Micro-events and Macro-dynamics: The Staccato Growth of Military Power*

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ABSTRACT

Although market economies exhibit booms and busts, many growth economists believe that the overall trajectories of such systems look relatively smooth when viewed from 30,000 feet. This is not true of international politics. The military power of states, hence their relative standings in the international system, can shift radically in a short time and sometimes never recover. This greater volatility of state power is over-determined, produced by a combination of mechanisms that are well-understood (governments sharply increasing military spending during war and cutting it afterwards) as well those that are poorly understood: in particular, war-dynamics often lack the micro-to-macro “smoothing” which makes economic growth relatively predictable. Instead, military competition exhibits micro-to-macro volatility: in some important wars and near-wars, partly random micro-events have impacted macro-dynamics. Thus, because the evolution of interstate systems is influenced by the dynamics of war and peace, it is fundamentally different---more chaotic and less predictable---than the dynamics of economic growth. Surprisingly, these properties of international politics have mostly been ignored by historical institutionalists. Our theoretical contribution is to reconcile historical institutionalist views on the evolution of state power with more conventional natural-science approaches and to identify specific properties of military competition that produce micro-to-macro volatility.

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1. Introduction

Economic growth looks quite different to macroeconomists and historians of technology.\(^1\) Empirical macroeconomists typically study growth trajectories that are relatively smooth (Deaton 2013; Jones 2015). To be sure, even from 30,000 feet one can see a few big dips—the Great Depression in many countries—and a few steep climbs—e.g., China’s last decade—but from a high enough altitude what is really striking over the last 200 years is, in Deaton’s felicitous phrase, the “Great Escape” from poverty in much of the world. From there, the errors, confusion, false starts and blind alleys that historians of technology have repeatedly discovered are almost invisible.\(^2\)

In this paper we argue that the growth of military power of states, hence their standing in the international system, is much more uneven and that this unevenness is often visible even at low levels of resolution. This difference is not due to big differences in technological uncertainty: Popper’s conundrum covers economic innovations as well as military ones.\(^3\) Some of the real causes are subtle, involving differences in how micro-events get mapped into macro-dynamics.\(^4\)\(^5\) And our explanation implies that other domains exhibiting the properties leading to

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1 We are lumping together historians of technology and economic historians (e.g., Mokyr 2003) who study growth in a fine-grained way, focusing on the emergence of useful artifacts and industrial processes.

2 The list of relevant references is huge. Mokyr (2003) is a good place to start.

3 Popper’s conundrum is based on two claims: the evolution of societies depends on the growth of knowledge and the latter is intrinsically unpredictable (if we could predict future knowledge in detail then we would have it now—it wouldn’t be future knowledge). Hence the evolution of societies is intrinsically unpredictable.

4 We are not claiming that political dynamics are generally more uncertain than economic dynamics. That claim is far too sweeping to be supported by available evidence. Our claim is constrained to a rather special (though important) type of policy domain: national security. Indeed, our analysis of the properties of this domain implies that the trajectories of many other policy domains—e.g., education—are not very volatile. Thus, to the extent that our argument can be regarded as historical institutionalist, it is a sharply qualified member of that class.

5 Thinking about the difference in macro- vs. micro-dynamic in terms of investment portfolios provides useful intuition. The net assets of traders with diversified portfolios change slowly because particular micro-level events impact individual stocks or bonds that are only a small part of overall portfolio value. Traders with only one or two investments are more likely to see wild fluctuations in their net worth. (N.b.: what matters is the size distribution. If one stock is 99 percent of a portfolio’s value, volatility will ensue even if there are thousands of other stocks in the
volatility in military power (e.g. the irreducibility of strategic uncertainty and the small number of organizations in war) will display similar volatility.⁶

To see this dynamic consider figure 1, which plots an annual estimate of military power, the M-Score, and GDP per capita for six major world powers since 1800.⁷ The difference in volatility is striking. Although some of the military variability reflects states’ investment decisions, that reflects underlying variation in strategic situations that are part and parcel of the phenomenon we aim to explain.

INSERT FIGURE 1 ABOUT HERE.]

Military volatility is partly demand-driven, a component long studied by public finance scholars and students of budgeting. Since the creation of mass armies in the 1800s, military spending by the Great Powers has exhibited booms and busts, spiking up during war and decreasing, sometimes sharply, afterwards. (The U.S. after the Civil War and World War I is a good example of dramatic reductions in military spending once wars end.) But this is not the only mechanism that produces volatility in military power: we will identify several others that are much less well-known than varying demand.⁸

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⁶ Many dictionary definitions of “volatile” contain both an ex post property (the relevant time series has big swings) and an ex ante one (swings are unpredictable). We follow that usage.

⁷ The M-Score of military power takes into account both military size and sophistication, with the latter proxied by the ratio of expenditures to personnel normalized by the average ratio for any given time period. See Arena (2012) for details. GDP data from the Maddison Historical GDP Data. Appendix figure A1 shows the same figure using the Composite Indicator of National Capabilities (CINC) measure from the Correlates of War Project (V.4) that measures relative power as a function of a country’s share of total military personnel worldwide plus its share of world population and energy production. Because the CINC score contains a number of slow-moving smooth variables (total energy consumption and population) the measure is smoother than the M-Score, but still substantially more volatile than GDP.

⁸ Further, spending is an input, not an output, as is military power. Hence, given sufficient corruption a government could sharply increase its military spending but get little for it: Chiang Kai-Shek’s government in World War II is an example. Thus volatility in a country’s M-score adds information, above and beyond fluctuations in spending.
Indeed, we believe that the volatility of military power is over-determined.\(^9\) Thus the contribution of this paper is two-fold: a conjecture about comparative volatility and some explanations for this difference.

Common to all the causal mechanisms we examine is a fundamental systemic property of international politics and inter-state competition: anarchy---no third-party regulation. In contrast, most firms operate in nation-states that regulate economic competition in important ways.\(^10\) Hence when firms compete there is often reliable third-party enforcement of rules and orderly re-allocation of losers’ productive assets. Not so for militaries; hence losers of inter-state conflicts often suffer greatly.\(^11\) This property figures either explicitly or implicitly in all the mechanisms we examine.

The remainder of this paper develops these points as follows. Section 2 motivates the analysis by examining Figure 1 and our dependent variable---the volatility of military power trajectories---in more depth. Here we identify several patterns that any satisfactory account of the macro-dynamics of military power must account for. We then turn to explanations: three mechanisms for military volatility. Section 3 briefly reviews the well-known demand-side mechanism noted above as well as a complementary but less well-known mechanism: victors intentionally degrading the military power of losers. Both mechanisms operate at the level of states: they can be seen without examining the internal structure of institutions. Section 4

\(^9\) To avoid repetition we refer to the volatility of military power without adding "in comparison to economic growth trajectories." However, although the central thesis turns on a comparison of volatility in two different domains, we also believe that military power fluctuates quite dramatically in an absolute sense.

\(^10\) See Waltz (1979) for the canonical discussion of how anarchy makes international relations differ from economic competition; see Wendt (1992) for an alternative perspective. Dixit (2007) analyzes different kinds of economic interactions in anarchic settings and mechanisms that sustain exchange in the absence of central authority.

\(^11\) There are rules of war but third party enforcement is much weaker than is rule-enforcement for competing firms. Further, organizations can use violence when economic competition lacks third party enforcement: e.g., drug gangs in Latin America or mineral extractors in the Congo. Such cases look a lot like war.
takes up this latter type of cause by comparing micro-to-macro smoothing in markets versus military hierarchies. Because this type of mechanism is less well known than the state-level response to fluctuations in threats of war (i.e., demand-driven volatility), sections 5-7 are devoted to fleshing out section 4’s argument. These sections explore different ways in which micro-events regarding the behavior and performance of militaries are not dampened but instead reverberate up to the macro-level. In these sections we compare R&D competition in markets versus militaries, how operational shocks in militaries can have major macro-effects, and the irreducibility of strategic uncertainty in military affairs. Section 8 examines several systemic properties that, although they are not part of all the other causal mechanisms, are nonetheless causally important. Section 9 concludes by drawing on the analysis to outline observable traits of different domains that determine the extent to which macro outcomes are contingent on micro-level randomness, and thus the extent to which different policy domains exhibit micro-to-macro smoothing.

2. The Volatility of Military Power

As noted, the dependent variable’s basic contours—that military power trajectories display greater volatility than do those of economic growth—is well-represented by figure 1. The picture is even more dramatic with larger graphs that depict the time-series of only two countries: the United States and Japan (Figure 2). As a recent overview put it, “For nearly 150 years, GDP per person in the U.S. economy has grown at a remarkably steady average rate of around 2 percent per year.”12 Even the worst economic shock, the Great Depression, does not loom large in a long time series: by 1939 GDP per capita was back to its 1929 level; by the late forties the country was back on the track of two percent growth. It is no wonder that growth

12 Jones 2016, 2
economists have worked hard on balanced growth models, which typically yield the implication that an economy experiencing a steady increase in capital and labor will grow at a constant (exponential) rate. That is not even a rough approximation of what is reflected by the U.S.’s military power time-series, with its wild spikes and plunges in the nineteenth century and the first half of the twentieth.

[Figure 2 about here]

Some of this is unsurprising: a simple model of time-varying demand for military security does a lot of the work.\textsuperscript{13} Whether one assumes that the state is a rational actor, as in classical IR theory, or a boundedly rational one, as in adaptive models of budgeting (Crecine 1969), is not crucial. Either type of model predicts what we observe: spending shoots up when war starts and plummets when it stops. In particular, a victorious country usually enjoys a peace dividend when the conflict ends. Turn, then, to the time series for Japan. In the early twentieth century we see a similar pattern in the military time-series, as the country mobilizes first for the war with Russia (1905), briefly reduces its strength and then re-mobilizes for World War I. But Japan was on the losing side in World War II: a simple demand-side explanation doesn’t work here. Moreover, although the Japanese economy was also hurt by the Second World War, much of its industry having been destroyed by bombing, that shock looks like a blip in the economic time-series when compared to the collapse of Japan’s military power. A similar pattern holds for Germany: two losses in major wars drove down military power; its economic trajectory was much smoother despite the Great Depression (Table 1).\textsuperscript{14}

\textsuperscript{13} Such models ignore the endogeneity of armed conflict. Wars aren’t earthquakes, which are primarily exogenous shocks. The irregular occurrence of war itself needs to be explained.

\textsuperscript{14} Interestingly, one of the biggest economic swings—the sharp decline from 1943 to 1947 in German GDP—was almost certainly caused by its military defeat. (Had we measures of Carthage’s GDP, we would see an even more dramatic economic drop after that city-state lost the last Punic War: economic activity ceased.) Sometimes economic volatility is driven by military outcomes.
Finally, although there undoubtedly is measurement error---the M-scores are rather crude indicators of military power---there are good reasons for believing that the dependent variable’s basic pattern is robust to different measures of military power. For example, military historians agree that the U.S. Army in the 1880s was a shell of its Civil War self and that after World War II Japan was effectively demobilized. And some swings not shown in Figure 1 are even bigger: the Austro-Hungarian Empire fielded an army of well over a million men in World War I; this force vanished in 1919 with the disappearance of its parent organization, the Austro-Hungarian state.

These swings aren’t measurement artifacts. They are big facts about states’ histories.

3. State-Level Mechanisms

This section describes the two major state-level sources of volatility in military power. The first, noted above, is a simple demand-side mechanism: leaders usually increase military spending when war breaks out, or shortly before, and reduce it when war ends. The second source, discussed less often, are actions winners take to try to lock in their advantage for the longer-term by diminishing their vanquished enemy’s military power.

Mechanism 1: Preparing for or Fighting Wars (the demand-side component)

As noted, variation in the demand for military power by politicians is the best-known cause of fluctuations of military power, both absolute and sometimes relative military power as well.\footnote{Although the spikes in the budgetary time-series are usually easy to explain, they were sometimes quantitatively surprising to the actors themselves. World War I was an outstanding example of this, regarding}
powerful electoral incentives to help long-suffering voters by delivering a peace dividend. A paradigmatic example is the military trajectory of the United States in both relative and absolute terms.

In 1865, at the end of the Civil War, the U.S. had one of the most powerful land forces in the world; by 1880 it was smaller than Switzerland’s. After the Civil War and the end of Reconstruction the U.S. army became a frontier constabulary which had small units with a great deal of combat experience from the Indian wars but whose skills in handling large-scale campaigns had atrophied. Following a brief ramp up for the Spanish American war, which was plagued by logistical failures attributable partly to inexperience managing large forces, the Army went back to being a garrison force, leaving only the Marines to fight their “Small Wars” in the Philippines and China. Hence President Wilson faced a serious problem after war was declared in April 1917: compared to the huge armies fielded by both sides in the Western Front, the U.S. had little to contribute.

A thought experiment can help us understand demand-side volatility. Consider an isolated nation-state that is occasionally hit by a random shock, e.g., an earthquake. Suppose the state cannot predict when these bad events will occur but knows what to do once they happen. This includes organizing disaster relief, with all the relevant resources---trained personnel and equipment. Once the event is dealt with, the state terminates disaster relief and reallocates the resources to other programs. Given these properties, good measures of state capacity in this domain will be volatile: the relevant time series will display unpredictable booms and busts separated by lulls.18

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both aggregate spending and the expenditure on some key components---notoriously, artillery shells.

16 Hendrickson 2003, 10
17 Paulus 1998
18 Conditional on the occurrence of a shock, however, much can be predicted. This is a standard feature of
Note: this example does not rely on conflict among any organizations. Indeed, the state’s efforts at disaster relief could be a common-value problem. This is empirically unlikely, given the need to allocate scarce disaster relief resources, but the analytical point is clear: a well-organized state coping with unpredictable bad shocks will typically exhibit a volatile time-series of activity and capacity.

This may be why the demand-side cause of booms and busts in military spending has often been modelled decision-theoretically by public finance and budgetary scholars, even though wars, unlike earthquakes, involve strategic processes.

**Mechanism 2: Degrading the Military Power of Losers**

In 1919 and again in 1945 the Allies confronted “the German problem”: how to decrease the threat posed by a powerful aggressive state located in the heart of Europe.\(^{19}\) In 1919 their solution, ultimately embodied in the reparations provisions of the Treaty of Versailles and subsequent arms limitation pacts, was to keep Germany militarily and economically weak.

At Versailles, after four years of devastating war fought mostly on French soil, Prime Minister Clemenceau naturally focused on ways of protecting France’s security.\(^{20}\) This was a difficult task, given the obvious structural issues: France’s chronically low birth rate meant that Germany’s population, already substantially larger than France’s, would continue to enjoy an advantage, and industrial capacity also favored Germany. Despite this, undoing

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\(^{19}\) Revisionist historians who have argued that no one country was to blame for WWI and that all of the Great Powers stumbled into the catastrophe might object to this statement. But this revisionist thesis has been challenged: many historians now believe that Germany and Austria-Hungary were the most culpable countries. Further, and more importantly for the present paper, the French and British decision makers at Versailles undoubtedly believed there was a German problem.

\(^{20}\) For details on Clemenceau’s views see MacMillan 2001, 35-36 & 39-42.
Bismarck’s project—dismembering Germany—was not seriously contemplated at Versailles. The Allies did, however, degrade Germany’s power significantly: the Army was limited to 100,000 men, a small fraction of its wartime size. Britain, a sea power, had already degraded Germany’s naval strength.

Clemenceau realized, of course, that Germany’s demographic, economic, and scientific resources would enable it to rebuild its military power eventually. The Weimar government took modest steps in this direction, but the process really accelerated after Hitler took over in 1933. By 1938 the Nazi regime was strong enough to threaten Czechoslovakia, by 1939 to invade Poland, and by 1940 to defeat France. The rapidity of Germany’s reararmament and its terrible effects convinced the Allies that Germany’s military power had to be degraded much more than the Versailles Treaty had done.

Not surprisingly, then, the question of what to do with postwar Germany was on the agenda of every meeting of Allied leaders from 1943 on, as records from Tehran, Yalta, and Potsdam show. Though the Grand Alliance ultimately agreed to divide Germany into multiple military occupation zones to oversee the country’s demilitarization, disarmament, denazification, and democratization, dismemberment featured heavily in earlier plans, advocated for most forcefully by Stalin.

At Tehran in late-1943 there seemed to be an informal consensus among the allies that Germany would be dismembered to prevent its resurgence. With that tacit agreement, Stalin, Churchill and Roosevelt focused on discussing other matters such as reparations and the postwar French role. Although dismemberment wasn’t discussed in detail at Tehran, Yalta, or

21 Sharp 2008, passim.
22 “Stalin agreed that the task was to make the world safe from Germany for at least 50 years but did not think the Prime Minister’s proposed measures – disarmament, economic controls and territorial changes – went far enough.” (Roberts 2006, 183).
23 Roberts 2007, 9-10
Potsdam, Stalin had a commission prepare policy briefs before Yalta when it seemed that Germany would be broken up would go ahead. The commission “spent a great deal of time in 1943 and 1944 discussion various schemes of dismemberment…. No firm conclusions were reached about how many states should replace Germany but by January 1945 Litvinov was proposing a maximum of seven – Prussia, Hanover, Westphalia, Württemberg, Baden, Bavaria, and Saxony.”

When Stalin pushed for a firmer commitment to dismembering Germany at Yalta in February 1945, however, he encountered resistance. He subsequently “…reassessed his own position and in light of western reluctance dropped the idea of dismemberment.” Stalin did so for practical reasons: his delegation at Yalta proposed to extract $20 billion from Germany in reparations, $10 billion of which would go to the USSR. “In order that the USSR could extract substantial reparations from Germany, the defeated country had to be treated as a single entity.”

When it became clear that Germany would not be dismembered, Stalin realized it was inadvisable to be the only one advocating it, so from then on “Stalin spoke publicly and privately only of a united Germany – disarmed, demilitarized, de-Nazified and democratized, but not dismembered.” Had Stalin has his way, Germany’s loss would have meant its exit from the international system; the 20th century in Europe would then have been quite

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24 Roberts 2006, 229
25 ibid, 244
26 Bessel 2009, 295
27 Bessel 2009, 295. Other historians interpret events similarly. Leffler and Painter, for example, write that “Stalin’s priorities in relation to Germany were by 1945 increasingly economic: i.e. the securing of large-scale reparations to aid Soviet post-war reconstruction. Dismemberment could be a distraction, perhaps even a hindrance, in relation to such a priority.” (1994, 50).
28 Roberts 2006, 244
different.\textsuperscript{29}

As these examples show, strategic action by victors can, but does not always, contribute to the great variability of military power. Because relative power is what really matters in interstate competition, a country can make itself more secure either by augmenting its military strength or by degrading its enemy’s. Hence this second mechanism is the flip side of the first.\textsuperscript{30} In its extreme form---exterminating an enemy---it is, unfortunately, an ancient method.\textsuperscript{31} (The Latin word for this, `deballatio’, is old.) The logic of this strategy is as deadly as it is obvious: an enemy that has been wiped out poses no threat at all. Thus this method maximizes relative power, even if the victor has done little to boost his absolute power.

The key property of the strategic environment that enables degradation of enemies’ power is the anarchic character of the international system, especially the absence of third party enforcement of rules.\textsuperscript{32} That absence has two consequences. First, there is no one to intervene when the victor seeks to wipe out its former enemy, as the Roman army did when it destroyed Carthage in 146 B.C.E. and much of Jerusalem in 70 A.D. Second, and equally importantly, integrating the vanquished is harder because there is no one to enforce the terms agreed upon at the time of victory over the long run. The contrast to the rule-governed collapse of firms is instructive; and in particular to bankruptcy law which makes such strategic degradation undesirable.\textsuperscript{33}

\textsuperscript{29} Some historians (Barnett 2002) have argued that dismembering Germany after World War I would have prevented the Second World War.
\textsuperscript{30} There is no direct analogue to this in the domain of natural disasters. One might argue that preventing disasters is analogous but this is a stretch in several respects. Most importantly, trying to prevent disaster requires expending resources: e.g., spending money on dams in order to prevent floods. In contrast, dismembering an enemy’s military can increase the victor’s resources, by the seizing of arms and other equipment.
\textsuperscript{31} This is not restricted to humans: chimpanzee bands have been observed practicing it (Mitani 2010).
\textsuperscript{32} Though see Whitman (2012) for a discussion of a long historical period that exhibited an equilibrium of self-policing in which the consequences of losing wars were bounded by mutual consent.
\textsuperscript{33} One cannot destroy the human capital, but firms could simply write off the assets and allow them to go unused.
Economic Competition

Obviously there are winners and losers in economic competition; indeed, sometimes the losers are destroyed. Over the last two centuries much of this has been driven by technological innovation. (The invention of digital watches, for example, drove many Swiss watch manufacturers out of business.) So there is something to Schumpeter’s famous idea that “creative destruction” underlies economic growth in capitalist economies.\textsuperscript{34} But his phrase, when compared to war’s destructiveness, exaggerates the degree of suffering. In today’s market economies the losers are not thrown into debtors’ prisons.\textsuperscript{35} Or shot. And losing firms’ productive assets are not destroyed to prevent their re-emergence; typically they are incorporated into winning firms or re-allocated to other uses.

All of this re-allocation is facilitated by institutions that manage economic competition. Of these, bankruptcy law, a rather recent invention, is among the most obviously designed to promote the peaceful and not-too-inefficient preservation and reallocation of economically useful resources: “the central role of bankruptcy in modern capitalist economies is to encourage reorganization.”\textsuperscript{36}

Military competition can be quite different, as we’ve seen. In particular, the strategy of degrading an enemy’s military power contrasts sharply with what winners are allowed to

\textsuperscript{34} In particular, scholars of hedonics have discovered that losing a job is very painful and hedonic adaptation is slow. (Lucas et al. 2004)

\textsuperscript{35} Debtors’ prisons slow the reallocation of economic resources and hence are inefficient institutions. (Some advocates argued that they deter misconduct in business transactions [Lester 1995, p. 112], but it is hard to find evidence that they did so efficiently.) Efforts to end the practice began in Britain in the 1830s. Most imprisonment for debt was ended by the Debtors’ Act of 1869. Interestingly, exceptions were made if the person could pay the debt but refused to do so.

\textsuperscript{36} Stiglitz 2001, 2
do in economic competition, where there is little analogue for the true winner-take-all outcome that victors of decisive wars can impose. In economic competition physical and human capital are not destroyed. To see why it is worth examining one especially decisive victory in corporate competition.

The case’s history goes back to Thomas Edison’s development of the first practical incandescent light bulb in 1879.\(^{37}\) Eager to corner the market, he started marketing his invention through the Edison Electric Light Company and several other firms that eventually merged to form the Edison General Electric Company.\(^{38}\) Edison’s system worked on direct current that provided power at the same voltage as customers required. Although this system had the advantage of simplicity and met the technology of the time, it was impractical for transmitting power over long distances:\(^{39}\) “…the only way to increase the amount of direct current flowing out into an Edison power grid was to provide heavier (and highly expensive) copper wires to carry those greater numbers of electrons to their ultimate destination.”\(^{40}\) Despite the Edison brand and the novelty of his incandescent light bulb, it remained a luxury service for years:\(^{41}\) “Edison’s direct current central station system, with its half-mile limitation in any direction, was proving a tough sell in less compact cities and towns.”\(^{42}\)

In the late-1880s the Westinghouse Electric & Manufacturing Company acquired a series of patents from Nikolas Tesla for alternating current (AC) generation and transmission

\(^{37}\) King, 2011
\(^{38}\) Essig 2003, 102-104
\(^{39}\) The reasons why are subtle. All conductors create resistance: the longer the wire, the more power is lost. Those losses are linearly proportional to voltage, but proportional to the square of the current. Doubling the transmission voltage yields the same power with half the current, so transmission losses are effectively halved for the same power. But high voltages are unsafe for home applications and reducing the voltage of DC power is difficult, so to handle transmission losses DC systems require more current. Transmitting more current without excess heating and resistance, however, requires larger, more expensive wires. Thus DC power could not be transmitted long distances at usable voltage over affordable wires.
\(^{40}\) Jonnes 2003, 97
\(^{41}\) Essig, 104
\(^{42}\) ibid, 106
and began commercializing them. In AC systems power is transmitted via oscillating waves, which makes changing voltage much easier. Varying (or alternating) the current in a coil of wire induces a current in a nearby second coil.\textsuperscript{43} Because increasing voltage is more efficient than increasing current for sending power over long distances, induction coils “allowed high-voltage transmission of alternating current over long distances and low-voltage distribution near the point of consumption.”\textsuperscript{44} Essentially, AC allowed electrical companies to send power at high voltages over thin wires “…then use induction coils to reduce the voltage to levels safe for use in homes and offices.”\textsuperscript{45} This was much cheaper than the thick-wire DC alternative.\textsuperscript{46} Edison was aware of alternating current’s (AC) potential but had dismissed the idea early on, citing safety concerns (and conveniently backing his own system).\textsuperscript{47}

By 1886, “Edison enjoyed a virtual monopoly in incandescent lighting,” owing partly to his brand name.\textsuperscript{48} Westinghouse, who had developed an incandescent lighting system that was too similar to Edison’s to be competitive, presented a rival product in 1886.\textsuperscript{49} He and his leading electrician, William Stanley, had designed a system that used alternating current. AC transmitted farther than DC, so because “most Americans still lived in sparsely populated areas, and the limited range of the Edison system left them in the dark,” Edison began to worry about the threat Westinghouse posed in rural areas.\textsuperscript{50}

\textsuperscript{43} ibid, 110-111
\textsuperscript{44} ibid, 113
\textsuperscript{45} ibid, 112
\textsuperscript{46} ibid, 109
\textsuperscript{47} Edison, said Tesla, responded ‘bluntly that he was not interested in alternating current; there was no future to it and anyone who dabbled in that field was wasting his time; and besides, it was a deadly current whereas direct current was safe.’’ (Essig, 107.) “Edison’s evaluation of alternating current was accurate, given the state of the industry in 1886. But Westinghouse was placing a bet that the efficiency would improve, that meters and motors would be invited, that the dangers of high voltage could be controlled.” (Essig,114.)
\textsuperscript{48} Essig,105
\textsuperscript{49} ibid, 105, 109
\textsuperscript{50} ibid, 113-115. Edison’s low-voltage system required thick copper conductors and required multiple generating
Eager to stifle his competition, Edison embarked on a PR campaign to link Westinghouse’s alternating current with electrical executions, hoping that a fear of being accidentally shocked would drive consumers to Edison’s safer alternative.\textsuperscript{51} To highlight AC’s lethal potential, Edison held demonstrations for reporters and state committees in which he electrocuted dogs, calves, horses, and once even an elephant.\textsuperscript{52}

Over the next three years the two companies fought a proxy war in the press, academic journals, and courtrooms. The Edison Team urged decision-makers to adopt execution by electrical shock to cement the association while Westinghouse disputed the link, insisting that Edison’s experiments were doctored and misleading.\textsuperscript{53} Westinghouse’s product weathered the storm. In 1893 he outbid Edison’s company for the Chicago World’s Fair contract, a huge public victory.\textsuperscript{54} By then, however, Edison’s company was investing heavily in AC, recognizing the changing tide and even offering a package with AC current in their own bid at the World Fair.\textsuperscript{55} Though the two companies continued to compete, the central battle was no longer over the merits of DC vs. AC as the latter took the lead.

What happened to the Edison General Electric Company? We know it today as GE, one of the world’s largest industrial conglomerates. \textit{Losing the signature technological battle of its day did not destroy GE}. The company adapted: it de-emphasized DC generation and transmission and became a leader in AC power. Today GE is the only firm of the original 12 companies on the New York Stock Exchange still listed there.

\begin{flushleft}
\textsuperscript{51}King, 2011
\textsuperscript{52}King, 2011
\textsuperscript{53}Essig, 152-170
\textsuperscript{54}Jonnes, 270-274
\textsuperscript{55}ibid, 254, 293
\end{flushleft}
4. The internal structure of markets versus states

At this point we need to look inside economies and states. They exhibit significant differences. Perhaps the most important are the number of organizations in each domain and how correlated their performance is.

Mechanism 3: Markets, Hierarchies, and the Law of Large Numbers

Consider the leader of a contemporary Great Power who seeks economic growth and more military power. He realizes that random shocks can impact either system. He also understands that their internal structures differ markedly:

1. The economy of every Great Power is composed of many firms.
2. The annual performances of firms are often weakly correlated.\(^56\)
3. In contrast, inside his Department of Defense is one Army, one Navy, and one Air Force.\(^57\)
4. These subunits are mainly complements, not substitutes. Hence in war they have a high degree of common fate: the success of one is correlated with the performance of the others. And overall victory or defeat imposes an even stronger positive correlation: wars are won or lost at the state level; all the defense department’s subunits succeed or fail together.\(^58\)

The leader’s advisors tell him the following. Facts (1) and (2) imply micro-to-macro smoothing: the volatility so evident at the level of individual firms is much reduced at the

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\(^56\) Further, his economists tell him that the fortunes of firms in the same product market can be negatively correlated: e.g., if one firm wins an R&D race. More generally, the presence of winners and losers in economic competition indicates that the performances of such organizations are negatively correlated, which typically produces more micro-to-macro smoothing than uncorrelated performance.

\(^57\) This is consistent with Weber’s definition of a state: it has a monopoly of violence within its borders. We repeat this definition to students without contrasting the use of the word “monopoly” to properties of markets. Monopoly is linked to the hierarchical nature of governments, which is required for effective third-party resolution of disputes.

\(^58\) As trade economists remind us, nations don’t compete economically (unless economic growth is tied to military competition). On the contrary: because international trade is usually a positive-sum game, countries can grow together.
level of the national economy. In contrast, facts (3) and (4) imply micro-to-macro volatility: a bad performance by one service can significantly impair how well the others do. And if in turn a service has only a few subunits, little smoothing occurs at that level as well: an army’s infantry, artillery and armor are complements, not substitutes.

All four organizational properties characterize every contemporary Great Power. (Small countries may not have many firms, so (1) and hence (2) may not hold for them.) We believe that the difference between (1) and (2) versus (3) and (4) help to explain the difference in volatility depicted in Figure 1.

5. Parallel R&D efforts in war and markets

It is well-known that the pace of innovation has accelerated dramatically over the last 200 years. This holds for the military as well as the economy. But we think there is an important parametric difference: how much parallel R&D effort there is in the two domains. In some very important cases military R&D has exhibited little redundancy.

Mini-case: the race for the Bomb

Both sides in WWII devoted considerable effort to developing nuclear weapons. Fortunately,

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59 Reduced; not eliminated. There are, of course, systemic economic shocks: e.g., the liquidity crisis of 2008.
60 For example, in 1863 the Confederacy had at most three major armies: the Army of Northern Virginia, the Army of Tennessee, and some would count the army at Vicksburg. When Grant defeated the latter in July 1863 and later that year Thomas destroyed the Army of Tennessee, the South’s prospects would have been grim even had Lee triumphed at Gettysburg.
61 Apart from China, each Great Power has a defense department with administrative responsibility for all of that country’s armed forces. This is fairly recent. Prior to the Second World War most of those states had a separate department of the navy. And in some cases—counterintuitively, Imperial Germany and Imperial Japan—the army and navy departments were poorly coordinated. We suspect that a perceived need to coordinate land and sea forces more effectively was a key reason for creating another level of hierarchy inside national governments. See Eilon and Lyon (2010, 4-7) for a summary of motivations for the creating of a Department of Defense in the United States.
Heisenberg’s team failed.\textsuperscript{62} Just as fortunately, that was the only German team working on the problem. Due to this lack of redundancy, *failure at the team level implied failure at the organizational level* (the German military) and at the meta-organizational level (the German state) as well.

Because the implications of Hitler having the bomb are gruesomely obvious, we need not belabor the conclusion: this micro-event (the failure of Heisenberg’s team) had ramifications all the way up to the inter-state system.

One might object to this example: perhaps it is atypical of governmental R&D. We know of no hard data on the matter. It is true that some R&D projects conducted or sponsored by governments have included parallel teams working on the same (difficult) problem; the Manhattan Project itself had some of these. But again, our point is comparative (ordinal): we are arguing that there is usually more redundancy in markets than in government: Landau’s classic article (1969) became well-known in the field of public administration partly because its thesis---duplication is not always wasteful---was so controversial. And although systematic evidence concerning this ordinal hypothesis is not yet available, we think it is plausible.

Further, even if the German bomb effort were an unusual case, it was historically important. Here we agree with historical institutionalists: in some domains rare events can be extremely consequential.

It is instructive to compare the race for the Bomb to the development of a contemporaneous innovation: radar. Though it too required resolving significant technical uncertainties, there were two important differences. First, doing so cost much less. Hence, all the Great Powers could afford the effort (Brown 1999). Second, the technical uncertainties

\textsuperscript{62} Apparently they weren’t close; several of them were surprised that the Manhattan Project had succeeded (Cornwell 2003, 394-95).
surrounding radar were much smaller. Building the bomb required addressing basic scientific challenges in chemistry, electrical engineering, mathematics, and metallurgy. Developing radar required incremental advances in existing fields (e.g. improvements in radio wave transmission and reception). These factors are related. When R&D is inexpensive, a significant amount of parallel problem-solving is feasible. And if there are many teams, the probability that at least one of them succeeds can be high even if the chance any given one succeeds is low.63

The effect of these parametric differences was significant: by the start of WWII eight countries had viable R&D projects on radar. Both sides used the technology extensively during the war. The development of radar exhibited less micro-to-macro volatility than did the Bomb projects.

6. Operational Shocks and Macro-Dynamics

This section provides two examples of how chance operational events can have macro-level impacts in war and politics in ways that have no obvious analogy in economic competition.

Example 1: Lee’s Lost Orders

In September 1862 General Lee took the Army of Northern Virginia across the Potomac River into Maryland. It was a bold move---it stretched his supply lines---but the timing seemed propitious.64 Earlier that year Lee’s forces had beaten the Union army badly at the Second Battle of Bull Run, so it was reasonable to surmise that the morale of the Army of the

63 Let \( f \) be the probability that a team fails. If the performance of teams is independent then the probability that at least one succeeds is \( 1 - f^n \), which for \( f \) in \((0,1)\) rises monotonically to one as \( n \) gets arbitrarily big.

64 For a good summary of the campaign see Hartwig, “The Maryland Campaign of 1862.” For longer treatments see: Harsh (1999) and Sears (1983).
Potomac was not high. Lincoln had been unable to find generals to match Lee or his key subordinates (Jackson and Longstreet); perhaps worse, the relations between several top Union commanders, McClellan and Pope especially, were so bad that Lincoln and others suspected that McClellan had intentionally allowed Pope to be overwhelmed at Bull Run by not coming to his aid in that battle.  

Furthermore, the string of Southern victories had international repercussions: British leaders were starting to wonder whether the time had come to recognize the Confederacy as an independent nation. Perhaps if Lee took the offensive and smashed McClellan in a battle of maneuver in Maryland, London would take that decisive step. France might then follow suit. The consequences of recognition would have been major: in particular, it would have strengthened the argument of Northern Democrats that the war was hopeless, thereby influencing the November elections and the entire project of restoring the Union.

Even the problem of a lengthened supply line was offset by the fact that Virginia’s resources had been sharply drawn down by 15 months of war fought on its soil. Lee believed that provisioning his army in untouched Maryland would not be hard, and Virginia would benefit from the respite.  

Jefferson Davis, persuaded that the move north was a worthwhile gamble, backed Lee’s plan, and the Army of Northern Virginia---threadbare in supplies but sky-high in morale---entered Maryland.

The Army of the Potomac was hunkered down near Washington. Morale---especially after the return of McClellan, beloved by many soldiers---was better than Lee believed, but major problems remained. In particular, McClellan knew little of Lee’s plans. There were

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65 Salmon Chase, a man of strong views but no fool, thought that McClellan should have been shot.
66 Because armies in this period survived by foraging supplies locally, moving to Maryland removed a heavy tax on civilians in Virginia.
reports that his forces had crossed the Potomac, but their destination was uncertain. Would they swing east, toward Baltimore, filled with secessionists awaiting the arrival of a Southern army? Move north and attack Pennsylvania? Or, as Halleck, the Union general in chief, feared, was this a feint designed to strip Washington of its protection of the Northern army, to be followed by a devastating attack on the capital? Nobody knew.

In the face of this uncertainty, the ever-cautious McClellan slowly moved his forces in the general direction of Lee’s---exactly what Lee wanted him to do. If the Army of the Potomac stumbled around in the open field, Lee---aided by the usually accurate intelligence provided by Jeb Stuart’s cavalry---could out-maneuver McClellan, pick a place suited to his forces, and win a big victory. Given the armies’ track records, this was a realistic plan.

There was a problem however: the Union forces at Harper’s Ferry were in Lee’s rear. They jeopardized his supply lines. Further, Lee didn’t want to be caught between those troops and McClellan’s. To eliminate this threat he sent Jackson’s divisions to capture the garrison and its stores. This meant dividing his small army in the face of a larger one---violating a standard military heuristic---but Lee had done this before and gotten away with it. Knowing McClellan’s tendencies, he believed he could do it again. Jackson and his men were skilled at this sort of campaign---their earlier whirlwind efforts against larger forces in the Shenandoah Valley are still taught in military academies today---so Lee was confident that they could complete their mission and rejoin Lee before it was time to stand and fight the main Union army.

Lee sent Longstreet’s corps in yet another direction, north, to secure the town of Hagerstown against Union forces. Thus the three main parts of the Army of Northern Virginia were in three separate places. Splitting up a command this way required clear orders, and
though a gambler Lee (trained in military engineering) wasn’t sloppy: he had a set of orders for his senior subordinates transcribed by his adjutant, Robert Clinton, and distributed.

Then a copy of those orders got lost. Historians are unsure how this happened. But it undoubtedly occurred: a complete packet of the orders, wrapped around three cigars, found its way into a field.

There’s more. The field was of no particular significance. But by a bizarre stroke of luck two non-commissioned officers of the 27th Indiana moving in a skirmish line stumbled upon the orders.67 The soldiers sent them up the chain of command until they reached General Alpheus Williams, commander of the XII Corps. Williams' acting adjutant general, Samuel Pittman was able to authenticate the orders by identifying Chilton's signature.68 In another remarkable coincidence, Pittman had been a teller at Michigan State Bank when Chilton was paymaster for the army and Pittman was familiar with his signature from checks and account records kept by Chilton at the bank. General Williams passed the authenticated orders to McClellan, who swiftly recognized what had fallen into his hands.

Altogether, this was a colossal random shock. James McPherson, an eminent Civil War historian, described McClellan’s obtaining Lee’s lost orders as “fantastic luck…[McClellan had] hit the all-time military jackpot.”69

McClellan did not, however, seize all of the opportunity offered by the discovery of the lost orders. Governed by his habitual caution, the Army of the Potomac continued to move slowly: four days elapsed before it was in position to fight the Confederates at

67 For details on the incident, see Hartwig, “The Maryland Campaign of 1862.”
68 This version of the story draws on the National Park Service’s history, <http://www.nps.gov/mono/learn/historyculture/an-invitation-to-battle.htm>. A different version of the story holds that an officer who’d served with Lee in Mexico and who knew his handwriting happened to be present and confirmed that the orders were genuine. That version has a crucial flaw: Lee would not have written out his own orders.
69 McPherson 1988, 537
Antietam. By this time intelligence about McClellan’s movements had reached Lee. Realizing he was in danger of being overwhelmed by a much larger force, Lee ordered A. J. Hill to rejoin him immediately and told Jackson that he must take Harper’s Ferry as swiftly as possible and then force-march back to Sharpsburg. Thus McClellan lost a golden opportunity to crush the Army of Northern Virginia piece by piece.

For our purposes, the key point is that the improbable string of events that caused Lee’s orders to wind up on McClellan’s desk ruined the Confederate plan. In the single bloodiest day of an extremely bloody war, the Battle of Antietam was fought to a tactical draw---a strategic defeat for the South. Exhausted and more than decimated, with staggering losses among its officers, the Army of Northern Virginia retreated. Lee’s Maryland campaign was over.\(^\text{70}\) Lincoln seized the then-unusual moment of a Confederate retreat to announce the Emancipation Proclamation. This changed the meaning of the war. Given the prevalence of anti-slavery opinion in Britain, the new meaning made it likely that Her Majesty’s government would remain neutral.\(^\text{71}\) And so it did.

Example 2: A Close Call in the Cuban Missile Crisis

The single best example of the contingency of military outcomes starts with a tense operational incident during the Cuban Missile Crisis.\(^\text{72}\) On October 1, 1962, the B-59, a Soviet Foxtrot-class diesel-electric attack submarine, was ordered to sail for Cuba from its homeport...

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\(^{70}\) Aggressive as usual, Lee considered continuing the campaign and would have do so “did the army exhibit its former temper and condition”, but he reluctantly concluded that “the condition of the army prevented [the attempt]. . .the hazard would be great” (letter to Jefferson Davis, September 25, 1862; quoted in Harsh, p. 471).

\(^{71}\) Some historians disagree about causation. In particular, Jones (1992) argues that Antietam did not stay Britain’s hand. A reviewer, however, said that “Unfortunately, he does not provide enough evidence to turn the tide of existing scholarship” (Frawley Review.).

\(^{72}\) This account draws on two excellent books on the Cuban missile crisis.
in Murmansk, along with three other submarines.\textsuperscript{73} On October 24 the US imposed a naval blockade around Cuba after confirming the presence of short-range nuclear-armed missiles on the island.\textsuperscript{74} On the same day the Pentagon sent a message to the Soviet government via the U.S. Embassy in Moscow explaining a new signal: dropping practice depth charges meant that submerged submarines should surface and identify themselves.\textsuperscript{75} But, “the Soviet government never acknowledged receipt of the message about the underwater signals, and never relayed the contents to the commanders of the four Foxtrots [including B-59].”\textsuperscript{76} On October 27, eleven U.S. destroyers and the aircraft carrier USS Randolph, enforcing the blockade, cornered the B-59 and started dropping practice depth chargers to tell the vessel to surface.\textsuperscript{77}

The potential for a mistake was obvious. By the 27\textsuperscript{th} the crew had been trying to evade American warships for several days. The men onboard were hot and exhausted, there were critical levels of CO2 in the air, and the ship’s batteries were dangerously low.\textsuperscript{78} Further, the submarine’s crew could not easily discern the difference between practice charges and the real thing. Hence the B-59 considered using its nuclear torpedo. Matters might then have escalated rapidly. At the time the United States had no plans for a graduated response to a Soviet use of tactical nuclear weapons; the only nuclear war plan on hand involved a full-scale strike.\textsuperscript{79} Hence, had the B-59 responded as though it were under

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{73} Roberts 2012, 13
\item \textsuperscript{74} Roberts, 13
\item \textsuperscript{75} Dobbs, 2008 299
\item \textsuperscript{76} Dobbs, 300. According to Roberts, “The Kremlin, however, failed to transmit this information to its submarine commanders.” (Roberts, 13)
\item \textsuperscript{77} Roberts, 13
\item \textsuperscript{78} Scott, 2007, 105
\item \textsuperscript{79} The SIOP guiding the use of nuclear weapons had only one option in 1962, a devastating full-scale strike against targets across the USSR and Warsaw Pact. It was revised after Kennedy and a few civilian advisors learned of this fact during the Cuban Missile Crisis.
\end{itemize}
\end{footnotesize}
attack, the potential for nuclear war was great. And were it not for one particular staffing
decision, the B-59 could well have launched a mistaken attack.

The executive officer onboard B-59, Commander Vasily Arkhipov, had an unusual
history. He had behaved heroically in an accident aboard a Soviet ballistic missile submarine
(the K-19) the year before and was therefore given command of the four-submarine flotilla
although on his boat he was only second-in-command.\textsuperscript{80}

As the practice depth charges began falling the B-59’s captain, Valentin Grigorievich
Savitsky, inferred that war had begun and started advocating forcefully for launching his
boat’s nuclear torpedo at the USS Randolph.\textsuperscript{81} Under established procedures, he could not fire
the weapon unless the flotilla commander (who happened to be Arkipov) and his boat’s
political officer (Maslennikov) agreed. Arkipov refused.\textsuperscript{82} He persuaded the B-59’s captain to
surface and request further orders from Moscow.\textsuperscript{83} This may have averted nuclear war.

When they surfaced, one of the US ships had its band playing on deck to show that
their intentions were not hostile.\textsuperscript{84} After rejecting assistance from the Americans, B-59
continued on its way, finally breaking contact from the Americans after two days of
surveillance.\textsuperscript{85} Had any other officer been in Arkhipov’s shoes, perhaps one without his
stature and rank, or had the flotilla commander been on another vessel, our world might be a

\textsuperscript{80} Scott, 302
\textsuperscript{81} According to Orlov’s account, “[Grigorievich] summoned the officer who was in charge of the nuclear
torpedo, and ordered him to make it combat ready. ‘Maybe the war has already started up there while we are
doing somersaults down here,’ shouted Valentin Grigorievich emotionally, justifying his order. ‘We’re going to
blast them now! We will perish ourselves, but we will sink them all! We will not disgrace our navy!’” (Dobbs,
303) (Scott, 105)
\textsuperscript{82} Roberts, 14
\textsuperscript{83} Roberts, 14
\textsuperscript{84} Roberts, 14
\textsuperscript{85} Dobbs, 328
very different place.  

7. Strategic Uncertainty and Macro-Dynamics

Most IR scholars---hawks, doves, and owls---agree that military strategy is causally important. (As Trotsky said, “you may not be interested in war, but war is interested in you.”) It is less noted how variable it is. Although military historians are perfectly comfortable with the observation that some generals are better strategists than others---this variation has long been grist for their mill---this fact is more awkward for balance-of-power theorists, who emphasize structural factors. And even historians can be puzzled by intra-personal variation: e.g., Stonewall Jackson’s performance in the Seven Days Battle was mystifyingly inept. And when the law of large numbers does not hold, that occasional variability can resonate throughout history.

There are strong systematic reasons for this. Several of these turn on the cognitive difficulty of strategic situations. The computational complexity of war makes chess look like tic-tac-toe, but even chess is complex enough so that chess players vary enormously in skill. Further, the assumption of optimal play is inaccurate even for grandmasters. All this suggests that students of international relations, including those who argue that states’ military policies depend on their strategic environment, should be open to the proposition that leaders facing a

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86 This example shows that increasing returns, a mechanism emphasized by historical institutionalists, are not necessarily involved. A thermonuclear exchange would have produced no clear winner; the military power of both sides would have been severely degraded. Increasing returns are more likely to occur in wars that end in clear victories and the winner amplifies power-volatility by degrading the loser’s military.

87 Standard game theoretic models assume zero variance in strategic ability: by assumption a fully rational agent optimizes, i.e., makes no ex ante mistakes.

88 This was the final battle of the Union’s 1862 Peninsular Campaign where they came close to taking the Confederate capital. Although the Union forces were turned back, Jackson performed poorly during the battle, in stark contrast to the tactical brilliance he displayed before and after that week.

89 Bendor and Shapiro, 2015
complex strategic situation can have very different views about how to handle the same problem.

We consider two important historical examples of strategically complicated problems.

The Election of 1860

All three main contenders for the 1860 Republican nomination, William Seward, Salmon Chase and Abraham Lincoln, were anti-slavery. They weren’t interchangeable, however, either as candidates or potential Presidents. The differences were important because Lincoln’s win at the convention was far from certain. In fact, had his supporters not engaged in outright fraud, he probably would have lost the contest.

The story starts with the candidates’ relative rankings. Initially, Lincoln was the long-shot behind Senator Seward and Chase, then governor of Ohio. But the convention was held in Chicago, where Lincoln was the local favorite. His supporters capitalized on this in two ways. First, Lincoln supporter Norman Judd “…flexed his muscles as a railroad attorney and had the rail fares reduced by half on the Illinois Central Railroad and other Prairie State lines for the first days of convention week,” thereby making attendance easier for Republicans from Illinois than from Ohio. Judd also ensured that Seward’s supporters were placed far from the stage.

Second, and more egregiously, when it became clear the night before the nominating vote that Lincoln had little support, Ward Lamon, a former prosecutor (!) who was one of Lincoln’s Springfield friends “…directed a crew that forged signatures of convention officials

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90 Goodwin (2005) provides a clear summary of the election and the candidates’ relative popularity going into the convention.
91 Ecelbarger 2008, 203
on counterfeit tickets that looked just like the originals” at a Chicago printing house.\footnote{Sautter and Burke 1996, 11} In the morning thousands of Lincoln supporters arrived with counterfeit tickets, many having taken advantage of the aforementioned “…special cheap rate.”\footnote{Ibid, 11} Thus when “…Seward’s ‘irrepressibles’ arrived after breakfast, the Wigwam’s main floor and balconies were packed with excited Lincoln supporters….Only official Seward delegates could get in.”\footnote{Ibid, 11-12}

So what? Would a Seward victory have made much difference? There are good reasons for believing that it could have. First consider the election. Had Seward been on the ballot, he could well have lost to Stephen Douglas. At the convention the main objection to Seward was that he “…was too radical on slavery and liberal on immigration to win battleground states [such as] Indiana, Illinois, New Jersey, and Pennsylvania.”\footnote{Goodwin, 240} In 1860 a presidential candidate needed 152 electoral votes to win; otherwise the presidency would be decided by “the turbulent chamber of the House of Representatives, which might well prove unable to elect anyone.”\footnote{Ibid, 260} Seward likely would have lost several states that Lincoln won, including “Indiana, Pennsylvania, [and] Ohio [where] Douglas had considerable strength”\footnote{Ibid, 240} as well as Illinois, Douglas’s home state, dropping Seward below the 152 vote threshold. Then Douglas might have been selected by the House. Or he might have won outright. Either would have altered the course of American history.

Now suppose that Seward would have won the election despite the above obstacles. What about governance? One counterfactual is easy to support: given that Seward was seen as more intensely anti-slavery than Lincoln, the South would almost certainly have seceded in this
scenario. Would President Seward have then used force to preserve the Union? If not, then obviously American history would have been greatly changed. Alternatively, had Seward gone to war, how skillfully would he have done so? Two dimensions are especially worth considering: the chief executive’s judgment about war-objectives and his management of an exquisitely delicate coalition. Many historians give Lincoln high marks in both respects.\textsuperscript{98} To the surprise of many of his contemporaries, Lincoln turned out to be a gifted commander-in-chief, skilled in “grand strategy”---the intertwined political and military aspects of fighting a civil war. Seward was an able politician, but managing the Union’s efforts was an extraordinarily difficult task---it was a near-run thing as it was---and skill-variations matter for problems of such difficulty. Even grandmasters make mistakes, but their odds of winning are better.

*The Spring Offensive of 1918*

Twentieth century Europe was reshaped by World War I. Empires collapsed and nations emerged, the stage was set for WWII and the subsequent Cold War.\textsuperscript{99} A new alliance was forged between Britain and France that impacted politics in Europe and across the world through their colonial possessions. But the war’s outcome was far from a foregone conclusion. To see why requires a short discussion of the fundamental tactical problem of the war.

\textsuperscript{98} The argument for the grade is as follows. (1) Lincoln’s high ranking among Presidents is based on his successful prosecution of the war. (2) He succeeded in this task partly because his war aims evolved intelligently, first emphasizing preserving the Union and only later stressing emancipation. This reflected a close understanding of Northern sentiment, vital coalitional issues, especially those involving key border-states such as Kentucky, and the attitudes of important foreign powers (Britain). (3) Doing all this right required subtle thinking and excellent timing (e.g., when to issue the Emancipation Proclamation). The margin for error was small.

\textsuperscript{99} Kershaw, 2015
After the first few months the fighting on the Western Front settled into trench warfare. The challenge facing the opposed armies was how to cross the area between the trench lines, known ominously as ‘No Man’s Land’, and then sustain the advance into the enemy’s rear area. To do that an attacking army first had to move soldiers across a rugged, broken landscape while under fire from massed machine guns. Once across, the attackers had to resist counter-attack by the well-rested reserves of the other side long enough for follow-on forces to be brought forward. Then they needed to advance quickly enough to prevent the enemy from establishing additional trench lines. And, during all this, their original lines, through which the follow-on forces had to pass, remained within the defender’s artillery range.

This tactical problem was not completely new. The 10-month siege of Petersburg during the American civil war involved battle tactics that looked much like trench warfare. Indeed, after losing a battle in 1864 in which his forces made a frontal assault on well-entrenched defenders, one Union general reportedly said “We realized now, as never before, the futility of direct assaults upon entrenched lines already well prepared and well manned” (Catton 1965). Although the Europeans didn't realize it, the Civil War provided relevant tactical lessons. In the hands of well-protected veterans in entrenched positions, even the rifled musket (the standard weapon on both sides for most of the war) could do terrible damage to soldiers making a frontal assault. Hence the repeating rifles and machine guns wielded by armies in 1914 should have been expected to stymie such attacks.100 And while some military planners did expect trench warfare, no one had figured out a way around it.101

100 It wasn’t just the Civil War. Both the Russians and the Japanese used trenches extensively in the Battle of Port Arthur (1905); infantry attacks on entrenched Russian positions failed repeatedly. The Japanese lost roughly twice as many men as the Russians did in battle and it took 6 months for them to capture a garrison they outnumbered more than 2 to 1 and which they had cut off from resupply.

101 See Lieber (2005) for a summary. As early as 1874 German Field Marshal von Moltke argued that “improvements in firearms have given the tactical defense a great advantage over the tactical offense” (Lieber,
Contrary to the once-common belief that generals on the Western Front mechanically repeated the same tactics, with the same dreadful consequences, today most specialists believe that there was extensive trial-and-error learning by both sides from spring 1915 to spring 1918 (Griffith 1996; Lupfer 1981). The British emphasized developing a new weapon, the tank, which would not be vulnerable to machine guns or squad level weapons. They believed that if the attackers could reach enemy trenches quickly then defensive artillery would be ineffective and the tank’s heavier weaponry would enable attackers to overcome the defenders’ relatively light infantry weapons.

Meanwhile, the Germans slighted the tank, emphasizing instead new tactics: infiltration. Small dispersed infantry units were to penetrate weak points in enemy defenses after a short artillery barrage. This was the opposite of the standard tactic: a long preparatory artillery fire to degrade enemy defenses followed by a massed infantry attack. The logic behind infiltration tactics was twofold. First, long preparatory barrages warned the enemy where you would attack, enabling them to place reserves. Hence even if the offense managed to take the first line of trenches, the inevitable counterattack would be devastating. Second, dispersion allowed the Germans to take advantage of natural opportunities for cover and concealment offered by the terrain of no-man’s land. Using this approach the attacker would bypass strong points and get rapidly into enemy’s rear areas where they could move more effectively and disrupt the advancing reserves. Follow-on units could then move en masse through gaps created in

180).

102 Furthermore, non-specialists tend to ignore the fact that trench warfare in WWI was itself an adaptation---a response to the terrible losses produced by the maneuver warfare of 1914. The speed of this learning was sometimes impressive: “It is remarkable how quickly French fighting methods improved… the French infantry [near the Ardennes] was already using trenches on 26 August, spurning an open fight in favor of the protection of buildings and folds in the ground” (Strachan 2001, 230). The author was referring to August 1914.

103 For a good summary of the value of cover and concealment and the evolution of the “Modern System” of ground combat during WWI and afterwards see Biddle (2006).
defenses. This method required innovations in command and control to coordinate dispersed units, as well as better trained troops.

Although both British and German solutions matured eventually, the latter worked first. Tanks were too slow and unreliable in the spring of 1918 to travel far beyond the first line of defenses and they remained vulnerable to infantry anti-tank weapons. Infiltration tactics, however, succeeded in crossing No Man’s Land: in the Spring Offensive of 1918 the Germans broke through Allied lines across much of Northern France. The Allies recovered, partly due to fresh (American) troops but also because of German failures to exploit breakthroughs. The Germans could not move enough men and material through the lines to keep attacks moving before the Allies dug new trench lines that contained breakthroughs. The tactic’s value was clear, however; the allies would use a variant of it in their successful war-ending offensive later that year.

What would have happened had the German Army solved the tactical problem somewhat faster, by late 1917 instead of early 1918? What if all German forces in the East had, after the collapse of the Russian armies, been reassigned to the Western Front, to exploit breakthroughs? What if all that happened before the substantial new American forces were in theater?104 The rest of the 20th century might then have looked very different.105 In contrast, it is hard to think of a situation in economic competition where a six-month difference in

104 Stone (2015) argues that the Russian Revolutions could have occurred earlier, with similar effects. Thus history was doubly contingent here: World War I could have ended differently either had the Germans solved their tactical problem somewhat faster or the Tsarist regime had collapsed earlier.

105 An objection to this line of reasoning is that logistical problems would have nullified an earlier German adoption of infiltration tactics. In March 1918 the state of the art in logistics was poor, particularly in the German Army that still relied on horses for much of their towing power; hence allied forces could have quickly re-established their defensive lines. But Germany had much experience with mobile warfare on the Eastern Front, managing it there with a combination of mechanized vehicles and horse. More likely, the failure to exploit the breakthroughs in 1918 resulted from a resource constraint: too few trucks that could move quantity needed at speed needed over available roads. That constraint would have been looser the previous year.
learning and technology development would have world-shaking consequences.

8. Systemic Properties that Increase the Volatility of Military Power

Earlier we underscored a systemic property---the anarchic nature of inter-state competition---embedded in all the causal mechanisms we have examined. In this section we briefly study three other systemic properties that also increase the volatility of military power even though they may not occur in all of the causal pathways examined here. We believe there are substantial quantitative differences between military and economic competition on all three dimensions.

First, inter-state competition usually involves a small number of actors, and this is virtually always true of the major actors (hence the term “the Great Powers”). Therefore, the best-understood microeconomic theory, perfect (atomistic) competition, is inapplicable here.\textsuperscript{106} This is not coincidental: military conflicts are contests, as economists use the term (Skaperdas 1996): size matters. This has long been true: one of Rome’s key advantages was the ability to field new armies even after devastating losses such as Cannae (216 B.C). Size matters even today: although the sheer number of soldiers is now less important, being a superpower is very expensive. (For example, a new nuclear aircraft carrier could cost the U.S. Navy 13 billion dollars.) Hence, laws of large numbers are less likely to apply in inter-state competition, so micro-level variance is less smoothed out.

Second, although military organizations are built to fight wars, peace usually prevails. In striking contrast, almost all firms and most government agencies are continuous-operation

\textsuperscript{106} For this reason formal theorists studying balance of power in international relations turn to game theory rather than to classical microeconomic models (e.g., Niou et al. 1989).
organizations. This matters because militaries behave fundamentally differently at war than they do during peace. Every war entails considerable surprise and maladaptation. U.S. forces invading Iraq in 2003, for example, drove soft-sided jeeps because they did not anticipate the IED threat. More generally, because militaries aren’t continuous-operation organizations the best feedback about a host of vital operational variables—how new equipment functions, which tactics work well, how a crucial logistical system performs—is obtained during war. Performance of these key components in peacetime exercises typically offers only a crude estimate of their true military value. Further, war-fighting skills can degrade in peacetime. Military organizations throughout history have struggled to stay effective in peacetime—so much so that they often seek out war-like missions simply to maintain skills (e.g. U.S. naval forces enforcing UN sanctions against Iraq in the late-1990s partly to maintain proficiency in wartime tasks). These are stable differences between market competition, which normally involves continuous-operation organizations, and military competition.

The first and the second factors together mean that Great Powers often must rely on small data sets about many operational matters. A famous example of this concerned the tactical implications of the huge increases in the lethality of artillery and rifles in the late 1800s and early 1900s. Although military leaders in the Great Powers realized that the equipment had changed dramatically—only idiots would have missed that obvious fact—there was little data to help them forecast how different tactics would work. In the four decades between the Franco-Prussian War and 1914 there was only one Great Powers war:

107 Fire departments are not continuous-operation organizations. But even here temporal aspects of operation differ sharply. For most fire departments the “off” periods are days or weeks; for militaries, typically years or decades.
108 In some cases the jeeps were literally soft-sided with canvas doors stretched onto a metal frame.
109 The literature on this problem is voluminous; see e.g. Imlay and Toft (2006).
Russia and Japan in 1905. And in that conflict one battle was most studied: Port Arthur. That is a very small sample. On big issues---strategic ones---when feedback arrives it is often too late. Tsar Nicholas II and his advisers badly underestimated Japan’s military strength; once they got the relevant feedback, much of Russia’s Baltic fleet was at the bottom of Tsushima Strait.

We believe that this paucity of feedback increases the impact of chance on war and hence the volatility of military power.

Third and finally, wars are not exogenous to the trajectories of military power: they are endogenous. Most game theoretic models that examine when states will go to war predict that they typically do so when there is uncertainty about the sides’ relative power. The reason is simple: most of these models assume that there is “bargaining in the shadow of the war”; hence, if side A can predict that it will be crushed by B then it concedes most of B’s demands; in equilibrium, war is averted. When the sides are more evenly matched, however, it is harder to predict who will win. Given imperfect information, many models have equilibria in which war occurs. This also means, of course, that weak states have incentives to fake being strong, creating more opportunities for conflict. This endogenous uncertainty increases the volatility of military power dynamics.

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110 Some would add the Boer War---although the Afrikaans were not a Great Power they used modern firepower, sometimes with devastating effects on British forces using outmoded tactics (e.g., the Battle of Spion Kop)---and, as noted earlier, the U.S. Civil War. Even so, this is much less data than prototypical continuous-operation organizations (e.g., factories or hospitals) can acquire.

111 For a detailed examination of the implications of the different cycle-times of tactics versus strategy see Bendor and Shapiro (2015).

112 Such models have difficulty explaining events such as the war between Paraguay and the alliance of Brazil, Argentina and Uruguay (1864-1870)---predictably, Paraguay was crushed---but we conjecture that the key result at issue here (wars are a biased sample of international conflicts, skewed toward those with uncertain outcomes) is robust to assumptions about the rationality of leaders. Boundedly rational leaders probably also reach peaceful deals more often when it is obvious who would win a war than when it isn’t.
9. Conclusion

A key thesis of historical institutionalism is the importance of contingency in politics.\textsuperscript{113} We have argued that there are large systematic differences in how much micro-contingencies impact macro-trajectories across different policy domains. Such contingencies are usually more important in military affairs than in economic growth or, we suspect, than in public health trajectories, despite the unpredictability of epidemics. And other domains, such as education, exhibit even more stability and insensitivity to micro-events. K-12 education in the United States exhibits massive statistical smoothing (National Center for Education Statistics 2013, p. 1). Several intertwined factors generate smoothing in education: there are a great many organizations (the U.S. has over 10,000 school districts) that are only weakly causally interdependent (the performance of schools in Seattle has little effect on Miami’s). Further, because this organizational multitude is embedded in a decentralized structure, policy shocks are less likely to sweep through this system than, say, liquidity shocks can tear through the financial sector.

This comparison between public schools and the financial sector indicates that it is an oversimplification to see the difference as “politics and public policies are more volatile than markets and private goods.” There is something to this claim, insofar as competition in the international system has selected for tightly integrated hierarchies---modern militaries---in which operational micro-shocks (the mistaken launch of a nuclear torpedo by one submarine) can have enormous macro-repercussions. And there is nothing more “public” than contemporary militaries.

Nevertheless, we believe that more fundamental than the distinction between politics

\textsuperscript{113} Some scholars overestimate contingency. In an on-line appendix we provide a case study, based on recent research (Kalmoe 2014), that illustrates how a military event (the fall of Atlanta) widely regarded as pivotal (regarding Lincoln’s re-election in 1864) was in fact neither surprising nor all that powerful causally.
and economics are the following two properties: (1) the size distribution\textsuperscript{114} of entities within the unit of analysis (e.g. the state) whose fortunes aggregate up to the kind of systemic capacity (e.g., military power) in question, and (2) whether inter-organizational conflict in the domain is effectively regulated by a third party. A financial system dominated by a few big banks can be quite unstable. If this turns out to be true then we will understand why certain subfields in political science focus more on history than do other subfields. It will also suggest a natural rapprochement between historical institutionalism and the more conventionally scientific approaches in the discipline. If a few fundamental parameters explain when and why history matters then we will have a basis for a scientific history of politics as well as a better understanding of what `scientific' means.

\textsuperscript{114} Not merely the number: see footnote 5.
Sources


Jonnes, Jill. Empires of Light: Edison, Tesla, Westinghouse, and the Race to Electrify the


Scott, L. V. *The Cuban Missile Crisis and the Threat of Nuclear War: Lessons from History*. 


Tables

Table 1. Germany GDP per capita 1910-1965 (5 yr intervals)

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP per capita (1990 Int.)</th>
<th>M-Score</th>
<th>CINC Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1910</td>
<td>3,348</td>
<td>0.359</td>
<td>0.135</td>
</tr>
<tr>
<td>1915</td>
<td>2,899</td>
<td>0.828</td>
<td>0.151</td>
</tr>
<tr>
<td>1920</td>
<td>2,796</td>
<td>0.081</td>
<td>0.072</td>
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<tr>
<td>1925</td>
<td>3,532</td>
<td>0.257</td>
<td>0.082</td>
</tr>
<tr>
<td>1930</td>
<td>3,973</td>
<td>0.331</td>
<td>0.074</td>
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<tr>
<td>1935</td>
<td>4,120</td>
<td>0.667</td>
<td>0.103</td>
</tr>
<tr>
<td>1940</td>
<td>5,403</td>
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<tr>
<td>1945</td>
<td>4,514</td>
<td>0.403</td>
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<tr>
<td>1950</td>
<td>3,881</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1955</td>
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<tr>
<td>1960</td>
<td>7,705</td>
<td>0.567</td>
<td>0.050</td>
</tr>
</tbody>
</table>

Note: GDP data from The Maddison-Project, http://www.ggdc.net/maddison/maddison-project/home.htm, 2013 version. M-Score from Arena’s M-Score data. CINC score from Correlates of War v4.0. Germany CINC score for 1945-1990 is the sum of GDR and GFR scores.
Figures

Figure 1. Military power (M-Score) and GDP since 1820
Figure 2. Military power (M-Score) and GDP since 1820 for US and Japan
Appendix Figures
Figure A1. CINC Scores and GDP since 1820