Military Technology and the Duration of Civil Conflict*

Jonathan D. Caverley  
Massachusetts Institute of Technology  
caverley@mit.edu

Todd S. Sechser  
University of Virginia  
todd.sechser@virginia.edu

Abstract

Why do some civil conflicts end quickly, while others last for years? This paper argues that an incumbent government’s military forces play a crucial role in conflict duration. Specifically, “combined arms” militaries – which bring to bear a mixture of mechanized infantry, armor, and aircraft – make short conflicts more likely. The use of mechanized ground forces in combination with airpower increases the likelihood of decisive engagements early in a conflict, helping to mitigate information asymmetries that can drive violence. By contrast, less-mechanized forces have greater difficulty bringing the fight to the enemy. Combined-arms militaries therefore tend to bring conflicts to more rapid conclusions. However, like maneuver warfare in conventional interstate conflict, these outcomes are not always favorable for the incumbent governments. To test this argument, we employ new, detailed data on military mechanization and airpower from civil conflicts between 1967 and 2003. The results indicate that national militaries with high combined arms capabilities are associated with significantly shorter conflicts. Perhaps surprisingly, this relationship remains robust even when the analysis is limited to insurgencies.

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Introduction

One of the most puzzling characteristics of intrastate conflicts is that some last for days, while others last for years. This wide variation distinguishes civil conflicts from interstate wars: the longest interstate war during the past two centuries lasted just 11 years, whereas conflicts in Colombia, Myanmar, and elsewhere have persisted for decades. At the same time, some civil conflicts end quickly. It took just eight months for rebels to defeat the Gaddafi regime in Libya in 2011, in part due to intervention from Western airpower. Yemen crushed a 1994 separatist movement in a mere two months without outside assistance, confounding widespread expectations of a lengthy stalemate. Most civil conflicts, in fact, last less than two years. What explains this dramatic variation?

This paper examines the role of military technology in explaining the duration of civil conflicts. Specifically, it evaluates how *mechanization* – that is, a military’s relative reliance on airpower, armor, and vehicles versus manpower – can influence the likelihood that a conflict will reach a rapid conclusion. National militaries vary widely in the degree to which they rely on mechanized forces. Some militaries rely primarily on manpower for their fighting capability, while others possess vast fleets of aircraft, armored vehicles, and tanks. How does this variation shape the nature of conflict? Do highly mechanized militaries bring about quicker resolutions to military conflicts, or do they prolong them by precluding decisive victories?

We argue that mechanized militaries can bring about more rapid resolutions to civil conflicts. Incumbent governments that can draw on a diverse military portfolio of mechanized infantry, armor, and aircraft – known as “combined arms” in military parlance – tend to fight significantly shorter conflicts than those that do not. Combined-arms forces help generate battlefield outcomes that more rapidly resolve information asymmetries among combatants, leading to shorter conflicts. First, their superior mobility and logistics allows them to reach conflict zones more quickly, thus minimizing the time lag between the onset of a conflict and a decisive military engagement. Second, the combination of airpower and mobile ground forces helps prevent opponents from retreating and regrouping. Instead of merely scattering
rebel forces during an attack, government forces are more likely to engage them, increasing the likelihood of an informative military result. Finally, combined arms militaries can deliver rapid punishment in the event of cease-fire violations, thus deterring rebel forces from reigniting conflicts. Combined-arms militaries are not necessarily more likely to win civil conflicts, but their unique features do make it more likely that a verdict will be reached rapidly.

To test this theory, we employ a new dataset containing detailed information on the military manpower, armored vehicles, tanks, and combat aircraft of states embroiled in civil conflicts. A series of survival models and logistic regressions provides evidence that military mechanization is correlated with shorter conflicts – but only when mechanized ground forces and airpower are combined. This result holds even after accounting for factors such as national wealth, external assistance, geography; and other factors that influence the duration of conflicts. Perhaps most surprisingly, the effect of combined arms remains robust even when we limit our analysis to insurgencies.

These findings help advance the study of conflict in two key ways. First, they contribute to a growing literature that seeks to understand why and when civil conflicts end (e.g., Balch-Lindsay and Enterline 2000; Hegre 2004; Cunningham 2006; Buhaug et al. 2009; Wucherpfennig et al. 2012). Understanding the duration of civil conflicts is important in part because longer conflicts tend to be much more costly. Civil conflicts kill people, destroy infrastructure and institutions, displace refugees, and suppress economic growth.¹ The destructiveness of conflicts therefore depends to a large extent on their duration. This study examines the question of duration from a military angle, emphasizing the role of weapons technology in explaining why civil conflicts end – or fail to end.

Second, this paper adds to a growing body of research about the role of military technology in international conflict. A variety of studies have recently argued that explaining the nature and outcomes of violent conflicts – both within and among states – requires that we understand the military forces and strategies employed by combatants (e.g., Biddle 2004; Hess 2003).

While there is a fair amount of agreement that mechanization is likely to yield short, sharp, and decisive interstate wars (e.g., Bennett and Stam 1996), the effect of mechanization on intrastate conflicts is less clear. Further, the debate on military mechanization has tended to emphasize the effects of military technology on the outcomes of conflicts – especially insurgencies.  

This paper adds a new dimension to the debate, demonstrating that mechanization carries important consequences for the duration of conflicts as well. By introducing the concept of combined arms into this literature, this paper demonstrates the need for continued innovation in how we conceptualize and measure force structure.

The paper proceeds in four parts. The first section discusses the impact of military mechanization and combined arms on the duration of civil conflicts. In particular, it explains combined-arms warfare and discusses how it can be employed effectively in both interstate and intrastate settings. It then derives several explicit hypotheses about the effects of mechanization and combined arms on civil conflict duration. The second section describes our data on combined arms and our empirical approach to modeling the duration of conflict. The third section presents empirical results from a series of event-history models and logistic regressions. The final section offers conclusions and discusses implications for future research.

Military Technology and Civil Conflict Duration

Explanations for the duration of civil conflicts tend to cluster into three broad groups. The first group of theories emphasizes rebel capacity for sustaining the fight and evading government attack. Factors such as material capabilities, rebel strategy, and external supporters play a central role in these explanations. Several studies, for example, have found that military capabilities (Cunningham et al. 2009; Hultquist 2013), third-party assistance (Regan 2002; Balch-Lindsay and Enterline 2000; DeRouen and Sobek 2004; Cunningham 2010),
guerrilla strategies (Balcells and Kalyvas 2012), and access to natural resources or primary commodities (Fearon 2004; Ross 2004; Lujala 2010) enable rebels to prolong civil conflicts,\(^3\) whereas measures designed to undermine combatant capacity (such as economic embargoes) tend to shorten civil wars (Escribà-Folch 2010). Along similar lines, several studies have found that rebels based in remote, rough terrain are better able to prolong conflicts (DeRouen and Sobek 2004; Buhaug et al. 2009; Bleaney and Dimico 2011).\(^4\)

A second body of research points to the role of information problems in explaining conflict duration. Like many interstate wars, civil conflicts often arise – and persist – because the combatants disagree about their relative power or resolve (Fearon 1995; Walter 2009). Information problems are particularly acute in the early stages of conflicts, when combatants are poorly informed about their opponents’ capabilities (Walter 2009). The existence of multiple factions and outside actors can exacerbate the problem, making information about combatants difficult to obtain and quickly obsolete (Cunningham 2006; Nilsson 2008). Governments face further challenges collecting information on rebel groups operating in remote regions, across borders, or within large sympathetic populations (Salehyan 2009). All of these factors make information problems difficult to ameliorate, thereby impeding the resolution of conflicts.

Third, scholars have highlighted the importance of commitment problems in explaining civil conflict duration. When the parties to a civil conflict cannot credibly commit to upholding a peace deal after it is signed, according to this view, termination will be very difficult to achieve without a decisive victory by one side (de Figueiredo, Jr. and Weingast 1999; Walter 2002). Fearon (2004) argues that settlements may be difficult to strike if a rebel group expects that the government will grow stronger over time and eventually renege on the deal. Several other scholars have observed that ethnic wars tend to be longer-lasting and more difficult to settle (e.g., Kaufmann 1996; Collier et al. 2004; Kirschner 2010; Wucherpfennig et al. 2012).

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\(^3\)Humphreys (2005), however, finds that natural resources are associated with shorter wars.  
\(^4\)For a contrary view see Rustad et al. (2008).
Mechanization and Air Power: A Prescription for Stalemate?

Together, the literature on civil conflict has painted an extensive picture of the geographic, economic, and political factors underlying civil conflict duration. The effects of military technology and force employment, however, have gone largely unexplored. This is an important theoretical and empirical gap, because conflict duration is fundamentally a military outcome: lengthy conflicts occur when both sides lack the ability to achieve a decisive military victory. It is therefore likely that military factors – hardware, technology, and doctrine – play at least some role in shaping the likelihood of conflict termination.

The nature and technology of fighting in civil conflicts differ in important ways from combat in conventional interstate wars. Whereas interstate wars tend to feature direct, force-on-force engagements whose central objective is to seize territory, civil combatants are more likely to rely on rapid hit-and-run strikes against both military and civilian targets.\(^5\) Direct military engagements, when they occur, often involve smaller numbers of troops fighting in rough terrain such as jungles or mountains. Further, civilians often play a greater role in intrastate conflicts, providing information to combatants and sometimes taking up arms themselves. While seizing or defending territory is an important goal in these conflicts, obtaining and preserving support from local populations is often even more critical.

Stalemate on the Ground

The received wisdom holds that the unique characteristics of intrastate conflicts – in which the objective is often to root out insurgents and win support from local populations – lend themselves poorly to mechanized warfare. In the United States, this view emerged shortly after the Vietnam War: observers such as Krepinevich (1986) famously argued that a key reason the war devolved into a lengthy quagmire was that the U.S. Army relied on a vehicle- and firepower-intensive doctrine that was poorly-suited for achieving decisive results against the North Vietnamese guerrillas.\(^6\) Several influential studies (e.g., Lyall and Wilson 2009; Of course, civilians are often targeted in interstate wars as well; see Downes (2008). See Caverley (2010) for a review of the debate surrounding U.S. counterinsurgency strategy in Vietnam.
Lyall 2010) have since concurred that mechanized ground forces are ill-equipped to achieve rapid, decisive victories in unconventional conflicts.\footnote{For dissenting views, see Smith and Toronto (2010) and MacDonald (2013).}

One key reason is that mechanized ground forces are poorly suited for collecting information about local allies and adversaries, especially in urban settings.\footnote{Lyall and Wilson (2009) develop this argument nicely in their article about counterinsurgency strategy.} In intrastate conflicts – and particularly counterinsurgency campaigns – recruiting informants and identifying enemy collaborators among the local population are key objectives, since enemy personnel may be disguised among local inhabitants rather than waiting in uniform on the battlefield. Non-mechanized infantry forces tend to be more integrated into the local population, since they are not protected by vehicles and depend more on local sources for food and supplies. As a result, they are better positioned to enmesh themselves into local networks and accumulate information about the enemy.

Mechanized armies, by contrast, tend to be more isolated from local populations and subject to “information starvation” (Lyall and Wilson 2009). With advanced transportation and logistics, mechanized troops depend more on external supply lines for provisions, which in turn reduces interaction with the local population. Mechanized forces also tend to be garrisoned on separate bases, furthering their estrangement. The upshot is that mechanized armies have lower levels of information about enemy locations and must therefore choose between using violence indiscriminately (and losing the support of the local population) or allowing enemy combatants to operate with relative impunity. Neither of these options is conducive to quick resolution.

At the same time, according to this argument, mechanized forces are difficult to defeat outright. Because mechanized forces require significant logistical support, they tend to be stationed away from urban areas on well-protected bases that are difficult for rebels or insurgents to destroy. While limiting contact with local populations can inhibit an army’s ability to collect information, it has the advantage of bolstering force protection by minimizing troops’ exposure to potential guerrilla attacks. Moreover, mechanized forces are highly
mobile and therefore better able to evade or escape from perilous engagements than their non-mechanized counterparts. These advantages make it difficult for rebel forces to quickly impose costs on government armies; instead, they must bleed the enemy gradually over time.

Mechanized ground armies, in short, are less likely to achieve outright victory but are also more difficult to defeat. If this logic is correct, we should observe civil conflicts involving mechanized ground armies lasting longer, on average. We therefore test the following hypothesis:

**Hypothesis 1.** *Civil conflicts involving highly mechanized government ground forces will be longer, on average, than conflicts in which a government’s ground forces are not highly mechanized.*

**Stalemate in the Air**

A related perspective suggests that militaries that rely primarily on airpower face similar challenges in bringing civil conflicts to an end. Kocher et al. (2011) and Lyall and Wilson (2009) suggest that the problems of information starvation, civilian casualties, and alienation of local populations also characterize airpower-intensive strategies. Pape (1996: 74) likewise argues that airpower is unlikely to be effective against guerrillas and rebels.\(^9\) According to this perspective, then, relying on airpower alone to combat rebels and insurgents precludes decisive outcomes by limiting the capacity of each side to defeat the other outright.\(^10\) This logic yields a second testable hypothesis about military technology and the duration of civil conflicts:

**Hypothesis 2.** *Civil conflicts involving militaries with a high proportion of combat aircraft will be longer, on average, than conflicts in which a government’s air forces are limited.*

\(^9\)Pape notes, however, that bombing may be able to assist interdiction campaigns against rebel supply lines.

\(^10\)Even the most vocal proponents of airpower in unconventional settings acknowledge the need for ground support. See, for instance, Andres et al. (2006) and Dunlap (2007, 2008), who discuss the role of airpower in support of counterinsurgency ground operations.
Mechanization and Civil Conflict: A Revised Perspective

Existing research on military technology in civil conflicts has tended to examine ground mechanization and airpower in isolation. However, this approach offers an incomplete picture of how these weapons can be used by incumbent governments to fight rebels. We argue that the interaction of a government’s airpower and mechanized ground forces – in other words, its “combined arms” capability – encourages rapid decisions in ways that each platform in isolation does not. In this section, we describe the basic components of combined arms doctrines, and explain why they tend to shorten civil conflicts.

Combined Arms in Theory and Practice

What is a combined arms doctrine? While the term can encompass a wide variety of strategic and tactical variations, central to all of them is the integrated use of airpower and ground combat vehicles to exploit enemy vulnerabilities. Mechanized ground forces and airpower each offer features that the other cannot, thus mitigating the independent limitations of each type of force when used in tandem.

Tanks, armored personnel carriers, and self-propelled artillery offer superior mobility, firepower, force protection, and the ability to seize and hold ground. Patrolling aircraft simply cannot target enemy combatants on the ground with the same scale, immediacy, and degree of precision as nearby vehicles. Aircraft also cannot take and hold territory by themselves. Aircraft, however, offer their own unique advantages: fixed-wing transports and rotary aircraft can deliver soldiers to remote areas of a country more rapidly – and more safely – than ground forces, and they can bring more firepower per vehicle to decisive points on the battlefield. Airborne assets also perform reconnaissance, communication, and command and control functions that ground units cannot. Perhaps most importantly, close air support can quickly prepare a battlefield for an armored assault by destroying large weapons and disrupting enemy positions.

\(^{11}\)An important exception is Lyall and Wilson (2009), who include the use of helicopters in their analysis of mechanization.
The doctrine of integrating aircraft and armored ground vehicles in combined operations developed over the course of World War II. At the end of the war, General Omar Bradley wrote that “the air-armor team is a most powerful combination in the breakthrough and in exploitation” (U.S. Army 1945: 61), and modern militaries have tended to follow his prescription. The U.S. Army’s famous “AirLand Battle” doctrine of the 1980s, for example, envisioned the close integration of armored ground forces and aggressive airstrikes designed to disrupt the enemy’s ability to reinforce its lines and coordinate a defensive response.\(^\text{12}\) As depicted in the U.S. Army’s doctrinal manual, AirLand Battle rested on a firm belief that “arms and services complement each other by posing a dilemma for the enemy. As he evades the effects of one weapon, arm, or service, he exposes himself to attack by another” (U.S. Army 1986: 25).

In conventional interstate wars, the integrated use of mechanized ground forces and airpower is thought to favor quick and decisive battlefield outcomes. Indeed, that is frequently the explicit objective: combined arms doctrines aggressively employ maneuverable ground and air forces in “blitzkrieg” offensives to pursue rapid knockout victories.\(^\text{13}\) Airpower and mechanized ground forces are critical to these operations, which rely foremost on speed and mobility.\(^\text{14}\) And as Stam (1996: 52) notes, maneuver strategies tend to result in wars that end quickly: decisive engagements occur early in the war, so “rapid success or failure becomes apparent.” Indeed, Bennett and Stam (1998) found that the maneuver strategies enabled by combined arms doctrines produced more rapid decisions in interstate wars – although not necessarily more favorable outcomes.

While the combined arms approach to warfare was originally designed for conventional combat at the interstate level (House 2001), it is also frequently applied in intrastate con-

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\(^{13}\)See, for instance, Mearsheimer (1983); Posen (1984); Stam (1996); Kier (1997).

\(^{14}\)While maneuver strategies typically require combined arms, however, the reverse is not necessarily true: militaries employing combined arms can, in principle, adopt other approaches. Mearsheimer (1983), for example, describes the 1939 invasion of Poland by the German Wehrmacht – one of the first militaries to use combined arms effectively on the battlefield – as a war of attrition rather than maneuver.
One obvious reason for this is that many civil wars are fought conventionally. Conflicts triggered by territorial separatist movements or intra-army fractures lend themselves to fights involving heavy and medium armor, well-trained and organized armies, and direct battlefield engagements. According to Kalyvas and Balcells (2010), roughly one-third of all civil wars since 1944 – and half of those beginning after 1990 – have been primarily conventional conflicts.

The role of combined arms in intrastate conflicts, however, has not been limited to strictly conventional wars. Indeed, they have also played an important role in several recent counterinsurgency campaigns. In the first Chechen War, for example, Russian forces employed an integrated air and ground doctrine, incorporating elements of attrition and maneuver warfare to isolate and destroy rebel forces (Toft and Zhukov 2012). After a failed initial assault on Grozny, in early 1995 the Russians reorganized their “forces into small mobile assault groups, made better use of snipers and heavy artillery, and made sure that units talked to each other and to air assets, so that mutual support was possible” (Oliker 2001: 24). The result was a brutal but rapid conquest of the Chechen capital, paving the way for a negotiated settlement that had appeared improbable at the war’s outset. When Chechen forces invaded Dagestan three years later, the Russians returned to Grozny and neighboring towns with an even more intensive combined arms approach (Johnson et al. 2008), using “massive artillery and air strikes followed by dismounted forces...artillery, tanks, surface-to-surface missiles, attack helicopters, and bombers” (Oliker 2001: 78).

**Combined Arms and Conflict Duration**

Ending a military conflict requires, at a minimum, one of two conditions: either one side must achieve a complete victory, or battlefield engagements must provide the combatants with enough information about their relative strength to allow them to agree on a deal. As

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15Even the U.S. military’s AirLand Battle doctrine, which was designed partly to discourage American politicians from engaging in unconventional conflicts like Vietnam (Crane 2002), envisioned applications in civil wars and insurgencies: according to the U.S. Army’s 1986 *Operations* manual, “the tenets of AirLand Battle doctrine apply equally to the military operations characteristic of low-intensity war” (U.S. Army 1986: 6).
long as one or both sides are overly optimistic about their chances – a condition contributing
to the outbreak of many conflicts in the first place – it may be impossible to find a mutually-
acceptable settlement (Fearon 1995; Walter 2009). This observation implies that factors
that favor large-scale, decisive engagements early in a conflict will tend to be associated with
shorter conflicts. Early engagements maximize the chances of a decisive victory and allow the
combatants to quickly learn about the capabilities of the other side (Ramsay 2008; Weisiger
2013). Both factors favor more rapid conflict termination. By contrast, conflicts involving
small, scattered skirmishes with irregular fighters will last longer because they carry less
information.

Combined arms doctrines help achieve decisive early engagements in two key ways. First,
the enhanced mobility of a mechanized army enables it to attack distant enemy strongholds
quickly, thereby reducing the chances that rebels in remote locations will be able to draw
out a conflict simply because they are difficult to reach. Conflicts featuring mechanized
government forces therefore are less likely to feature long periods of low-intensity fighting,
since government forces are better able to locate and strike the enemy. The integration
of airpower with ground forces also enables incumbent forces to supply operating bases in
enemy territory, further bolstering its ability to press the fight (Read 2010). In Colombia,
for example, FARC insurgents have been able to successfully coordinate insurgency activities
since the 1960s in part because their location – largely in remote, rural areas – has insulated
them from attacks by the poorly-equipped Colombian military.

Second, combined arms strategies help prevent rebels from retreating and prolonging
conflicts. The combined employment of tanks, armored vehicles, helicopters, and close-air
support enables rapid strikes against elusive rebel targets that might otherwise scatter or
retreat. Airpower is an essential component here, working in tandem with motorized ground
forces to help incumbent governments flush out, surround, and contain enemy forces (Biddle

\textsuperscript{16}Note, however, that information is not always a sufficient condition for conflict termination. As
Fearon (2004: 290) observes, “after a few years of war, fighters on both sides of an insurgency
typically develop accurate understandings of the other side’s capabilities, tactics, and resolve.”
Even with complete information, he argues, commitment problems can still preclude peaceful settlements.
See also Fearon (1995) and Powell (2012).
In Algeria during the 1950s, for example, France employed more than 800 fixed wing aircraft alongside a well-equipped General Reserve of parachutists and mobile Foreign Legion forces to attack enemy concentrations before they could disperse (Alexander and Keiger 2002; Griffin 2010).

By contrast, when used in isolation, airpower and mechanized ground forces are unlikely to produce these same effects. Airpower alone can rapidly deliver firepower to targets, but because aircraft cannot take and hold territory, air operations without ground support carry a greater risk of allowing the enemy to scatter and retreat (Corum and Johnson 2003: 425-8). Mechanized ground forces, for their part, can more effectively cut off enemy lines of retreat, but they cannot reach the battlefield as quickly, nor do they benefit from the degree of real-time intelligence and reconnaissance that airpower offers.

**Combined Arms in Civil Conflicts: Illustrations**

Combined arms strategies have been used in a variety of civil conflicts during the last half-century. Below we discuss four cases that illustrate the effects of combined arms in civil conflicts. In the first case (Yemen), government forces employed a combined-arms doctrine from the beginning and brought the conflict to a rapid conclusion. The second case (Nigeria) offers a contrasting example of a military that failed to adopt a combined-arms strategy and consequently fought a longer war than necessary. The final two cases (Sri Lanka and Chad) illustrate how the adoption of a combined arms doctrine in the midst of a conflict can help bring about an end to the fighting.

**Yemen, 1994**

The Republic of Yemen was only four years old when the southern portion broke away to declare the Democratic Republic of Yemen in 1994. Unionist forces counterattacked quickly, employing an aged but relatively mechanized force of roughly 80 aircraft, 1,500 tanks and armored vehicles, and 40,000 ground troops. The government’s campaign began on May 4, 1994 with a four-column offensive. The widely-dispersed columns quickly cut the southern
territory in half, and then converged on Aden from three directions. After a two-week siege of the city, Aden fell on July 7 (Ayalon and Maddy-Weitzman 1994).

The Yemen episode illustrates how the use of combined arms can yield rapid and decisive results in a civil conflict fought with conventional weapons and tactics. The mobility of northern forces was critical in enabling government troops to seize territory, maintain long supply lines, and force decisive engagements during the first weeks of the war (Kostiner 1996: 80–81). Indeed, the war lasted just two months, an outcome that would have been unthinkable if the government had lacked the ability to quickly press the fight against rebel forces. In this case, however, the combination of air and ground forces allowed the Yemeni government to quickly defeat the rebels, bringing the conflict to a swift conclusion.

Nigeria, 1967–70

Unlike Yemen in 1994, the Nigerian military found itself ill-equipped to suppress a rebellion when the region of Biafra broke away in June, 1967. At the outset of the conflict, Nigerian forces had no working combat aircraft, tanks, or heavy artillery. As a result, the Federal government was slow to react to Biafra’s declaration of independence, and the military missed key opportunities to put an early end to the conflict. After a surprise rebel strike into Nigeria’s midwest in August 1967, the Biafran army found itself overextended and in hostile territory. If the Nigerian army had been more mobile, according to one general, it could have ended the war then and there simply by cutting Biafran supply lines and surrounding enemy units (Obasanjo 1980). Instead, Biafran troops were able to outrun Nigerian forces and regroup.

Recognizing this deficiency, within a few months the Nigerian military obtained a few Soviet MiG fighters and Czech Delfin light attack planes. These were joined by IL-28 bombers in early 1968 (Brown 1968: 25–26). However, these aircraft were rarely employed in tandem with ground forces as close air support; instead, they were used to bombard key occupied towns in advance of ground offensives (Barua 2013: 19). But much like Western front combatants in World War I, Biafran citizens and troops learned to anticipate these assaults
due to the large artillery and air barrages that preceded them (de St. Jorre 1972: 279). Furthermore, the Federal air wing engaged in indiscriminate bombing and strafing of civilian targets, often with large numbers of civilian casualties. In this sense, the use of airpower alone may have prolonged the war: although it was soon apparent that the numerically-superior Federal military would eventually defeat Biafran forces, Biafrans were encouraged to fight on by fears that the Nigerian military was planning a genocide.\footnote{Lake and Rothchild (1996), de Figueiredo, Jr. and Weingast (1999), Fearon (2004), and others discuss how fears of genocide can create commitment problems that prolong military conflicts.}

Lacking the hardware and doctrine necessary to employ combined arms, Nigerian operations during the conflict were the antithesis of rapid and decisive. Ground vehicles played little role in combat and were kept well behind the front lines (Samuels 1969: 19; de St. Jorre 1972: 279). One observer describes Federal operations during the war as featuring “slow, cautious probes, and long distance bombardments of doubtful object with doubtful accuracy,” punctuated by “aimless and wasteful shooting” (Cervenka 1971: 51). Furthermore, the army’s poor logistics and lack of mobility hindered its resupply operations, causing delays of several months between major engagements. The result was a “plodding war of attrition” (Stafford 1984). After two years of stalemate, however, the Nigerian military gradually surrounded Biafran territory, ultimately imposing a blockade that cut off Biafra almost entirely from the world and caused widespread famine. Biafra capitulated in January 1970.

Although the conflict ended decisively, Nigeria’s inability to employ integrated air/ground operations weakened its ability to end the war quickly. In the early stages of the war, Nigerian forces were too immobile to exploit rebel vulnerabilities, and the military did not mount its first offensive until several months after the war began. Even after Nigeria began to acquire mechanized equipment, its failure to integrate air and ground operations allowed the outnumbered Biafrans to contain Nigerian forces until they were overwhelmed by sheer numbers.

In the early 1980s, the Liberation Tigers of Tamil Eelam (LTTE) launched an insurgency campaign against the Sri Lankan government, seeking autonomy for the nation’s ethnic Tamils. From the beginning, the government had difficulty quelling the insurgency, in part due to Indian support of the LTTE rebels. Using assassinations, suicide attacks, and other terrorist tactics, the LTTE seized more than 15,000 square kilometers of territory (nearly a quarter of the country), while the government resorted to massacres and attacks against civilians in largely unsuccessful efforts to dislodge the LTTE.

After decades of bloody but ineffective operations, in 2006 Sri Lanka’s military adopted a new doctrine that envisioned small units of commandos coordinating closely with air platforms to launch surprise lightning raids far inside enemy territory, dividing enemy units and destroying them before they could retreat (Seneviratne 2008; Amarasinghe and Khandawaarachchi 2009; Hashim 2013: 138). The strategy achieved immediate and decisive results. Using helicopters and fixed-wing fighters such as the MiG-27, the Sri Lankan military carried out more than 20,000 sorties in support of ground offensives between 2006 and 2009 (Reddy 2009). The result was a crushing defeat for the LTTE. While the LTTE’s demise was due to a variety of factors – including the loss of international supporters as well as the Sri Lankan navy’s campaign against its seaborne supply routes18 – the Sri Lankan military’s effective use of combined arms played a key role in bringing the 26-year conflict to an abrupt and unexpected end.

Chad, 2005–10

In 2005, aided by the Sudanese government, rebel groups in eastern Chad mounted a rebellion against Chadian president Idriss Déby. In April 2006, more than 1,000 rebels drove from bases in Darfur, Sudan across the desert to the Chadian capital, N’Djamena, and attempted to overthrow the government. Although Chadian forces repulsed the attack, the brazenness of the assault motivated Déby to embark on a major military modernization program.

18See Smith (2010).
Over the next few years, as the rebellion continued, Chad imported Mi-24 combat helicopters, Su-25 “Frogfoot” fixed wing aircraft, and more than 150 armored ground vehicles. In addition, Chad received considerable amounts of training from the French and U.S. militaries, both highly capable practitioners of combined arms warfare (Wezeman 2009; Hansen 2013: 4). On a global scale, Chad remained one of the least mechanized armies in the world, but these acquisitions nevertheless represented a major upgrade for a military whose equipment was described by one observer as “sparse, old and barely serviceable” (Seibert 2007: 15).

In May 2009, one year after a second failed rebel assault on N’Djamena, the Chadian army launched a counterattack against a pair of towns held by the Union of Resistance Forces (UFR), an umbrella rebel group. Accompanied by air support from 4 Su-25 fighters and 5 Mi-24 helicopters, flanking columns of armor and soldiers quickly took the towns. The small air component played a pivotal role in the offensive, demonstrating that the revamped Chadian army now had the ability to project power against rebel strongholds inside Sudan’s territory – an ability it had not previously possessed (Feichtinger and Hainzl 2011; Wezeman 2009). The offensive seemingly persuaded Sudanese leaders to sue for peace, and Sudan and Chad reached an agreement in 2010 to terminate hostilities, reopen their shared border, and establish a joint force to monitor rebel activity (International Crisis Group 2009, 2010).

**Conflict Duration Versus Outcomes**

As these examples suggest, militaries with extensive combined arms capabilities are likely to fight shorter civil conflicts. However, this logic does not necessarily imply that combined arms militaries are more likely to *win* these conflicts. Maneuver strategies are quick and decisive, but risky. They require extensive training and close coordination between air and ground forces, and can fail if not employed correctly (Stam 1996). While the vignettes discussed above describe mostly incumbent victories, counterexamples also abound. Georgia, for example – which boasted the world’s highest combined arms score from 1991–93, by our measure – employed a mechanized strategy to regain control over Abkhazia in 1992.
Although the war lasted just one year, it ended in defeat for Georgia. Brevity and victory do not necessarily go hand in hand.

To sum up, combined arms operations do not necessarily enhance a government’s chances of prevailing in a civil conflict. However, combined arms do increase the likelihood of decisive engagements early in the war by enabling government forces to reach areas of rebel activity more quickly and easily. Information asymmetries narrow more rapidly as a consequence, and conflicts become more likely to end.

The hypothesis that follows from this logic therefore is:

**Hypothesis 3.** Civil conflicts involving government military forces with both a high degree of airpower and ground force mechanization will be shorter, on average, than conflicts in which government forces lack these capabilities.

### Data and Research Design

Our analysis utilizes an adapted version of the UCDP/PRIO Armed Conflicts Dataset, v. 3–3005 (Gleditsch et al. 2002).\(^{19}\) The unit of analysis in this dataset is the conflict-year. The dependent variable in the analysis is the duration of intrastate conflict, measured in days. According to the UCDP coding rules, conflicts are included in the dataset if they reach twenty-five deaths in a single year.\(^{20}\) The data set overall contains 147 unique intrastate conflicts (excluding coups), all of which began between 1967 and 2003.\(^{21}\) The duration of these conflicts ranges from a low of one day (three conflicts) to a maximum of 9,380 days, with a mean duration of 1,710 days.

The UCDP dataset employs a low casualty threshold, requiring that conflicts inflict just twenty-five battle fatality per year to be included in the data set. If our argument is correct, combined arms militaries can result in very brief conflicts, often ending before they escalate.

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\(^{19}\)These data have been adapted for duration analysis by Gates and Strand (2004); we obtained these data from Buhaug et al. (2009).

\(^{20}\)Following Buhaug et al. (2009: 556), we consolidated conflicts involving the same actors and locations into a single conflict, so long as they were not separated by more than two years of inactivity.

\(^{21}\)Conflicts ongoing in 2003 are right-censored.
to drawn-out wars. A higher fatality threshold (say, 1,000) would risk excluding many of the briefest conflicts, thereby preventing us from observing the full effect of combined arms doctrines. For this reason, a low fatality threshold is more appropriate.\textsuperscript{22}

\textbf{Measuring Mechanization and Combined Arms}

The explanatory variable of greatest interest to this study is the use of combined arms by government militaries. As we discuss below, we measure combined arms by evaluating the possession of \textit{hardware} (armored vehicles and aircraft) rather than examining each military’s fighting \textit{doctrine} in each conflict. In other words, our method measures incumbent governments’ abilities to employ combined-arms doctrines, but not their actual behavior. While there is precedent for using a military’s material capabilities as a proxy for doctrine\textsuperscript{23}, we nevertheless acknowledge that our hardware-based measurement is likely to be an imperfect proxy. We choose this route because directly coding an incumbent state’s doctrine is not only highly subjective, but also can be done only after the war has concluded, introducing the risk of retrospective bias. Moreover, there are significant barriers to acquiring data on the battlefield employment of forces, particularly in smaller conflicts from decades past. Sources for many such conflicts are likely to be scarce, incomplete, and unreliable, casting doubt on the utility of such an effort. As a result, we utilize data on military capabilities rather than actual force employment.

Measuring the degree to which a military can employ a combined arms doctrine requires data on the doctrine’s two material requirements: mechanized air and ground forces. First, we obtained data on ground mechanization from Sechser and Saunders’ (2010) \textit{National Mechanization Index}. Their index reports the number or armored vehicles per 100 soldiers for most countries, using information contained in the International Institute for Strategic

\textsuperscript{22}This lower fatality threshold is standard practice in studies of civil conflict; see, for example, Nilsson (2008, 2010); Buhag and Gleditsch (2008); Buhag et al. (2009); Østby et al. (2009); Cunningham et al. (2009); Cunningham (2010).

\textsuperscript{23}For example, in their statistical analysis of strategy choice, Reiter and Meek (1999: 374–5) code maneuver strategies based on the presence of “maneuver arms and air mobility,” inferring that a high proportion of both implies an offensively-oriented doctrine.
Studies’ *Military Balance* series of publications. The variable GROUND MECHANIZATION is calculated by dividing an army’s number of motorized vehicles (including main battle tanks, heavy armored combat vehicles, armored personnel carriers, and infantry fighting vehicles) by the number of ground soldiers, and then calculating the natural logarithm of the resulting figure.

Second, we measured air force mechanization by collecting annual data—again from *The Military Balance*—on each country’s holdings of combat aircraft. Our measure includes fixed-wing fighters, bombers, and command and control planes, as well as helicopters of all types. The variable AIRCRAFT MECHANIZATION represents the natural logarithm of a country’s ratio of combat aircraft to soldiers.

As Figure 1 illustrates, there is a distinct positive correlation between air and ground mechanization ($r = 0.52$). Countries that have large proportions of armored ground vehicles are also likely to have large numbers of combat aircraft. Yet this correlation is far from perfect: a simple linear regression of AIRCRAFT MECHANIZATION against GROUND MECHANIZATION reveals several significant outliers. Croatia and Thailand, for instance, exhibited high levels of aircraft mechanization but relatively middling levels of ground mechanization, whereas Yemen and Angola possessed disproportionately more armored ground vehicles than aircraft.

One immediate observation is that countries experiencing civil conflicts tend to lie toward the bottom of the mechanization scale, compared to the rest of the world. Sechser and Saunders (2010) found that the average mechanization rate worldwide between 1979–2001

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24 The data collected by Sechser and Saunders (2010) contains ground mechanization information for all odd-numbered years from 1979–2001. Using the same sources and procedures, we extended the dataset’s temporal range and collected data for the even-numbered years during the period covered by Sechser and Saunders, resulting in a dataset of annual ground mechanization rates for most countries between 1967 and 2003.

25 Note that vehicles belonging to marine or naval infantry units are included in the count of armored vehicles. We follow Sechser and Saunders (2010) in excluding personnel and vehicles belonging to strategic nuclear forces, paramilitary forces, domestic police forces, and reserves from these measurements, since these forces are not consistently tracked from year to year by *The Military Balance*.

26 In such a regression, $\beta = 0.513$, with a standard error of 0.033. The predicted values in Figure 1 were derived from this regression.
translated to just over 2 armored vehicles per 100 soldiers. In our dataset, however, the mean value of GROUND MECHANIZATION during the same period translates to less than 0.7 vehicles per 100 soldiers. Indeed, Sechser and Saunders (2010) find that military mechanization is strongly associated with economic wealth; given that conflicts are much more common in poorer countries (e.g., Fearon and Laitin 2003), then, it is perhaps not surprising that these countries exhibit lower levels of mechanization when compared to their less conflict-prone counterparts.

The central explanatory variable in the analysis below is COMBINED ARMS. This variable is calculated by interacting GROUND MECHANIZATION with AIRCRAFT MECHANIZATION. The resulting variable ranges from a value of 8.2 (Myanmar, 1991–94) to 60.3 (Georgia, 1991–93), with a mean of 29.1 and median value of 27.0. This variable provides the central test of the hypotheses outlined in the previous sections: on one hand, our theory expects

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**Figure 1.** Mechanization rates of civil conflict incumbents, 1967–2003.
that aircraft and ground mechanization *in isolation* lengthen conflict duration; on the other hand, it also expects that the *interaction* of these two types of mechanization – COMBINED ARMS – leads to shorter conflicts.\(^{27}\)

As Table 1 demonstrates, incumbent states vary widely in their combined arms capabilities. States with (comparatively) high combined arms capabilities include major powers (Great Britain and Russia), former Soviet republics (Georgia and Uzbekistan), and Eastern European states (Romania, Yugoslavia, and several former Yugoslav countries).\(^{28}\) States in the Middle East and North Africa also tend to rank highly, with Saudi Arabia, Algeria, Yemen, Egypt, and even Mali appearing toward the top of the list. Conversely, states in Sub-Saharan Africa and Southeast Asia tend to have a smaller combined arms capability: Eritrea, Uganda, Myanmar, Cambodia, Chad, and Indonesia all have manpower-dominated militaries with few armored vehicles and combat aircraft.

Our analysis in this study focuses on the duration of civil conflicts from the incumbent’s perspective, rather than the duration of third-party interventions. A consistent finding from the empirical literature is that interventions into civil wars – on either side – tend to prolong them (Regan 2002; Balch-Lindsay et al. 2008; Cunningham 2010). However, external interveners generally devote only a portion of their forces to far-flung interventions. By contrast, incumbent governments have stronger incentives to throw the full weight of their military capabilities against incipient rebellions. Since our measurement of combined arms is based on observed holdings, our index is likely to more accurately represent the military strategies of incumbents rather than interveners. We therefore focus on the capabilities of incumbent states rather than third-party interveners. Measuring and assessing the nature of interveners’ military forces, however, will be a crucial task for future research.

\(^{27}\)The combined metric therefore captures the “force multiplier” effect theorized in counterinsurgency literature (Petraeus and Amos 2006).

\(^{28}\)It is worth recalling that this list includes only civil conflict combatants, and thus excludes many states with highly sophisticated combined-arms militaries – such as the United States and most of its NATO allies. We therefore use the phrase “high combined arms capability” only in a relative sense, in comparison to other incumbents.
<table>
<thead>
<tr>
<th>Country</th>
<th>Period</th>
<th>Arms Score</th>
<th>Country</th>
<th>Period</th>
<th>Arms Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georgia</td>
<td>1991–93</td>
<td>60.3</td>
<td>Côte d’Ivoire</td>
<td>2002–03</td>
<td>29.6</td>
</tr>
<tr>
<td>Russia</td>
<td>1993–96</td>
<td>54.2</td>
<td>Philippines</td>
<td>1994–2003</td>
<td>29.1</td>
</tr>
<tr>
<td>Soviet Union</td>
<td>1990–91</td>
<td>51.9</td>
<td>Ghana</td>
<td>1982</td>
<td>29.1</td>
</tr>
<tr>
<td>Yemen (South)</td>
<td>1986</td>
<td>49.5</td>
<td>Pakistan</td>
<td>1990</td>
<td>28.6</td>
</tr>
<tr>
<td>South Africa</td>
<td>1981–88</td>
<td>48.8</td>
<td>Pakistan</td>
<td>1995–96</td>
<td>27.8</td>
</tr>
<tr>
<td>Togo</td>
<td>1991</td>
<td>46.9</td>
<td>Guinea-Bissau</td>
<td>1998–99</td>
<td>27.4</td>
</tr>
<tr>
<td>Romania</td>
<td>1989</td>
<td>45.4</td>
<td>Spain</td>
<td>1980–81</td>
<td>27.4</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>2000</td>
<td>44.8</td>
<td>Burundi</td>
<td>1991–2003</td>
<td>27.0</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>1979</td>
<td>44.6</td>
<td>Nicaragua</td>
<td>1978–79</td>
<td>26.9</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>1991</td>
<td>44.4</td>
<td>Tunisia</td>
<td>1980</td>
<td>26.8</td>
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<tr>
<td>Yemen</td>
<td>1994</td>
<td>44.3</td>
<td>Malaysia</td>
<td>1981</td>
<td>26.8</td>
</tr>
<tr>
<td>Mali</td>
<td>1990</td>
<td>44.0</td>
<td>Pakistan</td>
<td>1974–77</td>
<td>26.6</td>
</tr>
<tr>
<td>Croatia</td>
<td>1992–95</td>
<td>43.2</td>
<td>Somalia</td>
<td>1981–96</td>
<td>26.4</td>
</tr>
<tr>
<td>Algeria</td>
<td>1991–2003</td>
<td>43.2</td>
<td>Yemen</td>
<td>1980–82</td>
<td>26.1</td>
</tr>
<tr>
<td>Congo</td>
<td>1997–99</td>
<td>41.3</td>
<td>Mexico</td>
<td>1996</td>
<td>26.0</td>
</tr>
<tr>
<td>Thailand</td>
<td>1974–82</td>
<td>40.4</td>
<td>Mexico</td>
<td>1994</td>
<td>25.8</td>
</tr>
<tr>
<td>Syria</td>
<td>1979–82</td>
<td>40.4</td>
<td>India</td>
<td>1978–2003</td>
<td>25.2</td>
</tr>
<tr>
<td>Congo</td>
<td>1993–94</td>
<td>39.7</td>
<td>Malaysia</td>
<td>1974–75</td>
<td>24.1</td>
</tr>
<tr>
<td>Iraq</td>
<td>1973–96</td>
<td>37.9</td>
<td>Nicaragua</td>
<td>1981–89</td>
<td>23.7</td>
</tr>
<tr>
<td>Congo</td>
<td>2002</td>
<td>37.6</td>
<td>Rwanda</td>
<td>1990–94</td>
<td>23.3</td>
</tr>
<tr>
<td>El Salvador</td>
<td>1979–91</td>
<td>37.3</td>
<td>Argentina</td>
<td>1973–77</td>
<td>22.8</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>1992–95</td>
<td>36.8</td>
<td>Indonesia</td>
<td>1990–92</td>
<td>22.6</td>
</tr>
<tr>
<td>Peru</td>
<td>1982–99</td>
<td>36.2</td>
<td>Laos</td>
<td>1989–90</td>
<td>22.1</td>
</tr>
<tr>
<td>Spain</td>
<td>1991–92</td>
<td>35.1</td>
<td>Pakistan</td>
<td>1971</td>
<td>22.0</td>
</tr>
<tr>
<td>Lebanon</td>
<td>1975–90</td>
<td>34.3</td>
<td>India</td>
<td>1967–72</td>
<td>20.4</td>
</tr>
<tr>
<td>Guinea</td>
<td>2000–01</td>
<td>33.1</td>
<td>Indonesia</td>
<td>1976–78</td>
<td>18.2</td>
</tr>
<tr>
<td>Iran</td>
<td>1979–93</td>
<td>33.0</td>
<td>Chad</td>
<td>1997–2002</td>
<td>17.2</td>
</tr>
<tr>
<td>Spain</td>
<td>1987</td>
<td>31.3</td>
<td>Cambodia</td>
<td>1978–98</td>
<td>14.5</td>
</tr>
<tr>
<td>Uganda</td>
<td>1972</td>
<td>29.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1.** Average combined arms scores of civil war incumbents, 1967–2003.
Control Variables

We include several additional variables that may be relevant to the duration of civil conflicts (as well as our combined arms independent variable). First, we include several measures of a conflict’s geographic proximity to the incumbent’s capital. Buhaug et al. (2009) show that conflicts located in a country’s periphery are likely to last longer than wars fought near capital cities. The variable DISTANCE TO CAPITAL measures the natural logarithm of the distance (in kilometers) between the state’s capital and the conflict zone (Buhaug and Gates 2002; Buhaug et al. 2009). In addition, the variable CONFLICT AT BORDER denotes conflicts fought along international boundary lines (Buhaug et al. 2009), reflecting the possibility that rebel groups fighting along borders may have better access to supplies, cross-border havens, and other assets that could lengthen conflicts (e.g., Gleditsch 2007; Salehyan 2008). We also include the interaction term BORDER $\times$ DISTANCE to account for the potential moderating effects of border conflicts on distance.

Second, although the primary hypotheses of this article address the military capacity of incumbent governments, the material capacity of rebel groups may also impact war duration. Specifically, Buhaug et al. (2009), Wucherpfennig et al. (2012), and others have shown that conflicts involving more powerful rebel groups tend to be shorter, on average. We draw data on rebel strength from Cunningham et al. (2009) to create REBEL FIGHTING CAPACITY, which codes rebel groups as “weak,” “moderate,” or “strong.”29 Further, we create a second variable, REBELS’ RELATIVE STRENGTH, which accounts for the comparative strength of rebel forces versus those of the government. This variable is coded 1 if Cunningham et al. (2009) code the rebel group as stronger than government forces, and 0 otherwise.

Third, there is some evidence that the presence of lootable resources such as diamonds and gemstones, illicit drugs, and (to a lesser extent) petroleum contribute to longer conflicts both by providing income for rebel groups to sustain the fight and by reducing the incentives

29The data provided by Cunningham et al. (2009) code the strength of each rebel group. To adapt these data to our conflict-based data set, we therefore follow Buhaug et al. (2009) in using the value for the strongest group in each conflict to code REBEL FIGHTING CAPACITY.
for contraband-fueled rebel groups to settle (e.g., Fearon 2004; Ross 2004; Lujala 2010). The variable LOOTABLE RESOURCES denotes conflicts in which one or more of these resources was present in the conflict zone.\textsuperscript{30}

Fourth, terrain may create favorable conditions for insurgencies by inhibiting government military operations and providing safe locations for rebels to hide. Both may contribute to longer civil conflicts (Fearon and Laitin 2003). We include ROUGH TERRAIN in the analyses below to assess the effect of mountainous and forested terrain on conflict duration. This dichotomous variable is coded 1 if the conflict zone in question was covered by either 60% mountainous terrain or 60% forested terrain.\textsuperscript{31}

Fifth, it could be the case that democracies have a lower tolerance for casualties (Caverley 2010) and therefore may be less willing to sustain a lengthy, costly battle against a rebel group. We employ the Scalar Index of Polities (SIP) (Gates et al. 2006), which contains a measure of regime type on a scale of 0 to 1. The resulting variable is INCUMBENT DEMOCRACY. Although the Polity data set (Jaggers and Gurr 1995) is often used to generate measurements of regime type, several scholars have pointed out that Polity incorporates the existence of civil wars in its measure, thereby creating an endogeneity problem for studies using them to study civil conflict (Gates et al. 2006; Vreeland 2008). The SIP data are preferable because they do not suffer from this problem.

Sixth, scholars have argued that wealthier governments tend to fight shorter conflicts (e.g., Balcells and Kalyvas 2012). GDP per capita therefore is an obvious control to include, representing a state’s material capacity to prosecute a conflict. GDP has also been identified as a key predictor of military mechanization, since wealthier states can afford to build more capital-intensive militaries (Sechser and Saunders 2010). We include the logged value of each state’s GDP at the onset of the conflict.

Seventh, we account for external assistance from third-party governments to the incumbent government and rebels. Using data from Cunningham et al. (2009), we include

\textsuperscript{30}We obtained geo-referenced data on oil and gas deposits from the PETRODATA dataset (Lujala et al. 2007); gemstone mining data from the GEMDATA and DIADATA datasets (Lujala 2009; Gilmore et al. 2005); and data on drug cultivation from the DRUGDATA dataset (Buhaug and Lujala 2005).

\textsuperscript{31}Terrain data were obtained from Buhaug et al. (2009).
dichotomous variables for both: EXTERNAL SUPPORT: REBELS and EXTERNAL SUPPORT: GOVERNMENT.

Eighth, the Cold War era saw both high levels of rebel support from the superpowers and arms transfers to client states (Kalyvas and Balcells 2010). Both activities could impact the duration of civil conflicts fought during this period. We therefore include the dichotomous variable POST-COLD WAR to denote conflicts fought in 1989 or later.

Finally, a number of scholars have noted that insurgencies and irregular conflicts tend to be longer-lived than other types of civil conflicts (e.g., Fearon 2004; Johnston and Urlacher 2010; Balcells and Kalyvas 2012). We therefore draw from Lyall and Wilson’s (2009) dataset of insurgencies to code the dichotomous variable INSURGENCY.

**Estimation Techniques**

We employ two approaches to estimating the effect of combined arms on conflict duration. First, we utilize Weibull accelerated failure-time regressions in which combined arms is a central independent variable; second, we estimate a series of logistic regressions with time-dependence controls. Both are standard approaches to assessing the duration of civil conflict.\(^{32}\) Because countries in the UCDP data can experience multiple conflicts at the same time, all of our regressions employ robust standard errors clustered on country.

**Results**

Table 2 presents the results of a battery of Weibull hazard models designed to estimate the effect of mechanization and combined arms on conflict duration.\(^{33}\) Interpretation of these results is straightforward: factors with negative coefficients shorten the duration of civil wars, whereas positive coefficients denote factors that lengthen conflicts. Model 1 includes

\(^{32}\)For example, the Weibull technique is used by Fearon (2004); Gates and Strand (2004); Buhaug et al. (2009); Balcells and Kalyvas (2012). Logistic regressions have been used by DeRouen and Sobek (2004); Cunningham (2006); Escribá-Folch (2010), among others.

\(^{33}\)To check the robustness of these findings, we re-estimated the models in Table 2 using a Cox proportional hazards model, a semi-parametric model which uses less restrictive assumptions than the Weibull model. The results were virtually identical.
only measures of military technology. Models 2–8 gradually incorporate different sets of control variables. Model 9 includes mechanization, combined arms, and the full range of control variables simultaneously. Model 10 employs a rescaled version of the three military technology variables, in which the variables have been standardized on a scale of 0 to 10 to minimize the possibility that differences in scaling might skew the interaction between air and ground mechanization scores.

First, we evaluate Hypotheses 1 and 2, which suggest that army mechanization and airpower – when employed independently – lengthen the duration of civil conflicts by both shielding and handicapping government forces, thus preventing either side from achieving decisive victory. The primary test of these hypotheses is provided by the GROUND MECHANIZATION and AIRCRAFT MECHANIZATION variables, which measure the effect of each type of mechanized force when the other is absent. In all eight regressions, both variables are positive and significant at the 90% level or above, suggesting that states with either highly mechanized ground armies or comparatively large air forces – but not both – tend to fight longer conflicts. These findings offer strong confirmation for Lyall and Wilson (2009) and others who have pointed out the drawbacks of military mechanization in intrastate conflicts.

Matters change, however, when we evaluate the interactive effect of ground and air mechanization. Hypothesis 3 argues that even if these two types of mechanization prolong conflicts when employed independently, their simultaneous use can have the opposite effect. This hypothesis expects that states employing combined arms should fight shorter conflicts, on average, than those employing just one form of mechanized force. The regressions in Table 2 provide consistent support for this view: in each of the eight models, the coefficient for COMBINED ARMS is negative and statistically significant at the 95% level or above, indicating that the use of armored ground vehicles in tandem with airpower may be able to reverse the independent effects of each type of mechanization.

As a robustness check of these results, Table 3 presents a series of logistic regressions with conflict termination as the dependent variable. The regressions are specified identically to those in Table 2, with the exception that three time-dependence variables are included
<table>
<thead>
<tr>
<th>Ground Mechanization</th>
<th>Aircraft Mechanization</th>
<th>Combined Arms</th>
<th>Distance to Capital</th>
<th>Conflict at Border</th>
<th>Border x Distance</th>
<th>Rebel Fighting Capacity</th>
<th>Rebels’ Relative Strength</th>
<th>Natural Resources</th>
<th>Rough Terrain</th>
<th>Incumbent Democracy</th>
<th>GDP per Capita</th>
<th>External Support: Rebels</th>
<th>External Support: Government</th>
<th>Insurgency</th>
<th>Post-Cold War Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.080**</td>
<td>1.342***</td>
<td>-0.250***</td>
<td>0.537***</td>
<td>0.954**</td>
<td>-0.594***</td>
<td>-0.120</td>
<td>-0.336</td>
<td>0.667*</td>
<td>0.573*</td>
<td>0.472</td>
<td>-0.361†</td>
<td>0.150</td>
<td>-0.173</td>
<td>0.738*</td>
<td>-0.397</td>
</tr>
<tr>
<td>(0.337)</td>
<td>(0.380)</td>
<td>(0.063)</td>
<td>(0.151)</td>
<td>(0.334)</td>
<td>(0.168)</td>
<td>(0.549)</td>
<td>(0.779)</td>
<td>(0.305)</td>
<td>(0.277)</td>
<td>(0.503)</td>
<td>(0.208)</td>
<td>(0.284)</td>
<td>(0.359)</td>
<td>(0.327)</td>
<td>(0.427)</td>
</tr>
</tbody>
</table>

| Number of Conflicts | 129                   | 129           | 119                 | 129               | 122              | 129                     | 129                    | 129               | 122          | 129             | 129          | 129                | 129                    | 129         | 122              |
|                     | (1.845)               | (1.886)       | (1.907)             | (2.418)           | (1.887)          | (2.105)                | (1.792)                | (2.302)           | (3.335)      | (2.714)        | (2.714)      | (2.714)             | (2.714)                | (2.714)   | (2.714)          |
|                     | (678)                 | (678)         | (662)               | (678)             | (633)            | (676)                  | (678)                 | (664)             | (603)        | (603)          | (603)        | (603)              | (603)                | (603)    | (603)            |

Note: Robust standard errors in parentheses. † p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

in the models to control for duration.\textsuperscript{34} The substantive results are consistent with those in Table 2: while independent measures of mechanization are associated with longer conflicts, the combination of ground and air mechanization is associated with a higher likelihood of conflict termination.\textsuperscript{35}

To illustrate the substantive impact of combined arms, Figure 2 plots three-dimensional surface of the predicted probability that a civil conflict will terminate in a given year, as the three mechanization variables vary.\textsuperscript{36} At low values of air mechanization, increases in ground mechanization reduce the probability of civil conflict ending. Likewise, when an incumbent possesses few mechanized ground forces, adding aircraft makes it less likely that a conflict will end.

However, the curve also illustrates the importance of using mechanized ground forces in tandem with airpower, rather than in isolation. At high levels of each mechanization variable, increases in the other mechanization score are associated with a higher probability that a conflict will end. This supports the combined-arms hypothesis: the effect of adding aircraft to a state’s military portfolio depends on whether the state possesses other types of mechanized forces. If not, the state will depend solely on aircraft, leading to longer conflicts. However, if aircraft are combined with highly mechanized ground forces, the state will be better positioned to force a rapid decision on the battlefield. The upshot is that combined arms doctrines lead to shorter civil conflicts, whereas unevenly mechanized forces lengthen them.

The analysis yields several other interesting results as well. Consistent with the findings of Rustad et al. (2008) and Buhaug et al. (2009), distance exerts a strong effect on conflict duration. Conflicts fought far from a nation’s capital, as well as those fought along

\textsuperscript{34}Specifically, the variable \textit{TIME} measures the number of days a conflict has been ongoing at the time of observation. The variables \textit{TIME}^2 and \textit{TIME}^3 were then included as well; see Carter and Signorino (2010) for a discussion of this method. Note that coefficients for these variables are not reported in Table 3, given their lack of theoretical importance.

\textsuperscript{35}Note that the substantive interpretation of logit coefficients in Table 3 is opposite that of Table 2: negative coefficients in Table 3 signify factors that reduce the likelihood of war termination, whereas positive coefficients indicate factors associated with shorter conflicts.

\textsuperscript{36}This figure was generated using coefficient estimates from Model 11 in Table 3.
<table>
<thead>
<tr>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
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<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Arms</td>
<td>Geography</td>
<td>Fighting Capacity</td>
<td>Terrain</td>
<td>Regime Type</td>
<td>State Wealth</td>
<td>External Actors</td>
<td>Insurgencies</td>
<td>All Controls</td>
<td>Standardized IVs</td>
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<td>−0.921**</td>
<td>−0.995***</td>
<td>−0.958**</td>
<td>−0.946**</td>
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<td>(0.287)</td>
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<td>(0.294)</td>
<td>(0.325)</td>
<td>(0.333)</td>
<td>(0.301)</td>
<td>(0.278)</td>
<td>(0.330)</td>
<td>(0.391)</td>
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<td>−1.004**</td>
<td>−0.962**</td>
<td>−1.147***</td>
<td>−1.150**</td>
<td>−0.965**</td>
<td>−1.036**</td>
<td>−1.036**</td>
<td>−0.889*</td>
<td>−1.104*</td>
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<td>(0.332)</td>
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<td>(0.318)</td>
<td>(0.384)</td>
<td>(0.342)</td>
<td>(0.358)</td>
<td>(0.324)</td>
<td>(0.383)</td>
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<td>0.187***</td>
<td>0.211***</td>
<td>0.207***</td>
<td>0.194***</td>
<td>0.186**</td>
<td>0.191***</td>
<td>0.178**</td>
<td>0.209**</td>
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<td>(0.055)</td>
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<td>(0.061)</td>
<td>(0.062)</td>
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<td>CONFLICT AT BORDER</td>
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<tr>
<td>BORDER × DISTANCE</td>
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<td>NATURAL RESOURCES</td>
<td>−0.478*</td>
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<tr>
<td>ROUGH TERRAIN</td>
<td>−0.358†</td>
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<tr>
<td>INCUMBENT DEMOCRACY</td>
<td>−0.259</td>
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<td>GDP PER CAPITA</td>
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<td>EXTERNAL SUPPORT: REBELS</td>
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<td>(0.251)</td>
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<tr>
<td>INSURGENCY</td>
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<td>POST-COLD WAR YEARS</td>
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<td>(0.421)</td>
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<tr>
<td>(1.525)</td>
<td>(1.727)</td>
<td>(1.517)</td>
<td>(1.960)</td>
<td>(1.675)</td>
<td>(1.866)</td>
<td>(1.472)</td>
<td>(1.808)</td>
<td>(2.773)</td>
<td>(2.114)</td>
</tr>
</tbody>
</table>

Observations: 678 678 662 678 633 676 678 664 603 603

Note: Three time-dependence variables not reported. Robust standard errors in parentheses. † p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.

Equally interesting are three factors that do not reliably impact civil conflict duration in our analysis. First, conflicts fought on forested or mountainous terrain do not appear to last longer: although the ROUGH TERRAIN variable achieves 95% significance in one regression, this result does not survive alternate model specifications or estimators. Indeed, this finding is in line with several other studies that also found rough terrain to be unrelated to civil war duration (e.g., Collier et al. 2004; Rustad et al. 2008; Escribà-Folch 2010; Bleaney and Dimico 2011). Second, democracies do not seem to fight shorter wars: INCUMBENT DEMOCRACY does not achieve statistical significance in any of the regressions, echoing the findings of Fearon (2004); DeRouen and Sobek (2004); and Balcells and Kalyvas (2012). Third, the findings are mixed with respect to the presence of lootable resources – oil, drugs, and gemstones – in the conflict zone. In some regressions, lootable resources appear to be

Figure 2. Predicted probability of conflict termination as GROUND MECHANIZATION and AIRCRAFT MECHANIZATION vary (Model 11 estimates).
associated with longer wars, but this result is not robust.\footnote{Other studies have also found inconclusive evidence regarding the impact of lootable resources. A somewhat more consistent finding is that oil exerts little systematic effect on civil war duration, which could be driving the mixed findings here (Collier et al. 2004; Escribà-Folch 2010; Bleaney and Dimico 2011; Balcells and Kalyvas 2012).}

**Combined Arms and War Outcomes**

As we have noted, the theory presented in this paper is a theory about the effects of military technology on the duration of civil conflicts – not their outcomes. Whereas the debate about military mechanization has focused primarily on whether mechanized militaries win or lose (Lyall and Wilson 2009; Smith and Toronto 2010; Friedman 2011; MacDonald 2013), our interest is in whether such militaries fight longer conflicts. Nevertheless, the outcomes of conflicts can offer some insight into the logic of our argument. In particular, the logic of Hypothesis 3 implies that militaries using combined arms should be neither more nor less likely to prevail in their conflicts. Using combined arms may force an earlier verdict in a conflict, but not necessarily a more favorable one.

Table 4 puts this hypothesis to the test, using logistic regressions to examine the relationship between military mechanization and the likelihood of either an *incumbent victory* (Models 21 and 22) or a *rebel victory* (Models 23 and 24). Because the UCDP dataset does not code conflict outcomes, however, we turn to Balcells and Kalyvas (2012), who code outcomes for all civil wars in the UCDP dataset involving at least 1,000 fatalities.\footnote{The analyses also include the same control variables used in Balcells and Kalyvas (2012).} If combined arms is reliably associated with either victory or defeat for the incumbent government, this would suggest that the logic described in this paper is at best incomplete, and that combined arms strategies have either more strengths or weaknesses than we have acknowledged.

The results in Table 4, however, suggest that this is not the case. Models 21 and 22 indicate that mechanization is a poor predictor of incumbent victory: states with high mechanization scores are neither consistently more nor less likely to prevail in civil wars. Likewise, in the second set of models, the three mechanization variables exhibit no reliable correlations with rebel victories in civil wars. This evidence suggests that both victories and
defeats are responsible for the observation that mechanized militaries fight shorter conflicts. A combined arms strategy is no guarantee of victory in intrastate combat.

**Combined Arms and Insurgencies**

While these results demonstrate the importance of combined arms in the broad category of civil conflicts, not all intrastate conflicts are alike. Kalyvas and Balcells (2010) demonstrate that civil conflicts may be fought as conventional set-piece battles, peasant revolts, or urban insurgencies. The mode of combat – and therefore the utility of mechanized military forces – may vary widely across different types of conflicts. Insurgencies in particular may pose...
special challenges to mechanized militaries, since fighting often occurs house-to-house rather than in open battlefields. Insurgencies therefore represent the “hard cases” for combined arms warfare. Do the effects of combined arms hold for insurgencies as well?

Table 5 evaluates this question by estimating two of the regressions in Table 2 against a sub-sample of only insurgencies. The results suggest that combined arms have duration effects not only in conventional civil wars but also in counterinsurgencies. Consistent with Lyall and Wilson (2009), the coefficient for MECHANIZATION is positive and statistically significant at the 99% level or above in both regressions, indicating that incumbent states with mechanized ground forces but little airpower fight longer insurgencies. But when combined with airpower, the effect of mechanized ground forces is reversed: the coefficient for COMBINED ARMS in Table 5 is negative and achieves statistical significance at the 95% level in both models. The overall conclusion is that combined arms doctrines are strongly associated with shorter civil wars – even insurgencies.

Implications and Conclusions

This article has evaluated the role of military technology in explaining the duration of civil conflicts. While conventional wisdom holds that mechanized land armies tend to produce lengthy, indecisive stalemates, we have argued that the opposite effect may obtain when mechanized ground forces are combined with airpower. The simultaneous, coordinated use of land-based armor and combat aircraft – known as a combined-arms doctrine – can create the conditions for more rapid, decisive battlefield outcomes, leading to shorter conflicts. Using fine-grained data on the military forces of incumbent states, we evaluated this claim by conducting a systematic empirical analysis of the relationship between military technology and civil conflict duration. There were three key results. First, we found support for Lyall and Wilson’s (2009) finding that mechanized ground forces favor stalemate rather than victory. Secondly, we found evidence that airpower alone is likely to extend civil wars.

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The other six model specifications used in Table 2 yield similar results. These models are not reported here to avoid unnecessary repetition.

<table>
<thead>
<tr>
<th></th>
<th>Combined Arms</th>
<th>All Controls</th>
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<tr>
<td>Ground Mechanization</td>
<td>1.543***</td>
<td>1.596***</td>
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<tr>
<td></td>
<td>(0.416)</td>
<td>(0.429)</td>
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<tr>
<td>Aircraft Mechanization</td>
<td>1.748***</td>
<td>1.788**</td>
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<tr>
<td></td>
<td>(0.378)</td>
<td>(0.672)</td>
</tr>
<tr>
<td>Combined Arms</td>
<td>-0.324***</td>
<td>-0.270**</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.093)</td>
</tr>
<tr>
<td>Distance to Capital</td>
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<tr>
<td></td>
<td>(0.193)</td>
<td></td>
</tr>
<tr>
<td>Conflict at Border</td>
<td>0.746*</td>
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<tr>
<td></td>
<td>(0.338)</td>
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</tr>
<tr>
<td>Border x Distance</td>
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<td>(0.173)</td>
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<tr>
<td>Rebel Fighting Capacity</td>
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<td>(0.631)</td>
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<tr>
<td>Rebels’ Relative Strength</td>
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<td>(0.818)</td>
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<td>Natural Resources</td>
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<td></td>
<td>(0.650)</td>
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<tr>
<td>Rough Terrain</td>
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<td>Incumbent Democracy</td>
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<td>(0.711)</td>
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<tr>
<td>GDP per Capita</td>
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<td>(0.517)</td>
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<tr>
<td>External Support: Rebels</td>
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<tr>
<td>External Support: Government</td>
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<td>Post-Cold War Years</td>
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<td>3.180</td>
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<td>(1.795)</td>
<td>(2.530)</td>
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</table>

**Note:** Robust standard errors in parentheses. † *p* < 0.10, * p < 0.05, ** *p* < 0.01, *** *p* < 0.001.

Third, and most importantly, the analysis revealed that using mechanized ground forces in conjunction with airpower can offset these effects. States that combine airpower with mechanized armies tend to fight shorter – not longer – civil conflicts.

These results offer an important revision to our understanding of military mechanization in intrastate conflicts. While mechanized ground forces indeed appear to suffer serious limitations against nonconventional opponents, as Lyall and Wilson (2009), Lyall (2010),
Friedman (2011), and others have found – our findings suggest that the addition of airpower may help states overcome some of these limitations. Ground force mechanization on its own may be problematic, but militaries that use armored vehicles in combination with combat aircraft fight shorter wars, on average, than militaries that rely strictly on ground-force mechanization. While our analysis focuses on incumbent states rather than third-party interveners, these findings may offer a warning to policymakers against precipitously reducing the role of armor and airpower in counterinsurgency operations.

At the same time, this study leaves two important questions unanswered. First, although conflicts involving combined arms militaries may be shorter, this does not mean that they are less costly. Indeed, Balcells and Kalyvas (2012) provide evidence that since the Cold War’s end, civil wars have grown shorter but more destructive. Further research is needed to determine the effects of combined arms on both military fatalities and civilian collateral damage. Even if combined arms yield shorter conflicts, those conflicts may be no less devastating than their longer, low-intensity counterparts.

Second, as noted earlier, shorter civil wars do not necessarily imply more successful civil wars for incumbent governments. It could be the case that combined-arms militaries are more likely to achieve quick victories – but they may also be more likely to suffer rapid losses. Additional research could help isolate the connections between the outcomes of civil conflicts – particularly non-insurgencies – and military technology.

In general, our study points to the need for more fine-grained data about military capabilities and doctrine in civil wars. Although our analysis utilizes new and detailed data on the weapons stockpiles of civil war combatants, raw stockpile data does not indicate how these weapons were used in combat. New data on the military doctrines of civil war incumbents would permit a more direct assessment of combined-arms operations in these conflicts. On a similar note, our study accounts only for the mechanization levels of incumbent governments, not rebel groups. Yet, as several studies have demonstrated, there is wide variation in the military strategies employed by rebels and insurgent groups. Indeed, their strategies are sometimes quite similar to those of conventional militaries, involving the use of armored
vehicles and even airpower (Arreguín-Toft 2005; Kalyvas and Balcells 2010). New data about how rebels fight would help researchers better specify the effects of military technology on the duration and outcomes of civil wars.

Most broadly, the findings of this study underscore the importance of incorporating military technology into our theoretical models of civil conflict. Explaining the dynamics of intrastate conflict requires understanding how the technology of warfare interacts with geographic, economic, and political factors to shape battlefield events and political decisions. Further investigation into the role of military technology is likely to yield new insights both for researchers interested in explaining costly conflicts, and for policymakers interested in preventing them.
References


