The Army You Have: The Determinants of Military Mechanization, 1979–2001

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Recent research suggests that a crucial factor in understanding the outcomes of military conflicts is the extent to which militaries are mechanized—that is, their relative dependence on tanks and armored vehicles compared to manpower. Since World War II, militaries have become increasingly mechanized both among the great powers and in unexpected quarters of the developing world. Yet the extent of military mechanization varies widely across states. Why have some states adopted highly mechanized force structures, while others have not? This paper tests several hypotheses about the determinants of military mechanization. One perspective suggests that strategic factors—including the force structures of adversaries and neighbors, recent combat lessons, and internal insurgency threats—shape a military's mix of manpower and vehicles. A second set of hypotheses points instead to domestic institutions such as democracy and civilian control of the military. Still other theories emphasize economic forces and international norms. To test these and other hypotheses, we construct a new data set containing mechanization rates for more than 150 militaries from 1979 to 2001. Broadly, we find significant support for the strategic perspective and little support for domestic institutional explanations. In addition, the results suggest systematic and predictable differences in the ways states structure their militaries in response to security pressures.

Often overlooked in the political debate surrounding the 2007 ''surge'' of US troops into Iraq was the shift in military doctrine that accompanied it. After nearly four years of struggle in Iraq, the US military began to abandon its

reliance on firepower and armored vehicle patrols to subdue the Iraqi insurgency. In place of this approach, American commanders adopted a doctrine that called for fewer vehicle patrols, more dismounted troops, and greater interaction with the local population[1]—an adaptation that ''came at a frightful human, financial, and political cost,'' as Secretary of Defense Robert Gates (2009:36–37) put it. While there remains debate over the effect of the ''surge,'' the dramatic reduction in violence that followed naturally raises the question: why did this doctrinal adjustment not occur earlier? An important part of the answer lies in the way the US military is built: for decades the United States has prepared mainly for mechanized warfare, acquiring large numbers of tanks and combat vehicles more suited for open battles on the plains of Europe than for house-to-house counterinsurgency operations. But recent research has confirmed what counterinsurgency theorists have long argued: a heavy reliance on armored vehicles tends to undermine an army's ability to defeat insurgencies (for example, Lyall and Wilson 2009).[2] In short, choices about force structure made years earlier hampered the ability of the world's most powerful military to defeat a relatively low-technology insurgency.

What explains why some states (such as Libya, Mongolia, and Hungary) have constructed highly mechanized armies—that is, armies with a high proportion of tanks and armored vehicles relative to manpower—while others (such as India and South Korea) have not? One possibility is that states react primarily to security pressures, calibrating their armies in response to likely adversaries, recent warfighting experiences, and internal insurgency threats. In this view, for example, the US military maintained a high level of mechanization during the Cold War because of the need to prepare for a major conventional war against another highly mechanized army—the Soviet Union—in Europe.

Other theoretical perspectives, however, argue that decisions about military force structure cannot be explained from a purely strategic standpoint. Domestic institutions, for example, play a role by mediating the political and parochial interests that influence defense spending and procurement choices. Thus, while some see the United States' reliance on a highly mechanized military as puzzling in light of the nation's continued involvement in ''small wars'' and counterinsurgency operations (for example, Cohen 1984; Downie 1998), an institutional perspective suggests that it may reflect voters' preferences for the lower human costs associated with a vehicle-intensive military (Caverley 2009/2010). Still other perspectives emphasize the role of wealth and resource endowments, the political pressures of alliances, and international norms that shape decisions about how militaries ought to be built.

In this article we evaluate these and other hypotheses about military mechanization using a new data set constructed from volumes of the International Institute for Strategic Studies' series *The Military Balance*. Our analysis shows several types of security factors to be closely associated with mechanization: foreign adversaries, neighbors, insurgency threats, and prior battlefield experiences are strongly and systematically associated with national mechanization levels. In addition, the results suggest that some states adapt to security pressures in systematically different ways: specifically, the impact of counterinsurgency experiences depends heavily on whether those experiences occurred at home or abroad. We find these security pressures to be important determinants of mechanization even after controlling for economic endowments, which also play a powerful role in determining which states build the most mechanized armies. Domestic

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[1] The new strategy is reflected in the United States Army and Marine Corps' (2007) new counterinsurgency field manual.

[2] Many commentators, for instance, assign a significant share of blame for the US defeat in Vietnam to the highly mechanized nature of American forces (for example, Krepinevich 1986).

attributes, in contrast, do not appear to exert a significant influence. Our findings indicate that democratic governance, civilian control of the military, and domestic political instability are not systematic determinants of mechanization.

The empirical analysis carries important implications for the study of national security policy. Recent literature in this field has emphasized, among other factors, the role of military and strategic culture (Legro 1995; Kier 1997; Johnston 1998), political institutions (Avant 1994), organizational biases (Snyder 1984; Sagan 1993), social structure and ethnicity (Rosen 1996; Hoyt 2007), regime type (Reiter and Stam 2002), and global norms (Katzenstein 1996) in shaping various aspects of defense policy. These studies are important because they demonstrate that institutions, ideas, and other non-material factors are critical to explaining the choices that militaries make. As our understanding of these factors has grown increasingly sophisticated, however, empirical work about defense policy—particularly quantitative work—continues to operationalize strategic variables in somewhat simplistic ways. The analysis below aims to improve on previous work by incorporating more nuanced data about the military capabilities of adversaries and allies, while also acknowledging the broad spectrum of internal and external security pressures that weigh on a state's defense choices. The results reveal a much more important role for strategic factors than previous work has been able to demonstrate. Moreover, they provide systematic evidence that states construct their militaries with an eye toward more than just the raw material capabilities of potential adversaries—the data show that the *type* of army fielded by an adversary matters as well.

We proceed below by first discussing the importance of studying military mechanization. Second, we derive a series of hypotheses about the determinants of mechanization. Third, we introduce our data set, the National Mechanization Index, and present descriptive statistics about our measure of mechanization. Fourth, we describe how we operationalize each hypothesis and generate independent variables. Fifth, we report results from a cross-sectional time-series analysis of the data on mechanization rates from 1979 to 2001. Conclusions and implications follow.

Why Study Military Mechanization?

In international relations scholarship, military capabilities have long formed the heart of explanations for conflict and cooperation. National military power constitutes the basis for theories of balancing and alliance formation (Waltz 1979; Walt 1987), deterrence and the outbreak of war (Huth 1988), and even patterns of trade (Gowa 1995), to name only a few. Yet, as Biddle (2004:4) and others have argued, these theories rest on ''very simplistic treatments'' of military power, relying on crude measures such as military expenditures or personnel under arms. While many scholars rightly have pointed to non-material factors underlying state behavior, there remains much to explore in the realm of material capabilities. By studying armies' relative reliance on tanks and armored vehicles, we hope to advance the use of more fine-grained hypotheses and data about force structure in security studies.

Understanding the determinants of mechanization is important because today's choices about what sort of army to build constrain tomorrow's decisions about how states fight. Some military strategies require very particular force structures: in conventional warfare, for example, highly mechanized armies are ideal for supporting ''maneuver'' (or *blitzkrieg*) strategies, which require large numbers of motorized armored vehicles and rely on speed and offensive mobility to defeat the enemy.[3] Scholars have found that offensive maneuver strategies, in

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[3] Mearsheimer (1983) classifies military strategies into three types: maneuver, attrition, and limited-aims; Stam (1996) revises this typology into maneuver, attrition, and punishment strategies.

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turn, are associated with a greater likelihood of militarized dispute initiation (Mearsheimer 1983; Reiter 1999), improved military effectiveness, especially vis-à-vis attrition strategies (Stam 1996:137–145), and shorter wars (Bennett and Stam 1996). Identifying the conditions under which militaries are likely to adopt mechanized force structures could help scholars explain when and where these phenomena are likely to occur.[4]

Additionally, recent research suggests that military mechanization may play a key role in the effectiveness—or ineffectiveness—of counterinsurgency operations. For instance, Lyall and Wilson (2009) find that a high mechanization rate is an excellent predictor of counterinsurgency failure. They argue that while tanks and infantry vehicles offer protection and mobility to ground troops, they also tend to insulate soldiers from the local population and inhibit them from acquiring vital intelligence about the locations of insurgents. Using data from counterinsurgencies fought between 1800 and 2005, they show that more mechanized armies are less likely to defeat insurgencies because ''their structural design inhibits information-gathering among conflict-zone populations'' (68). Arreguín-Toft (2005) reports a similar pattern, finding that ''direct'' conventional strategies with regular army units tend to fare poorly against ''indirect'' guerrilla strategies. And after examining the effectiveness of democracies in counterinsurgency campaigns, Lyall (2010) concludes that mechanization is much more important than regime type in explaining counterinsurgency success and failure. This line of research implies that uncovering the sources of military mechanization could improve our ability to explain the outcomes of counterinsurgency wars.[5]

These considerations suggest that states face a tradeoff between the firepower, maneuverability, and force protection afforded by armored vehicles and the intelligence-gathering and population-control capabilities of a manpower-intensive army. Indeed, this tradeoff is reflected in current debates about US defense policy. In the wake of the doctrinal shift in Iraq and the increased US counterinsurgency effort in Afghanistan, there remains intense debate over whether US force structure should shift permanently toward increased preparedness for unconventional warfare or instead remain focused on countering potential conventional threats. In April 2009, Defense Secretary Gates unveiled a new Pentagon budget reflecting increased capabilities for combating insurgencies. Notably, the budget called for an increase in Army and Marine Corps personnel while cutting weapons systems (Drew and Bumiller 2009). The budget quickly faced skepticism from members of Congress, who worried that the shift in resources would leave the US military underprepared to meet more traditional threats from states like China, Russia, North Korea, or Iran (Shanker 2009). Indeed, there is debate on this issue within the US military itself (Bacevich 2008): some officials advocate devoting fewer resources to preparing for traditional conflicts and more to troop-intensive strategies like counterinsurgency and nation-building, while others counter that such an approach would leave the military ill-equipped for conventional warfighting.

These choices are important because today's decisions about force structure constrain the extent to which a military can quickly and affordably make

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[4] It is important to note that while mechanized armies make maneuver strategies possible, they can also be used to support more defensive postures. A highly mechanized army enables but does not necessitate a *blitzkrieg* doctrine. See, for instance, Lieber (2005).

[5] The relationship between mechanization and conventional effectiveness, however, is less well understood in the academic literature. As Biddle (2004), Brooks and Stanley (2007), and others note, conventional effectiveness depends on a wide variety of factors, including force employment, skill and training, intelligence and assessment, combat motivation, and weapons quality. However, we know of no research that has directly investigated the effect of mechanization on conventional effectiveness. Although it seems plausible that mechanization should be related to conventional effectiveness under some conditions, additional research is needed to clarify how mechanization interacts with other components of military effectiveness.

strategic adjustments later on—especially during wartime. To paraphrase a recent US Secretary of Defense, states go to war with the armies they have—and restructuring those armies can be costly. For example, the Pakistani Army has long emphasized preparations for a potential conventional war against neighboring India. In 2009, Pakistan engaged in a major offensive against Taliban insurgents in the Swat Valley in an effort to expel militants from key cities and villages. But the Pakistani military was sufficiently unaccustomed to counterinsurgency warfare that the United States proposed $3 billion in counterinsurgency aid, citing, in part, Pakistan's previous preoccupation with fighting India (Schmitt and Shanker 2009). Likewise, the Israeli Army, consistently among the most mechanized in the world, faced tremendous difficulties suppressing Hezbollah insurgents in the 2006 Lebanon war. And even militaries with a history of employing unconventional strategies can find themselves flat-footed when attempting to fight against insurgencies. In 1979, for instance, Cambodian insurgents launched a campaign against the occupying Vietnamese Army. Though the Vietnamese Army had successfully used insurgent tactics against the United States and the non-communist government of South Vietnam during the 1960s and 1970s, by 1979 it had reoriented itself for mechanized warfare and ironically could not decisively defeat the Cambodian insurgency. Understanding the sources of mechanization can help explain why these states were ill-prepared to fight against unconventional opponents.

A growing body of literature in security studies has begun to investigate states' choices about force structure and armaments. However, we still lack a systematic understanding of how militaries arrive at their particular mix of vehicles and manpower. For instance, scholars have considered a variety of theoretical explanations for US weapons procurement (Kurth 1972; Allison and Morris 1975), Third World militarization (Wendt and Barnett 1993), the proliferation of advanced conventional weapons (Eyre and Suchman 1996), and the choice between conventional and guerrilla forces (Farrell 2001). We can draw only limited inferences from these studies, however, since most of them do not utilize cross-national, time-series data.[6] In one of the few studies of force structure that traces cross-national differences over time, Gartzke (2001) finds that a state's capital-labor ratio is a crucial determinant of military capitalization. While Gartzke's work provides new evidence about the connection between economic forces and the military, the relationship between his chosen dependent variable (capital allocations to defense) and the physical makeup of ground forces is unclear since the former includes expenditures for air, nuclear, and naval forces, rather than ground force composition alone. Likewise, the extensive literature on military expenditures (for example, Bueno de Mesquita, Smith, Siverson, and Morrow 2003; Fordham and Walker 2005) provides only limited insight into explaining mechanization since changes in overall military "effort" need not involve changes to force structure (Gartzke 2001:468). Overall, despite increasing recognition of the importance of military force structure, mechanization remains a poorly understood phenomenon.

Theories of Mechanization

In this section, we develop a set of general explanations for military mechanization and describe several testable hypotheses that derive from each perspective.

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[6] Wendt and Barnett (1993), for example, examine just a single year of *Military Balance* data. Eyre and Suchman (1996) use snapshots of the developing world from 1970, 1980, and 1990, but they examine raw weapons inventories rather than proportionate holdings of manpower and vehicles. Lyall and Wilson (2009), on whom our measure of mechanization is patterned, collect mechanization data only for states that fought counterinsurgencies, and only for the year prior to fighting a counterinsurgency war.

Strategic Threats

Strategic threats are a natural starting point for explaining national defense policy. The general proposition here is straightforward: troop levels and weapons procurement are based primarily on anticipated threats and overall security needs (Posen 1984; Zisk 1993; Goldman 2007). We should therefore expect states to choose mechanization levels that reflect their particular threat environment. Describing a state's threat environment, however, requires a broad consideration of possible security priorities that states may face—priorities that may at times be countervailing. Yet existing studies of defense policy often address strategic issues in cursory ways. Gartzke's (2001) study of the capital-labor balance in militaries, for instance, finds that international threats play little role in determining how much militaries emphasize capital assets over manpower. Yet the variables it uses to capture a state's threat environment are rudimentary at best, comprising just three dichotomous indicators for major powers, enduring rivalries, and participation in recent militarized disputes. Another study (Reiter and Meek 1999) finds no relationship between security threats and military strategy, but likewise uses crude indicators of security threats.[7] A more recent analysis of the determinants of maneuver strategies (Wallace 2008) fails to include even a single control variable for external security threats. None of these studies accounts for the nature of the military capabilities available to a state's adversaries, neighbors, or allies. Nor do they consider potential internal threats that might influence defense policy. The hypotheses below focus on three different threats: existing threats from interstate adversaries, emerging threats from nearby states, and potential internal challenges to a government's authority. In addition, we consider the possibility that states look to recent wartime experiences to guide their strategic behavior.

First, an important component of a state's threat environment is the mix of capabilities possessed by existing adversaries. A state that expects to confront a relatively less-mechanized adversary may wish to structure its forces to be similarly less mechanized in order to effectively counter the enemy's strategy. Conversely, states that expect to confront highly mechanized adversaries should be more likely to invest in highly mechanized forces. Adversaries, moreover, differ in their importance within a state's overall threat matrix. As an adversary's power and the severity of its hostility increase, its importance to military force structure decisions is likely to grow in tandem.

Second, since most international conflicts are fought between neighbors, the mechanization rates of neighboring states—especially powerful neighbors—may be particularly relevant to a state's own decisions about military force structure. States that live in highly mechanized ''neighborhoods'' may feel pressured to mechanize as well in order to guard against possible future threats.

Third, force structure decisions may also reflect internal threats to the state. In particular, governments may fear challenges from domestic insurgencies, which directly threaten regime survival. In their analysis of civil war onset, Fearon and Laitin (2003) find that rough terrain facilitates the advent of insurgencies since mountains and jungles are difficult for governments to administer effectively. Following the logic that mechanization and effective counterinsurgency may be inversely related (Lyall and Wilson 2009), states with high proportions of

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[7] Threat-based variables in Reiter and Meek (1999) include a state's number of contiguous neighbors, whether friend or foe; a state's raw number of recent militarized disputes; and a dichotomous indicator for states with multiple dispute opponents.

rough terrain may maintain lower mechanization levels in anticipation of insurgency threats.[8]

These three strategic considerations yield the following hypotheses concerning external and internal threats:

Hypothesis 1: *States that face highly mechanized adversaries will have more mechanized militaries, on average, than states facing less-mechanized adversaries.*

Hypothesis 2: *States with highly mechanized neighbors will have more mechanized militaries, on average, than states with less-mechanized neighbors.*

Hypothesis 3: *States with mountainous terrain will have less-mechanized militaries, on average, than states with flat terrain.*

Significant battlefield experiences may also exert important influences on procurement and troop level decisions. Many studies highlight the importance of ''shocks''—particularly losses in war—as catalysts for changes in force structure (for example, Posen 1984; Avant 2000; Farrell 2001).[9] Building on insights from social psychology and organization theory, Reiter (1996) argues that failure prompts states to innovate and change, whereas success breeds continuity. According to this view, we should expect states to take recent battlefield losses into account when making procurement decisions.[10]

The effect of battlefield experience is likely to depend on the nature of the conflict. Highly mechanized forces may be useful for fighting conventional conflicts, but if Lyall and Wilson (2009) and others are correct, states may discover that they tend to be a hindrance when combating insurgencies. Thus, we might expect states that conduct unsuccessful counterinsurgency campaigns to have lower mechanization levels, other things being equal. Conversely, states that lose conventional wars should be more likely to have higher mechanization levels.[11]

The salience of past battlefield experiences also may be mediated by the location of these wars. Specifically, outside interveners may react differently to battlefield failures than combatants who face conflicts on their own territory. Consider the case of counterinsurgency. Lyall (2010) finds that external occupiers fare significantly worse in fighting counterinsurgencies than do states fighting insurgencies within their own borders. He argues that external occupiers

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[8] Fearon and Laitin (2003) also find per capita income to be associated with civil war onset, arguing that poorer states have weaker central government control. As described below, we control for this factor as well. But since per capita income may instead represent factor endowments—which Gartzke (2001) argues are associated with military capitalization—by itself it is not a clear test of the importance of internal threats. But if terrain also is a significant predictor of lower mechanization levels, as we find below, this would provide clearer evidence that states select mechanization rates in light of probable insurgent threats.

[9] Various strands of organization theory argue that states and military organizations are slow to adapt and innovate even in the face of failure, whether due to strategic culture (Record 2007: chapters 4–5); bureaucratic and parochial biases (Posen 1984; Lebovic 1996); or promotion policies (Rosen 1991). While we cannot distinguish among these diverse obstacles in our cross-national data, we can detect whether states that experience formative battlefield events exhibit a broad tendency to have higher or lower mechanization levels than states that do not experience such events.

[10] Note that this question is distinct from the hypothesis that states are responsive to ''system-wide'' lessons from other states' battlefield experiences (Reiter 1996:71–72), which we do not test here.

[11] Note that these hypotheses do not test whether mechanization is detrimental to counterinsurgency; rather, they are designed to evaluate whether states appear to be gleaning this lesson from unsuccessful counterinsurgencies. Whether mechanization and military effectiveness are in fact related has been tackled by other scholars (for example, Lyall and Wilson 2009) but is beyond the scope of this paper; we do, however, assess whether states behave *as if* this logic is correct.

are more likely to be fighting ''wars of choice'' rather than wars for survival and can therefore withdraw without risking existential damage to the state.[12] Such states may react to battlefield failures not by adjusting their military capacity, but by instead vowing to avoid such wars in the future—precisely the reaction many ascribe to the United States after the Vietnam War (see, for example, Krepinevich 1986:268–275).[13] In contrast, states that confront insurgencies within their own borders must win or face one of two regime-imperiling scenarios: at best, making significant concessions to insurgents (in the case of a draw), or at worst, losing power altogether. Even for governments that manage to fight domestic insurgents to a draw, the threat of renewed insurgency may lead to lower mechanization rates. This logic suggests that the effect of formative battlefield events depends on whether the regime has either selected itself into a foreign counterinsurgency or confronted an existential battle for survival.[14]

These arguments form three general propositions about the influence of battlefield experiences on military mechanization:

Hypothesis 4: *States that have recently experienced failure in counterinsurgency wars will have lower mechanization levels, on average, than states that have not.*

Hypothesis 5: *States that have recently experienced failure in conventional wars will have higher mechanization levels, on average, than states that have not.*

Hypothesis 6: *States experiencing counterinsurgency failure within their own borders will have lower mechanization levels, on average, than states experiencing counterinsurgency failure in external interventions.*

Domestic Institutions

A variety of alternative theoretical perspectives suggest that decisions about military strategy and force structure are not dictated solely by strategic imperatives. One cluster of arguments posits that choices about defense policy are mediated by domestic institutions, which may not necessarily prioritize national security interests above all else. Several hypotheses about military mechanization can be grouped under this general rubric.

First, regime type has occupied a central role in the literature on military behavior, with scholars debating whether democratic institutions are a help (Reiter and Stam 2002), a hindrance (Merom 2003), or irrelevant (Desch 2008; Downes 2009; Lyall 2010) when fighting wars. Scholars in this tradition have posited at least two mechanisms linking democratic governance with force structure and mechanization. One strand of research focuses on democracies

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[12] For a discussion in the context of military intervention, see Saunders (2009:120).

[13] A less charitable suggestion comes from Waltz (1979:195), who argues that powerful states—and therefore most external occupiers—have the luxury of not learning. In his view, ''weak states operate on narrow margins. Inopportune acts, flawed policies, and mistimed moves may have fatal results. In contrast, strong states can be inattentive; they can afford not to learn; they can do the same dumb things over again.'' Either way, external occupiers would be less likely to adjust to these counterinsurgency failures.

[14] We consider only counterinsurgency wars when evaluating the role of occupiers because the period we investigate contains only 10 conventional wars—too few to generate any reliable inferences once they are divided into wars fought at home and abroad. In contrast, the data set overlaps with 75 distinct counterinsurgency wars. In principle, however, the logic could apply to conventional wars as well: an external intervener in a conventional conflict might not adjust its mechanization rate after a defeat, whereas a state defeated on or near its home territory might be inclined toward a higher mechanization rate.

and casualty aversion: since citizens' consent is required for democratic states to go to war, and because those same citizens will be called upon to do most of the fighting, democratic leaders may have incentives to build capital-intensive militaries (Caverley 2009/2010). In addition to minimizing the number of soldiers exposed to combat risks, mechanized militaries support the adoption of maneuver strategies, which emphasize shorter and lower-cost wars (Reiter and Meek 1999). And if casualties tend to undermine public support for wars (Mueller 1973; Gartner 2008),[15] then capital-intensive militaries might serve as a firewall between wartime costs and public discontent. A second line of inquiry emphasizes public aversion to the types of missions that may require low-mechanized forces. Jentleson (1992), for instance, finds that the American public is generally more supportive of wars to counter foreign aggression than interventions that interfere in other states' internal affairs. Democratic publics may therefore pressure leaders to build mechanized armies, which are likely to be more suitable for conflicts of the former variety. Both mechanisms imply that democracies are disproportionately likely to favor heavy investment in armored vehicles, while avoiding labor-intensive armies.

Another explanation related to domestic institutions concerns the influence of civil-military relations on arms procurement. This explanation holds that when civilian control of the military is weak, the military's parochial interests—which tend to favor force structures that emphasize tangible military power and symbolic weaponry (Eyre and Suchman 1996:84–85)—dominate defense policy-making, leading to higher mechanization levels. A related argument suggests that militaries prefer offensive doctrines and the expensive weapons that underpin those doctrines (Posen 1984:47–50). Sechser (2004), for example, finds that military governments are more likely to initiate militarized conflicts than civilian regimes; higher mechanization levels and the offensive doctrines they support could help explain this finding.

A final institutional hypothesis concerns the stability of a state's governing arrangements. Wendt and Barnett (1993:329) argue that in the developing world, where high mechanization levels are particularly puzzling, state structures are fragile and governments frequently lack legitimacy. Since the population of an unstable state may itself represent a threat to the government, leaders may be reluctant to rely on the population as a pool of potential manpower for a labor-intensive army. Instead, according to this logic, highly mechanized militaries are a better alternative for unstable regimes. Moreover, unstable governments may rely more heavily on the military to maintain domestic order, leading to weakened civilian control and higher mechanization levels. Thus, we would expect the following three hypotheses for institutional factors:

Hypothesis 7: *Democratic states will have higher mechanization levels, on average, than nondemocratic states.*

Hypothesis 8: *States with military governments will have higher mechanization levels, on average, than those with civilian governments.*

Hypothesis 9: *States experiencing internal instability will have higher mechanization levels, on average, than states with stable domestic institutions.*

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[15] For an important set of qualifications to this proposition, see Feaver and Gelpi (2004: chapter 4).

Several other factors may be important determinants of force structure, which we test alongside the two broad perspectives described above.

Economic Factors

Gartzke (2001) argues that choices about military force structure can be explained in part by economic factor endowments—specifically, he argues that states allocate resources to defense roughly in proportion to the relative abundance of capital and labor. Thus, states with high *capital-labor ratios* should have more highly capitalized militaries, while states well endowed with labor should have less capitalized and more labor-intensive militaries. Indeed, Gartzke finds that national capital-labor ratios are a better predictor of military capitalization than regime type.[16] Along similar lines, the ability to produce *iron and steel*—the raw materials of tanks and military vehicles—may impact a state's ability to mechanize.

Alliances

As states evaluate their security needs and make choices about their mechanization levels, they must also consider the potential contributions of allies. On the one hand, states may seek allies either to fill gaps in their own force structure or to avoid producing those capabilities themselves. South Korea, for example, may not have needed to match North Korea's higher mechanization level during the 1980s because it enjoyed the protection of the highly mechanized US Army. On the other hand, states may form alliances precisely because they face common threats and have similar force structures that will dovetail in combating that threat. Either way, it is important to account for the effects of *allies' mechanization rates*. In addition, it could be the case that membership in a *Cold War alliance bloc*—that is, NATO or the Warsaw Pact—exerted a unique influence on mechanization rates. Membership might be positively associated with mechanization if the superpowers, as two of the world's largest exporters of mechanized weapons, provided allies with special preference (or pressure) in the sales of tanks and other armored vehicles. The effect could, however, be negative if alliance membership allowed members to ''shirk'' by free-riding off the high mechanization levels of their superpower patrons.

International Norms

Force-structure decisions may also be guided by shared norms about the nature of modern militaries. Building on the work of sociologists highlighting remarkable cross-national similarities in how states organize themselves (for example, Meyer, Boli, Thomas, and Ramirez 1997), scholars in the security field have hypothesized that states might acquire certain types of weapons in order to conform with international norms about what constitutes a modern, professional military, irrespective of the strategic value of these weapons (Wendt and Barnett 1993; Farrell 2001; Lyall and Wilson 2009). Moreover, states may view tanks and other high-technology weapons as symbols of legitimacy and prestige (Eyre and Suchman 1996; Gilady 2006). Many of these scholars suggest that the transmission of norms requires transnational ''carriers,'' such as *international governmental organizations* (Eyre and Suchman 1996:102). If membership in these organizations reflects the degree to which states have adopted international norms about

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[16] As noted earlier, the key dependent variable in Gartzke's study is overall military capitalization, but the logic of his argument applies equally well to the narrower question of army mechanization, so we test it here.

military mechanization, then states highly enmeshed in IGOs may tend to have higher mechanization levels.[17]

Former Soviet Republics
The collapse of the Soviet Union gave rise to a number of newly independent states that found themselves in possession of vast quantities of former Soviet military equipment but relatively small armies. Thus, one consequence of the dissolution of the Soviet military was that many *former Soviet republics* were left with artificially high mechanization levels, having had little time to build armies around the large vehicle stores left behind by departing Soviet troops.

Finally, there is an important class of propositions that we do not directly test in our empirical analysis. Numerous scholars have argued that bureaucratic, institutional, cultural, or social attributes play a major role in shaping decisions about military operations and strategy. Kier (1997), for instance, argues that the doctrines of the British and French armies during the interwar period can be best understood as products of each state's unique military culture.[18] Others point to bureaucratic, organizational, and other non-material factors in explaining military innovation (Grissom 2008) and military effectiveness (Brooks and Stanley 2007). One might therefore expect that decisions about force structure and mechanization are shaped by similar forces. Yet operationalizing many of these factors would be infeasible within the quantitative research design used in this article, so they are not explicitly included in our analysis. At the same time, since factors like bureaucratic inertia and culture would presumably render mechanization rates slow to change, we can account for their influence through the inclusion of a lagged dependent variable (discussed below). This variable is an important, if admittedly crude, way to account for persistence in a state's mechanization level that might stem from bureaucratic, organizational, cultural, or social factors.

Dependent Variable: Military Mechanization

How well do security threats explain states' military mechanization levels, especially as compared to domestic institutions, economic factors, and other variables? What are the relative strengths of these factors, and in which direction do they push? Evaluating these questions with quantitative data requires an index that measures national mechanization levels at multiple points in time. Using data on military arsenals and force levels provided by *The Military Balance*, a series of annual reports published by the International Institute for Strategic Studies, we construct a National Mechanization Index (see Saunders and Sechser 2010) that reports the number of armored vehicles per 100 soldiers for all odd-numbered years between 1979 and 2001.[19] National mechanization rates tend to exhibit only gradual changes from year to year, so collecting observations from every other year is an efficient means of covering a longer time span without losing a great deal of information. There are thus effectively 12 temporal periods contained in the data set.

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[17] This reasoning is different from the socialization process expected by neorealists such as Waltz (1979:127). In the neorealist view, security imperatives drive states to mimic the military practices of leading powers. Observationally, the two socialization processes are different in that neorealism expects states to rapidly emulate dominant military practices, whereas normative or cultural arguments usually require some mediating variable (such as transnational networks or domestic political groups) to inculcate the norm within the state.

[18] For other work along these lines, see Avant (1994); Legro (1995); Rosen (1996).

[19] As the *Military Balance* itself makes clear in each edition, the data are imperfect. In particular, various types of equipment and weapons are tracked in some years and not others. In constructing our measure of mechanization, we take care to include only data about vehicles that are tracked consistently over time, and we explicitly exclude certain categories (such as paramilitary forces) that are inconsistently tracked.

Our aim is to measure the degree to which militaries employ motorized armored vehicles, which enhance mobility and force protection but can also isolate soldiers from contact with local populations. We include three broad classes of vehicles in our measurement. First, we include main battle tanks such as the American M-1 Abrams, the Soviet T-80, and the Chinese Type-59 tank. *The Military Balance* defines a main battle tank as an armored, tracked combat vehicle with a minimum weight of 16.5 metric tons and a 360° traverse gun whose caliber is at least 75 mm. The second class of vehicle included in our count is the heavy armored combat vehicle, defined as an armored vehicle weighing at least 6 metric tons and containing an organic direct-fire weapon of at least 75 mm. Heavy armored combat vehicles include light tanks such as China's amphibious Type-63 and Taiwan's M-41, as well as armored reconnaissance vehicles such as the Israeli RBY and the British-built Ferret. Third, we count stocks of armored personnel carriers and infantry fighting vehicles. These vehicles are designed to transport infantry squads and are armed with organic cannons of at least 20 mm. Examples include tracked vehicles such as the Bradley Fighting Vehicle and the Soviet-built BMP systems as well as wheeled vehicles like the Chinese WZ551.[20]

The National Mechanization Index contains only ground vehicles (including amphibious variants) and counts only army, naval infantry, and marine troops, reflecting the fact that the foregoing propositions relate primarily to the mechanization of land armies. To remain faithful to these hypotheses, it is important to avoid the possibility that the presence of air and naval branches in some states might skew mechanization scores. We thus exclude most naval personnel (except for marines and naval infantry) and all air force personnel from our tally of troops, as well as equipment in these branches.[21]

Each index entry is constructed by first dividing each state's total number of vehicles in a given year by the sum of its army, marine, and naval infantry forces.[22] In the regressions below, the dependent variable, LOG MECH, uses the natural logarithm of the index values to normalize the distribution and mitigate the influence of outlying values. The logged value also reflects what we expect to be a non-linear relationship between mechanization and the independent variables. At low initial levels of mechanization, the independent variables should have a larger impact, with declining marginal effects as mechanization increases. All other variables involving mechanization (such as the mechanization level of adversaries) are also logged.

Mechanization: Trends and Descriptive Statistics

The National Mechanization Index covers all odd-numbered years from 1979 to 2001 and contains information on the force structures of 173 unique states. To mitigate the possibility that "microstates" such as Grenada, Brunei, and the Bahamas might skew inferences drawn from the data, states with a population of

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[20] Note that the index treats all vehicles equally, without weighting for vehicle type (for example, main battle tanks versus personnel carriers) or quality.

[21] The index excludes air force personnel and weapons because the linkage between air power and ground strategy is often highly uncertain: air warfare is a central component of maneuver warfare in the United States, for instance, but it has also formed the backbone of counterinsurgency strategies (for example, the Soviet Union in Afghanistan). A pure ground force index offers a better—if imperfect—indicator of how states might plan to use their forces in battle. Also excluded are strategic nuclear forces, paramilitary forces, domestic police forces, and reserves, since several of these categories are not consistently tracked across issues of *The Military Balance*. Main battle tanks, armored combat vehicles, and infantry transport vehicles in possession by marine or naval infantry units, however, are counted.

[22] Lyall and Wilson (2009) measure mechanization in countries experiencing insurgencies, but their scale measures soldiers per vehicle, which would generate undefined mechanization scores for countries reporting no vehicles. We therefore calculate the ratio of vehicles to soldiers instead.
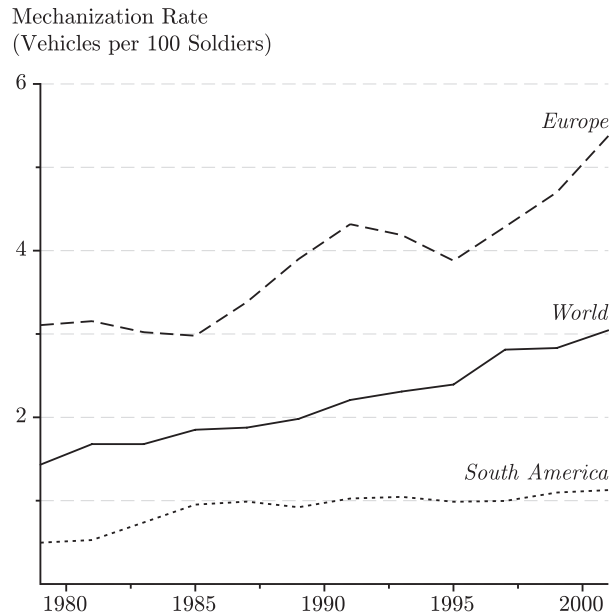
Mechanization Rate
(Vehicles per 100 Soldiers)

Fig 1. Average Mechanization Rates, 1979–2001

less than 750,000 are not included in the data set, leaving 153 states in the data set that we evaluate.[23]

The data exhibit a clear upward trend over time. Figure 1 illustrates mean mechanization scores for the entire world and selected regions over the duration of the data set, revealing that mechanization rates increased in nearly every year observed. The global average level of mechanization roughly doubled from 1979 to 2001, increasing from about 1.4 vehicles per 100 soldiers to 3.0. Mechanization rates in Asia increased most dramatically, jumping from 0.6 vehicles per 100 soldiers in 1979 to an average score of 2.3 in 2001. The world's highest average mechanization rate belonged to Europe in all years except 1981–1985, when that distinction belonged to the Middle East/North Africa. The least mechanized region was South America for all years except 1983–1987, when Asia had the least mechanized armies, on average.

One might generally expect the world's most mechanized states also to be the wealthiest overall, since states with high GDPs presumably can most easily afford the expense of buying tanks and other fighting vehicles. This suspicion is not correct. The correlation between GDP and mechanization is 0.11; the correlation between logged values of these variables is 0.23. Figure 2 illustrates the year-to-year quartile ranges for the National Mechanization Index and denotes states whose mechanization rate ranked among the top 10 of all militaries worldwide. The chart demonstrates that the most mechanized states each year are not necessarily the wealthiest. Libya, for instance, ranked as the world's most mechanized army in 1981 and 1985 and ranked in the top 10 worldwide in all other years except 2001. Mongolia appeared in the top 10 in all but one year from 1987–2001; former Soviet republics and client states such as the Czech Republic, Bulgaria, Ukraine, and Russia dominated the top 10 after 1991. The Israeli army, which relies on a highly mobile *blitzkrieg* doctrine, placed in at least the top 10 in

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[23] Eyre and Suchman (1996) likewise exclude states with populations of less than 750,000 from their analysis of the determinants of conventional weapons proliferation. We exclude Switzerland as well because of the unusually ambiguous active/reserve status of its army personnel.
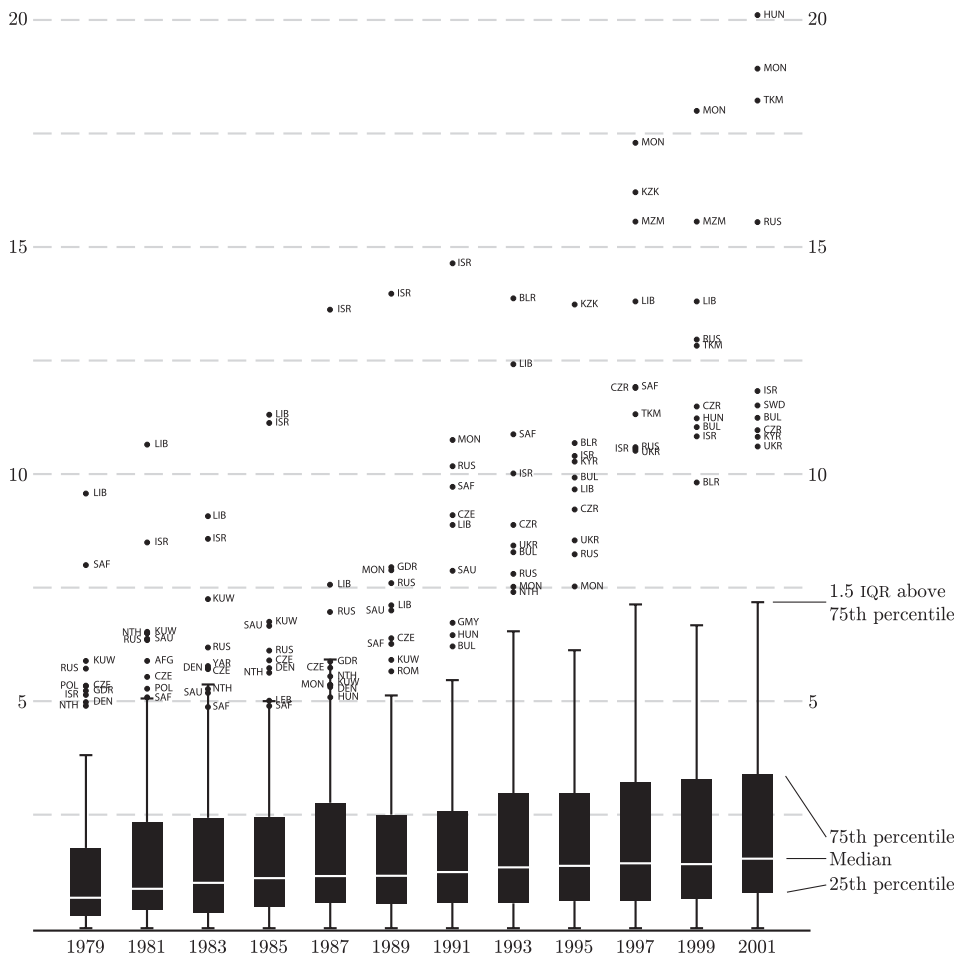
F<small>IG</small> 2. The Annual Range of Mechanization Scores and the Ten Most Mechanized States, 1979–2001

every year covered by the data set and ranked as the world's most mechanized army in 1987, 1989, and 1991. In contrast, the United States, the world's wealthiest state throughout this period, never appeared in the index's top 10, ranking as low as 26th in 2001. Indeed, of all the states that boasted one of the world's top 10 GDPs at some point during this period (the United States, China, Japan, India, France, Russia/Soviet Union, Italy, Britain, Brazil, Indonesia, Canada, Mexico, and Spain), only one—Russia—ever ranked in the top 10 in the National Mechanization Index. Even wealthy NATO members such as Belgium and West Germany were never among the 10 most mechanized states between 1979 and 2001.

It is also not the case that states that spend the most on their militaries have the highest mechanization levels. The correlation between mechanization and military expenditures (taken from the National Material Capabilities data, discussed below) is only 0.19 (logged values of both variables correlate at 0.39). An expensive military does not necessarily imply a highly mechanized military.

As the world's average level of mechanization has grown, the disparity in mechanization has remained roughly constant and even declined slightly. The spectrum of mechanization rates consistently follows a long-tailed distribution (Figure 3), with most countries clustered at the very low end of the mechanization scale.
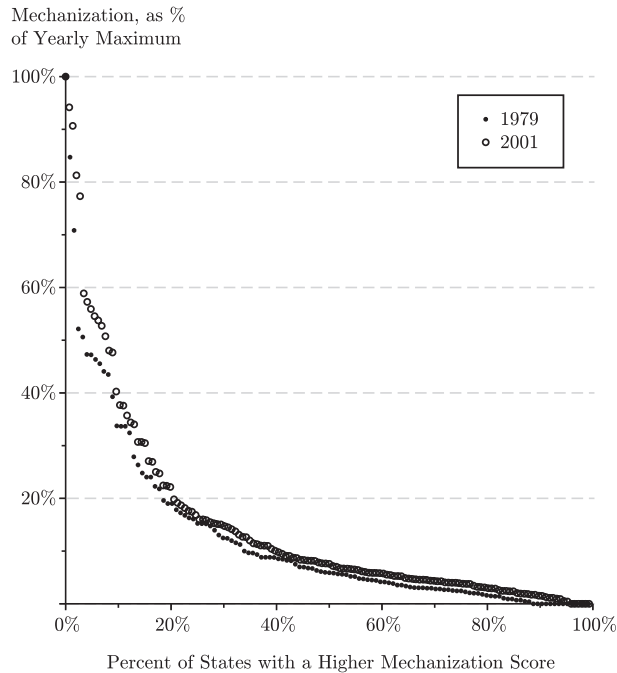
Mechanization, as %
of Yearly Maximum

Fig 3. Relative Distribution of Mechanization Scores, 1979 and 2001

Yet since 1979 more countries have climbed into the ranks of the highly mechanized, both in absolute and relative terms. In 1979 only 4% of states had a mechanization score that was at least half the rate of the world's most mechanized state; in 2001 that figure had risen to more than 8%. At the other end of the spectrum, in 1979 67% of states' mechanization scores were less than one-tenth the score of the most mechanized state; but in 2001, roughly 60% of states fit that description.[24]

Research Design and Independent Variables

In this section we describe procedures for operationalizing a series of independent variables to test the hypotheses described above using quantitative data. Most independent variables are lagged by two years (that is, one period) to rule out the possibility of reverse causality. In the regressions most independent variables are also logged to minimize the effect of outliers and to account for the likely declining marginal effects of the independent variables.

Strategic Threats

Five variables account for the influence of strategic pressures on choices about military force structure and mechanization. To remain as faithful as possible to the hypotheses concerning enemies, neighbors, and allies, the variables reflect both the material power and force structure of these states. The first variable, LOG MECH ENEMIES, is the logged annual average mechanization score for a state's adversaries, testing the proposition that states respond to security pressures by mimicking the force structures of their enemies (Hypothesis 1).

[24] The standard deviation of the National Mechanization Index in 1979 was 1.95 vehicles per 100 soldiers (median 0.67); in 2001 the standard deviation was 3.94 (median 1.53).

An enemy is defined as a state with whom a country has engaged in at least one militarized interstate dispute (MID) during the preceding ten years, irrespective of who initiated the dispute.[25] Each adversary's contribution to the annual average is weighted by the frequency of MIDs within the dyad during the preceding 10 years as well as each its Composite Indicator of National Capabilities (CINC) score (Singer, Bremer, and Stuckey 1972).[26] The formula for calculating MECH ENEMIES in a given year, where i indexes a state's MID opponents during the past 10 years and n represents the total number of opponents from the 10-year period, is given by:

$$\text{MECH ENEMIES} = \sum_{i=1}^{n} \left[\frac{\text{MIDs}_i \times \text{CINC}_i}{\sum_{i=1}^{n} (\text{MIDs}_i \times \text{CINC}_i)} \times \text{MECH}_i \right]$$

A second variable, LOG MECH NEIGHBORS, represents a logged weighted average of the mechanization scores of a state's contiguous neighbors. Since the vast majority of interstate conflicts occur between geographic neighbors (Bremer 1992), states must pay especially close attention to the structure and doctrine of nearby military forces (Hypothesis 2).[27] In constructing this variable, each neighbor's mechanization rate is weighted according to its CINC score using a calculation similar to that for LOG MECH ENEMIES.

Both of these variables are in fact interaction terms that take on positive values only when at least one of the relevant dyad partners (that is, enemies or neighbors) exists. This coding is achieved by interacting the calculated averages with the dummy indicators ENEMIES DUMMY and NEIGHBORS DUMMY, which indicate whether states had at least one recent enemy or contiguous neighbor. The interaction step is necessary to ensure that the coefficients associated with LOG MECH ENEMIES and LOG MECH NEIGHBORS are interpreted correctly, since the values for these coefficients are relevant only when a state has at least one of these respective partners.

Third, to test the proposition that states with especially rough terrain might maintain less-mechanized militaries to guard against insurgencies (Hypothesis 3), we include Fearon and Laitin's (2003) logged estimates of the percentage of mountainous terrain within a state, which we label LOG MOUNTAINOUS.

The fourth and fifth strategic variables examine the influence of recent battlefield experiences—especially failures. First, we integrate data on state participation in counterinsurgency conflicts from Lyall and Wilson (2009) to determine whether states that have experienced failed campaigns against less-mechanized guerrilla or insurgent forces have lower mechanization levels (Hypothesis 4). For convenience, we refer to these events as ''anti-mechanization lessons,'' reflecting the finding that lower mechanization rates appear to be more appropriate for fighting against insurgents. But it is important to note that we make no judgment about whether (or how) states ought to adapt to wartime failures; we are interested only in the empirical question of whether states actually appear to do so. In addition, this variable can only determine whether states adjust their mechanization rates in ways that are consistent with this hypothesis, but it contains no direct information about the process causing the adjustment.

Cases in which states experienced a loss or a draw against an insurgency qualify as anti-mechanization lessons. As Lyall and Wilson (2009:71) note, a draw

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[25] Data regarding MID participation are drawn from version 2.0 of Maoz's (2003) Dyadic Militarized Interstate Disputes data set and version 3.1 of the Correlates of War Project's Militarized Interstate Disputes data set (Ghosn, Palmer, and Bremer 2004).

[26] The CINC index includes military personnel, military expenditures, iron and steel production, energy consumption, and both urban and overall population in its calculated scores.

[27] Data on state contiguity are drawn from the Correlates of War Project's Direct Contiguity data (Stinnett, Tir, Schafer, Diehl, and Gochman 2002).

requires the incumbent to make concessions to the insurgents and implicitly leaves open the possibility that the insurgency will reignite. Thus, it makes sense to treat both stalemates and losses as ''failures'' to which states might potentially respond. We also hypothesize that anti-mechanization lessons would include cases in which a guerrilla force came to power via a successful insurgency, on the grounds that these leaders grasp particularly well the logic of guerrilla warfare and might therefore prefer low mechanization rates. Our data include counterinsurgencies fought both at home and abroad, but we exclude instances in which a state sent aid to an incumbent to fight against an insurgency but did not confront the insurgency directly.[28] For each counterinsurgency that ultimately resulted in a loss or a draw for the incumbent state, we assign the dummy variable ANTIMECH LESSON the value of 1 during each year in which the state participated in the counterinsurgency, as well as the two years following the end of the conflict. These procedures are designed to accommodate two possibilities: first, that a poor performance in wartime may inspire adaptation even before the conflict ends; and second, that lessons learned on the battlefield may persist beyond the end of the war. In other words, ANTIMECH LESSON is coded 1 if, during the preceding two years, a state participated in a counterinsurgency that ultimately ended in a loss or a draw. The variable is also coded 1 if the state experienced a takeover by a successful insurgency during the preceding two years, and 0 otherwise.

A related variable, PROMECH LESSON, addresses the corollary hypothesis: that states might respond to losses on conventional battlefields by increasing the proportion of vehicles in their land forces (Hypothesis 5). Just as defeat at the hands of a guerrilla army might persuade leaders to more closely mimic the less-mechanized force structure of their foe, a loss to a conventional enemy might convince leaders of the need for greater mechanization. Using data from Gleditsch (2004), we create the dummy variable PROMECH LESSON that indicates whether a state has fought in a losing conventional war during the preceding two years.[29]

Domestic Institutions

An indicator for democratic regimes (Hypothesis 7) is derived from data collected by the Polity IV project (Marshall and Jaggers 2007). The Polity project provides composite indicators of democracy and autocracy on 11-point scales (0–10); as has become customary in the field, we add 11 points to the democracy score and subtract the autocracy score from it to obtain an overall regime type indicator on a scale of 1 to 21, with 21 being the democratic extreme of the spectrum. We then create the dummy variable DEMOCRACY to denote states whose overall regime score is greater than 14. Following Fearon and Laitin (2003), a second dummy indicator, INSTABILITY, denotes whether the state's Polity IV score was more than two points different from its score two years prior (Hypothesis 9).[30]

A third institutional variable is designed to test associations between force structure and the political power of the military (Hypothesis 8). Arthur Banks'

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[28] We also included several cases of occupation discussed in Edelstein (2008) and made minor modifications to the list of insurgencies provided by Lyall and Wilson (2009). A complete list of conventional and counterinsurgency wars used in this analysis is available from the authors.

[29] We removed a few cases from the list of conventional wars to avoid overlap with insurgencies. While some wars (such as the Vietnam War) undoubtedly involve both conventional and insurgency phases, we sought to distinguish the effect of conventional and unconventional wars as clearly as possible.

[30] To denote instability, Fearon and Laitin (2003) require a 3-point change in Polity score during the preceding three years. Our measure is therefore both more and less restrictive—the change required is smaller, but the window under consideration is also narrower.

(2002) Cross-National Time Series data set identifies countries whose heads of state are also active military officers (for example, Pakistan under General Pervez Musharraf). These data permit the construction of MILITARY GOVT, a dummy variable denoting national military rule.

<div align="center">*Additional Variables*</div>

Economic Factors

To test the hypothesis that national capital-labor ratios affect the ability to generate capital-intensive, mechanized armies, we incorporate data on real GDP per capita, which Gartzke (2001:475) argues is a reflection of the capital-labor ratio in the economy. This variable has the advantage of accounting for both industrial and human factors of production: other things being equal, large stocks of capital suitable for the purchase or production of mechanized weapons will be associated with a higher GDP per capita, whereas large pools of potential military manpower (that is, large populations) will correspond to a lower GDP per capita. We employ data drawn from version 6.2 of the Penn World Table (Heston, Summers, and Aten 2006) regarding real per-capita GDP (in constant 2,000 dollars) and compute the logarithm to generate the variable LOG GDP CAP.

To account for the ability of states to produce the raw materials necessary for mechanized armies, we draw from Singer et al.'s (1972) national material capabilities data to create IRON & STEEL, which measures states' annual iron and steel production in billions of tons.

Alliances

Accounting for the influence of alliances on military force structure requires a measurement of the (logged) mechanization rates of allies (LOG MECH ALLIES), defined as states with whom a country has a formal defense treaty.[31] Like LOG MECH ENEMIES and LOG MECH NEIGHBORS, this variable is weighted by CINC scores and is paired with the dummy variable ALLIES DUMMY that is given the value of 1 for states that have at least one formal ally. In addition, to identify any unique effects of membership in the world's rival alliance systems during the Cold War, the dummy variable COLD WAR BLOC indicates whether a state was a member of either NATO or the Warsaw Pact during the year in question.

International Norms

The hypothesis that state behavior is influenced by international norms also suggests that international institutions transmit those norms. A common indicator of a state's ''connectedness'' to the international community, which we adopt here, is the number of intergovernmental organizations (IGOs) in which the state possesses full and active membership (for example, Eyre and Suchman 1996). We draw from the updated version of Wallace and Singer's (1970) International Governmental Organization data set to generate the variable IGOS, which is a simple count of a state's IGO membership in a given year.

Former Soviet Republics

We use the dummy variable POST SOVIET to denote states that were once part of the Soviet Union, allowing a test of the hypothesis that the collapse of the Soviet Union left these states with artificially large stockpiles of tanks and vehicles.

Lagged Dependent Variable

Finally, the model includes a lagged value of LOG MECH, which has important consequences for the interpretation of the model. While the lagged dependent

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[31] We obtained data on alliances from Leeds, Ritter, Mitchell, and Long (2002).

variable has advantageous properties for model estimation (discussed below), there are theoretical reasons to include it in this model as well.[32] There is likely to be natural persistence in the data, especially for states hoping to expand their military vehicle inventories—it can take years for vehicle production orders to trickle into operational stockpiles. Of even greater theoretical importance, however, are bureaucratic, cultural, and other factors that can generate continuity in defense policy over time. A lagged dependent variable can capture this inertia explicitly.[33]

Modeling Approach and Estimation Issues

We employ ordinary least squares regression, using several corrections to deal with estimation issues that we review below. This approach allows us to assess cross-national variation in mechanization rates across a multi-year period. We use a variant of panel-corrected standard errors, with LOG MECH as the dependent variable. Since we anticipate that errors in the data will vary by country (for example, if certain states are more inclined to conceal weapons than others), we employ panel-level heteroskedastic errors. We take precautions to minimize three additional estimation problems commonly posed by panel data.

Serial Autocorrelation
First, the lagged value of LOG MECH helps account for year-to-year dependence within the dependent variable (see Beck and Katz 2004). As mentioned, there is undoubtedly a high level of temporal dependence among observations, since military force structure is slow to change from year to year and may be constrained by bureaucratic, organizational, or cultural factors. Including a lagged dependent variable in the model helps correct for serial correlation in mechanization scores.

Spatial Autocorrelation
A second possible problem is spatial autocorrelation: it could be that the errors of states in close proximity to one another are correlated. In other words, a state's mechanization rate may be tied to the mechanization rates of its geographic neighbors. Beck (2001), Franzese and Hays (2007) and others suggest including a weighted spatial lag in the model specification to correct for this problem. Indeed, our variable LOG MECH NEIGHBORS is just such a variable: it is a weighted, lagged average of mechanization values for spatially proximate units in the data set.[34] This variable, combined with the correction and test for serial autocorrelation above, helps correct for interrelationships among observations in the data.

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[32] Achen (2000) discusses the importance of using theory to guide the inclusion of lagged dependent variables.

[33] For an example of a similar approach in the context of foreign aid policy, see Carey (2007:454). It should be noted that given the effective number of years in the data set and the inclusion of the lag, much of the variation captured by the regressions is cross-sectional.

[34] As Franzese and Hays (2007) argue, failing to include a spatial correction is a form of omitted variable bias that may lead to overestimation of nonspatial factors, such as external events or shocks. But the inclusion of a spatial correction may itself produce simultaneity bias, leading researchers to infer too much from spatial interdependence and downplay events or external factors. Spatial corrections introduce endogeneity into the model because, for example, while Germany's mechanization rate may predict France's mechanization rate in a given year, so too does France's mechanization rate help predict that of Germany. In this case, then, simultaneity bias provides a difficult test for event-driven hypotheses such as those based on battlefield events—if we find support for these hypotheses in the presence of a spatial correction, the evidence for their importance would be even stronger.

Contemporaneous Correlation
Third, there is a possibility that unobserved characteristics of some states are related to unobserved characteristics of other states, and that these features influence mechanization choices. An example of this might be a particularly influential event—say, the fall of the Soviet Union—that impacts mechanization decisions across the globe in a particular year. Such within-year (or contemporaneous) error correlation necessitates the use of a correction. The addition of dummy variables for each year in the data set addresses this problem.[35]

Excluding the year-dummy variables, the basic equation estimated in the linear regression models is as follows:

$$
\begin{aligned}
\text{LOG MECH} = {} & \beta_0 + \beta_1 \text{LOG MECH ENEMIES}_{t-2} + \beta_2 \text{ENEMIES DUMMY}_{t-2} \\
& + \beta_3 \text{LOG MECH NEIGHBORS}_{t-2} + \beta_4 \text{NEIGHBORS DUMMY}_{t-2} \\
& + \beta_5 \text{LOG MOUNTAINOUS}_{t-2} + \beta_6 \text{ANTIMECH LESSON} \\
& + \beta_7 \text{PROMECH LESSON} + \beta_8 \text{DEMOCRACY}_{t-2} \\
& + \beta_9 \text{INSTABILITY} + \beta_{10} \text{MILITARY GOVT}_{t-2} \\
& + \beta_{11} \text{LOG GDP CAP}_{t-2} + \beta_{12} \text{IRON\&STEEL}_{t-2} \\
& + \beta_{13} \text{LOG MECH ALLIES}_{t-2} + \beta_{14} \text{ALLIES DUMMY}_{t-2} \\
& + \beta_{15} \text{COLD WAR BLOC}_{t-2} + \beta_{16} \text{IGOS}_{t-2} + \beta_{17} \text{POST SOVIET} \\
& + \beta_{18} \text{LOG MECH ENEMIES}_{t-2} + \varepsilon
\end{aligned}
$$

Empirical Analysis
Model 1 in Table 1 contains linear regression results with LOG MECH as the dependent variable, using a full specification of the independent variables described above.[36] The lagged dependent variable appears to successfully minimize serial autocorrelation: a Lagrange multiplier test (Beck 2001) shows that the regression's residuals are poorly predicted by its lagged residuals ($p = 0.58$, $R^2 = 0.01$), demonstrating that residual serial autocorrelation is not a serious problem here.

As expected, the lagged dependent variable has a very strong effect on the current value of LOG MECH, reflecting persistence and inertia in the data. The following results for other independent variables reflect variation even in the face of this persistence.

Strategic Variables

Enemies
The coefficients for the interaction term LOG MECH ENEMIES and its associated dummy variable are statistically significant at the 95% level or higher and jointly significant at the 95% level. The effect of the mechanization rates of adversaries is substantively significant as well: holding all other independent variables at their median values, an increase in LOG MECH ENEMIES from the 10th percentile to the 90th percentile is associated with a 12% increase in a state's absolute mechanization rate, on average. A state with no enemies would have a predicted mechanization score of 1.37, other things being equal—equivalent to having enemies whose weighted mechanization average lies in only the 25th percentile.

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[35] Missing data and unbalanced panels preclude us from directly estimating a model that assumes contemporaneous correlation across panels. The dummy variables for each year are a less optimal correction since year-specific events are assumed to affect all states, but still allow some correction for contemporaneous correlation.

[36] Note that coefficients for the year-dummies are not reported here.

Table 1. Linear Regression Results for LOG MECH

	Model 1 Panel-corrected	Model 2 Panel-corrected	Model 3 Random effects
LOG MECH ENEMIES$_{t-2}$	0.042* (0.018)	0.041* (0.018)	0.044* (0.019)
ENEMIES DUMMY$_{t-2}$	0.204** (0.075)	0.194* (0.076)	0.209** (0.081)
LOG MECH NEIGHBORS$_{t-2}$	0.022† (0.012)	0.024† (0.012)	0.023† (0.013)
NEIGHBORS DUMMY$_{t-2}$	0.141* (0.055)	0.143** (0.055)	0.149* (0.059)
LOG MOUNTAINOUS$_{t-2}$	−0.015† (0.009)	−0.016† (0.009)	−0.016† (0.009)
ANTIMECH LESSON	−0.095* (0.038)	−0.118** (0.043)	−0.095* (0.044)
OCCUPIER ANTIMECH LESSON		0.158* (0.081)	
PROMECH LESSON	−0.170† (0.087)	−0.151† (0.089)	−0.166* (0.078)
DEMOCRACY$_{t-2}$	0.046 (0.029)	0.042 (0.029)	0.047 (0.029)
MILITARY GOVT$_{t-2}$	0.083 (0.058)	0.070 (0.058)	0.083 (0.073)
INSTABILITY$_{t-2}$	−0.017 (0.042)	−0.010 (0.042)	−0.018 (0.039)
LOG GDP CAP$_{t-2}$	0.050*** (0.015)	0.049*** (0.015)	0.056*** (0.016)
IRON & STEEL$_{t-2}$	−0.865† (0.484)	−0.942* (0.479)	−0.831† (0.496)
LOG MECH ALLIES$_{t-2}$	−0.039† (0.022)	−0.039† (0.022)	−0.039† (0.023)
ALLIES DUMMY$_{t-2}$	−0.133† (0.079)	−0.130† (0.079)	−0.130 (0.083)
COLD WAR BLOC$_{t-2}$	0.066† (0.038)	0.069† (0.039)	0.067† (0.039)
IGOS$_{t-2}$	−0.002* (0.001)	−0.002* (0.001)	−0.002* (0.001)
POST SOVIET	0.063 (0.079)	0.071 (0.080)	0.065 (0.081)
LOG MECH$_{t-2}$	0.870*** (0.019)	0.864*** (0.020)	0.858*** (0.020)
CONSTANT	−0.773*** (0.199)	−0.801*** (0.203)	−1.050*** (0.200)
N	1,235	1,235	1,235
R^2	0.872	0.872	–

(*Notes.* Standard errors in parentheses. Eleven year-dummy variables not reported; $^{\dagger}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.)

Neighbors

The coefficient estimate for LOG MECH NEIGHBORS is less significant, both statistically and substantively, than the estimate for LOG MECH ENEMIES. This seems sensible since neighbors are a cruder proxy for a state's threat environment than actual crisis opponents. Nevertheless, a Wald test for joint significance indicates that LOG MECH NEIGHBORS and its associated dummy are jointly significant at the 95% level. Holding other variables at their medians, as LOG MECH NEIGHBORS increases from the 10th to the 90th percentile, mechanization rises roughly 7%. And having no neighbors at all is associated with an average mechanization decline of roughly 6% compared to a state whose LOG MECH NEIGHBORS is at the median level.[37]

Terrain

Hypothesis 3 predicts that states with a great deal of rough terrain may maintain low mechanization rates in anticipation of internal threats from insurgencies. Indeed, we find that LOG MOUNTAINOUS is negative and significant at the 90% level, indicating that states with greater proportions of mountainous territory tend to have lower mechanization rates, on average. For the ''median state,''

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[37] As an alternative specification, we replaced LOG MECH NEIGHBORS with LOG MECH STRONGEST NEIGHBOR, which is the logged mechanization score of the contiguous state with the highest CINC score. The change actually strengthened these findings somewhat: the coefficient for LOG MECH STRONGEST NEIGHBOR was 0.027 and was significant at the 95% level. All previously significant coefficients remained so, with significance levels at least as high as in the original model.

as LOG MOUNTAINOUS increases from the 10th percentile to the 90th percentile, mechanization rates decline 6%, on average.[38]

Battlefield Experiences

Wartime failures against insurgencies appear to have a reliable and sharply negative association with mechanization rates. Holding other variables at their median values, states that have recently experienced a battlefield loss or draw (or successful insurgent takeover) at the hands of a guerrilla army have 9% lower mechanization rates, on average, than states that have not. This evidence is in line with Hypothesis 4, which posits that states experiencing anti-mechanization ''lessons'' will have lower mechanization rates than states that do not.[39] The result is robust to changes in the lesson ''window'' from two to four, six, eight, or 10 years.[40]

It could be the case that this result simply reflects the tendency of militaries to ''fight the last war'' by simply adjusting to their most recent enemy, whether or not that enemy was defeated. To evaluate this possibility, we re-estimated the models in Table 1 with an additional dummy variable denoting successful counterinsurgencies fought during the preceding two years. If the ''last war'' hypothesis is correct, the coefficient for this variable should be significant and in the same direction (that is, negative) as ANTIMECH LESSON, indicating that winning and losing militaries react similarly to recent counterinsurgencies. This variable was never statistically significant, however, and all other results were unchanged, suggesting that changes in mechanization depend on the particular outcomes of counterinsurgency wars rather than their mere occurrence.

These data allow us to investigate whether states structure their forces differently in response to different kinds of counterinsurgency failures. Hypothesis 6 suggests that the lessons taught by failure on the battlefield depend partly on whether the war was fought on home territory or as an intervention abroad—in other words, whether or not it was largely voluntary. Governments that fail to defeat guerrilla insurgencies inside their national boundaries, for instance, might fear additional insurgencies and therefore adopt less-mechanized force structures than states that have not faced this experience. In contrast, states that intervene in unsuccessful counterinsurgencies abroad may simply resolve not to conduct such interventions again.

To test this hypothesis, we include a new variable (OCCUPIER ANTIMECH LESSON) that is coded 1 if, during the preceding two years, a state participated in a counterinsurgency *outside of its borders* that ultimately ended in a loss or a draw, and 0 otherwise.[41] The objective here is to identify differential effects of failed interventions versus counterinsurgencies fought at home. Model 2 in Table 1 presents the results of a regression that includes this new variable. These results

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[38] The significance of the terrain variable is sensitive to the inclusion of Switzerland, the eighth most mountainous state in the data set. If Switzerland's large citizen militia is incorporated into its mechanization score, LOG MOUNTAINOUS remains significant and negative. However, since Swiss militia cohorts rotate in and out during the year for training, only about 15,000 to 20,000 troops are in service at any given time, according to *The Military Balance*. If this smaller figure is used to compute Switzerland's LOG MECH, then LOG MOUNTAINOUS no longer reaches conventional levels of significance. Because of the unusual ambiguity surrounding the appropriate classification for these personnel, we exclude Switzerland from the regressions reported in Table 1.

[39] Again, note that ANTIMECH LESSON also includes states whose leaders recently came to power under successful insurgencies, such as Zimbabwe's Robert Mugabe in 1979. For simplicity, however, we continue to refer to this variable as an indicator of ''counterinsurgency failure.''

[40] The effect becomes gradually smaller as this window expands, suggesting a declining effect of the lesson over time, but in each case the 95% confidence interval for the coefficient estimate does not include 0.

[41] Data on occupiers are taken from Lyall and Wilson (2009). Occupiers that experienced a counterinsurgency failure in the data set include Azerbaijan, Ethiopia, Israel, South Africa, the Soviet Union, Syria, Yugoslavia, the United States, and Vietnam. Those states experiencing counterinsurgency failure at home between 1979 and 2001 are too numerous to list here (numbering 40 in all), but they include Guatemala, Nicaragua, Chad, Burundi, Angola, Turkey, Sri Lanka, and Indonesia. The average mechanization score for these states is 1.20 vehicles per 100 soldiers, whereas for occupiers that experienced counterinsurgency failures, the mean score is 4.62.

vindicate both hypotheses 4 and 6: ANTIMECH LESSON is now significant at the 99% level, and OCCUPIER ANTIMECH LESSON is significant at the 95% level.[42] The difference between states that fought an unsuccessful counterinsurgency at home versus those that did so abroad is striking: states failing to defeat a home-grown insurgency in the past two years had a 15% lower mechanization rate, on average, than those whose external interventions went poorly. Indeed, a state experiencing counterinsurgency failure abroad had a 4% *higher* mechanization rate, on average, than states that had no recent counterinsurgency losses or draws at all. This evidence is consistent with the proposition that a military's response to a counterinsurgency failure depends on whether the war was a voluntary choice or not.[43]

Contrary to Hypothesis 5, conventional losses do not appear to correlate with greater mechanization. Although PROMECH LESSON is significant at the 90% level, it is also negative, indicating that defeat at the hands of a conventional opponent is associated with *declines* in mechanization.[44] It should be noted, however, that this result is not robust to changes in the lesson window: when the variable is expanded to include failures that occurred four years ago (or more), PROMECH LESSON is no longer significant. Still, the evidence that states experiencing recent conventional defeats have lower mechanization levels appears to contradict hypothesis 5.[45]

It is possible that these results reflect the simple loss of equipment during war. In other words, states that experience battlefield failures may have lower mechanization levels simply because they have lost tanks or other vehicles in battle. However, militaries could just as easily lose significant manpower during wartime, so mechanization levels (which account for both vehicles and manpower) need not necessarily drop following wars. Nevertheless, it is worth trying to disentangle intentional force structure decisions from simple attrition. Lengthening the lesson window helps accomplish this task. As time passes after a war, states can replace or repair destroyed vehicles if they wish to—thus, larger windows can attenuate the effects of sheer vehicle destruction on mechanization rates. The fact that ANTIMECH LESSON remains significant and negative even when the window is extended well beyond two years indicates that states may be deliberately holding down their mechanization levels. In other words, lower mechanization levels among states experiencing counterinsurgency failure do not seem to be simply the result of wartime equipment losses. In contrast, the insignificance of PROMECH LESSON for windows beyond two years suggests that the negative result here may be driven by wartime losses.[46]

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[42] A Wald test indicates that the two are also jointly significant at the 95% level.

[43] It could be that unsuccessful domestic counterinsurgents exhibit lower mechanization rates not because of battlefield failures but because of factors that precipitated their home-grown insurgencies in the first place. Fearon and Laitin (2003), for example, identify a number of variables that correlate with the outbreak of civil wars; such factors might also stifle military mechanization. The results above, however, already control for three key factors that Fearon and Laitin show to be associated with civil war onset: mountainous terrain (LOG MOUNTAINOUS), political instability (INSTABILITY), and GDP per capita (LOG GDP CAP). Even after accounting for these factors, however, recent battlefield failures are associated with lower mechanization rates.

[44] Given that there are only 32 observations (out of more than 1,200) in which PROMECH LESSON is equal to 1, even this level of statistical significance is notable.

[45] Coding the ''shock'' in the first year of the war and every year thereafter produces substantially similar results, with anti-mechanization lessons exerting a significant and negative effect and pro-mechanization lessons exerting no consistent impact.

[46] Note that these results compare states that experienced pro- or anti-mechanization ''lessons'' with those that did not, reflecting mostly cross-sectional variation rather than changes over time. With a relatively low number of temporal observations, we hesitate to draw longitudinal inferences. One way to look for such patterns might be to simply evaluate the direction of mechanization in a given state from year to year, but this can be misleading. The hypothesis expects a state's mechanization level after such a lesson to be lower than it otherwise would have been—but not necessarily lower than before. Other factors could intercede and cause the overall rate to remain stable or even increase. Thus, we cannot merely look for drops in mechanization rates to assess the effect of counterinsurgency failures on individual states over time.

Taken together, these results provide strong support for the notion that mechanization choices are closely related to states' security environments. External threats, the risk of internal challenges, and wartime experiences all appear to be associated with military force structure.

Regime Characteristics

In contrast to the results for security threats, institutional variables do not find support in our analysis.

Democracies
The conjecture that democratic publics may prefer to substitute military capital for labor, thus exhibiting higher mechanization rates, is not supported by the analysis. The coefficient for DEMOCRACY is indeed positive, as Hypothesis 7 would predict, but it is not significant at even the 90% level. Re-estimating the model using 21-point Polity scores in place of the DEMOCRACY dummy variable does not alter the result. We therefore cannot reject the null hypothesis that democratic institutions have no effect on military mechanization.

Military Governments
Nor can we reliably conclude that military-ruled states are associated with more mechanized militaries. The fact that MILITARY GOVT does not achieve conventional levels of statistical significance casts doubt on Hypothesis 8, even though the coefficient is in the predicted direction. This undercuts the conventional view that parochial military interests favor expensive, high-technology military equipment.

Political Instability
Rapid changes in a state's governing arrangements do not appear to matter. The variable INSTABILITY does not approach statistical significance, and in any case the model indicates that a median state that has recently experienced rapid governmental change will have an average mechanization rate only 1.7% lower than a state that has not.

Additional Variables

Economic Factors
The coefficient for LOG GDP CAP is positive and significant at the 99.9% level. This is in line with the findings of Gartzke (2001), who argues that national capital-labor ratios—for which GDP per capita may serve as a proxy—are positively related to military capitalization levels since capital is cheaper when it is abundant. When other variables are held at their medians, moving from the 10th percentile in LOG GDP CAP to the 90th percentile is associated with a 17% increase in mechanization, on average.[47] The coefficient for IRON & STEEL is also statistically significant but negative, perhaps suggesting that the wide availability of tanks and military vehicles on international markets during this period obviated the need for states to produce them on their own.[48]

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[47] If LOG GDP CAP is replaced with LOG GDP, the variable is positive and significant at the 90% level, likely reflecting its high correlation with LOG GDP CAP. With the exceptions of LOG MECH ALLIES and ALLIES DUMMY, all variables achieving at least 90% significance in Model 1 remain significant at equal or higher thresholds.

[48] The substance of the results does not change if we use CINC scores in place of IRON & STEEL as a measure of material capabilities; CINC is also statistically significant and negatively associated with mechanization.

Alliances

The coefficients for LOG MECH ALLIES and ALLIES DUMMY are both nega-
tive, implying that having more highly mechanized allies is associated with lower
mechanization rates. This is consistent with the hypothesis that allies tend to
adopt complementary force structures rather than mimic one another. The
result is of limited reliability, however, with both variables achieving statistical
significance at only the 90% level and not joint significance ($p = 0.20$). The
dummy variable COLD WAR BLOC also achieves significance at the 90% level,
suggesting that close ties to a superpower exerted a unique effect on members
of NATO and the Warsaw Pact, even after controlling for other alliance effects.
Membership in one of these blocs is associated with a 7% higher mechanization
rate, on average.

International Norms

Membership in international organizations is significantly related to mechaniza-
tion, but our analysis contradicts the hypothesis that international connectivity is
positively related to mechanization: in the results above, IGO membership is *neg-
atively* associated with military mechanization. Indeed, when other variables are
held at their medians, moving from 31 IGO memberships (10th percentile) to
84 memberships (90th percentile) corresponds to a reduction of 8.7% in that
state's mechanization level. The implications of this finding, however, are ambig-
uous. If mechanization is considered a hallmark of modern militaries, expanding
IGO participation does not appear to encourage the adoption of modern mili-
tary standards. But it could be the case that our instrument is simply flawed: per-
haps states do mechanize in part to conform with international norms, but these
norms do not spread through international institutions. Alternatively, our mea-
sure of mechanization may not necessarily correlate with military ''modernness,''
particularly since the index does not measure the quality of tanks and vehicles.
A third possibility is that states on the periphery use mechanization as a way to
gain international legitimacy, but once they have achieved integration into the
international community (expressed in part through IGO memberships), highly
mechanized militaries are no longer needed for such purposes. Any of these
explanations would be consistent with our findings. These results therefore
cannot refute the possibility that international norms encourage military mecha-
nization, but they do disconfirm the hypothesis that greater participation in
international organizations is associated with the spread of highly mechanized
militaries.

Former Soviet Republics

States born from the wreckage of the Soviet Union exhibited mechanization
rates that are not reliably different from other states, after controlling for other
factors. This finding most likely owes to the uneven distribution of Red Army
equipment among these republics after the Soviet Union's collapse—states such
as Ukraine and Belarus received a disproportionate quantity of former Soviet
equipment, whereas the states of Central Asia and the Caucasus region received
comparatively little.

Robustness of the Results

It could be the case that the results in Model 1 are an artifact of our chosen
estimation technique. To ensure that this is not the case, Model 3 estimates a
random-effects generalized least squares regression using robust standard errors.
The results, presented in Table 1, are virtually identical to the panel-corrected
model, with two minor exceptions: first, PROMECH LESSON is significant at the
95% rather than the 90% level; second, ALLIES DUMMY is no longer significant

at the 90% level. Aside from these two minor differences, no coefficients change sign or significance level in the random effects model, and the results of joint significance tests remain unchanged.[49]

To assess whether alternative specifications of certain variables influenced the results, we performed several robustness checks in addition to those described above. The results are robust to several other ways of accounting for temporal effects, including a secular time trend and a dummy variable distinguishing the Cold War from the post-Cold War period. A possible confounding factor in our analysis, however, might be the influence of unique regional characteristics. However, we find that including dummy variables for all but one region has little effect on the estimates and significance levels for the variables already included in Model 1. The major exceptions are the estimates for LOG MECH NEIGHBORS, NEIGHBORS DUMMY, and LOG MOUNTAINOUS, which become statistically indistinguishable from 0 when the regional dummies are added. This is not surprising, however, since the regional variables essentially replace one set of geographic variables with another. Moreover, none of the coefficients for the regional dummies are statistically significant, and a Wald test for joint significance fails to reject the null hypothesis (at the 95% significance level) that there are no unique regional effects independent of the variables already included in the analysis.

Conclusions and Implications

The world's militaries have become significantly more mechanized during the past few decades. In part this is a natural consequence of the dissemination of technology, which has made tanks and fighting vehicles cheaper and more widely available to states that could not previously afford them. But the trend toward greater mechanization also reflects conscious choices that states have made about how to structure their militaries. Mechanized armies are not thrust upon states; states must build or buy them. Why have some militaries embraced the mechanization of land warfare more than others?

The analysis above demonstrates that choices about mechanization are strongly associated with a state's security environment, in at least four ways. First, states that have recently engaged in militarized disputes with highly mechanized rivals are more likely to possess vehicle-intensive armies of their own. The data reveal systematic evidence consistent with the hypothesis that states' security policies reflect not merely the aggregate balance of power, but also rivals' military force structures. Second, the data uncover a strong tendency for states to mimic the mechanization rates of their neighbors. Since contiguous neighbors represent the most likely security threats, this evidence also supports a security-based explanation for mechanization trends. Together, these two results imply that we can understand the broader global trend toward mechanization partly as a self-reinforcing spiral consistent with the classic logic of the security dilemma. Third, states facing a greater risk of insurgency due to their high proportion of rough terrain tend to maintain lower mechanization rates, possibly in anticipation of this domestic threat. Fourth, battlefield failures appear to influence force structures, but their effect depends on the location of the war. Specifically, states that perform poorly in counterinsurgency wars at home tend to have lower mechanization rates than states that do not experience such battlefield events.

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[49] We do not include a model with country fixed effects. Many of our independent variables are either time-invariant or change very slowly over time. Furthermore, given the inclusion of a lagged dependent variable, as well as the relatively small number of time periods as compared with the large number of countries in the data set (and thus the primarily cross-sectional nature of the variation), the country-dummy variables are highly correlated with the lagged dependent variable.

States that experience counterinsurgency failure during occupations or interventions abroad, however, do not seem to have systematically lower mechanization levels, and indeed may even have more highly mechanized militaries than other states.

Economic factors also exhibit a reliable association with military mechanization. In particular, GDP per capita is highly correlated with mechanization, possibly reflecting the importance of factor endowments (as opposed to raw national wealth) in shaping military force structure. Iron and steel production, however, is negatively associated with mechanization, suggesting that the importance of factor endowments may not extend to raw materials.

Domestic institutions, in contrast, do a poor job of explaining variation in national mechanization rates across geography and time. Other things being equal, democracies exhibit mechanization rates no higher, on average, than those of non-democracies. This finding undermines the common wisdom that democracies tend to adopt less labor-dependent militaries. The data also reveal that states ruled by military governments are no more mechanized than other states, contrary to the received wisdom that militaries prefer expensive, capital-intensive procurement policies. The propensity for states with weak civilian control of the military to initiate international conflicts (Sechser 2004) therefore probably cannot be explained by systematic differences in military force structure.

Our findings suggest that states are broadly strategic in their force structure decisions. For scholars studying the factors that drive choices about national security policy, the results highlight the importance of examining a state's full spectrum of threats—both internal and external—rather than merely looking at individual threats in isolation. States confront multiple threats, some of which may exert countervailing pressures on security decisions. Force structures that seem inappropriate in the wake of recent battlefield experience may in fact be entirely rational within a larger grand strategy that places more weight on other threats. Moreover, while studies have identified a variety of myopic, parochial tendencies in military decision making, it appears that such tendencies are not the product of regime type or internal instability. In our analysis, states appear to exhibit strategic behavior across a wide variety of domestic institutional arrangements.

An interesting implication of these findings relates to our understanding of US defense policy—in particular, the widely observed failure of the United States to adopt a less-mechanized military force structure after its defeat by a guerrilla insurgency in Vietnam, contrary to the prescriptions of counterinsurgency theorists.[50] Our data suggest that US force structure likely exemplifies a broader tendency of intervening states to ignore the lessons of counterinsurgency campaigns abroad. The analysis shows that states that experience counterinsurgency failures tend not to exhibit lower mechanization rates if those failures occurred during occupations or other ''voluntary'' military missions. But in light of the results above, we should not infer from this lack of adjustment that the United States and other occupying states are not strategic in their force structure decisions: other threats—in this case, the Soviet threat to Western Europe—play a central role in mechanization choices as well. Moreover, interveners like the United States may also enjoy the luxury of simply vowing to avoid unconventional conflicts in the future, thus obviating the need to adjust their force structure.[51] Unless less-mechanized adversaries come to occupy a more central place in the hierarchy of threats confronting the United States, we

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[50] Our data do not cover the Vietnam War or immediate post-Vietnam War era, but they do indicate that the US mechanization rate increased steadily during the early 1980s. In 1979, the US military had 3.8 vehicles per 100 soldiers, increasing to 7.0 in 1993 before beginning to drop in 1995.

[51] Of course, the United States did not keep this vow, suggesting that decisions to participate in unconventional conflicts may not necessarily follow the same strategic logic as force structure decisions.

should not necessarily expect the United States to make major, enduring changes to its military force structure in the wake of the occupations in Iraq and Afghanistan.

The limitations of this study highlight important new angles for research about military force structure and warfighting strategy. Although the quantitative data presented here shed light on a variety of key hypotheses about the sources of military mechanization, other important hypotheses were necessarily left out. Qualitative case research about mechanization choices will be necessary to evaluate the influence of strategic culture, bureaucratic politics, and other factors that could not be measured by our data but may have contributed to the strong year-to-year persistence in mechanization rates. Additionally, our data reveal strong associations between, for instance, homeland counterinsurgency wars and lower mechanization rates, but they cannot demonstrate a causal linkage. Further analysis could assess whether this association plays out in individual states over time, and if so, what mechanism drives such adjustments. Are states "learning" in the sense of updating their beliefs about how best to fight wars? Or are they myopically fighting the last war? In-depth case research would help answer these and other related questions.

More generally, our findings point to the need for additional cross-national research to understand the sources and consequences of military strategy. One of the central challenges in conducting research about military strategy is that a nation's choice of strategy is typically difficult to observe during peacetime. As a result, scholars have been limited in their ability to study the relationship between military strategy and peacetime phenomena such as deterrence or defense spending. To the extent that mechanization and strategy are correlated, the National Mechanization Index could help address this problem since the index spans periods of both peace and war. Yet the correlation between mechanization and strategy is uncertain and requires additional study. In any event, aggregate mechanization data are no substitute for detailed information about military plans: knowing that a state merely possesses tanks and armored vehicles does not tell us how it is preparing to use them. Greater knowledge about the empirical relationship between mechanization and military strategy could help scholars move beyond crude categorical classifications of strategy and improve our ability to investigate the causes, conduct, and outcomes of military conflicts.

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