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AMOS PERLMUTTER PRIZE ESSAY

Economic Development and Military Effectiveness

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ABSTRACT What makes some states more militarily powerful than others? A growing body of research suggests that certain 'non-material' factors significantly affect a country's ability to translate resources into fighting power. In particular, recent studies claim that democracy, Western culture, high levels of human capital, and amicable civil-military relations enhance military effectiveness. If these studies are correct, then military power is not solely or even primarily determined by material resources, and a large chunk of international relations scholarship has been based on a flawed metric. The major finding of this article, however, suggests that this is not the case. In hundreds of battles between 1898 and 1987, the more economically developed side consistently outfought the poorer side on a soldier-for-soldier basis. This is not surprising. What is surprising is that many of the non-material factors posited to affect military capability seem to be irrelevant: when economic development is taken into account, culture and human capital become insignificant and democracy actually seems to degrade warfighting capability. In short, the conventional military dominance of Western democracies stems from superior economic development, not societal pathologies or political institutions. Therefore, a conception of military power that takes into account both the quantity of a state's resources and its level of economic development provides a sound basis for defense planning and international relations scholarship.

KEY WORDS: Military Power, Military Effectiveness, Economic Development

What makes some states more militarily powerful than others? The vast majority of international relations studies and defense analyses assume that military power is a direct product of material resources, often measured in terms of the size of a state's defense budget, military forces, or gross domestic product (GDP). A growing body of research, however, claims that certain non-material factors significantly affect

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the ability of states to translate their resources into fighting power. In particular, recent studies suggest that democratic political institutions, Western culture, high levels of human capital, and amicable civil-military relations significantly enhance the creation of military power. If this is true, then military power is not solely or even primarily determined by material resources, and the large number of theoretical and empirical works based on this assumption are flawed.

Neither of these two views is entirely correct. Purely materialist conceptions of military power are unsound because they ignore military effectiveness. Some states consistently excel at turning hard assets into military power, others display endemic weaknesses, and still others exhibit variations in their warfighting capabilities over time. In short, a state's level of military power depends not only upon the size of its resource endowments, but how well it uses those resources for military purposes. The materialist view only takes the former into account and, as a result, fundamentally misrepresents military capability.

Yet, the alternative view – that military capability is, to a significant extent, a product of political and social factors – also suffers from a major shortcoming. In particular, every study in this body of scholarship overlooks the most crucial ingredient of military power: economic development. This omission is especially troubling because Western democracies with high levels of human capital and low levels of civil-military frictions also rank among the most economically developed states in the world. It is entirely plausible, therefore, that the correlations found between these political and social factors and military effectiveness are spurious.

The major empirical finding of this article suggests that this is indeed the case. In hundreds of battles and wars between 1898 and 1987, states with higher levels of economic development consistently outfought less developed opponents. This is not surprising. What is surprising is that many of the political and social factors posited to affect military capability either seem to be irrelevant or have the opposite effect of that found in previous studies: when economic development is taken into account, culture and human capital become insignificant and democracy actually degrades warfighting capability. In short, the conventional military dominance of Western democracies stems primarily from superior levels of economic development, not societal pathologies or political institutions.

This finding qualifies both of the major views of military power. For the traditional materialist view, this article suggests that a country's degree of development – not just the size of its economy, defense budget, or military – is an important ingredient for military success. In other words, military power is a function of both quantity and quality; states of comparable size may still differ in their level of military power

because economically developed states field more effective forces. For the alternative view, these findings suggest that military power is rooted in a state's economy rather than its political institutions, culture, or education system. While economic development may not be the only determinant of military effectiveness, it seems to be the primary determinant. Therefore, a conception of military power that accounts for both the quantity of a state's resources and its level of economic development provides a sound basis for defense planning and international relations scholarship.

For the study of international relations, few topics could be more fundamental. Military power is widely considered to be the most important variable in international relations because it functions as a decisive arbiter of disputes when it is used, and shapes relationships among states even when it is not. Empirical studies have found that military power influences patterns of international cooperation, trade policy, economic development, identity construction, and, of course, war causation and termination. Moreover, much of international relations theory essentially boils down to a debate about the extent to which military power affects state behavior. Yet few academics have attempted to develop a sound conception of military power or to rigorously explore its determinants. Without such an analysis, the study of international relations lacks a foundation upon which to base broader theoretical and empirical claims. This article seeks to provide such a foundation.

Understanding what makes some countries more militarily powerful than others is also important for prudent policymaking. Take, for example, the security implications of China's rapid economic development. If economic development is the key ingredient for an effective military, then the growth of China's economy is synonymous with the expansion of its military potential. But if China's authoritarian political institutions or non-Western culture systematically undermine its ability to turn resources into military power, then the security threat posed by its economic rise may be less menacing than many people assume. Since vital decisions regarding grand strategy, alliance commitments, threat assessment, military doctrine, budget allocation, and the use of force are based on such determinations, the study of military power deserves the most incisive and rigorous research that modern scholarship can provide.

Most importantly, accurate military assessments help prevent foolish wars. Wars are fought over a variety of issues, but most share a fundamental cause: false optimism.[1] Disputes escalate to wars when both sides believe they can use force to accomplish political objectives

[1]Geoffrey Blainey, *The Causes of War*, 3rd ed. (New York: Free Press 1988), Ch.3.

at acceptable costs, or in other words, when both sides think they can win. Of course, few wars in history have been win-win affairs, meaning that at least one side in just about every war – and very often both sides – underestimated the strength of the enemy and ended up paying an excessive price in blood and treasure as a result. In short, erroneous estimates of military power cause wars, therefore accurately conceptualizing and measuring military power increases the likelihood of peace.

This paper proceeds in four sections. The first section reviews the literature on the determinants of military power. The second section outlines a theory relating economic development to military effectiveness and derives several testable hypotheses. The third section tests these hypotheses and finds that economic development best explains military outcomes. The fourth section discusses the implications of these findings.

The Study of Military Power

The existing literature offers two main answers to the central question of this article: why are some states more militarily powerful than others? The first and most prevalent hypothesis is that military power is a direct function of material resources. Many of the classic realist texts, for example, consider the relative quantity of material resources – troops, defense expenditures, GDP, population, industrial base – to be the main determinant of state behavior.[2] Liberals and constructivists often conceptualize military power in material terms when refuting its causal significance.[3] And the most widely used measure of military capability in quantitative studies – the Composite Indicator of National Capability – is an index of six material variables: military expenditure, military personnel, energy consumption, iron and steel production, urban population, and total population.[4] Quite simply, a large chunk

[2]E.H. Carr, *The Twenty Years' Crisis, 1919–1939: An Introduction to the Study of International Relations* (New York: Harper and Row 1964), 109–32; Hans J. Morgenthau, *Politics among Nations: The Struggle for Power and Peace*, 4th ed. (New York: Knopf 1967), 106–44; Kenneth N. Waltz, *Theory of International Politics* (New York: Random House 1979); John J. Mearsheimer, *The Tragedy of Great Power Politics* (New York: Norton 2001), Ch.2.

[3]Robert O. Keohane and Joseph S. Nye, *Power and Interdependence: World Politics in Transition* (Boston, MA: Little Brown 1977); Alexander Wendt, *Social Theory of International Politics* (Cambridge: CUP 1999).

[4]David J. Singer, 'Reconstructing the Correlates of War Dataset on Material Capabilities of States, 1816–1985,' *International Interactions* 14/2 (April 1988), 115–32.

of international relations scholarship rests on the assumption that material indicators provide accurate proxies for military power.

Materialist conceptions of military power also dominate policy analyses and military operations research in the US Department of Defense and in many other Western governments.[5] Mathematical models and computer simulations of combat draw heavily on technological and numerical indicators of military power, while placing much less emphasis on intangible factors, such as leadership and force employment, and ignoring political and social variables altogether.[6] Military units are assessed by means of head-to-head numerical force comparisons, and the most common rule of thumb in defense analyses is that successful attack requires at least a 3:1 local superiority of troops or a 1.5:1 theater-wide advantage.[7] While a plethora of sophisticated indicators – such as force densities, attrition coefficients, and 'firepower scores' – have been employed, the vast majority are essentially measures of material assets, either in terms of manpower or firepower.

Other studies, however, have shown persuasively that these material indicators fail to predict or explain actual combat outcomes. In numerous wars and individual battles, sides with fewer resources have outfought and defeated materially preponderant enemies. Prior to the 1991 Gulf War, military analysts employed the best available net assessment methods to predict casualty ratios, but the best over-estimated American losses by a factor of three; the next best was off by a factor of six; and the majority were off by more than an order of magnitude.[8] These types of failures motivate an alternative conception

[5]Edmund Dubois, Wayne Hughes and Lawrence Lowe, *A Concise Theory of Combat* (Monterey, CA: US Naval Postgraduate School 1998), Ch.1.

[6]Risa A. Brooks, 'The Impact of Culture, Society, Institutions, and International Forces on Military Effectiveness', in idem and Elizabeth A. Stanley (eds.), *Creating Military Power: The Sources of Military Effectiveness* (Stanford UP 2007), 5–6; Aaron L. Friedberg, 'The Assessment of Military Power: A Review Essay', *International Security* 12/3 (Winter 1987/88),192; Seth Bonder, 'Army Operations Research: Historical Perspectives and Lessons Learned,' *Operations Research* 50/1 (Jan.–Feb. 2002), 25–34.

[7]John J. Mearsheimer, 'Assessing the Conventional Balance: The 3:1 Rule and Its Critics', *International Security* 13/4 (Spring 1989), 54–89.

[8]See, e.g., 'Defense Analysts: Limited War to Free Kuwait Could Cut Casualties by Over Half,' *Inside the Army*, 10 Dec. 1990, 11; *Crisis in the Persian Gulf: Sanctions, Diplomacy and War, Hearings Before the Committee on Armed Services, House of Representatives*, House Armed Services Committee No. 101-57 (Washington DC: US GPO 1991), 448, 462, 463, 485, 917; 'Air Strike on Iraq, the Favored Strategy, Means Big Risks for Both Sides', *New York Times*, 23 Oct. 1990, A10; Michael Gordon and Bernard Trainor, *The Generals' War* (Boston: Little, Brown 1995), 132–3, 174; US News and World Report, *Triumph Without Victory* (New York: Random House 1992), 129, 141; Bob Woodward, *The*

of military power that takes into account not only the quantity of a state's material resources, but also how well it uses those resources in battle.

Stephen Biddle, for example, argues that militaries that employ what he calls the 'modern system' – a tightly interrelated complex of cover, concealment, dispersion, suppression, small-unit independent maneuver, and combined arms at the tactical level, and depth, reserves, and differential concentration at the operational level – are more likely to carry out successful operations, even against materially preponderant enemies.[9] Similarly, Colonel Trevor N. Dupuy stressed the role of less tangible factors, such as morale, leadership, and training, in his influential models and writings on military power.[10] And political science studies find that strategy, doctrine, and tactical force employment have decisive effects on combat outcomes.[11]

The key point made by all of these studies is that the manner in which military force is employed mediates the relationship between material strength and military power. Simplistic 'bean counts' of weapons and troops are poor measures of modern military capability. More fundamental to such assessments are the quality of equipment, the skill of the soldiers, and the degree and efficiency of organization. A state's military power, therefore, is a function of two things: its stock of material resources and how well it can translate those resources into force, a capability often referred to as 'military effectiveness'. Military effectiveness thus provides the crucial link between materiel and military power, between what a state's resources suggest it could do and what it actually can do in war.

This point about effectiveness is not inherently incompatible with the traditional materialist view. For example, when realists refer to states as billiard balls or 'like-units', they imply that different countries tend to generate the same amount of military power from a given level of resources. Over time, according to this logic, the pressures exerted by the anarchical international system demonstrate what forms of

Commanders (New York: Simon & Schuster 1991), 349; Tom Matthews, 'The Secret History of the War', *Newsweek*, 18 March 1991, 28ff.

[9]Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton UP 2004).

[10]See, for example, Col. Trevor N. Dupuy, *Numbers, Predictions, and War,* rev. ed. (Fairfax, VA: Hero Books 1985).

[11]Ralph Rotte and Christoph M. Schmidt, 'On the Production of Victory: Empirical Determinants of Battlefield Success in Modern War', *Defence and Peace Economics* 14/3 (June 2003), 175–92; Ivan Arreguin-Toft, *How the Weak Win Wars: A Theory of Asymmetric Conflict* (Cambridge: CUP 2005); Allan C. Stam, *Win, Lose, or Draw: Domestic Politics and the Crucible of War* (Ann Arbor, MI: Univ. of Michigan Press 1996); John J. Mearsheimer, *Conventional Deterrence* (Ithaca, NY: Cornell UP 1983).

behavior succeed and fail, and by that means either socialize all states into a common set of military practices or eliminate those that fall by the wayside.[12] Since states use materiel optimally, the materiel itself is the only relevant source of military power. Thus, traditional conceptions of military power do not necessarily ignore effectiveness, they just do not assign it a causal role independent from material resources.

Recent studies, however, suggest that a host of political and social factors may systematically degrade or enhance a state's military effectiveness, thereby causing some wealthy states to squander their resources, while allowing some poor states to generate inordinate amounts of force.[13] Material factors may represent a state's *potential* level of military power, but non-material factors significantly affect its *actual* level of military power. It follows from this view that the largest or wealthiest states, or even the states with the highest defense budgets, do not necessarily possess the most military might.

To date, this research has focused on four variables – regime-type, culture, civil-military relations, and human capital – though other factors such as ethnic divisions and international relationships have also received attention. Concerning regime-type, Dan Reiter and Allan C. Stam find that democracies win more battles than non-democracies and explain these results by producing statistical evidence linking democratic political institutions to superior leadership and initiative on the battlefield.[14]

Other scholars claim that culture shapes military performance, either because armies reflect the norms and structures of their societies, or because efforts taken to divorce militaries from their societies have consequences for the amount of usable military power available to the state. For example, Ruth Benedict linked the ferocious, suicidal defenses of Japan during World War II to Japanese concepts of honor and shame.[15] More recently, Kenneth Pollack argued that Arab cultural pathologies explain Arab militaries' poor tactical initiative, weak combined arms practices, intelligence failures, inability to perform tactical maneuvers, and systematic displays of individual bravery.[16] This finding is partially supported by Stephen Biddle and Stephen Long's quantitative analysis, in which the authors find that

[12]Waltz, *Theory of International Politics*, 127.

[13]For a summary, see, Brooks, 'The Impact of Culture, Society, Institutions, and International Forces on Military Effectiveness'.

[14]Dan Reiter and Allan C. Stam, *Democracies at War* (Princeton UP 2002), Ch.3.

[15]Ruth Benedict, *The Chrysanthenum and the Sword: Patterns of Japanese Culture* (Boston, MA: Houghton Mifflin 1946).

[16]Kenneth M. Pollack, 'The Influence of Arab Culture on Arab Military Effectiveness', PhD dissertation, Massachusetts Institute of Technology 1996, 37–82, 541, 586, 579.

states with Muslim and Buddhist cultures perform poorly in battles against Western adversaries.[17]

Several studies suggest that the nature of a state's civil-military relations has decisive impacts on the amount of military power it can produce. In countries in which civil-military relations are rancorous and combative, civilian leaders may adopt self-defensive measures that purposefully undermine the military's unity and proficiency. Such interventions include purges of the officer corps and promotion of officers on the basis of loyalty rather than merit, suppression of communications, isolation from foreign sources of expertise or training, and encouragement of divisions within and among different services. These policies may help insulate the regime from military coups, but they systematically reduce the will and capacity of soldiers to pursue apolitical military proficiency.[18]

The final non-material determinant of military effectiveness to receive scholarly attention is human capital. Stephen Biddle and Stephen Long hypothesize that better-educated soldiers may be more receptive to training, more adept at operating and maintaining sophisticated machinery, and more capable of executing tactical maneuvers on the battlefield. In support of this hypothesis, the authors find that developed states with high levels of primary and secondary education outperform less educated enemies on the battlefield.

Taken together, these studies suggest that Western democratic states with low levels of civil-military friction, and high levels of human capital, should be soldier-for-soldier, dollar-for-dollar more militarily powerful than states that lack these characteristics. The potential implications of these findings are immense, not only for the study of military power, but for the entire field of international relations: if political and social factors decisively shape the creation of military power, then the large number of academic theories and policy assessments based on materialist conceptions of military power may be seriously flawed. According to Stephen Biddle, 'an enormous scholarly edifice thus rests on very shaky foundations' because 'the standard measures of military capability at the heart of all this are actually no better than coin flips at predicting real military outcomes'.[19]

[17]Stephen Biddle and Stephen Long, 'Democracy and Military Effectiveness: A Deeper Look', *Journal of Conflict Resolution* 48/4 (Aug. 2004), 525–46.

[18]Stephen Biddle and Robert Zirkle, 'Technology, Civil-Military Relations, and Warfare in the Developing World,' *Journal of Strategic Studies* 19/2 (June 1996), 171–212; Risa A. Brooks, *Political-Military Relations and the Stability of Arab Regimes* (London: International Institute for Strategic Studies 1998).

[19]Biddle, *Military Power*, 2.

These recent studies have made major contributions by highlighting the importance of military effectiveness and by providing several potential explanations of why some states, at some times, fight better than others. The literature, however, still suffers from three shortcomings.

First, there is no comprehensive theory that can explain and predict the military effectiveness, and therefore the military power, of particular states. A review of the literature suggests that Western democracies with educated populations and low levels of internal conflict should fight particularly well, but few countries possess all of these attributes or lack them entirely. Instead most states, including many of the major powers today (e.g. Russia, Japan, China, India, Brazil) fall somewhere in-between these two extremes, possessing some but not all of the ostensible ingredients for military success. In order to develop our understanding of military power, therefore, we need to know not only which factors matter, but how much each one matters in relation to others. In general, the existing literature has succeeded in the first of these tasks, but has come up short with respect to the latter: only one of the studies discussed above (Biddle and Long 2004) tests multiple factors together across a large number of cases.

Second, the relationship between materiel and military power has not been properly tested. Some scholars have attempted to discredit materialist conceptions of military power by examining war and battlefield outcomes. The battlefield analyses to date, however, have been biased against material hypotheses, and war outcomes cannot be used to assess military power in the first place.

Concerning war outcomes, several scholars have pointed out that the materially weaker side has won about half of all wars in the modern era.[20] This fact, however, only highlights that wars are political events not solely determined by military power, not that military power has a non-material basis. When wars break out, the belligerents tend to be closely matched in some combination of capability and resolve because factors that systematically increase the likelihood of victory for one side make war less likely in the first place.[21] In other words, there is a natural overrepresentation of wars in which one side's material superiority is mitigated by the other side's superiority in resolve. Thus we should not be surprised when material factors 'perform no better

[20]Biddle, *Military Power*, 21–4; Arreguin-Toft, *How the Weak Win Wars,* Ch.1; Steven Rosen, 'War Power and the Willingness to Suffer', in Bruce Russett (ed.), *Peace, War, and Numbers* (London: Sage Publications 1972), 167–84.
[21]Blainey, *The Causes of War,* Ch.3.

than a coin toss' at predicting war outcomes because the political outcomes of most wars are, in fact, coin tosses.

With respect to battle outcomes, Stephen Biddle finds that several material indicators do not predict casualty ratios.[22] These results, however, do not constitute fair tests of the relationship between materiel and military power, because casualty ratios measure the *quality* of a state's military units while the material indicators tested measure its *quantity* of resources. There is little reason to expect numerical superiority to correlate with soldier-for-soldier quality. In fact, it is more common for states with large armies and populations to substitute sheer mass for military effectiveness. For example, in both World Wars many Russian soldiers were sent into battle without rifles because Russia had an abundance of manpower but a scarcity of capital.[23] This imbalance did not mean that Russia was militarily weak, just that victory required tremendous human sacrifice. As the old Finnish saying goes: 'Each Finnish soldier is worth ten Russian soldiers, but what happens when the eleventh Russian shows up?'[24] To conduct a fair test of the relationship between material factors and military effectiveness, therefore, it is necessary to weight a state's absolute level of resources by the population over which those resources are distributed. This can be accomplished by using indicators such as per-capita GDP or military spending per soldier. Unfortunately, no existing study of battlefield effectiveness has done so.

Third, and most importantly, the current body of research overlooks a critical determinant of effectiveness: economic development. Politically stable, Western democracies with high levels of human capital also tend to be economically prosperous. It is distinctly possible, therefore, that the correlations found between these political and social variables and military effectiveness reflect a more general connection between economic development and military power. Yet *none* of the studies described above considers this possibility or controls for economic development. A few studies examine the link between development and mobilization capacity and find that (at least in the World Wars) economically developed states successfully produce and deliver more resources to the

[22]Biddle also uses territorial gain as a dependent variable, but the results are mixed. In particular, he finds that the defender's force-to-space ratio has a significant effect on the attacker's ability to gain territory. As he points out, this result is consistent with materialist conceptions of military power. See, Biddle, *Military Power,* 170–3.

[23]Jonathan R. Adelman, *Revolution, Armies, and War: A Political History* (Boulder, CO: Lynne Rienner 1985), 88–92.

[24]Thanks to Richard Betts for passing on this phrase.

battlefield than poorer states.[25] But this insight only links development to quantities of military resources; it does not explain variations in the quality of those resources.

We now come to the central argument of this study: military effectiveness is primarily a product of economic development. In particular, economically developed states tend to possess more sophisticated and reliable equipment and more skilled military personnel than less developed states. These two qualitative advantages, of equipment and skill, translate directly into military superiority. The next section expands on this argument while the subsequent section tests it empirically.

Economic Development and Military Effectiveness

The essence of economic development is efficiency of production. The higher a state's level of economic development, by definition, the more efficiently its workers produce goods and services. There may be a natural tendency to view civilian and military realms as separate entities, but militaries are actually embedded within economic systems. Thus, countries that excel in producing civilian goods and services also tend to excel in producing military force.[26] In particular, economic development improves a state's ability to produce high-quality military equipment and skillful military personnel.

This theory goes beyond the traditional materialist view, which only links military effectiveness to defense spending and implies that poor, technologically backward states can still piece together powerful militaries by stealing or purchasing arms from abroad and channeling investment into defense at home. As the subsequent discussion and empirical tests make clear, however, the relationship between economic development and military effectiveness extends far beyond sums of money.

[25]Stephen Broadberry and Mark Harrison (eds.), *The Economics of World War I* (Cambridge: CUP 2005); Mark Harrison (ed.), *The Economics of World War II* (Cambridge: CUP 1998); Klaus Knorr, *Military Power and Potential* (Lexington, MA: Heath Lexington Books 1970); Klaus Knorr, *The War Potential of Nations* (Princeton UP 1956).

[26]Obviously economically developed countries may, for various reasons, decide not to invest in military power. The point here is that given a fixed quantity of resources devoted to defense, economically developed states will produce more effective forces and therefore be more militarily powerful than less developed states. In other words, this paper is not about whether states have an *interest* in military power, but rather whether they have the *capacity* to produce and employ it.

Equipment

Innovations occur sporadically in all societies, but only economically developed states are capable of sustained technological progress. The institutional foundation of economic growth – secure and enforceable property rights – encourages the creation and application of new innovations, while high levels of commerce and mobility facilitate their dissemination. Developed economies also posses the financial capital to fund technological innovation, and the production capacity to manufacture equipment in large quantities. As industries within an economy become more advanced, they increasingly benefit from economies of scale that diminish the unit costs of production and, therefore, increase the likelihood that new innovations, including military innovations, will be developed and adopted.

This capacity for sustained technological progress translates into technological supremacy in battle, as evidenced most clearly by the history of colonialism. Consider that in 1850, Great Britain's GDP was only half that of India's, yet Britain's fourfold advantage in economic development (as measured by per capita income) translated into vastly superior weapons and organization, which in turn facilitated political domination.[27] Throughout this period technological asymmetries resulted in extremely one-sided military outcomes. For example, in 1898 during the Battle of Omdurman, a British-led army used Maxim guns and Lee-Enfield rifles to cut down 11,000 Dervishes for the loss of only 49 of its own troops.[28]

Even when two sides possess similar types of equipment, those possessed by economically developed states tend to be of higher quality. For example, the original designs for the American M1 tank and the Soviet T-72 entered production within ten years of each other. The M1, however, was produced by the most vibrant economy on earth while the T-72 emerged from a stagnant, technologically backwards society. The resulting 'tank gap' was never exploited during the Cold War, but it was made manifest during the 1991 Gulf War.[29] While US tank rounds had no problem penetrating Iraqi T-72s from distances

[27]Figures calculated from data in, Angus Maddison, 'Historical Statistics, World Population, GDP and Per Capita GDP, 1–2003 AD', 2007, accessed at <www.eco.rug.nl/~Maddison/>.

[28]For a summary, see, Michael Clodfelter, *Warfare and Armed Conflicts: A Statistical Reference to Casualty and other Figures, 1500–2000*, 2nd ed. (Jefferson, NC: Mcfarland 2002), 228.

[29]On the superiority of US tanks over Soviet tanks, see Malcolm Chalmers and Lutz Unterseher, 'Is There a Tank Gap? Comparing NATO and Warsaw Pact Tank Fleets', *International Security* 13/1 (Summer 1988), 5–49.

up to 3,700 meters, Iraqi T-72 rounds – some of which were fired from within 500 meters – often failed to damage American tanks or even slow them down.[30] Soviet fighter aircraft similarly lagged far behind those of the United States. When a Soviet pilot, seeking asylum, flew his MiG-25 to Japan in 1976, inspectors on the ground found it was devoid of any next-generation technologies and described it as basically a 'rocket with a window'.[31]

These technological deficiencies did not stem from a lack of funding – throughout the 1970s and 1980s, the USSR allocated 2–3 per cent of its entire gross national product to military research and development[32] – but rather from economic underdevelopment.

In considering technological superiority, moreover, it is important not to fixate solely on weapons platforms. Advantages in communications, intelligence, medical care, and logistics can have decisive impacts on military outcomes. For example, American victory in the Pacific campaigns of World War II was due in no small part to the ability of US soldiers to stay healthy while Japanese forces were decimated by disease. Moreover, the historically low loss rate in the 1991 Gulf War can be partially explained by the decisive American advantage in intelligence systems, including its constellation of global positioning system (GPS)-based navigation systems, Joint Surveillance and Target Attack Radar System (JSTARS) aerial surveillance radar, satellites, and spy-planes.

While states can purchase advanced technologies from others, only developed economies possess the technological industry and skilled workforce necessary to modernize them. For example, in the mid-1930s, Fascist Italy was spending more on defense than Britain, France, or the United States, yet this massive military investment lacked a solid economic foundation. In 1938, Italy possessed only 2.8 per cent of the world manufacturing production, produced only 2.1 per cent of its steel, and had a per capita income equal to that achieved by Britain in the middle of the *nineteenth* century.[33] Without a vibrant technology sector or a robust industrial infrastructure, Italy was incapable of keeping pace with vital military developments and entered World War

[30]Enzio Bonsignore, 'Gulf Experience Raises Tank Survivability Issues,' *Military Technology* 16/2 (Feb. 1992), 64–70.
[31]Robert L. Paarlberg, 'Knowledge as Power: Science, Military Dominance, and US Security', *International Security* 29/1 (Summer 2004), 123–4.
[32]Ibid., 136.
[33]Paul Kennedy, *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000* (New York: Vintage Books 1987), 294; Maddison, 'Historical Statistics, World Population, GDP and Per Capita GDP, 1–2003 AD'.

II with obsolete equipment: Italian biplanes flew at half the speed of Allied aircraft while Italian tanks, weighing a mere 3.5 tons and armed with two machine guns, were no match for Allied tanks that weighed 20 tons and had much heavier weaponry.[34] Shackled to such outdated technology, it is little wonder that the Italian Army was routed in the North Africa campaign.

Even if underdeveloped states obtain the 'teeth' of a technologically sophisticated military, they may not possess the 'tail' needed to support it.[35] Poor countries may, for example, purchase modern tanks and aircraft but lack the spare parts or the technicians to keep them running. These two deficiencies, of supplies and trained personnel, often go hand-in-hand and reinforce each other, creating a problem one scholar termed 'the logistic snowball': a state with meager supplies needs to use what it has efficiently, but it is poor in the first place precisely because it is incapable of operating efficiently. Thus, accomplishing a given task requires more personnel, who in turn require more resources and personnel to transport, house, feed, and manage them, and so on.[36]

Finally, militaries often rely directly on civilian equipment, supplies, and techniques. For example, in 1973 Israeli milk trucks carried ammunition across the Suez Canal, and El Al's passenger planes delivered high-priority spare parts and ammunition.[37] Today, the American military depends on private companies to provide logistical services and to produce information technologies, such as fiber optic-laced clothing, head-mounted computer displays, global satellite phones, impromptu wireless networks, and rugged laptop computers. Two of the most important modern weapons systems, stealth and multispectral technologies, depend on innovative manufacturing and design technologies that reside in the commercial sector, and three-quarters of the computing power in the Aegis cruiser depends on commercial equipment.[38] In these respects, a solid economic infrastructure enhances military effectiveness *during* wars, as well as in the periods that precede them.

In earlier eras, copying and imitation through espionage were viable options for laggard states seeking to catch up with technological

[34]Kennedy, *Rise and Fall of the Great Powers*, 295.
[35]Eliot A. Cohen, 'Distant Battles: Modern War in the Third World,' *International Security* 10/4 (Spring 1986), 164–6.
[36]Henry E. Eccles, *Logistics in the National Defense* (Harrisburg, PA: Stackpole 1959), 104.
[37]Cohen, 'Distant Battles', 166.
[38]Richard J. Samuels, *Rich Nation, Strong Army: National Security and the Technological Transformation of Japan* (Ithaca, NY: Cornell UP 1994), 26.

leaders. In the early 1900s, it only took three years for Germany to copy and produce its own version of the British super battleship HMS *Dreadnought*. The first US detonation of a nuclear weapon in 1945 was followed by a Soviet detonation only four years later. Today, however, military technologies are much more difficult to copy because they are not stand-alone pieces of hardware. Military power used to consist primarily of weapons platforms and troops; today it is comprised of systems, which link weapons and troops to sensors, satellites, and command centers. Countries may be able to purchase certain aspects of these systems from abroad, but only developed states will have the supporting infrastructure necessary to assimilate state-of-the-art military technologies and integrate them into a cohesive, lethal whole.

Skill

Military effectiveness also requires skill. As Stephen Biddle has pointed out, the extreme lethality of modern weapons makes exposed mass movement on the battlefield suicidal. To survive in such an environment, military units must master demanding tactical schemes that allow them to accomplish military missions while simultaneously minimizing their exposure to enemy firepower.[39] Skill is also crucial at the operational level. Officers must be able to synthesize a host of factors – the mission, the strength and objectives of the enemy, terrain, weather, etc. – and make decisions regarding strategy, doctrine, and tactics that maximize the power of their forces. Moreover, leaders must continually assess military units and improve operational plans and training programs accordingly. For example, after defeating Poland in World War II, the German military leadership critically examined its own forces and instituted organizational changes. This process produced a much more effective fighting force and facilitated the subsequent drubbing of France in May and June 1940.[40]

In addition, military effectiveness hinges upon the quality of administrative decisions regarding military organization and structure. Successfully coordinating, supplying, and transporting forces in theaters of combat requires not just trained soldiers but also talented managers and brainy analysts to determine and implement the most effective distribution of manpower, equipment, and expenditures. In this regard, scientific techniques, such as operations research and systems analysis, provide a foundation of rigorously derived knowledge upon which sound operational decisions can be made.

[39]Biddle, *Military Power*, 38–48.

[40]Williamson Murray, 'German Response to Victory in Poland: A Case Study in Professionalism', *Armed Forces and Society* 7/2 (Winter 1981), 285–98.

Skill, however, is an extremely perishable commodity. Each successive class of soldiers must receive rigorous training, and existing units must drill continually to prevent atrophy. Basic training for a typical soldier may only take a few months, but training officers to lead them takes years and requires a system of military academies to disseminate military know-how and breed trust within the ranks.[41] Furthermore, an effective military administration requires a robust infrastructure of government, academic, and private research institutions, as well as a constant supply of human capital to staff them. The key point is that militaries need *sustained* investment to remain effective because it is extremely difficult to develop or rebuild skills once lost.

Supporting a large military establishment for a long period of time, however, may reduce the rate of economic growth and therefore the wealth needed for future military power. States throughout history have faced the dilemma of balancing the short-term security afforded by large defense budgets against the longer-term security of rising wealth. But this predicament is far less acute for economically developed states that can produce effective militaries while devoting a relatively small percentage of their economic resources to defense.

In addition, superior economic efficiency lowers the unit costs of weapons and supplies, thereby providing soldiers more opportunities to train with them, and more opportunities for administrators to test new weapons and determine their feasibility for full deployment.[42] By contrast, underdeveloped states may not be able to afford wasting ammunition and supplies on training and testing, or be able to pay and retain skilled soldiers in peacetime. For example, the Soviet MiG-21 fighter aircraft received overhauls at triple the rate of many Western aircraft, and Soviet T-62 tank engines reportedly wore out completely after 500 hours or less of use. As a result, the Soviet military was forced to keep its weapons 'packed away like a family's best china', using them only for special exercises once or twice a year.[43]

Economically developed states are also more likely to have skilled military administrations. As incomes rise, education systems expand, thereby enlarging the pool of human capital from which to assemble

[41]Allan R. Millett, Williamson Murray and Kenneth H. Watman, 'The Effectiveness of Military Organizations', in Allan R. Millet and Williamson Murray, eds., *Military Effectiveness, Volume I: The First World War* (Boston, MA: Allen & Unwin 1988), 14.
[42]Michael Horowitz, 'The Diffusion of Military Power: Causes and Consequences for International Politics,' PhD dissertation, Harvard Univ. 2006, 49–50.
[43]Richard K. Betts, *Military Readiness: Concepts, Choices, Consequences* (Washington DC: Brookings Institution Press 1995), 156–9.

a competent bureaucracy.[44] Moreover, a dynamic economy provides many opportunities to develop managerial skills, which can then be transferred to militarily relevant industries and organizations. Economically developed states are also more likely to possess the technological capacity for rigorous data analysis and communication. In short, skillfully run economies beget skillfully run militaries. As Eliot Cohen has argued, the few cases of poor states successfully administering military operations (e.g. North Vietnam) are 'the exception that proves the rule' because poor states 'almost by definition face an acute shortage of the kind of managerial expertise needed'.[45]

Finally, economic development mitigates political constraints that impede the generation of military skill. Some studies have noted that internal political discord significantly reduces military effectiveness by eroding trust among soldiers from different societal groups or by causing regimes to purposefully undermine the military's unity and proficiency. Prosperous states, however, are far less likely to be afflicted by such schisms. It is an empirical fact that economically developed states experience fewer coups than less developed states. In fact, no democracy has ever fallen in a country with a per capita income above $6,055.[46] Moreover, at least four studies have found that higher per capita incomes significantly reduce the likelihood of civil wars.[47] As the World Bank concluded in 2003 after four years of research on the topic: 'the key root cause of (internal) conflict is the failure of economic development'. In short, economically developed states are far more likely to have political environments conducive to the development of military proficiency.

[44]Edward L. Glaeser, Rafael La Porta, Florencio Lopez-de-Silane and Andrei Shleifer, 'Do Institutions Cause Growth?' *Journal of Economic Growth* 9/3 (Sept. 2004), 271–303.

[45]Cohen, 'Distant Battles', 162–3.

[46]Jess Benhabib and Adam Przeworski, 'The Political Economy of Redistribution under Democracy', *Economic Theory* 29/2 (Oct. 2006), 270–91; Adam Przeworski, Michael E. Alvarez and Jose Antonio Cheibub, *Democracy and Development: Political Institutions and Material Well-Being in the World* (Cambridge: CUP 2000), 106–17.

[47]Nicholas Sambanis and Havard Hegre, 'Sensitivity Analysis of Empirical Results on Civil War Onset', *Journal of Conflict Resolution* 50/4 (Aug. 2006), 508–35; Paul Collier and Anke Hoeffler, 'Greed and Grievance in Civil Wars', *Oxford Economic Papers* 56/4 (Oct. 2004), 563–95; James D. Fearon and David D. Laitin, 'Ethnicity, Insurgency, and Civil War', *American Political Science Review* 97/1 (Feb. 2003), 75–90; Robert H. Bates, 'Political Insecurity and State Failure in Contemporary Africa', Center for International Development, Harvard Univ., Working Paper 115 (2005).

Endogenous Development

The preceding point highlights the fact that economic development is itself partly a product of political and social factors. One might even argue that development is an outcome of democracy, civil-military relations, human capital, or culture. If this were true, then we would find an association between economic development and military effectiveness, not because economic development is the primary determinant of effectiveness, but because development serves either as a proxy for these political and social factors or as an intervening variable between them and military effectiveness.

The latter possibility, however, is somewhat beside the point because existing studies of military effectiveness claim that political and social factors *directly* shape the creation of military power, not that they do so indirectly through their effects on economic development. Thus, even if economic development were largely an outcome of culture, regime-type, human capital, or civil-military relations, that does not refute the claim that development directly shapes military effectiveness.

More importantly, it is doubtful that economic development is a product primarily of one or some combination of these four factors. For instance, there is no hard evidence that amiable civil-military relations are a precondition for economic development. By contrast, it has been found that economic downturns precipitate civil-military antagonisms because, among other reasons, they often result in significant cuts in defense spending.[48] As noted above, the best predictor of regime survival and internal order is high per capita incomes. To the extent that wealth insulates regimes from internal threats and allows them to focus on external enemies, it seems plausible that civil-military comity actually constitutes one of the causal mechanisms through which economic development enhances military power.

Similarly, there is no consensus that democracy promotes economic growth. While democratic institutions may help secure property rights by constraining rulers, they may also unleash popular demands for consumption or empower interest groups to force through inefficient redistributions of resources.[49] This theoretical uncertainty is reflected in the empirical record. In a review of existing studies on the issue, eight conclude that democracy facilitates economic growth, eight argue that

[48]Brooks, *Political-Military Relations and the Stability of Arab Regimes*, 23–9.

[49]On savings and investment, see Walter Galenson, 'Introduction', in Walter Galenson (ed.), *Labor and Economic Development* (New York: Wiley 1959). On interest groups, see Mancur Olson, *The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities* (New Haven, CT: Yale UP 1982).

dictatorship increases growth, and five studies find that regime-type makes no difference.[50] A subsequent study by Robert Barro also failed to find clear empirical support either way.[51] Finally, the reverse argument, that economic development causes democratization, has been around for decades (modernization theory) and recently received statistical support.[52]

Debates over the relationship between culture and economic growth are similarly unresolved. At least since Max Weber's *The Protestant Ethic and the Spirit of Capitalism* in 1920, groups of scholars have argued that culture drives economic performance.[53] According to this view, certain societies have systems of attitudes, values, and knowledge that facilitate economic growth. Others, however, respond that attributing economic and political outcomes to culture mistakes cause for effect. These scholars maintain that coherent configurations of attitudes across broad groups of citizens rarely exist, and when they do, they do not persist for long periods of time. Moreover, some of the findings linking culture to political and economic performance were revealed to be results of statistical errors or omitted variable bias.[54] Finally, the fact that many of today's fastest growing economies include a diverse array of cultures casts doubt on the argument that economic development is culturally determined.

Higher levels of human capital almost certainly facilitate economic growth, but only certain types are essential. While trained scientists are obviously required for indigenous technological innovation, economic growth does not necessarily require that the population at large be

[50]Adam Przeworski and Fernando Limongi, 'Political Regimes and Economic Growth', *Journal of Economic Perspectives* 7/3 (Summer 1993), 51–69.

[51]Robert J. Barro, *Determinants of Economic Growth: A Cross-Country Empirical Study* (Cambridge, MA: MIT Press 1997).

[52]Carles Boix and Susan C. Stokes, 'Endogenous Democratization', *World Politics* 55/4 (July 2003), 517–49.

[53]Max Weber, *The Protestant Ethic and the Spirit of Capitalism* [1920] 3rd ed. (Los Angeles, CA: Roxbury 2000); Ronald Inglehart, 'The Renaissance of Political Culture', *American Political Science Review* 82/4 (Dec. 1988), 1203–30; Ronald Inglehart, *Culture Shift in Advanced Industrial Society* (Princeton UP 1990); Avner Grief, 'Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies,' *Journal of Political Economy* 102/5 (Oct. 1994), 912–50; Timur Kuran, 'The Islamic Commercial Crisis: Institutional Roots of Economic Underdevelopment in the Middle East', *Journal of Economic History* 63/2 (June 2003), 414–46.

[54]Edward N. Muller and Mitchell A. Seligson, 'Civic Culture and Democracy: The Question of Causal Relationship', *American Political Science Review* 88/3 (September 1994), 635–52; Robert W. Jackman and Ross A. Miller, 'A Renaissance of Political Culture?' *American Journal of Political Science* 40/3 (Aug. 1996), 632–59.

highly educated.[55] After all, Great Britain, the most economically developed state in 1850 and the birthplace of the Industrial Revolution, was far from being the best educated, most literate, or best-endowed in human capital.[56] Perhaps for this reason, some studies have found that the economic returns to education are not especially high.[57] Finally, human capital is itself endogenous to growth. As a recent study has shown, the initial level of income is a strong predictor of subsequent growth in education, likely because more developed countries can afford more robust systems of education.[58]

In sum, economic development is related to, but distinct from, human capital, civil-military relations, democracy, and culture. It follows that studies of military effectiveness can and should test these factors together. Not only is economic development a potentially crucial determinant of effectiveness, but previous findings, concerning the effects of democracy, culture, human capital, and civil-military relations, cannot be verified until alternative explanations, such as economic development, have been controlled for. At this point, we can derive several testable hypotheses:

> **Hypothesis 1.** States with higher levels of economic development should perform more effectively on the battlefield than less developed states.

Confirmation of this hypothesis does not imply that economic development is all that matters, it merely suggests that economic development is one of several important determinants of military effectiveness.

A stronger claim would be that economic development is the primary determinant of military effectiveness. According to this view, correlations found by previous studies between political and social variables and military effectiveness are spurious. Western democracies with high levels of human capital and low levels of civil-military friction fight better simply because they tend to be more economically developed than states that lack these characteristics.

[55]Joel Mokyr, 'Long-Term Economic Growth and the History of Technology', in Phillippe Aghion and Steven N. Durlauf (eds.), *Handbook of Economic Growth* (Amsterdam: Elsevier 2005), Ch.17.
[56]David Mitch, 'The Role of Education and Skill in the British Industrial Revolution,' in Joel Mokyr (ed.), *The British Industrial Revolution: An Economic Perspective*, 2nd ed. (Boulder, CO: Westview Press 1998), 241–79.
[57]Lant Pritchett, 'Where Has All the Education Gone?' *World Bank Economic Review* 15/3 (Oct. 2001), 367–91.
[58]Glaeser *et al.*, 'Do Institutions Cause Growth?', 271–303.

Hypothesis 2. After controlling for economic development, regime-type, culture, human capital, and civil-military relations should not associate strongly with performance on the battlefield.

Finally, some earlier studies used the level of defense spending per soldier as a proxy for the quality of military forces.[59] This association of defense spending with military effectiveness is consistent with the traditional view that military capability is a function of material resources. The preceding discussion, however, suggests that the benefits of superior economic development go beyond merely having more money to invest in the military. In particular, economically developed states are more likely to have robust technological infrastructures, large-scale production capacities, skillful personnel, and stable political environments, which may enhance effectiveness independent of the level of defense spending.

Hypothesis 3. States with higher levels of economic development should perform more effectively on the battlefield than less developed states, even after controlling for the level of military spending.

Empirical Analysis

The empirical analyses below test these three hypotheses by drawing upon the same data used in previous studies claiming that regime type, culture, human capital, and civil-military relations have significant effects on military performance.[60] The goal is to provide a meaningful contribution to our understanding of military effectiveness while making the smallest possible changes to the research designs of the latest studies. This technique helps prevent bias in favor of my hypotheses and enables the reader to trace specific changes in substantive conclusions to particular methodological alterations.[61] Therefore, except for robustness checks and to create variables for economic development, defense spending, and regime consolidation variables, *all of the data* used in this study comes from Biddle and Long (2004), which is the latest quantitative study on the determinants of military effectiveness.

[59]See, for example, Stam, *Win, Lose, or Draw*.
[60]Reiter and Stam, *Democracies at War*, Ch. 3; Biddle and Long, 'Democracy and Military Effectiveness'.
[61]Gary King, 'Publication, Publication', *Political Science and Politics* 39/1 (Jan. 2006), 119–26.

The Biddle and Long data is a modified version of the CBD90 dataset, which was compiled for the US Army by the Historical Evaluation and Research Organization, now called the Dupuy Institute. Biddle and Long's modified version covers 381 battles fought since 1900. Each observation represents a battle, with attacker and defender attributes as variables. The original data set contained significant errors.[62] But Biddle and Long improved the quality of the data by removing double counts of battles and fixing historical inaccuracies.[63]

Dependent Variable

Loss-exchange ratio (LER): the LER is simply the attacker's casualties divided by defender's casualties and has been used as a measure of military effectiveness in Biddle and Long (2004) and Biddle (2004). This measure can be calculated for individual battles or entire wars. LERs have several benefits. First, it provides an objectively measurable, continuous variable that is not dependent on subjective, post-hoc codings like 'win/lose/draw'. Second, LERs permit the magnitude of the victory or defeat to be recorded and thus retain more of the actual variance in the data. Third, LERs naturally control for the scale of combat action, which is important because many military outcome measures vary with the size of the units involved. Fourth, LERs have been found to coincide significantly with more qualitative assessments of effectiveness[64] – the militaries considered by historians to have been the most formidable have also tended to achieve the most favorable LERs in battle. It should be noted that smaller LERs coincide with greater military effectiveness for the attacker. Thus, in the empirical analyses that follow, *negative coefficients represent positive effects on military effectiveness*.

Independent Variables

Democracy: The attacker's fraction of the total democracy score for combatants, measured by the respective Polity III 'DEMOC' variable values in the year prior to the outbreak of war. The higher the value, the more democratic was the attacker relative to the defender and vice versa.

[62]Michael C. Desch, 'Democracy and Victory: Why Regime Type Hardly Matters', *International Security* 27/2 (Fall 2002), 39–41.
[63]Biddle and Long, 'Democracy and Military Effectiveness', 533–5.
[64]Dupuy, *Numbers, Predictions and War,* 45–6; Stephen Biddle, 'Explaining Military Outcomes', in Brooks and Stanley, *Creating Military Power*, 213–14.

Human capital: The attacker's fraction of the sum of attacker and defender states' years of primary and secondary education per capita in the year prior to the outbreak of war as reported in the Banks data.[65] The higher the value, the greater the attacker's relative edge in human capital.

Civil–military relations: Two dummy variables are used. The first, 'civmil favoring attacker', takes a value of 1 if the defender had at least one more coup d'état in the five years prior to the war than the attacker as reported in the Banks data. The second, 'civmil favoring defender', takes a value of 1 if the attacker had at least one more coup d'état in the five years prior to the war than the defender.

Culture: A series of dummy variables representing combatant states' primary religious affiliations as rough cultural indicators are employed. 'PC' denotes a state in which the most common religious affiliation is Protestant or Catholic; 'BU' Buddhist, Confucian, Shintoist, or a combination thereof; 'MU' Muslim; 'JE' Jewish; and 'OR' Orthodox (Eastern Orthodox, Russian Orthodox, etc.). Each dummy represents a pair of states – the first two letters identify the attacker's religion, the second give the defender's.[66]

Economic development: The attacker's fraction of the sum of attacker and defender states' per-capita incomes in the year prior to the battle. The higher the value, the greater the attacker's relative per-capita GDP. Data is taken from the Maddison dataset.[67]

Military spending per soldier: The attacker's fraction of the sum of the two sides' military spending per soldier in the year prior to the battle. Data is obtained from the Correlates of War National Material Capabilities dataset.[68]

Control Variables

Troops: the attacker's fraction of the two sides' total troop strength.

[65]Arthur S. Banks, *Cross-National Time Series, 1815–1973* (Computer file). ICPSR ed. (Ann Arbor, MI: Inter-University Consortium for Political and Social Research (producer and distributor).

[66]Data were compiled by Biddle and Long using, CIA, *The World Factbook 2001* (Washington DC: Government Printing Office).

[67]Maddison, 'Historical Statistics,World Population, GDP and Per Capita GDP, 1–2003 AD'.

[68]Singer, 'Reconstructing the Correlates of War Dataset on Material Capabilities of States, 1816–1985'.

Tank prevalence: the total number of tanks engaged (on both sides) divided by the total number of troops (on both sides).

Ground-attack aircraft prevalence: The total number of ground-attack aircraft sorties (on both sides) divided by total troops (on both sides).

Artillery prevalence: The total number of artillery tubes engaged (on both sides) divided by the total troops engaged (on both sides).

Hypothesis 1: Economic Development Increases Military Effectiveness

Figure 1 shows that as the attacker's per-capita GDP increases relative to the defender's, the number of defenders killed per attacker killed also increases. Bivariate regressions show that these relationships are significant at the 1 per cent level. In short, economically developed states significantly outperform less developed states in battle.

To validate this finding, I employed four robustness checks. First, all cases were dropped in which the economic development variable was more than one standard deviation above or below its mean average. Dropping these extreme cases, however, does not alter the initial results. Thus, even relatively small differences in economic development produce disparities in military effectiveness.

Second, to control for momentum or spillover effects between battles, a smaller sample was created, containing only one battle per dyad per month. This helps ensure that each observation is independent

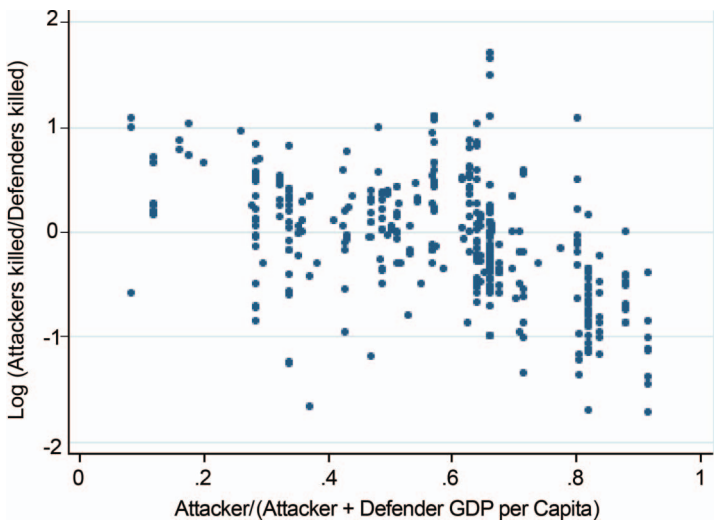

Figure 1. GDP per capita as a predictor of loss-exchange ratios in battles, 1904–1982.

of others. Once again, however, this modification does not alter the results.

Third, two alternative measures were used for economic development: energy consumption per capita and iron and steel production per capita.[69] As shown in Figure 2 and Figure 3, these alternative measures do not change the basic pattern: economic development increases effectiveness.

Finally, the relationship between development and effectiveness is tested using the Correlates of War Inter-State War dataset. This alternative source of data introduces a more diverse array of cases and a different unit of analysis – wars as opposed to battles – thereby ensuring that the previous findings were not the result of idiosyncracies of the CDB90 dataset. Calculating loss-exchange ratios in coalition wars, however, is problematic since it is not clear which country inflicted particular sets of casualties. Therefore, I exclude all coalition wars and consider only the bilateral wars for which per capita income data was available. While this exclusion reduces the number of cases, it should not bias the results. Moreover, some of the major coalition wars (e.g. both World Wars and the four Arab–Israeli wars) are overrepresented

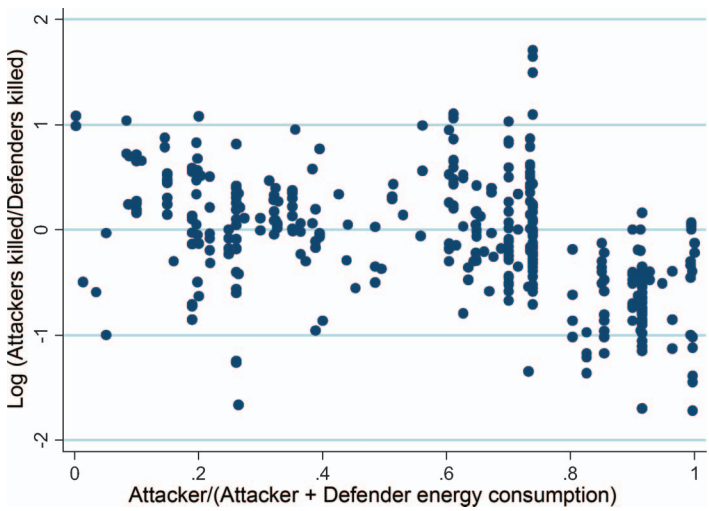

Figure 2. Energy consumption per capita as a predictor of loss-exchange ratios in battles, 1904–1982.

[69]Data for these variables was obtained from the National Material Capabilities dataset, version 3.02. For a description of the dataset see, Singer, 'Reconstructing the Correlates of War Dataset on Material Capabilities of States, 1816–1985'.

in the CDB90 dataset. Thus, dropping them helps check against the possibility that the previous results were unique to these wars. Figure 4 shows that the relationship between economic development and military effectiveness remains quite distinct, even when a different dataset is used.

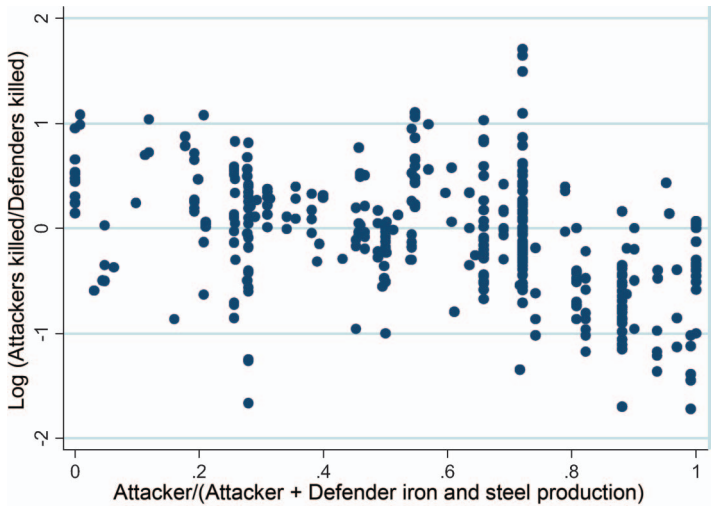

Figure 3. Iron and steel production per capita as a predictor of loss-exchange ratios in battles, 1904–1982.

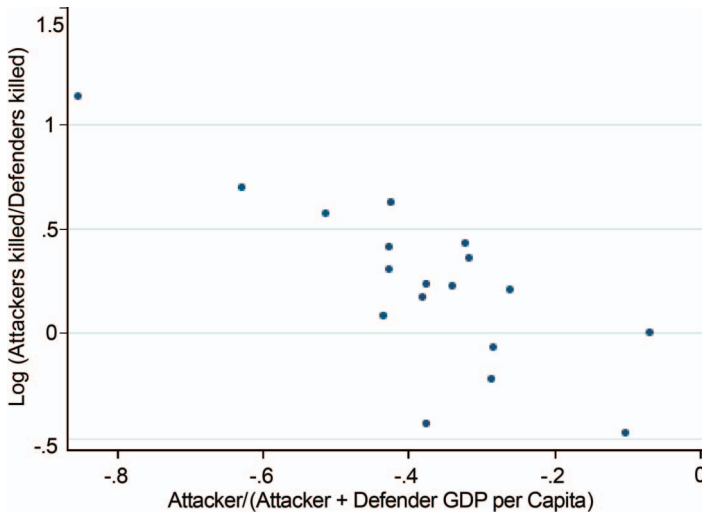

Figure 4. GDP per capita as a predictor of loss-exchange ratios in wars, 1898–1987.

In sum, there is considerable support for the first hypothesis. The positive relationship between economic development and military effectiveness holds across two different datasets, three different operationalizations of economic development, after extreme values of the independent variable have been dropped from the analysis, and after controlling for temporal dependence.

Hypothesis 2: Economic Development is the Primary Determinant of Effectiveness

Table 1 presents multivariate results suggesting that the primary determinant of military effectiveness is economic development, and that many of the political and social factors posited to affect military capability either seem to be irrelevant or have the opposite effect of that found in previous studies. Two regressions are presented. Model 1 replicates the findings of Biddle and Long (2004), which shows that human capital, culture, democracy, and civil-military relations significantly affect loss-exchange ratios.

Table 1. Determinants of Military Effectiveness (Dependent variable: log(LER))

	Model 1	Model 2
GDP per capita		**−1.89**** (0.58)
Human capital	**−1.13*** (0.49)	−0.26 (0.49)
PC-PC	−0.19 (0.16)	0.08 (0.17)
PC-BU	**−1.18**** (0.17)	−0.37 (0.31)
PC-MU	0.70 (0.60)	1.22 (0.62)
OR-MU	0.42 (0.26)	**0.72*** (0.30)
OR-BU	0.22 (0.33)	0.67 (0.39)
JE-MU	**−0.78**** (0.21)	−0.18 (0.25)
OR-PC	0.16 (0.23)	0.18 (0.16)
Democracy	**0.36*** (0.14)	**0.72**** (0.18)
Civmil favors defender	**0.40*** (.17)	**0.48**** (0.16)
Civmil favors attacker	−0.15 (0.11)	**−0.32**** (0.11)
Troops	0.51 (0.33)	0.25 (0.33)
Tanks	1.68 (5.66)	0.78 (5.46)
Aircraft	3.22 (5.07)	4.01 (4.87)
Artillery	**10.70*** (4.72)	8.10 (4.72)
Constant	0.19 (0.41)	0.44 (0.35)
N	223	223
R-sq	0.42	0.46

Note: Entries are OLS regression coefficients with standard errors in parentheses. All results employ robust standard errors.
*p < .05, **p < .01.

Model 2 simply adds a variable for economic development (per capita income). The first thing to notice is that the economic development variable is highly significant (at the 1 per cent level), suggesting that the positive relationship between development and effectiveness holds even when controlling for materiel (number of troops, aircraft, artillery, tanks) and a host of political and social factors.

Second, human capital becomes insignificant once per-capita GDP is added to the regression. This suggests that primary and secondary education exerts no meaningful, independent influence on military effectiveness once development is taken into account. It is unlikely that this result is caused by multicollinearity because the correlation between per-capita GDP and human capital is only .38.

Similarly, the variables suggesting that Western culture improves military effectiveness (Protestant/Catholic vs. Buddhist (PCBU) and Jewish vs. Muslim (JEMU)) also become insignificant once economic development is taken into account. In particular, the fact that the JEMU variable loses its significance suggests that the military dominance of Israel over its Arab enemies, attributed by some scholars to Arab cultural deficiencies, is more likely a consequence of Israel's superior level of economic development. Strangely, the Orthodox vs. Muslim (ORMU) variable becomes significant once economic development is accounted for. This might suggest that Eastern or Russian Orthodox cultures have some military advantage over Muslim cultures. It should be kept in mind, however, that this result is tentative, because it is based on a limited number of observations, namely a handful of battles against the Ottoman Empire in World War I. It should be noted that a recent case study on the subject concludes that economic underdevelopment, 'more than anything else ... holds the key to understanding the capacity and performance of the Ottoman military during World War I'.[70] Moreover, if Orthodox culture systematically enhances effectiveness, or if Muslim culture systematically undermines it, then we might expect some of the other dummy variables that include them (e.g. JEMU or PCOR) to be significant. In sum, Biddle and Long's findings about culture do not hold once economic development is taken into account, and the only finding that supports cultural explanations of military effectiveness is sketchy.

Third, Model 2 corroborates Biddle and Long's finding that democracy has a highly significant negative effect on military effectiveness. This contradicts Reiter and Stam's studies and suggests that their finding of a positive relationship between democracy and

[70]Sevket Pamuk, 'The Ottoman Economy in World War I,' in Stephen Broadberry and Mark Harrison (eds.), *The Economics of World War I* (Cambridge: CUP 2005), 112–36.

battlefield effectiveness is actually attributable to other factors that correlate positively with democracy. Thus, it seems that democracies perform better on the battlefield *in spite of* their democratic political institutions, not because of them.

The correlation between democracy and per capita GDP is quite high (.68) but the reversal of the sign on democracy occurred when human capital was added to the regression in Biddle and Long's original model, and the correlation between those two variables is only .35. More importantly, if there were a multicollinearity problem between per capita GDP and democracy, one of those two variables would become insignificant because its effect would be absorbed by the other variable. Finally, an examination of the variance inflation factors does not indicate a potential multicollinearity problem.[71]

Fourth, both civil-military relations variables are significant, indicating that coups hurt military effectiveness. This result suggests that political stability is an important determinant of effectiveness, but the incidence of coups does not necessarily reflect the state of civil-military relations within a country. In fact, it is often the *absence* of a coup that indicates that leaders have solidified their own authority by purposefully undermining the military's power and organization. Arab states, for example, rarely experience coups despite having extremely hostile civil-military relations.[72] In short, political stability and amicable civil-military relations do not necessarily go hand-in-hand, so the Biddle and Long civil-military relations variable cannot be used to confirm or deny the civil-military relations hypothesis. This will have to be a subject for future research.

It is possible, however, to test further the possibility that political stability independently affects military performance. To do so, I conducted additional tests (not shown) using an alternative operationalization of political stability: the level of regime consolidation. Literature on political change and civil wars has shown that highly autocratic and highly democratic states are less prone to internal conflict and violent regime changes than 'intermediate' regimes in which neither democracy nor autocracy has been fully consolidated.[73]

[71]The highest variance inflation factor (VIF) value is 8.98 (for the per capita income variable), but only values greater than 10 suggest a multicollinearity problem. On this point, see, John Neter, William Wasserman, and Michael H. Kutner, *Applied Linear Regression Models: Regression, Analysis of Variance, and Experimental Designs*, 3rd ed. (Homewood, IL: Irwin 1990), 408–11.

[72]Brooks, *Political-Military Relations and the Stability of Arab Regimes*.

[73]See, for example, Havard Hegre, Tanja Ellingsen, Scott Gates and Nils Petter Gleditsch, 'Toward a Democratic Civil Peace? Democracy, Political Change, and Civil War, 1816–1992', *American Political Science Review* 95/1 (March 2001), 33–48.

This paper follows these studies in using Polity data as a proxy for political consolidation. The Polity IV data classifies political regimes using a 21-point scale ranging from -10 (most autocratic) to +10 (most democratic). For each battle the absolute value of each side's Polity score (for the year before the battle) is taken and a variable is created for the attacker's fraction of the total Polity score of both sides. In a simple bivariate regression (not shown here), more politically consolidated sides achieve more favorable loss-exchange ratios, suggesting that political stability increases effectiveness. This positive effect, however, disappears once economic development is added to the regression. It is unlikely that this change is the result of multicollinearity because the correlation between per capita income and regime consolidation is only .44.

In sum, there is mixed support for the second hypothesis.[74] Economic development significantly improves military effectiveness even when a host of other factors are taken into account. The results also suggest, however, that the incidence of coups has a significant effect on subsequent performance in battles, and democratic political institutions degrade effectiveness. Economic development, therefore, is not all that matters, but it is certainly one of the essential determinants of military effectiveness.

Hypothesis 3: Economic Development Matters Independent of Defense Spending

Table 2 presents multivariate results suggesting that economic development positively affects military capability even when levels of defense spending are taken into account. Model 1 shows that economic development and defense spending both significantly enhance military effectiveness. In other words, a state with a high level of defense spending but a low level of economic development will not be as militarily effective as a state with the same level of military spending

[74]The same robustness checks were employed as for hypothesis 1 (except for using the Correlates of War data). Dropping extreme cases and controlling for momentum did not alter the results. The alternate codings for economic development (iron/steel production and energy consumption) are significant in regressions without the culture dummy variables. Once the culture dummies are added, however, both of these proxies for economic development become insignificant while the PCBU and JEMU culture variables are statistically significant. There was also an attempt to control for pairwise fixed effects by adding dummy variables for every dyad in the dataset. However, this increased the number of independent variables to 64. Since there are only a few hundred observations in the data set, there were simply not enough degrees of freedom to produce any significant results.

Table 2. Military Spending per Soldier and Military Effectiveness (Dependent variable: log(LER))

	Model 1	Model 2
Military $ per soldier	**−.71**** (.20)	.07 (.24)
GDP per capita	**−.80**** (.25)	**−1.85**** (0.59)
Human capital		−0.29 (0.51)
PC-PC		0.11 (0.17)
PC-BU		−0.35 (0.33)
PC-MU		dropped
OR-MU		dropped
OR-BU		0.69 (0.39)
JE-MU		−0.22 (0.26)
OR-PC		0.22 (0.17)
Democracy		**0.75**** (0.18)
Civmil favors defender		**0.55**** (0.18)
Civmil favors attacker		**−0.32**** (0.11)
Numerical preponderance		0.12 (0.33)
Aircraft		5.64 (5.51)
Tanks		0.93 (5.49)
Artillery		8.77 (4.88)
Constant	0.76 (0.08)	0.45 (0.38)
N	322	216
R-sq	0.25	0.45

Note: Entries are OLS regression coefficients with standard errors in parentheses. All results employ robust standard errors.
*p < .05, **p < .01.

but a higher level of economic development. This conclusion is further substantiated by Model 2, which adds the full set of independent variables. Economic development retains a highly significant positive effect on military performance, but defense spending becomes insignificant once other factors are taken into account. While past studies have used defense spending per soldier as a proxy for the quality of military forces, these results suggest that the level of economic development is a much more accurate predictor.

Conclusion

The most influential ideas about military power heretofore have centered either on material assets or political and social pathologies. The first view, however, ignores military effectiveness, while the second view mischaracterizes its determinants. Military effectiveness is a crucial component of military power, but it is primarily a function of

economic development, not of political and social factors. In particular, economically developed states are more capable of generating highly skilled military units and producing, maintaining, and modernizing sophisticated military equipment. Part of this advantage stems from a greater surplus of wealth, which allows developed states to sustain large military investments without undermining long-term economic growth. But economically developed states also derive military benefits from their technological infrastructures, efficient production capacities, advanced data analysis networks, stocks of managerial expertise, and stable political environments. In short, military effectiveness cannot be bought; it must be developed.

This positive relationship between development and effectiveness holds across hundreds of battles, dozens of wars, and several different operationalizations of development itself. Moreover, the connection between economic development and fighting power remains robust even when a host of other characteristics are taken into account. By contrast, many political and social factors seem to have, at best, marginal or idiosyncratic effects, suggesting that some of the correlations found between these variables and military effectiveness may not be causal. Instead, certain political and social pathologies may be produced by, or correlate with, economic development. While some of these factors may influence the process of economic growth and thereby indirectly shape effectiveness, the results presented here suggest that few directly affect military capability. Thus, the conventional military dominance of Western democracies is really just the conventional military dominance of the most economically developed states.

For those interested in developing a sound and quantifiable conception of military power, this conclusion simplifies things: a state's absolute level of material resources measures the quantity of its military assets, while its level of economic development provides a solid proxy for the quality of those assets. Combining these two components – resources and effectiveness – produces an accurate indicator of military power upon which broader theoretical and empirical claims can be tested.

The measures used in most academic studies and defense analyses, by contrast, mistakenly conflate size with power and thereby overstate the capabilities of large but underdeveloped states. China, for example, currently possesses the world's largest military and will have the biggest economy within the next 30 to 40 years. But these achievements reflect demographic rather than military preponderance. In fact, size increasingly counts for little as advances in firepower, targeting, and communications make it possible for compact but sophisticated militaries to inflict unprecedented levels of destruction upon massed forces. Taiwan, Australia, and Singapore, to take three examples, can

do far more against potential adversaries than they could 30 years ago. Meanwhile, China and India – the two most populous countries on earth – have eschewed their comparative advantage in mass and reoriented their militaries to fight, what former Chinese President Jiang Zemin called, 'local wars under modern high technology conditions'.[75] In short, the balance between quantity and quality has shifted decisively in favor of the latter.

Countries like China, India, and Brazil are often considered to be simultaneously great powers *and* developing countries, but the empirical record suggests this is oxymoronic, at least in a military sense. Poor states simply cannot offset the military deficiencies inherent in economic backwardness. The main issue for military assessments, therefore, is not whether other countries raise their defense budgets or increase their access to advanced technologies from abroad – though these factors remain important – but whether they develop the economic capacity to produce, maintain, and coordinate complex military systems. Despite much talk in recent years of 'peer competitors' and 'power transitions', the United States is in a class by itself in these respects.

This conclusion, however, should not be cause for excessive optimism. Other countries can 'pose problems without catching up', meaning they do not necessarily need to surpass the United States in an absolute sense to radically alter the status quo regarding a specific issue or within a particular region.[76] Since slight changes in capabilities can have large geopolitical effects, it is absolutely essential to understand how military effectiveness ebbs and flows over time. Much of the existing literature on this subject assumes that a country's military effectiveness is rooted in its culture and institutions. This article, by contrast, suggests that the cultural and institutional barriers to effectiveness dissipate as states become more economically developed. Thus, the current surge in global prosperity, though miraculous and wonderful in many ways, will also bring about considerable military modernization. The American lead in conventional military capabilities is larger than typically assumed, but it may recede at a faster rate.

Managing the geopolitical consequences of economic development has always been a fundamental task of statecraft, but the unprecedented pace and scope of growth today makes this both more difficult and more important than ever before. Many factors will determine

[75]Jiang Zemin, *Lun guofang yu jundui jianshe* [On National Defense and Army Building] (Beijing: Jiefangjun chubanshe 2002), 83.

[76]Thomas J. Christensen, 'Posing Problems without Catching Up: China's Rise and Challenges for US Security Policy', *International Security* 25/4 (Spring 2001), 5–40.

whether such change occurs without violence, but one crucial ingredient is clarity about the distribution of military power. As historian Geoffrey Blainey concluded: 'Wars usually begin when two nations disagree on their relative strength.' Thus an explicit military pecking order promotes peace. The most important point to be made, therefore, is that the determinants of military power need to receive the same kind of sustained and rigorous study that has been given to its effects. Military power plays a pivotal role in shaping numerous aspects of international relations, yet few analysts have taken the time to develop a sound conception of this crucial variable or to understand how it is created. Since so many policy decisions and academic theories rely on assessments of military capability, it is absolutely imperative that we get those assessments right.

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