Talking About Killing:
Cell Phones, Collective Action, and Insurgent Violence in Iraq[1]

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Abstract

Does improved communication as provided by modern cell phone technology affect the production of violence during insurgencies? Theoretical predictions are ambiguous. On the one hand, cell phones are assumed to enhance communication among insurgents, thus making it possible for them to coordinate more effectively. On the other hand, mobile communications can also hamper insurgent activity, by allowing the population to share information with counterinsurgents. This paper makes a first attempt to provide a systematic test of the effect of cell phone communication on conflict. Using data on Iraq's cell phone network as well as event data on violence, we assess this effect at two levels. First, we analyze how violence at the district level changes as a result of the introduction of new cell phone towers. Second, using a novel identification strategy, we examine how insurgent operation in the tower's vicinity is affected by the introduction of coverage. Taken together, our results show that mobile communication seems to increase the information flow from the population to the military, thus reducing insurgent effectiveness and ultimately, violence.

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INTRODUCTION

In 2007, cell phone subscriptions reached 3.3 billion worldwide, which corresponds to half the world's population.[2] The increase in wireless communication has been one of the most important technological advances of the last two decades, with tremendous economic and social consequences. There are plenty of reasons to be enthusiastic about this progress. Economists, for example, have shown that improved mobile communications can enhance market performance in Indian fishing communities (Jensen 2007) and reduce price dispersion in Nigerian grain markets (Aker 2008). At the same time, however, there are circumstances under which cell phone communication can have more pernicious effects. Governments are increasingly afraid of the potential for collective mobilization that is introduced by modern communication technology. During the recent protests in Egypt, the Mubarak government shut down all cell phone communications in an attempt to stop the large crowd of protesters from growing further.[3] Similarly, Mozambique's government attempted to shut down text message traffic during swelling protests over food prices in Fall 2010.[4] Analysts of organized crime, terrorism, and insurgency have long argued that the spread of cheap and reliable mobile communications will open up a range of new organizational models for terrorists and rebels (see e.g. Arquilla, Ronfeldt, and Zanini 1999; Andreas 2002).

If cell phone communication is conducive to subversive action, insurgents should be among the keenest adopters of this technology. Indeed, anecdotal evidence from Iraq suggests this. The Washington Post labels cell phones an "explosive tool for insurgents", pointing to the numerous uses of this technology in Iraq.[5] Muckian (2006) even goes as far as to say that mobile

[2] Reuters Nov 29, 2007, http://www.reuters.com/article/2007/11/29/us-cellphones-world-idUSL2917209520071129.
[3] NYTimes, January 28, 2011, http://www.nytimes.com/2011/01/29/technology/internet/29cutoff.html
[4] BBC, September 14, 2010, http://www.bbc.co.uk/news/world-africa-11300211
[5] Washington Post, March 7, 2005, http://www.washingtontimes.com/news/2005/mar/7/20050307-121323-4533r/

communication enabled what he calls a "networked insurgency" in Iraq. In other words, cell phones seem to be the key infrastructure for insurgent communication. This is corroborated by the observation that insurgents in Iraq frequently attacked water and electricity networks, but carefully spared the cell phone network.[6] Strikingly, insurgents threatened the telecommunication companies to maintain their network, in order for them to use it.[7] This pattern from Iraq, however, contrasts with anecdotes from Afghanistan, where the Taliban insurgents seemed to be afraid of cell phone technology. The Taliban issued a decree ordering all cell phone towers to be turned off during nightly hours, in an attempt to prevent villagers from calling in tips to the military forces.[8] In some instances, cell towers were even attacked and destroyed for the same purpose.[9]

The above examples show that it is far from obvious whether and how the availability of cellular communications influences political violence. Governments facing active insurgencies in Colombia, India, Pakistan, the Philippines and elsewhere must balance the well-documented economic advantages of expanding mobile phone coverage with the possibility that such coverage will make it harder to establish stability. A number of countries including Bangladesh, Pakistan, and the Philippines have recently considered tighter restrictions on cell phone registration because of their utility to violent groups and Thailand introduced new identification standards for mobile phones in 2005 exactly because of the phones' perceived utility for separatist insurgents in southern Thailand.[10] Such measures must reduce cell phone penetration

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[6] Newshour, January 27, 2007, http://www.pbs.org/newshour/extra/features/jan-june07/infrastructure_1-29.html
[7] The Sunday Times, July 22, 2005, http://business.timesonline.co.uk/tol/business/industry_sectors/telecoms/article546896.ece
[8] Wall Street Journal, March 22, 2010, http://online.wsj.com/article/SB10001424052748704117304575137541465235972.html
[9] Wired, February 25, 2008, http://www.wired.com/dangerroom/2008/02/in-iraq-when-th/
[10] "IDs to be mandatory for SIM cards." *Bangkok Post*. April 19, 2005. "Will ID requirements deter terrorists?" *Bangkok Post*. April 25, 2005.

on the margins and so the assumption that greater cellular use is a net benefit to terrorists and insurgents may have lasting negative economic externalities.

Existing theories about the industrial organization of violence are little help in sorting out possible impacts as none explicitly deal with the ease of communication. As we mentioned above, cell phones make collective action easier. Equipped with light, mobile communication devices, insurgents can easily coordinate actions, execute attacks and quickly react to counterinsurgency operations (see e.g. Cordesman 2005, Leahy 2005, Strother 2007). Following this line of reasoning, increased cell phone availability should lead to higher levels of violence. At the same time, however, cell phone availability could benefit counterinsurgents. In general, cell phones make it easier for the population to share information about insurgent activity, and to safely and anonymously call in tips. If this were true, and if the provision of information to counterinsurgents by the population were generally the binding constraint on the production of violence (Berman, Shapiro, and Felter 2009), then greater cell phone availability would lead to less violence. Insurgent use of cell phones, moreover, may create operational vulnerabilities given many governments' abilities to monitor them. It was cell phone monitoring, in part, that helped U.S. forces kill several al-Qa'ida in Iraq leaders including Abu Musab al-Zarqawi and that reportedly played a key role in leading the U.S. to Osama bin Laden.[11] That communicating by cell phones creates intelligence opportunities for government forces is one more mechanism by which increased mobile communications might cause a reduction in violence.

This paper makes the first systematic attempt to answer whether cellular communications networks are security enhancing or not. Using detailed data on cell phone networks and violence in Iraq, we estimate the effect of cell phone network expansion on insurgent violence at two levels. First, because the insurgency was organized regionally, we conduct a district-level

[11] CNN, June 10, 2006, http://www.cnn.com/2006/WORLD/meast/06/09/iraq.al.zarqawi/.

analysis, assessing whether increased coverage at the district level is associated with changes in violence. We find that better coverage at the district level leads to a clear and robust decrease in insurgent attacks, suggesting that the information-enhancing effects of improved cell phone communication swamp their effects on insurgents' ability to organize. Second, we address the local effect of cell phone towers within specific coverage areas. Using a novel spatial-temporal difference-in-difference design, we show that the introduction of cell phone towers leads to more successful counterinsurgency operations in the tower's coverage area. Specifically, the introduction of cell phone coverage reduces the number of improvised explosive devices that go off, but increases the number found and cleared as a proportion of all IEDs attempted. This finding is especially striking given that the introduction of cellular communications opens up a broad range of technologies for fusing IEDs.

The remainder of the paper proceeds as follows. Section 1 outlines the core theoretical ambiguity motivating the paper. Section 2 provides background on the history of the Iraqi cellular communications network and outlines the empirical strategy that flows from this history. Section 3 describes our data in detail and provides core descriptive statistics. Section 4 provides the results, first at the regional level and then for specific local coverage areas. Section 5 concludes by discussing the relevance of our findings for studies of the impact of technology on society and for studies of political violence and insurgency.

1. Cell Phones and Insurgent Violence

Theories of insurgent violence and collective action provide conflicting predictions about the impact of introducing cellular communications into areas with ongoing violence. Cellular communication technology could lead to increasing violence to the extent that introducing cell phones made it easier for insurgents to coordinate attacks, mass forces, operate in a coordinated fashion without a defined chain of command, and the like. We know, for example, that governments routinely shut down cellular communications to fight mass political behaviors (see e.g. the recent unrest in Egypt).

There is ample evidence that some players in the Iraqi insurgency felt that cell phone networks were a boon to insurgents. In the first place, cell phone service opened up a range of fusing options for improvised explosive devices (IEDs). With cellular coverage insurgents could call phones to detonate bombs, they could set up bombs that would detonate when Coalition jammers terminated a call, and they could communicate between spotters and those controlling an explosive, meaning that the controller no longer needed to be within line-of-sight of the IED. Figure 1 shows a cell-phone triggered IED. Given the manifest potential military advantages to insurgents of having cell phones, it is perhaps not to surprising that in 2005 the chairman of the Iraqi National Communications and Media Commission reported companies were being "threatened by terrorists for delays in setting up masts" because “Terrorists like mobile companies.” (Blakely 2005).

[INSERT FIGURE 1 ABOUT HERE.]

Yet there are also strong reasons to think the expansion of cellular communications could have aided Coalition intelligence gathering efforts. First, the better coverage is, the more insurgent might use cell phones, and one thing the Coalition was very good at was exploiting wireless communications. Second, shortly after the invasion in 2003, the National Tips Hot Line was rolled out by the Coalition Provisional Authority with nearly $10 million budgeted for billboard, print, radio, and television advertising.[12] Throughout Baghdad in 2004, the tip line was

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[12] Semple, Kirk, US Backs Hot Line in Iraq, NYT, Nov 5, 2006. http://www.nytimes.com/2006/11/05/world/middleeast/05tips.html? r=1.

advertised as a way to "fight the war in secret."[13] Soldiers in many areas carried cards advertising tip lines, such as the one in Figure (1) that was distributed by soldiers of the U.S. Army 3rd Infantry Division operating in al-Zubayr, near Basrah, in 2010. Indeed, in Afghanistan insurgents have long targeted cell towers exactly because cellular communications make it easier for the population to inform on them (see e.g. Trofimov 2010).

[INSERT FIGURE 2 ABOUT HERE.]

A very simple model can help frame the discussion of how increasing cellular communications could influence observed levels of violence. Suppose that insurgents' production of violence at any point in time requires two inputs: labor, l, and organizational capital, c, which captures a range of factors including monetary resources, weaponry, and organizational infrastructure. To capture the intuition that cell phone coverage makes it easier to coordinate insurgent activity let the marginal product of labor be increasing in the level of cell phone coverage, which we will call κ. The production of violence is restricted by the ability of counterinsurgents to attack the group, destroying a portion of its production. Counterinsurgents capacity to attack is a function of their force levels as a proportion of the total population, f, and the amount of tactically-relevant information—the location of weapons caches, identities of insurgents, and the like—shared by the population, i. The more information is shared, the more efficiently counterinsurgents can capture/kill insurgents and defend their installations. To capture the intuition that the level of information is increasing in the ease of communicating tips (or of listening to insurgents' communications) let the amount of information shared be increasing in κ.

Assuming insurgents produce at capacity, total violence produced in any period can be represented with a Cobb-Douglas production function:

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[13] Miles, Donna, Hotline Succeeding in Foiling Iraqi Insurgents, Dec. 28, 2004. http://www.defense.gov/news/newsarticle.aspx?id=24486

$$(1) \qquad V = (l^{a(\kappa)} c^{b})(1 - fi(\kappa)),$$

where $f, i \in [0,1]$, with $i = 1$ implying that all tactically relevant information is shared.[14] To match our intuition on the potential effects of cell phone coverage assume $a'(\kappa), i'(\kappa) > 0$. Taking the derivative of the log of (1) with respect to κ yields the intuitive condition for when the level of violence will be increasing in communications:

$$(2) \qquad a'(\kappa)\ln(l) > \frac{fi'(\kappa)}{1 - fi(\kappa)}.$$

It is obvious that this condition is more likely to be met when insurgent labor is plentiful and when the marginal impact of increasing communications on the productivity of insurgent labor is large. The condition is less likely to be met when counter-insurgent force levels are large, when the impact on information flow of increasing communications is large, and when the level of information flow at existing levels of communication are large.

There are a number of fully strategic models that yield the same basic ambiguity about how altering the ease of communication influences the level of violence observed in equilibrium, but the core ambiguity of the effect is cleanly captured by this basic approach. We therefore leave testing any one of those models to future work and focus in what follows on identifying the direction of the relationship in Iraq.

2. BACKGROUND AND IDENTIFICATION STRATEGY

2.1 THE BUILDUP OF IRAQ'S CELL PHONE NETWORK

[14] See Hanson, Iyengar, and Monten (2009) for an explicit analysis of insurgent substitution between capital and labor in the production of violence. For the comparative statics that interest us what matters is that insurgents are at the production frontier before the increase in cell phone coverage, so that regardless of the reallocation following a the change in coverage, there will be more or less violence depending on whether the condition in (2) is met.

Whereas under the regime of Saddam Hussein mobile communication was only accessible to a small minority of Iraqis, the network has seen a rapid expansion in the recent years. Less than 10% of Iraq's population of approximately 25 million people lived in areas with cell phone coverage at the beginning of 2004.[15] By February 2009, when our data on violence end, Zain alone reported over 10 million subscribers. Figure 3 shows the number of Iraqis living in areas covered by Zain Iraq's network from 2004 through 2009. Figure 4 shows the spatial-temporal evolution of the network over the course of the study period. Existing towers in the respective year are shown in black, towers introduced during the course of the year in red, and future towers in grey. The histograms below each panel show the numbers of towers introduced per month.

[INSERT FIGURES 3 AND 4 ABOUT HERE.]

These maps show exactly what one would expect given the fact that after coalition forces had invaded Iraq and toppled Saddam in 2003, the establishment of modern communication networks was a priority during the reconstruction efforts. In late 2003, the Iraqi government sold contracts to establish cell phone networks to three companies, one for each of three regions (northern, southern and central Iraq). Asiacell won the contract for the northern region. Iraqna, then part of the Egypt-based Orascom group, provided services in the central region including Baghdad. The contract for the southern region went to MTC Atheer, part of the MTC Corporation that operates in various countries in the Middle East and Africa. Already in early 2005, there were an estimated 1.6 Million cell phone users in Iraq.[16] All providers relied on the de-facto global cell phone standard, "Global System for Mobile Communication" (GSM).

The fragmented structure of the cell phone network led to various inconveniences for service users. Frequently, because of the necessity to communicate from different regions,

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[15] Authors' calculations based on coverage areas and Landscan population data.
[16] USA TODAY, March 3, 2005, http://www.usatoday.com/news/world/iraq/2005-03-03-cell-phones_x.htm

people were required to carry multiple phones, each for one of the providers.[17] In order to improve existing coverage and enable nation-wide competition, the government auctioned three licenses for national coverage in fall 2007. Two of these licenses were awarded to operators based primarily in northern Iraq (Asiacell and Korektel), and MTC Atheer won the third. Iraqna did not bid, because it considered the costs of the license to be too high. Shortly after, the MTC group announced its decision to buy Iraqna and merge it with its existing Iraqi company, MTC Atheer, creating the largest cell phone provider in Iraq. In January 2008, the MTC group changed its name to Zain. Even though other providers are expanding heavily in Iraq's central and southern regions, Zain Iraq is the largest provider in Iraq, with an estimated number of 10.3 Million customers at the end of 2009.[18] During most of the period under study, companies that are now part of Zain provided all the coverage in Southern and Central Iraq where the vast majority of the civil war violence took place.

2.2 Local Expansion of the network

Since our analysis exploits the dynamic expansion of the network in Iraq for assessing its effects on violence, a more detailed look at the micro-dynamics of network expansion is necessary. This discussion provides crucial background for our identification strategy and so we go into some detail. The following description is based on conversations with MEC Gulf, a consulting firm that advises cell phone companies on network expansion, as well as the chief technology officers for Zain Iraq and Asiacell, two of the three major telecommunications providers in Iraq. It represents a consensus view, though details varied across firms, over time, and between projects.

[17] USA TODAY, March 23, 2006, http://www.usatoday.com/news/world/iraq/2006-03-23-cellphones-iraq_x.htm
[18] Zain Iraq website, http://www.zain.com/muse/obj/portal.view/content/About%20us/Worldwide%20Presence/Iraq

Development of the cellular communications network in Iraq was based on a phased approach in which firms first selected larger areas for expansion, and then chose specific sites for cell phone towers within these areas based on the practicalities of providing coverage at minimum cost. For both Zain and Asiacell, areas for expansion were selected on an annual basis (towards the end of each company's fiscal year) based on three core criteria: requirements to meet service standards in existing areas as usage picked up; demand for cell phone service (large population without service); and contiguity with pre-existing coverage areas. An area chosen for expansion would typically be a large town, such as Fallujah, which first received coverage in 2004, or a semi-rural area with a large number of small communities.

Once these larger areas were selected, the radio-frequency (RF) design teams would map out a coverage plan that met a number of criteria including minimizing the number of towers while maximizing coverage and backhaul capacity. Two factors made their task more challenging in Iraq. First, the network backhaul in Iraq—the transmission of signals from the tower to a switch and then back out to the appropriate tower—occurred mostly via microwave as the country had no fiber optic network. This meant that towers had to be placed more closely together than in other settings to avoid interference from the microwave signals between towers.[19] Second, the pervasive use of jammers in Iraq by both Coalition forces and civilians meant that the providers needed to broadcast a stronger signal to guarantee coverage inside buildings than would be the case in normal urban settings.

Taking these constraints into account, the RF design teams would identify search rings of approximately one block radius in a number of locations within the targeted areas. Within these rings, a site selection team would then identify two or three potential sites that were suitable for

[19] The microwave signals between towers are highly directional. If towers were placed too far apart, there would be interference in those signals between towers as the beam from one tower to the other would spread beyond the width of the receiving antenna.

tower installation. These would typically be buildings that had a relatively unobstructed view, but at the same time could support the weight of a cell phone antenna and the supporting equipment (generator). Once a list of candidate buildings had been put together, the respective proprietor of the building or the landowner would be contacted regarding a possible lease by the site acquisition team. If a search ring were deemed to be in an inaccessible area, then the RF design team would typically need to identify new search rings for multiple towers, not just the one initially sited in an inaccessible area. Typically, it would take two to three months for the market research process of identifying target expansion areas, about a month for the RF design, and then another two to three months from the establishment of the initial search rings to the completion of the final site list with sites secured, leased and ready to build. The setup of towers themselves would take anything from a couple of days (for rooftop sites) to a few weeks (for ground towers in more rural areas).

2.3 Identification Strategy

We seek to identify the impact of cell phones on violence in Iraq at two levels: First, at the district level and second, for specific local coverage areas. Each requires a slightly different approach.

District-Level Empirical Approach

At the district level we employ the standard panel data approach of using a range of controls to account for factors influencing the expansion of the network. We might, for example, be concerned that expansion of the network is correlated with economic activity, which appears to be positively correlated with insurgent violence in Iraq (Berman, Callen, Felter, and Shapiro 2011). Our panel data approach is justified to the extent that we believe controlling for factors such as the number of pre-existing towers in a district and a robust set of time and space fixed effects will account for the core drivers of network expansion. So how viable is this approach?

Given what we know about how the network was built, it is extremely unlikely that month-to-month variation in violence impacted the networks construction. In our conversations with those involved in the network build-out in Iraq we heard no reports of major design changes being made in response to existing or anticipated insurgent violence. The site acquisition teams reportedly employed various strategies to push expansion even in the context of difficult security situations such as Fallujah in 2004 and Ramadi in 2006. Most importantly, the teams would typically enter into long-term contracts with local community members and organizations to pay for site rental, generator fueling, site security, and training of local engineers to provide these services. Where possible, they would engage with local elites to identify the personnel who could be entrusted with these jobs. This strategy of establishing close connection to local elites meant that once marketing had identified an area for network expansion, teams were mostly able to move in effectively even in areas with high violence.

Many factors orthogonal to violence clearly did influence tower construction, often in ways that lead us to believe the month-to-month timing had a large random component. Towers were delayed, for example, due to unpredictable decisions by government officials, difficulties in identifying whether a potential lessor actually held title to the land that was supposed to be leased for a tower, and disputes that arose once a site had been selected as the value of the lease and servicing contracts drew interested parties to make claims to land. Given these risks, the major firms often employed what was described as a “scatter-shot” approach to mitigate the risks from insecure titles. The idea was that as soon as the site-selection was done they would try to secure title to all of the sites in their expansion plan at the same time, as opposed to securing them in the order marketing suggested. As a practical matter, this meant they often built out in a different order within the year than the marketing priorities alone would have dictated.

The variability in the rate of new tower construction is highlighted in Figure (5) which plots the monthly time-series of violence per capita in the blue series (left-hand axis) and the number of towers introduced in the red series (right-hand axis) for 20 select districts of Iraq. Two patterns are apparent here. First, there is tremendous month-to-month variation in the rate of new tower introduction, both within periods of high violence and during periods of peace. Second, there appears to be some correlation between extremely high violence and low tower introduction (Al-Muqdadiyah in Baghdad in 2007 for example) in a few places. There is also an obvious relationship is at the national level where the rate of tower construction dropped dramatically during the peak of the civil war, from August 2006 to July 2007, as Figure (6) highlights. It is not obvious however, how the local correlations or national level drop in tower construction would bias the results. If towers are being built right up to the period when violence starts, for example, then lagged tower introductions should correlate positively with current levels of insurgent violence, the opposite is the case. The patterns in Figures (5) and (6) strongly suggest that adequately controlling for these secular trends at the district level is key to estimating the effect of towers on violence.

[INSERT FIGURES 5 AND 6 ABOUT HERE.]

In order to conduct a more specific test of the possibility that tower construction was influenced by violence trends, we plot the average date of tower introduction within a district in a given year on the levels of violence in: (a) the last six months of violence in the previous year and (b) the first six months of violence in a given year. If towers are being introduced in ways that avoid violent districts, we should see a positive slope in both plots for each year as tower construction is delayed by levels of violence at the end of the previous year (which may have made it harder to adjudicate titles) or in the beginning of a year (which would have delayed construction plans). As can be seen in Figure (7), this pattern fails to emerge at the district level. The top panel shows that there is no consistent relationship between levels of violence in the last six months of a year and the average date of tower introduction; none of the slopes in the figure is strongly positive. There is also no consistent relationship across years between levels of violence early in the year and the mean date of tower introduction (Figure 7, bottom panel).

[INSERT FIGURE 7 ABOUT HERE.]

Our core specification at the district level is therefore a basic first-differences approach in which we identify the within-district variation in tower introductions and violence as follows:

$$(3) \qquad v_{i,t+1} - v_{i,t} = \alpha + \beta_1 (newtowers_{i,t} - newtowers_{i,t-1}) + f_i + \delta_t + \varepsilon_{i,t} \,,$$

where f_i is a district fixed-effect and δ_t is a time-fixed effect. We lag the difference in tower construction by one month to prevent simultaneity bias. In the results section, we will rely on (a) the robustness of the core results to the inclusion of a broad range of time fixed-effects and (b) the fact that the core results pass both geographic and temporal placebo tests to provide confidence that the results are not driven by selection based on anticipated violence.

Table (1) provides descriptive statistics at the district/month level. The data cover all 63 districts in which Zain had towers for the 60 months between February 2004 and February 2009, the period for which we have data on attacks. While the average district of Iraq was quite violent during this period, experiencing 43 attacks per month, the distribution is actually quite uneven as Figures (5) and (7) dramatically illustrate. Some districts experience very little violence on both a per capita and absolute basis, while others were quite violent in both senses. Importantly, even the most violent districts had substantial infrastructure put in during the period under study.

Tower were introduced at a rate of 1 every two months in the average district, though the rate was much higher in the larger, more densely populated areas such as the districts in Baghdad governorate.

[INSERT TABLE 1 ABOUT HERE.]

Local-Level Empirical Approach

In order to assess the localized impact of providing cell phone coverage and to provide evidence as to the mechanisms driving our district level results, we need to study the impact of cell phone coverage at a smaller level. Because each tower covers a defined area when it is introduced, a natural approach is to think of something akin to a temporal regression discontinuity design in which we ask what the trends in violence are in the area a tower will cover before it is turned on and then see how those trends change after the tower is turned on.

A natural objection to this approach is that towers might be turned on exactly when the cell phone providers expect the security situation to improve. While we believe this possibility unlikely given the exigencies of the expansion process described above, the nature of the network in Iraq provides a natural way to test for this possibility. Because coverage areas of towers in Iraq overlap (both for the standard reason that providing proper coverage requires a 'hand-off' between towers and because of the unique backhaul challenges in Iraq led providers to place towers closer than is common in other settings) we can compare how the introduction of towers impacts areas that truly receive coverage for the first time with areas nearby that are already covered by other towers. These already-covered areas then serve as a kind of placebo to allow us to test whether our effects could be driven by local trends that also motivated the introduction of the tower.

A graphic intuition for this approach is useful and Figure (8) provides one, showing three different areas, **a**, **b**, and **c**, which we will call 'slices.' Here tower X is the existing tower and tower Y is the new tower. Prior to the onair date for tower Y, slices **c** and **b** have coverage but **a** does not. After the onair date all three do. In practice, these 'slices' are rarely so clean and circular but they approximate the areas that receive coverage when towers go in. In a standard difference-in-differences design we would simply let our estimate of the treatment effect be $E[(\mathbf{a}_{\mathbf{post}} - \mathbf{a}_{\mathbf{pre}}) - (\mathbf{b}_{\mathbf{post}} - \mathbf{b}_{\mathbf{pre}})]$. In this setting such an approach is untenable because the slices created by any one tower vary tremendously in their relative sizes. Thus while we can say that the introduction of the tower creates a standard temporal difference, the geographic boundary between 'new' and 'already-covered' slices may divide areas of roughly equal size, or it may divide a large already-covered slice from a small new slice, or vice versa.[20]

[INSERT FIGURE 8 ABOUT HERE.]

Rather than estimate a formal dif-in-dif, we therefore estimate fixed-effects regressions at the slice/15-day level and do so separately for already-covered slices and new slices. Using these short 15-day periods is intended to allow us to pick up any immediate impact of introducing towers. While we are working at a smaller temporal resolution, our core specification at the slice level is similar to that above except that we now use a measure of the number of towers existing in the district the slice is in to control for changes in that area's value as a node in the cell phone network. This gives us the following specification:

$$(4) \qquad v_{s,t} = \alpha + \beta_1 pre9_{s,t} + \cdots + \beta_8 pre2_{s,t} + \beta_9 post1_{s,t} + \cdots + \beta_{17} post9_{s,t} + f_s + \delta_t + \varepsilon_{s,t},$$

[20] While population weighting may seem like an attractive option for dealing with this comparability option, the population data are insufficiently precise to do so. They are calculated on an 800x800m grid whereas these coverage slices are not nearly so neat. Estimating population figures at the slice level therefore introduces a great deal of random measurement error, making it impossible to discern effects with confidence.

where f_s is a slice fixed-effect, δ_t is a month fixed effect, and the *pre* and *post* variables capture 15-day periods before and after tower introduction. We then estimate equation (4) to allow each period to have a different mean shift from the 15-days immediately prior to tower construction. This flexible form allows us to identify the duration of the effect as well as to run various tests on differences over various aggregations (say the mean for t-4 and t-3 vs. the mean for t+3 and t+4). In addition to equation (4) will estimate both a simple post-tower mean shift for the 10 periods after tower introduction, relative to the 10 before.

Table (2) provides descriptive statistics at the slice/15-day level for 986 slices with area greater than 1km^2 were created by towers established between 18 June 2004 and 16 October 2008. These are the slices for which we have a full 9 periods of violence data (135 days) before and after towers were introduced. Of these slices 457 are areas already covered by existing towers, according to our estimates of 4km in urban areas and 12km in rural areas, while 529 are areas that previously had no service according to our estimates. Panels (A) and (B) provides key characteristics for the already-covered slices while (C) and (D) do the same for the new coverage slices. As we can see, the already-covered areas are, on average, a bit larger and substantially more violent on an absolute basis. Though we do not use per-capitized violence in the results below (though the results are broadly similar) for reasons discussed above, it is worth noting that new areas are more violent on a per-capita basis. The distinct characteristics of the two kinds of slices highlights why we have chosen not to use a direct difference-in-differences approach and have instead focused on correctly identifying the temporal variation within each type of slice and then comparing that variation across slice types.

[INSERT TABLE 2 ABOUT HERE.]

3. DATA

3.1 CELL PHONE COVERAGE

Data on the coverage of the cell phone network was made available to us by *Zain Iraq* and covers the period 2004-2009. As described above, Zain purchased the other provider operating in central and southern Iraq, Iraqna, in 2007 and so our data include the vast majority of towers operating in areas of Iraq experiencing violence between 2004 and 2008. The original dataset records information on 7,687 cellphone antennas with their precise onair date and geographic location. Antennas were installed in groups of three per cell phone tower, so that together they provided a roughly 360˚ coverage around the tower. From the original dataset we derived a tower dataset of 2,489 unique locations. Due to missing onair dates, 73 of these towers were dropped, which leaves us with 2,416 towers included in the analysis.

For our tower-level analysis described in detail below, we require approximations of the towers' coverage areas. We approximate the coverage of individual towers by a circular area. Depending on whether a tower is located in a urban or rural area, we assign a short radius or a long radius. In conversations with electrical engineers we determined radii of 4 km and 12 km to be good first-order approximations of the coverage areas, but also conduct robustness checks with alternative ones. In ongoing work we are estimating more precise coverage areas by exploiting information on other factors including the azimuth of antennas on the towers, the microwave backhaul requirements of the network, and the changing requirements for coverage over time as Zain built out in densely-populated areas. This analysis entails substantial complications and so for purposes of this paper we restrict ourselves to approximating coverage.

3.2 ATTACKS

Our measure of attacks against Coalition and Iraqi government forces is based on 193,264 'significant activity' (SIGACT) reports by Coalition forces that capture a wide variety of information about "…executed enemy attacks targeted against coalition, Iraqi Security Forces (ISF), civilians, Iraqi infrastructure and government organizations" occurring between 4 February 2004 and 24 February 2009. Unclassified data drawn from the MNF-I SIGACTS III Database were provided to the Empirical Studies of Conflict (ESOC) project in 2008 and 2009. These data provide the location, date, time, and type of attack incidents but do not include any information pertaining to the Coalition Force units involved, Coalition Force casualties or battle damage incurred. Moreover, they exclude coalition-initiated events where no one returned fire, such as indirect fire attacks not triggered by initiating insurgent attacks or targeted raids that go well. We filter the data to remove attacks we can positively identify as being directed at civilians or other insurgent groups, leaving us with a sample of 168,730 attack incidents.[21] Figure (6) highlights the great variation in the patterns of violence over time across the 30 most violent districts in our sample.

[INSERT FIGURE 8 ABOUT HERE.]

3.3 Civilian Population and Ethnicity

To estimate the population we employ the fine-grained population data from LandScan (2008), a population raster dataset whose cell-based estimates were aggregated up to the district level.[22] Estimates of a district's ethnic composition were obtained by combining these data with precise ethnic maps of Iraq. After collecting every map we could find of Iraq's ethnic mix, we geo-

[21] We thank LTC Lee Ewing for suggesting the filters we applied.

[22] The LandScan data provide worldwide population estimates for every cell of a 30" X 30" latitude/longitude grid (approx. 800m on a side). Population counts are apportioned to each grid cell based on an algorithm which takes into account proximity to roads, slope, land cover, nighttime illumination, and other information. Full details on the data are available at http://www.ornl.gov/sci/landscan/

referenced them and combined them with the population data to generate estimates of the proportion of each district's population that fell into each of the three main groups (Sunni, Shia, Kurd).[23] Using the figures from what we judged to be the most reliable map (a CIA map from 2003), we coded districts as mixed if no ethnic group had more than 66% of the population, otherwise the district was coded as belonging to its dominant ethnic group.[24]

4. RESULTS

This section analyzes the impact of expanding the cell phone network on violence at two levels. First, we analyze regional effects using standard panel data techniques and report a number of robustness checks. Second, we show how the regional effects of expanded coverage vary by type of attack and by sectarian area, providing evidence as to the mechanisms at play. Finally, we analyze the effect of introducing coverage over specific local areas using a novel approach based on looking for discontinuous changes in violence when towers are turned on.

4.1 REGIONAL IMPACT OF CELL PHONES: DISTRICT-MONTH RESULTS

At the district level, we find that adding additional cell phone coverage decreases violence. In column (3) of Table 3 we present results from a simple model regressing total attacks in period t on the number of towers built in t-1, the number of pre-existing towers in a district, the

[23] Thanks to Josh Borkowski and Zeynep Bulutgil for conducting the coding. Full codebook and replication files are available on request.

[24] An alternative approach is to code all parties participating in the December 2005 legislative election, which saw broad Sunni participation, according to their sectarian affiliation. Using that approach one can calculate the vote share gained by each group's (Sunni, Shiite, Kurd) political parties. Unfortunately, the election results were never tabulated at the district level for security reasons and so that approach can only yield governorate-level estimates. Twenty five of 104 districts are coded differently using these two approaches, mostly in districts that were coded as Sunni, Shia, or Kurdish using governorate-level vote shares but were coded as mixed using the map-based method. It is not clear a priori which approach is more accurate. The vote shares are based on observed recent behavior and so are a direct measure but suffer from aggregation issues. The ethnic population shares are based on fine-grained data but ultimately rest on an outside organization's guess as to the sectarian mix in Iraq.

proportions of the district that are Sunni and Shia, and province and half-year fixed effects to pick up the large secular trends in violence. In this basic specification, the introduction of one new tower correlates with approximately 2.7 less attacks in that month in an average sized Iraqi district. This effect is not large, the average district sees 36 attacks per month during the period of our data, but is strongly significant using robust standard errors clustered at the district level.

[INSERT TABLE 3 ABOUT HERE.]

Columns (4) – (10) present the core specification in first differences, which nets out district-specific trends such as the anticipated long-term economic value of the district, which might impact both insurgent violence and the introduction of cell phones. The results in differences are smaller but are statistically significant once we add in more refined time fixed-effects (columns 5 and 6), add a district fixed-effect in addition to differencing (column 7) and allowing the fixed effects to vary across the intersection of time and ethnicity (columns 8 to 10). The result remains substantively similar and statistically very strong even when we include a district fixed effect and net out the average violence in the each of the 13 provinces in the data each quarter (column 10), an extremely robust way to control for the broad trends in the conflict and in incentives to build towers. Appendix Tables (3A) shows the results of the most stringent specifications (columns 7 and 10) are robust to the inclusion of the spatial lag of violence as an additional control.

Overall, the introduction of new towers correlates with less violence no matter how we handle secular trends in violence. In the most stringent model, column (10), a one standard deviation increase in the number of towers in a district (1.8) predicts 1.1 less attacks (-.188 * 3.27 * 1.8) in the following month, a 10% decrease from the mean level of violence.

Before proceeding it is worth assessing whether the results might be driven by either: (1) omitted variables driving trends in both violence and tower construction; or (2) the direct impact of violence on future tower construction. To check for the first possibility we use temporal and geographic placebo tests. Appendix Table (3B) places the number of new towers introduced in the next month on the RHS (the lead difference) and Appendix Table (3C) places the number of towers introduced in neighboring districts on the RHS (the spatial lag of the lagged difference). None of the coefficients are significant in the differenced specifications, providing additional confidence that the combination of differencing and fixed effects in Table (3) properly identify the impact of tower construction at the district-month level.

While we argued the second possibility is unlikely given that the cell phone providers reported insurgent violence did not interfere with tower construction, violence might impact tower construction in less direct ways. The providers reported that the main source of month-to-month delays in tower construction arose from the need to secure clear title to properties before building. Past sectarian violence, which is weakly correlated with insurgent attacks ($\rho = .203$), clearly drove population movements which likely made if harder to secure clear title to desired tower locations, thereby delaying tower construction. If that dynamic introduced bias into our estimates we should find that controlling for various kinds of sectarian violence alters the results. Appendix Table 3D shows this is not the case. Panel (A) of reports the core specification of columns (6 and 7) from table (3), Panel (B) controls for total sectarian violence in a number of ways, and Panel (C) controls for targeted killings by sectarian organizations. None of the controls significantly impact our estimates of the impact of cellular coverage, providing additional confidence in the estimates in Table (3).

4.2 Mechanisms at the District-Month Level: Variation in regional effects

The affect of expanded cell phone coverage on insurgent attacks varies in informative ways across different insurgent tactics and across sectarian areas. Different kinds of insurgent attacks have different sensitivities to the productivity of labor and to information sharing by the population. In particular, direct fire attacks (ambushes and the like) typically involve multiple individuals coordinating their actions but are sensitive to information sharing by the population, which can observe insurgents setting up. In the terms of the simple production function presented above this means that both $a'(\kappa)$ and $i'(\kappa)$ are likely to be large. Indirect fire attacks (mortars and the like) require less coordination and are less sensitive to information sharing as insurgents have great flexibility in choosing their firing position. Returning to the production function, indirect fire attacks should have $a'(\kappa)$ and $i'(\kappa)$ close to zero, at least in the near term. IED attacks, require much less coordination than direct fire attacks and reveal less information to non-combatants, but remain sensitive to tips relative to indirect fire attacks, especially as tips about weapons caches can remove a large number of IEDs from circulation.[25] For IED attacks then $a'(\kappa)$ is likely close to zero but $i'(\kappa)$ is likely to remain positive, though smaller than for direct fire attacks. Finally, IEDs cleared conditional on the number attempted are a relatively direct measure of how much information the population is sharing.[26]

As Table (4) shows, emplacing more towers reduces all types of attacks, but has heterogenous effects across the four main attack types. Panel (A) of Table (4) reports the core first differences model for each type of attack with district and month fixed effects, analogous to column (7) of Table (3). The effect us negative but not statistically significant for direct fire attacks and positive but not statistically significant for indirect fire attacks and IEDs cleared

[25] Direct fire weapons such as AK-47s are ubiquitous throughout Iraq and so their supply is unlikely to be as sensitive to raids being conducted on the basis of tips.

[26] There are no major month-to-month changes in the technologies of IED detection. The large changes happened once or twice in each district as units adopted new technologies and so the vast majority of month-to-month variation in IEDs cleared within a district is likely to be driven by changes in intelligence, not in technology.

given total IED attempts. The effect is negative and statistically significant for IED attacks. The substantive effects are meaningful but not large. A one standard deviation increase in the number of towers introduced reduces the number of direct fire attacks in an average district-month by approximately 6.5%, and reduces the number of IED attacks by approximately 8.1%.

[INSERT TABLE 4 ABOUT HERE.]

What is more interesting about Table (4) is that the results are not particularly sensitive to dropping the periods which introduce the greatest concern about broad trends in violence creating spurious results. One such possibility is that the period of peak violence had few tower introductions and so the results might be driven by the negative correlation for that period. Panel (C) checks this possibility by dropping the months of peak violence from the analysis. The coefficient on overall attacks becomes smaller, and is not statistical significant without this period. The coefficient on IED attacks, however, becomes larger when we drop the period of peak violence. Another possible source of spurious results is that during the period of peak violence, from August 2006 to July 2007, few towers were built, creating pent up demand that was met by the large construction boom in 2008 that is evident in Figure (6). If all these towers were being built during a period when violence was declining, that could drive the results. Fortunately, Panel (D) shows this is not the case, the core results actually become substantially stronger when we drop 2008 from the analysis.

What about geographic heterogeneity? As Table (5) shows, it turns out that the results are mostly driven by a strong affect in Sunni areas. Column (1) of the table reports our core first differences specification, and the remaining columns report the results for different sectarian subsets of the data. Column (5) combines Sunni and mixed areas, showing that the average affect across the parts of the country where the war was really fought is negative and substantively modest, so that a one standard deviation increase in towers in these areas led to 3.9 fewer attacks in the next month (1.9*-.496*4.176), a 12.3% reduction. Columns (6) report the results for ethnically homogenous districts, where 80% of the population is from one sect, and column (7) shows the results for non-homogenous districts. The effects are substantively similar across these areas, with the standard errors being much larger in the non-homogenous districts because of the smaller sample size. Appendix Table (5A) breaks these results down by both attack type and sectarian region, showing that the effects are driven by Sunni and mixed areas, which makes sense as there were relatively few insurgent attacks in Shia and Kurdish districts, and that the reduction in direct fire attacks is strongest in Sunni areas is far and away the strongest affect.

[INSERT TABLE 5 ABOUT HERE.]

What do these patterns imply? First, that the affects of expanded coverage are strongest in Sunni areas. These are the regions where we might expect that (a) Coalition forces' ability to run human sources would be weakest and (b) in-group policing by insurgents would be most effective. Both imply that the impact of expanding coverage should be large there as it created a collection channel for intelligence and provided people a safe way to share tips. Second, the effects are of similar magnitude for direct fire and indirect fire attacks (nearly identical if we drop 2008 from the analysis), making it seem unlikely that expanding coverage substantially eased coordination, if it had the effect on direct fire attacks should have been muted. Third, ethnic homogeneity does not appear to be a key factor; the affects are substantively similar between the 48 homogenous districts and the 15 non-homogenous ones.

4.3 Local Impact of Cell Phones: Slice-Level Results

To estimate the impact of cellular communications at the slice level we would ideally like to know how levels of violence within towers' coverage areas change between the periods immediately before towers are introduced and the periods immediately after. This approach identifies a causal impact if the timing of tower introduction is random conditional on our controls. We argued above that once we account for the overall marketing decisions, the month-to-month timing of tower introduction is largely random given the exigencies of actually building the network.

Fortunately, we can do better than weighing in on the theological validity of that position. We can test it by using the portion of the area covered by a new tower that already has coverage as a placebo. As those 'already-covered' slices are contiguous with new slices in all kinds of odd ways—the boundaries are rarely as neat as in Figure (8))—we expect them to be subject to the same unobservable factors with respect to violence as the genuinely new coverage slices. We can therefore run the analyses below twice, once for 'already-covered' slices and once for new coverage slices. If we find an effect in the new coverage slices and not in the others, we can have some confidence that we have identified a causal effect.

Comparing mean levels of violence (conditional on time and space fixed effects) at the slice level in the 120 days before towers are introduced and the 120 after shows that introducing towers leads to a modest decrease in total attacks and IED attacks after towers are introduced and a modest increase in the number of IEDs found and cleared conditional on the number attempted. As Table (6) shows, the negative IED effect is statistically and substantively larger in already-covered slices (Panel A) while the effect of towers on IEDs found and cleared is substantively larger and twice as statistically significant in the newly covered slices (Panel B). In thinking about these results it is critical to note that the average rate of IED attacks in already-covered slices is three times larger than in new coverage slices (.98 vs. .32). In new coverage slices the proportional reduction in IED attacks from introducing coverage is 24.3% (.078/.32), 77% larger than the 13.7% (.134/.98) reduction in already covered slices.

[INSERT TABLE 6 ABOUT HERE.]

Comparing the mean levels of violence over large periods before and after towers are introduced may mask important effects that are short in duration. A more flexible approach is to estimate equation (4) which assesses the difference between mean incidents in the 15-days before a tower is built and each 15-day period before or after for 8 periods in either direction. This approach effectively traces out the response to tower construction over time. Since tables with 5 columns of 16 coefficients are not terribly nice to read they are relegated to the appendix. Instead, Figure (10) illustrates this approach graphically. Each graph shows a local polynomial smoother with 90% confidence intervals applied to the residuals from a regression of attacks on a slice fixed effect, month fixed effect, and the number of towers already in the district. The smoother is calculated separately before and after tower introduction for each type of attack. The y-axis shows the average level of violence not predicted by those variables and the x-axis shows the number of 15-day periods before or after a tower was introduced. The upper panel shows the results for four kinds of attacks in already-covered slides. Here there is no effect. The lower panel shows the results for new coverage slices. In the new slices there is a clear, although not statistically significant decrease in the rate of IED attacks when towers are introduced and a statistically significant increase in the number of IEDs cleared conditional on total attempts.

[INSERT FIGURE 10 ABOUT HERE.]

A more formal way to think about the significance of these effects is to ask whether there are changes over fixed periods. As one would expect from figure 10, Appendix Table 7 shows that the difference in means between the last 15-days prior to construction and the first 15-days after construction is never statistically significant for any type of attack or region. Aggregating the effects up to slightly larger temporal units shows what one would expect from Figure (10), something is different in these small areas for a short period after towers are turned on. Consider 30-day periods. Using a robust Wald test we fail to reject the null hypothesis that violence in *t-2* and *t-3* is different than in *t-1* for all types of events in new coverage areas, so for from 45 to 15 days prior to installation violence is no different than the period immediately before towers go in. However, in the 30 days after installation the average number of IED attacks is 16.9% lower than in the average period in a new slice (-.054/.319), a statistically significant effect at the 94.6% level (two-tailed). The average number of IED attacks in the 30 days post-installation is smaller and not statistically significantly different in old slices (-.024, $p = .13$). On the flip side, as one would expect from Figure (10), the average number of IEDs found and cleared, conditional on total attempts, is significantly higher than in the periods before installation. For the 60-days following installation, the average number of IEDs found and cleared is 35% higher than the mean for new coverage areas (.024/.068), a statistically significant effect at the 92.9% level (two-tailed). These differences are insignificant in previously-covered areas. We can also test whether the rate of IEDs found and cleared (conditional on total attempts) is the same in *t-4* to *t-2* as it is in t+2 to t+4. The average rate is .07 higher in this 45 day post-tower period in new coverage areas, fully 100% of the mean rate of IEDs cleared in such areas. For comparison, the difference in already covered areas is positive but is only 60% of the mean rate for those areas and is not statistically significant ($p = .75$).

These slice-level results as a whole suggest that the effect of information flowing to Coalition forces is key mechanism driving the panel data results. Introducing cell phone coverage has a modest localized impact in reducing the number of IEDs and increasing the number of IEDs found and cleared in new coverage areas but not in contiguous previously-covered areas. This is particularly striking as putting coverage over an area increases the range of IED fusing options which should, if anything, decrease the proportion counterinsurgents can successfully neutralize.

5. CONCLUSION

This paper presents the first systematic examination of the affect of cellular communications on political violence using novel micro-level data from Iraq. We estimate the effect of cell phone network expansion on insurgent violence at two levels. First, because the insurgency was organized regionally, we conduct a district-level analysis, assessing whether increased coverage at the district level is associated with changes in violence. Here our analysis shows that increasing the density of cell phone coverage led to a decrease in insurgent violence at the district level and an increase in counterinsurgent success against one tactic, improvised explosive devices (IEDs). These results suggest that the information-enhancing effects of improved cell phone communications swamp any effects on insurgents' ability to organize.

Second, we address the local effect of cell phone towers within specific coverage areas. Using a novel spatial-temporal difference-in-difference design, we show that the introduction of cell phone towers leads to more successful counterinsurgency operations in the tower's coverage area. Specifically, introducing coverage over a defined geographic area for the first time had no impact on levels of direct fire attacks, ambushes and the like, but reduced the number of improvised explosive devices that went off and strongly increased the number found and cleared as a proportion of all IEDs attempted. This finding is especially striking given that the introduction of cellular communications opens up a broad range of technologies for fusing IEDs.

Taken together these findings suggest the mechanism driving the impact of cellular communications on violence is increased information flow from the population. At the district level, where insurgent bands are organized, greater cellular communications capacity is a clear negative for insurgents. Our data are ambiguous about whether this is because coverage enhances voluntary information flow from non-combatants by reducing the risks of informing, or because insurgents using cell phones present a good target for government intelligence gathering efforts

At the local level though, the effects seem more consistent with information flow from the population being the key factor. Analyzing coverage 'slices' we find that the rate of insurgents' organized multi-person attacks is not heavily affected by the introduction of towers, but the rate of IED attacks is. This is sensible, one does not, after all, need to be physically at the movie theater to coordinate with friends on what movie you will see when you get there. However, when an area gets coverage it becomes easier for people in that region to call in tips about the location of IEDs, just as it becomes easier to tell your friend at home about a twenty dollar bill you found on the floor of the movie theater if you get coverage in the theater.

These results speak to a number of literatures. First, they contribute to a growing body of literature demonstrating the beneficial effects of expanding communications opportunities (Jensen 2007, Aker 2008). Our findings suggest cellular communications may confer a range of governance and stability advantages that have not previously been tested in this literature.

Second, the results also speak to debates about what kinds of ethnic concentrations increase the risk of civil war (Weidmann 2009) and to discussions of why insurgencies are more successful when operating from rural areas (Kocher 2004; Bates 2008; Staniland 2010). The question at issue in these debates is whether urban terrain makes it easier or harder for state security forces to control violent groups. The key argument on the ‘easier’ side is that in urban areas many people necessarily have information on the insurgents, by virtue of simple population density, which makes them acutely vulnerable to informants. By showing that exogenous environmental changes which reduce the cost of informing leads to a clear and unambiguous reduction in insurgent violence, we provide solid empirical grounding for a mechanism discussed, but never tested, in this literature.[27]

Third, and perhaps most importantly, these results are highly relevant to ongoing policy in all countries facing active insurgencies and the need to grow their wireless infrastructure. For countries such as Colombia, India, Pakistan, and Thailand, the policy debates typically hinge on how tightly regulated access to phones and SIM cards should be. For the international community the debates are about the extent to which the expansion of cellular communications should be subsidized. In Afghanistan, for example, there have been ongoing discussion about whether or not foreign governments and aid agencies should work with telecommunications firms that make compromises with local militants in order to protect their towers and staff. Much of the policy community currently argues there should be little engagement so long as towers are being turned off at night when the Taliban demands. Our analysis suggests this approach may be wrong-headed. If in addition to their economic impact towers that are on only part of the day confer counterinsurgency benefits, as we show towers which are on all day do, then the international community may well want to subsidize the expansion of the Afghan cell phone network regardless of how the firms managing the network interact with the locals.

Finally, this research suggests a number of future directions. First, future work should seek direct measures of information flow to government forces to distinguish between possible

[27] We thank James Fearon for pointing out this connection.

mechanisms for the beneficial impact of cellular communications. Second, similar studies should be conducted in other countries that built out there communications infrastructure during periods of intense conflict; Afghanistan, Colombia, and the Philippines come to mind. Such studies would be both policy relevant and potentially informative as to how cellular communications impact the production of violence. Afghanistan and Iraq, for example, are different conflicts in a number of ways—Iraq is more urban, more developed, and the insurgency was much more diffuse—including the fact that insurgents have been much more negative towards mobile communications in Afghanistan. Understanding how the impact of expanding cellular communications differs across these countries may provide insight into how those differences affect the production of violence.

Figures

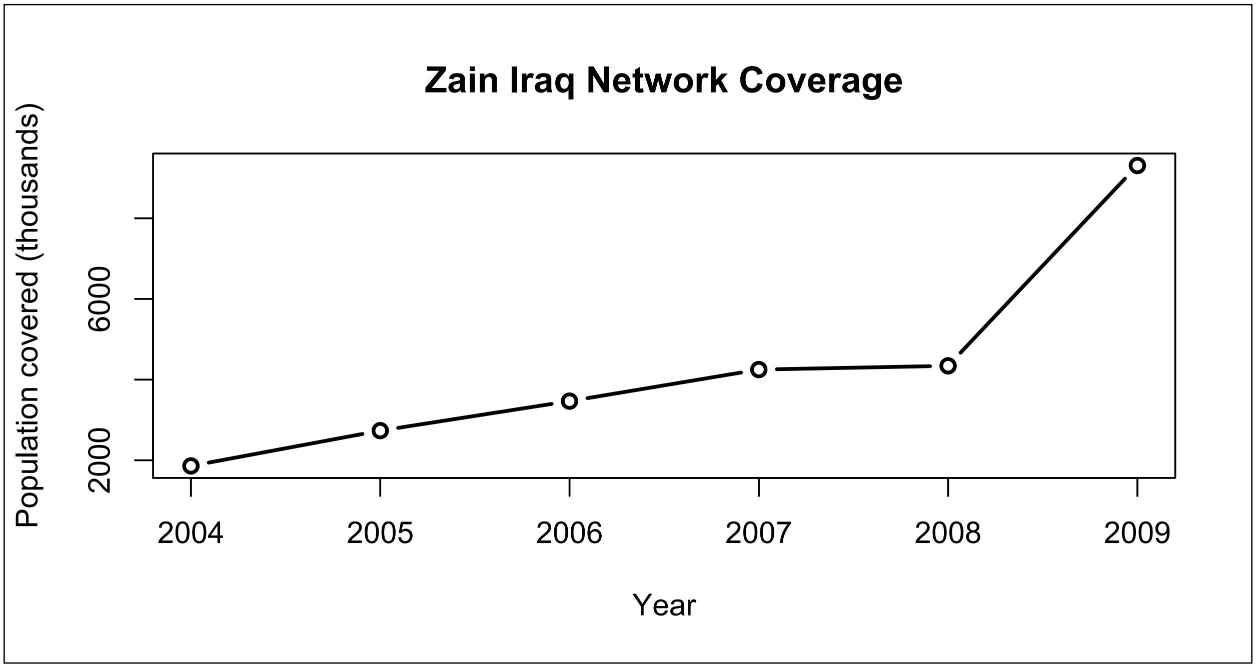
Figure 1. Cell-Phone Triggered Improvised Explosive Device

Figure 2: Tip Line Card

Note: A card handed out by soldiers from the U.S. Army 3rd Infantry Division providing contact information for a government-run tip line. The card reads as follows:

> "Have you seen, heard or become aware of criminal activities or those hostile to Iraq? Do you wish you could do something about it? You can!! Talk anonymously and help your country by giving news about crimes or actions hostile to Iraq. Fulfill your duty to take care of your children, your loved ones and society. You may phone or text to this number: 07712477623. Give any information you want, no names needed. The way YOU can fight is by calling this number: 07712477623."

Figure 3. Expansion of Coverage by Population, 2004-2009



Source: Author calculations cell tower data provided by Zain Iraq and LandScan (2008) gridded population data. Coverage areas estimated with 4km radius in urban areas and 12km radius in rural areas.

Figure 4: Expansion of the Zain Iraq Network, 2004 2009

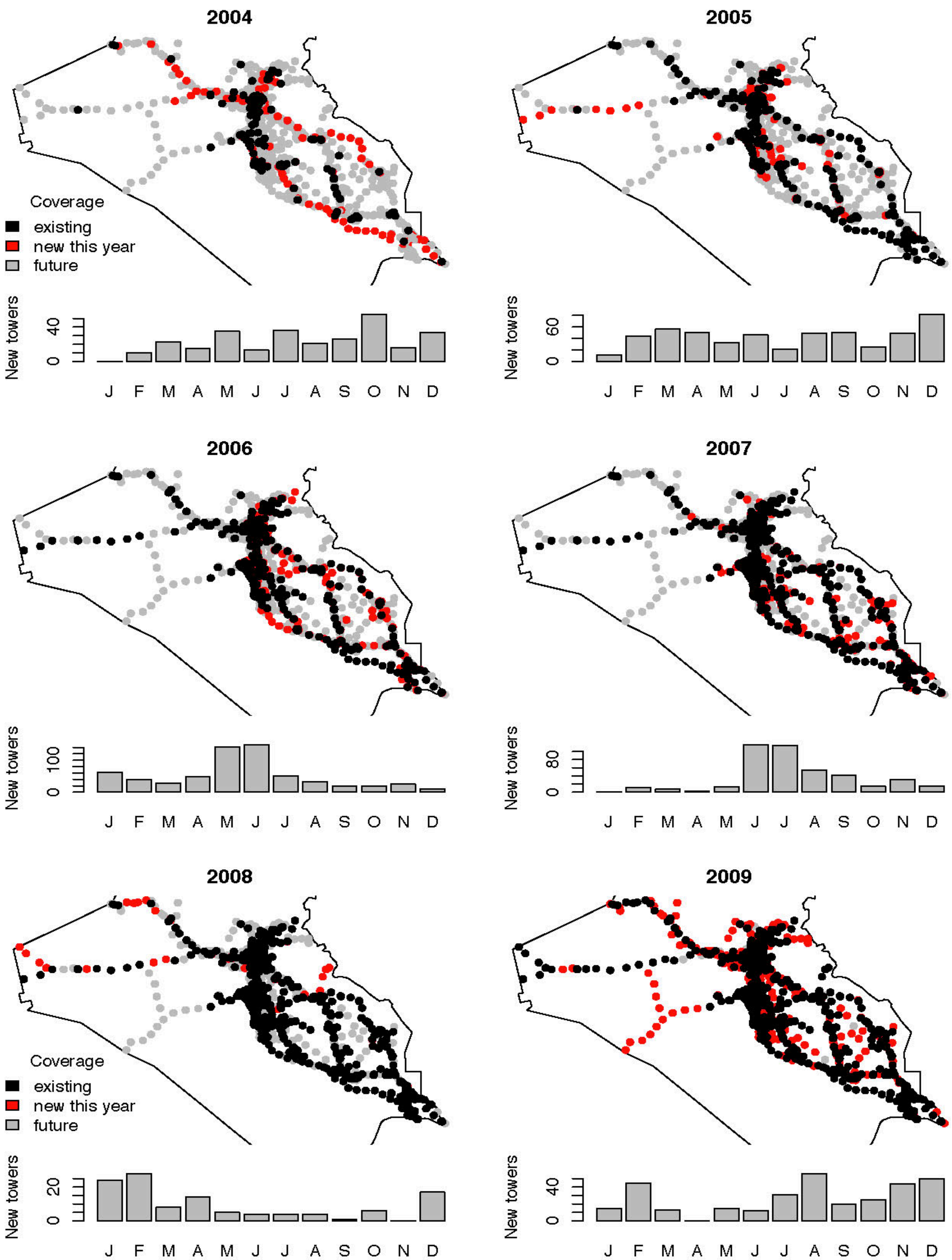
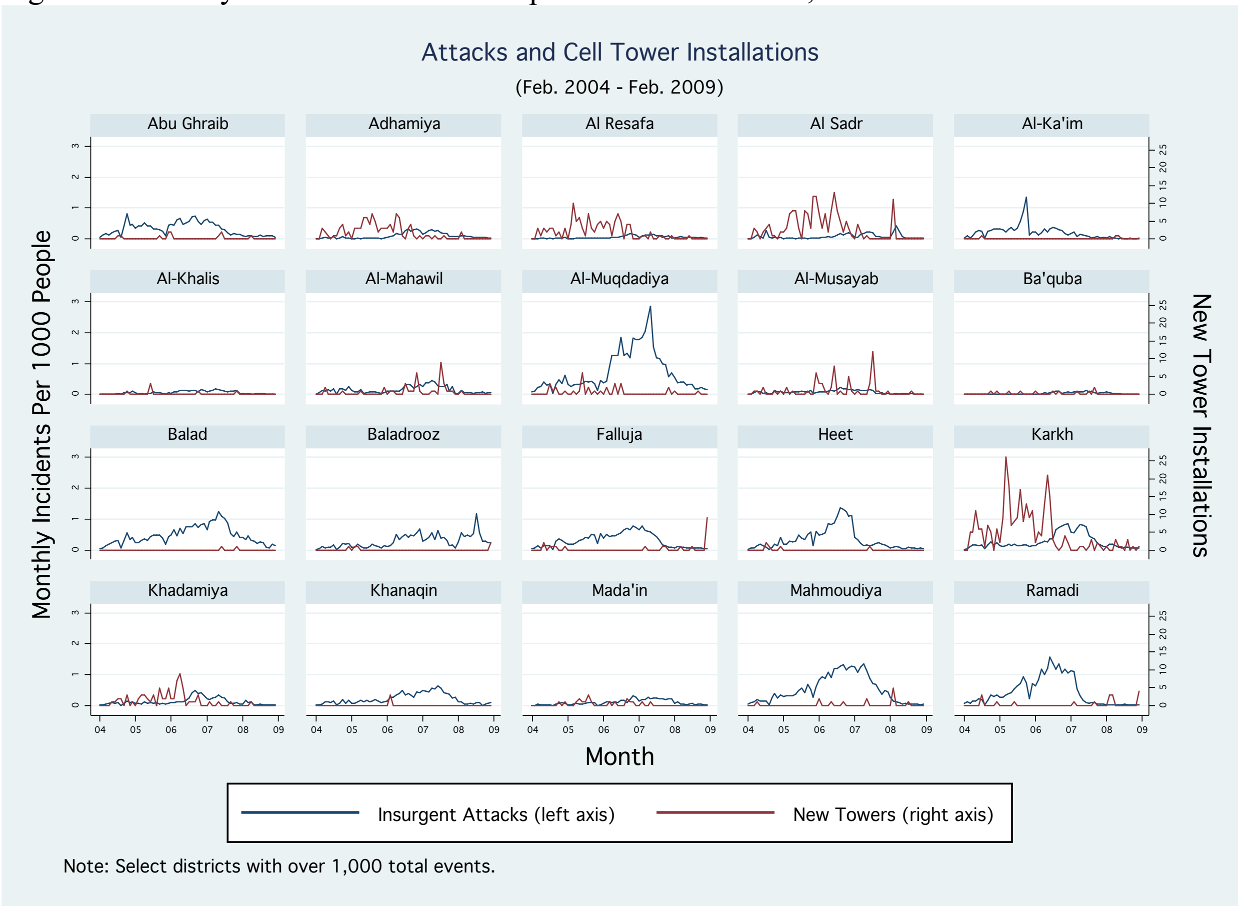
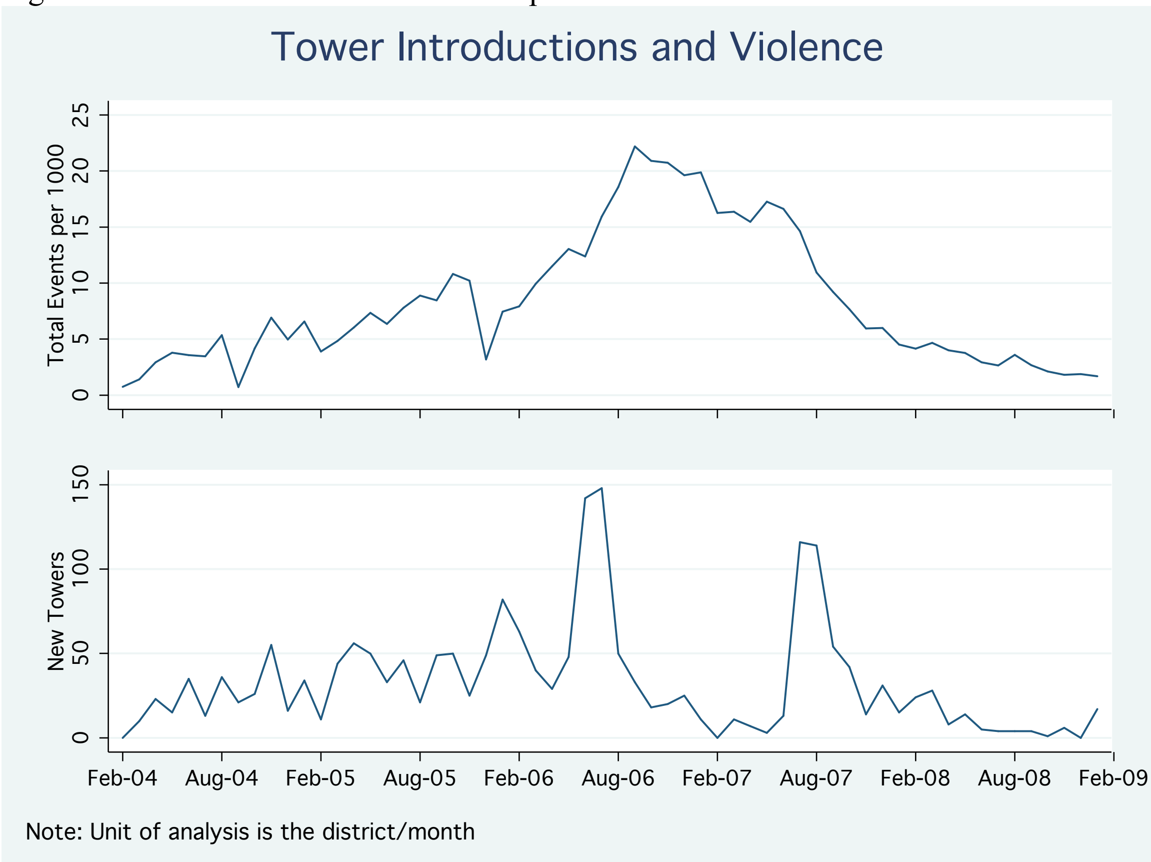


Figure 5: Monthly Trends in Network Expansion and Violence, Select Districts



Note: Unit of analysis is the district month. Violence data are from MNF-I SIGACT-III database. Population data are from World Food Program Food Security and Vulnerability Analysis surveys fielded in 2004:I, 2005:II, and 2007:I. Data on cell phone tower installations provided by Zain Iraq.

Figure 6: National Trends in Network Expansion and Violence



Note: Unit of analysis is the month. Violence data are from MNF-I SIGACT-III database. Population data are from World Food Program Food Security and Vulnerability Analysis surveys fielded in 2004:I, 2005:II, and 2007:I. Data on cell phone tower installations provided by Zain Iraq.

Figure 7: Impact of Violence on Tower Construction at District/Month Level

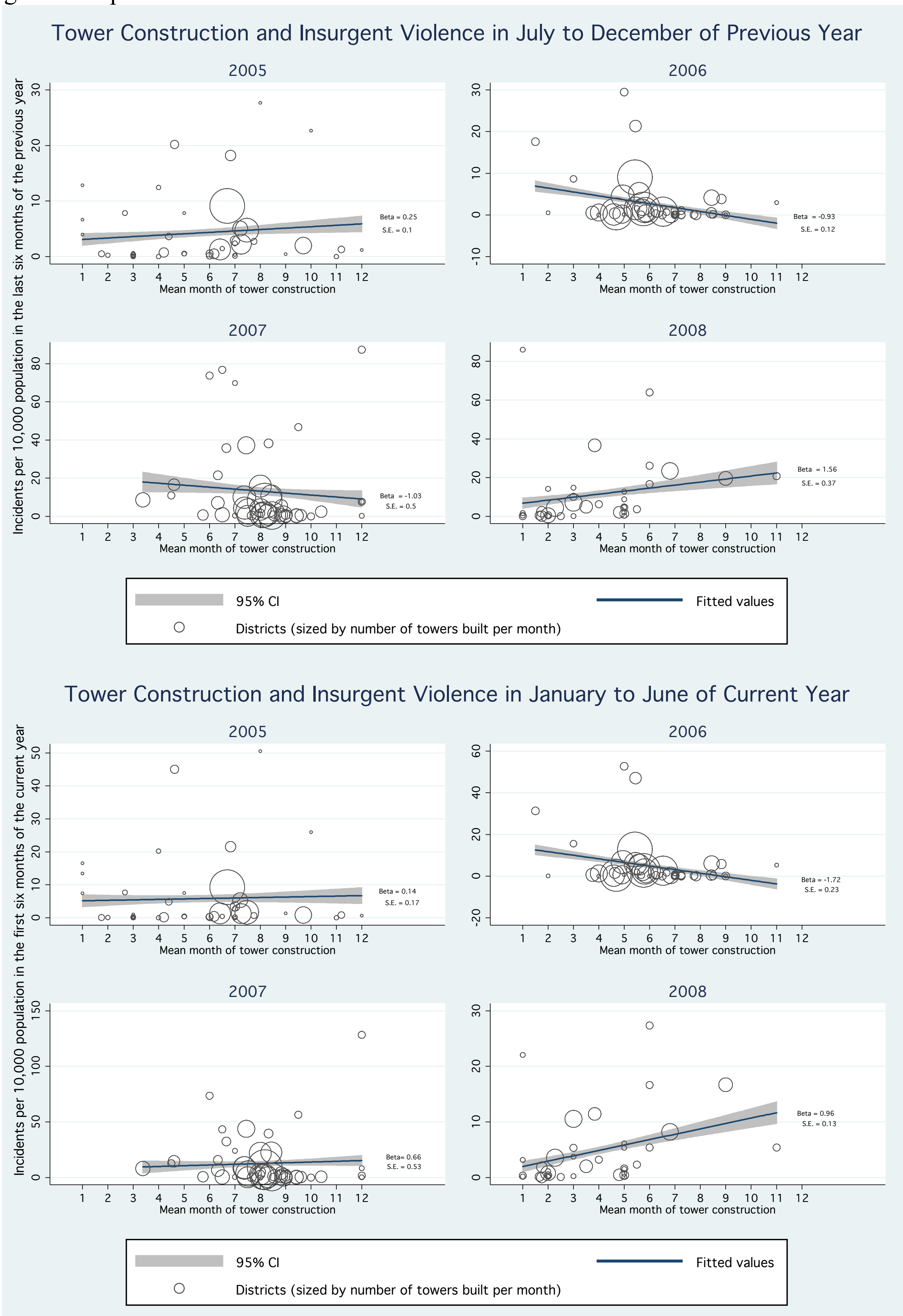


Figure 8: Comparing Old and New Slices

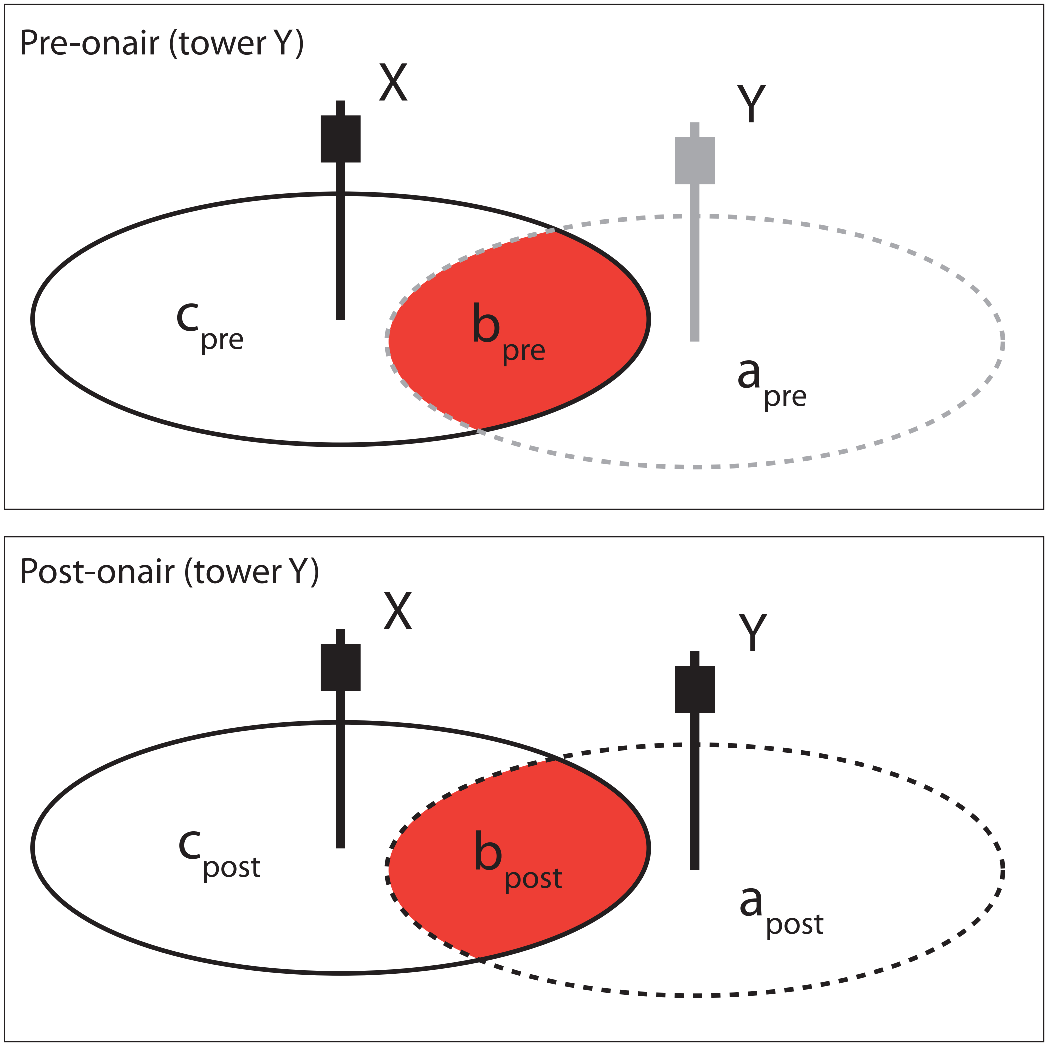
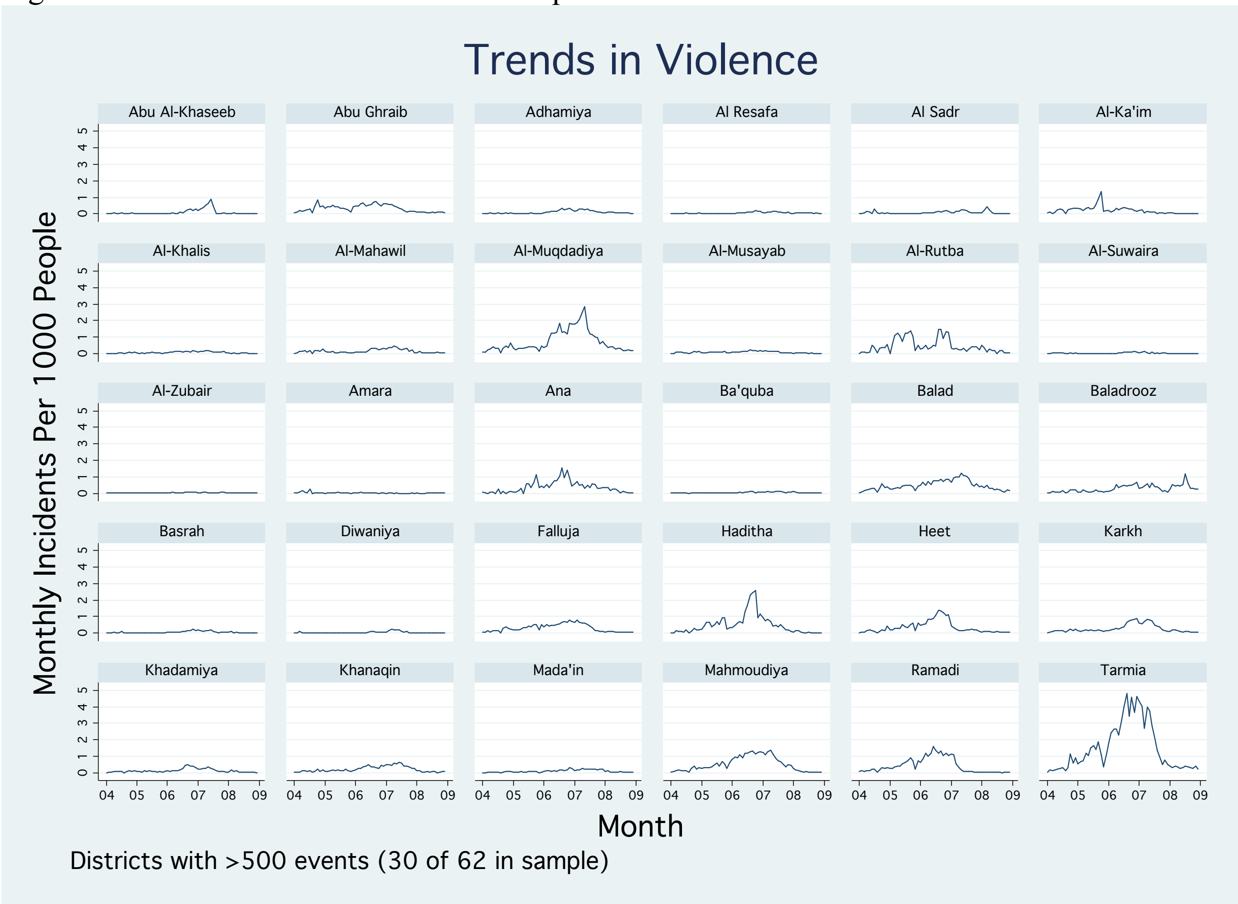
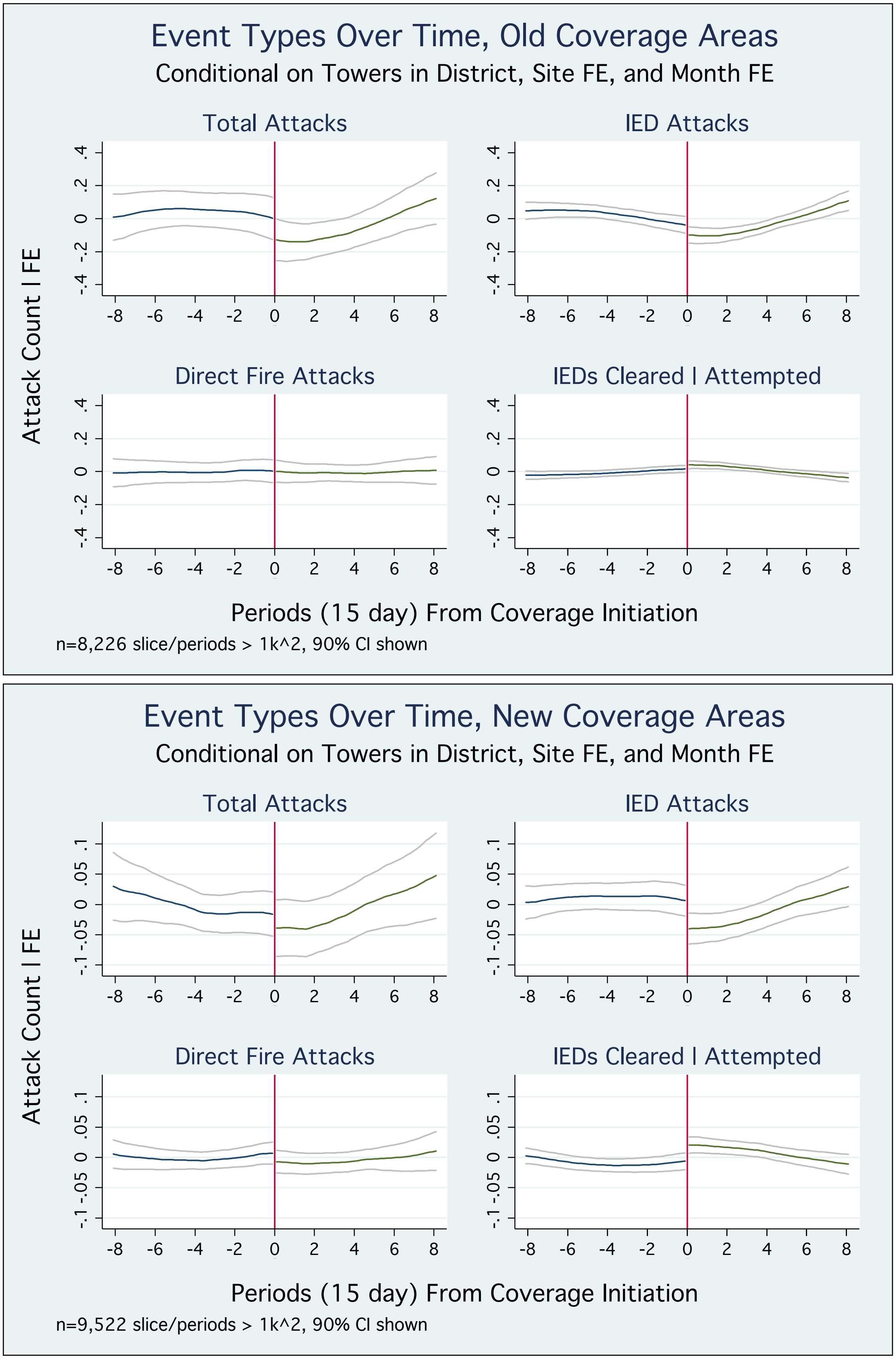


Figure 9: Variation in Violence Across Iraq



Note: Unit of analysis is the district month. Violence data are from MNF-I SIGACT-III database. Population data are from World Food Program Food Security and Vulnerability Analysis surveys fielded in 2004:I, 2005:II, and 2007:I.

Figure 10: Local Impact of Introducing Towers, Comparing Old (b) vs. New (a) Areas



Tables

Table 1: Summary Statistics – District/Month

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Panel A: Violence Variables					
SIGACTs / 100,000	3,780	13.21	34.92	0	481
Attacks / 100,000	3,780	12.04	32.82	0	453
Direct Fire / 100,000	3,780	3.25	10.26	0	156
IEDs /100,000	3,780	5.22	14.94	0	244
IEDs Cleared /100,000	3,780	1.69	7.47	0	160
Sectarian Killings/100,000	3,780	1.79	6.63	0	170
Targeted Killings/100,000	3,780	0.648	4.74	0	170
Panel B: Control Variables					
New Towers	3,780	0.519	1.833	0	35
Total Towers Active	3,780	18.74	38.67	0	296
Population (1000)	3,780	327	320	11	1662
Proportion Sunni	3,780	0.243	0.355	0	1
Proportion Shia	3,780	0.742	0.371	0	1

Notes: Unit of analysis for violence is district/month, February '04 – January '09. Violent events based on data on MNF-I SIGACT-III database. Civilian casualty data from Iraq Body Count collaboration with ESOC. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007). Analysis restricted to 63 districts in which Zain operated during period under study.

Table 2: Summary Statistics – Slices, 15-day periods

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Panel A: Violence Variables – Already Covered Slices					
SIGACTs	8,226	3.09	12.58	0	360
Attacks	8,226	2.50	8.40	0	195
Direct Fire	8,226	0.90	3.18	0	66
IEDs	8,226	0.98	3.74	0	88
IEDs Cleared	8,226	0.15	1.11	0	33
Panel B: Slice Characteristics – Already Covered Slices					
Area (km^2)	457	95.86	121.19	1.19	447.92
Population (1000)	457	95.19	133.74	0.00	1000.57
Proportion Sunni	457	0.16	0.27	0.00	1.00
Proportion Shia	457	0.84	0.27	0.00	1.00
Panel C: Violence Variables – Already Covered Slices					
SIGACTs	9,522	0.70	3.77	0	81
Attacks	9,522	0.66	3.51	0	66
Direct Fire	9,522	0.18	1.10	0	36
IEDs	9,522	0.32	1.63	0	38
IEDs Cleared	9,522	0.07	0.79	0	21
Panel D: Slice Characteristics – New Slices					
Area (km^2)	529	91.76	147.02	1.02	449.49
Population (1000)	529	9.12	26.04	0	334.99
Proportion Sunni	529	0.18	0.30	0	1
Proportion Shia	529	0.81	0.31	0	1

Notes: Unit of analysis for violence is slice/bimonth (15-day period). Slices are unique coverage areas created by an 4km radius around cell phone towers in urban areas and 12km radius in rural areas. 33% of slices are urban. Slices include both ‘new’ slices and ‘already-covered’ slices. Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data. Includes only slices with at least 9 periods before and after onair date.

Table 3. Impact of Increased Cell Phone Coverage on Total Attacks – District/Month

Dependent Variable:	(1) SIGACT /100,000	(2) SIGACT /100,000	(3) SIGACT /100,000	(4) FD of SIG /100,000	(5) FD of SIG /100,000	(6) FD of SIG /100,000	(7) FD of SIG /100,000	(8) FD of SIG /100,000	(9) FD of SIG /100,000	(10) FD of SIG /100,000
New Towers in *t*-1	-0.815*	-0.640**	-0.857**							
	(0.44)	(0.25)	(0.39)							
Lagged First Difference of Tower Count				-0.0780	-0.0882*	-0.115**	-0.149**	-0.0887*	-0.0952*	-0.188*
				(0.047)	(0.049)	(0.056)	(0.070)	(0.054)	(0.055)	(0.11)
Existing Tower Count		-0.0251	-0.0873							
		(0.033)	(0.071)							
Sunni Proportion	40.01**	40.60**	30.69							
	(16.8)	(17.4)	(29.3)							
Shia Proportion	-4.101	-3.560	-10.88							
	(6.51)	(7.04)	(25.1)							
Observations	3717	3717	3717	3654	3654	3654	3654	3654	3654	3654
R-squared	0.28	0.28	0.31	0.01	0.01	0.07	0.07	0.03	0.06	0.07
Time FE	Half	Half	Half	Half	Quarter	Month	Month	Sect X Half	Sect X Quarter	Province X Quarter
Space FE	No	No	Province	No	No	No	District	No	No	No
First Differences	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Unit of analysis for violence is district/month, February ‘04 – January ’09. Analysis restricted to 63 districts in which Zain Iraq operated during period under study. Robust standard errors, clustered at the district level in parentheses. Each model’s fixed effects are noted. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).

Table 4. Impact of Increased Cell Phone Coverage by Attack Type

Dependent Variable: FD of Attacks/100,000	(1) All Attacks	(2) Direct Fire	(3) Indirect Fire	(4) IED Attacks	(5) IEDs Cleared
Panel A: Full Sample					
Lagged FD of Towers	-0.149**	-0.0449	0.00525	-0.0641*	0.0166
	(0.070)	(0.033)	(0.0083)	(0.033)	(0.017)
Lagged FD of IED attacks					0.274***
					(0.056)
Observations	3654	3654	3654	3654	3654
R-squared	0.07	0.03	0.09	0.07	0.31
Panel B: Full Sample with Spatial Lag					
Lagged FD of Towers	-0.140**	-0.0437	0.00544	-0.0578*	0.0162
	(0.069)	(0.033)	(0.0083)	(0.032)	(0.017)
Spatial Lag of DV	0.0323***	0.00435*	0.000681*	0.0224***	-0.00528**
	(0.008)	(0.0023)	(0.00036)	(0.0051)	(0.0021)
Lagged FD of IED attacks					0.290***
					(0.056)
Observations	3654	3654	3654	3654	3654
R-squared	0.12	0.04	0.09	0.15	0.32
Panel C: Without Peak Violence (August 2006 – July 2007)					
Lagged FD of Towers	-0.100	-0.0220	0.00598	-0.0794*	0.0191
	(0.065)	(0.030)	(0.0068)	(0.041)	(0.016)
Lagged FD of IED attacks					0.132***
					(0.038)
Observations	2898	2898	2898	2898	2898
R-squared	0.11	0.07	0.09	0.09	0.21
Panel D: Without 2008					
Lagged FD of Towers	-0.184**	-0.0631*	0.00452	-0.0746**	0.0184
	(0.075)	(0.037)	(0.0093)	(0.037)	(0.018)
Lagged FD of IED attacks					0.252***
					(0.066)
Observations	2898	2898	2898	2898	2898
R-squared	0.07	0.03	0.09	0.07	0.28

Notes: Unit of analysis for violence is district/month, February '04 – January '09. Analysis restricted to 63 districts in which Zain operated during period under study. Robust standard errors, clustered at the district level in parentheses. All results include district and month fixed effects. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).

Table 5. Impact of Increased Cell Phone Coverage by Sectarian Area

Dependent Variable: Attacks/100,000	(1) All Areas	(2) Mixed	(3) Kurd/Shia	(4) Sunni	(5) Mixed/Sunni	(6) Ethnically Homogenous	(7) Non-Homogenous
Tower First Differences	-0.149**	-0.251	-0.00960	-2.259*	-0.496*	-0.195**	-0.184
	(0.070)	(0.19)	(0.058)	(1.07)	(0.29)	(0.083)	(0.15)
Observations	3654	580	2436	638	1218	2784	870
Number of Districts	63	10	42	11	21	48	15
R-squared	0.07	0.30	0.10	0.23	0.18	0.06	0.21

Notes: Unit of analysis for violence is district/month, February ‘04 – January ’09. Analysis restricted to 63 districts in which Zain operated during period under study. Robust standard errors, clustered at the district level in parentheses. All results include month and district fixed effects. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007). Sectarian areas coded as Kurdish/Shia or Sunni if greater than 60% of population is from that affiliation, mixed otherwise.

Table 6: Impact of Introducing Cellular Communications for Coverage Slices, Mean Shift.

Dependent Variable:	(1) Total Attacks	(2) Direct Fire Attacks	(3) IED Attacks	(4) IEDs Cleared
Panel A: Already Covered Slices				
Post1 (t=0 to *t+8*)	-0.244	0.00336	-0.134*	0.0445
	(0.18)	(0.076)	(0.073)	(0.047)
Tower Count	0.00757*	0.00174	0.00314**	-0.00106**
	(0.0040)	(0.0017)	(0.0016)	(0.00048)
Total IEDs				0.234***
				(0.09)
Observations	8226	8226	8226	8226
Slices Included	457	457	457	457
R-squared	0.06	0.05	0.04	0.27
Panel B: New Coverage Areas				
Post1 (t=0 to *t+8*)	-0.0270	-0.0187	-0.0780	0.0504*
	(0.089)	(0.043)	(0.050)	(0.026)
Tower Count	0.00243***	0.000617*	0.00116**	-0.000220
	(0.00083)	(0.00037)	(0.00045)	(0.00020)
Total IEDs				0.231***
				(0.05)
Observations	9522	9522	9522	9522
Slices Included	529	529	529	529
R-squared	0.04	0.03	0.03	0.22

Notes: Unit of analysis is slice/15-day period in relative time from tower onair date. Slices are unique coverage areas created by a 4km radius around cell phone towers in urban areas and 12km radius in rural areas. Reference category is *t-8* to *t-1* (-119 to -1 days). Robust standard errors, clustered at the district level in parentheses. All specifications include slice and month fixed effects and number of towers already active in district. Estimates significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent Events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008).

References

Aker, Jenny C. 2008. "Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger." BREAD Working Paper #177.

Andreas, Peter. 2002. "Transnational Crime and Economic Globalization." In *Transnational Organized Crime and Inter- national Security. Business as Usual?*, eds. Mats R. Berdal and Monica Serrano. Boulder: Lynne Rienner, p. 37-52.

Arquilla, John, David Ronfeldt, and Michele Zanini. 1999. "Networks, Netwar, and Information-Age Terrorism." In *Strategic Appraisal: The Changing Role of Information in Warfare*, eds. Zalmay M Khalilzad and John P White. Santa Monica, CA: RAND.

Bates, Robert H. 2008. *When Things Fell Apart: State Failure in Late-Century Africa*. New York: Cambridge University Press.

BBC. 2010. "Mozambique 'blocked riot texts'." *BBC*.

Berman, Eli, Michael Callen, Joseph H. Felter, and Jacob N. Shapiro. 2011. "Do Working Men Rebel? Insurgency and Unemployment in Iraq and the Philippines." *Journal of Conflict Resolution* forthcoming.

Berman, Eli, Jacob N. Shapiro, and Joseph H. Felter. 2011. "Can Hearts and Minds Be Bought? The Economics of Counterinsurgency in Iraq." *Journal of Political Economy* forthcoming.

Blakely, Rhys. 2005. "Terrorists 'threaten' Iraq mobile operators." *The Times*.

Brand, Jon. 2007. "Iraqi Insurgents Target Water and Electricity, But Spare the Cell Phone." *Newshour*.

Cordesman, Anthony. 2005. *Iraq's Evolving Insurgency*. Washington D.C.: Center for Strategic and International Studies.

Frank, Thomas, and Zaid Sabah. 2006. "Cellphone use soaring, but network hasn't caught up." *USA Today*.

Helsinki. 2007. "Global cell phone use at 50 percent | Reuters." *Reuters*.

Jensen, Robert. 2011. "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector." *Quarterly Journal of Economics* 122(3): 879-924.

Kocher, Matthew. 2004. "Human ecology and civil war." University of Chicago. Manuscript.

Leahy, Kevin. 2005. “The Impact of Technology on the Command, Control, and Organizational Structure of Insurgent Groups.” Masters Thesis. US Army Command and General Staff College.

Miles, Donna. 2004. “Hotline Succeeding In Foiling Iraqi Insurgents.” *Defense.gov*.

Muckian, Martin. 2006. “Structural Vulnerabilities of Networked Insurgencies: Adapting to the New Adversary.” *Parameters* (Winter): 14-25.

Perry, Cal et al. 2006. “Cell phone tracking helped find al-Zarqawi.” *CNN*.

Richtel, Matt. 2011. “Egypt Cuts Off Most Internet and Cellphone Service.” *The New York Times*.

Sadeq, Mohammed Hayder, and Sabah al-Anbaki. 2005. “Cell phone service spotty, but reception's been great.” *USA Today*.

Semple, Kirk. 2006. “U.S. Backs Hot Line in Iraq to Solicit Tips About Trouble.” *The New York Times*.

Shachtman, Noah. 2008. “Taliban Threatens Cell Towers.” *Wired*.

Staniland, Paul. 2010. “Cities on Fire: Social Mobilization, State Policy, and Urban Insurgency.” *Comparative Political Studies*.

Strother, Tiffany. 2007. *Cell Phone Use by Insurgents in Iraq*. Shawnee, OK: Urban Warfare Analysis Center.

Trofimov, Yaroslav. 2010. “Cell Carriers Bow to Taliban Threat.” *Wall Street Journal*.

Washington Times. 2005. “Cell-phone technology an explosive tool for insurgents.” *Washington Times*.

Weidmann, Nils B. 2009. “Geography as Motivation and Opportunity.” *Journal of Conflict Resolution* 53(4): 526 -543.

Appendix Tables and Figures

This appendix contains supplementary tables for "Talking About Killing." These tables are as follows:

- Figure 7A Replicates Figure 7 with violence in the last six months of the year.
- Table 2A replicates Table 2 with the inclusion of a spatial lag of the DV.
- Table 3A replicates Table 3 with the inclusion of a spatial lag of the DV.
- Table 3B replicates Table 3 with the leads of key IV on the RHS.
- Table 3C replicates Table 3 with the spatial lags of key IV on the RHS.
- Table 3D replicates column (7) from Table (3) controlling for past sectarian violence.
- Table 5A breaks the impact of increased coverage down by both sectarian region and attack type.
- Table 7 shows the full results of estimating equation 4

Figure 7: Impact of Current Year Violence on Tower Construction at District/Month Level

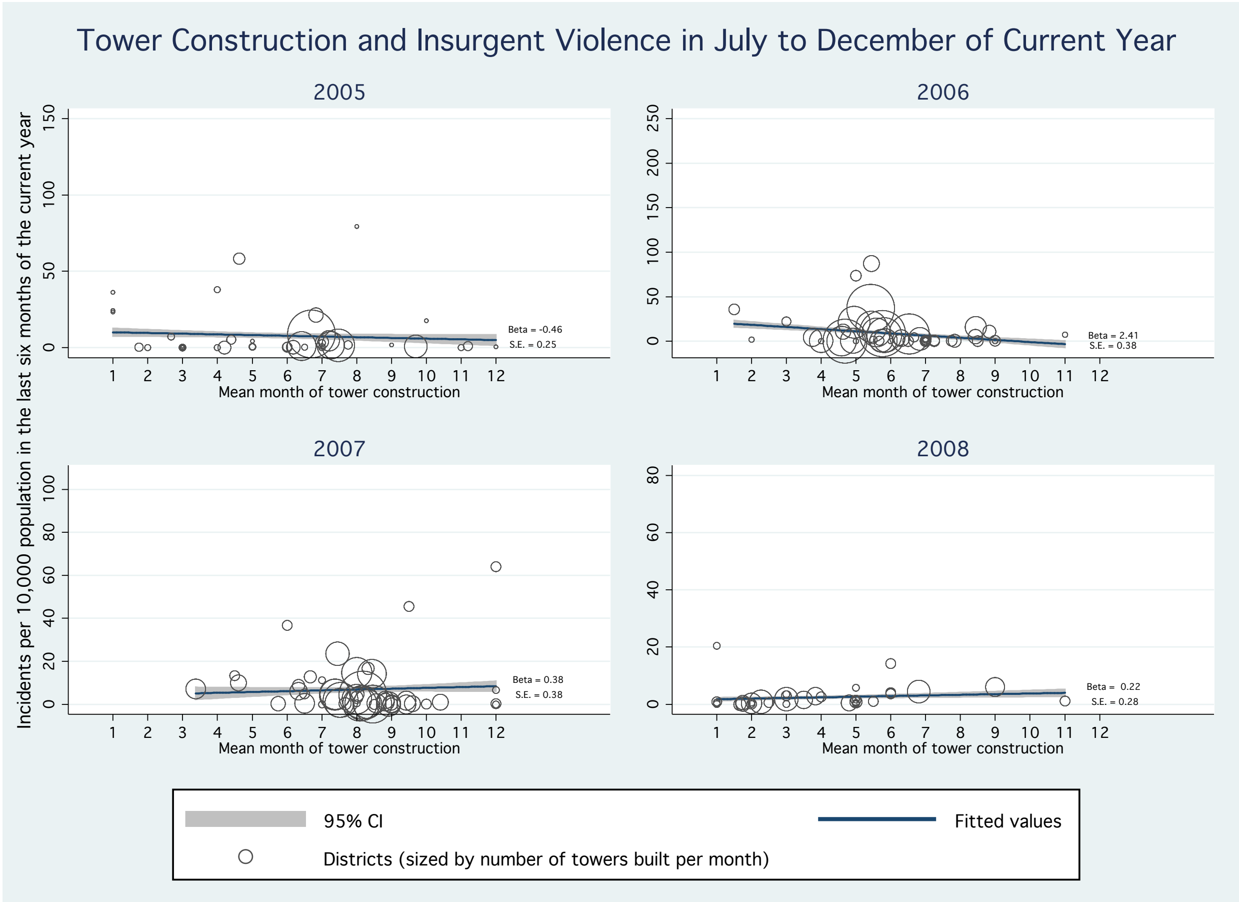


Table 3A. Impact of Increased Cell Phone Coverage on Total Attacks with Spatial Lag of DV – District/Month

Dependent Variable:	(1) SIGACT /100,000	(2) SIGACT /100,000	(3) SIGACT /100,000	(4) FD of SIG /100,000	(5) FD of SIG /100,000	(6) FD of SIG /100,000	(7) FD of SIG /100,000	(8) FD of SIG /100,000	(9) FD of SIG /100,000	(10) FD of SIG /100,000
New Towers in *t*-1	-0.470	-0.452**	-0.661**							
	(0.29)	(0.18)	(0.31)							
Lagged First Difference of Tower Count				-0.0719	-0.0812	-0.108*	-0.140**	-0.0841	-0.0916	-0.180*
				(0.048)	(0.049)	(0.056)	(0.069)	(0.054)	(0.056)	(0.097)
Existing Tower Count	0.0301	0.0300	0.0334	0.0384***	0.0379***	0.0323***	0.0323***	0.0366***	0.0341***	0.0344***
	(0.023)	(0.023)	(0.022)	(0.0091)	(0.0090)	(0.0079)	(0.0080)	(0.0083)	(0.0080)	(0.0087)
Sunni Proportion		-0.00254	-0.0671							
		(0.023)	(0.062)							
Shia Proportion	26.62**	26.70**	16.91							
	(10.8)	(11.2)	(27.8)							
New Towers in *t*-1	-5.316	-5.259	0.628							
	(5.81)	(6.04)	(24.6)							
Observations	3717	3717	3717	3654	3654	3654	3654	3654	3654	3654
R-squared	0.34	0.34	0.37	0.09	0.10	0.12	0.12	0.10	0.12	0.14
Time FE	Half	Half	Half	Half	Quarter	Month	Month	Sect X Half	Sect X Quarter	Province X Quarter
Space FE	No	No	Province	No	No	No	District	No	No	No
First Differences	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Unit of analysis for violence is district/month, February ‘04 – January ’09. Analysis restricted to 63 districts in which Zain Iraq operated during period under study. Robust standard errors, clustered at the district level in parentheses. Spatial lags are total of given variable in neighboring districts, Each model’s fixed effects are noted. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).

Table 3B. Temporal Placebo Test of Impact of Increased Cell Phone Coverage on Total Attacks – District/Month

Dependent Variable:	(1) SIGACT /100,000	(2) SIGACT /100,000	(3) SIGACT /100,000	(4) FD of SIG /100,000	(5) FD of SIG /100,000	(6) FD of SIG /100,000	(7) FD of SIG /100,000	(8) FD of SIG /100,000	(9) FD of SIG /100,000	(10) FD of SIG /100,000
New Towers in *t* +1	-0.794*	-0.595**	-0.820**							
	(0.43)	(0.24)	(0.38)							
Lead First Difference of Tower Count				0.0148	0.00348	0.0728	0.0948	-0.00794	-0.0351	-0.115
				(0.048)	(0.052)	(0.064)	(0.081)	(0.050)	(0.053)	(0.10)
Existing Tower Count		-0.0286	-0.0911							
		(0.034)	(0.072)							
Sunni Proportion	40.19**	40.88**	30.63							
	(16.8)	(17.4)	(29.3)							
Shia Proportion	-3.872	-3.230	-10.53							
	(6.55)	(7.12)	(25.1)							
Observations	3717	3717	3717	3654	3654	3654	3654	3654	3654	3654
R-squared	0.27	0.27	0.30	0.01	0.02	0.07	0.07	0.05	0.07	0.09
Time FE	Half	Half	Half	Half	Quarter	Month	Month	Sect X Half	Sect X Quarter	Province X Quarter
Space FE	No	No	Province	No	No	No	District	No	No	No
First Differences	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Unit of analysis for violence is district/month, February ‘04 – January ’09. Analysis restricted to 63 districts in which Zain Iraq operated during period under study. Robust standard errors, clustered at the district level in parentheses. Each model’s fixed effects are noted. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).

Table 3C. Geographic Placebo Test of Impact of Increased Cell Phone Coverage on Total Attacks – District/Month

Dependent Variable:	(1) SIGACT /100,000	(2) SIGACT /100,000	(3) SIGACT /100,000	(4) FD of SIG /100,000	(5) FD of SIG /100,000	(6) FD of SIG /100,000	(7) FD of SIG /100,000	(8) FD of SIG /100,000	(9) FD of SIG /100,000	(10) FD of SIG /100,000
Spatial Lag of New Towers in *t* -1	-11.51** (4.80)	-6.243** (3.04)	-5.867*** (2.02)							
Lagged FD of Tower Count in Neighboring Districts				-0.158 (0.14)	-0.185 (0.19)	-0.217 (0.25)	-0.285 (0.34)	-0.126 (0.16)	-0.106 (0.16)	-0.236 (0.42)
Existing Tower Count		-0.750*** (0.23)	-0.607** (0.29)							
Sunni Proportion	445.4** (207)	463.0** (211)	412.6*** (112)							
Shia Proportion	40.39 (69.5)	56.57 (73.3)	-344.4*** (89.1)							
Observations	3717	3717	3717	3654	3654	3654	3654	3654	3654	3654
R-squared	0.25	0.26	0.32	0.01	0.02	0.12	0.12	0.04	0.07	0.07
Time FE	Half	Half	Half	Half	Quarter	Month	Month	Sect X Half	Sect X Quarter	Province X Quarter
Space FE	No	No	Province	No	No	No	District	No	No	No
First Differences	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Unit of analysis for violence is district/month, February '04 – January '09. Analysis restricted to 63 districts in which Zain Iraq operated during period under study. Robust standard errors, clustered at the district level in parentheses. Each model's fixed effects are noted. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).

Table 3D. Impact of Increased Cell Phone Coverage on Total Attacks controlling for Past Sectarian Violence – District/Month

Dependent Variable: First Differences in SIGACTs/100,000	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Core Specifications		*Panel B: Controls for Total Sectarian Violence*			*Panel B: Controls for Targeted Killings by Sectarian Militias*		
Lagged FD of Towers	-0.116**	-0.151**	-0.143**	-0.137*	-0.166**	-0.146**	-0.144**	-0.167**
	(0.056)	(0.070)	(0.070)	(0.069)	(0.072)	(0.071)	(0.071)	(0.073)
FD of Sectarian Violence	0.0259	0.0260	0.00946	-0.0392		0.0273	-0.0307	
	(0.031)	(0.031)	(0.048)	(0.051)		(0.045)	(0.061)	
Lagged FD of Sectarian Violence			-0.0347	-0.112		0.00724	-0.0797	
			(0.047)	(0.072)		(0.055)	(0.098)	
Second Lag FD of Sectarian Violence				-0.114			-0.117	
				(0.069)			(0.084)	
Sectarian Violence 3-Month Lagged Moving Average Lag					-0.143**			-0.209
					(0.066)			(0.15)
Observations	3717	3717	3717	3654	3654	3654	3654	3654
R-squared	0.28	0.28	0.31	0.01	0.01	0.03	0.06	0.07
Time FE	Month	Month	Month	Month	Month	Month	Month	Month
Space FE	No	District	District	District	District	District	District	District
Sectarian FE	Yes	Yes	2 Lags	3 Lags	Lagged Moving Avg.	2 Lags	3 Lags	Lagged Moving Avg.
First Differences	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Unit of analysis for violence is district/month, February '04 – January '09. Analysis restricted to 63 districts in which Zain Iraq operated during period under study. Robust standard errors, clustered at the district level in parentheses. Each model's fixed effects are noted. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).

Table 5A. Impact of Increased Cell Phone Coverage by Attack Type and Sect

Dependent Variable: Attacks/100,000	(1) All Attacks	(2) Direct Fire	(3) Indirect Attacks	(3) IED Attacks	(4) IEDs Cleared
Panel A: Mixed Areas					
Tower First Differences	-0.251	-0.0836	-0.000700	-0.100	-0.0108
	(0.19)	(0.077)	(0.0068)	(0.072)	(0.020)
IED attacks					0.163***
					(0.047)
Observations	580	580	580	580	580
R-squared	0.30	0.24	0.35	0.29	0.34
Panel B: Kurdish/Shia Areas					
Tower First Differences	-0.00960	-0.00668	0.00144	0.00890	0.00789
	(0.058)	(0.027)	(0.0074)	(0.013)	(0.0075)
IED attacks					0.292***
					(0.046)
Observations	2436	2436	2436	2436	2436
R-squared	0.10	0.08	0.10	0.05	0.31
Panel C: Sunni Areas					
Tower First Differences	-2.259*	-0.877**	0.133	-0.878	0.150
	(1.07)	(0.39)	(0.13)	(0.60)	(0.22)
IED attacks					0.305***
					(0.055)
Observations	638	638	638	638	638
R-squared	0.23	0.10	0.21	0.26	0.43
Panel D: Mixed Sunni Areas					
Tower First Differences	-0.496	-0.158	0.0130	-0.272**	0.0483
	(0.29)	(0.12)	(0.015)	(0.12)	(0.035)
IED attacks					0.290***
					(0.057)
Observations	1218	1218	1218	1218	1218
R-squared	0.18	0.08	0.16	0.20	0.39

Notes: Unit of analysis for violence is district/month, February '04 – January '09. Analysis restricted to 63 districts in which Zain operated during period under study. Robust standard errors, clustered at the district level in parentheses. All results include month and district fixed effects. Estimates which are significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007). Sectarian areas coded as Kurdish/Shia or Sunni if greater than 60% of population is from that affiliation, mixed otherwise.

Table 7: Impact of Introducing Cellular Communications for Coverage Slices Over Periods

Dependent Variable:	(1) Total Attacks	(2) Direct Fire Attacks	(3) IED Attacks	(4) IEDs Cleared	(5) Total Attacks	(6) Direct Fire Attacks	(7) IED Attacks	(8) IEDs Cleared
	Panel A: Already Covered Slices				*Panel B: New Covered Slices*			
pre9	0.579	0.0794	0.500***	-0.163*	0.324**	0.0755	0.107	-0.0406
	(0.42)	(0.20)	(0.19)	(0.096)	(0.16)	(0.058)	(0.092)	(0.053)
pre8	0.504	0.119	0.409**	-0.123	0.205	0.0191	0.0796	-0.0543
	(0.42)	(0.20)	(0.18)	(0.090)	(0.14)	(0.064)	(0.077)	(0.052)
pre7	0.379	-0.157	0.526***	-0.185**	0.0758	0.0159	0.0321	-0.0521
	(0.39)	(0.18)	(0.19)	(0.090)	(0.12)	(0.057)	(0.075)	(0.051)
pre6	0.405	-0.0324	0.383**	-0.130	0.0716	-0.0396	0.0745	-0.0632
	(0.36)	(0.18)	(0.16)	(0.087)	(0.10)	(0.045)	(0.079)	(0.049)
pre5	0.519**	0.0991	0.376***	-0.114	0.104	-0.00437	0.0887	-0.0624
	(0.25)	(0.13)	(0.12)	(0.081)	(0.099)	(0.047)	(0.074)	(0.044)
pre4	0.565**	0.0584	0.299***	-0.0580	0.156	0.0192	0.107	-0.0660
	(0.27)	(0.14)	(0.11)	(0.067)	(0.097)	(0.037)	(0.086)	(0.048)
pre3	0.259	-0.00867	0.217**	-0.0688	0.0131	-0.0110	0.0348	-0.0511
	(0.21)	(0.11)	(0.10)	(0.053)	(0.076)	(0.040)	(0.060)	(0.040)
pre2	0.119	-0.0494	0.151*	-0.0521	0.0812	0.0222	0.0269	-0.0133
	(0.15)	(0.082)	(0.087)	(0.045)	(0.068)	(0.031)	(0.047)	(0.028)
post1	0.0712	0.0940	-0.0440	0.0429	-0.0488	-0.0463	-0.0221	0.0158
	(0.15)	(0.086)	(0.070)	(0.038)	(0.058)	(0.038)	(0.030)	(0.014)
post2	-0.0542	-0.0517	0.0194	0.0183	-0.0400	-0.00626	-0.0854**	0.0275
	(0.19)	(0.095)	(0.073)	(0.025)	(0.066)	(0.033)	(0.039)	(0.022)
post3	-0.364*	-0.113	-0.0666	-0.000200	0.0398	0.00389	-0.0113	0.0212
	(0.22)	(0.10)	(0.093)	(0.032)	(0.087)	(0.030)	(0.051)	(0.017)
post4	-0.231	-0.0153	-0.222**	0.0675	-0.0380	-0.0368	-0.0509	0.0317*
	(0.19)	(0.10)	(0.087)	(0.048)	(0.12)	(0.053)	(0.046)	(0.016)
post5	-0.352**	-0.0989	-0.215***	0.0482	-0.0792	-0.0617	-0.0611	0.0403*
	(0.18)	(0.088)	(0.079)	(0.037)	(0.12)	(0.060)	(0.051)	(0.021)
post6	-0.167	-0.0295	-0.124	0.0241	-0.118	-0.0597	-0.0489	0.00929
	(0.17)	(0.10)	(0.079)	(0.028)	(0.12)	(0.061)	(0.052)	(0.014)
post7	0.0259	0.0494	0.0113	-0.0439	0.0729	0.000651	0.0113	0.0367
	(0.19)	(0.11)	(0.089)	(0.034)	(0.100)	(0.044)	(0.061)	(0.026)
post8	-0.232	-0.145*	-0.0316	0.0331	0.0156	-0.0368	0.00803	0.0290
	(0.17)	(0.087)	(0.081)	(0.030)	(0.088)	(0.043)	(0.048)	(0.018)

Tower Count	0.00830***	0.00178	0.00393***	-0.00130***	0.00269***	0.000658*	0.00113*	-0.000270
	(0.0029)	(0.0014)	(0.0011)	(0.00044)	(0.00093)	(0.00034)	(0.00060)	(0.00026)
Total IEDs				0.235***				0.231***
				(0.089)				(0.061)
Obs.	8226	8226	8226	8226	9522	9522	9522	9522
Slices Included	457	457	457	457	529	529	529	529
R-squared	0.06	0.05	0.05	0.28	0.04	0.03	0.03	0.22

Notes: Unit of analysis is slice/15-day period in relative time from tower onair date. Slices are unique coverage areas created by a 4km radius around cell phone towers in urban areas and 12km radius in rural areas. Reference category is *t-1* (-15 to -1 days). Robust standard errors, clustered at the district level in parentheses. All specifications include slice and month fixed effects and number of towers already active in district. Estimates significant at the 0.05 (0.10, 0.01) level are marked with at ** (*, ***). Violent events based on data on MNF-I SIGACT-III database. Cell tower data provided by Zain Iraq. Population data from LandScan (2008) gridded population data and WFP surveys (2003, 2005, and 2007).