Can Hearts and Minds Be Bought? The Economics of Counterinsurgency in Iraq
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Can Hearts and Minds Be Bought? The Economics of Counterinsurgency in Iraq

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We develop and test an economic theory of insurgency motivated by the informal literature and by recent military doctrine. We model a three-way contest between violent rebels, a government seeking to minimize violence by mixing service provision and coercion, and ci-

vilians deciding whether to share information about insurgents. We test the model using panel data from Iraq on violence against Coalition and Iraqi forces, reconstruction spending, and community characteristics (sectarian status, socioeconomic grievances, and natural resource endowments). Our results support the theory's predictions: improved service provision reduces insurgent violence, particularly for smaller projects and since the "surge" began in 2007.

> Successful guerrilla operations involve the people. It is the quality of their resistance to the enemy and support for the guerrillas which in the end will be the decisive factor. . . . In fact, a guerrilla force will be unable to operate in an area where the people are hostile to its aims. (*Handbook for Volunteers of the Irish Republican Army* 1996, chap. 6)[1]

> At the start of 2006, General Chiarelli took command of the Army's day-to-day operations in Iraq, and he was certain that no amount of killing or capturing could exhaust the ranks of unemployed and angry Iraqis willing to join the insurgency. . . . Chiarelli became convinced that the way to win Baghdad was through civilian outreach, not skirmishes. When Chiarelli's men compared maps of insurgent activity with those showing access to electricity and drinkable water, they found a direct correlation between terrorist incidents and a lack of services. (Raffi Khatchadourian, July 6, 2009)

I. Introduction

The twin tasks of rebuilding social and economic order in conflict and postconflict areas will be critical for the United States and allied governments for the foreseeable future. Beyond Iraq and Afghanistan, unstable areas pose significant security threats from Gaza to Somalia, to East Timor, and to parts of South America. Huge flows of aid spending have been directed to these areas on the theory that rebuilding economies can help rebuild societies, addressing donors' security concerns while improving the lives of those directly affected by the lack of order. Yet, little if any empirical research has evaluated these efforts to see where, when, and how efforts to improve material conditions in conflict zones actually enhance social and economic order.

Answering such questions is hardly a passing concern. A wide variety of structural factors—greater economic integration, a more unequal distribution of conventional military capabilities, the lethality and high

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[1] We thank Lindsay Heger for pointing this quote out to us.

capital costs of modern weaponry, and the like—imply that, in the future, conflict will continue to be characterized less by conventional force-on-force battles and more by various forms of insurgency and irregular warfare currently engaging U.S. troops in Iraq, Afghanistan, and elsewhere.[2] The consensus among scholars and practitioners on how to most effectively conduct such conflicts is reflected in the U.S. Army's counterinsurgency doctrine (U.S Army 2007). This doctrine, which underlies a massive military and foreign policy effort and hundreds of billions of dollars in spending, places a heavy emphasis on influencing "human factors," for example, the population's tolerance for insurgent activities, by combining benign measures such as economic reconstruction with carefully targeted strikes against violent actors.

While this combined approach makes intuitive sense, existing discussions of it are not grounded in a coherent social scientific theory of insurgency that can generate clear predictions about how—and therefore where and when—benign measures work. Some argue that reconstruction addresses grievances; others claim that reconstruction raises the opportunity cost of rebellion for potential recruits by improving local labor market opportunities; still others view reconstruction as a method of buttressing local allies. There is little systematic evidence for any of these hypotheses, and none match well with the intuition embedded in close accounts of historical insurgencies. Motivated by military doctrine and the literature on counterinsurgency, we therefore develop a fourth approach: modeling insurgency as a three-way interaction between rebels seeking political change through violence, a government trying to minimize violence through some combination of service provision and hard counterinsurgency, and civilians deciding whether or not to share information about insurgents with government forces. Our first major contribution is in formalizing that argument to allow empirical testing.

The information-sharing model generates testable hypotheses about the relationship between spending on benign measures and violence. We test these using new data from Iraq that include geospatial information on violence against U.S. and Iraqi forces, reconstruction spending, and community characteristics (social cohesion, sectarian status, and natural resources). To motivate our approach to modeling and estimation, consider figure 1, which illustrates how much violence per capita (directed against Coalition and Iraqi forces) varies across Iraq's 104 districts from 2004 to 2008. (Data sources and definitions are pre-

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[2] Irregular warfare is certainly not a new form of conflict. Fearon and Laitin (2003) report that civil wars account for four times as many casualties as interstate wars in the second half of the twentieth century. Some analysts warn against assuming that future conflicts will all be irregular, arguing that building capacity for such conflicts comes at the expense of proficiency in conventional operations (see, e.g., Gentile 2009).

FIG. 1.—Violence directed against Coalition and Iraqi forces by district

sented in Sec. IV.) Our second major contribution is in testing a model that can account for differences in these highly localized patterns of violence.

Focusing on the effects of reconstruction spending on violence allows us to test the model while informing ongoing debates about the proper allocation of scarce reconstruction resources. From March 2003 through December 2007, the U.S. government spent at least $29 billion on various reconstruction programs in Iraq (Tarnoff 2008). This money has had little obvious effect; the correlation between reconstruction spending and violence across Iraqi districts is generally positive. Problems of graft render suspect the data on large-scale reconstruction projects (Special Inspector General for Iraq Reconstruction 2007). For that reason, and because the theory suggests that small projects will be more effective in reducing violence, we focus on the $2.9 billion in U.S. reconstruction funds allocated through the Commander's Emergency Response Program (CERP) and related smaller programs.[3]

CERP has two major advantages for our study. First, CERP funds are allocated in small amounts without layers of subcontracting that make the relationship between dollars spent and work done tenuous for most American reconstruction spending. Second, CERP is explicitly designed to provide military commanders with resources to engage in small-scale projects that meet the needs of local communities with the aim of improving security and protecting forces. The idea is that these projects help Coalition and Iraqi security forces better combat insurgent activity and thereby enhance social order. By assessing how the relationship between CERP spending and violence varies over time and space in Iraq, we test our theory and help answer practical questions about where, when, and how benign activities help build order in conflict and post-conflict settings.

The remainder of this paper proceeds as follows. Section II reviews existing arguments linking governance, service provision, and insurgency. Section III develops a model of insurgency and governance that analyzes the situation in which the population's willingness to share information determines the success or failure of counterinsurgent actions. Section IV introduces new data on the provision of government services and conflict in Iraq. Section V tests three implications of the theory, finding that (1) CERP spending reduces violence, (2) the effect is larger for smaller projects and for spending from 2007 on, and (3) community characteristics that predict violence also predict CERP spending, consistent with the model's implication about optimal en-

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[3] As the results below indicate, we find little evidence that other types of reconstruction spending have reduced violence in Iraq or addressed the immediate problems of unemployment and poverty.

dogenous local public-good provision. Section VI discusses future research and offers policy implications.

II.   Literature

Prevailing theories of insurgency and counterinsurgency differ from conventional models of interstate conflict in their emphasis on the decisive role of noncombatants. Mao Tse-Tung (1937) famously describes the people as "the sea in which rebels must swim," a perspective reinforced by a generation of twentieth-century counterinsurgency theorists (Trinquier 1961; Galula 1964; Taber 1965; Clutterbuck 1966; Thompson 1966; Kitson 1977). Twenty-first century scholarship by practitioners of counterinsurgency reinforces the enduring relevance of noncombatants (Sepp 2005; Petraeus 2006; Cassidy 2008; McMaster 2008). The most prevalent explanation for the importance of garnering popular support is that parties to insurgent conflicts use it to gain critical information and intelligence. Kalyvas (2006) demonstrates that this information increases the effectiveness of both defensive and offensive operations.

Prescriptions for gaining popular support vary considerably. Leites and Wolf (1970) suggest that efficient counterinsurgency can reduce the supply of insurgents, reduce demand for them, or both. Political scientists studying civil war and insurgency have debated the relative merits of employing attractive versus coercive measures. Proponents of "hearts and minds" theories advocate reducing the demand for rebellion. They believe that inasmuch as the government can secure the population and address popularly held grievances, the local beneficiaries of these efforts will reciprocate and reward it with their support (Gurr 1970; Horowitz 1985).

Skeptics criticize an overreliance by counterinsurgents on winning hearts and minds. Research on the supply of rebels suggests that popular support is largely irrelevant where states are weak and where government could not act on information if it had it. In such states, quasi-criminal rebels' profits from insurgency outweigh government efforts to buy off individual combatants (Sambanis 2003; Collier and Hoeffler 2004; Ross 2004). Supporting this micro-level mechanism, Dube and Vargas (2008) find that increases in the prices of agricultural exports reduce insurgency in rural Colombia, interpreting their finding as an opportunity cost mechanism like Becker's (1968) model of crime. Subsequent research casts doubt on opportunity costs as a general mechanism (Bazzi and Blattman 2011; Berman et al. 2011). Fearon and Laitin (2003) find that the patterns of civil war are not well predicted by the nearly ubiquitous grievances that could, in principle, be addressed with economic growth and better governance. Instead, civil war correlates with difficult

terrain and low GDP per capita (which they interpret as a symptom of weak state capacity).[4]

A broader assessment of the literature suggests that the division between coercive and attractive measures to combat insurgency may be misconceived. These may be complements: security may increase the efficacy of benign activities and vice versa. Signaling both capacity and commitment to providing security is critical to increasing support, cooperation, and information flow from the population. Economic aid and service provision by government could then contribute to the popular perception that the state is capable of maintaining order and enforcing security.[5]

Noncombatants are responsive and active actors in this competition for their support. Galula (1964) and Petersen (2001) show that support for government and rebels varies at the individual level and shifts across space and time in reaction to both rebel and state activities. Popkin (1979) emphasizes that noncombatants make rational decisions regarding the direction and degree of their cooperation. Taken together, these findings suggest that the interaction of insurgents, counterinsurgents, and the populace whose cooperation they compete for is best understood by accounting for the preferences and incentives of all three (Nagl 2002; Sepp 2005; Petraeus 2006; Fridovich and Krawchuk 2007; Cassidy 2008; McMaster 2008).

III.   A Model of Insurgency and Counterinsurgency

> Without good intelligence, counterinsurgents are like blind boxers wasting energy, flailing at unseen opponents and perhaps causing unintended harm. With good intelligence, counterinsurgents are like surgeons cutting out

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[4] Most previous scholarly effort to model competition for popular support focuses on the interaction between governments and rebels. Gates (2002) examines competition between rebels and the government as it affects the ability of rebels to control their own fighters. Azzam (2006) argues that rebels sometimes use loot to make joining relatively more attractive than staying in the normal economy. Kalyvas (2006) focuses on how the competition for information creates incentives for both sides to engage in or refrain from violence against civilians. Fearon (2007) models an endogenous size constraint on rebel bands, implicitly treating community norms as fixed. Shapiro (2007) explores how government efforts to elicit information influence rebels' choice of organizational form. For a broad recent survey of the literature, see Bueno de Mesquita (2008).

[5] This complementarity has long been explicit in the "community policing" antigang literature (Bayley 1994). Gangs and rebel groups have three strong similarities: both often enjoy community support, both are extremely vulnerable to leaks and defection if their control over territory is weak, and both often work hard to maintain the support of communities. Akerlof and Yellen (1994) interpret gangs' efforts to maintain the support of communities as self-interested, an insight we also apply to government in what follows. For recent perspectives on the literature, see Bueno de Mesquita (2008) and Lake (2008).

cancerous tissue while keeping other vital organs intact.
(U.S. Army 2007, par. 1-126)

Unlike other forms of warfare, counterinsurgency is fundamentally a struggle over people, not territory. Since counterinsurgents typically possess superior military capacity, the key component in suppressing insurgents, and thereby providing security for the population, is information. Acquiring information is particularly valuable in insurgencies such as Iraq and Afghanistan where two conditions obtain. First, at least some noncombatants know what insurgents are doing. In 2006 a Shi'ite sheik in Tal Afar irately described the situation in a city council meeting, declaring to his Sunni colleagues: "The people who are fighting—where do they come from? They don't pop up from the ground. Some of you know who they are" (quoted in Packer [2006]). Second, given sufficient information (e.g., the identity of insurgents, a planned ambush, the location of an improvised explosive device [IED], or that of a weapons cache), counterinsurgents can prevent any given attack by exploiting their advantage in mobility and firepower throughout the country, day or night. That asymmetry of force distinguishes the Iraqi case (with U.S. assistance) from insurgencies in which counterinsurgents have limited coercive capacity (e.g., rural African insurgencies).

Taken together, these particular conditions suggest that the silence of the population, or a substantial portion thereof, is critical for insurgent success. The much-heralded "Anbar awakening" illustrates this point. For many years the residents of Anbar governorate knew who the insurgents were but lacked either the will or the violent capacity to resist them. American and Iraqi security forces had the combat power but not the required information. In late spring 2006, a number of local leaders in Anbar governorate decided to share information with counterinsurgents. After a short spike in June and July, violence in Anbar began a steady downward trend through December 2007 and remained low afterward (see, e.g., Haditha and Ramadi in fig. 1).

If we view counterinsurgency as fundamentally about information, then the critical question is, what makes information more or less forthcoming on the margins? We take as our starting point the notion that the level of information sharing, and consequently the level of violence, is the result of a three-way strategic interaction between rebels, the community, and the government (including forces allied with the government),[6] building on a model of criminal street gangs proposed by

[6] In treating the rebels as unitary actors, our approach differs from models of insurgency that study the strategic choices of individual rebels over participation (Grossman 1991; Gates 2002; Weinstein 2005; Kalyvas 2006; Fearon 2007) and of noncombatants over information sharing (Kalyvas 2006). The treatment of community members as representative agents is easily generalized, as discussed in n. 15 below, but we differ from Kalyvas both

Akerlof and Yellen (1994). We state a minimal model under strong assumptions, leaving generalizations and further explanations to Appendix A and to the accompanying footnotes.

A.   Assumptions

1.   Players and Actions

The government, G, seeks to reduce violence through counterinsurgency effort and service provision. A rebel group, R, seeks to impose costs on government by attacking it (attacks that target civilians are considered in App. A).[7] A utility-maximizing community, C, can help deliver control of a territory to the government by anonymously sharing information about rebels.[8]

2.   Sequence of Play

Information sharing by the community requires no preparation, whereas service provision, counterinsurgency efforts, and rebel violence are less flexible, requiring predeployment of people and resources. So we assume that C can move last. Play proceeds in four stages:

1. Nature draws community norms favoring rebel (over government) control of their territory, n, from a uniform distribution $U[n_L, n_U]$; n is private to C. (We refer to these as "community norms.")
2. Government G chooses a level of public goods to provide, g, and a level of violence mitigation (counterinsurgency) effort, m. At the same time, R chooses a level of violence, v, to attempt against G. (We assume that n_L and n_U span enough of the real line to allow $n_L \leq v + g \leq n_U$. That will be equivalent to assuming that the support of n is broad enough to allow neither side to fully determine information sharing through its actions.)

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in the assumption of anonymous information sharing and in the assumption that rebel violence does not target noncombatants.

   [7] Violence has to occur in equilibrium, rather than just the threat of it, since we observe violence in the data. Violence is inefficient in a Coasian sense; for it to occur there must be incomplete contracting ability between rebels and government (Fearon 2004; Powell 2006). This is not a very restrictive assumption: governments and rebels often have trouble credibly committing to bargains.

   [8] The model shares a main testable implication with the "club" model (Berman and Laitin 2008): good governance—specifically public-good provision—constrains rebel violence. Yet the club model has other implications for rebel groups not shared by all Iraqi rebels: strong clubs provide local public goods in a way that discriminates in favor of members and supporters; strong clubs can also choose high damage tactics that make them extremely vulnerable to information leaks by members but are not vulnerable to leaks by nonmembers. Many rebel organizations cannot form strong clubs. This model seeks to explain those weaker organizations. The distinction between models has important implications for tactic choice by insurgents and terrorists, a subject we plan to pursue in future work.

3. Community C decides how much information, i, to share with G, having observed the actions of G and R.
4. Uncertainty regarding control of territory, a, is resolved, and payoffs occur.

3. Technology of Control

Control of territory is represented by a binary variable, a, which is one if the government controls the territory and is zero if it is controlled by rebels. The probability of government control is given by

$$P(a = 1) = h(m)i,$$

where m is violence mitigation (counterinsurgency) effort by G ($m \geq 0$), and $h(m) : R^+ \to [0, 1]$ is a monotonically increasing, concave contest success function,[9] with $h(0) = 0$ and $h \to 1$ as $m \to \infty$. Here i is the level of information that C chooses to share with G ($1 \geq i \geq 0$). (All variables are real numbers unless otherwise specified.) Consistent with current doctrine, this makes some minimal information sharing a necessary condition for government control (U.S. Army 2007, par. 1-23). (Rebel control does not exclude government forces; it implies that attempted rebel violence against those forces will succeed in causing damage. In contrast, attempted rebel violence in government-controlled areas fails to do harm. That stark assumption is relaxed in App. A.)

4. Payoffs

Community.—Community utility is given by

$$U_C(a, g, n, v) = u(c + g - n)a + u(c - v)(1 - a).$$

If $a = 1$ (government control), then the community consumes $c \geq 0$ and benefits from government services, $g \geq 0$, so it attains utility $U_C = u(c + g - n)$, where $u(\cdot)$ is continuously differentiable and monotonically increasing. The services we are thinking of are local public goods such as safety, justice, education, health, welfare, garbage collection, utilities, or infrastructure. Community norms favoring rebel control, n, generate disutility when the government is in control.

Alternatively, if $a = 0$, rebels may successfully carry out violence, $v \geq 0$, against government targets. In that case, community members will attain utility $U_C = u(c - v)$. Rebel violence, v, is not directed against community members per se, but we assume that they suffer from it

[9] See Skaperdas (1996) on contest functions. Control is determined by both information and selective violence, as in Kalyvas (2006, 196). The term v is absent from the contest function; G can always prevail in a conventional two-sided conflict over territory, so we focus on the larger contest over information and territory, $h(\cdot)i$.

nonetheless because they are accidentally affected by crossfire (so-called collateral damage) or because they empathize with government employees or value government targets. In Appendix A we generalize the model to allow rebel violence to affect the community when $a = 1$ in two ways: we introduce violence directed at the community, and we allow the community to suffer disutility from rebel violence directed at the government (v) or from government suppression of that violence.

Note that in the case of rebel control the community does not benefit at all from government services, g, either because the government withdraws services when it cannot protect its employees and contractors or because it conditions local public-good provision on control, as collective punishment. Conditionality would be unusual for a social welfare–maximizing government but is U.S. military policy in administering CERP.[10] Survey evidence reveals that a majority of CERP implementers in Afghanistan practice conditionality.[11] This assumption is clearly extreme; it cannot fully apply to all types of services, such as roads, which cannot be easily withdrawn. It could fully apply to services such as policing and justice and partially apply to services such as health and education. We allow for spending on unconditional g in Appendix A and examine whether it is violence-reducing.[12]

This is a "rational peasant" model, in the tradition of Popkin's (1979) description of Vietnamese peasants: noncombatants decide on the basis of a rational calculation of self-interest rather than an overwhelming ideological commitment to one side or another. This is not to say that ideological commitment is irrational or unusual, just that on the margin, governments can influence noncombatants' decisions by providing services.

If we incorporate the uncertainty that C faces about a, C's payoff is the expected utility function

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[10] Conditionality of development programs is implied by the counterinsurgency field manual in the discussion of economic development: "Ensure that noncompliance with government policies has an economic price. Likewise, show that compliance with those policies is profitable. In the broadest sense, counterinsurgency operations should reflect that 'peace pays'" (U.S. Army 2007, 173, par. 5-49).

[11] In a survey of officers and officials with CERP implementation authority conducted in October and November of 2010 by the International Security and Assistance Force Counterinsurgency Advisory and Assistance Team in Afghanistan, 61 percent of the 210 respondents indicated that they would "halt implementation of a CERP project if the local population increased its support for anti government elements." That proportion is statistically greater than half ($t = 3.19$). Survey details are available from the authors on request. We thank the editor for pointing out how jarring this assumption is at first glance.

[12] We have also assumed that consumption is unaffected by rebel control. The model is easily generalized to allow economic benefits (handicaps) to government control, due to increased returns to legal (illegal) activities. A consumption gap $c_g - c_r$ associated with government control would add a constant in (4) below, increasing incentives to share information, just as n decreases those incentives, but not affecting results.

$$EU_C(g, v, n, p)|_n = u(c + g - n)h(m)i + u(c - v)[1 - h(m)i]. \qquad (1)$$

Rebels.—Following a large literature in political science, we assume that rebels use violence to impose costs on government, either in an attempt to extract concessions or in an effort to overthrow the government altogether (Tilly 1978).[13] In the Iraqi context, these attacks would be mostly improvised explosive devices and direct fire directed at government or Coalition forces. Let G's cost of rebel violence be $A(v)(1 - a)$, which accounts for the damage caused by an attack. Rebel group R's benefit from violence is then $U_R = A(v)(1 - a)$, where we assume that $A(0) = 0$ and that A is an increasing, concave function. Rebels' cost of violence is $B(v)$, which is increasing and convex. (Henceforth, all functions are assumed to be twice continuously differentiable.) So rebels face an expected payoff

$$EU_R(v, a) = E[A(v)(1 - a) - B(v)] = A(v)(1 - p) - B(v), \qquad (2)$$

where $p \equiv h(m)E(i)$. Note that $p = P(a = 1)$ for rebels, for whom i is a random variable.

Government.—The government bears the costs of violence as well as the costs of violence mitigation (counterinsurgency), m, and of service provision, g, and gets expected utility

$$EC_G(v, m, g, a) = E[A(v)(1 - a) + D(m) + H(g)]$$
$$= A(v)(1 - p) + D(m) + H(g). \qquad (3)$$

It is not a social welfare maximizer. This is not necessarily a normative criticism but rather an extreme assumption about the objectives of government that allows us to focus on the optimal behavior of a government whose first priority is repressing violence.[14] This assumption may fit particularly well for an ally or occupying power more concerned about externalities of violence than about the welfare of residents—especially non-coethnics or those in the periphery—or it may describe a dictatorship or dysfunctional democracy.

We assume that $D(0) = H(0) = 0$. We further assume that the cost functions $D(\cdot)$ and $H(\cdot)$ are monotonically increasing. Convexity is a reasonable assumption for $D(\cdot)$ and $H(\cdot)$ for a government facing in-

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[13] Government might also value territory even if it were not a platform for rebel violence, which would add a term $E[1 - a]$ to objective functions (2) and (3) below. That generalization would not change our results, which rely on the natural assumption of at least some complementarity between rebel control of territory and rebel capacity to inflict damage on government. For a discussion of rebel objectives, see U.S. Army (2007, 2, par. 1-2). We abstract from rebel recruiting constraints in committing violence as Berman et al. (2011), and Bazzi and Blattman (2011) make us skeptical that those constraints bind. We consider capacity-constrained rebels below.

[14] Why would government provide public goods rather than simply buy information? It might do so as well, but private goods have the disadvantage of undermining the anonymity of the informant. We are pursuing data on private payments to explore the optimal allocation by government.

creasing marginal costs in revenue generation on the one hand and diminishing returns in service provision and counterinsurgency technologies on the other. We also assume that $A(n_v) > D'(0)$, which will mean that the fixed costs of m are not so high that communities maximally predisposed to not share information are never cost effective to engage at all.

B. Equilibrium

We focus on subgame-perfect Nash equilibrium in pure strategies, solving by backward induction, starting with the community (step 3).

Community.—The community chooses i on the closed interval $[0, 1]$ to maximize expected utility,

$$\max_{0 \leq i \leq 1} EU_C(i, g, n, v, m)\big|_n = u(c + g - n)p(m, i) + u(c - v)[1 - p(m, i)].$$

Note that since the probability of control is proportional to information shared, public-good provision and information are complements, as are counterinsurgency effort and information. Since C chooses i, $\partial p/\partial i = h(m)$, so the first-order condition for C is

$$0 \geq \frac{\partial EU_C}{\partial i} = u(c + g - n)h(m) - u(c - v)h(m),$$

which implies either that $m = 0$ or that the best-response function of the community is

$$i^* = \begin{cases} 0 & \text{if } u(c + g - n) \leq u(c - v) \leftrightarrow n \geq g + v \\ 1 & \text{if } u(c + g - n) > u(c - v) \leftrightarrow n < g + v \end{cases} \tag{4}$$

(the equivalent conditions to the right follow from $u(\cdot)$ being strictly monotonic). Consumption is neutral: it occurs whether information is shared or not. Norms favoring rebel control reduce incentives to provide i.

Figure 2 graphs the expected utility of community members with information revelation, i, on the horizontal axis (when $m > 0$). The expected utility of the representative community member is a linear function of i. The upper line illustrates the case in which that slope is positive, and the lower line shows the case in which the slope is negative. Community C's best response, i^*, is to fully share information when U_C is increasing in i (the positive slope in the figure) and not to share any information otherwise. A slope of zero defines the noncooperation (or "no snitching") constraint, the conditions under which the community is indifferent between sharing information with the government
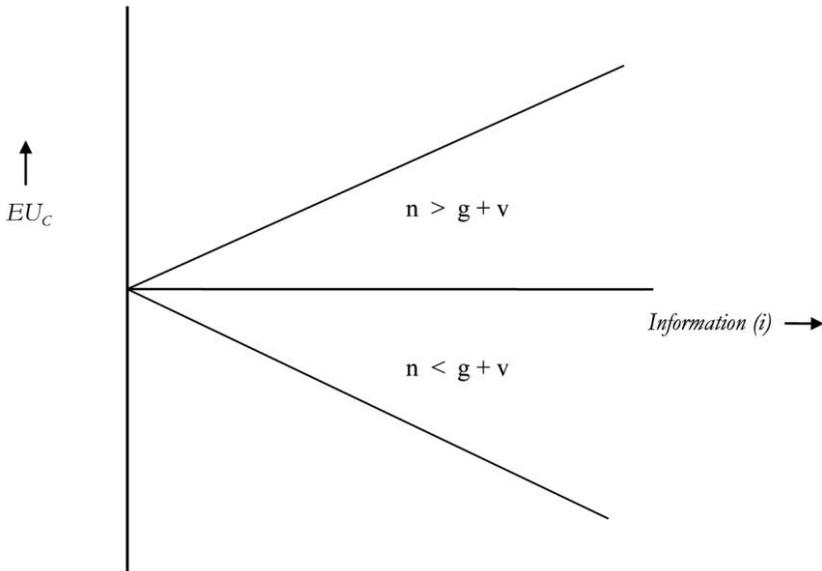
FIG. 2.—The utility of a noncombatant community from sharing information

and staying quiet.[15] Higher levels of service provision by government increase the incentives of C to share information, whereas both norms favoring rebel control and violence reduce that incentive. Note that regardless of its attitude toward the welfare of the community, G has good reason to provide services in order to influence information flow.[16]

It will be useful to define $p^* \equiv p(i^*, m)$, the probability of government control anticipating optimal information sharing by the community. If $m > 0$, then

$$E(i^*) = P(i^* = 1) = P(n < g + v) = F(g + v) = (g + v - n_L)f,$$

where $f = 1/(n_U - n_L)$, the density of the uniform distribution, so that

$$p^* = \begin{cases} (g + v - n_L)fh(m) & \text{if } m > 0 \\ 0 & \text{if } m = 0. \end{cases} \tag{5}$$

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[15] This model easily generalizes from having a representative community member to a community with heterogeneous members, some of whom have a higher propensity to share information than others, since only one individual need share information to obtain the results below. If individual community members hold some unique relevant information, a generalization is less elegant.

[16] The idea that G is instrumental in gaining intelligence is laid out in the counterinsurgency manual's description of the Vietnam era Civil Operations and Rural Development Support program: "Keen attention was given to the ultimate objective of service the needs of the local populace. Success in meeting basic needs of the populace led, in turn, to improved intelligence that facilitated an assault on the Viet Cong political infrastructure" (U.S Army 2007, 75, par. 2-53).

Government.—Continuing backward through the sequence of play, the government anticipates the optimal behavior of C and minimizes expected costs by optimally choosing m and g, trading off reductions in expected damage against the marginal costs of counterinsurgency and service provision. Government G solves

$$\min_{g \geq 0, m \geq 0} EC_G(v, m, g, p^*) = A(v)(1 - p^*) + D(m) + H(g).$$

The first-order condition for m is

$$0 \leq \frac{\partial EC_G}{\partial m} = -A(v)(g + v - n_L)fh'(m) + D'(m),$$

which for an interior solution equates the marginal cost of counterinsurgency effort to the marginal benefit in reduced expected violence costs.

CLAIM. $m = 0$ cannot be a Nash equilibrium if $A(n_U) > D'(0)$.

Proof.   A value of $m = 0$ implies that $p = 0$ (regardless of C's choice of i), and examination of (2) reveals that R's best response must be a corner solution for v, at $v = n_U$ (the largest possible value, assuming—without loss of generality—that $g = 0$). The cost function $EC_G(\cdot)$ at $m = 0$, $v = n_U$ is differentiable $(1 - p^* = [1 - (n_U - n_L)fh(m)] = [1 - h(m)] = 1$ at $m = 0)$ and has a negative derivative with respect to m as long as $A(n_U) > D'(0)$. So G's best response to $v = n_U$ would be some $m > 0$; thus $m = 0$ is not a Nash equilibrium. QED

Note first that $A(n_U) > D'(0)$ is a very weak condition and, second, that this resolves the ambiguity in the solution to i^* in step 3 and p^* in equation (5).

Turning to a solution for m^*,

$$\frac{\partial^2 EC_G}{\partial m^2} = -A(v)(g + v - n_L)fh''(m) + D''(m) > 0,$$

so m has a unique interior solution for some $m^* > 0$, given v and g, defining a best-response function $m^*(v, g)$.

The government also chooses a level of services, g^*, that solves the first-order condition $0 \leq \partial EC_G / \partial g = -A(v)fh(m) + H'(g)$, which for an interior solution equates the marginal cost of services to the marginal benefit in reduced expected costs of violence. Then $\partial^2 EC_G / \partial g^2 = H''(g) > 0$, which ensures a unique interior solution at some $g^* > 0$, defining a best-response function for services, $g^*(v, m)$.

How does government react to violence? The cross-partial derivative

$$\left. \frac{\partial^2 EC_G}{\partial g \, \partial v} \right|_m = -A'(v)fh(m) < 0,$$

so that $\partial g^* / \partial v|_m > 0$, by the implicit function theorem. Optimal service provision also increases with counterinsurgency since

$$\frac{\partial^2 EC_G}{\partial m \partial v}\bigg|_v = -A'(v)(g + v - n_L)fh'(m) - A(v)fh'(m) < 0,$$

so $\partial g*/\partial m|_v > 0$ (implicit function theorem again). Moreover, m and g are strategic complements—as discussed in Section II—since

$$\frac{\partial^2 EC_G}{\partial g \partial m}\bigg|_v = -A(v)fh'(m) < 0.$$

So both government services and coercive counterinsurgency increase with violence. Intuitively, higher damage costs increase returns to suppressing the probability of rebel control, and m complements both v and g in increasing p.

Rebels.—Rebels simultaneously choose a level of violence to maximize expected violence costs imposed on government, anticipating optimal behavior of C:

$$\max_{v \geq 0} EU_R(v, g, m, p*) = A(v)(1 - p*) - B(v).$$

Since information sharing is increased by violence (assuming $m > 0$), the expected utility of rebels increases initially in v but must eventually decline. When we solve the first-order condition for v,

$$0 \geq \frac{\partial EU_R}{\partial v} = A'(v)(1 - p*) - A(v)fh(m) - B'(v),$$

which indicates how rebels weigh the marginal benefit of increased violence against the increased probability of government control and increased marginal costs. The second-order condition,

$$\frac{\partial^2 EU_R}{\partial v^2} = A''(v)(1 - p*) - 2A'(v)fh(m) - B''(v) < 0,$$

so that $v*$ is a unique maximum (because of the concavity of $A(\cdot)$ and the convexity of $B(\cdot)$),[17] given g and v. Thus the first-order condition defines R's best-response function $v*(g, m)$. Since $A(0) = 0$ and $A' > 0$, $v*$ must be positive; so rebels will always attempt some violence, and it will do damage with probability $1 - p*$.

How will rebel choice of violence respond to government provision of services, g? The cross-partial derivative of expected rebel utility

$$\frac{\partial^2 EU_R}{\partial v \partial g}\bigg|_m = -A'(v)fh(m) < 0,$$

which implies that $\partial v*/\partial g|_m < 0$ by the implicit function theorem. Intuitively, government services increase the probability that C will snitch,

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[17] Rebels' capacity might alternatively be bounded by their own resource constraints, which we consider below.

lowering the expected marginal damage (i.e., marginal benefit to rebels) associated with a given level of violence and thus reducing the rebel best response, v^*. We test that partial equilibrium prediction in the empirical section below, as well as the comparative static relationship between g and v.

Optimal violence also declines in the level of counterinsurgency effort, m, since

$$\left.\frac{\partial^2 EU_R}{\partial v \partial m}\right|_g = -A'(v)(g + v - n_L)fh'(m) - A(v)fh'(m) < 0,$$

so that $\partial v^*/\partial m|_g < 0$. The logic is that m increases the probability of government control, p, reducing both expected marginal damage and expected absolute damage in the first-order condition that determines v^*.

Existence.—Assembling results, we have a closed-form solution for optimal information sharing by C in stage 3 and three equations in three unknowns that determine best-response functions $m^*(v, g)$ and $g^*(v, m)$ for G and $v^*(g, m)$ for R in stage 2 (eq. [4]):

$$i^* = \begin{cases} 0 & \text{if } u(c + g - n) \leq u(c - v) \leftrightarrow n \geq g + v \\ 1 & \text{if } u(c + g - n) > u(c - v) \leftrightarrow n < g + v; \end{cases}$$

$$0 = \frac{\partial EC_G}{\partial m} = -A(v)(g + v - n_L)fh'(m) + D'(m^*),$$

$$0 = \frac{\partial EC_G}{\partial g} = -A(v)f + H'(g^*), \tag{6}$$

$$0 = \frac{\partial EU_R}{\partial v} = A'(v^*)(1 - p^*) - A(v^*)fh(m) - B'(v).$$

Though in the general case we cannot solve for closed-form solutions for m^*, g^*, and v^*, the concavity of EU_R and the convexity of EC_G ensure existence of a Nash equilibrium for the game (see Mas-Collel, Whinston, and Green 1995, proposition 8.D.3).

Note the broad implication of this result: noncombatants are not enfranchised and the government puts no weight on their welfare, yet they receive services in equilibrium anyway. This service-provision effect is common to that in Akerlof and Yellen (1994) and U.S. Army (2007). It results from the optimal behavior of a government trying to motivate information sharing by noncombatants as a means of suppressing violence.

$g^*(v,m)$

$g^*(v,m')$

$v^{*'}(g,m)$

$v^{*'}(g,m^i)$

$v^*(g,m)$

Violence (v)

B

C

A

Government Services (g)
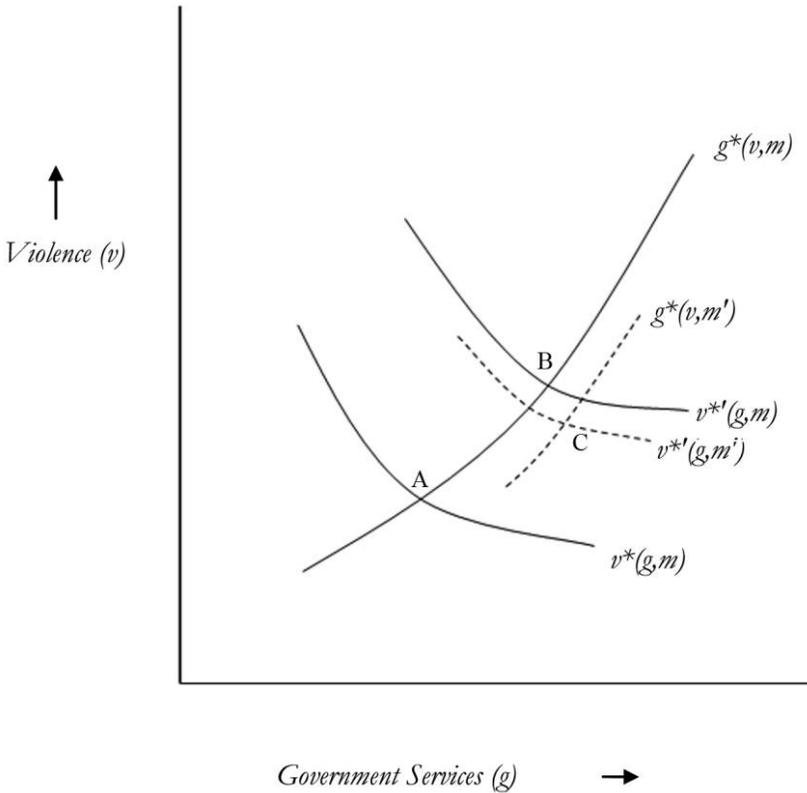
Fig. 3.—Comparative statics in service provision and violence

C. Comparative Statics

How should government apply services and counterinsurgency effort across regions with different predispositions toward violence? That question is policy relevant. It also directly affects our inference in estimating $\partial v^*/\partial g|_m$, as predispositions of communities toward violence likely vary across communities, creating an omitted variable in a regression of v on g. We consider comparative statics both in the marginal costs of violence for rebels, $B'(v)$, and in norms favoring rebel control, n.

1. Rebel Costs of Violence

Consider the effects of a decline in the marginal cost of violence function for rebels, $\Delta B'(v) < 0$. The effects are illustrated in figure 3, which plots the best-response function of rebel violence $v^*(g, m)$ and the best-response function of government services $g^*(v, m)$. The original equi-

librium is at point A, where the downward-sloping optimal violence curve intersects an upward-sloping optimal services curve. The equilibrium effects of a decline in the marginal cost of violence can be analyzed in two stages, first holding m constant and then allowing it to respond. When m is held constant, the effect is to shift v^* upward at all levels of g to the new curve $v^{*\prime}(g, m)$. The g^* curve is unchanged, so the new intersection would be at point B. The response of m (not shown) will be positive since it is a strategic complement of both v and g (since $\partial g^*/\partial m|_v > 0$ and $\partial v^*/\partial m|_g < 0$, respectively), shifting the g^* curve to the right and the $v^{*\prime}$ curve downward, to equilibrium at point C.

As the figure illustrates, comparing locations at which rebels face different marginal costs of violence will yield a positive correlation of violence and government services (from A to C). A symmetric analysis in v, m space would show a positive correlation of violence and counterinsurgency effort due to variation in the marginal cost of violence. Government optimally invests the most resources in areas where rebels face the lowest marginal costs of violence. That occurs not because it faces convex costs of violence (they are concave) but because the violence-reducing effect of increasing the probability of control, p, is greatest where violence is greatest.

In anticipation of our results, a positive cross-sectional correlation of v and g across Iraqi districts is in fact what we observe in the data. It could have been otherwise. For instance, if the dominant source of variation in violence were due to the marginal costs of counterinsurgency, $D'(m)$, differing across districts—as they undoubtedly do because of infrastructure and geography—the cross-sectional correlation of v and g would trace out a downward-sloping v^* curve (since m and g are complements) and thus be negative. We infer that cross-sectional variance in violence in Iraq is mostly due to the predisposition of some communities (or locations) to violence, which motivates comparative statics in community norms favoring rebel control.

2. Norms Favoring Rebel Control

Should government always invest the most resources in areas most predisposed to rebel violence? The answer changes if predisposition is due to community norms rather than to rebel costs of violence. Consider a shift in the distribution of norms toward favoring rebel control (i.e., away from information sharing), so that the new distribution is $U[n_L + \Delta n, n_U + \Delta n]$.[18] When g, v, and m are held constant, the effect of that shift on p is $\Delta n(\partial p/\partial n_L) = -\Delta n f h(m)$.

Comparative statics for g, v, and m when n shifts have in general an

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[18] This shift would occur in stage 1 and be revealed to all players.

ambiguous sign. When either rebels or the government is capacity constrained, however, the results are unambiguous. Examining why is instructive. Consider first the equilibrium in which the government is constrained in its use of counterinsurgency by a limited local capacity so that $m \leq m_U$, a constant, and the optimum is at a corner solution $m^* = m_U$.[19] Comparative statics for g and v are again illustrated in figure 3. Point A illustrates equilibrium at the original distribution of n, at the intersection of the downward-sloping v^* best-response function, and at the upward-sloping g^* best-response function.

The change in v^* can be calculated by solving the cross-partial

$$\frac{\partial^2 EU_R}{\partial v \partial n_L}\bigg|_{m,g} = A'(v^*)fh(m) > 0,$$

which, when the implicit function theorem is applied, implies that $\partial v^*/\partial n_L|_{m,g} > 0$. Intuitively, the reduced probability that C will snitch increases the expected marginal damage (i.e., marginal benefit to rebels) associated with a given level of violence and thus increases the optimal v^*. That shift is illustrated in the upward shift in the v^* curve to $v^{*\prime}$. The g^* curve is unchanged by the shift in n, since it does not appear in the first-order condition for g^*, that is, $\partial^2 EC_G/\partial g \partial n_L|_{m,v} = 0$. The new equilibrium is at point B, with higher levels of both services and violence, with the increase in the latter attenuated by the government's provision of more services.

As in the case with varying marginal costs to rebels, when communities with different norms are compared, the correlation of g^* and v^* will be positive (again, assuming m is fixed).

Alternatively, consider the effect of a shift in n for the case in which m has an interior solution but R is constrained by a limited capacity for violence so that $v \leq v_U$, a constant, and finds an optimum at the corner solution $v^* = v_U$,[20] as illustrated by point D in figure 4. The change in m^* can be calculated by solving the cross-partial

$$\frac{\partial^2 EC_G}{\partial m \partial n_L}\bigg|_{v,g} = A(v)fh'(m) > 0,$$

which implies that $\partial m^*/\partial n_L|_{v,g} < 0$ by the implicit function theorem. Intuitively, m and i are complements in p, so that a reduction in n makes m less protective, reducing the optimal level of counterinsurgency effort. Since m and g are complements and n has no direct effect on g (i.e., $\partial^2 EC_G/\partial g \partial n_L|_{m,v} = 0$), the best-response function $g^*(v, m)$ would shift to lower levels of service, as illustrated by the serrated curve to the left,

[19] The constraint would be revealed in stage 1 only to G; if R knew, it would increase v.

[20] This constraint would be revealed in stage 1 only to R.
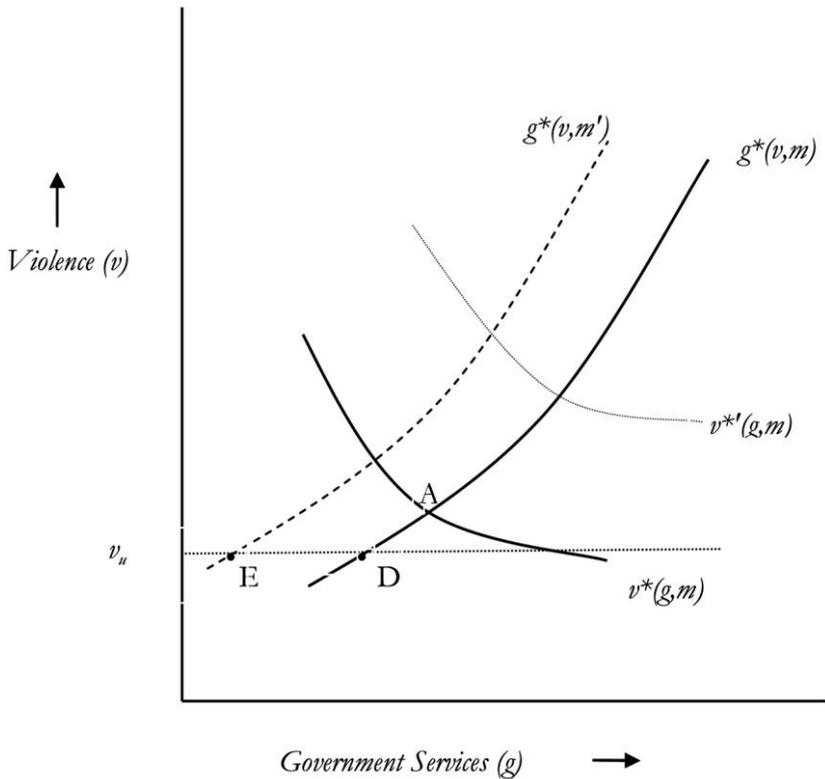
FIG. 4.—Comparative statics in violence and services: constrained rebel violence

$g^*(v, m')$. The new equilibrium would be at point E, with the same level of violence but lower levels of services. Among areas sharing the same v_U, those with higher norms favoring rebel control would receive less government services in equilibrium, because services and counterinsurgency are complements and counterinsurgency is less effective when information is less likely to be shared.

These two cases illustrate the two conflicting forces at work in determining the effect of a community's predisposition to share information on optimal levels of m and g. Service provision increases in reaction to both counterinsurgency and violence, ceteris paribus. Yet a shift in n pulls m and v in opposite directions, making the net effect on g ambiguous and, indeed, making the net effect on all three ambiguous. As we have seen, constraints on m, or even very convex costs of m, would tend to allow a larger equilibrium effect of norms on violence. The same will be true of constraints or convex costs regarding g. The equilibrium level of violence also influences comparative statics in g. Examining the

cross-partial derivatives reveals that at high levels of violence m is more responsive to n and g is more responsive to m, since the returns to suppression are higher. At low levels of violence, by contrast, g is more responsive to v and v is more responsive to n because of diminishing returns in the damage function $A(\cdot)$. On net, even without further assumptions, that would indicate that at low levels of equilibrium violence a shift of n away from the government will increase g^* and m^*, whereas at high levels of violence the opposite would be the case. Intuitively, as predisposition to share information approaches zero, the return to counterinsurgency approaches zero and the argument to reduce m dominates.

These ambiguous comparative statics do not apply only to norms. Appendix A explores the implications of two other sources of rebel influence: rebel service provision and retaliatory violence and civilian casualties by government. These share the same comparative statics as a shift in norms. Since the cross-sectional correlation of v and g is positive, our results indicate that neither shifts in norms when violence is high nor any of these other mechanisms are the dominant sources of cross-sectional variation in Iraqi violence.

D.   Implication for Estimation

What do comparative statics (in both rebel costs and norms) imply for taking the model to data? When local characteristics are held constant, an exogenous increase in government spending on services reduces violence, both directly through the optimal response of v^* and indirectly through the induced effect on m^*, which will also reduce v^*.[21]

In contrast, the sign of an unconditional regression of v on g is ambiguous. When local characteristics shift in favor of rebels, the direct effect will be an increase in violence. The comparative static analysis indicates that the government might optimally respond by increasing spending on g (the decrease in rebel costs of violence or the shift in norms in the case of low violence) or it may reduce spending on g (the shift in norms at high violence). Thus the sign of the omitted variable bias in an *unconditional* regression of v on g is unclear.

Before turning to data and estimation, we make two further comments. Should rebels face high marginal costs of violence, the government will choose very low levels of benign and violent counterinsurgency since $\partial g^*/\partial v|_m > 0$ and $\partial m^*/\partial v|_g > 0$, and g and m are complements. This can explain the initial passive posture of U.S. forces in Iraq in terms of

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[21] More generally, it is possible to show using Cramer's rule that if we perturb the equilibrium with a decrease in marginal costs of services and the equilibrium effect is an increase in services, the equilibrium effect on violence is negative.

both. Similarly, Condra (2010) argues that many African countries decline to suppress low-capacity rebels who operate on the periphery of their territory.

Second, in the longer run, a government could seek to reduce violence by incurring fixed costs that improve the efficiency of governance (i.e., reducing D' and H'). Capacity building by allies would take this form and would be reflected in a shift to the right of the g^* curve in figures 3 and 4, resulting in lower violence in equilibrium. Governments that expect to remain in power for a long time would pursue these longer-term strategies, whereas roving rebels and short-term occupying forces might not bother.

Overall, our model suggests three testable hypotheses for available data.

H_1.   A regression of violence on reconstruction spending (of the type that affects the welfare of local communities) will yield a negative coefficient, when controlling for rebel strength and community norms and other local characteristics, which we will estimate in a fixed-effects regression.

The model yields no closed-form estimating equation. The derivative we seek to estimate is

$$\left. \frac{\partial v^*}{\partial g} \right|_m < 0, \tag{7}$$

where the partial derivative holds all local characteristics constant.

The second hypothesis requires a short derivation. If we relax the simplifying assumption that the marginal utility of g is unity in (1) and allow it a coefficient β_g, it is easy to show that $\partial v^*/\partial g|_m$ is monotonically decreasing in β_g.[22] That is to say, the violence-reducing effect of service provision is amplified (i.e., more negative) by the marginal utility of those services to the community. The better government is at choosing types of spending on g that the community prefers, the greater the violence-reducing effect. We state that intuitive conclusion as follows.

H_2.   The violence-reducing impact of reconstruction spending will be greater when government forces have better knowledge of local community needs and preferences.

A third testable implication follows from combining the comparative statics results with the fact that the cross-sectional correlation, corr(v,

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[22] Assuming $u(\cdot) = u(c + \beta_g g - n)$ implies $i^* = 0 \leftrightarrow n \geq \beta_g g + v$ and $p^* = (\beta_g g + v - n_L)fh(m)$. Thus

$$\left. \frac{\partial^2 EU_R}{\partial v \partial g} \right|_m = -\beta_g A'(v)fh(m) < 0,$$

which implies (by the implicit function theorem) that $\partial v^*/\partial g|_m < 0$ and is monotonically decreasing in β_g.

g), is positive, which we knew prior to formulating the theory. In comparative statics the sign of this correlation is ambiguous, but if it is positive, the cause must be the dominant influence of the cross-sectional variance in either the marginal costs of violence to rebels or community norms. Graphically, factors that shift the v^* curve in figure 3 generate more variance than factors that shift g^* or m^* (not shown). So government should optimally allocate more g to communities with a (predictable) predisposition toward violence.

H_3. Across communities, variables that predict violence should also predict spending on government services.

A further inferential benefit of that approach is to discover what those predictors are, as they can inform us about competing theories linking community characteristics to rebel violence.

E. Alternative Assumptions

How robust are the three testable implications to alternative assumptions? The central result (H_1), that $\partial v^*/\partial g|_m < 0$ (with counterinsurgency efforts, community norms, and other community characteristics held constant), is essentially due to six assumptions: the community benefits from services, both the community and the government suffer from violence, information flow from the community can induce government control, the costs of rebel violence can be reduced by increasing the probability of government control, and counterinsurgency effort complements service provision in increasing the probability of government control. All these assumptions are consistent with current counterinsurgency doctrine (U.S. Army 2007), reflect the professional literature on counterinsurgency, and are easily motivated. The extensions in Appendix A demonstrate that H_1 would be overturned if all service provision were unconditional or if rebel violence were as harmful to the community under government control as it is when under rebel control. Appendix A also demonstrates that allowing rebel service provision and retaliation by rebels does not overturn H_1. Hypothesis H_2 is an immediate implication of H_1, and H_3 is implied by the same assumptions as H_1, with the addition of cross-sectional variation in location-specific predisposition to rebel violence, which we will provide evidence of below. Overall then, the model rests on a set of relatively modest assumptions.

IV. Data

This section describes a new data set on the provision of government services and conflict in Iraq. Our data include geolocated U.S. government data on violence against Coalition and Iraqi security forces, geolocated reconstruction spending at the project level, district-level com-

munity characteristics measured by Iraqi Central Statistical Office (COSIT) and World Food Programme (WFP) surveys, and Geographic Information System data on oil reserves and infrastructure measures such as road density.[23]

Our key dependent variable is the intensity of insurgent activity measured as attacks per capita against Coalition and Iraqi government forces. The attack data are based on 193,264 "significant activity" (SIGACT) reports by Coalition forces that capture a wide variety of information about enemy attacks that target Coalition forces, Iraqi forces, civilians, infrastructure, and government occurring from February 2004 through December 2008. Unclassified data from the MNF-I SIGACTS III database were provided to the Empirical Studies of Conflict (ESOC) project.[24] 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 in which no one returned fire, such as indirect fire attacks not triggered by initiating insurgent attacks (e.g., air strikes targeting specific individuals). 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.[25]

The SIGACT data have two relevant weaknesses. First, they capture violence against civilians and between nonstate actors only when U.S. forces are present and so dramatically undercount sectarian violence (Government Accountability Office 2007; Department of Defense 2008; Fischer 2008). As our theoretical and empirical focus is on attacks against Coalition and Iraqi forces, missing sectarian violence does not bias our results (though these data clearly undercount overall violence). Troop strength is a potential omitted variable, which we discuss below. Second, these data almost certainly suffer from some measurement error in that units vary in their thresholds for reporting something as an incident. Fortunately, there is no evidence that the error is nonrandom with respect to our key variables.[26]

Our key independent variable is spending on reconstruction projects. Data were compiled from the U.S. Army Corps of Engineers Gulf Region Division's Iraq Reconstruction Management System (IRMS). These data

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[23] Full replication data are available from the authors.

[24] ESOC is a joint project based at Princeton University and the Hoover Institution. It collects microdata on a wide range of conflicts.

[25] We thank Lt. Col. Lee Ewing for suggesting the filters we applied.

[26] Kilcullen (2006) reports that attempts to reconcile the SIGACT data with unit leaders' recollections show that the accuracy of the data varies widely by unit. One source of these discrepancies is that the element responsible for initial SIGACT reports varies across units and over time. We should expect, e.g., different reporting biases from a company headquarters than from a battalion intelligence officer.

are unclassified and include the start date, end date, project description, funding source, type of project, and amount spent for 62,628 reconstruction projects active from March 2003 through December 2008. They cover over $25.3 billion in projects funded under a variety of programs, including Department of Defense–administered programs such as the CERP, the Iraq Relief and Reconstruction Fund, and State Department programs, including the Economic Support Fund spending by the U.S. Agency for International Development. Altogether, these IRMS data account for the vast majority of reconstruction funds spent during the period for which we have high-resolution data on violence.[27]

To generate a measure of reconstruction spending directed toward providing local public goods, we combined spending under three programs: CERP; the Commanders Humanitarian Relief and Reconstruction Program (CHRRP); and Overseas Humanitarian, Disaster Assistance, and Civic Aid (OHDACA). These three sources accounted for approximately $3.1 billion in spending on 29,975 individual projects. The vast majority of this spending occurred through the CERP program ($3 billion), and so we will use CERP to refer to spending on local public goods. For each project we averaged spending over time by dividing it evenly by the number of days between project start and project completion and then calculated a daily total for each district. These totals were then aggregated to generate district/month reconstruction spending totals. Table 1 provides summary statistics for reconstruction spending of different types: CERP spending, non-CERP spending, large projects, and spending by different sectors of the economy.[28] An obvious thing to note from this table is a great deal of variation in the size and duration of projects.

V. Testing: Have U.S. Efforts to Provide Public Goods Helped?

This section seeks to answer a basic question: does the provision of public goods reduce insurgent activity? More generally, have the billions of dollars the United States has spent on reconstruction in Iraq had any effect on violence as measured by attacks recorded by Coalition and

[27] The CERP program is described in Multinational Corps Iraq (2009). These are the most complete data available on reconstruction spending in Iraq. The differences between totals captured in IRMS and estimates of total reconstruction spending from other sources are largely due to the failure of the Coalition Provisional Authority (CPA) to maintain detailed accounts of reconstruction spending. The CPA, which directed the reconstruction effort from May 2003 until it was dissolved in June 2004, initially tracked roughly $20 billion in expenditures on an Excel spreadsheet (Special Inspector General for Iraq Reconstruction 2009, 328). These errors in tracking spending are unlikely to affect our estimates, which are based on the period from 2004 onward.

[28] Large projects include all non-CERP projects over $100,000 in total cost with a spending rate of greater than $5,000 per day. Sectoral project figures include both CERP spending and spending across all other types of programs in those sectors.

TABLE 1
U.S.-Funded Reconstruction Projects

	Project Type			Project Sector				
	Non-CERP Projects	CERP Projects	Large Projects	Education	Electricity	Health	Transportation	Water and Sanitation
Mean cost ($000s)	678	104	7,588	97	187	242	207	500
Standard deviation ($000s)	5,435	425	18,379	390	544	973	646	502
Mean duration (days)	232	87	281	256	91	190	138	157
Standard deviation	237	103	279	342	100	304	180	193
Observations	32,653	29,975	2,469	4,825	1,814	1,487	2,580	5,526

Source.—U.S. Army Corps of Engineers Gulf Region Division's Iraq Reconstruction Management System (IRMS) database, October 2, 2009.
Note.—We dropped 860 projects because of suspect coding in the original data source. Statistics pertain to all projects active between January 1, 2004, and December 31, 2008. Large projects are non-CERP projects over $100,000 in total cost with a spending rate of greater than $5,000 per day. The list of sectors is not exclusive.

Iraqi security forces? At first glance the answer to both questions appears to be "no": the simple correlation between reconstruction spending and violence is positive. When, however, we control for local conditions and focus on spending intended to provide local public goods, the kind of spending our model suggests should matter, a different picture emerges.

Any analysis of the correlates of insurgent violence must normalize by population size, so we organize our data around the smallest geographic unit for which accurate population estimates are available, the district (*qada*).[29] Iraq has 104 districts in 18 governorates. We use the WPF's well-documented population estimates generated in 2003, 2005, and 2007 as part of its food security and vulnerability analysis (WFP 2004, 2006, 2008).[30] Using repeated observations of the population helps minimize the probability that our results are sensitive to biases driven by the substantial population movements Iraq suffered during the war.

Violence clearly varies along ethnosectarian lines. Unfortunately, we lack systematic countrywide data on the ethnosectarian mix of Iraq, so we instead use governorate-level returns in the December 2005 election. When at least 66 percent of the population in a governorate voted for a clearly Sunni, Shia, or Kurd party, we classify the districts in that governorate according to the majority group. With that system, 61 percent of Iraqis lived in governorates dominated by one group in 2004, whereas 39 percent lived in the remaining (mixed) governorates, 64 percent of whom lived in Baghdad. Population movement since 2005 has increased geographic segregation, though we lack precise estimates. Our core results control for district fixed effects and broad temporal trends by sectarian area, and so we should not be too concerned by the lack of precision on this score.

Table 2 describes our variables for the estimation sample: 1,040 district/half years observations (104 districts × 10 half years from January 2004 through December 2008). Weighted by population, we record 21 percent of Iraqis voting for clearly Sunni parties, 17 percent voting for clearly Kurdish parties, and 47 percent voting for clearly Shia parties.

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[29] District and governorate boundaries in Iraq have changed substantially since 2003, as has the number of districts. We calculate all district-level variables on the basis of the most refined boundaries for which we could generate consistent population estimates. Many of these changes were politically driven, and so analysts cannot assume consistent boundary definitions over time when using published district-level data.

[30] The 2003 WFP population estimates used Iraqi government birth and death rates to update figures from the 1997 census. The 2005 and 2007 estimates were adjusted on the basis of earlier survey results. Owing to massive conflict-driven population movements—between 12 and 23 percent of Iraqis have been displaced since March 2003—these estimates likely become less accurate over time (Brookings Iraq Index [2007], http://www.brookings.edu/iraqindex; UN High Commission on Refugees [2010], http://www.unhcr.org/4c9084e49.html). They are, however, an improvement on using time-invariant population data, which would cause us to even more severely understate the effects of conflict, as people flee areas of high violence.

TABLE 2
SUMMARY STATISTICS

Variable	Observations	Weight	Mean	Standard Deviation	Minimum	Maximum
Incidents per 1,000	1,040	288,023,728	.586	1.253	0	22.754
Ethnicity:						
Sunni vote share	18	28,104,187	.210	.252	0	.917
Shia vote share	18	28,104,187	.466	.351	0	.902
Kurdish vote share	18	28,104,187	.171	.326	0	.993
Reconstruction spending ($ per capita):						
CERP projects	1,040	288,023,728	10.562	17.159	0	552.812
CERP excluding CHRRP and OHDACA	1,040	288,023,728	10.281	16.956	0	552.812
Of which > 50,000 projects	1,040	288,023,728	9.043	15.302	0	527.450
Of which ≤ 50,000 projects	1,040	288,023,728	1.238	3.007	0	69.214
Non-CERP projects	1,040	288,023,728	68.856	124.632	0	10,840.8
Large projects	1,040	288,023,728	57.750	115.165	0	10,813.0
Education projects	1,040	288,023,728	.461	2.127	0	33.107
Electricity projects	1,040	288,023,728	.003	.105	0	9.944
Health projects	1,040	288,023,728	.872	2.450	0	45.795
Transportation projects	1,040	288,023,728	.743	2.858	0	89.415
Water and sanitation projects	1,040	288,023,728	6.981	68.294	0	10,830.4
Economy:						
Unemployment rate	312	84,647,702	.096	.069	0	.495
Proportion of population in 1st or 2nd income quintile	304	84,181,884	39.686	14.555	5	80
Income quintile change, 2002–4	100	26,637,385	−.012	.394	−1.6	1.925
Natural resources:						
Oil and gas reserves, price weighted	1,040	288,023,728	.0012	.002	0	.017
Pipeline volume, price weighted	1,040	288,023,728	13.143	29.218	0	250.963

NOTE.—Means weighted by WFP district population estimates. Vote shares are from December 2005 elections at the governorate level. Unit of observation for time-varying data is the district/half year. Summary statistics for variables based on survey data are weighted by population during survey. Economic variables are based on COSIT surveys fielded in 2004:I, 2005:II, and 2007:I.
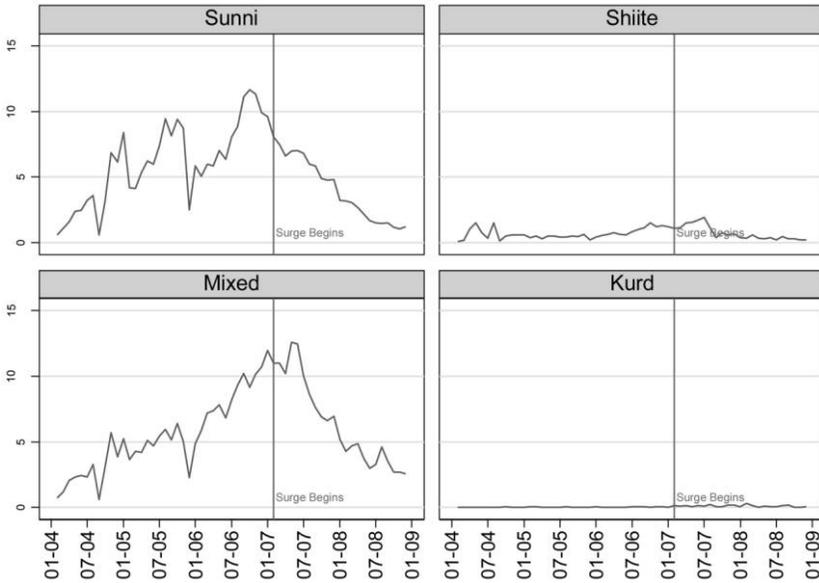
Fig. 5.—Trends in violence by sectarian group

The remaining votes were cast either for secular-nationalist parties (9 percent), for parties whose sectarian affiliation could not be identified by the Iraq experts we consulted (1 percent), or for parties that never received more than 1 percent of the vote share in any governorate (5 percent). CERP spending per resident per half year (which includes other measures of local public-good spending, as described above) averages $10.56. It varies widely across district/periods: in the second half of 2007, for example, 17 districts had no CERP spending, mostly in Shia and Kurdish regions.

Rates of attacks against Coalition or Iraqi forces also vary widely across districts and over time, averaging 0.59 attack per 1,000 residents per district/half year. Most of Iraq is quiet, with incidents concentrated in a small number of districts. There were no reported incidents for 193 district/half years over the sample period, spanning 44 districts. This pattern is illustrated in figure 1, which demonstrates variation across regions in violence. Only five districts average more than three incidents per 1,000 residents: Al Daur, Hamdaniya, Mahmoudiya, Muqdadiya, and Tarmia. Among districts experiencing heavy violence, there is great variation over time and high serial correlation.

Our model links characteristics of regions to levels of violence. What characteristics of districts predict violence? Figure 5 breaks the trends in per capita violence down by sectarian mix. Two factors stand out.

First, violence in Iraq is largely driven by two distinct conflicts: a sectarian conflict in mixed areas and a quasi-nationalist insurgency in Sunni areas. Second, the reduction in violence observed in 2007 was initially driven by a fundamental change in Sunni areas, one that predates any nationwide change in Coalition strategy or operational patterns.[31]

We begin by examining predictors of violence. Though the model is static, the setting is dynamic; since spending on service provision requires preparation time, an optimal response of service provision to violence would require an ability to predict the location and severity of violence. Predictability of violence is thus a necessary condition to testing the three hypotheses of the model.

Table 3 reports predictors of violence at the district level. The most important characteristic in predicting violence is Sunni vote share, which accounts for 18 percent of the cross-sectional variation, as reported in column 1.[32] A district that voted entirely Sunni is predicted to have 2.1 more incidents per 1,000 than a district with no Sunni votes, which is predicted to have only 0.14 incident, a 15-fold higher rate of violence. These estimates are likely biased toward zero as a result of measurement error since the Sunni vote share is only a noisy measure of the true proportion Sunni in a district, especially since it is measured at the more aggregated level of a governorate.

Year effects are also significant, reflecting the course of the conflict. Violence increased by 0.19 incident per 1,000 in 2005 over 2004, and further by 0.53 and 0.61 incident per 1,000 in 2006 and 2007, before dropping precipitously in 2008 (all measured per half year). Column 3 reports that most of that escalation is associated with districts that had a high Sunni vote share, as reported by the large and significant coefficients on year indicators interacted with Sunni vote share. Once these interactions are accounted for, there is no statistically significant pattern of increased violence in other Iraqi districts in 2005 and 2006 and an increase in 2007 of 0.23 incident per 1,000.[33] Column 4 includes the

[31] According to some reports, Coalition units in Anbar governorate in 2006 adopted many of the operational changes—dispersal of forces, more frequent dismounted patrols, and emphasis on political engagement with local leaders—that MNF-I implemented nationwide in early 2007.

[32] Standard errors in this table and in all tables that follow are robust to heteroskedasticity and are clustered by district to allow errors to be correlated temporally. Rebel and government strategies may be coordinated over areas larger than a district. For that and other reasons errors in this and other regression tables might be correlated across districts. A full treatment of spatial correlation is beyond the scope of this paper since the level of coordination across districts in Iraq varies widely given the heterogeneity of command and control structures across rebel groups and Coalition commands. As a robustness check we have also estimated this specification and those that follow with standard errors clustered at the governorate level to allow for cross-district correlation within governorates. All core results are robust to those alternatives.

[33] This increase in 2007 likely reflects increasing efforts by Coalition forces to reduce sectarian violence.

TABLE 3
PREDICTORS OF VIOLENT INCIDENTS AGAINST COALITION AND IRAQI FORCES

	DEPENDENT VARIABLE: INCIDENTS PER 1,000					
	(1)	(2)	(3)	(4)	(5)	(6)
Sunni share	2.123***	2.114***	.915***	1.113***	1.381***	.965***
	(.29)	(.29)	(.14)	(.15)	(.12)	(.139)
2005		.191***	−.0745*	−.0761*	.285	−.0009
		(.064)	(.043)	(.042)	(.190)	(.056)
2006		.531***	−.0215	−.0231	.243	.085
		(.15)	(.12)	(.12)	(.207)	(.071)
2007		.608***	.230**	.229**	.402***	.135*
		(.12)	(.10)	(.10)	(.149)	(.074)
2008		.0279	.0246	.0229	.110*	−.090*
		(.040)	(.034)	(.034)	(.059)	(.054)
Sunni share × 2005			1.321***	1.328***	1.172***	.027
			(.29)	(.29)	(.29)	(.244)
Sunni share × 2006			2.689***	2.696***	2.651***	.425
			(.78)	(.78)	(.79)	(.431)
Sunni share × 2007			1.857***	1.864***	1.886***	−1.313***
			(.40)	(.40)	(.376)	(.489)
Sunni share × 2008			.0713	.0777	.141	−1.270***
			(.25)	(.26)	(.285)	(.253)
Shia share				.251*	.543**	.083*
				(.14)	(.208)	(.050)
Income quintile change, 2002–4					−.215	−.030
					(.178)	(.036)
Unemployment rate					−3.252*	−.783
					(1.694)	(.475)
Proportion of population in 1st or 2nd income quintile					−.0101**	−.00006
					(.0042)	(.0009)
Incidents/1,000 lagged half year						.824***
						(.0258)
Constant	.144**	−.129**	.110***	−.0479	.305**	.0271
	(.067)	(.059)	(.035)	(.069)	(.120)	(.0346)
Observations	1,040	1,040	1,040	1,040	1,000	900
R^2	.18	.22	.26	.27	.32	.77

NOTE.—Robust standard errors are in parentheses, clustered by district. Results are robust to clustering by governorate instead. Regressions are weighted by estimated population.

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Shia vote share, which picks up differences in violence between Shia and Kurdish areas, both of which have low violence.

Economic indicators of inequality, changing inequality, and unemployment contribute some additional predictive power (col. 5), though the coefficients on inequality and unemployment have surprising signs. We will return to interpret those coefficients in the discussion of table 7 below, focusing now on the question of whether violence is predictable.

The strongest predictor of future violence is, quite naturally, the district's history of violence against Coalition and Iraqi forces. Column 6 reports that including lagged incidents in the previous half year increases the proportion of variance predicted to 77 percent. (Lagged

TABLE 4
VIOLENT INCIDENTS ON CERP SPENDING, 2004–8

	INCIDENTS PER 1,000					
	(1)	(2)	(3)	(4)	(5)	(6)
Basic controls		Y	Y			
Time controls			Y	Y	Y	Y
First differences				Y	Y	Y
Preexisting trend (Δv_{t-1})					Y	Y
District-specific trends						Y
CERP per capita	.0213***	.0147***	.0115***	−.00945**	−.0111**	−.0110**
	(.004)	(.0038)	(.0040)	(.0043)	(.0043)	(.0046)
Preexisting trend (Δv_{t-1})					.195**	.192**
					(.080)	(.087)
Constant	.361***	.306**	.262**	.217***	−.124***	.0890**
	(.085)	(.13)	(.10)	(.046)	(.041)	(.042)
Observations	1,040	1,000	1,000	936	832	832
R^2	.08	.25	.33	.17	.21	.21
Mean squared prediction error (10-fold coefficient of variation)	3.52	3.05	2.81	4.77	4.95	5.25

NOTE.—Robust standard errors are in parentheses, clustered by district. Results are robust to clustering by governorate instead. Regressions are weighted by estimated population. Basic controls include sect, unemployment, and income variables (as in table 3). Time controls include year indicators and their interaction with Sunni vote share (as in table 3). District-specific trends are district effects in a differenced specification. Basic controls are dropped from first-differenced specifications since they do not vary on a semiannual basis.

  * Significant at the 10 percent level.
  ** Significant at the 5 percent level.
  *** Significant at the 1 percent level.

incidents predict 72 percent of the variance in incidents by themselves.) We conclude that violence is predictable enough that Coalition forces should be able to adjust CERP spending appropriately.

A. *Evaluating the Effect of CERP Spending*

We turn now to testing the main implication of the model, that conditional on local characteristics such as norms favoring rebel control (n), marginal costs of violence to rebels, and counterinsurgency effort (m), CERP spending reduces violence (H_1). Our empirical challenge is to find a way to carry out that conditioning—a standard omitted variable bias issue in evaluating treatment effects. We deal with selection on local characteristics first and then turn to counterinsurgency effort.

  Table 4 reports the result of analyzing the effect of CERP spending on incidents by estimating the derivative in (7) with the coefficient β in

$$v_{it} = \alpha_i + \beta g_{it} + \gamma' z_{it} + \varepsilon_{it}. \tag{8}$$

Here v is violence, as measured by incidents; g is CERP spending; z is a vector of control variables, including year indicators and their interaction with the Sunni vote share; the subscript i represents one of 104 Iraqi districts (*qada*); and t counts half years from 2004 through 2008.

Column 1 reports the coefficient of a simple regression of incidents on CERP spending, which is positive. We interpret this as reflecting the selection effect that we described in the comparative static analysis: districts with predictable violence received high CERP spending, so that the positive correlation should be understood as predicted violence (i.e., high-α_i districts) attracting high spending. (Al-Qa'ida in Iraq, one of the main insurgent organizations, organized its administrative and tactical units along lines that mostly corresponded to the official government districts; see Bahney et al. 2010.) Consistent with that interpretation, the coefficient on CERP spending declines by about a third in column 2, where we condition on the predictors of violence from table 3: proportion Sunni, proportion Shia, year indicators, and interactions. This is again consistent with the idea that these other predictors proxy for omitted variables—such as norms favoring rebel control—reducing positive selection bias in the CERP coefficient. Column 3 adds time × ethnicity controls, which further reduce the size of the estimated coefficient.

To account more fully for possible selection of CERP into predictably violent areas, we estimate a first-differenced version of equation (8), augmented with controls for preexisting trends,

$$\Delta v_{it} = \delta_i + \beta \Delta g_{it} + \gamma' \Delta z_{it} + \phi \Delta v_{it-1} + \Delta \varepsilon_{it}, \tag{9}$$

where the Δ operator indicates a half year difference within districts ($\Delta x_{it} = x_{it} - x_{it-1}$). Column 4 reports the result of the first-difference regression, which eliminates possible selection bias in levels by differencing out district fixed effects (α_i). The resulting coefficient on CERP becomes negative and statistically significant, at $-.0095$. That negative estimate is consistent with H_1: *conditional on district characteristics, government spending on public goods reduced violence.*

Another source of potential selection bias comes from predictable trends in violence that could potentially affect CERP spending. To control for these, we take two approaches, including both lagged changes in violence (Δv_{it-1}) in column 5 and district-specific trends (δ_i) in column 6. While lagged changes in violence do have some predictive power, their inclusion has little effect on the estimated coefficient on CERP spending, which becomes only slightly more negative, at $-.0111$. Including district-specific trends has little effect on the CERP coefficient. Overall, that estimate is negative and robust to the inclusion of trend terms, which is to say that CERP is violence-reducing.
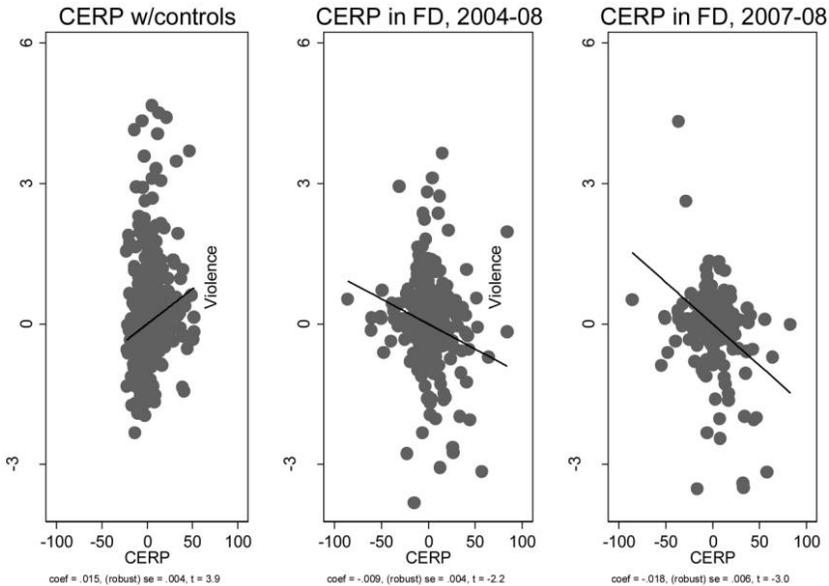
FIG. 6.—Violence versus CERP spending: outliers dropped; FD denotes first differences.

There may remain an attenuation bias. Any classical measurement error in CERP would create an attenuation bias that would be amplified by differencing and by including district-specific trends, which would remove signal but not noise. Our estimate of CERP spending flows must involve some measurement error as we were forced to assume a uniform spending flow between project start and project completion dates, whereas the true flow may have been quite lumpy. So if anything, the estimates probably underestimate the violence-reducing effect of CERP projects.

Figure 6 provides a graphical representation of these results. Each panel plots insurgent violence (not explained by the control variables) on the y-axis and reconstruction spending (unexplained by the control variables) on the x-axis.[34] The left panel replicates column 3 from table 4, and the center panel replicates the first-difference estimate from column 4. Two patterns stand out: first, in accordance with our comparative static analysis, selection is positive; that is, there is a positive relationship between CERP spending and violence when we do not

[34] Observations more than four standard deviations from the conditional mean have been dropped for visual clarity. This does not affect the substantive results, but dropping outliers does slightly alter the coefficient estimates for specifications used in the figures relative to those in tables 4 and 5.

control the strategic allocation of aid based on rebel strength and community characteristics. Second, in accordance with H_1, when we control for selection using first differences, government spending on public goods appears to be violence-reducing.

The right panel shows the first-differences estimate for 2007–8 only, illustrating that the violence-reducing effect of CERP becomes stronger from January 2007 on. In early 2007 U.S. forces in Iraq began to implement both an increase in troop strength (the "surge") and a set of operational changes including increased dispersal of forces, more dismounted patrols, and a greater emphasis on engaging with local political leaders. In Baghdad, for instance, U.S. combat forces moved from large bases outside the city in January 2007 to occupying over 60 "combat outposts" spread throughout the city by May 2007. While the extra troops were disproportionately deployed in Baghdad and the immediate vicinity, the operational changes were implemented throughout the country. In the spirit of our model, those operational changes should help officials allocating CERP develop better information about community needs, increasing the marginal utility of public goods, β_g in our model. In accordance with H_2, it appears that the violence-reducing impact of small-scale reconstruction spending is greater from January 2007 on.

To formally test this result, table 5 repeats our analysis for the pre- and post-"surge" phases of the sample period, 2004–6 and 2007–8, respectively. In the first subperiod the coefficient on CERP spending is weakly positive in a differenced specification but becomes statistically zero when preexisting trends are allowed for, indicating possible selection bias in CERP spending but also suggesting that CERP was not violence-reducing from 2004 through 2006. In contrast, from 2007 on, the coefficient on CERP is strongly negative ($-.0176$ in col. 4) and remains strongly negative when preexisting trends and district-specific trends are adjusted for. Column 7 reports a formal test of the difference in coefficients across periods, comparing specifications with the full set of controls (cols. 3 and 6): the increased effectiveness in CERP associated with the surge period is $-.0199$ and is statistically significant. The table indicates that (even if some selection bias remains) CERP spending became more effective in reducing violence in the latter period, implying that conditions under which development aid is delivered are critical to its effectiveness.

To quantify the estimated effect of CERP in column 6, an additional dollar of per capita CERP spending causes 1.59 fewer violent incidents per 100,000 residents, both over the span of half a year. To put that estimate in context, average incidents per capita were 58.6 per 100,000 residents during the entire period, which could be remediated at $37 ($= 58.6/1.59$) per capita of CERP spending, at the violence-reduction rate in the later period.

TABLE 5
Violent Incidents on CERP Spending, by Period

	INCIDENTS PER 1,000						
	2004–6			2007–8			2004–8
							Difference-in-Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time controls	Y	Y	Y	Y	Y	Y	Y
First differences	Y	Y	Y	Y	Y	Y	Y
Preexisting trend (Δv_{t-1})		Y	Y		Y	Y	Y
District-specific trends			Y			Y	Y
CERP per capita	.00724*	.00348	.00400	−.0176***	−.0181***	−.0159***	.00400
	(.0040)	(.0035)	(.0026)	(.0059)	(.0059)	(.0057)	(.0026)
Preexisting trend (Δv_{t-1})		.429**	.0258		.127*	.0182	.0258
		(.18)	(.21)		(.072)	(.066)	(.21)
CERP per capita, post-2006							−.0199***
							(.0069)
Preexisting trend (Δv_{t-1}) post-2006							−.008
							(.196)
Constant	.161***	.0625	.231***	−.0639	−.0887	−.0748	−.139
	(.038)	(.038)	(.034)	(.059)	(.059)	(.048)	(.035)
Observations	520	520	520	416	416	416	832
R^2	.13	.24	.53	.13	.14	.38	.45
Mean squared prediction error (10-fold coefficient of variation)	4.28	4.25	4.78	5.18	5.42	5.47	5.06

Note.—Robust standard errors are in parentheses, clustered by district. Results are robust to clustering by governorate instead. Regressions are weighted by estimated population. All regressions include year indicators and their interaction with Sunni vote share (as in table 3). District-specific trends are district effects in a differenced specification, as in eq. (9). The differences-in-differences specification in col. 7 allows separate district-specific trends in each period.
  * Significant at the 10 percent level.
  ** Significant at the 5 percent level.
  *** Significant at the 1 percent level.

Compared to an estimated effect that is statistically zero in the initial period, the post-2007 coefficient represents a dramatic improvement in program effectiveness. This change provides supportive evidence for hypothesis H_2, that the violence-reducing effect of service provision is enhanced when government forces use methods that provide them better knowledge of community needs, which was part of the surge deployment strategy. We return to another test of H_2 below.

B.   Alternative Explanations

An alternative explanation for the estimated effectiveness of CERP spending is that CERP merely proxies for local counterinsurgency effort,

m, which increased in the summer of 2007. This is especially a concern since analytically m and g are complements and m reduces violence; so theory predicts an omitted variable bias that may not be mitigated by first-differencing in equation (9). We explore this possible bias by checking robustness to including proxies for force levels on the one hand and to excluding locations that received the majority of force levels on the other.

CERP spending on large projects should serve as a good proxy for m since large projects should require a larger troop presence to keep them safe. Including spending on large projects on the left-hand side should therefore allow a more consistent estimate of the partial derivative $\partial v^*/\partial g|_m$ (eq. [7]). Recalling that the omitted variable bias due to omitting m should be positive (if it is not mitigated by first-differencing in [9]), then controlling for large projects should reduce the size of the estimated coefficient in

$$\Delta v_{it} = \delta_i + \beta^S \Delta g_{it}^S + \beta^L \Delta g_{it}^L \gamma' \Delta z_{it} + \phi \Delta v_{it-1} + \Delta \varepsilon_{it}. \qquad (10)$$

If this form of omitted variable bias is driving the results, however, the coefficient should be more negative for large projects than for small ones so that $-\beta^S < -\beta^L$.

Hypothesis H_2, however, provides an alternative prediction. Financial disbursement regulations that CERP programs adhered to gave battalions much more flexibility in spending on small projects than on large. Troops faced spending authorization thresholds that required approval from higher-ranking (and more remote) officers as project costs increased. Spending over \$50,000 actually required a memorandum of agreement from a local government official, in addition to additional paperwork for remote authorization, making that sum a natural cutoff in project size. If spending on small projects better reflected the local knowledge of battalions than spending on large projects did, then H_2 predicts that $-\beta^S > -\beta^L$.

Table 6 reports the result of estimating separate coefficients for large and small projects. Column 1 reproduces the estimated slope for all CERP (from table 4, col. 6, in a first-differenced regression with time controls, a preexisting trend, and a district-specific trend). Column 2 reports the same coefficient when we restrict projects to CERP narrowly defined (excluding CHRRP and OHDACA projects). Columns 3 and 4 estimate separate slopes for (narrowly defined) CERP spending on small and large projects. Small-project CERP is associated with almost six times as much violence reduction as CERP spending in general, a finding consistent with H_2. Column 5 reports coefficients estimated simultaneously for both small- and large-project CERP. Comparing the one-at-a-time estimates in columns 3 and 4 to the joint estimate, we see only a little evidence of omitted variable bias from omitting a measure of m

TABLE 6
VIOLENT INCIDENTS ON CERP SPENDING, BY PROJECT SIZE

	INCIDENTS PER 1,000					
	(1)	(2)	(3)	(4)	(5)	(6)
Time controls	Y	Y	Y	Y	Y	Y
First differences	Y	Y	Y	Y	Y	Y
Preexisting trend (Δv_{t-1})	Y	Y	Y	Y	Y	Y
District-specific trend	Y	Y	Y	Y	Y	Y
CERP per capita	−.0110** (.00463)					
CERP per capita excluding CHRRP and OHDACA		−.0114** (.00477)				
Of which ≤ 50,000 projects			−.0606*** (.0172)		−.0531*** (.0156)	−.0535*** (.0154)
Of which > 50,000 projects				−.0101** (.00471)	−.00793** (.00390)	−.00836** (.00390)
Non-CERP reconstruction						.000718* (.000390)
Preexisting trend (Δv_{t-1})	.192** (.0868)	.192** (.0866)	.181** (.0908)	.189** (.0874)	.191** (.0876)	.194** (.0882)
Constant	.0890** (.0416)	.0879** (.0415)	.0594 (.0370)	.0816** (.0404)	.0845** (.0408)	.0795** (.0399)
Observations	832	832	832	832	832	832
R^2	.214	.215	.219	.204	.233	.236

NOTE.—Robust standard errors are in parentheses, clustered by district. Results are robust to clustering by governorate instead. Regressions are weighted by estimated population. All regressions include year indicators and their interaction with Sunni vote share (as in table 3). District-specific trends are district effects in a differenced specification, as in eq. (9).
  * Significant at the 10 percent level.
  ** Significant at the 5 percent level.
  *** Significant at the 1 percent level.

(and no statistically significant evidence), indicating that the use of first differences, preexisting trends, and district-specific trends in equation (9) likely purged our estimates of that bias.

Comparing the estimated coefficients in column 5 also leads us to reject that $-\beta^S < -\beta^L$ in favor of the alternative $-\beta^S > -\beta^L$ ($t = 2.92$, $p = .004$). The point estimates indicate that small projects are six or seven times more violence-reducing than large, which is consistent with H_2. Finally, an alternative approach to proxying for troop presence would be to look at non-CERP reconstruction projects, which represent about sixfold higher spending than CERP projects and might therefore be an even better proxy for troop strength; they would presumably require even higher levels of security. Column 6 reports the result of including an additional variable measuring non-CERP spending in the regression: neither the coefficient on small CERP spending nor that on

large CERP spending is altered, reinforcing our conclusion that troop strength is not a source of omitted variable bias. The coefficient on non-CERP spending is positive and weakly significant ($t = 1.84$), suggesting that non-CERP spending is not violence-reducing.

As an additional check, other categories of non-CERP spending could plausibly serve as proxies, as most of the spending in those categories was also controlled by the Department of Defense. Appendix table B1 reports a test of that implication. Column 1 repeats the main first-difference result for CERP spending, from tables 4 and 5 (col. 4), in both the full and the postsurge periods. Column 2 reports the results of the same first-differenced regression for non-CERP reconstruction spending (as described in table 1). Unlike CERP, non-CERP spending shows a small and insignificant coefficient in the 2007–8 period. The same is true of large non-CERP projects, reported in column 3. Columns 4–8 study five different categories of non-CERP reconstruction spending. Only one of these categories yields a negative and statistically significant coefficient in panel B (water and sanitation projects with $p = .085$). If CERP were merely proxying for coercive activity, then these seven non-CERP coefficients should have been as large and negative as that for CERP, leading us to reject that conjecture.

The alternative explanation, that CERP spending proxies for m, would be particularly relevant in the postsurge period, that is, that the increase in U.S. forces beginning January 2007, rather than the change in tactics, made CERP spending more productive. As a first cut, this explanation would imply that other categories of spending should show similar changes in effectiveness from January 2007 on. Table B1 shows that this is not the case. As a second cut, since most of the additional forces were deployed in and around Baghdad, we can test this alternative explanation by repeating the analysis in table 5 with the nine districts in Baghdad removed. Table B2 reports those results. Examining the rest of Iraq, where the increase in troop strength was relatively small and substantially less concentrated, we see essentially the same results: CERP spending has a significantly negative effect on violence; non-CERP spending and large projects do not; only one of the five subcategories of non-CERP spending shows a significant coefficient (this time education). The same result obtains if we exclude all districts that received surge forces from the analysis (not reported). Surge forces, and forces in general, were concentrated in areas with large Sunni populations, yet the effectiveness of CERP spending in the postsurge period is unrelated to the proportion Sunni in a district (not reported). We conclude that the increased violence-reducing effect of CERP must be due more to a change in tactics associated with the surge than to increased force levels. Taken together, the results in tables B1 and B2 provide strong

evidence that an improvement in the effectiveness of CERP, rather than omitted variable bias, drives the CERP-associated decline in violence.

C. Predictors of Violence and of CERP Spending

The model's final testable implication (H_3) is that the same community characteristics that predict violence will predict CERP spending. To reconstruct that logic, the correlation of v and g is positive (table 4, col. 1), which implies that the positive slope of the best-response function $\partial g^*/\partial v$ dominates comparative statics. Furthermore violence is predictable (table 3), so variables that predict violence should predict government spending on services (i.e., CERP is deployed endogenously to predictably violent areas). Note that it could be otherwise: government spending on services could be predicted by poverty, unemployment, or shared ethnicity with the party in power.

Table 7 reports the result of that test, using parallel specifications to predict violent incidents (cols. 1–3) and CERP spending (cols. 4–6). Ethnicity variables, year indicators, and lagged violence have coefficients that share the same signs and are statistically significant in parallel specifications. The only exception is that in the specifications with lagged violence (cols. 3 and 6), the decline in violence in Sunni districts in 2007 and 2008 does not translate into a decline in CERP spending. Overall, the table reports evidence consistent with the hypothesis at the district level: predictors of violence are also predictors of CERP spending, indicating that the logic of endogenous CERP spending in the model is evident in the Iraqi data: CERP spending is aimed not at the poorest areas, as traditional development assistance might be, but at areas that are predictably violent. Note that the estimated coefficients in columns 4–6 should not be interpreted as causal; coercive counter-insurgency, though unobserved, would follow the same pattern according to the model, which would account for at least part of the predictive power of variables that predict violence.

While H_3 is not the key prediction of the model, this evidence clearly refutes an alternative model of the government (or, more accurately, of CERP administrators) as social welfare maximizers, who might allocate spending at the margin on the basis of need (i.e., low income).

Table 7 has an additional inferential benefit: it allows us to examine how well alternative theories predict violence. The literature on civil wars suggests that competition for natural resource endowments and economic weakness are significant predictors of violence at the national level. At the local level, though, it is unclear how these factors should

TABLE 7
PREDICTORS OF VIOLENCE ALSO PREDICT CERP SPENDING

	DEPENDENT VARIABLE: INCIDENTS/ 1,000			DEPENDENT VARIABLE: CERP SPENDING ($ per Capita)		
	(1)	(2)	(3)	(4)	(5)	(6)
Sunni share	1.141***	1.381***	.965***	12.07***	13.19***	11.95***
	(.159)	(.199)	(.139)	(3.012)	(3.518)	(3.629)
2005	−.0660	.285	−.000867	5.990***	8.476***	5.969***
	(.0448)	(.190)	(.0560)	(2.009)	(2.640)	(2.220)
2006	−.00518	.243	.0848	5.674***	7.738***	5.871***
	(.128)	(.207)	(.0713)	(1.127)	(1.539)	(1.404)
2007	.252**	.402***	.135*	10.24***	11.55***	9.128***
	(.113)	(.149)	(.0735)	(2.897)	(3.107)	(2.500)
2008	.0632	.110*	−.0903*	7.986***	9.052***	6.956***
	(.0408)	(.0594)	(.0538)	(2.641)	(2.370)	(2.109)
Sunni share × 2005	1.344***	1.172***	−.0270	12.18***	8.012***	1.599
	(.282)	(.291)	(.244)	(3.962)	(2.165)	(2.068)
Sunni share × 2006	2.720***	2.651***	.425	10.61**	6.557*	−5.099
	(.771)	(.791)	(.431)	(4.209)	(3.451)	(4.940)
Sunni share × 2007	1.895***	1.886***	−1.313***	17.75	17.33	.711
	(.392)	(.376)	(.489)	(11.12)	(11.60)	(10.98)
Sunni share × 2008	.127	.141	−1.270***	14.38**	13.33**	5.813
	(.287)	(.285)	(.253)	(5.856)	(6.381)	(7.226)
Shia share	.268*	.543**	.0833*	8.005***	8.550**	6.715**
	(.136)	(.208)	(.0497)	(2.703)	(3.398)	(3.153)
Income quintile change, 2002–4		−.215	−.0298		.302	1.520
		(.178)	(.0361)		(2.455)	(2.536)
Unemployment rate		−3.252*	−.783		−17.14	−5.010
		(1.694)	(.475)		(14.49)	(13.07)
Proportion of population in 1st or 2nd income quintile		−.0101**	−5.72e−05		−.196**	−.151*
		(.00419)	(.000888)		(.0947)	(.0842)
Oil and gas reserves, price weighted	−6.382			515.8		
	(21.14)			(516.6)		
Pipeline volume, price weighted	−.00323*			−.0437		
	(.00174)			(.0304)		
Incidents/1,000 lagged half year			.824***			4.195***
			(.0258)			(1.148)
Constant	−.0356	.305**	.0271	−4.196***	3.722	3.333
	(.0656)	(.120)	(.0346)	(1.483)	(2.877)	(2.852)
Observations	1,040	1,000	900	1,040	1,000	900
R^2	.273	.319	.767	.155	.235	.288

NOTE.—Robust standard errors are in parentheses, clustered by district. Results are robust to clustering by governorate instead. Regressions are weighted by estimated population. Regressions with sect/year interactions include Shia vote share.
 * Significant at the 10 percent level.
 ** Significant at the 5 percent level.
 *** Significant at the 1 percent level.

affect violence.[35] In our model, for example, rebels from economically successful areas may be able to afford higher levels of activity (and of complementary service provision). The grievance model predicts that

[35] Subnational variation in resources and economic strength should predict increased violence if they can be captured at the local level (see Dunning 2005; Fearon 2005; Dube and Vargas 2008).

communities disadvantaged by the war should experience more rebel violence whereas the opportunity cost model suggests more rebel violence where unemployment and poverty are high, at least if finding recruits is a binding constraint on rebel production of violence.

Columns 1–3 of table 7 report the results of our efforts to assess the influence of natural resource endowments, economic grievances, and opportunity costs on violence in Iraq. We measure natural resources in two ways: price-weighted oil reserves accessible in a district and price-weighted volume of oil pipelines passing through a district. The latter attempts to measure the availability of resource rents, either by tapping pipelines or by extorting payoffs from government officials with threats to attack pipelines. The volume of oil and gas reserves yields a statistical zero, whereas pipeline volume is weakly significant, but with the opposite sign of that predicted.

We measure economic grievances with self-reported movement between income quintiles from 2002 to 2004 and measure the opportunity cost of rebellion using both unemployment and the proportion of a district's population in the bottom two national income quintiles.[36] Movement between income quintiles yields no prediction. Measures of opportunity costs yield significant coefficients, but in the wrong direction for an opportunity cost model. Berman et al. (2011) discuss this finding in depth, reporting the same negative correlation in the Philippine and Afghan insurgencies. Note that higher unemployment predicting less violence is consistent with a core premise of our model—that noncombatants' propensity to share information constrains rebel violence—provided that coalition spending buys more information where poverty and unemployment are high.[37] This finding is inconsistent with the notion that recruiting fighters is the key constraint on rebels in Iraq, reinforcing our decision not to model a manpower constraint for rebels.[38]

In interpreting our results it is important to keep in mind the measurement error inherent in the SIGACT data. Conversations with former battalion and brigade staff officers suggest that the proportion of true

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[36] Unemployment and poverty measures were generated from WFP surveys in 2003, 2005, and 2007. Values for 2004 and 2006 are based on population-weighted interpolation.

[37] Note that this is a separate mechanism from the one modeled in Sec. III and tested in the discussion of tables 4 and 5, that coalition efforts to provide small-scale public goods can motivate the community to greater information sharing. The interaction of CERP spending and unemployment does have the negative sign we would expect if CERP spending helped buy information; but while unemployment and its interaction with CERP are jointly significant ($p < .06$), the coefficient estimates are not significant at the 10 percent level. We thank an anonymous reviewer for this suggestion.

[38] This finding is consistent with that of Hanson, Iyengar, and Monten (2009), who argue that exogenous increases in CERP spending—which they posit create short-term improvements in local labor markets—lead to little change in overall levels of attacks but a clear substitution from labor-intensive to capital-intensive attacks.

incidents recorded as SIGACTs drops as the intensity of violence rises. A battalion with elements in contact 40 times over a 3-day period might report only 30 incidents, whereas a battalion with elements in contact three times over the same period is likely to report every incident. Even if the rate of undercounting is constant, this form of measurement error biases coefficient estimates downward in levels, introducing a conservative bias to our estimation.

Another potential source of bias in these data is that SIGACTs might capture criminal violence attracted by CERP spending.[39] If CERP incentivizes criminal violence, it will introduce measurement error whose magnitude is positively correlated with CERP, biasing against observing a violence-reducing effect of CERP. This conservative bias lends additional credence to our findings.

A final use of our model is its ability to account for changes in violence that occurred in 2006 and 2007. Returning to figure 5, which summarizes monthly incidents per capita by sectarian affiliation across Iraq, note that the downward trend in violence in Sunni areas—which accounts for most of the downward trend through 2007—substantially predates any changes in nationwide Coalition counterinsurgency practices. The changes in late summer 2006 do coincide with the well-documented decision by local leaders in Anbar governorate to turn against foreign militants and begin sharing information with Coalition forces. In the context of our model, this amounts to an exogenous change in community norms, n.

VI.   Conclusion

Between March 2003 and December 2008 at least 100,000 civilians were killed in the conflict in Iraq, between 2 and 4 million people were displaced, thousands of Coalition and Iraqi soldiers died, and hundreds of billions of dollars were spent on fighting the war and rebuilding the shattered Iraqi state. Against this tragic background our goal is not to judge whether the Coalition could have better supported the political development in Iraq. Rather, given the prospect that rebuilding conflict and postconflict states will remain a central policy objective, we seek to identify conditions under which providing local public goods will help rebuild social and economic order in future conflicts.

[39] In central Baghdad in 2006, e.g., a battalion used CERP funds to pay for garbage collection, exactly the kind of visible, small-scale public good the model suggests should reduce violence. The garbage trucks were soon attacked, and the attacks duly entered into the SIGACT data. After some investigation, the battalion commander learned that the attackers were not insurgents but criminals directed by the owner of a competing garbage collection firm vying for a piece of the lucrative CERP contract! (private communication, Col. Jeffrey Peterson, September 17, 2008).

To do so we developed a model of insurgency as a three-party struggle over information. Government seeks to fight the insurgency through military means and by providing services, public goods, to motivate the community to share information, which in turn enhances the effectiveness of military counterinsurgency. Rebels seek to persuade the population to refrain from sharing information by restraining their violence to levels the community will tolerate. They can also do so by retaliating against those who do share and by providing competing services (as analyzed in App. A). The community shares information if the benefits of doing so outweigh the costs.

This simple framework generates a number of testable predictions about service provision and violence. We tested that model using data at the level of Iraqi districts.

Several results stand out. First, the conflict in Iraq is concentrated in a very few areas. Second, the timing of violence varies greatly within these areas. While overall violence in Sunni governorates began dropping precipitously in October 2006, the decline in key areas such as Balad and Tikrit did not begin until mid-2007. Third, the dynamics of conflict are fundamentally different in Sunni areas, where the conflict looks like a quasi-nationalist insurgency, as opposed to the sectarian conflict driving violence in mixed areas.

Our results support the model. Though regional spending on local public goods is unconditionally correlated with greater violence, once we condition on community characteristics, we find that this spending is violence-reducing. This violence-reducing effect of service provision became substantially stronger from January 2007 onward when operational changes meant that Coalition forces nationwide had a better understanding of their communities' needs. In that period every additional dollar per capita of CERP spending predicted 1.59 fewer violent incidents per 100,000 population per half year. While this may seem to be a relatively small coefficient, four points should be kept in mind. First, it may underestimate the effect of CERP because of attenuation biases in estimation. Second, it represents an average across programs and regions, some of which were not very violent to start with. Third, if interpreted causally, mean violence in Iraq over the entire period (58.6 incidents per 100,000 per half year) is equivalent to about $37 per capita per half year of CERP spending. Fourth, smaller projects—at a scale in which units with better local knowledge implemented them—were about five times more effective at violence reduction.

The vast majority of reconstruction spending (the non-CERP spending that constituted about 90 percent) had no violence-reducing effect. Whether that was due to unconditional implementation, poor local knowledge, or poor oversight is an open research question.

Our analysis also carries an important caution for policy makers: an

observed positive relationship between service provision and violence does not imply that service provision makes things worse. Optimal distribution of aid may dictate exactly that type of selection, delivering it to where it is most violence-reducing. Efforts to understand the effects of nonviolent measures on conflict outcomes must explicitly take into account that selection bias.

While we have tested several implications of an information-sharing model, the evidence does not conclusively exclude alternative models of insurgency, which share the property that provision of services reduces violence. Those include models in which noncombatants are swayed not by improved governance but by grievances allayed, jobs provided, or the cooptation of their leaders and models in which the consequential act of noncombatants is not information sharing but active resistance to rebel activity, taxation, or recruitment. We chose an information-sharing model because it is the approach most consistent with existing doctrine and because it seems most plausible to us on the basis of the experience of practitioners and on our reading of the literature.

We have also provided some evidence (in table 7) against grievance-based mechanisms or opportunity cost models of what sways communities. We also see the increased efficacy of government spending when accompanied by a more population-focused military strategy (tables 5 and 6) as evidence for an information-sharing model, as opposed to alternatives. Nevertheless, an important task for future research is to better distinguish between the predictions of alternative models of counterinsurgency.

Overall, then, our results indicate that more attention needs to be paid, analytically and empirically, to factors that influence the returns to service provision, in the context of any of these models. In substate conflicts, governance tends to be extremely poor; governments, aid agencies, and nongovernmental organizations require better guidance on where investments in service provision will yield the highest returns in terms of social order and program effectiveness, as well as in reduced violence. We are currently investigating that question with more detailed data on reconstruction spending. Progress will go a long way toward addressing a central question in both development and counterinsurgency: how to effectively provide basic governance to residents of conflict areas.

Appendix A

Extensions

We examine a number of extensions that are relevant to the Iraqi insurgency and illustrate the robustness of the basic logic of the information-sharing model

to more general assumptions. The testable implications and basic characteristics of the model are unaffected by these extensions.

Retaliation and Service Provision—Other Sources of Rebel Influence

Rebels may also influence information flow through their ability to retaliate against communities that inform and through benign services that they provide. When the assumption that an individual informant is anonymous is retained, rebels are able to infer that $i > 0$ at the community level if $a = 1$ occurs and then retaliate. Retaliation, which we label r, is distinct from v in two senses: it is directed at noncombatants, and it can damage noncombatants even under government controls. Suicide attacks are an example of a technology that can target noncombatants without leaking information about assailants, thus allowing attacks within areas where information is shared with government. Most rebels have limited capacity to carry out such attacks for organizational reasons.[40]

Rebels may also influence information sharing by providing services, as Muqtada al Sadr's Mahdi Army did in Iraq. Let $s \geq 0$ be services provided by rebels, which we assume to be perfect substitutes for g. Rebel provision of government-like services is fairly widespread but has not been documented until recently.[41] For example, Berman (2009) describes provision of services by Hamas, Hezbollah, the Mahdi Army, and the Taliban; Heger (2010) documents community services provided by the Irish Republican Army; and Keister (2010) describes services provided by the Moro Islamic Liberation Front and the Moro National Liberation Front in the southern Philippines. These sources and anecdotal evidence suggest that when rebels control territory, they typically provide at least some form of security and dispute adjudication services to noncombatants, apparently at low cost to themselves. Introducing retaliation and rebel service provision into the model yields an expanded version of C's expected utility,

$$EU_C(i, g, s, v) = u(c + g - n - r)p + u(c - v + s)(1 - p). \tag{1a}$$

That formulation yields a term $n + r + s$ that plays the role of n in the baseline model, yielding (following the same derivations as above)

$$i^* = 1 \Leftrightarrow n < g + v - (r + s). \tag{4a}$$

Both r and s reduce the probability that C will share information.

The rebel's objective becomes

$$\max_{s \geq 0, v \geq 0, r_U \geq r \geq 0} EU_R(v, g, m, r, s) = A(v)(1 - p^*) - B(v) - S(s),$$

where S is an increasing, continuously differentiable function, $S'' > 0$, and r_U is the capacity constraint on rebel retaliation, r. It is straightforward to show a

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[40] See Berman (2009) for an explanation of organizational constraints to suicide attacks.

[41] The counterinsurgency manual refers to rebel provision of services only in passing (U.S. Army 2007, 105, par. 3-89).

unique interior solution for s and a corner solution for r at $r = r_U$.[42] So r^* is either zero when information is not shared or r_U when it is. Observed retaliation can thus be understood in equilibrium as a method of intimidating noncombatants into not sharing information with government.[43]

Note that the probability of retaliation is therefore increasing in g (ceteris paribus), in contrast to v^*, which is decreasing in g (ceteris paribus). This highlights the importance of distinguishing between types of violence.

Following the discussion of comparative statics above, r and s both complement v and substitute m, ceteris paribus, increasing the ability of rebels to impose costs on government through violence.

In this sense the model formalizes the idea of "competitive governance" in counterinsurgency: regardless of their attitude toward the welfare of the community, rebels (like government) have good reason to provide services in order to influence information flow and thus increase their latitude for violence.

Shifts in the marginal costs of service provision and shifts in the capacity for retaliation, r_U, have the same comparative statics as a shift in n_L. A government might consider reducing s by increasing the marginal costs of rebel service provision (in the extreme shutting down justice provision or welfare services by rebels), but only at the risk of increasing norms favoring rebel control. It could alternatively establish a reputation for prosecuting retaliators (reducing r_U).

Can Services Be Neutral?

We made the strong assumption in (1) that g is entirely valueless to the community when the territory is controlled by rebels. That cannot be literally true of infrastructure such as roads, which cannot be easily withdrawn, even by a government practicing conditionality of service provision. A more general formulation allows two types of services: g_c, which are provided conditional on government control, and g_n, which are not. The expected utility of C is then

$$EU_C(i, g, s, v) = u(c + g_c + g_n - n)p + u(c + g_n - v)(1 - p). \qquad (1b)$$

Note that in this case the flow of utility from unconditional services provided by government is independent of p, so that the optimal information-sharing condition (4) is unchanged, since g_n has no effect on information sharing. Effectively, even infrastructure has a mix of aspects that can and cannot be conditioned (roads require maintenance, e.g., and can be blocked). Qualitative results in the text follow if a proportion of g is g_c (i.e., they will be weaker but retain their signs).

Why do governments provide g_n at all? They might assign some social welfare weight to U_C. Or perhaps they built roads in order to serve other communities

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[42] Why is $r = 0$ when $a = 0$? A realistic extension would allow R simultaneous play of r with C in stage 3, so that it could choose an optimal r^* for each value of a. In that case R will optimally choose no retaliation when $a = 0$ and maximal retaliation when $a = 1$, since that minimizes incentives for C to share information with government in (4a). (That result might be reversed in a repeated game in which rebels signal capacity for retaliation.)

[43] Retaliation differs from the type of terrorism typically seen in the West, which also targets noncombatants but with the purpose of influencing government behavior—territorial control being an unattainable goal for terrorists in that context.

or other purposes. A possible interpretation of the statistical zeros associated with non-CERP service provision (table 6 and tables B1 and B2) is that they are the implication of unconditioned reconstruction spending.

"Collateral Damage"

A final strong assumption of the basic model is that the community does not suffer from violence when the government is in control. A weaker assumption is that when G is in control, v generates disutility for C proportional to violence, δv, where $0 < \delta < 1$ is a constant. That δ proportion could reflect so-called collateral damage to noncombatants from G's attempts to suppress v, because government forces are not discriminating enough in targeting insurgents to protect noncombatants from injury, or it could be that the community empathizes with suppressed rebels. Alternatively, δ may reflect G's success in shielding C from the effects of v, for example, with technologies such as blast walls that shield noncombatants from IEDs directed at G or with better medical care to treat the injured. That generalization yields

$$EU_C(i, g, s, v) = u(c + g - n - \delta v)i + u(c - v)(1 - i). \tag{1c}$$

The optimal information-sharing condition is then

$$i^* = 1 \Leftrightarrow n < g + (1 - \delta)v, \tag{4c}$$

and the optimal choice of violence by rebels satisfies

$$0 = \frac{\partial EU_R}{\partial v} = A'(v)(1 - p^*) - A(v)(1 - \delta)fh(m) - B'(v)(1 - \delta).$$

Rebels can allow themselves higher levels of violence the greater the collateral damage caused by the government. This is consistent with the findings of Condra et al. (2010), who find that civilian casualties caused by Coalition forces in Iraq predict future attacks on those forces. Note that as δ approaches one the expected cost of violence for rebels disappears and rebel violence becomes unbounded; intuitively, C becomes as endangered by sharing information as it is by not sharing. In that (extreme) case the government cannot reduce violence by coercive or benign means, motivating the emphasis on protecting the population in current doctrine.

Appendix B

Additional Tables

TABLE B1
ADDITIONAL SPENDING CATEGORIES: FIRST DIFFERENCES

	CERP (1)	Non-CERP (2)	Large (3)	Education (4)	Electricity (5)	Health (6)	Transportation (7)	Water and Sanitation (8)
A. 2004–8								
Spending per capita	−.0095**	.0002	.0002	−.0214	−.1345	.0082	−.0034	−.000023
	(.0043)	(.0002)	(.0002)	(.0181)	(.0094)	(.0114)	(.0041)	(.000032)
R^2	.17	.15	.15	.15	.15	.15	.15	.14
Observations	936	936	936	936	936	936	936	936
B. 2007–8								
Spending per capita	−.0176***	−.0006	−.0005	−.0266	−.0339	.0363	−.0090	−.0094*
	(.0059)	(.0006)	(.0005)	(.0266)	(.0213)	(.0396)	(.077)	(.0054)
R^2	.13	.03	.03	.03	.04	.03	.03	.03
Observations	416	416	416	416	416	416	416	416

NOTE.—Panel A specifications include year indicators and their interactions with Sunni vote share. Panel B includes an indicator for 2008 and its interaction with Sunni vote share. Robust standard errors are in parentheses, clustered by district. Regressions are weighted by estimated population.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

TABLE B2
ADDITIONAL SPENDING CATEGORIES, BAGHDAD OMITTED: FIRST DIFFERENCES

	CERP (1)	Non-CERP (2)	Large (3)	Education (4)	Electricity (5)	Health (6)	Transportation (7)	Water and Sanitation (8)
				A. 2004–8				
Spending per capita	−.0094	.0002	.0002	−.0122	−.0159	.0063	−.0053	−.000021
	(.0057)	(.0002)	(.0002)	(.0171)	(.0117)	(.0110)	(.0031)	(.000029)
R^2	.19	.17	.17	.17	.17	.17	.17	.17
Observations	855	855	855	855	855	855	855	855
				B. 2007–8				
Spending per capita	−.0172**	−.0005	−.0004	−.0479*	−.0366	.0561	−.0079	−.0057
	(.0084)	(.0006)	(.0005)	(.0259)	(.0276)	(.0443)	(.0073)	(.0056)
R^2	.13	.04	.04	.05	.06	.05	.04	.04
Observations	380	380	380	380	380	380	380	380

NOTE.—Panel A specifications include year indicators and their interaction with Sunni vote share. Panel B includes an indicator for 2008 and its interaction with Sunni vote share. Robust standard errors are in parentheses, clustered by district. Regressions are weighted by estimated population. Five additional combat brigades were ordered to Iraq beginning in January 2007, including approximately 20,000 additional troops. One brigade deployed each month from January through May with all in place by late June 2007. Two of five brigades were deployed to Baghdad and the remaining three were deployed within 30 miles of the capital, across five provinces.

  * Significant at the 10 percent level.
  ** Significant at the 5 percent level.
  *** Significant at the 1 percent level.

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