Wearing Away the Stone

**Assessing Theories of Combat Attrition**

March 15, 2012

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**Paper Presented to**:

*Journal of Comparative Strategy*

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This manuscript has not been submitted simultaneously for publication elsewhere.

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“We are practically through the enemy’s defences, the enemy has only flesh and blood against us.”[[1]](#footnote-1)

British Field Marshal **Douglas Haig**, (October 1917)

**Abstract**

The most common explanation for military victory and defeat is numerical preponderance. This is the causal assumption that victory goes to the ‘big battalions.’ When it comes to battle, more is better, whether it be of the immediate concern of troops in the field or a matter of the potential power of economic resources behind the front line. Unfortunately, this theory has rarely been tested, particularly against a series of cases with great historical breadth. This paper has therefore collected data from 754 battles, spanning nearly 3,500 years, and contrasted these empirical details against the core hypotheses of preponderance theory. Unfortunately for the theory, the returns to preponderance are highly ambiguous. Historically, armies both large and small emerge victorious in nearly equal fashion—a result highly contrary to the theory’s central claim.

Mass has generally been considered by war’s leading theoreticians as a “class above” other principles, such as surprise and economy of force.[[2]](#footnote-2) Generals in particular tend view the deployment of superior numbers at decisive points as the most crucial precursor to victory. This certainly was the case in the Great War, where officers like Haig and Falkenhayn considered a preponderance of force, directed against crucial salients—such as Ypres, the Somme, and the Aisne—as the key to unlock the Western stalemate that threatened to bleed their armies to death. In classic attritional terms, the French staff concluded that “breakthrough followed by exploitation is impossible until the enemy has been so worn down that he has no reserves available to close the gap.”[[3]](#footnote-3) Yet tragically, the concentration of ever-greater numbers of men and materiel did not bring victory. No matter how optimistic the assessment—such as Haig’s callous and stunningly erroneous assertion in the epigram—an endless stream of fruitless casualties and perpetual stalemate laid the futility of this strategy bare. By the time Haig’s words were written, roughly 70,000 British troops had been killed and over 170,000 wounded in the mud of Passchendaele (1917), all to little change in the front lines. That the battle was preceded by a 19-day bombardment, sustained by 321 train loads of a shells—a year’s worth of production for 55,000 workers—did nothing but help turn the battle area into swamp. In all, five months of bloody effort resulted in a gain of just 45 square miles—or roughly 8,222 men lost per square mile.[[4]](#footnote-4) To the south, Nivelle’s similarly misguided efforts along the Aisne resulted in 130,000 French casualties in less than a week. These dreadful tallies therefore stand as a testament to the futility of pursuing victory through preponderance. Judging by their performance in the Great War, generals, it seems, have a misguided faith in numbers. What follows is a systematic examination of 3,500-years of battle data to determine if the years 1914-18 were a historical anomaly, or if this error has been consistent over time.

**1.0 Literature Review: Preponderance Theory**

Political science’s most popular set of explanations for military victory and defeat are those related to *numerical preponderance*. Here the argument is that material superiority leads to victory, or that “states with larger populations, larger or more industrialized economies, larger militaries, or greater military expenditures should prevail in battle.”[[5]](#footnote-5) At the conceptual level, preponderance theory is straightforward. It is the view that, as Napoleon famously suggested, “God is on the side of the big battalions.”[[6]](#footnote-6) Put more formally, the argument is that the probability of military success correlates highly with the material strength of one nation or a coalition of nations relative to that of the adversary.[[7]](#footnote-7) The balance of material resources is therefore crucial, for the probability of achieving military success is more a function of this capability distribution than any other concern.[[8]](#footnote-8) Even the ‘soft’ version of preponderance theory holds that “when moral qualities, discipline, training, and armament are approximately equal, superiority of numbers is likely to prove victorious even against superior leadership.”[[9]](#footnote-9) More stridently, the ‘hard’ version argues that side that commands more of these power resources will “always win,”[[10]](#footnote-10) regardless of other considerations.

This faith in the causal importance of material superiority is what unites preponderance theorists. Material goods are seen as the chief ingredient of military power. What actually constitutes these ‘power resources,’ however, is a matter of some dispute. In simplified terms, there is a split between approaches that are concerned with labour and those with capital. Some in the literature echo Napoleon and stress the number of troops in battle as the ultimate expression of military power. Armies with more troops than their adversary are thus seen as more likely to win. Others, however, find that troop numbers do not do justice to the virtues of material advantage. Superior wealth can, after all, be used to lavish an army with capital-intensive weaponry, improving combat performance in turn and thus making the prospect of victory more likely. The capital school therefore looks instead to the balance of aggregate economic potential between two belligerents when determining the probable victor.

**Economic Preponderance**

Today, the most common variant is concerned with economic preponderance. The metrics offered here are less concerned with troop numbers or divisional strengths, but rather with relative economic size and industrial composition. The argument is that capital-intensive armies rely on factories and investment, and thus the success of military operations ultimately depends upon a state’s ability to marshal overwhelming economic power. In this way, “all warlike operations depend so much on the condition of the national revenue.”[[11]](#footnote-11) Without the money to pay for them, there can be no swords or guns. As such, authors such as Singer *et al* (1972) argue military, industrial, and demographic capacities are the critical variables behind overall national capabilities.[[12]](#footnote-12) This was certainly the view of Organski, who offered gross national product, or national income, as the best shorthand yardstick of national capability,[[13]](#footnote-13) given that it serves as a reliable, quantifiable summary of population size and economic development.[[14]](#footnote-14) For similar reasons, Waltz (1979) advocates the adoption of gross national product (GNP) as a rule-of-thumb measure of national power.[[15]](#footnote-15) Armed with such measures, predictions regarding the outcomes of military contests become possible. More precisely, since economic strength is seen to translate to military strength, the balance of power between rivals ultimately rests upon the distribution of wealth.[[16]](#footnote-16) The prospects for victory and defeat therefore rely on a comparison of each nation’s stock of aggregate wealth.[[17]](#footnote-17) According to economic preponderance theory, the winners of combat will be those who outmatch their opponents in this regard.

It is this ‘outmatching’ that is so important to economic preponderance theorists. Indeed, their argument is that wealth bestows combat power through its provision of capital-intensive weaponry. Wealthy nations need not rely solely on light infantry, but can instead afford to lavish their armies with high-cost tools of lethality. Examples include expensive equipment like siege works, cavalry, artillery, and, most recently, armour and airpower. In effect, material preponderance provides the firepower necessary to speed up the rate at which casualties are imposed on an enemy. Take how the theory looks to America’s unmatched 20thC affluence as the means underlaying the country’s capital-intensive approach to fighting wars.[[18]](#footnote-18) An abundance of wealth has given the United States far greater capacity than its rivals to spend mightily on vehicles, tanks, and bombs, all of which have served to increase the rate of losses inflicted on America’s enemies. The North Vietnamese in the Vietnam War, for example, suffered dearly from relentless—and comparatively unchallenged—US airstrikes, which where the bequest of America’s unmatched industrial might. So once again, more is better. Against such firepower poorer, less well-equipped forces will be ground to dust long before the preponderant side reaches the same state of desperation.

**Troop Preponderance**

This is not to say that the troop strength argument, the older of the two variants, is without its adherents. Hans Delbrück, for example, has argued that victory in the Renaissance depended on the number of troops committed to battle: “only a large number of soldiers gave the prospect of victory.”[[19]](#footnote-19) Generals, too, often espouse the logic of numbers as chief arbiter of victory and defeat. Henry Wager Halleck, who rose to become Grant’s chief of staff in the US Civil War, concluded that strategy—and thus victory—was a matter of the “art of directing masses on decisive points.”[[20]](#footnote-20) For Halleck, numbers were the central concern. Even Clausewitz infused some of his writing with preponderance notions. In a classic encapsulation of the logic of numbers, Clausewitz argued that “victory comes to the one who holds out a moment longer than the other.”[[21]](#footnote-21) Meanwhile Jomini, Clausewitz’s contemporary and another veteran of the Napoleonic wars, went even further. His search for the “fundamental principle” underlying victory in war was in many ways built around the need to successfully “maneuver to engage the mass of forces against fractions of the hostile enemy army.”[[22]](#footnote-22)

To this commanders in the 20th century largely agreed. Echoing Napoleon, Erich Ludendorff held that “It is a fact that victory ‘goes to the big battalions.’”[[23]](#footnote-23) His French rival, Ferdinand Foch, concurred, lamenting that while “‘Small battalions’ have also carried off victories,” the Great War would have been conducted far more differently if France were materially preponderant. “Eight more Army Corps at the beginning of the War,” he suggested, “would have secured us the victory.”[[24]](#footnote-24) Even the commander of the British Expeditionary Force, Douglas Haig, argued that there was no alternative to attrition. “In the stage of wearing-out struggle losses will necessarily be heavy on both sides, for in it the price of victory is paid.”[[25]](#footnote-25)

Haig’s comment succinctly illustrates troop preponderance theory’s brutal conception of battle. Armed contests are ultimately a matter of killing and dying. Indeed, the job of armies is to use deadly force to assert their command over a particular terrain. When a rival contests this imposition of will, violence ensues. The struggle will continue until one side is broken and can fight no more. This is why force strength and battle losses are so important. On one hand, the more troops a belligerent deploys, the more there are to do the killing. Larger quantities of troops entails more bullets or steel deployed in anger, and thus greater enemy losses. At the same time, the larger a force that is deployed, the more casualties it can endure before breaking. Larger divisions, for example, can absorb heavier losses before their combat effectiveness is removed. These are the virtues of the ‘big battalions’ of which Napoleon spoke; this is how larger armies win.[[26]](#footnote-26) And more is always better. Indeed, “The greater the initial numerical superiority, the greater the probability of victory for the stronger nation.”[[27]](#footnote-27)

**Attrition as Causal Mechanism**

The chief lesson of this tour through the logic of preponderance is that for both the theory’s variants the underlying causal mechanism of victory is attrition.[[28]](#footnote-28) “Generally, the side with…the greater incentive and pool of resources with which to keep on fighting—will win.”[[29]](#footnote-29) In other words, ‘winning’ is achieved by gradually reducing an enemy’s strength through sustained attack, until the point where only one belligerent remains standing. Haig’s description of “wearing-out” the enemy is therefore equally applicable to theories of force size and those of economic wealth. More specifically, the luxury of economic preponderance is that superior wealth makes possible superiority in capital-intensive equipment, such as tanks, airplanes, artillery, and radios. Such an endowment accelerates the rate at which an enemy incurs losses, leaving the prospect of victory more likely for the materially preponderant. Troop preponderance theory is no different, with again the causal mechanism being attrition. A superior weight in numbers permits a grinding down of the opposition, both because of the higher number of losses the preponderant can sustain, and also because outnumbering an opponent speeds up the rate at which casualties are inflicted on the enemy. It is not easy, as the catastrophic defeats at Adrianople (378 AD), Manzikert (1071), and Bagration (1944) have shown, to fight effectively when surrounded by a more numerous foe.[[30]](#footnote-30) Preponderance entails more resources with which to kill an opponent and more casualties which in return can be endured before exhaustion is met. Preponderance is what allows attrition to do its dreadfully bloody work and yet still ensure one side emerges the victor.

The relevance of this assumption should not be underplayed. Indeed, preponderance and its causal mechanism of attrition deeply inform thinking about war and peace in the international system.[[31]](#footnote-31) Regardless of which metric an observer prefers—be it the relative size of armies or economies—preponderance theory and attrition lie at the heart of realist thinking.[[32]](#footnote-32) For realists, the “distribution of power will heavily determine when fighting occurs, who will side with whom, and who will win.”[[33]](#footnote-33) Military conflict is, after all, seen as a series of “grinding, attritional struggles, with both sides earning victories and defeats.” In the end, the final outcome is the “result of cumulative gains made and losses incurred, added up on some ‘cosmic toteboard.’”[[34]](#footnote-34) The resolution of military conflict is thus essentially governed by an accounting equation.

Balance of power theory provides a case in point. According to the preponderance camp’s logic, stability in the international system is attained by balancing force against force. The strength needed to equalize these relationships is generated either through alliances with like-minded neighbours, or internal efforts to boost military power.[[35]](#footnote-35) Above all, these efforts are a matter of ensuring material equality. In other words, force is represented by material realities—in this case, generally with military size—and thus the number of armies, tank divisions, nuclear missiles, and so on. The implicit assumption here is that superior numbers will win the day. The explanatory variable is a number meant to encapsulate some aspect of material strength; not technology, not skill, nor even chance. One side must equal the material strength of the other if stability is to be achieved. This is precisely what the land and naval arms race between the European powers hoped to achieve in the years leading up to 1914. The same can be said of Britain’s desperate gamble to deter Germany from war with a massive military building program in 1938. Similar thinking lay at the heart of the Cold War’s ‘missile race.’[[36]](#footnote-36) In each case, policy was driven by a perceived need to match, if not exceed, a rival’s material bounty. Failure to do so was seen as eminently dangerous, given that inferiority would ensure defeat if hostilities broke out.

It is this straightforward logic that makes preponderance theory so appealing among academics, generals, and policymakers. But it is also the starting point for the theory’s staunchest critics. While few deny that troop numbers and economic strength matter a great deal, these forces are much more than inanimate variables. Rather than figures neatly summed in a bookkeeper’s notebook, economies sputter from mismanagement, money is spent on guns that often do not work, troops become lost, and generals have been known to sleep in late. Just because one deploys the largest army in battle does not mean that it will fight hard, let alone competently. Superiority in numbers means nothing when frittered away by poor tactics and technique. Victory is less a matter of the raw numbers involved, but rather how well they are used. So too is there the matter of happenstance and ill luck. The unpredictable ‘fog of war’ has befuddled even the most best of armies and the most promising of campaigns. Clearly, numbers alone do not determine the outcome of battles.

To these charges preponderance theorists have little to say. Most, in fact, simply assume the material in question (whether it be armies or economic product) will be used “optimally.”[[37]](#footnote-37) As we have seen, the specific matters of strategy and tactics are not generally discussed by preponderance theorists.[[38]](#footnote-38) Instead, the assumption is that “within reasonable limits of analysis, states make the best possible decisions for attack or defense, taking into account their own and their opponents' options for strategy and force posture.”[[39]](#footnote-39) In this theory there is no role ascribed for military doctrine and force deployments. This is because labour and capital themselves are deemed the central cause of victory, leaving all other factors to fall by the wayside. Accordingly, the potential for poor generalship, uneven troop quality, and even technological conditions provide the gravest threats to the logic of preponderance theory. In other words, what if the preponderant do not win? What happens if larger armies fail? To do so would be in stark contravention to the theory. We therefore move now to an examination of the historical record, seeking to determine if preponderance theory’s parsimonious explanation of victory and defeat finds congruence with the empirical record.

**2.0 Research Design**

**Hypothesis Formulation & Operationalization**

Preponderance theorists contend we can infer combat outcomes purely from a material balance. Is this, however, truly the case? Is the central claim of preponderance theory—that the numerically preponderant will use their material advantage ‘optimally’ and win the military conflicts they engage in—verified by the available data? Does the side with relatively greater material ‘power’ emerge victorious in armed struggle? To answer, we first must draw from the theory testable hypotheses, then choose a series of related metrics to determine whether or not the hypothesized independent and dependent variables operate in the manner that the theory predicts.

As we have seen, some preponderance theorists emphasize relative economic size, while others prefer troop numbers. Either way, the respective hypotheses are relatively easy to draw. Regarding the latter, the central claim is that when the troop levels of belligerent A are greater than that of belligerent B, victory for A will result. These variables can be tracked in a relatively straightforward manner. The independent variable, army size, is a relatively well-known quantity in the historiography of war, at least when concerning pitched battle. As for the dependent or outcome variable, Clausewitz tells us that victory is best determined by the decision of one side to give up in combat.[[40]](#footnote-40) Victory is therefore most accurately ascribed to the belligerent who commands the field upon day’s end.

Moving to economic preponderance hypothesis, the concern here is with the balance in wealth between pugilists. More specifically, when the economic size of A is greater than that of belligerent B, A will emerge from the battle victorious. As for the dependent variable, victory, the definition of geographic control will once again be used. When metricizing the independent variable, however, the story becomes more complicated the further back into the past the study goes. This is because the study’s chronological breadth extends well past the production estimates economic historians have so far been able to compile.[[41]](#footnote-41) Our choice of proxy will thus have to be more nuanced if it is to accurately capture the economic balance between belligerents. To this end, we will have to shift from Gross Domestic Product (GDP) measures of the economic balance between belligerents to population, at least for the period prior to the Industrial Revolution. Although imperfect, this arrangement comes best to meeting the methodological and theoretical needs of the study.

**Reliability and Validity of Measures**

Troop preponderance theory asks us to track the number of in-theatre combatants over time.[[42]](#footnote-42) Here the most obvious reliability concern is the fact that the estimates offered by historians do not always agree. This tendency to diverge over numbers becomes more acute as the ambiguity of the historical evidence increases. In particular, the longer a battle endures and the larger the battlespace it incorporates, the more the questionable the estimate becomes. In battles as vast as those of the Russo-German War of 1941-1945, the scale involved prohibits easy estimation. Even more problematic, however, is the paucity of evidence from battles long ago. In the most extreme cases, such as those found in Africa, Asia, and pre-Colombian America, there is very little written—and, frequently, even archeological—evidence to work with. The violent struggles of tribal societies do not leave paper trails or shell fragments, nor even a large concentration of arrowheads. Meanwhile, in more modern times, the politicization of body counts during the Vietnam War demonstrates that modern estimates are not free of error either.[[43]](#footnote-43) Leaders throughout history have faced an obvious incentive to embellish military results, regardless of the epoch within which they live.[[44]](#footnote-44) Nevertheless, given the tremendous work of historians to cross-check the battle estimates of ancient writings against the archeological and even geographical evidence, there is good reason for a comparatively high level of faith in the precision of these numbers.[[45]](#footnote-45) Indeed, while oral and written records may be influenced by state propaganda and private boast, the physical remnants and contexts of battle are far more immune to bias. Thus through the confluence of an assortment historical techniques, there generally exists a rough consensus regarding the numbers involved with the great battles of history, at least for those of the Mediterranean, Near East, and Western Europe. Fears of reliability regarding army size can therefore be allayed at least to a degree acceptable to our purposes here.

It matters not just how we count a variable, but also *what* exactly we are counting. For this study to be valid, troop counts must reflect the same phenomenon—raw power—across time. Only then can the events of the ancient world inform us about those of the present. Fortunately, despite all their historical and cultural idiosyncrasies, armies are more or less like units. One can generally identify the soldiers of an army, regardless of language or costume. The Ottoman troops who marched on Vienna in 1683 formed columns of plodding infantry remarkably similar to the Pharaohic armies of ancient Egypt, or even Canadian troops outside Kandahar in 2010.[[46]](#footnote-46) Indeed, the Twelfth Dynasty Egyptian armies of 1900 BC stepped off ‘by the left’, as have every army ever since.[[47]](#footnote-47) This makes the counting of armies relatively straightforward, and, more importantly, suggests a strong sense of conceptual continuity from one millennium to the next. What is therefore left as the major validity worry is the difference between the highly orchestrated battles of advanced societies and the drawn-out skirmishing of primitive ones. Given that pre-civilization struggles left little written or material evidence—and therefore are not incorporated in the dataset that follows—the applicability of this study's findings will have to be constricted to those contests that did.

We must also consider the reliability and validity of the metrics assigned to economic preponderance theory. In terms of the latter, as we have seen, authors such as Organski have made a persuasive case that the adoption of a parsimonious metric like GNP effectively encapsulates economic potential.[[48]](#footnote-48) Unfortunately, this approach is handicapped by a scarcity of data. Even Maddison’s figures for total economic production—which are the chronologically broadest available—are found at yearly intervals only post 1820.[[49]](#footnote-49) Prior to that, Maddison’s data (available as GDP) is limited to the years 1700, 1600, 1500, 1000, and 1 AD. Given that the dataset includes many battles both between these dates and prior to, relying on GDP alone would leave many cases without a proxy to test for the hypothesized relationship. Other arrangements will have to be made if this study’s total collection of battle data is to be put to good use.

Thankfully, there is an alternative metric that can be used to fill in the missing gaps, at least for the period prior to the Industrial Revolution: population.[[50]](#footnote-50) This measure holds promise because prior to the industrial era, population and economic growth advanced in tandem, keeping a relatively common pace.[[51]](#footnote-51) This led Adam Smith to remark that “the most decisive mark of the prosperity of any country is the increase in the number of its inhabitants.”[[52]](#footnote-52) The reason for this is because, at the time, innovation could not consistently outpace population growth. Technological advancement occurred in only fits and starts, and therefore never managed to distance itself from population too greatly. Numbers would rise until the new technological ceiling was reached and no more new mouths could be fed. Total population would then hold steady until further advances allowed the process to continue all over again. Absent conditions of sustained innovation, population can be seen as in a perpetual state of ‘catching up,’ never far from a society’s total stock of wealth or total productive capacity. As such, “population and resources develop along more or less parallel lines,”[[53]](#footnote-53) a fact which leaves GDP and population, at least for the epochs used here, as conceptually interchangeable. As a consequence, for the years not covered by Maddison’s GDP estimates, population figures will be used as the explanatory variable.

The reliability of this approach can once again be considered relatively high. Although far from perfect, these estimates are the product of a concerted effort to adhere to the most fundamental rule of accounting: that the numbers balance. In both matters of population and GDP, great effort has been made to ensure that inputs correspond with outputs. Modern standardized accounts demonstrate this technique admirably, for national output estimates are cross-checked by ensuring that an economy’s income (total wages, rents, and profits), demand (the sum of final expenditures by consumers, investors, and government), and production (the sum of value added in different sectors—such as agriculture, industry, and services—net of duplication) all balance out.[[54]](#footnote-54) When they do, we can be reasonably certain the figure is an accurate measurement of the phenomenon under study. Population, too, has been cross-checked in this way. Demographers have spent considerable effort comparing known rates of birth and death against outbreaks of disease, wars, and even peace. What is left for the political scientists is a series of measures whose precision is sufficient for the purposes of this study.[[55]](#footnote-55)

**The Sample**

The sample’s battle data was drawn primarily from Perrett (1996), for it was the most comprehensive (in terms of chronological breadth) and accessible (in terms of summarized deployment and casualty figures). Thereafter, data from Chandler (1997), Badsey (1999), and Clodfelter (2009) was used to add any missing battles and to reconcile gross discrepancies through cross-referencing.[[56]](#footnote-56) Disagreements were resolved by adhering to the more common figure. This approach reflects the assumption that the dataset should reflect the mainstream historiographical consensus. The exception, of course, are any instances where the available evidence appears to the author as patently erroneous. In addition, Eggenberger (2008) and Dupuy (1979) were used to clarify attacker and defender, as well as victor and loser, when other sources left this unclear. As for economic data, Maddison’s online study of historical GDP was used, as it is a resource similarly unmatched for its comprehensiveness and accessibility. The same can be said of the source for population data, McEvedy and Jones (1985), which again is the most comprehensive and accessible resource of its kind.[[57]](#footnote-57)

A total of 754 battles[[58]](#footnote-58) were collected in the dataset, though the level of data precision and availability for each case is not uniform. The complete collection is publicly available at the author’s website: <http://web.me.com/sean_m_c>. Unsurprisingly, the earlier back in history, the more likely it was that firm estimates of troop strength are available only for one side. Even so, sufficient data was collected to gather a series of cases that stretched for a 3,500-year period, ranging from Megiddo in 1469 BC, to contemporary operations in Iraq and Afghanistan. Moreover, so far as the author is aware, this dataset constitutes the broadest and most complete collection of battle data available. Such breadth enables the testing of preponderance theory against more epochs than has previously been possible.

**3.0 Data Analysis**

Having collected the results of 754 separate engagements, we can now look at the relationships between the independent variables offered by troop and economic preponderance theories, and the outcome of victory. Each hypothesis will be examined in order.

**H(P)1 (‘troop preponderance’)**

Out of a total of 754 battles in the dataset, 617 cases had sufficient data to test for hypothesis H(P)1, or preponderance theory as measured by troop strength. Battles included ranged from Kadesh (1294 BC) to Wanat (2008). Of these cases, however, only 287 confirmed the preponderance hypothesis. In other words, in only 287 of 617 battles did the larger army (as determined by peak battle deployment numbers) emerge victorious. This computes into a mere 46.5% of all available engagements, meaning that less than one out of every two preponderant armies in the sample won. For every occasion where the numerically preponderant trounced its rival, such as the overwhelming Soviet force at Stalingrad (1942), there exists a case representing the opposite dynamic, such as Yellow River (1226), where an army numerically inferior nevertheless defeated its opponent. In the latter case, no more than 180,000 Mongol troops proved sufficient to utterly destroy the 300,000-strong Hsia army that barred its entrance into southern China. Overall, the explanatory efficacy of preponderance hypothesis H(P)1 is thus *less* than a coin toss. Indeed, when history is examined in its totality, a preponderant army is just as likely to correctly call heads as it is to win in battle. This is a rate of success only the foolhardy should find comfort in.

Although preponderance theory does not predict this, there is the potential for a historical skew in the data. If, for example, preponderance played a role entirely counterproductive to victory during the Renaissance era, yet conformed to the predictions of troop preponderance theory elsewhere, a glimmer of hope for troop preponderance theory would remain. In other words, the theory would not be completely falsified. The best way to account for this potential is to disaggregate the above results into distinct epochs (table 1.0). To do so, however, will require the division of cases into units of differing historical breadth. This is because the pre-modern era is particularly short on battle data, and therefore requires larger blocks of time to arrive at a statistically-relevant number of cases. Despite this modification, we need not worry about damage to the study’s validity because of the relatively slow pace of political, social, and economic change in premodern times. Glacial agricultural productivity growth provides a useful illustration of this point, for improvement in crop yields accelerates noticeably only with the advent of the industrial revolution.[[59]](#footnote-59) The millennium-length intervals used for the first two samples are thus both methodologically convenient and sufficiently long enough to illustrate the broad dynamics of the pre-industrial age. Meanwhile, from roughly the Enlightenment onwards, it becomes both necessary and possible to divide the periods into smaller units of time. First, from the early Renaissance onward, the periods are reduced to 200 years apart, followed by just 100 years, when more data becomes available.

**Table 1.0 Preponderance Success** (defined as the numerically superior belligerent, disaggregated by period).

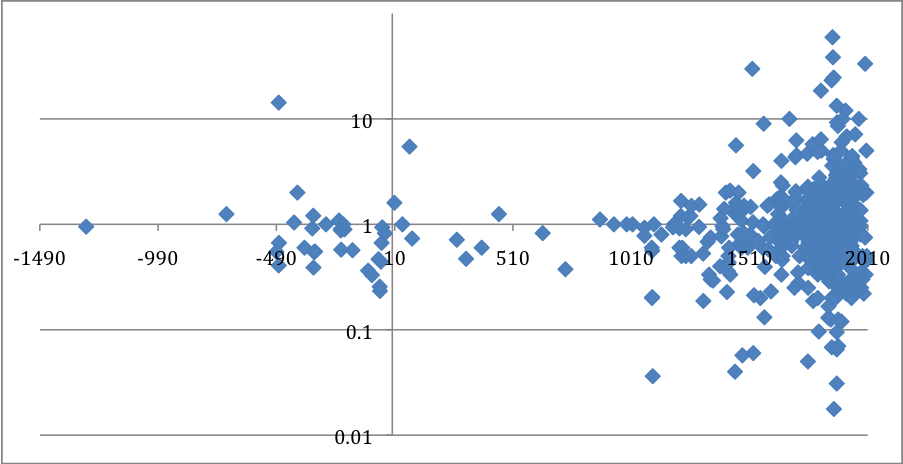
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Pre-0 AD | 0 AD - 1299 | 1300-1499 | 1500-1699 | 1700-1799 | 1800-1899 | 1900-1999 | 2000-present |
| Total Battles | 29 | 33 | 40 | 62 | 78 | 167 | 204 | 5 |
| Prepon’t Wins | 6 | 10 | 16 | 27 | 34 | 76 | 116 | 2 |
| % | *20.7* | *30.3* | *40.0* | *43.5* | *43.6* | *45.5* | *56.9* | *40.0* |

\*Based on results of 617 cases.

The story that emerges from the data is an interesting one. Out of a total of eight separate historical epochs, preponderance theory manages to accurately predict more than 50% of battle results just once. Only in the 20thC century, where 57% of preponderant armies emerged victorious, did preponderance offer a belligerent better than even odds of winning. In contrast, the results downplaying the role of preponderance were quite consistent. With the exception of the 1900s, the years 1300 onward saw the percentage returns to preponderance remain mired in the mid-to-low 40s. Overall, despite a gently upward-sloping improvement over time,[[60]](#footnote-60) the historical norm is thus for the belligerent enjoying troop preponderance to in fact *lose* the engagement, a result precisely the opposite of what the troop preponderance theory predicts. Indeed, the failure of numerical superiority spans not only the many battles of antiquity, where highly-advanced-yet-outnumbered armies fought their barbarian rivals, but also more recent centuries, where relative social and technological parity was the norm. The distinctions between the armies of Napoleon, Wellington, and Kutuzov, for example, paled in comparison to those between Roman and Goth. Yet preponderance has remained of little aid even now that qualitative parity is much more the norm. For most of history, then, boasting superior military strength can be at best seen as of dubious causal significance; at worst, as a burden or curse.

The sheer ambiguity of the connection between preponderance and victory is best illustrated by scatterplotting the victor:vanquished ratio over time (fig. 1.0). This ratio is simply the balance in the force size between victor and vanquished, measured in terms of the victor. For example, at the battle of Kadesh (1294 BC), where the victorious Hittites were outnumbered by their Egyptian foes by 19,000 troops to 20,000, the ratio stands at 0.95. That this number is less than 1.0 reflects that it was in this instance the numerically *inferior* that emerged victorious. In all, we have enough data to examine 524 cases in this manner. When plotted graphically, preponderance theory anticipates the dataplots will be found to be consistently above the 1.0 line on the y-axis. The more that lie above, the greater the number of instances where the victorious belligerent was numerically superior to the vanquished. Unfortunately for the theory, the evidence does not bear this out. In stark contradiction to troop preponderance theory’s prediction, as many plots can be seen below this line as above. This remarkably even distribution both above and below indicates that the numerically inferior are just as likely to win an engagement as the side with the larger army. Such a result is something the theory most definitely does not predict.

**Figure 1.0 Victor:Vanquished Preponderance Ratio** (relative size of victor, as measured by peak troop deployment & date).



\*Note: logarithmic scale.

It is important to note just how varied and random the association between relative troop strength and victory is. Armies numerically superior to their opponents have sometimes used their advantage in troop strength to grind out victory, such as the Persians at Thermopylae (480 BC; 14.3 victor-vanquished troop ratio). There, in a narrow pass along the Aegean coast, king Xerxes enjoyed sufficient numerical superiority to overcome the Greek defender’s advantages of geography, motivation, and individual skill. After three days of brutal fighting the tiny Greek garrison was ultimately forced to concede to superior Persian numbers. In other cases, however, decisive numerical advantage appears to have played no part in victory whatsoever. Caesar was surrounded by an army at least four times his own at Alesia (52 BC; 0.23 ratio), yet this imbalance was overcome in brilliant fashion by a combination of methodically-prepared defensive works and a surprise attack on the rear of Vercingetorix’s relief army. Gallic preponderance could not halt the Romans’ and their march of brutal conquest. More importantly, this apparent disconnect between preponderance and victory has remained consistent over time. Numerically inferior armies have carried off major victories everywhere from Issus (333 BC), where Alexander himself led a decisive cavalry charge that broke the Persian lines, to Suomossalmi (1939), where devastating Finnish rear-guard attacks destroyed the impetus of the Soviet’s advance. This is problematic for troop preponderance theory because, as illustrated in figure 3.3, the numerically inferior have proven just as apt at winning battles as the preponderant.

**H(P)2a (‘economic preponderance’: population)**

Out of a total of 754 battles in the dataset, 633 had sufficient data to test for hypothesis H(P)2a, or preponderance theory as measured by material resources, using population as a proxy. Of these, 336 cases confirmed the preponderance hypothesis. In other words, in 336 of 633 battles studied, running from rebellion against Egypt at Megiddo (1469 BC) to NATO and its Taliban opponents during Operation Achilles (2007), the wealthier belligerent—as determined by population totals—emerged victorious. This computes into a bare majority of just 53.1% of all possible battles, which is once again hardly a ringing endorsement of the theory. Indeed, although the preponderant are now at least more likely to win the battles they fight than lose, the effect of material supremacy is decidedly marginal. The returns to preponderance are now somewhat better than a coin toss, but only just. When history is examined in aggregate, economic size is anything but a guarantee of military success.

Perhaps, however, the importance of material preponderance has varied over time. To account for this potential we can once again disaggregate the data into a series of statistically relevant, but also historically appropriate, epochs (table 2.0). The results tell an interesting story. Unlike the slow, gradually upward trend in the returns to troop preponderance, the utility of wealth to military endeavours has been much more variable. The historical performance curve is in fact decidedly jagged, with the importance of material preponderance (again, measured in this case by population) rising and falling in three distinct waves. Twice in history—the epochs of late antiquity/medieval and the 20th century, in particular—the causal success of material preponderance reached 60%, indicating at least some bias towards the armies of the rich. In these cases, where material preponderance is at its peak efficacy, H(P)2a is at least a noticeable improvement over the coin toss.

**Table 2.0 Economic Preponderance** (defined as the economically superior belligerent; population as proxy).

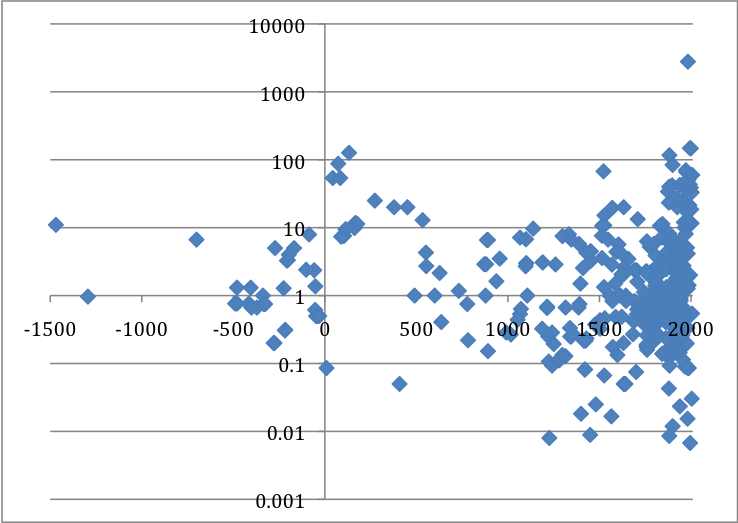
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Pre-0 AD | 0 AD - 1299 | 1300-1499 | 1500-1699 | 1700-‘99 | 1800-‘99 | 1900-‘99 | 2000-present |
| Cases | 34 | 63 | 30 | 40 | 73 | 158 | 228 | 8 |
| Prepond’t Wins | 13 | 39 | 9 | 20 | 30 | 86 | 135 | 4 |
| % | *39.4* | *61.9* | *30.0* | *50.0* | *41.1* | *54.4* | *59.21* | *50.0* |

\*Based on results of 633 cases.

The problem, however, is the variability in the results. Unlike troop preponderance theory, which could claim a slow, but relatively steady increase in its causal efficacy over time, material preponderance appears to go from peak to trough. Following each tolerable showing, the relevance of material preponderance to victory retreats to even less impressive heights. Something in the early Renaissance, for example, reduced the potency of capital-intensive armies almost completely. But it was not economic size. Unlike during the preceding epoch, material preponderance provided almost no assistance to armies throughout the 14th and 15th centuries. Yet by the 1900s, the materially preponderant were back to winning almost 60% of the time. This suggests a great degree of variability in the causal import of material preponderance. In other words, the theory’s independent variable appears to not be particularly independent after all. Something else must therefore lie as the ultimate cause of victory and defeat. Worse, however, is that the results lack a systematic trend in one direction. Whatever exogenous causal force is manipulating the relative importance of material preponderance—be it technology, political sophistication, military acumen, and so forth–it is not doing so consistently. As is, the results here appear arbitrary and are therefore theoretically suspect.

Reinforcing this conclusion is a scatterplot of the victor-vanquished ratio data (fig. 2.0). Just as above, this graph is a reflection of the material balance (with population as proxy) between a battle’s winner and loser. Thus at Lake Trasimene (217 BC), where the victorious Carthaginians were backed by a population of 1.5 million against Rome’s 4.8 million, the preponderance ratio was 0.31. In other words, we can reasonably assume that the Carthaginian economy was not quite a third of Rome’s when Hannibal thrashed the legions of Gaius Flaminius. More importantly, should preponderance theory be proven correct, the dataplots must once again be consistently found *above* the 1.0 line on the y-axis. Yet here we find a similarly dramatic inconsistency in the results. With the exception of the 500 years of the Roman Empire’s height,[[61]](#footnote-61) battles throughout the dataset are almost as likely to be won by the materially *inferior* belligerent as the preponderant. The relatively even distribution of dataplots above and below the line of equality leave preponderant belligerents little hope that their victory in battle is in any ways assured. Unlike the theory’s assertion, the materially inferior do win—and win a great deal of the time.

**Figure 2.0 Victor-Vanquished (Population) Ratio** (relative size of victor, as measured by economic size/population).



\*Note: logarithmic scale. Based on 665 cases.

The erratic nature of these results indicates that population preponderance does not work in the universal manner its proponents assume. Most urgently, it offers no explanation as to why such variability in causal importance exists in the first place. Nowhere in the logic of attrition is there the suggestion that it should operate more effectively in some circumstances than others. In contrast, the theory contends that superior numbers will prevail regardless of the circumstance; that is the heart of preponderance theory’s parsimonious claims. That they do not deeply undercuts the theory’s explanatory power.

**H(P)2b (‘economic preponderance’: GDP)**

As useful an approximation of national wealth as population is, it works as an unbiased proxy only until the onset of the industrial revolution. That its utility diminishes is because the commercial and technological innovations associated with late 18th and early 19th centuries enabled economic growth to outpace population growth for the first time. More importantly, this decoupling of population and economic product emerged in different geographic regions at different times. Great Britain’s economic transformation came first, followed in turn by Western Europe and the European offshoots, then Latin America and East Asia. These time lags deal a blow to the validity of the population measure. Until this time, population could be counted on as a rough reflection of aggregate economic potential. However, from the industrial revolution onwards we can no longer be as confident because we are no longer dealing with like units, at least when comparing regions of varied economic development. In other words, for most of human history, per capita wealth remained relatively equal.[[62]](#footnote-62) When it was, population works as a fine proxy for relative wealth between two powers. But when per capita wealth is not, population alone tells an insufficient story. In this way population comparison for the battles of the various Franco-German Wars, where both combatants were roughly equivalent in per capita wealth, is methodologically sound. Yet to use the population metric to gauge the struggles between France and Algeria after the Industrial Revolution began to transform the French economy would underplay the actual degree of material difference between the two belligerents, given that the level of wealth per person had by now become dramatically different.

To control for this data validity problem we shift now from population to GDP estimates.[[63]](#footnote-63) Although by no means perfect, these figures provide a remarkably precise view of the relative material balance between two belligerents. The chief limitation of GDP data is that it is far scarcer than population estimates, and thus is generally limited to recent times. Given the difficulties of valuation and the relatively ephemeral nature of most goods, estimates of economic production are far more onerous to assemble than those of population. Even so, a total of 409 battles were able to be tested for hypothesis H(P)2b, or preponderance theory as measured by material resources (GDP). To be clear, the majority of these were found in the years following 1820, a time when the Industrial Revolution was now firmly underway. Of this decidedly modern-skewing sample, 254 cases confirmed the preponderance hypothesis; that is, in 254 of 409 battles the wealthier belligerent (as determined by GDP totals) won. This computes to 62.1% of the engagement total, and serves as a noticeable improvement over the casual success rates of the previous hypotheses. This result does not, however, stray far from the earlier concerns of causal ambiguity. No general can afford to sleep soundly when relying on odds in the neighbourhood of 60%.

To test for the possibility possible that wealth facilitates victory to a greater extent in some eras as opposed to others, we can once again disaggregate the data into six epochs and examine the consistency of the results. All data prior to 1820, totalling just 32 available cases, is grouped together to establish a baseline for pre-industrial results. Thereafter, the results can be separated into roughly 50-year intervals, leading up until the present day, and compared accordingly (table 3.0).

**Table 3.0 Economic Preponderance** (defined as the economically superior belligerent; GDP as proxy).

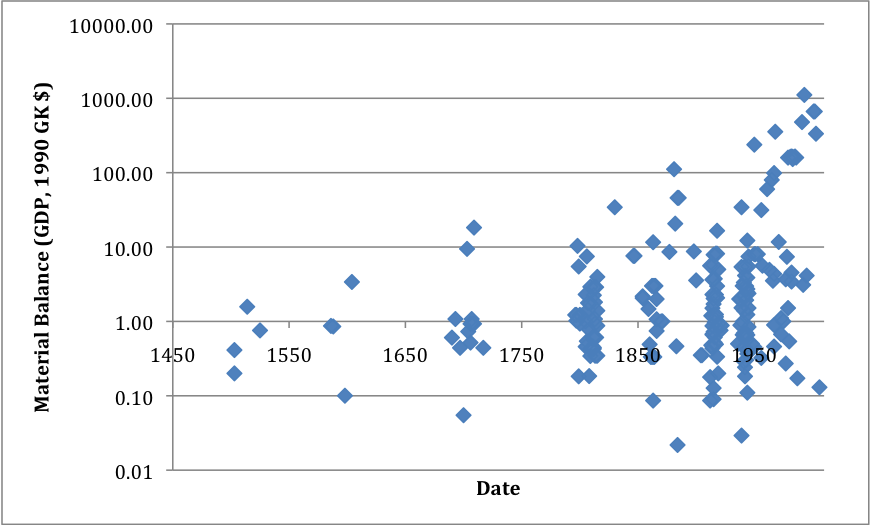
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Pre 1800 | 1800-‘49 | 1850-‘99 | 1900-‘49 | 1950-‘99 | 2000-‘06 |
| Cases | 32 | 59 | 91 | 159 | 59 | 9 |
| Prepond’t Wins | 14 | 36 | 56 | 92 | 50 | 6 |
| % | *43.8* | *61.0* | *61.5* | *57.9* | *84.7* | *66.7* |

\*Based on results of 409 cases.

The findings present an interesting story. Once again it appears that, prior to the industrial revolution, economic preponderance played very little role in achieving victory on the battlefield. Although this conclusion is admittedly based on a limited sample of just 32 cases, almost 60% of victorious belligerents in this period enjoyed *less* economic wealth than their defeated rivals. Rather than the key to victory, superior wealth in this era was just as likely a dangerous encumbrance. Nevertheless, once the industrial revolution took place the evidence suggests that a preponderance of material wealth played a useful—albeit limited—role in securing victory. Between 1800 and 1950, the causal success rate of material preponderance (GDP) remained in the neighbourhood of 60% per epoch, which was roughly the average of all results in aggregate. While this is hardly an overwhelming result, the theory can claim during this century and a half to being more correct than not, a modest boast that sits in stark contradiction to the previous variations of the theory examined above.

Even more impressive is the latter 20th century, which provides by far the most compelling example of congruence between theoretical prediction and empirical outcome. Of the 59 recorded battles fought between 1950 and 1999, victory went to the materially preponderant (as measured by GDP) roughly 85% of the time. This epoch’s results are a strict departure from the historical norm, both in light of the other epochs assessed according to the predictions of H(P)2b, as well as the alternative hypotheses studied here as well. From 1950 onwards, the materially-preponderant have won their battles with a greater frequency than professional NBA basketball players make free throws.[[64]](#footnote-64) A result in excess of 80% is therefore indicative of a very powerful degree of correlation between the independent and dependent variables hypothesized by the theory, at least for the postwar era.[[65]](#footnote-65) In the latter half of the 20th century, the bigger battalion finally became king.

**Figure 3.0 Victor-Vanquished (GDP) Ratio** (relative size of victor, as measured by GDP).



\*Based on results of 362 cases. Logarithmic scale.

A scatterplot of the material balance between victor and vanquished illustrates how the prospects of the materially-preponderant have dramatically improved over time (fig. 3.0). Prior to 1800, the plots are just as likely to be found above the line of material equality (1.0 on the y-axis) as below. This indicates that the battlefield influence accorded to superior GDP was at the time highly ambiguous. As the nineteenth century progresses, however, the balance of plots slowly begins to shift in a manner favourable to the theory. After 1950 in particular, the balance of plots can be found well above the equality line. This indicates remarkable congruence between the evidence and the theory’s central prediction, at least for this period. Indeed, from roughly the Second World War until 9/11, the materially preponderant were almost assured victory on the battlefield.

**An Interesting—But Confounding—Anomaly**

That GDP preponderance does so well in this particular epoch is worthy of praise. But before too many laurels are awarded, we must consider the unexplained riddles that remain. What is particularly disconcerting is that this spike in explanatory efficacy is such a departure from previous results. A plausible explanation can, however, be found within the seeds of preponderance theory. Economic theories of attrition contend that building new armies and lavishing them with capital-intensive weaponry brings victory. Favourable rates of attrition are attained by the side with bigger guns and more radios. Thus as the potential of capital grows, so too should its importance on the battlefield. Given that the lethality of a modern army 100,000 strong is roughly 2,000-times greater than one of antiquity,[[66]](#footnote-66) it is fair to posit that capital plays a much greater role on the contemporary battlefield. Indeed, capital-intensive weaponry played a much more prominent role during the American advance on Baghdad (2003) than Alexander’s crossing of the Granicus (334 BC). Modern armies rely on sophisticated equipment such as cruise missiles, wireless communication, and GPS systems as never before. We should therefore expect the preponderant to perform better in the modern, substantively different age.

The problem, however, is that the introduction of capital intensity to the battlefield occurred long before the materially preponderant started to win with any degree of certainty. The preliminary bombardment at Passchendaele (1917), for example, saw 120,000 British gunners fire 4.3 million shells—or 107,000 tons of explosive—at German lines over 19 straight days.[[67]](#footnote-67) The Great War was therefore obviously not short on capital. In fact, the material situation facing Haig at the Ypres salient was far more akin to that of Petraeus in Kandahar (2010) than Scipio at Zama (202 BC), or even Napoleon at Wagram (1809). Yet unlike during the postwar era, material preponderance did commanders in this period little good. Despite the almost massive amount of resources at the Entente’s disposal, the returns to preponderance in the 1900-49 period were less than a 60% chance of victory in all three versions of the theory. If a surfeit of capital is to explain the postwar anomaly, a similar abundance in earlier eras should have led to similar outcomes there as well.

We can measure capital’s stunning transformation of the battlefield in other ways as well. Foremost is the effect of industrialization on army lethality. Following the industrial revolution, technology and wealth advanced in tandem, furnishing military commanders with a previously unimaginable degree of destructive power. A typical army of the Great War, for example, was roughly 116 times more lethal than its equivalent in antiquity, 42 times than that of the days of Napoleon, and even 16 times more lethal than a comparable army in the US Civil War.[[68]](#footnote-68) In contrast, the armies that followed were much more modest in their improvement in the ability to kill. A typical army of World War II was only 5.5 times more lethal than one of the preceding World War I, and an army of the late 1980s just 3.2 times more lethal than that of World War II. In other words, while the German army of 1945 would have stood at least a fighting chance against its 1980s equivalent, the Prussian army of 1870 would have run roughshod over even the best armies antiquity had to offer. The great leap in battlefield lethality thus occurred not in the postwar era—where economic preponderance theory performs rather well—but at least a half-century *earlier*. Unfortunately for preponderance theory, while capital may have transformed the battlefield, it did so long before the fates of the economically preponderant became so favoured.

Consideration of military spending per soldier tells a similar tale. The capital-intensive nature of the postwar age can be demonstrated by observing British military expenditure. Between 1950 and 1998, the relentless cost of increasing technological sophistication drove spending from 22,000£ per serviceman to 105,500£, an increase of 480%. Yet in historical comparison, such growth in capital intensity hardly looks radical. Supported by the nation’s burgeoning industrial and financial wealth, British military expenditure per serviceman grew from 2,700£ in 1850 to 12,900£ in 1900—a jump almost identical to the previous figures.[[69]](#footnote-69) Regrettably for the poor shilling-a-day Tommy Atkinses, most of this extra funding did not go into pay, but rather to ever more elaborate capital-intensive weaponry and equipment.[[70]](#footnote-70) In other words, we again see how a growing capital intensity in military affairs long pre-dated the post-war era. Indeed, if capital transformed the battlefield to a degree that 85% of the economically preponderant won the battles they fought, it did so long before 1950. Why, then, did all the material wealth fail to ensure victory to the same startling degree in these earlier decades as well? Why would attrition work well in one era and not the other, particularly when the dramatic influence of capital can be demonstrated in both periods? To this preponderance theory offers no answers.

**4.0 Conclusions**

**Summary & Review**

The purpose of this paper has been to measure the causal efficacy of preponderance theory in each of its basic forms. Of the three hypotheses tested, none demonstrated an overwhelming relationship between an abundance of resources and victory on the battlefield. Folk wisdom fared worst, with more than half of all battles being won by the side numerically *inferior*. Not even the historical trend of slowly increasing returns to troop preponderance can overcome the fact that even in the best of circumstances the advantage conferred by ‘bigger battalions’ is slight. Economic preponderance theory offers little to boast about, either. When the relative material balance is measured using population as proxy—thereby allowing us to travel far back in time—the aggregate results indicate that the preponderant belligerent has won just 53% of the time. Even worse is the high degree of unpredictability associated with the results. This finding is not only in stark contrast to what the theory predicts, but also validation of the choice for the study’s comparatively long chronological scope. Attrition should benefit the strong regardless of the circumstances, yet the current literature is too historically narrow to allow for the potential that it does not. Economic preponderance, measured by GDP, faces a similar degree of unhelpful variability. When the results are disaggregated by epoch, some eras again appear more amenable to victory by the preponderant than others. The postwar era, for example, enjoys a striking 85% return on GDP preponderance, which is by far the most impressive result observed. Yet this spike in predictive success cannot be ascribed to the causal mechanism offered by preponderance theory—capital intensity on the battlefield—for capital transformed the battlefield long before those with a preponderance of it starting winning. The causal effect of preponderance can therefore only be deemed ambiguous.

The chief lesson of these weak results is that a reliance on preponderance to secure victory is not much more useful than leaving one’s fate to chance. Even the 85% result achieved by economic preponderance (GDP) for the postwar era is more a theoretical anomaly than part of a consistent trend of accurately predicting battlefield outcomes. This lack of a match between logically deduced ‘empirical statements’ and the accumulated evidence provides a severe blow to the theory’s credibility. In short, the results of this study indicate that the causal mechanism of attrition does not work in the manner predicted by preponderance theorists. As we shall see, this is a greater problem than is commonly assumed.

**The Problem with Preponderance**

The most disconcerting aspect of preponderance theory is not its lack of causal efficacy. Indeed, many international relations theories face a serious disjuncture when faced with the empirical record. It would therefore be unfair to single out preponderance for its failings in this regard. Instead, what is so dangerous about the theory is the popularity of its associated causal mechanism, attrition. It is, after all, one thing for a theory to remain no more than a topic for discussion in musty academic debates; it is something entirely another, however, to be taken as an article of faith by generals mired stalemate, unsure of where else to proceed—particularly when the evidence suggests that the concept is murderously unreliable. Indeed, the fashionability of preponderance and attrition should give reason for great discomfit precisely because of the deadly repercussions when they do not work.

No struggle demonstrates this dilemma with greater poignancy than the battle of Verdun (1916). This was, after all, an engagement whose expressed purpose was to achieve victory through attrition. With the Russians checked in the East after Gorlice-Tarnow (1915), the German Chief-of-Staff Falkenhayn considered the time ripe to resolve the deadlock in the West. With the British volunteer army rapidly growing in strength and the victory of Tannenberg (1914) averting crisis in the East, Falkenhayn selected as his target hard-pressed France, struggling mightily as it was against the much more populous Germany. “The strain on France,” he wrote, “has reached breaking point.” The best way forward, then, was to launch a limited offensive that would “compel the French to throw in every man they have. If they do so the forces of France will bleed to death.”[[71]](#footnote-71) By focusing on a point where the French would fight to hold regardless of the cost, Falkenhayn brought the truest measure of attrition to battle. In such a struggle, he believed, Germany’s superiority in numbers would ensure that the French would crack first. Germany would succeed by ‘bleeding the French white.’

The site chosen was the great French fortress of Verdun, exposed on three sides to 542 German heavy guns and a stock of 2.5 million shells to go along with them. The plan, labeled ‘Operation Judgement,’ was brutally simple:

“The French, forced to fight in a crucial but narrowly constricted corner of the Western Front, would be compelled to feed reinforcements into a battle of attrition where the material circumstances so favoured the Germans that defeat was inevitable. If the French gave up the struggle, they would lose Verdun; if they persisted, they would lose their army.”[[72]](#footnote-72)

Under the relentless German pounding, the French almost did. Just three days into the battle, a French lieutenant of the 72nd division reported that: “The commanding officer and all company officers have been killed. My battalion is reduced to approximately 180 men (from 600). I have neither ammunition nor food. What am I to do?”[[73]](#footnote-73) Even Émile Driant, the lieutenant colonel whose hastily constructed strongpoints in the Bois des Caures helped keep the Germans at bay in the battle’s opening stages, was shot in the forehead while calmly preparing a withdrawal.[[74]](#footnote-74)

But the Germans, opposed by an indomitable French fighting spirit, suffered mightily as well. *Ils ne passeront pas!*—They shall not pass!—became a common rallying cry.[[75]](#footnote-75) Desperate to carry the advance forward, the Germans pushed their horse-drawn gun teams further and further into the teeth of the enemy, suffering appalling casualties in the process. Some 7,000 horses are said to have been killed on a single day. German losses were so heavy that after the war the Crown Prince Wilhelm, commander of the Fifth Army, would record that “Verdun was the mill on the Meuse that ground to powder the hearts as well as the bodies of our soldiers.”[[76]](#footnote-76) As with any boiling cauldron, it scalded all who touched it.

For 302 days the battle raged. Falkenhayn had acquired the grinding, attritional struggle that he so desired. Back and forth the battle went, with the French rallying to each new challenge the Germans presented. The village of Vaux, for example, changed hands thirteen times in March alone. Yet for all this fierce fighting, nothing was accomplished outside the death and mutilation of men, and the despoliation of the countryside. The lines hardly moved. Verdun did not fall. The French army did not crack. “Verdun had become a place of terror and death that could not yield victory.”[[77]](#footnote-77) But that futility did not stop the appeal of attrition. Incredibly, the British took away from Verdun the idea that victory could be achieved in a similar attack at the Somme (1916), if only the tables of material preponderance were reversed against Germany’s favour. The assumption was that victory would arrive by simply doubling and tripling Britain’s artillery, attackers, and reserves. Here Haig boasted 1,500 pieces of artillery, one for every seventeen yards of the eighteen miles of curving front along which the BEF would be attacking.[[78]](#footnote-78) Breakthrough, the British concluded, would be achieved through sheer chemical and physical mass. One officer told his men, “You will be able to go over the top with a walking stick, you will not need rifles. When you get to Thiepval [a village to be taken on the first day] you will find the Germans all dead. Not even a rat will have survived.”[[79]](#footnote-79) Yet it was all utter folly, for the allure of preponderance was nothing more than a deceitful trick, and the struggle continued for more than 140 fruitless days. In the end, each side would endure over 600,000 casualties for a prize of six or seven miles of strategically worthless ground along a 30-mile front.[[80]](#footnote-80) As at Verdun, attrition would not bring victory to the Somme, only death and despair.

The lesson, then, is that attrition is the antithesis of strategy. It is a blind contention that ‘numbers will win out,’ yet then fails to suggest just how this is to be achieved. In policy terms, having a larger army, bigger battalions, and more plentiful weaponry has long been a foremost concern of leaders, both military and political. Britain entered into an alliance with France prior to the First World War for precisely such numerical reasons.[[81]](#footnote-81) Yet, as this study has demonstrated, faith in numbers is little insurance policy at all. As it was, the country was so mauled in the Great War that the splendour and glory of *Pax Britannica* was never to return. In theoretical terms, the results are far less vicious, but no less stark: the core hypothesis of all the variants of preponderance theory—that a superior weight in numbers is the ultimate guarantor of victory in battle—cannot be but considered conclusively dismissed.

1. Cited from John Keegan, *The First World War*, (Vintage Canada, 2000), p. 367. [↑](#footnote-ref-1)
2. John Alger, *The Quest for Victory*, (Westport, CN: Greenwood Press, 1982), p. 189. [↑](#footnote-ref-2)
3. Cited in Theodore Ropp, *War in the Modern World*, (New York: Collier Books, 1973 [1962]), p. 248. [↑](#footnote-ref-3)
4. Ropp, *Modern*, p. 250. [↑](#footnote-ref-4)
5. Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle*, (Princeton: Princeton University Press, 2004), p. 14. [↑](#footnote-ref-5)
6. Such faith in numerical preponderance has long been part of folk wisdom. For Napoleon’s quote, see John Bartlett, *Familiar Quotations*, 10th ed, (Boston: Little, Brown, 1919), no. 9707. [↑](#footnote-ref-6)
7. See, for example, Bruce Bueno de Mesquita, in his *The War Trap*,(New Haven: Yale University Press, 1981). [↑](#footnote-ref-7)
8. See the discussion in James E. Dougherty and Robert L. Pfaltzgraff, *Contending Theories of International Relations: A Comprehensive Survey*, (Longman, 2000), chapter 4, which touches upon the works of Kenneth Waltz, Karl Deutsch, and J. David Singer. See also J. David Singer *et al*, “Capability Distribution, Uncertainty, and Major Power War, 1820-1965,' in J. David Singer & Associates (eds), *Explaining War*, (Beverly Hills, Calif: Sage, 1979). [↑](#footnote-ref-8)
9. W.D. Bird, *The Direction of War: A Study of Strategy*, (Cambridge: Cambridge University Press, 1920), p. 28. Bird ascribes even greater importance to preponderance with his further observation that “in war the result of the first great battle is largely influenced by the number of efficient units that are available,” a fact which matters because “defeat in the first serious encounter is…often followed by failure in the campaign.” (p33). Thus not only is victory in battle seen here as determined by who has the most front-line quality forces as the start of the war, so too is the entire struggle. [↑](#footnote-ref-9)
10. Paul Kennedy, “The First World War and the International System,” in *Military Strategy and the Origins of the First World War*, Steven Miller (ed), (Princeton: Princeton University Press, 1985), p. 38. Kennedy later refined this his theory, arguing that victory is “caused” by material superiority.” Paul Kennedy, *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000*, (New York: Random House, 1987). [↑](#footnote-ref-10)
11. See Edward Mead Earle, “Adam Smith, Alexander Hamilton, Friedrich List: The Economic Foundations of Military Power,” in *Makers of Modern Strategy, from Machiavelli to the Nuclear Age*, Peter Paret (ed), (Princeton: Princeton University Press, 1986), p143; and William C. Martel, *Victory in War: Foundations of Modern Military Policy*, (Cambridge: Cambridge University Press, 2007), p. 39, 318 fn #150. [↑](#footnote-ref-11)
12. J. David Singer, Stuart Bremer, and John Stuckey, “Capability Distribution, Uncertainty, and Major Power War, 1820-1965,” in *Peace, War, and Numbers*, ed. Bruce Russett (Beverly Hills: Sage Publications, 1972), p. 21-27. [↑](#footnote-ref-12)
13. A. F. K. Organski, *World Politics*, 2nd ed, (New York: Knopf, 1968), p. 358. [↑](#footnote-ref-13)
14. Organski, *World Politics*, chpt 8, especially p. 203-210, in 1958 ed. See also Organski and Kugler *War Ledger*, p. 33-38. [↑](#footnote-ref-14)
15. Kenneth Waltz, *Theory of International Politics*, (Reading: Addison-Wesley, 1979), p172. Like Organski, he elsewhere suggested that it is possible to rank the capabilities of states by reference to “how they score on *all* of the following items: size of population and territory, resource endowment, economic capability, military strength, political stability and competence.” (p131). Even so, GNP was once again offered as a more parsimonious metric. See also Klaus Knorr, *The Power of Nations: The Political Economy of International Relations*, (New York: Basic Books, 1975), p. 45-69. To be fair, though, these authors did not deny other sources of power as well. See Waltz, *Theory*, p. 131; Knorr, *Power*, p. 69-78; Hans Morgenthau, *Politics Among Nations*, 6th ed, (New York: McGraw Hill, 1985), p. 80-108. [↑](#footnote-ref-15)
16. Robert Gilpin, *War and Change in World Politics*, (New York: Cambridge University Press, 1981), p. 67. [↑](#footnote-ref-16)
17. Note here the emphasis on *aggregate* wealth, as opposed to per capita wealth. While per capita figures offer a rough reflection of a country’s relative standard of living, preponderance theory is ultimately concerned with its total stock of wealth instead. This is because societies that are populous but poor can still shift surplus to frontline forces, thereby belying their citizen’s penury, and because those that are small and affluent still face relatively constrained treasuries. North Korea’s 25 million citizens, for example, may be extraordinarily poor, but the draconian redistribution of surplus enables the deployment of an impressive array of tanks, artillery, and even nuclear weapons. In contrast, Luxembourg’s 500,000-strong populace enjoys unsurpassed per capita wealth, yet still lacks the aggregate resources to match North Korea’s arsenal. [↑](#footnote-ref-17)
18. For works on US military history, see Russell Frank Weigley, *The American Way of War: A History of United States Military Strategy and Policy*, (1977); Robert Doughty *et al*, *American Military History and the Evolution of Western Warfare*, (1996); and Fred Anderson (ed), *The Oxford Companion to American Military History*, (2000). [↑](#footnote-ref-18)
19. Hans Delbrück, *History of the Art of War within the Framework of Political History*, vol IV: *The Modern Era*, Walter J. Renfroe Jr. (trans), (Westport, CT: Greenwood, 1975-85), p. 63. Here he was writing about the “Organization of Mercenary Armies.” [↑](#footnote-ref-19)
20. Henry Wager Halleck, *Elements of Military Art and Science*, (New York: D. Appleton, 1862), p. 37. [↑](#footnote-ref-20)
21. Cited in William C. Martel, *Victory in War: The Foundations of Modern Military Policy*, (Cambridge: Cambridge University Press), p. 34. [↑](#footnote-ref-21)
22. Antoine-Henri Jomini, *Précis de l’art de la guerre*, 2 vols., (Paris: Tanera, 1855 [1838]), I, p. 158. Cited in John Alger, *The Quest for Victory*, (Westport, CN: Greenwood Press, 1982), p. 26. [↑](#footnote-ref-22)
23. Erich Ludendorff, *The Nation at War*, A.S. Rapoport (trans), (London: Hutchinson, 1936), p. 87. [↑](#footnote-ref-23)
24. Cited in Martel, *Victory*, p. 322 fn#17. [↑](#footnote-ref-24)
25. Cited in M.J. Cohen and John Major, *History in Quotations: Reflecting 5000 Years of World History*, (London: Cassell, 2006), p. 722. He continued, “If the opposing forces are approximately equal in numbers, in courage, in moral [*sic*] and in equipment, there is no way of avoiding payment or of eliminating this phase of the struggle.” As demonstrated by the Somme (1916) and Passchendaele (1917), Haig was more than willing to pay this butcher’s bill. [↑](#footnote-ref-25)
26. Cynthia A. Cannizzo, “The Costs of Combat: Death, Duration, and Defeat,” in J. David Singer (ed), *The Correlates of War: II, Testing Some Realpolitik Models*, (New York: Free Press, 1980). [↑](#footnote-ref-26)
27. Cannizzo, “Combat,” p. 247. [↑](#footnote-ref-27)
28. So too does the logic of attrition apply to battles and wars in equal measure. A victory achieved by attrition in war is no different than that obtained in battle. For troop preponderance theory, the aim in both battles and wars is to outlast the opponent by having them run out of able-bodied soldiers first. For economic preponderance theory, the aim is to achieve a greater capital intensity than one’s rival, and thus a superior combat performance. In the case of wars, victory in war is simply a matter of possessing a superior material resource base, for that side can out-gun, out-mobilize, and out-last an opponent. Yet so too at the level of battles does the reliance on the superior attritional strength of capital remain, for here is the assumption that the materially preponderant will arrive at the battlefield battle better equipped, and thus able to erode an enemy’s strength faster than they endure casualties in return. [↑](#footnote-ref-28)
29. De Mesquita, *The War Trap*, p. 92. What is particularly interesting about de Mesquita’s argument is that while he highlights the importance of commitment to a cause, the implicit logic suggests that who actually wins and loses is determined by the relative balance of material capability. Indeed, commitment will either increase or decrease the relative amount of combat resources available to a belligerent, but it will ultimately be attrition that remains the actual causal mechanism of victory and defeat. [↑](#footnote-ref-29)
30. See, for example, Hans Delbrück, 1980, *The Barbarian Invasions*, Walter Renfroe (trans.) (Lincoln: University of Nebraska Press, 1980); John Haldon, *The Byzantine Wars: Battles and Campaigns of the Byzantine Era*, (Stroud: Tempus, 2001); Paul Adair*, Hitler's Greatest Defeat: The collapse of Army Group Centre, June 1944*, (Weidenfeld Military, 1994); S. Mitcham, *German Defeat in the East, 1944–5*, (Stackpole, 2007); and G. Niepold, *Battle for White Russia: The Destruction of Army Group Centre June 1944*, R. Simpkin (trans.), (London: Brassey's, 1987). [↑](#footnote-ref-30)
31. According to the typology adopted here, if the dependent variable is victory and the independent variable is some sort of metricized yardstick of raw material strength, the theory is ascribed to the preponderance camp. It is true, however, that some scholars, including Clausewitz and Morgenthau, concern themselves with the matter of exhortation or national will. As they observe, raw power must be harnessed to a willingness to fight. Resources must be mobilized before they can ever be deployed to the field. Yet the logic of preponderance remains, as a country’s mobilization level is no more than an intervening variable in the power balance equation. [↑](#footnote-ref-31)
32. Biddle, *Military Power*, p14. This observation comes even if some realists would deny it. Part of the problem with realism is that it is often a theoretically murky affair. In particular, realists are rarely explicit when it comes to their explanations of victory. For example, while it is true that classical realists such Morgenthau and Knorr referred in their works to the importance of strategy, ultimately their focus was chiefly on preponderance concerns. Even worse than this contradictory logic is that neither offered a testable treatment of *either* proposition. In fact, it is common for classical realists to ignore military doctrine altogether. Martin Wight, for example, cites the importance of nonmaterial “intangibles,” but ascribes them solely to matters of national will, rather than the adoption of particular tactics and strategies to enhance—or diminish—combat power. The only reasonable conclusion to draw, therefore, is that such scholars implicitly accept and ultimately advocate for the preponderance position. See Hans Morgenthau, *Politics Among Nations*, 6th ed, (New York: McGraw Hill, 1985), p. 141-42; Klaus Knorr, *Military Power and Potential*, (Lexington: D.C. Heath, 1970), p. 119-36. Martin Wight, *Power Politics*, (Leicester: Leicester University Press, 1978), p. 26-27. [↑](#footnote-ref-32)
33. John Arquilla, *Dubious Battles*, (Washington: Crane Russak, 1992), p. 10. [↑](#footnote-ref-33)
34. Arquilla, *Dubious Battles*, p. 24. [↑](#footnote-ref-34)
35. For the classic expression of how power equality helps reduce the probability of war, see Waltz, *Theory*, p. 123-28; but also Inis L. Claude, Jr., *Power and International Relations*, (Random House, 1962), p. 40-93; Arnold Wolfers, *Discord and Collaboration: Essays on International Politics*, (Baltimore: Johns Hopkins University Press, 1962), p. 122-24; Raymond Aron, *Peace and War*, R. Howard and A.B. Fox (trans), (Garden City, New York: Doubleday, 1966); Morton A. Kaplan, "Some Problems of International Systems Research," in *International Political Communities: An Anthology*, (Garden City, NY: Anchor, 1966), p. 469-486; Morgenthau, *Politics Among Nations*; Henry Kissinger, *The White House Years*, (Little, Brown, and Company, 1979); and Joseph M. Grieco, 'Anarchy and the Limits of Cooperation: A Realist Critique of the Newest Liberal Institutionalism,' *International Organization* 42 (1988) p. 485-507. [↑](#footnote-ref-35)
36. For details on each case, see David Stevenson, *Armaments and the Coming of War: Europe 1904-1914*, (Oxford: Clarendon Press, 1996); J. P. D. Dunbabin, “British Rearmament in the 1930s: A Chronology and Review,” *The Historical Journal*, (1975), 18: p. 587-609; and Paul P. Craig and John A. Jungerman, *Nuclear Arms Race: Technology and Society*, (New York: McGraw-Hill, 1990). [↑](#footnote-ref-36)
37. See, for example, Charles Glaser and Chaim Kaufman, “What is the offense-defense balance and can we measure it?”, *International Security* (Spring 1998), p. 55-57. As Biddle notes, “More broadly, all structural IR theory posits that states make optimizing choices guided chiefly by material constraints,” rather than any particular conception of good leadership and soldiery. Biddle, *Power*, p. 249 fn 32. For a further criticism of this position, see Timothy McKeown, “The Limitations of ‘Structural’ Theories of Commercial Policy,” *International Organization*, (Winter 1986), p. 43-64. [↑](#footnote-ref-37)
38. Consider the two biggest empirical databases primarily concerned with preponderance theory: neither the Correlates of War nor the Militarized Interstate Disputes datasets contain any information on tactical arrangements. Instead the focus is on material indices—a very clear indication of preponderance logic at work. See Meredith Reid Sarkees and Frank Wayman, *Resort to War: A Data Guide to Inter-State, Extra-State, Intra-State, and Non-State Wars, 1816-2007*, (CQ Press, 2010) for the latest update from the COW project; and Faten Ghosn and Scott Bennett, “Codebook for the Dyadic Militarized Interstate Dispute Data, Version 3.10,” (September 25, 2007), available at <http://www.correlatesofwar.org/COW2%20Data/MIDs/MID310.html>. [↑](#footnote-ref-38)
39. Glaser and Kaufman, “offense-defense,” p. 55. [↑](#footnote-ref-39)
40. Karl von Clausewitz, *On War*, O.J. Matthijs Jolles (trans), (Washington DC, Infantry Journal Press, 1950), p122; and Martel, *Victory*, p. 34-5. [↑](#footnote-ref-40)
41. Angus Maddison, the recently deceased dean of such macromeasurement, has collected regular figures only every 100 years, prior to 1820, and only every 500 years, prior to 1500. Similarly, B.R. Mitchell’s data extends no earlier than 1750, and Carlos Sabillon’s do much the same. This is not to serve as a criticism of these works, but rather as a reminder that much work remains to be done. Angus Maddison, *The World Economy: A Millennial Perspective*, (Paris: OECD, 2001). Carlos Sabillon, *World Economic Historical Statistics*, (New York: Algora, 2005); B.R. Mitchell, *International Historical Statistics* (3 Vols), (Basingstoke: Macmillan, 1992). [↑](#footnote-ref-41)
42. A good discussion of the methodological concerns surrounding military variables can be found in Gary Goertz and Paul F. Diehl, “Measuring Military Allocations: A Comparison of Different Approaches,” *Journal of Conflict Resolution*, Vol. 30, No. 3 (Sep, 1986), p. 553-581; cited at p. 556-7. [↑](#footnote-ref-42)
43. A discussion of the methodological problems of battle death data construction can be found in Levy, *Great Power*, 1983, p. 83-87. [↑](#footnote-ref-43)
44. This danger is particularly acute when only one belligerent is in a position to leave behind written records, thereby limiting the potential for dissenting voices recording and disseminating their own version of events. [↑](#footnote-ref-44)
45. Meanwhile, note the willingness of Daniel S. Geller and J. David Singer, *Nations at War: A Scientific Study of International Conflict*, (New York: Cambridge University Press, 1998); William Eckhardt, *Civilizations, Empires and Wars: A Quantitative History of* *War*, (Jefferson, NC, 1992); and Jack S. Levy, *War in the Modern Great Power System, 1495-1975*, (Lexington: University of Kentucky Press, 1983) to embrace these figures. As such, to accept the numbers offered by historians is hardly controversial. [↑](#footnote-ref-45)
46. For an interesting look at the “perdurability” of ground forces, see John English, *Marching Through Chaos: The Descent of Armies in Theory and Practice*, (Westport: Praeger, 1996). [↑](#footnote-ref-46)
47. Dyer, *War*, p. 12. [↑](#footnote-ref-47)
48. See again Organski, *World Politics*,(1968), p. 358; and above. [↑](#footnote-ref-48)
49. And even then, not for all countries. Maddison, *World Economy.* See also Angus Maddison, *Contours of the World Economy: the Pace and Pattern of Change, 1-2030 AD*, (Cambridge University Press, 2007). [↑](#footnote-ref-49)
50. The standard work is Colin McEvedy and Richard Jones, *Atlas of World Population History*, (London: Penguin, 1978/1985. See also Massimo Livi-Bacci, *A Concise History of World Population*, (Maiden, MA: Blackwell Publishing, 2007). [↑](#footnote-ref-50)
51. See, for example, the excellent graph comparing the two in North, *Understanding Economic Change*, (Princeton: Princeton University Press, 2010). [↑](#footnote-ref-51)
52. Adam Smith, *The Wealth of Nations*, (London: J.M Dent & Sons, 1964 [1776]) vol.1, p62. [↑](#footnote-ref-52)
53. Livi-Bacci, *Population*, p. 58. [↑](#footnote-ref-53)
54. This framework can also be expanded to include measures of labour input and capital stock, labour, and total factor productivity. Angus Maddison, *Growth and Interaction in the World Economy: The Roots of Modernity*, (Washington: AEI Press, 2005), p. 83. [↑](#footnote-ref-54)
55. McEvedy and Jones certainly expressed as much: “We have also become confident as the work has progressed that there is something more to statements about the size of classical and early medieval populations than simple speculation. The upper and lower limits imposed by common sense are often much closer together than might be thought. In fact, when all the various fuzzy approaches have been made, one is usually left with an answer that is fairly certain within an order of magnitude…even when there are no data that can be used to calculate a population figure we are far from helpless. There are always guidelines.” McEvedy and Jones, *Atlas*, p10-1. See also Sean Clark, “Revealing Clio’s Secrets: The Case for Macromeasurement,” *The International Journal of Interdisciplinary Social Sciences*, (Volume 4, Issue 8: 2009), p. 101-114. [↑](#footnote-ref-55)
56. Bryan Perrett, *The Battle Book*, (London: Arms & Armour, 1996); David Chandler, (ed), *The Dictionary of Battles*, (New York: Henry Holt and Company, 1987); Stephen Badsey, David Nicolle, and Stephen Turnbull, *The Timechart of Military History*, (Herts: Worth Press, 1999); Michael Clodfelter, *Warfare and Armed Conflict: A Statistical Reference to Casualty and Other Figures, 1494-2007*, (McFarland & Company, 2008); David Eggenberger, *An Encyclopedia of Battles: Accounts of Over 1,560 Battles From 1479 B.C. to the Present*, (New York: Dover, 1985; and R. Ernest Dupuy and Trevor N. Dupuy, *The Encyclopedia of Military History*, (New York: Harper & Row, 1977). [↑](#footnote-ref-56)
57. Maddison, “Historical Statistics of the World Economy: 1-2008 AD.” Available online and in electronic form at <http://www.ggdc.net/MADDISON/oriindex.htm>; McEvedy and Jones, *Atlas*. [↑](#footnote-ref-57)
58. The choice of battles as the unit of analysis is imperfect, but still useful. Speaking of a similar conundrum facing his own study, Biddle noted that “this is an imperfect test: victory in war is not the same as victory in operations per se (my unit of analysis here). Yet the intuition behind the materialist conception of military power draw little distinction between wars and operations—where preponderant material is thought to win wars, it is ostensibly by winning battles.” Biddle, *Military Power*, p. 20-21. [↑](#footnote-ref-58)
59. See, for example, Mark B. Tauger, *Agriculture in World History*, (London: Routledge, 2011) and G.J. Leigh, *The World’s Greatest Fix: A History of Nitrogen and Agriculture*, (Oxford: Oxford University Press, 2004). [↑](#footnote-ref-59)
60. It is possible that this trend reflects slowly improving command and control capabilities. What makes such a conclusion tenuous, however, is that between the fall of Rome and the imperial staffs and telegraphs of the 1800s, command performance would likely have been as chaotic and undisciplined as any other social organization of the day, at least in comparison to the smoothly professional institutions of high antiquity. This collapse and return of command ability displays little congruence with the linear improvement in preponderance performance observed here. For further reading, see Martin Van Creveld, *Command in War*, (Cambridge: Harvard University Press, 1985). [↑](#footnote-ref-60)
61. Of 19 battles in the dataset found between 0 and 500 AD, 18 involved the Roman Empire, fighting either neighbouring or internal rivals. [↑](#footnote-ref-61)
62. See Maddison,online. The bifurcation between North and South slowly began to emerge in the 1500s, but did not take off until the Industrial Revolution was well under way. [↑](#footnote-ref-62)
63. Angus Maddison, online. [↑](#footnote-ref-63)
64. John Branch, “For Free Throws, 50 Years of Practice Is No Help,” *New York Times*, (March 3, 2009). The professional mark of 75% stands as a useful threshold for the of this study. Free throws are seen as pretty close to a ‘sure thing,’ yet with an appreciation that events sometimes go awry. Policy makers can ask for no better or more realistic level of certainty. [↑](#footnote-ref-64)
65. Another standard to use is the advantage the home side enjoys in team sports. In Major-league baseball, 54% of games are won by the home team. In international cricket, the figure is 60%; in English Premier League soccer 63%, and 69% at the US collegiate level. *The Economist*, “The referee’s an anchor,” (March 12, 2011), p. 90. Based on data from Tobias Moskowitz and Jon Wertheim, *Scorecasting: The Hidden Influences Behind How Sports Are Played and Games Are Won* (Three Rivers Press, 2011). [↑](#footnote-ref-65)
66. Trevor Dupuy, *Attrition: Forecasting Battle Casualties and Equipment Losses in Modern War*, (Falls Church: Nova Publications, 1995), p. 29. [↑](#footnote-ref-66)
67. John Nef, *War and Human Progress*, (New York: W.W. Norton, 1950), p. 366. [↑](#footnote-ref-67)
68. Calculated from Dupuy, *Attrition*, p. 31. [↑](#footnote-ref-68)
69. Niall Ferguson, *The Cash Nexus*, (New York: Basic Books, 2002), p. 33, 35. Measured in 1998 prices. [↑](#footnote-ref-69)
70. See, for example, Allan Mallinson, *The Making of the British Army*, (Bantam Press, 2009); Alan Ramsay Skelley, *The Victorian Army at Home: the Recruitment and Terms and Conditions of the British Regular, 1859-1899* (Taylor & Francis, 1977); Edward M. Spiers, *The Late Victorian Army, 1868-1902*, (Manchester University Press, 1992). [↑](#footnote-ref-70)
71. Cited in John Keegan, *First World War*, p. 278. [↑](#footnote-ref-71)
72. Keegan, *First World War*, p. 279. To this end, the French certainly behaved just as Falkenhayn anticipated. That the “original citadel was the handiwork of Vauban, Louis XIV’s great military architect, the fortress has a patriotic aura that transcended its strategic significance.” After Fort Douaumont fell, the lynchpin of the defensive system and seen by some as the strongest fort in the world, the call went out for a vast build-up in the Verdun sector. Nine months later, two-thirds of the entire French army had seen action at this part of the front. Roger Chickering, *Imperial Germany and the Great War, 1914-1918*, (Cambridge: Cambridge University Press, 2007 [2004]), p67. [↑](#footnote-ref-72)
73. Cited from Keegan, *World War*, p. 281. [↑](#footnote-ref-73)
74. Meyer, *World Undone*, p. 371-375, 380-1. After the first day, after 80,000 shells fell on the wood—an area just 500 by 1,000 yards—Driant’s battalions (originally some 1,300 men under his command) counted only seven lieutenants, every one of whom was wounded, and about a hundred troops still capable of fighting. Driant himself was killed the next day. [↑](#footnote-ref-74)
75. This came from General Robert Neville’s June 23 1916 order of the day. Cited in Cohen and Major, *Quotations*, p. 714. [↑](#footnote-ref-75)
76. G.J. Meyer, *A World Undone: The Story of the Great War, 1914 to 1918*, (New York: Delta, 2006), p. 405. [↑](#footnote-ref-76)
77. Keegan, *First World War*, p. 285. [↑](#footnote-ref-77)
78. Meyer, *World Undone*, p. 437. [↑](#footnote-ref-78)
79. Cited in Meyer, *World Undone*, p. 438. [↑](#footnote-ref-79)
80. Robert O’Connell, *Of Men and Arms*, (Oxford: Oxford University Press, 1990), p. 255. [↑](#footnote-ref-80)
81. Good surveys of prewar diplomacy include M.B. Hayne, *The French Foreign Office and the Origins of the First World War, 1898-1914*, (Oxford: Oxford University Press, 1993; Zara S. Steiner, *Britain and the Origins of the First World War*, (New York: St. Martin’s Press, 1977); Samuel R. Williamson, Jr., *The Politics of Grand Strategy: Britain and France Prepare for War, 1904-1914*, (Cambridge, Mass.: Harvard University Press, 1969); Paul Kennedy, *The Rise of Anglo-German Antagonism, 1860-1914*, (London: Allen & Unwin, 1980); and John H. Maurer, *The Outbreak of the First World War: Strategic Planning, Crisis Decision Making, and Deterrence Failure*, (Westport, Conn.: Praeger/Greenwood, 1995). [↑](#footnote-ref-81)