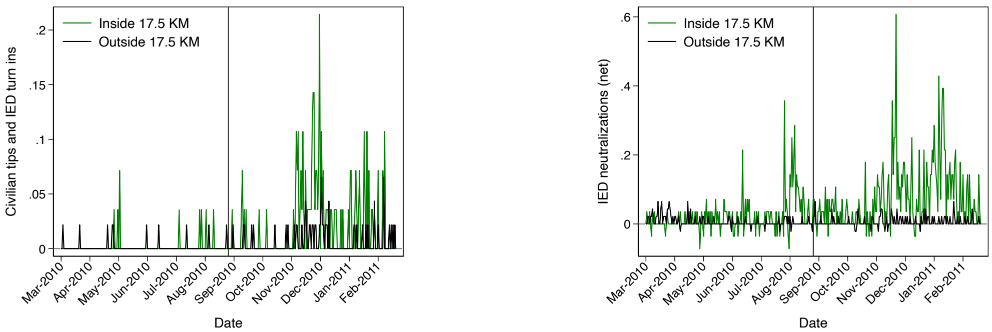
Notes: Figure illustrates the location of study site in Garmser. Panel (a) notes the location of settlements (light blue dots) and Combat Outpost (COP) Rankel (large dark blue dot). COP Rankel is the site of the Garmser Radio-in-a-Box (RIAB) tower. Panel (b) overlays the events recorded in the military logs used in the analysis. These red dots indicate combat and intelligence gathering locations during the sample period.

(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.

3.2 Descriptive Evidence

Using the signal cutoff described earlier, Figure 2 Panel 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 neutralizations (net detonations) in Panel B of

Figure 2: Descriptive Evidence of RIAB Messaging Impact on Civilian Cooperation and Bomb Neutralization



(a) Civilian collaboration

(b) Bomb neutralization

Notes: 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 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 neutralizations (net explosions).

the same figure. 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 lead to a short-term increase in civilian collaboration, we see no such trend. Overall, the descriptive trends prior to the onset of messaging suggest that civilian security cooperation and bomb neutralization 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 neutralization missions.

3.3 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:

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

where y_{gt} is (1) the count of civilian tips and IED turn-ins and (2) the count of bomb neutralizations (net explosions) by grid cell and day. λ and γ represent grid cell and time fixed effects, which absorb the base terms $Post_t$ and $Exposure_g$. β_1 captures the change in tips and bomb neutralizations 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.[7] 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 (.16 standard deviation) as well as a large increase in successful bomb clearance operations (.23 standard deviation). 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

[7] Additional summary statistics are provided in Table A-1.

could have lead 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, 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).[8]

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, Shapiro and Felter (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, Shapiro and Felter (2011) argue

[8]Our results are unaffected by the number of lagged time periods we incorporate, including 14 and 28 day lags.

is likely), then our main estimates overstate the positive impact of the radio campaign. On the other hand, if aid delivery is used to enhance community ties in villages beyond the coverage zone, we are likely to underestimate any positive effects (since 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. Since 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.

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 neutralization remains robust and substantively significant.

Table 1: Estimated effect of radio messaging on civilian collaboration and battlefield outcomes

Panel A: Civilian tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Signal	0.0143***	0.0150***	0.0149***	0.0152***	0.0150***	0.0191***	0.0214***
	(0.00447)	(0.00465)	(0.00466)	(0.00465)	(0.00472)	(0.00476)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0399	0.0399	0.0408	0.0408	0.0416	0.0422	0.0426

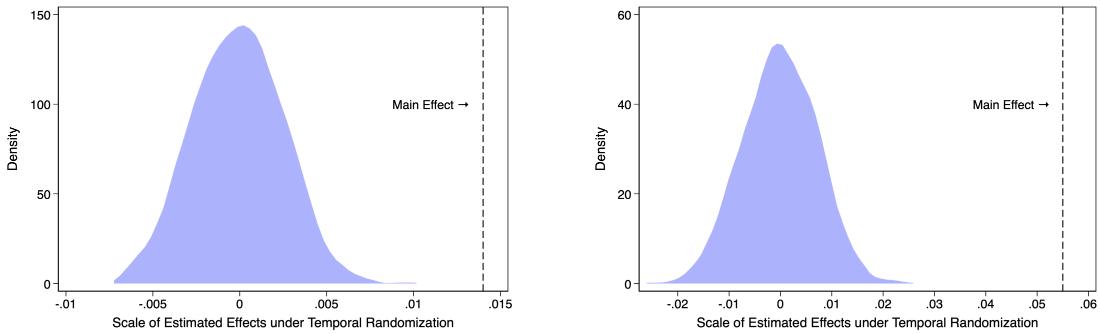
Panel B: Roadside bomb clearance missions (net detonations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Signal	0.0552**	0.0531**	0.0513**	0.0521**	0.0579***	0.0744***	0.0759***
	(0.0237)	(0.0221)	(0.0222)	(0.0220)	(0.0208)	(0.0276)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	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 highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We implement two additional exercises to assess the main result. First, to address potential concerns about spatial correlation in roadside bomb deployment and neutralization, we

Figure 3: Distributions of estimated effects of spatially-stratified randomization inference tests (temporal randomization)



(a) Civilian collaboration (b) Bomb neutralization

Notes: Outcome variable is shuffled randomly 1000 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 ($p < .001$). (B) Analysis of bomb neutralization (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 ($p < .001$).

conduct a set of spatially-stratified randomization inference tests ($\times 1000$) for each model. These tests are designed to account for spatial autocorrelation in combat and related activities by randomly shuffling actual realizations of the outcome within each grid cell across days in the study period.[9] The estimate distributions are presented in Figure 3. These results suggest the main results are highly unlikely to have occurred by chance ($p < .001$) and yield a measure of statistical precision consistent with our geographically clustered standard errors. Second, we use a Wald 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 behavior to evaluate the impact of cooperation on bomb neutralization. These results are introduced in Table 2. These results suggest a large effect via this mechanism, with each

[9] We thank Florence Kondylis and John Loeser for this recommendation.

Table 2: IV estimates of pass through effect of radio messaging on bomb neutralizations via civilian IED tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Civ. Tips/Turn Ins	3.852*	3.540**	3.440*	3.433**	3.863**	3.899**	3.543**
	(1.953)	(1.735)	(1.740)	(1.695)	(1.645)	(1.687)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
Kleibergen-Paap F Statistic	10.30	10.44	10.27	10.67	10.07	16.08	17.91

Notes: Outcome of interest is IED neutralization (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; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

additional messaging-related tip associated with roughly four net bomb neutralizations. 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 since 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.

3.4 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 kilometer buffers around the treatment zone and classify villages into four bins: within the coverage zone (less than 17.5 kilometers to the mast), in the first exterior buffer (17.5-22.5 kilometers to the mast), in the second exterior buffer (22.5-27.5 kilometers to the mast), and beyond 27.5 kilometers. 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 (3):

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

where parameters and notation follow Equation 2 and β_1 captures the change in tips and bomb neutralizations among the grid cells within the radio signal zone after the messaging begins; β_2 and β_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, β_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:

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

We anticipate the timing of increased collaboration and counterinsurgent activity will coincide with the establishment of the second, taller tower. That is, we expect that β_1 (in Equation 4) will be small and β_2 will be large relative to β_1 in Equation 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

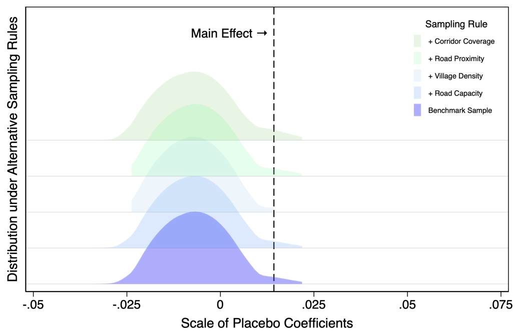
Table 3: Estimated effect of radio messaging on civilian collaboration and roadside bomb clearance (net detonations)

	Civilian tips and turn ins			IED neutralizations (net detonations)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post × Radio Signal	0.0143***	0.0152***		0.0552**	0.0548**	
	(0.00447)	(0.00453)		(0.0237)	(0.0238)	
Post × 5KM Outside		0.00222			0.00113	
		(0.00275)			(0.00564)	
Post × 10KM Outside		0.00345			-0.00442	
		(0.00621)			(0.00754)	
Post × Radio Signal (Short)			0.00197			0.00701
			(0.00191)			(0.0135)
Post × Radio Signal (Tall)			0.0206***			0.0797**
			(0.00652)			(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	26714	26714	26714	26714	26714	26714
No. of Clusters	74	74	74	74	74	74
R^2	0.0399	0.0399	0.0411	0.0628	0.0628	0.0652

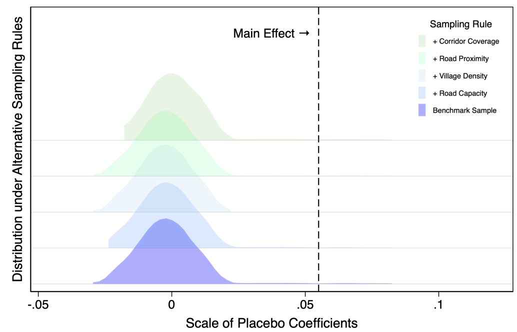
Notes: Outcome of interest varies by column. Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

actual tower site. These constraints include proximity to the road network (approximately 1 kilometer), 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 Equation 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.

Figure 4: Estimated effects of randomly seeded placebo radio towers on civilian cooperation and roadside bomb clearance



(a) Civilian collaboration



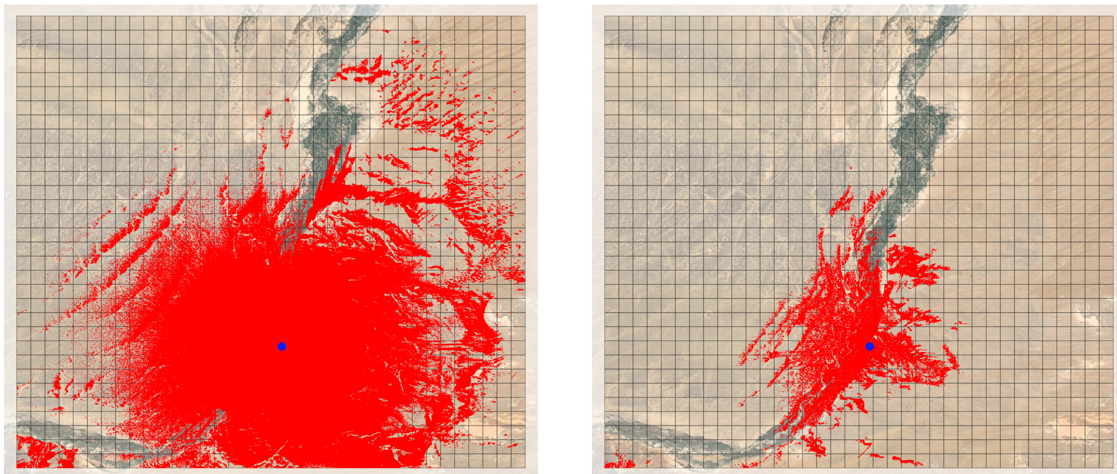
(b) Bomb neutralization

Notes: 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 kilometer along both axes); enhancing the road proximity threshold (to approximately .5 kilometer).

3.5 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 since 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 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

Figure 5: Estimation of latent irregular terrain and line-of-sight models from known and probable propagation parameters



(a) Irregular Terrain Model (b) Line-of-Sight Model

Notes: 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 CloudRF optimizing 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 (Appendix A1).

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 cloudrf.com. Figure 5 presents the baseline ITM result in Panel A. 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.[10] We use these various continuous measures of radio propagation to re-estimate our benchmark difference-in-differences approach above, replicating the specification noted in Equation 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 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 Figure A-1), including towers of varying heights (30 feet and 80 feet, reported in Tables A-2, A-3) or varying signal quality thresholds (30 and 35 dBuvm, reported in Tables A-4, A-5).

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

[10] Following advice from Alex Farrant, the lead radio engineer behind CloudRF, we set this dBuvm 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.

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

Panel A: Civilian tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0160***	0.0169***	0.0170***	0.0171***	0.0169***	0.0233***	0.0262***
	(0.00397)	(0.00416)	(0.00418)	(0.00418)	(0.00420)	(0.00438)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0398	0.0398	0.0407	0.0407	0.0416	0.0423	0.0427

Panel B: Roadside bomb clearance missions (net detonations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0507**	0.0472**	0.0459**	0.0460**	0.0505**	0.0709**	0.0832**
	(0.0234)	(0.0210)	(0.0210)	(0.0208)	(0.0194)	(0.0285)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	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). Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

measure is illustrated in Figure 5 as Panel 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).

4 Discussion

Evidence from the Garmser radio messaging program 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 behaviors even in a potentially adversarial environment, where 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 behaviors 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 weaponized 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 program in several ways. First, we gather data from two waves of proprietary nationwide military survey data, which include questions

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***	0.0224***	0.0223***	0.0225***	0.0227***	0.0278***	0.0315***
	(0.00590)	(0.00608)	(0.00609)	(0.00607)	(0.00640)	(0.00642)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	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**	0.0927**	0.0892**	0.0899**	0.103***	0.127***	0.132***
	(0.0390)	(0.0376)	(0.0380)	(0.0378)	(0.0357)	(0.0437)	(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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0651	0.0652	0.0749	0.0749	0.0834	0.0849	0.0852

Notes: Outcome of interest is civilian tips and turn ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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.[11] 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 (Table A-6). This finding is robust to a number of alternative specifications and is highly unlikely to be credibly driven by an unknown confounding variable (Table A-8, 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 neutralizations, 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 (Figure A-3). Finally, we construct a large-scale data set tracking civilian cooperation and counterinsurgent 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 neutralization and weapon cache clearances (Table A-10). 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

[11] See Figure A-2 for an overview of cooperation, refusal, and non-response rates. Also see Table A-9 for an overview of survey instruments. Additional information about ANQAR is described in Condra and Wright (2019).

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 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 FY 2021 to information operations like the Garmser program. 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.

5 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 neutralization. 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 behaviors even in a context where rebel forces have maintained consistent control and civilian attitudes towards the message sender are mixed or antagonistic. (In the 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 peace-building 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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Summary Statistics

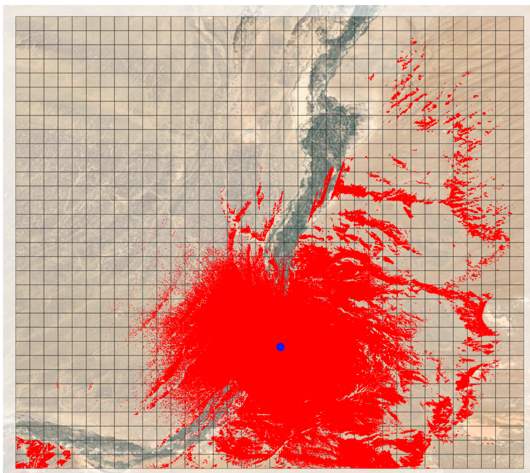
Table A-1: Summary statistics

Panel Data: Grid Cell × Day		
Variable	**Mean**	**Std. Dev.**
Civilian Tips and Turn Ins	0.007	0.085
Roadside bomb clearance missions (net detonations)	0.023	0.238
Close Combat Activity	0.008	0.103
Detained Insurgents	0.004	0.066
Military Aid (ln)	0.648	2.052
N	26714	

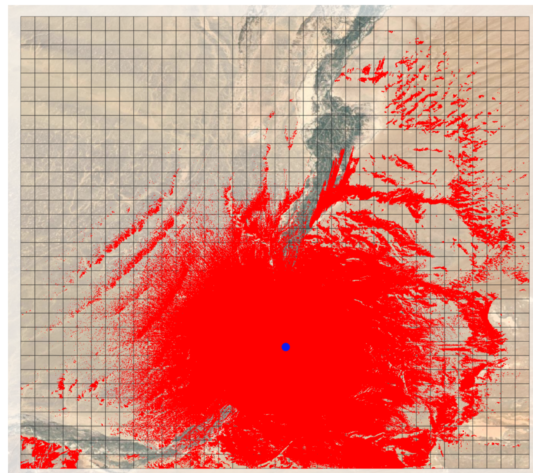
Cross Sectional Data: Grid Cell		
Variable	**Mean**	**Std. Dev.**
Radio Signal	0.378	0.488
Village Density	3.297	2.059
Night Lights	0.641	0.602
Terrain Ruggedness	78.439	149.765
Soil Quality: Nutrient Availability	2.005	0.039
Soil Quality: Nutrient Retention	1.991	0.077
Soil Quality: Excess Soil Salts	1.919	0.258
N	74	

Supplemental results to main analysis

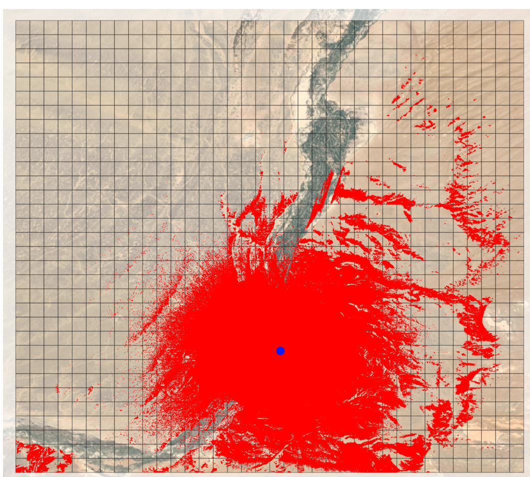
Figure A-1: Estimation of latent irregular terrain models from known and varying unknown propagation parameters (alternative tower height and signal reception thresholds)



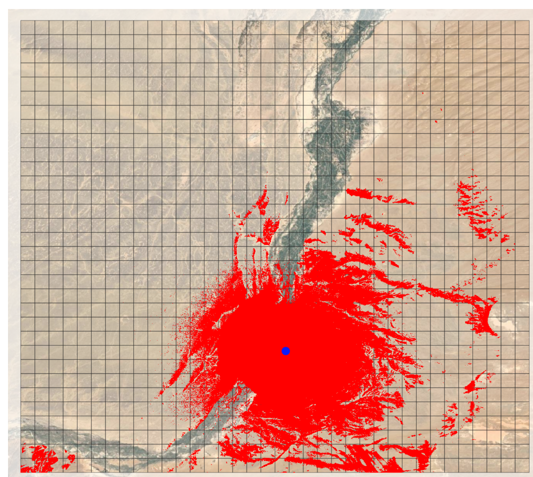
(a) ITM, 30 feet, 25 dBuvm



(b) ITM, 80 feet, 25 dBuvm



(c) ITM, 100 feet, 30 dBuvm



(d) ITM, 100 feet, 35 dBuvm

Notes: 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 CloudRF optimizing 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 (Appendix A1).

Table A-2: 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 (30 foot tower)

Panel A: Civilian tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0141***	0.0145***	0.0145***	0.0147***	0.0143***	0.0186***	0.0207***
	(0.00484)	(0.00492)	(0.00495)	(0.00497)	(0.00512)	(0.00544)	(0.00571)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0394	0.0394	0.0402	0.0403	0.0411	0.0415	0.0419

Panel B: Roadside bomb clearance missions (net detonations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0737**	0.0719**	0.0694**	0.0699**	0.0787**	0.101***	0.108***
	(0.0327)	(0.0313)	(0.0315)	(0.0313)	(0.0299)	(0.0383)	(0.0398)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0636	0.0637	0.0736	0.0736	0.0816	0.0830	0.0840

Notes: Outcome of interest is civilian tips and turn ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A-3: 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 (80 foot tower)

Panel A: Civilian tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0155***	0.0164***	0.0166***	0.0166***	0.0165***	0.0226***	0.0252***
	(0.00410)	(0.00428)	(0.00430)	(0.00430)	(0.00434)	(0.00457)	(0.00491)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0397	0.0397	0.0406	0.0406	0.0415	0.0421	0.0426

Panel B: Roadside bomb clearance missions (net detonations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0547**	0.0517**	0.0503**	0.0504**	0.0556**	0.0775**	0.0889**
	(0.0249)	(0.0227)	(0.0228)	(0.0226)	(0.0211)	(0.0305)	(0.0340)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0620	0.0620	0.0721	0.0721	0.0797	0.0808	0.0820

Notes: Outcome of interest is civilian tips and turn ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A-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 (100 foot tower, 30 dBuVm signal threshold)

Panel A: Civilian tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0134***	0.0139***	0.0139***	0.0140***	0.0137***	0.0183***	0.0201***
	(0.00439)	(0.00450)	(0.00453)	(0.00456)	(0.00466)	(0.00507)	(0.00526)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0393	0.0393	0.0402	0.0402	0.0411	0.0415	0.0418

Panel B: Roadside bomb clearance missions (net detonations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0655**	0.0633**	0.0611**	0.0616**	0.0691**	0.0918**	0.0967***
	(0.0295)	(0.0279)	(0.0280)	(0.0278)	(0.0264)	(0.0352)	(0.0363)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0630	0.0630	0.0730	0.0730	0.0808	0.0822	0.0830

Notes: Outcome of interest is civilian tips and turn ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A-5: 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 (100 foot tower, 35 dBuVm signal threshold)

Panel A: Civilian tips and turn ins

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0107*	0.0106*	0.0105*	0.0106*	0.0100*	0.0127*	0.0148**
	(0.00543)	(0.00543)	(0.00551)	(0.00553)	(0.00577)	(0.00639)	(0.00668)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0388	0.0388	0.0397	0.0397	0.0406	0.0408	0.0411

Panel B: Roadside bomb clearance missions (net detonations)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Radio Penetration	0.0842**	0.0821**	0.0794**	0.0799**	0.0921**	0.113***	0.119***
	(0.0381)	(0.0368)	(0.0371)	(0.0369)	(0.0356)	(0.0421)	(0.0436)
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	26714	26714	26196	26196	26196	26196	26196
No. of Clusters	74	74	74	74	74	74	74
R^2	0.0646	0.0647	0.0745	0.0745	0.0829	0.0843	0.0851

Notes: Outcome of interest is civilian tips and turn ins (Panel A) and roadside bomb clearance (Panel B). Relevant coefficient estimate is highlighted with gray bar (Post × Radio Signal). Additional parameters noted in table footer. Standard errors are clustered at the grid cell level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Results from Discussion

ANQAR Data Overview

Access to this survey platform, the Afghanistan Nationwide Quarterly Assessment Research (ANQAR), was negotiated between the host academic institution (University of Chicago) and the North Atlantic Treaty Organization (NATO). Data are collected quarterly, with approximately three months between sequential waves. For this study, we rely on waves 20 and 24, which are the two waves during Operation Enduring Freedom which collect reported exposure to counter-IED messaging (i.e., exposure to information operations). These waves correspond to May/June 2013 and 2014 respectively. The firm contracted to design and execute the survey is ACSOR. ACSOR is an Afghan subsidiary of the D3. ACSOR selects local (to survey region) enumerators. These enumerators are then trained in proper household and respondent selection, recording of questions, appropriate interview techniques, and secure use of contact information. The administrative district is the primary sampling unit (PSU) and districts are selected via probability proportional to size (PPS) systematic sampling. Due to population density, Kabul district is split into multiple urban areas. Among sampled districts, secondary sampling units (villages/settlements) are randomly selected from a sampling frame based on administrative records gathered from the Central Statistics Office. Enumerators use a random walk method to identify sampled households. Once households are selected, a Kish grid technique is used to randomize the respondent within each target household. Before administering each survey wave, ACSOR contacts local elders to secure access to sampled settlements.

In Figure A-2, we introduce plots of important survey diagnostics, including refusal, non-contact, and cooperation rates for the waves where this data is available (from NATO via ACSOR). Notice that the refusal rate never exceeds 5%, the non-contact rate is always below 4%, and the cooperation rate is above 96% in the two waves exploited in this study (20/24). These rates suggest the survey participation was high, and stronger than most national surveys conducted in developed countries (including the United States and United Kingdom). In Table A-9, we introduce question wording and the coding scheme used for the main analysis of the ANQAR data.

Then, we corroborate our survey findings with data on combat activity and intelligence reports drawn from declassified records provided by the U.S. Department of Defense. These data were collected as Significant Activities (SIGACTS) during Operation Enduring Freedom. Events were logged with a precise military grid identifier and time stamp (often precise to the minute). See Condra et al. (2018) for additional details.

Reporting Roadside Bombs

We begin by comparing individuals who have and have not been exposed to counter-IED messages, including posters, radio addresses, and television advertisements. The outcome of interest is the willingness of civilians to report a roadside bomb to local security forces. We estimate this effect using the following equation

$$tips_i = \alpha + \beta messaging_i + \theta X_i + \epsilon \tag{A1}$$

where $tips_i$ is the respondent i's willingness to report roadside bombs and $messaging_i$ is an indicator for exposure to counter-IED messaging in the prior six months. β is the coefficient of interest, providing the difference in reporting due to messaging exposure. To account for potential confounding factors, X_i contains respondent-specific demographic characteristics and parameters to capture constant differences across administrative districts and between survey waves. Standard errors are clustered by administrative district and models are adjusted using sampling weights.

Table A-6 presents these results. In Column 1, we introduce the simple bivariate correlation (BR) between messaging exposure and the willingness to report IED threats. β is large in magnitude, 17.2% ($p < .01$). To account for systematic differences in messaging frequency across the country and between survey waves, we added district and wave constants to Column 2, as well as demographic controls. If messaging, for example, is concentrated in some regions, we would expect β to decrease once we account for these systematic differences across districts. Indeed, β is smaller in magnitude (10.6%, $p < .01$). In Column 3, we account for village security conditions, which may influence both the likelihood of exposure to a government information campaign and willingness to report threats. In Column 4, we supplement this regression with measures of local security force patrol frequency, anti-government sentiments, and measures of armed actor territorial control over the respondent's community. β is stable and robust across these more demanding specifications.

In Table A-7, we introduce several additional robustness checks of the baseline model specification introduced in Table A-6. These include:

1. In Column 1, for reference, we replicate the baseline specification without additional covariates (Table A-6, Column 4).

2. In Column 2, we directly address potential concerns about respondent comprehension of the survey. Enumerators were asked to collect information on the subject's level of understanding of the questions within the survey. We use this information to categorize the subject's comprehension. This could, in principle, influence the reliability of their responses to questions. We find no evidence that this is true.

3. In Column 3, we introduce a parameter that captures the degree of respondent comfort with the survey. This might also influence whether the subject gives truthful answers to the enumerator's questions. Again, we find no evidence that this parameter substantially influences our regression estimates.

4. In Column 4, we incorporate a measure of the number of individuals present during the interview. Subjects may be less likely to respond truthfully if they are interviewed with a large number of people around while their answers are being recorded. We account for this explicitly. Our coefficient estimate is statistically indistinguishable from the baseline model.

In Table A-8, we introduce statistical bounds for our estimated treatment effects using the Oster coefficient stability test (Oster, 2017). This test reveals that the estimated effect remains at least 3.78% even under 'worst case scenario' assumptions about omitted variable bias.

Table A-6: Impact of psychological messaging exposure on civilian's willingness to provide tips about deployed roadside bombs

	(1) Basic Model	(2) Baseline Model w. Fixed Effects + Demo. Controls	(3) Baseline Model w. Village Security	(4) Baseline Model w. Political and Security Controls
Messaging Exposure	0.172***	0.106***	0.106***	0.0936***
	(0.0328)	(0.0147)	(0.0148)	(0.0150)
SUMMARY STATISTICS				
Outcome Mean	0.482	0.482	0.482	0.482
Outcome SD	0.500	0.500	0.500	0.500
PARAMETERS				
District + Wave Fixed Effects	No	Yes	Yes	Yes
Demographic Controls	No	Yes	Yes	Yes
Village Insecure	No	No	Yes	Yes
Police Patrols Weekly	No	No	No	Yes
Govt. going Wrong Direction	No	No	No	Yes
Terr. Control (Govt./Ins./Mixed)	No	No	No	Yes
MODEL STATISTICS				
N	24620	24620	24620	24620
Clusters	339	339	339	339

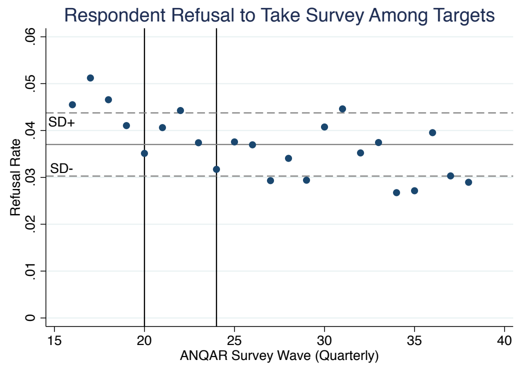
Notes: Outcome of interest is willingness to report insurgents planting IEDs. Unit of analysis is individual survey respondent. Baseline models include administrative district fixed effects (using ESOC boundaries), survey wave fixed effects, and demographic controls (age, education, gender, ethnicity, socio-economic status). See table notation for additional details. Standard errors are clustered at the district level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A-7: Impact of psychological messaging exposure on civilian's willingness to provide tips about deployed roadside bombs, accounting for potential survey effects [Robustness Checks for Table A-6]

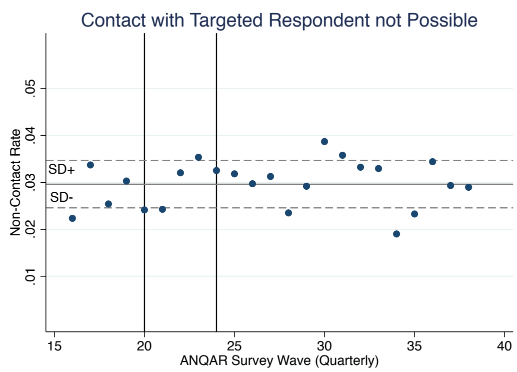
	(1) Baseline Model	(2) Baseline Model w. Survey Comprehension	(3) Baseline Model w. Survey Comfort	(4) Baseline Model w. Number Present During Survey
Messaging Exposure	0.0936***	0.0936***	0.0933***	0.0932***
	(0.0150)	(0.0150)	(0.0150)	(0.0150)
SUMMARY STATISTICS				
Outcome Mean	0.482	0.482	0.482	0.482
Outcome SD	0.500	0.500	0.500	0.500
PARAMETERS				
District + Wave Fixed Effects	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes
Village Insecure	Yes	Yes	Yes	Yes
Police Patrols Weekly	Yes	Yes	Yes	Yes
Govt. going Wrong Direction	Yes	Yes	Yes	Yes
Terr. Control (Govt./Ins./Mixed)	Yes	Yes	Yes	Yes
Survey Effects				
Understood Survey	No	Yes	Yes	Yes
Comfortable w. Survey	No	No	Yes	Yes
Number Present	No	No	No	Yes
MODEL STATISTICS				
N	24620	24620	24620	24620
Clusters	339	339	339	339

Notes: Outcome of interest is willingness to report insurgents planting IEDs. Unit of analysis is individual survey respondent. Baseline models include administrative district fixed effects (using ESOC boundaries), survey wave fixed effects, and demographic controls (age, education, gender, ethnicity, socio-economic status). See table notation for additional details. Standard errors are clustered at the district level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

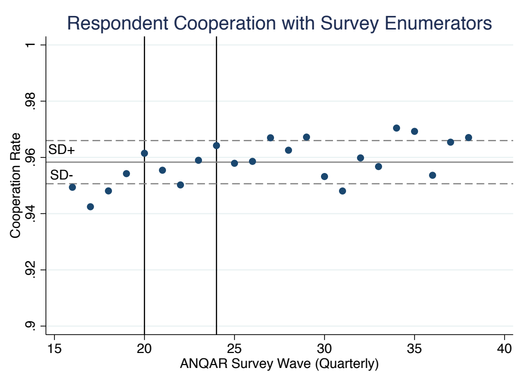
Figure A-2: ANQAR diagnostics during waves conducted by firm collecting Waves 20/24 survey data (ACSOR). Data on refusal, non-contact, and overall cooperation were shared with the authors by NATO. Authors' own calculations.



(a) Refusal rate



(b) Non-contact rate



(c) Cooperation rate

Table A-8: Estimating treatment effect bounds using the Oster coefficient stability test

		Panel A: Baseline Regression Diagnostic Information	
		(1)	(2)
Treatment Variable	Outcome Variable	Baseline effect (Std. error), [R^2]	Controlled effect (Std. error), [R^2]
Messaging	IED Reporting	0.172*** (0.0328) [0.025]	0.0936*** (0.0150) [0.248]

		Panel B: Oster Coefficient Stability Test Results	
		(3)	(4)
Treatment Variable	Outcome Variable	Effect for R_{max} $((\beta_{R_{max}}$ - $\beta_{ctrl})^2)$ [R_{max}]	Alt. Effect for R_{max} $((\beta_{R_{max}}$ - $\beta_{ctrl})^2)$ [R_{max}]
Messaging	IED Reporting	0.0378 (.00311) 0.375]	3.172 (9.48) [0.375]

Notes: Bounds for treatment effects are estimated using the Oster coefficient stability test (Oster, 2017). R_{max} set at 1.5 (exceeds 1.3 threshold in (Oster, 2017)). Model specifications are drawn from least and most conservative main specifications. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A-9: Survey Instruments Overview

Variable	**Question**	**Coding** (= 1 if)
IED tips	If you knew that an IED had been planted, how likely would you be to report it to the local security forces?	Very likely
Messaging Exposure	In the last six months, have you seen or heard any signs, announcements, radio advertisements, or television advertisements about IEDs?	Yes
Force Effectiveness	Tell me, how capable are the Police of protecting your mantaqa? Are they very capable, somewhat capable, somewhat incapable, or very incapable?	Very capable
Govt. Avoid Harm	Do you think ANDSF does enough to prevent the killing or injuring of civilians? Do you think that ADNSF does a little to prevent killing and injuring of civilians? Or does ANDSF do nothing to prevent killing and injuring of civilians?	Insurgent (AGE)
Govt. Inst. Use	If you had a legal dispute, would you take it to an Afghanistan state court or a local Shura/Jirga?	Government
Support Reintegrat.	If an insurgent were to stop fighting against the government and wanted to rejoin society, would you welcome him back to your mantaqa?	Yes
Village Insecure	How is the security situation in your mantaqa? Is it good, fair, or bad?	Bad
Police Patrols Weekly	How often do you see the Police in your mantaqa? Is it every day, once a week, 2-3 times a month, once a month, less than once a month, or never?	At least weekly
Govt. going Wrong Direction	Generally speaking, do you believe the Government of Afghanistan is going in the right direction, the wrong direction, or is in the same place, not going anywhere?	Wrong direction
Terr. Control (Govt.)	Between the two, the Anti-Government Elements (Mukhalafeen-e dawlat) and the Government, who has more influence in your mantaqa now?	Govt.
Terr. Control (Ins.)	Between the two, the Anti-Government Elements (Mukhalafeen-e dawlat) and the Government, who has more influence in your mantaqa now?	Ins.

Messaging Exposure and Military Data

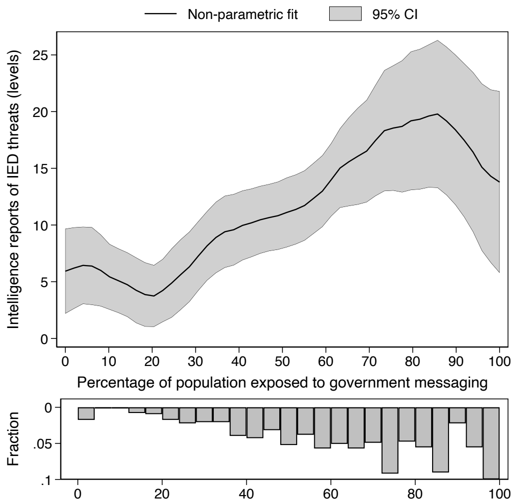
We next use intelligence reports about roadside bombs collected by security forces. To do this, we collapse our survey data by district-wave. This allows us to calculate the percentage of a district in a given survey period (wave) that reports exposure to the government's counter-IED campaign. We match this data with civilian reports of IED threats from our military intelligence records. We visualize the non-parametric relationship between messaging exposure and IED reports in Figure A-3 Panel A. From 20% to 85% exposure, the impact on intelligence reports is linearly positive. From 85% to 100%, the relationship appears to decrease in magnitude. The effect, however, is indistinguishable from the median level of exposure (65%). We introduce estimates from the following equation

$$tips_{dw} = \alpha + \beta_1 messaging_{dw} + \beta_2 messaging^2_{dw} + \theta X_{dw} + \epsilon \tag{A2}$$

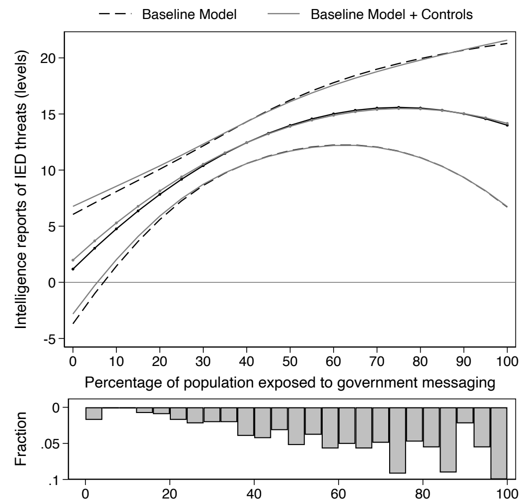
where $tips_{dw}$ is the sum of IED tips in district d in the six months prior to wave w. $messaging_{dw}$ and $messaging^2_{dw}$ capture the percentage of respondents (from 0 to 100) reporting exposure to government messaging and the square of this term. The square is added to capture the non-linearity suggested by Figure A-3 (Panel A). X_{dw} varies by model. Standard errors are clustered by district.

The regression-based evidence in Figure A-3 Panel B corroborates our survey evidence. In baseline model (black line), we account for trends in IED detonations and IED neutralizations (95% confidence intervals reported with dashed black lines). In a supplemental model (gray line), we account for the risks of sharing intelligence with local security forces using a measure of informant killings by rebels as well as broader trends in combat activity that might increase the supply of local security forces to collect intelligence (95% confidence intervals reported with gray lines). These results indicate a high degree of consistency in our finding that exposure to information operations increases actual civilian cooperation.

Figure A-3: Investigation of impact of information operations on field intelligence collected about roadside bombs.



(a) Non-Parametric



(b) Parametric with Controls

Notes: Data on intelligence records (SIGACTS) were declassified by the US Department of Defense and are calculated using the six month window prior to each survey wave (consistent with survey wording regarding messaging exposure). Data on messaging exposure is drawn from the ANQAR survey and calculated by district-wave as a percentage of the population reporting exposure. (A) Non-parametric estimates of relationship between aggregate psychological operations exposure and civilian tips about roadside bombs documented in military records. Histogram below plot. (B) Parametric regression estimates of impact of information operations on civilian collaboration with security forces. Black solid line indicates predicted values from non-linear regression with baseline control variables (black dashed lines indicate 95% confidence intervals). Gray solid line indicates predicted values from non-linear regression with baseline control variables and parameters accounting for intensity of insurgent combat operations (gray dashed lines indicate 95% confidence intervals). Histogram below plot.

The Pass-Through Effect in a Nationwide Study

Now we consider whether the pass through effect from the natural experiment (the impact of tips on battlefield outcomes) can be replicated in a large-scale, nationwide study. In Table A-10 Columns 1-4, we introduce estimates from the following equation

$$y_{dt} = \alpha + \beta_1 tips_{dt-1,4} + \beta_d + \eta_t + \gamma X_{dt-1,4} + \epsilon \tag{A3}$$

where y_{dt} is the number of counterinsurgent actions in district d in week t. These actions include roadside bombs found and cleared (Column 1), weapon caches neutralized (Column 2), tactical safe house raids (Column 3), and potential combatants captured and detained (Column 4). $tips_{dt-1}$ is the sum of intelligence reports collected in a given district in the week prior to t. In Columns 1 and 2, $tips_{dt-1}$ specifically indicates tips about IED threats. In Columns 3 and 4, $tips_{dt-1}$ includes all tactically relevant tips. β_d is a district fixed effect; η_t denotes a week-of-year fixed effect; X_{dt-1} is a vector of district-week specific control variables, including trends in tips and combat activity, from $t-1$ through $t-4$. Standard errors are clustered by district.

We find consistent evidence that intelligence reports lead to meaningful changes in battlefield outcomes. Columns 1 and 2 indicate civilian tips and are associated with an increase in the number of bombs and weapon caches neutralized in the following week. Columns 3 and 4 suggest similar increases in safe house raids and insurgent detention following tactically relevant tips from civilians.

Table A-10: Impact of civilian tips on battlefield outcomes

	(1) Baseline Model Roadside Bombs Found/Cleared	(2) Baseline Model Weapon Caches Found/Cleared	(3) Baseline Model Tactical Safe House Raids	(4) Baseline Model Insurgents Captured and Detained
Tips about IED deployment, Lagged	0.0153**	0.0147***		
	(0.00777)	(0.00360)		
All Tactical Tips, Lagged			0.00289***	0.0421**
			(0.000849)	(0.0182)
SUMMARY STATISTICS				
Outcome Mean	0.236	0.0769	0.00689	0.0785
Outcome SD	1.187	0.583	0.106	0.491
PARAMETERS				
District Fixed Effect	Yes	Yes	Yes	Yes
Week Fixed Effect	Yes	Yes	Yes	Yes
IED Detonation Trends	Yes	Yes	Yes	Yes
Close Combat Trends	Yes	Yes	Yes	Yes
Remote Combat Trends	Yes	Yes	Yes	Yes
MODEL STATISTICS				
N	171936	171936	171936	171936
Clusters	398	398	398	398

Notes: Outcome of interest varies by column and is noted in each model heading: (1) roadside bombs found and neutralized (cleared); (2) weapon caches (depots) found and neutralized (cleared); (3) tactical safe house raids yielding actionable intelligence about insurgent operations; (4) insurgents captured and detained by security forces. In (1) and (2) the explanatory variable is the number of tips about IED deployment lagged by one week. In (3) and (4), we investigate the number of tactical tips (including all combat activity) lagged by one week. Unit of analysis is district-week from 2006 to 2014. Data on intelligence records and combat activity (SIGACTS) were declassified by the US Department of Defense. All models include district (unit) and week (time) fixed effects. See table notation for additional details. Standard errors are clustered at the district level and presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

A1 Data and Software Description

A1 Military records

The military records come from the U.S. Defense Department's Significant Activities (SIGACTS) database. These data were jointly collected by Afghanistan's military and police forces and multinational forces of the North Atlantic Treaty Organization's (NATO) International Security Assistance Force (ISAF). This data includes information on combat activity and civilian collaboration, as described in the manuscript. The data were secured through a formal declassification process by Shaver and Wright (2016). Additional information about the combat data is provided in Condra et al. (2018) (see also Sonin and Wright (2020); Fetzer et al. (2020)). The data are available upon request from Shaver and Wright.

A2 Surveys

Our survey evidence relies on the Afghanistan Nationwide Quarterly Assessment Research (ANQAR) platform. ANQAR tracks civilian attitudes toward government, anti-government entities, and coalition partners. We offer a more detailed description of the enumeration process when introducing the first supplemental investigation. Survey responses are collected on a quarterly basis by local contractors. Before administering a survey wave, local elders are contacted to secure permission for enumerators to enter villages. When enumerators could not access sampled villages, intercept interviews were used to collect information from residents traveling in neighboring areas (Child, 2016; Condra and Wright, 2019).

The individual level ANQAR survey data are restricted access only. The authors established access through a data agreement with the organization that maintains the data, the North Atlantic Treaty Organization (NATO)'s Communications and Information Agency. Interested researchers can contact Wright (`austinlw@uchicago.edu`) for more information about the authorization process.

A3 Administrative boundaries and locations

Data on administrative boundaries (district, province) were retrieved from Empirical Studies of Conflict (ESOC) research group and are available at this link: https://bit.ly/39oJrre. These administrative boundaries are used for synchronizing combat event data and survey data. The main analysis focuses on Garmser district. Supplemental investigations used data that spans the broader set of administrative districts. The location of village settlements were compiled by the Afghanistan Information Management Service, Central Statistics Office, United States Agency for International, and Yale University. Additional information is available at this link: https://bit.ly/3q30Gpg.

A4 Military facilities

Information about the location of Combat Outpost Rankel and other Marine patrol posts is drawn from Malkasian (2016, 218) (see Map 11).

A5 Development aid projects

We incorporate information from the Afghan Commander's Emergency Response Program (CERP), a military-led scheme for small-scale development projects. The program and related data are described in Berman, Shapiro and Felter (2011) (Iraq) and Adams (2015) (Afghanistan). These data were obtained through formal channels. The data cover active and new projects initiated during the sample period. We gratefully acknowledge Duncan Walker for providing access to this archive.

A6 Land cover features

A6.1 Road network

We use the spatial extent of the road network as one of the constraints in a placebo exercise. Data on the road network in Garmser is drawn from Open Street Map repositories and described at this link: `https://bit.ly/3p5wiZY`.

A6.2 Night lights

We calculate night light variation using the DMSP OLS: Nighttime Lights Time Series Version 4, Defense Meteorological Program Operational Linescan System. This data is compiled by the National Oceanic and Atmospheric Administration (United States). We use the product known as `avg_lights_x_pct`, which is derived from the average visible band digital number of cloud-free light detections (i.e. satellite passes). This measure is then weighted by the persistence of lighting (i.e., the rate of light output detection across multiple satellite passes). For additional information, see the documentation available at this link: `https://bit.ly/2LFPH5M`.

A6.3 Soil suitability

Our measures of soil suitability are derived from data with information from Food and Agriculture Organization's Harmonized World Soil Database, which we extract at the grid-level cross section. The base data includes nutrient availability, nutrient retention, rooting conditions, oxygen availability, excess soil salts, toxicity, and packedness and workability (which impacts the ability to manage fields). Additional information about the measure is available at this link: `https://bit.ly/3q1vS8r`. In the study area, we observe variability in only three of these conditions: nutrient availability, nutrient retention, and excess soil salts. The corresponding measure captures the mean value of the class for each grid cell, where the underlying values (1 through 4) indicate increasing difficulty of workability.

A6.4 Terrain variability

We rely on raster data provided in Shaver, Carter and Wangyal Shawa (2019) to measure variability in terrain ruggedness. This approach uses the terrain ruggedness index devised in Riley, DeGloria and Elliot (1999) to quantify variability in terrain features at a small-scale (approximately 800 × 800 meter cells). For reference, this index is also used in Nunn and Puga (2012) and Carter, Shaver and Wright (2019).

A7 Software

To construct the baseline grid cell layer, we use the MMQGIS plugin (`create grid layer`) within QGIS, an open source geographic information systems (GIS) program. Distance measures are calculated using the standard functions. Random seeding of points – one of the placebo exercises – is implemented using `random points within extent` function. Estimation of the irregular terrain and line-of-sight models is conducted using the cloud-based platform `cloudrf.com`. We use the known and latent (probable) model specifications noted in the main text and follow the advice of the platform's lead radio engineer when setting our radio receiver signal strength threshold. Additional information is available at this link: `https://bit.ly/3lkpNlM`.

A2 Additional Theoretical Results

A1 Heterogeneous priors

In our supplementary investigations, we use information on agents' previous experience with the government, which is heterogeneous, and our empirical results demonstrate that this previous experience does matter. Thus, we consider the case of heterogeneous priors about the government friendliness.[12] Specifically, suppose that the share λ, $0 \le \lambda \le 1$ of people has received an additional noisy signal $\widehat{h}$, which is structured as follows: $P(\widehat{h} = f|g = f) = 1$, $P(\widehat{h} = f|g = u) = \gamma$, $0 \le \gamma \le 1$. This is equivalent to the assumption that the population consists of two groups with different priors: share λ has prior $\theta_1 = \frac{\theta}{\theta+(1-\theta)\gamma}$, while the share of $1-\lambda$ has the unchanged prior of θ, $\theta_1 > \theta$. To simplify the analysis, we assume that the government knows the priors of both groups. Finally, we assume that the probability that agent i received an additional signal is independent across agents; therefore, the distribution of costs of listening to the radio is the same for both groups.

Repeating the same calculations and assuming the internal solution, i.e., that the government targets two, rather than one, groups the equilibrium level of slant is given by

$$\beta^* = \frac{1}{2}\frac{\theta}{1-\theta}\frac{1-\lambda+\lambda\gamma}{1-\lambda+\lambda\gamma^2}\frac{2v^R - c - 2v^N + n}{c - v^R + v^N}.$$

The comparative statics with respect to θ, v^R, v^N, n, c is unchanged. An increase in λ, the share of people who receive an additional signal, increases the equilibrium amount of propaganda. When γ is small, a marginal increase in γ (which corresponds to an increase in noisiness of the signal and lower prior probability of friendly government) increases the equilibrium bias; when γ is close to 1 (which corresponds to pure noise), the impact on the bias is negative.

This extension of our basic model with heterogeneous priors produces the implications that we verify in our empirical work. Suppose that there is a share of citizens, determined independently of idiosyncratic costs, that has access to radio, and others who do not. In equilibrium, those who do not have access, do not report IEDs, while those who have access and have chosen to listen report IEDs upon receiving the message that the government is friendly. Those who have a higher prior probability of the government being friendly (e.g., because of their exposure to a good experience, participation in shura, etc.) are disproportionally represented in the sample of those who report IEDs.

A2 Opposition Sources

Suppose that the agents have the option to choose between one of the two sources, the government and the adversary, or not to listen radio at all. Furthermore, suppose that those

[12] In the theoretical literature on Bayesian persuasion, this environment corresponds to privately informed receivers (see Alonso and Câmara, 2016).

who listen to either source follow the advice. As shown above, the value of listening to the government alone is $(\theta + (1-\theta)\beta)\left(v^R - v^N\right) - (1-\theta)\beta c + \theta n$.

Now, the if agent i receives the adversary signal, then her posterior is

$$P(g = f|\widehat{m} = f) = 1, P(g = u|\widehat{m} = u) = \frac{1-\theta}{1-\theta+\phi\theta}.$$

Assuming that in equilibrium agent i's actions correspond to the signals ($a_i\left(\widehat{h} = f\right) = R, a_i\left(\widehat{h} = u\right) = N$), the expected utility of listening is

$$\begin{aligned} &\theta(1-\phi)v^R + (1-\theta+\phi\theta)\left(\frac{1-\theta}{1-\theta+\phi\theta}v^N + \frac{\phi\theta}{1-\theta+\phi\theta}(v(N-a)\right) \\ = \; &\theta(1-\phi)v^R + (1-\theta+\phi\theta)v^N - \phi\theta n, \end{aligned}$$

which means that the marginal value of listening is

$$\begin{aligned} I_E(\phi) &= \theta(1-\phi)v^R + (1-\theta+\phi\theta)v^N - \phi\theta n - \left(v^N - \theta n\right) \\ &= \theta(1-\phi)\left(v^R - v^N + a\right). \end{aligned}$$

First, we will establish that no one will listen to both media sources.

Lemma A1 *In the presence of both government and adversary media, no agent consumes information from both sources.*

Proof. Indeed, suppose agent i does listen to both sources. The equilbirum action following $\widehat{g} = f$, $\widehat{h} = f$ is $a_i = R$ as $P(s = f|\widehat{h} = f) = 1$. Likewise, if $\widehat{g} = u$, $\widehat{h} = u$, then $a_i = N$ as $P(s = u|\widehat{g} = u) = 1$. The situation $\widehat{g} = u$, $\widehat{h} = f$ is impossible as $P(s = u|\widehat{g} = u) = 1$ and, simultaneously, $P(s = f|\widehat{h} = f) = 1$. Finally, suppose that $a_i\left(\widehat{g} = f, \widehat{h} = u\right) = R$. This means that agent i ignores signal $\widehat{h}$ and will act the same if he consumes only one source, the pro-government one. Similarly, suppose that $a_i\left(\widehat{g} = f, \widehat{h} = u\right) = N$. This means that agent i ignores signal $\widehat{g}$ and acts the same based on one source, the opposition one. Therefore, it never makes sense to pay for access to two media sources. ■

Thus, the choice for each agent is whether or not to use one source or not use any source at all. Now, suppose that the government and the adversary are playing a noncooperative game, in which the government selects β to maximize action and the adversary selects ϕ to minimize it. We assume that there are no switching costs, i.e., if one media source provides more valuable information, then listeners switch to this source; if the marginal value of information is the same for both sources, the audience is split.

Proposition A2 *There is a unique Nash equilibrium in pure strategies, in which both sources provide slant-free information:* $\beta^* = 0$, $\phi^* = 0$.

Proof. The proof is by a standard Bertrand-like argument. Suppose that $\beta^* > 0$, $\phi^* > 0$ and $I_E(\phi^*) > I_G(\beta^*)$, which results in the number of actions equal to $\theta^2 (1-\phi^*)^2 \left(v^R - v^N + a\right)$. Choosing β so that $I_G(\beta) + \delta > I_E(\phi^*)$ for a very small $\delta > 0$ results in everyone who listens listening to the government source and the amount of action being equal to

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

Chosing such β is possible as $I_G(0) = \theta\left(v^R - v^N\right) + \theta n > \theta(1-\phi^*)\left(v^R - v^N + a\right)$ for any $\phi^* > 0$.

We need to show that the amount of action is higher under β than under β^*. First, note that people who listen to government radio recieve signal f more often than those who listen to the enemy radio as $\theta + (1-\theta)\beta > \theta > \theta(1-\phi)$ for any non-zero level of bias. Since the number of listeners depends on the marginal value of information only, if $I_G(\beta)$ and $I_E(\phi)$ are approximately the same, the number of viewers is approximately the same. Thus, β^* was not a best response to ϕ^*. The other cases are similar. ■

In the absence of any persuasion, the agents will follow their default choices, which is *no reporting of IEDs* in out setup. An important assumption underlying Proposition A2 is that the cost of producing any amount of bias is zero. This is done to highlight the informational nature of the competition, but might be implausible in applied models. Adding a cost of producing propaganda (naturally, with higher costs being associated with lower bias) would result in the non-zero amount of propaganda in equilibrium.