After the Hemoclysm:

The Likely Decline of Conventional War since 1950[1]

Michael Spagat

RHUL

Brennen Fagan

University of York

Stijn Van Weezel

Unaffiliated Researcher

Abstract

We provide strong evidence of a post-1950 decline in conventional war. A survey of the qualitative literature identifies the Korean War and other post-1950 factors as spurring decline, while a quantitative analysis of Project Mars database of all conventional wars between 1800 and 2011 finds a dramatic decrease in the war-arrival rate after 1950. When we restrict attention to relatively large wars, e.g., those with killed in action (KIA) counts above the median count for the whole period, evidence for decline remains strong and is strengthened further when we use KIA per 100,000 of world population as the war-size metric. We attach Bayesian posterior probabilities to the event of a post-1950 decline for a wide range of war-size measures and ranges and prior beliefs and provide an online interactive application that allows readers to conduct their own explorations. These calculations robustly find a likely decline in conventional war.

1. Introduction: The Decline of War Debate

John Gaddis famously argued that World War 2 was followed by a "Long Peace" (Gaddis 1986). This was, perhaps, an unfortunate coinage that can easily be misconstrued to imply an absence of war after 1945. However, Gaddis perceived relative, not absolute, peace and characterized the four decades following World War 2 as producing

> "…the greatest accumulation of armaments the world has ever known, a whole series of protracted and devastating limited wars, an abundance of revolutionary, ethnic, religious, and civil violence, as well as some of the deepest and most intractable ideological rivalries in human experience (Gaddis 1986)."

He expressed astonishment that the USA and the USSR had managed to avoid unlimited war for forty (now 76) years despite abundant provocations, some of which would probably have escalated into all-out war in earlier time periods.[2]

Multiple scholars built on Gaddis' observation. (Mueller 1990) argued that the very idea of war has been progressively discredited over many decades as increasing numbers of people recognize its "stupidity" as a form of dispute resolution (Mueller 2021). (Lacina, Gleditsch, and Russett 2006) capped their major data collection effort with a finding of global decline in the "risk of death in battle" since World War 2, thereby extending Gaddis' Long Peace story a further two decades and endowing it with a strong quantitative foundation.[3] Their risk measure divided global battle deaths by global population so as to compare the risks of dying in battle faced by randomly chosen individuals alive during different time periods. (Human Security

Centre 2006) focused on the post-cold-war period and looked beyond battle deaths, finding that military coups, genocides and the number of armed conflicts also declined, although subsequently the last number reversed course ('UCDP Home Page' 2022). (Goldstein 2012) found that the post-World-War-2 (uneven) decline in battle deaths has been accompanied by shrinkage in the geographical area afflicted by war.

(Pinker 2012) expansively considered many forms of violence and reported across-the-board reductions, not necessarily monotonic, in all forms he managed to analyse. Despite the wide scope of his book, Pinker's specific case for the decline of *war* concentrated narrowly on Gaddis' Long Peace and the subsequent post-Cold War period which he designated to be the "New Peace".[4] In contrast, (Morris 2015) and (Gat 2017) both argue that war has declined for many centuries with Gat pointing out that the 19th century had two great-power long peaces that, although shorter than Gaddis', were still substantial. However, we cannot, in the present paper, engage with this thesis since we use data going back only to 1800.

(Pinker 2012) also ventured beyond a litany of violence-decline statistics and introduced Lewis Fry Richardson's (Richardson 1960) discovery of the fat-tailed distribution of war sizes, usually modelled as a power law, into the decline-of-war discussion:

> "The thick tail of a power-law distribution, which declines gradually rather than precipitously as you rocket up the magnitude scale, means that extreme values are *extremely unlikely* but not *astronomically unlikely*. It's an important difference…. I hardly need to point out the implications for war. It is extremely

> unlikely that the world will see a war that will kill 100 million people, and less likely still that it will have one that will kill a billion. But in an age of nuclear weapons, our terrified imaginations and the mathematics of power-law distributions agree: it is not astronomically unlikely." (Pinker 2012)

(P. Cirillo and Taleb 2016), (Clauset 2018) and (Braumoeller 2019) subsequently incorporated the fat-tail property in the distribution of war sizes into a critique of the decline-of-war thesis without disputing the claim that battle deaths have declined since World War 2 (Lacina, Gleditsch, and Russett 2006).[5] Their central idea is that if truly massive wars are extremely, but not astronomically, unlikely then the absence of such wars after World War 2 may result merely from a run of relatively lucky draws from an unchanging distribution of war sizes. Further decades without truly massive wars would be needed before we could reject a hypothesis of an unchanging distribution of war sizes, applying both before and after World War 2, at a conventional significance level. Thus, a downward post-1945 trend in battle deaths is theoretically compatible with a stable, but fat-tailed, war-size generating mechanism.

(Clauset 2018) and (Braumoeller 2019) both fit power laws to war-size data[6], first for the period from 1816 through World War 2 and, second, for the post-World War 2 period. Neither researcher rejects a null hypothesis that the same slope coefficient (in a log-log plot) governs both their pre-war and the post-war estimated power laws, and both interpret this finding as demonstrating continuity between the pre- and post-war periods.

(Cunen, Hjort, and Nygård 2020) and (Fagan et al. 2020) both use change point detection methods designed for fat-tailed distributions that, while differing substantially in their specifics, deliver evidence for a decline of war that took hold some time after World War 2. (Cunen, Hjort, and Nygård 2020) identify 1950 as the best candidate for a switch to a downward trend. (Fagan et al. 2020) also pick out 1950 but, in addition, find evidence for change at 1910 and possibly for the 1830's, 1930's and 1990's. (Spagat and van Weezel 2020) did not use a general change point detection method but, rather, considered only 1945 and 1950 as possible change points. They found evidence for a downward shift in the war-size distribution starting at 1950 but only when war sizes are measured by battle deaths per 100,000 of world population. (van Weezel 2020) uses Bayesian methods to estimate a probability of at least 0.66 that the risk of dying in battle decreased after 1947.

The literature, in short, is divided on the grand question of whether war is in decline but the most recent literature is united on the need to integrate the fat-tailed nature of the distribution of war sizes into any analysis of the question. Note, further, that the papers described in the preceding three paragraphs focus only on numerical data, making little or no effort to connect their quantitative analysis with historical contexts as we try to do in the present paper.

Our paper advances the case for the decline-of-war thesis in three main dimensions. First, we introduce the Project Mars dataset (Lyall 2020b) into the debate and argue that it provides a more appropriate basis for analysis than does the primary database used in the literature: the Inter-State War data of the Correlates of War (COW)

Project (Sarkees and Wayman 2010). Second, and most important, we present our own analysis of the Mars dataset, using both null hypothesis significance testing (NHST) and a Bayesian approach, that strongly suggests a decline of war since 1950. Third, we link our analysis with the work of political scientists and cold-war historians who identify the Korean War (1950 – 53) and some subsequent post-1950 developments as setting the stage for a decline of war within a still dangerous and violent world. Thus, we find the qualitative work of this group of analysts to be consistent with our own quantitative work.

2. Important New Data

Project Mars (Lyall 2020b) provides data on many variables for all 252 conventional wars waged across the globe between 1800 and 2011 where conventional war is defined as "armed combat between the military organizations of two or more belligerents engaged in direct battle that causes at least 500 battlefield fatalities over the duration of hostilities." (Lyall 2020b) Appendix 1 quotes at greater length from the Project Mars codebook but the key point for out purposes is that the database covers a type of war with no requirement that belligerents must be States. The rigour of the Mars coding work is underscored by its list of a further 90 "edge cases" and their reasons for exclusion. We use the Mars variables for the start years of each war plus the low and high estimates of KIA where KIA includes just military personnel killed in battle; a concept that seems to be identical to that of "battle deaths" for COW.

Mars has such big advantages over the COW Inter-State database that its appearance necessitates a fresh exploration of the decline-of-war question. First, it is a truly global database of conventional wars over the last two centuries. In contrast, COW Inter-State is profoundly Eurocentric,[7] including 19th and early 20th century wars only if they are between two belligerent powers that were recognized at the time as bone-fide States by either France or the UK (Correlates of War Project, 2016).[8] This might seem like an innocuous technical assumption but it embeds a 19th century imperial view of much of the non-European world as ungoverned territory available for the taking. (Elkins 2022) demonstrates that the influential 19th century British historian Robert Seeley:

> "…suggested that the notion of conquest was misplaced. India was not a nation with a political community; rather, with the fall of the Mughal Empire, the subcontinent was home to a Hobbesian state of anarchy. 'It remains entirely incorrect to speak of the English nation as having conquered the nations of India…India can hardly be said to have been conquered at all by foreigners,' Seeley insisted, 'she has rather conquered herself.'" (Elkins 2022)

Due to the supposed dearth of legitimate political authority outside of Europe, COW contains 16 purely European wars, 12 wars between a European and a non-European country and just 10 wars without European participation between 1816 and 1913.[9] The "Great Game" and "scramble for Africa" notwithstanding, COW lists 0 wars in both South Asia and Sub-Saharan Africa during this period. China appears to be entirely peaceful until 1884, long after the obviously international Opium Wars were finished. Thus, the COW Inter-State war data is compromised by a colonial perspective which, paradoxically, erases 19th century colonialism.[10] Worse, COW applies the same criterion of non-recognition by the UK and France to exclude several non-colonial wars with clear relevance to the decline-of-war debate, including the US, Russian, Spanish and Chinese civil wars.[11] Dropping the requirement for British/French validation is the main reason why Mars raises the number of belligerent groups, relative to COW Inter-State, from 95 to 250 and the number of wars from 95 to 252. Appendix 2 of (Lyall 2020a) reveals that these differences apply overwhelmingly in the 19th century, thus biasing the COW Inter-State data against the decline-of-war thesis by making the 19th century appear more peaceful than it really was.

A second advantage of Mars is that it begins coverage in 1800 rather than 1816 as COW does, avoiding further bias against the decline-of-war thesis by including the massively violent Napoleonic Wars. In fact, COW begins only nominally in 1816 but actually starts in 1823 with the Franco-Spanish War after passing over the Bombardment of Algiers, Third Maratha War, Fifth Cape Frontier War, Ecuadorian War of Independence, Peruvian War of Independence, Greek War of Independence, Turko-Persian War, Brazilian War of Independence and Ashanti-British War, all starting between 1816 and 1823. Unfortunately, Mars only partially eliminates this starting-point bias since it still omits the earlier French Revolutionary and Seven Years Wars. Nevertheless, turning the clock back to 1800 is a step in the right direction.

Third, the Mars Project improves upon COW's erratic and poorly documented battle-death coding by revisiting the numbers and explaining its decisions in a well-documented codebook.[12] An example of COW miscoding with important implications for the decline-of-war debate is its conversion of the 1980-1988 Iran-Iraq war into the 3rd biggest war in the whole dataset by overestimating its battle deaths by at least a factor of 2 (Lacina 2009). This case notwithstanding, anomalies in COW's death estimates pertain mostly to incompatibilities between the inter-state war numbers, on the one hand, and the intra-state and extra-systemic numbers on the other. The latter figures often resemble excess deaths more than battle deaths (Lacina, Gleditsch, and Russett 2006). These incompatibilities do not affect the analysis of (Clauset 2018), (Braumoeller 2019) and (Cunen, Hjort, and Nygård 2020) since they use only the Inter-State data. They do, however, affect (Fagan et al. 2020), (Spagat and van Weezel 2020) and (van Weezel 2020), which all tried to go beyond COW Inter-State and then had to live with inconsistencies in COW coding across its datasets.[13]

We must bear in mind that the Mars Project endeavours to cover conventional wars, not all wars. Hence, we argue in the present paper for the likely decline of conventional war, not wars of all types. Nevertheless, the Mars list includes wars, such as the Vietnam War, that contain both conventional and non-conventional aspects and we are not aware of any purely non-conventional wars with KIA counts that would put them, e.g., into the top 10 for all types of wars combined.

We present the critique of the decline-of-war thesis made in (Fazal 2014) and (Fazal and Poast 2021) here, rather than in section 1, due to its relevance to our critique of COW. They argue that improvements in military medicine have, increasingly over time, converted (what previously would have been) war deaths into injuries. Thus, in their view, at least some of the observed post-World War 2 decline in battle deaths is illusory because the death statistics overlook large numbers of survivors who would have died in previous decades. Furthermore, COW's practice of including only wars that cross a threshold of 1,000 battle deaths can lead to the omission of whole wars that do not cross this threshold when they occurred but might have done so if they had been conducted amidst the cruder military practices of bygone decades.[14] We are convinced that this is a real phenomenon, at least for relatively rich countries, but we offer a different interpretation of its pertinence to the decline-of-war debate; the mobilization of science and organizational power to save lives does not, in our view, undermine the decline-of-war thesis but, rather, explains part of the observed decline in battle deaths.[15]

The analysis of (Fazal 2014) and (Fazal and Poast 2021) has the further virtue of highlighting the strong emphasis on battle deaths which pervades the decline-of-war debate and the conflict field more generally. This focus derives from data limitations, rather than research efficacy, and there should be wide agreement that our understanding of war would be greatly enriched by consistent long-run data on injuries and civilian plus combatant deaths of all varieties, including those due to diseases. We do not, unfortunately, have such consistent data but we do have pieces of pertinent information that are worth considering. Total deaths in the 19th century Taiping rebellion, absent from COW Inter-State, are thought to be in the 10's of millions (Platt 2012) as opposed to the roughly 100,000 KIA coded in Mars.[16] (V. J. Cirillo 2008) finds that military personnel of the US died far more from infectious diseases than they did from "enemy actions" for all US wars until World War 2 finally reversed this pattern. Similarly, (Bailey 2013) finds dramatic long-term decreases in deaths from tropical and infectious diseases for British military personnel. The US and the UK are just two (particularly active) countries, but their experiences are likely to resemble those of other rich countries. These considerations suggest that the practical necessity of narrowing the scope of our analysis to battle deaths introduces a strong bias against the decline-of-war thesis by forcing us to ignore a large category of war deaths that has declined dramatically over time.

3. 1950 as a Turning Point in Two Centuries of Warfare

(Fagan et al. 2020), (Cunen, Hjort, and Nygård 2020) and (Spagat and van Weezel 2020) all found evidence, albeit using COW data, that 1950 was a change point in the history of war over the last two centuries.[17] But these were pure quantitative studies that did not assess the historical case for why 1950 marked a change in the distribution of battle deaths. This section considers the extent to which qualitative analysis is consistent with the notion of 1950 as a change point. We find that, indeed, there is qualitative evidence for a pivot toward less conventional war violence that began around the Korean War of 1950 – 1953 and that was accentuated afterwards by some further factors. We make no claim that peace broke out after the Korean War and, indeed, some phenomena, such as spiralling defence spending and the nuclear arms race, were decidedly aggressive. Thus, the change was not to a new era of peace but, rather, to managed competition that was more restrained than had been the case previously.

We do not, and cannot, attempt here a full explanation for the dynamics or war over the last two-plus centuries. We aim, much more modestly, to make a qualitative case for 1950 as a change point in these dynamics. Some factors already mentioned, such as the progress of military medicine and the gradual discrediting of the idea of war as the solution to real problems, could play roles in a full explanation war dynamics over the last two centuries but we ignore them here because we do not think they contribute to a sharp change happening around 1950.

Robert Jervis, in a classic study (Jervis 1980), identified the Korean War as the key turning point in the onset of the Cold War.

> "American policy during the height of the cold war was distinguished by the following features: (1) a high degree of conflict with the USSR; (2) a significant perceived threat of war; (3) high defense budgets; (4) large armies in Europe; (5) the perception of a united Sino-Soviet bloc; (6) the belief that limited wars were a major danger; and, following from the latter two beliefs, (7) anti-Communist commitments all over the globe. While the first and perhaps the second characteristics were present from 1946 to 1947, the other five came only after Korea." (Jervis 1980)

Forty years later, and with access to vastly more archival material than Jervis had when he wrote the above, (Wells 2019) reached remarkably similar conclusions.[18]

(Gaddis 1974), (Warner 1980), (May 1984), (Trachtenberg 1988) and (Lafeber 1989) all make similar turning-point arguments, albeit with different nuances and emphases. (Gaddis 1974) and (May 1984) place Korea at the origin of a US commitment to contain communism all around the world with the US making little distinction between vital and peripheral interests. (Warner 1980) sees the Korean War as opening a major US/China rift and forging a (shaky) China/Soviet bond. (Trachtenberg 1988) portrays much of the US policy community shifting during and just after the Korean War from viewing nuclear war as winnable, and even desirable while the US held nuclear dominance, to widespread support for coexistence with the USSR and China. Post Korea there were vigorous struggles along the margins of each side's sphere of influence but all three powers broadly upheld the international status quo. (Lafeber 1989) argues that many of the big changes that coalesced during and just after the Korean war had earlier roots, but he still sees the war as transforming the nature, scope and scale of the NATO alliance.

(Foot 1985) demonstrates that that the Korean War came perilously close to going nuclear but, of course, did not and the war was ultimately dubbed, with good reason, "The Limited War" (Rees 1978). In fact, (Jervis 1980) argues that a well-formed concept of limited war was itself an outcome of the Korean War:

> "A war in Europe, it was assumed, would be unrestrained. Indeed, the whole concept of limited war which was to loom so salient after Korea was hardly present. As General Ridway(*sic*) explained, "The concept of 'limited warfare' never entered our councils" (1967: 11)….The decision makers had not rejected the idea of limited war; rather, they had not given it serious thought. Furthermore, consideration of it was inhibited by the same factors discussed above-to fight limited wars called for expensive capabilities which, in the prevailing political climate, the United States could not acquire. (Jervis 1980)

Fortunately, the concept of limited war took hold before Armageddon did, but the toll was still horrific on all sides.[19] Thus, point (6) of (Jervis 1980) above applies; limited war had become an option but it was, potentially, a very costly one.

The Korean War also provided a double test of rollback policies. The broad contour of the war was that, first, North Korea (with Soviet and Chinese support) tried to take over the south. Second, the UN (but mainly the US and South Korea) repelled this invasion and then tried unsuccessfully to take over the north. That is, two rollback adventures led to catastrophes and the two sides eventually settled on mutual containment.[20] Thus, the Korean War provided a cautionary tale: bold military moves to upset the global status quo are very risky.

In short, the historical record suggests that the Korean War was a transitionary event toward a tense Cold War stand-off that was, nevertheless, more restrained and less violent than the preceding period in global politics. To be sure, the world remained a violent place after the Korean War as (Chamberlin 2018) documents all too well. In fact, the Korean war stimulated an arms race and aggressive US/Soviet confrontations all around the globe. Yet it also alerted US and Soviet leaders to the necessity of managing their rivalry while also showing in microcosm how they might do so.

We close this section by singling out four further factors that have contained war violence in subsequent decades without contributing to a discrete change around 1950. First is decolonization which initially triggered violence that then declined over time as this phenomenon was largely completed. Second, is UN peacekeeping, convincingly demonstrated, e.g., by (Fortna 2008), to work and strongly emphasized by (Goldstein 2012) in his account of the decline of war. Third is a shift toward more "humane war" (Moyn 2022) that began during the Vietnam War and that reduced war violence, albeit without ending war. Fourth is the end of the Cold War which reduced international tensions for at least a decade.

4. Descriptive Statistics for the Mars Database

In this section we explore the Mars database with an emphasis on the decline-of-war question and continue our critique of the COW Inter-State data. Within the body of this paper we confine our critique of the decline-of-war critics to the inadequacy of the COW Inter-State data for addressing the decline-of-war question. However, in Appendix 2 we offer an extended critique of the decline-of-war critiques that accepts the COW data at face value and exposes under-appreciated flaws in the analysis.

The analysis in this section uses four different Mars-based measures of war sizes: high and low estimates of KIA counts in both raw and population-adjusted forms. The population adjustment roughly approximates the probability that a random person alive at any point in time will be killed in action. Population adjusted war sizes are interesting for the same reason that population adjusted homicide rates are interesting. For example, India's homicide rate in 2018 was less than 1/16th the El Salvadoran rate but India had more than 12 times the total homicides of El Salvador (Murder Rate by Country 2022, 2022). Both facts are interesting and useful in different contexts. Similarly, we think that both absolute and population-adjusted war sizes are relevant to the decline of war debate.

Table 1 gives both high and low per annum estimates of total KIA and KIA per 100,000 of world population, based on the Mars data, for the 19th century, 1900-1950 and 1951-2011. Unsurprisingly, 1900-1950 has far more KIA per annum than the other periods. More interestingly, the 19th century is strikingly violent compared to 1950 – 2011. KIA rates per annum per 100,000 of world population in the 19th century are more than double the analogous post-1950 figures. Even the raw post-1950 figures do not quite make it to 1.5 times their counterparts for the 19th century. Moreover, the 19th century war arrival rate is nearly double the post-1950 rate and, surprisingly, greatly exceeds the arrival rate for the exceptionally violent first half of the 20th century. We present formal statistical tests in the section 5 so we will just comment briefly here that the p values on the hypothesis that post-1950's arrivals were generated by the 19th century arrival rate is < 0.0001 and the p value on the 1900 - 1950 arrival rate generating post-1950 arrivals is 0.07.

These findings create an interesting echo from the pioneering work of the remarkable Lewis Fry Richardson (N. P. Gleditsch 2020) who, among other stellar accomplishments, introduced power laws into the conflict literature. One of his tentative conclusions based on his own data collection for wars between 1820 and 1949 is consistent with the Mars data:

> "There is a suggestion, but not a conclusive proof, that mankind has become less warlike since A.D. 1829. The best available observations show a slight decrease in the number of wars with time, and this contrasts with a theoretical increase proportional to $W^{0.57}$ [i.e., world population raised to a power derived

from a theoretical model]. But the distinction is not great enough to show plainly among chance variations."[21] (Richardson 1960, page 167)

In other words, Richardson assumed in a theoretical model that human tendencies toward war remained constant over time and derived a prediction that war frequencies would rise in proportion to a function of world population. Yet he observed roughly constant war frequencies in the face of rising population which he took, cautiously, as a hopeful sign of war in decline.

The COW Inter-State data, summarized in Table 2, tells a very different story. Annual 19th century battle deaths (the COW equivalent of KIA) fall just below 1/3 of their post-1950 counterpart and the former period remains just below the latter one even when we adjust for world population. Moreover, COW places the 19th century war arrival rate at only half that of the other two periods. These comparisons succinctly illuminate how the COW data has perpetuated a "myth of the hundred years peace" already challenged by (Lybeck 2010). Table 3 shows the 20 wars with the highest KIA counts that are excluded by COW Inter-State but included in Mars. Half are in the 19th century and only 3 are after 1950. Most exclusions are attributable either to non-recognition of belligerents by the colonial powers or to COW's post-1815 start.

Table 1

Table 2

Table 3

Table 4 provides summary statistics on the distributions of KIA counts for different time periods and measures, taking no account of the rates at which wars of various sizes arrived. The middle of the distributions for raw KIA counts are actually higher after 1950 than they were before 1950 although the reverse is true for population-adjusted counts.

Table 4

Figure 1 gives three different versions of the time series of the low estimates for Killed in Action according to the Mars data.[22] Panel a shows little more than that the two World Wars dwarf everything else. Panel b shows the same data on the traditional logarithmic scale; one can now see more about the rate e.g., the apparent slow down after 1900. Panel c orders the data instead by magnitude and the proportion of wars that are larger than the focal magnitude. This shows the typical heavy tail to the Mars data, as well as the increasing paucity of data as KIA increases. For example, above 100,000 KIA, there are only 4 wars that occur after 1950, 7 between 1900 and 1950, and 3 before 1900.

Figure 1

Figure 2 attempts to uncover possible turning points in the last two centuries of war by plotting a series of forward averages for both the low and high estimates of KIA.

Each point on one of the curves gives the mean number of KIA per year from that year forward to 2011 (when the data stops). We also orient readers by labelling some large wars and marking means for several time periods. The picture is dominated by the extreme violence for the first half of the twentieth century followed by a precipitous drop as this period closes with the Korean War. Subsequently, the forward means decrease almost monotonically.

Figure 2

In short, the summary statistics of this section show that the COW data underestimate 19^{th} century relative to post-1950 war violence. The summary statistics also are consistent with the idea of a post-1950 decline of war, as shown particularly in tables 2 and 4.

5. Testing Many Hypotheses of no Change after 1950

Suppose that war arrivals between 1800 and 1950 follow a Poisson process with rate parameter equal to their empirical arrival rate during this period, i.e., roughly 1.34 per year. If the underlying war arrivals process did not change in 1950 then this same rate of 1.34 should apply to 1951-2011, a period when Mars records 49 wars. We can calculate that the probability of 49 or fewer wars occurring during 61 years with a war arrival rate of 1.34 is less than 0.0001. This p value constitutes extremely strong evidence of a post-1950 slowdown in war arrivals. Next, we restrict attention to war arrivals for which the low estimates of KIA are above the median (4,178) for

1800-2011. The pre-1950 arrival rate in this war-size range is roughly 0.65 and there are 28 post-1950 wars with KIA counts above 4,178. Thus, the hypothesis of no post-1950 change leads, in this case, to a p value (probability of 28 or fewer wars) somewhat above 0.03: good evidence of a post-1950 slowdown in this above-median range.

We build on the approach of the previous paragraph by conducting many related hypothesis tests. These use both low and high KIA estimates, both raw and population-adjusted measures and every possible floor for KIA counts, i.e., not just 0 and the median as were used in the above paragraph. The main idea throughout is that if there is no change in 1950 then we should be able to split our sample into pre-1950 and post-1950 components and these should behave the same aside from random variation. More formally, we always test the hypothesis that war arrivals after 1950 follow a Poisson process with arrival rate equal to the pre-1950 arrival rate against the alternative hypothesis that the post-1950 war arrival rate is slower than the pre-1950 empirical rate. Readers should bear in mind that there are 151 years between 1800 and 1950 and 61 years between 1951 and 2011 while digesting the following algorithm.

1. Fix a minimum war size, S.

2. Define N(S) to be the number of wars between 1800 and 1950 that are at least as large as S.

3. Set the central prediction for the number of wars between 1951 and 2011 of size S or larger equal to N(S)*61/151.

4. Set 0.025 and 0.1 lower prediction limits for wars between 1951 and 2011 equal to percentiles 2.5 and 10, respectively, of the Poisson distribution with arrival rate parameter equal to N(S)*61/151.[23]

5. Repeat steps 1-4 for all S.

The general idea is that the empirical arrival rate of pre-1950 wars with more than S KIA is N(S)/151 and if we set this equal to the post 1950 Poisson arrival then N(S)*61/151 gives the predicted number of post-1950 arrivals with KIA great than S. Percentiles 2.5 and 10 are derived from the same Poisson process.

Figure 3

Figure 3 displays the results of these procedures, plotted on logarithmic X axes, with the top panel using the low estimates of KIA while the bottom panel uses the high estimates. Note first that when we use most of the data, e.g., when we set the minimum KIA count at around 3,000, then we strongly reject the hypothesis of no change in war arrival rates for 1951 – 2011 compared to 1800 - 1950, against an alternative hypothesis of slowdown. Moreover, the central predictions for numbers of post-1950 wars are always (almost always) lower than the actual number of post-1950 wars in every size range for the low estimates (high estimates) of KIA. The bottom 2.5% of the prediction intervals exceed the actual number of wars for every size range up to around 4,000 and above (6,000 and above) for the low (high) estimates of KIA. The corresponding cut-offs for the bottom 10% of predictions are around 8,000 for both the low and high KIA estimates. So at least until S rises above its median level we can rather confidently reject all no-change hypotheses in favour of a slowdown of war arrival rates.[24]

The above hypothesis tests can easily fail to reject (at a standard significance level) a no-change hypothesis for war arrivals with KIA counts above some value, S, even when there truly is a post-1950 slowdown. Intuitively, these false negatives tend to occur when S is relatively large, implying that arrival rates are slow and, hence, sample sizes are small. The following power analysis formalizes this intuition; unless there is a very large slowdown, the present methods have only a weak ability to detect real post-1950 declines in war arrival rates once the bottom of the KIA count range is much above its median value. These simulations assume a pre-1950 Poisson arrival process followed by a slower (or equally fast) post-1950 Poisson arrival process and calculate the probability that we will obtain a statistically significant rejection of the no-change hypothesis under these circumstances. We repeat these calculations for many pre-1950 arrival rates and slowdown factors. Following this logic, the points on the curves in figure 4 are calculated as follows:

1. Set a Poisson arrival rate, A, meant to represent arrivals of wars above some size, S, between 1800 and 1950.

2. Set a slowdown factor, F, equal to 1.0, 0.9. 0.8, 0.7, 0.6 or 0.5.

3. Calculate the probability that the number of arrivals generated over 61 years by a Poisson process with arrival rate F*A falls below percentile 2.5 of a 61-year Poisson process with arrival rate A.

4. Repeat and graph these calculations for many arrival rates and each of the slowdown factors.

For orientation, we add to Figure 4 the arrival rate (0.59) of wars whose low KIA estimates are above the median (4,178) in the Mars data. Around this median arrival rate there is less than a 50% chance of detecting, with statistical significance, a 30% post-1950 slowdown (slowdown factor of 0.7). 40 or 50% slowdown factors are likely to be detected even for war arrival rates well below the median rate observed in the Mars data. However, we are unlikely to detect 10 or 20 percent slowdowns even if we begin with an arrival rate of 1.5 wars per year, i.e., the rate recorded for wars of all sizes in the 19th century in the Mars data and never reached again. Thus, our failure to reject no-change hypotheses for KIA ranges bounded from below by values distinctly above the median KIA count[25] for all of the data constitutes, at most, weak evidence for no change within these relatively high ranges.[26] And remember that the point estimates tilt in favour of slowdowns even within these ranges.[27]

Figure 4

Figure 5 is constructed in the same way that figure 3 is but now we use KIA per 100,000 of world population rather than raw KIA numbers. Now the evidence for a post-1950 decline of war becomes very strong. Figure 5 shows that the bottom 2.5% of the prediction range exceeds the actual number of wars for every size range up to around 2.7 per 100,000 and above (3.9 and above) for the low (high) estimates of KIA. The corresponding cut-offs for the bottom 10% of the prediction ranges are around 10.1 and 8.8 for the low and high estimates respectively. The current world population is roughly 7.9 billion people, so these numbers translate into contemporary absolute war sizes between approximately 200,000 and 800,000 KIA. In short, once we adjust for world population, we can be very confident in a slowdown of war arrival rates even for ranges that begin at very large KIA counts.

Figure 5

Table 5 gives the results of a forward-looking robustness exercise that calculates the numbers of wars that would have to occur during the 20-year period since the last year covered in the Mars dataset to cause failure to reject the various no-change-of-arrival-rate hypotheses at the 0.05 level. For example, 4 wars with low estimates of KIA counts above the 3rd Quartile for the whole (present) dataset would tip the p value on the no-change hypothesis above 0.05 leading to a failure to reject at the 0.05 significance level. For orientation, there were 5 such wars between 1992 and 2011 (all before 1998). We judge it very unlikely that any of the numbers in Table 5 will be reached other than those ranged above the 3rd quartile for the low and high estimates of (raw) KIA. Indeed, the present war in Ukraine has, almost surely, breached these thresholds already (Lock 2022). Still, this is just one war; more very big wars would be needed in the next decade to prevent a statistically significant rejection of the no-change hypothesis even for wars above the 3rd quartile.

A weakness of the approach in this section is that, while it allows us to quantify the probability of detecting a change in the arrival rate of battle deaths, it does not in-and-of-itself allow us to quantify the probability of the decline of war thesis. We turn, therefore, to a Bayesian approach in the next section.

6. Bayesian Analysis Suggests that War went into Decline after 1950

We assume throughout this section that war arrivals in any KIA range follow a Poisson process with an unknown rate parameter that may differ for the periods 1800 - 1950 and 1951 - 2011. We then examine how prior information and 1951 - 2011 data combine to form posterior estimates for the unknown rate parameter.

There are two broad approaches we can employ to describe our prior information. First, we can incorporate just a bare minimum of information so as to provide maximum space for the data to speak for itself. In practice, this means setting the prior distribution over the rate parameter equal to a uniform distribution over a wide range. However, since we do not begin from a position of near ignorance this approach is not recommended (Stan Development Team 2020). Second, we can incorporate information from the pre-1950 history of wars, including their KIA totals and timings, into our prior distribution, e.g., by setting the mean of our prior distribution for the rate of post-1950 war arrivals within a particular size range equal to the pre-1950 arrival rate in this range. Alternatively, based on the qualitative and historical information presented in section 3, we might set the mean of our prior for the post-1950 arrival rate below the pre-1950 arrival rate. The spread of the prior distribution around the mean is an expression of our uncertainty about this parameter. This second approach of building information into our prior distribution is better suited to our problem than the first is. For the sake of completeness, we consider both approaches and a wide variety of informed priors.

Uniform and gamma distributed priors are sufficient to illuminate the transformation from beliefs about the post-1950 war arrival rate before seeing the post-1950 data to posterior beliefs about this quantity. This transformation in turn allows us to quantify how likely it is that there has been a decline in the arrival rate from before to after 1950. However, we expand our analysis in Appendix 3 with an R Shiny application (https://erniethecat.shinyapps.io/After_the_Hemoclysim_app/) that allows readers to explore their own alternatives. These include starting with a normal prior, varying the parameters on normal, gamma and uniform priors, considering different breaks in the time periods, i.e., not just pre and post 1950, and playing with different ranges and measures of war sizes.

Figure 6

All panels in figure 6 cover wars of all sizes as measured by the low estimate of KIA and were produced by the Shiny application[28]. The flat horizontal line in panel a shows a uniform prior between 0 and 3 while the dashed vertical line at 1.5 shows the mean for this prior. The vertical lines near 1.35 and 0.8 show, respectively, the mean pre-1950 and post-1950 war arrival rates. The bell-shaped curve shows the posterior distribution of the post-1950 arrival rate which is centred around the empirical post-1950 rate and is well to the left of the pre-1950 rate despite the prior's mean. The lack of influence of this prior is why the uniform is considered uninformative and is recommended against in practice. Panel b begins, instead, with a gamma-distributed prior with mean also equal to the pre-1950 war-arrival rate. The posterior, with a 50% credible interval shown, is again well to the left of the pre-1950 arrival rate but is also well to the right of the post-1950 arrival rate. Indeed, the mean pre-1950 rate exceeds 99% of the posterior rates and the probability that a random draw from the posterior is smaller than a random draw from the prior is 0.91. Panel c is constructed just like panel b except that the mean of the prior is set equal to the war-arrival rate for 1900 – 1950 (1.04) rather than for 1800 – 1950. The evidence for decline, now from a lower baseline, is weaker than it is in panel b. The prior mean still exceeds 94% of the posterior distribution, although the probability that a random draw from the posterior is smaller than that from the prior is now just 79%. Figure 6 displays just three possibilities but the R Shiny app that we link to in the appendix supports the exploration of countless additional scenarios.

Figure 7 explores how the exclusion of wars below various minimum KIA thresholds, S, for high or low estimates of KIA and for raw or population-adjusted values, influences the posterior arrival rates. Each point on a curve shows a probability that a draw from a posterior is less than a draw from a gamma prior, including the cases when the actual prior is uniform.[29] In short, these are probabilities of post-1950 declines in war-arrival rates within the corresponding size ranges.

Figure 7

Figure 7 is organised by the type of KIA estimate which can be either a low estimate or a high estimate and either a raw KIA count or KIA per 100,000. There are also separate panels for the cases of informed priors based on the period 1800 to 1950 or the period 1900 to 1950. Values above 0.50 on the y-axis favour decline of war while values below 0.50 lean against decline. As already seen in section 5, our statistical power decreases as we move toward higher size ranges and the dashed lines help us track this phenomenon by showing the fraction of wars that exceed each size.[30] The fact that sample size is decreasing in war sizes helps to explain why the curves based on the uniform distribution begin above the gamma-based curves but then draw even or below: the latter curves are based only on 61 years of data whereas the former ones use all the data. Thus, at the highest end for war sizes there is almost no data for the uniform to use, while the gamma can fall back on the prior data.

Figure 7 displays broadly consistent patterns. Posteriors for the post-1950 period generally favour the decline-of-war thesis although they leave room for doubt, particularly in the high KIA ranges. Evidence of decline is (necessarily) stronger for the population-adjusted figures than it is for the raw figures. The plots strongly favour decline when we include small wars, e.g., when the bottom of our range begins below 3,000 for raw KIA or below 0.3 for KIA per 100,000. However, the story grows gradually more ambiguous as we exclude more and more small wars, with the raw KIA curves dipping below 50% more quickly than those for KIA per 100,000. Evidence for decline is stronger for priors based on 1800 – 1950 than they are for priors based on 1900 – 1950 when arrival rates for wars of all or most sizes are considered, i.e., in the left sides of the graphs. However, the reverse is true when we restrict attention to just the larger wars, i.e., when we look at the right sides of the graphs. These findings make intuitive sense considering the facts that the 19th century had the highest overall war arrival rate whereas the first half of the 20^{th} century saw several of the very biggest wars of the whole period under consideration. Finally, there is some sensitivity to the choice of high or low estimates of KIA, especially for S > 30,000 KIA and S > 10 KIA per 100,000, where the evidence becomes ambiguous and can even lean against decline.

7. Conclusion

In this paper we build on several evidence streams. First is the qualitative historical record, summarized in section 3, that points to 1950 as a key turning point in the Cold War. Second is what might be called the “Long Peace School”, beginning with (Gaddis 1986) and surveyed in section 1, that identifies declining trends in a variety of post-World War II violence indicators and proposes explanations based on, *inter alia*, political, institutional and cultural factors. Third is a very recent quantitative literature that begins with the fat-tail property of the distribution of war sizes and the consequent possibility that at least some of the declining trends identified by this Long Peace School can be consistent with an unchanged underlying war-generation mechanism. However, this quantitative work is based ultimately on the highly flawed COW data.

The new Mars data provides a high-quality alternative to COW Inter-State and the main contribution of our paper is to introduce it into the decline of war debate and use it to analyse the relationship between arrival rates and war sizes within the data. The exploratory analysis of the Mars data in section 4 points towards a post-1950 slowdown in war arrival rates while exposing the strong tendency of COW Inter-State to underplay 19th century war violence. The more formal analysis of the next two sections, presented in both NHST (section 5) and Bayesian (section 6) frameworks, strongly supports the post-1950-slowdown idea. When we use all the data, i.e., when we consider the arrival rates of wars of all sizes, the evidence for a post-1950 slowdown in conventional war is overwhelming. Even when we restrict attention to wars with raw KIA counts above the first quartile (above the median) for all wars between 1800 and 2011 the evidence for a post 1950 slowdown remains very strong (strong). We do not find good evidence of a slowdown in war arrival rates with KIA counts above the 3rd quartile, but a power analysis reveals that this should come as no surprise since we have little ability to detect such changes even if they exist.[31] A robustness exercise shows that new data through 2031 is unlikely to reverse any of the above results, except possibly for those covering the range above the 3rd quantile. KIA counts for the recent war in Ukraine are almost surely already (in March of 2023) in the 4th quartile for all conventional wars since 1800 but this is just one war which cannot, on its own, reverse the patterns we have identified in this paper.

When we measure war sizes in population-adjusted, rather than absolute, terms then the evidence for a post-1950 slowdown remains strong even for ranges that are bounded from below by very high values of KIA per 100,000 or world population. If we convert these values into raw KIA counts using contemporary populations then these lower bounds, above which there is strong evidence of slowdown, are well into the 100's of thousands. Of course, one can always pick a range with a lower bound high enough so that the evidence against the no-change hypothesis is weak: this is just a matter of reducing the sample size sufficiently with a large enough choice of lower bound. But we found no positive evidence in favour of a no-change hypothesis for these very high ranges.

Our Bayesian analysis allows us to derive probability distributions over the post-1950 arrival rates of wars in all size ranges. Regardless of the prior and KIA metric, the probabilities of decline are generally quite high, falling into ambiguity only when we focus exclusively on large wars (above the 3rd quartile) over the full dataset. When we base the prior only on data from the tremendously bellicose first half of the 20th century then the evidence continues to favour the decline-of-war thesis even for war-size ranges bounded from below by very large KIA numbers. On the other hand, when we base the prior on 1800 – 1950 the evidence for the decline of wars of all, or almost all, sizes becomes extremely strong. Of course, one could "stack the deck" for no change by choosing priors stronger than those we have considered that concentrate large probability mass near or above the pre-1950s rates. However, such priors could only be convincing if they were based on, e.g., a historical analysis that points strongly toward no change. They could not be justified based only on the Mars data nor would the material surveyed in section 3 support such a prior. Nevertheless, a distinct advantage of the Bayesian approach is that anyone can experiment with their own priors, size ranges and measures and discover how these translate into posteriors. We enable such experimentation through the Shiny application that we provide in appendix 3.

The above analysis focuses on comparing 1800 – 1950 with 1951 – 2011. The findings are of intrinsic historical interest as they illuminate the dynamics of warfare.

They have potential policy relevance as well by suggesting that at least some of the policy measures undertaken in recent decades by the international community to reduce the scourge of conventional war may have helped and should be continued and extended. Regarding the future, we must bear in mind that the slowdown we have identified could be, or might already have been, reversed due to some big change in the world such as global warming or the war in Ukraine. Nevertheless, the recent past is usually a good starting point for predicting the future and we would cautiously venture the prediction that the warfare experience of the next few decades will resemble1951 – 2011 more than 1800 – 1950.

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Figure 1 - Three Views of the Mars KIA Counts for all Wars

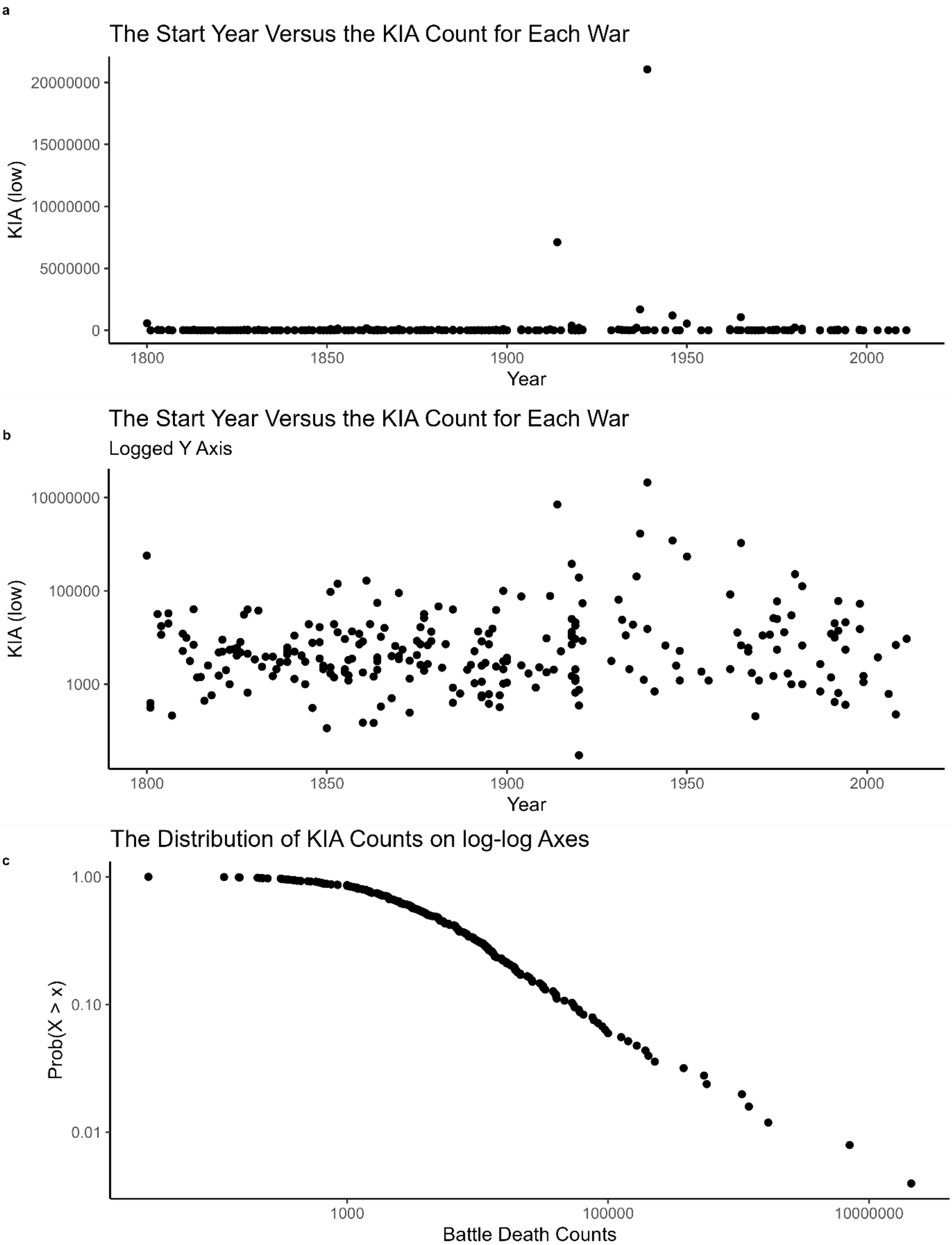
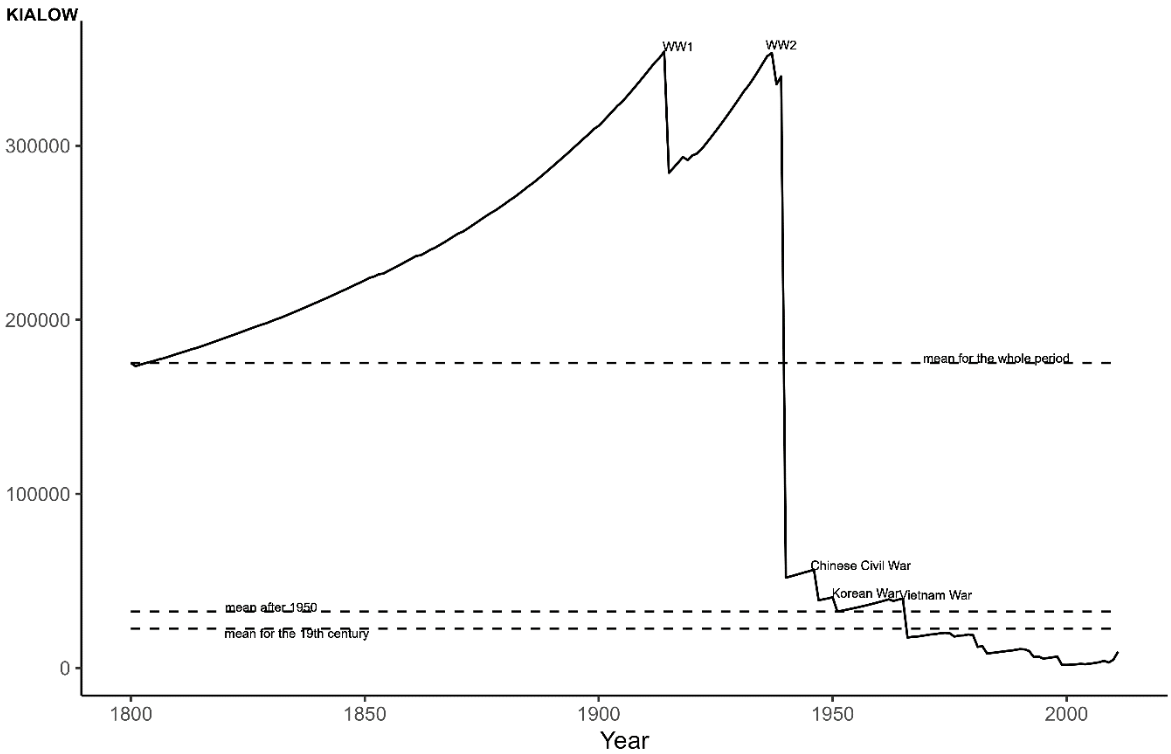


Figure 2 - Annualized Averages for Killed in Action from each Year Forward to 2011



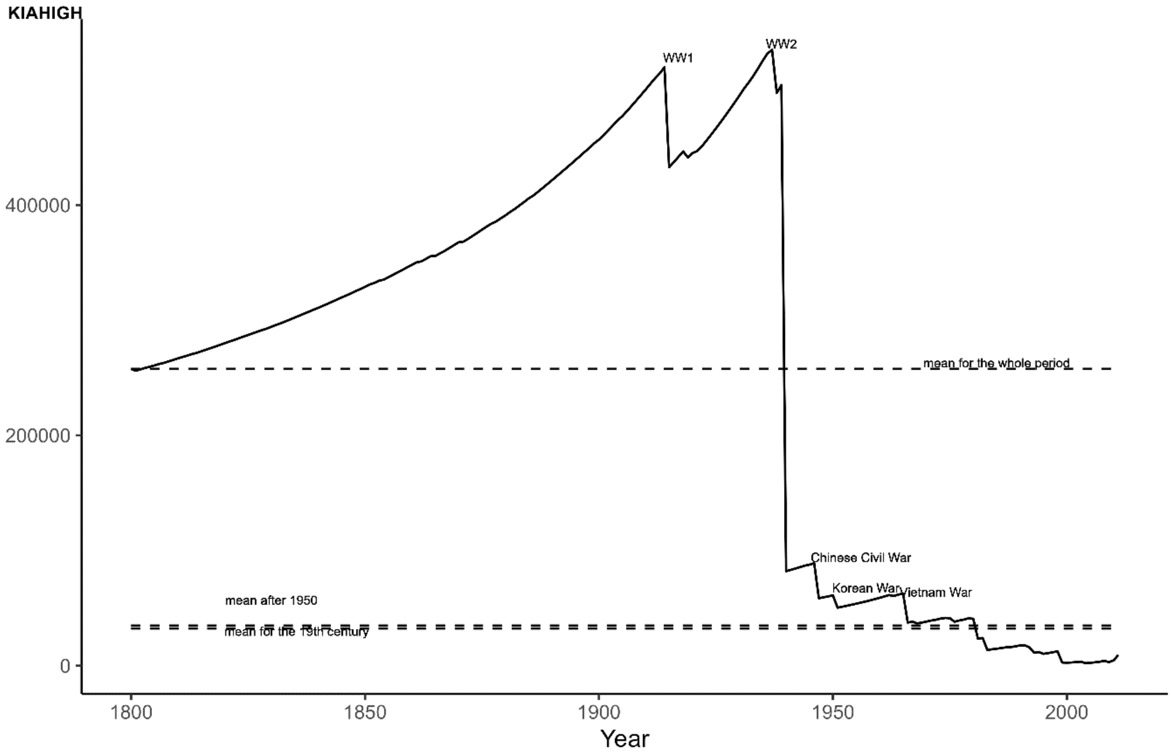


Figure 3 - Pre-1950 War Patterns Predict more Post-1950 Wars of all Sizes than Actual

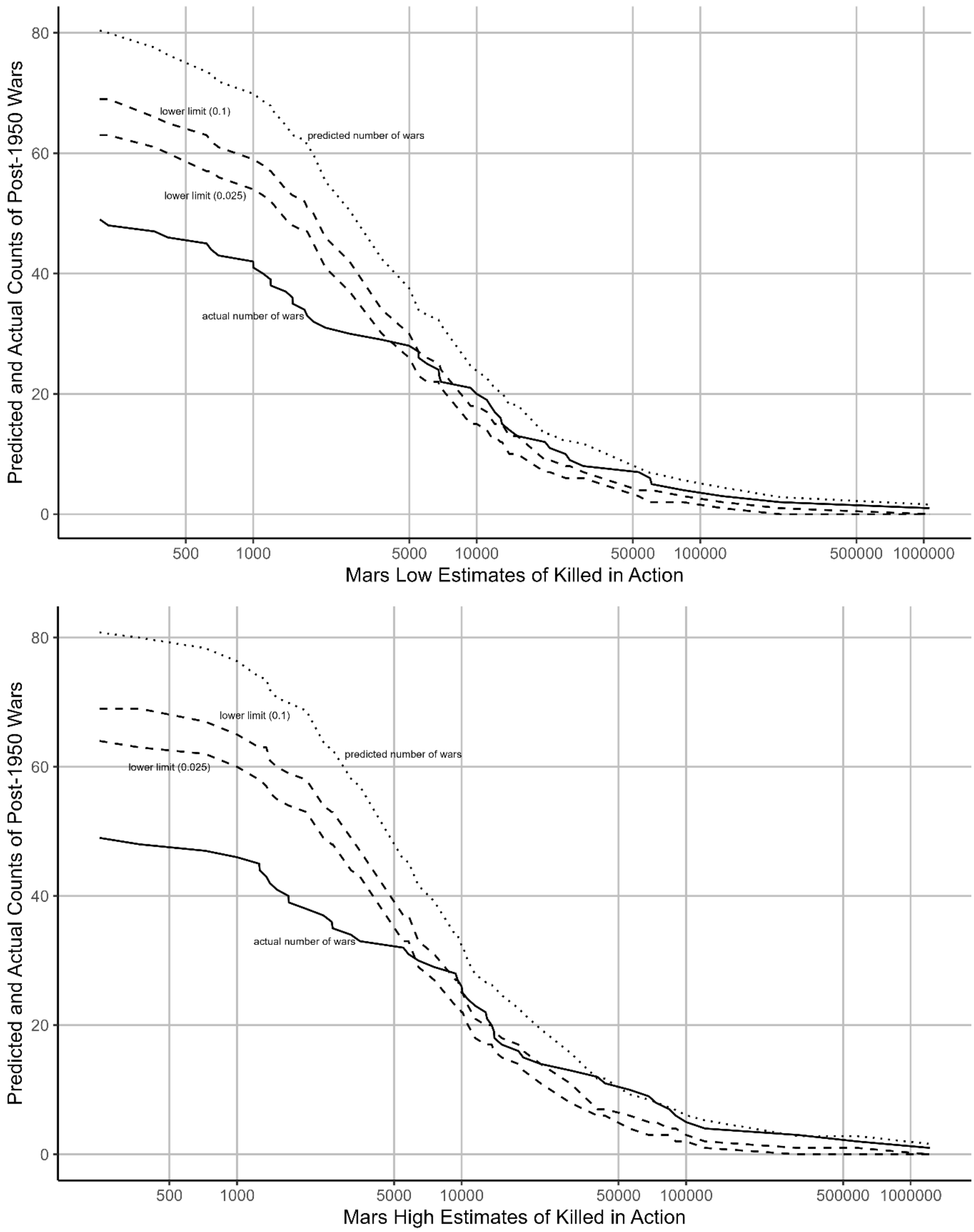


Figure 4 - The Tests Have Low Power for Detecting Slowdowns

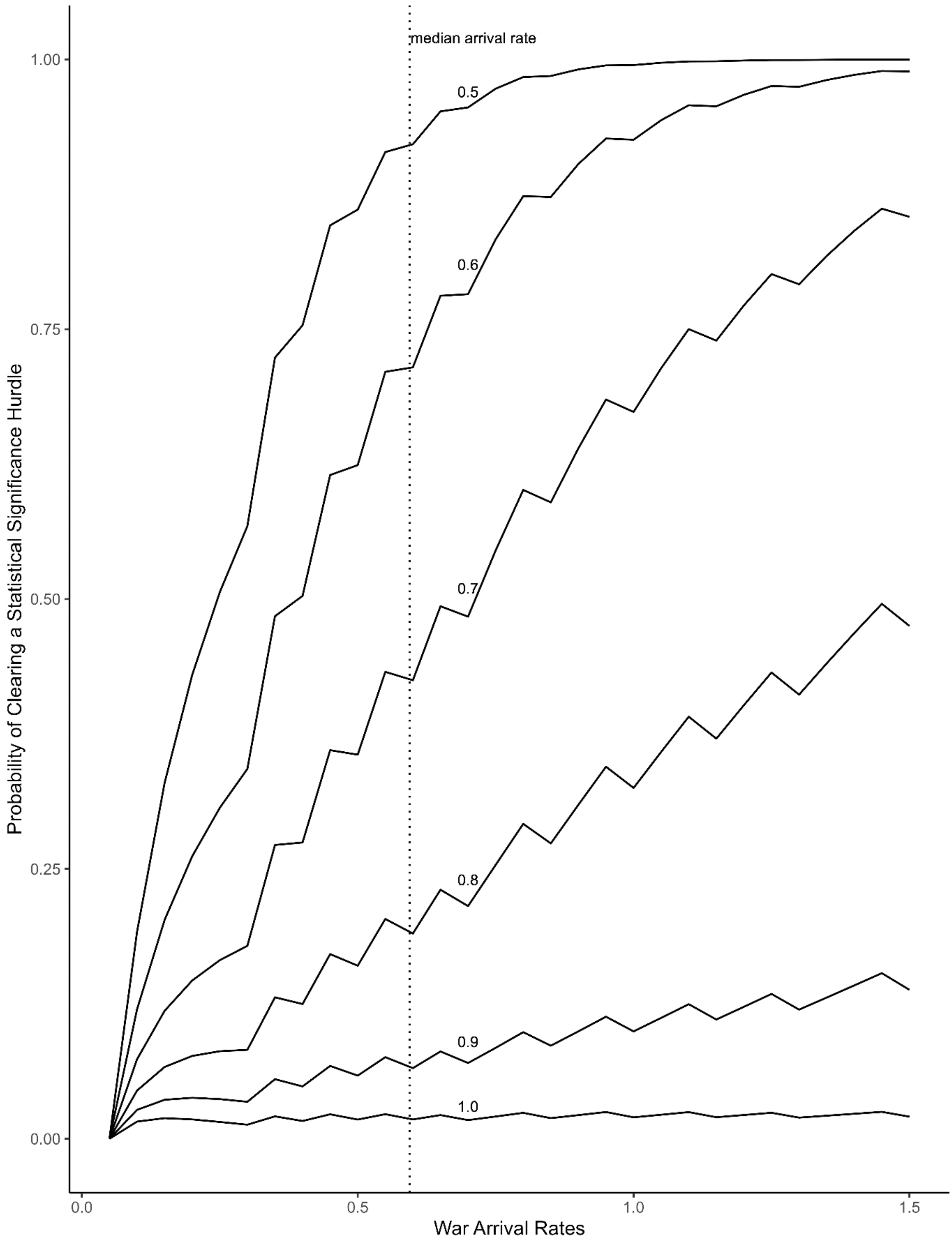


Figure 5 - Pre-1950 War Patterns Predict more Post-1950 Wars of all Sizes than Actually Happen

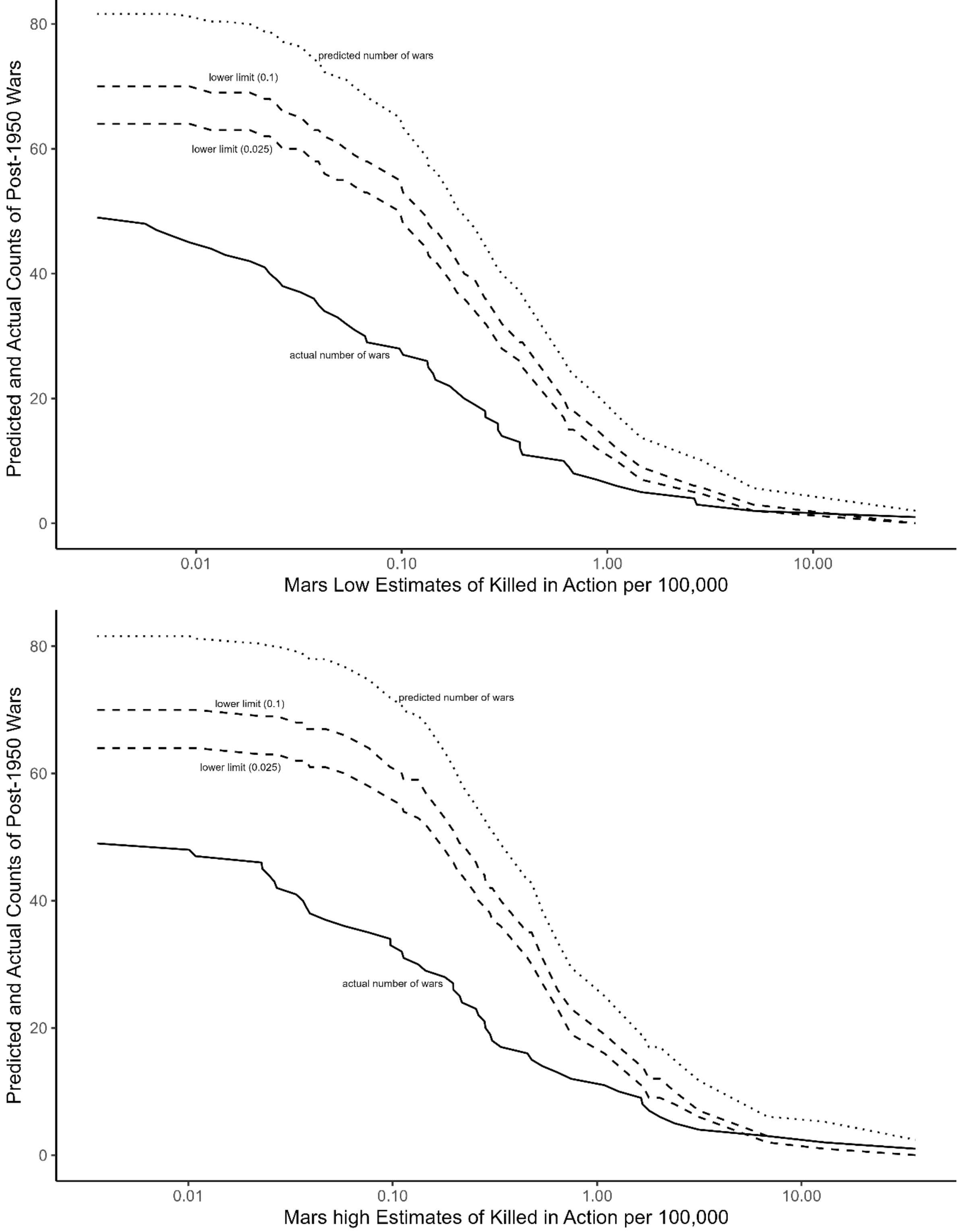


Figure 6

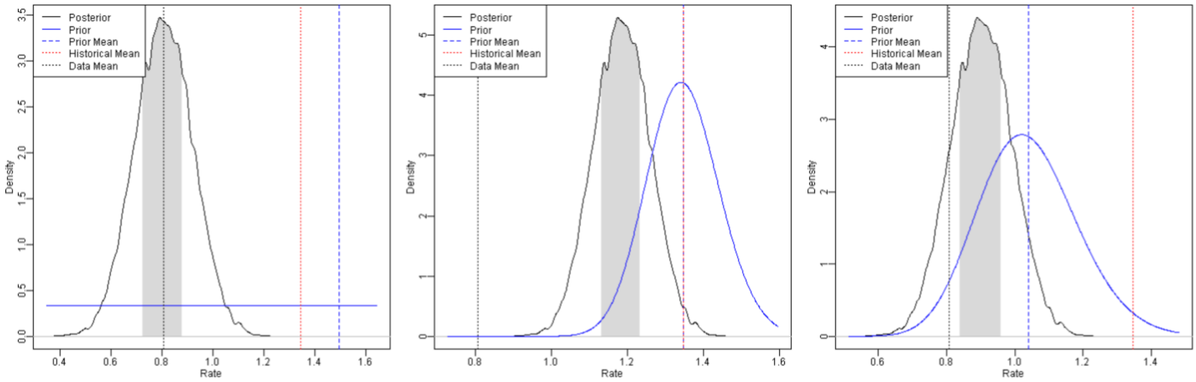

Posterior
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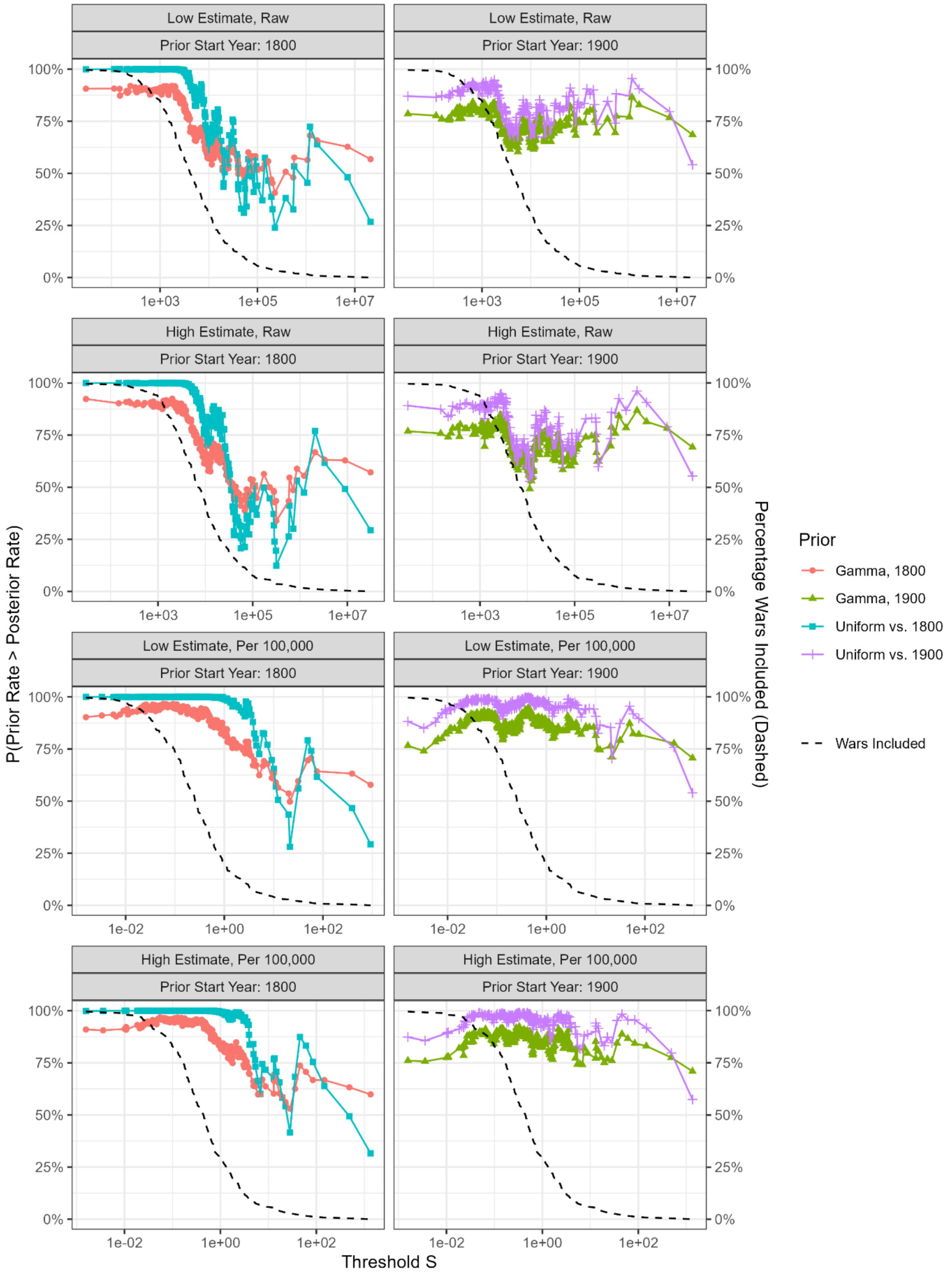
Figure 7



Low Estimate, Raw
Prior Start Year: 1800
Prior Start Year: 1900
High Estimate, Raw
Low Estimate, Per 100,000
High Estimate, Per 100,000
100%
75%
50%
25%
0%
1e+03
1e+05
1e+07
1e-02
1e+00
1e+02
P(Prior Rate > Posterior Rate)
Percentage Wars Included (Dashed)
Threshold S
Prior
Gamma, 1800
Gamma, 1900
Uniform vs. 1800
Uniform vs. 1900
Wars Included

Table 1 - Killed in Action and Number of Wars Per Annum for Three Time Periods

Periods	Low[1]	High[2]	Low per 100,000[3]	High per 100,000[4]	Number of Wars
1800-1899	22,667	34,812	1.9	2.8	1.5
1900-1950	645,281	942,821	29.9	43.3	1.0
1951-2011	32,372	50,403	0.9	1.3	0.8

[1] Using the low estimates of killed in action
[2] Using the high estimates of killed in action
[3] Using the low estimates of killed in action per 100,000 of world population
[4] Using the high estimates of killed in action per 100,000 of world population
Data: Project Mars

Table 2 - Battle Deaths and Number of Wars Per Annum for Various Time Periods

Periods	Battle Deaths	Battle Deaths per 100,000	Number of Wars
1800-1899	14,000	1.0	0.3
1900-1950	550,112	26.0	0.6
1951-2011	43,035	1.1	0.6

Data: Correlates of War

Table 3 - The Twenty Biggest Wars Excluded from CoW

Ordered by the low estimates of Killed in Action

War Name	kialow	kiahigh	Start Year	End Year
Chinese Civil War	1,200,000	2,071,610	1946	1949
Napoleonic Wars	570,328	598,225	1800	1815
Russian Civil War	379,483	858,742	1918	1921
Spanish Civil War	203,839	288,150	1936	1939
Warlord Era: Anhui-Zhili War	193,400	280,300	1920	1930
American Civil War	166,040	229,000	1861	1865
Tigrean and Eritrean War	126,000	315,000	1982	1991
Thousand Days' War	100,000	100,000	1899	1902
Taiping Rebellion	95,000	111,000	1851	1864
North Yemen Civil War	84,000	100,000	1962	1969
Battle of Shanghai	64,770	74,870	1931	1932
Angolan Civil War	59,650	68,135	1975	2002
Rif War	54,370	70,000	1921	1926
First Mahdi War	46,349	56,461	1881	1885
Durrani Empire-Sikh War	40,400	56,900	1813	1823
Ethiopian-Mahdi War	40,000	75,000	1885	1889
November Uprising	37,900	37,900	1831	1831
Second Maratha War	31,868	39,696	1803	1805
Vientiane-Siam War	31,000	31,000	1827	1827
Satsuma Rebellion	26,300	26,300	1877	1877

Data: Project Mars and CoW

Table 4 - Summary Statistics for the Distributions of KIA Counts

Various KIA Measures and Time Periods

	Minimum	Quartile 1	Median	Quartile 3	Maximum	Mean
Low Estimate of Killed in Action						
1800-2011	30	1,539	4,178	13,123	21,058,659	147,424
1800-1950	30	1,742	4,000	12,138	21,058,659	173,281
1951-2011	206	1,200	5,750	15,200	228,220	19,139
High Estimate of Killed in Action						
1800-2011	30	2,734	7,298	20,182	30,859,974	216,824
1800-1950	30	2,900	6,475	19,801	30,859,974	254,015
1951-2011	244	1,700	10,386	30,442	578,000	41,053
Low Estimate of Killed in Action per 100,000						
1800-2011	0.002	0.096	0.259	0.733	921.281	6.991
1800-1950	0.002	0.116	0.289	0.879	921.281	8.422
1951-2011	0.003	0.025	0.134	0.307	5.116	0.409
High Estimate of Killed in Action per 100,000						
1800-2011	0.002	0.165	0.445	1.321	1,350.072	10.187
1800-1950	0.002	0.194	0.494	1.435	1,350.072	12.262
1951-2011	0.004	0.038	0.205	0.641	12.958	0.897

Data: Project Mars. There are 203 wars before and 49 wars after 1950.

Table 5 - Numbers of Wars between 2012 and 2031 Required for Non-Rejection of No-Change Hypotheses

Various KIA Measures and Time Periods

	Ranges		
Measures	Above Quartile 1	Above the Median	Above Quartile 3
Low Estimates of KIA	34	13	4
High Estimates of KIA	34	11	4
Low Estimates of KIA per 100,000	43	31	14
High Estimates of KIA per 100,000	43	31	11

Each table entry gives the number of wars required to push the p value on the corresponding no-change hypothesis above 0.05. For example, if there are 34 wars between 2012 and 2031 with low estimates of KIA counts above the 1st quartile of KIA counts for 1800-2011 then we would (just) fail to reject the no-change hypothesis for wars in this size range. Data: Project Mars

Endnotes

[1] We would like to thank Ian Horwood, Jason Lyall, Niall Mackay, Steven Pinker and participants at seminars at RHUL for helpful comments although the authors bear full responsibility for the content of this paper.

[2] (Chamberlin 2018) argues that this focus on great power conflict has obscured the proxy wars these powers sponsored throughout the Cold War. We agree but argue below that Chamberlin's observation is even more true of the 19th century than it is of the Cold War.

[3] Note, however, the post-World War 2 decline in battle deaths is not monotonic.

[4] (Pinker 2012) does consider European war all the way back to 1400 but finds ups and downs over the subsequent seven centuries: "The career of organized violence in Europe, then, looks something like this. There was a low but steady baseline of conflicts from 1400 to 1600, followed by the bloodbath of the Wars of Religion, a bumpy decline through 1775 followed by the French troubles, a noticeable lull in the middle and late 19th Century, and then, after the 20th- century Hemoclysm, the unprecedented ground- hugging levels of the Long Peace."

[5] Hereafter, we set aside Cirillo and Taleb (2016), as their dataset is not publicly available, and their analysis explicitly does not consider change points or time series analysis. They eschew the latter based on an assumption of geospatial independence which, although potentially valid, is not obviously satisfied while change point analysis is a common tool for identifying possible changes in the statistical properties of sequential independent samples.

[6] They both use the Inter-State War data of the Correlates of War project (Sarkees and Wayman 2010).

[7] COW Inter-State dataset is used extensively in the quantitative IR field with (Clauset 2018) and (Braumoeller 2019) relying on it exclusively and heavily, respectively. Different issues would arise for other COW datasets, but we confine our critique to the data they use rather than to data they might have used.

[8] After their founding, recognition by the League of Nations and, later, the UN became another pathway into the COW Inter-State dataset. However, there are inconsistencies in the coding that make it hard to understand (K. Gleditsch et al. 2004).

[9] We treated the Ottoman Empire as part of Europe for this calculation.

[10] (Lybeck 2010) argues that a Eurocentric perspective gave rise to a myth of a peaceful 19th century. During this period Europeans did indeed curtail their fighting with one another within Europe but, on the other hand, they were also highly active and aggressive outside of Europe. (Chamberlin 2018) makes a similar critique of the post-1945 Long Peace thesis, arguing that the superpowers merely deflected the violent aspect of their competition to poor countries. This is true but it is even more true of the 19th century.

[11] These wars, all international to various degrees despite their names, are included in the COW Intra-State dataset. However, (Clauset 2018), (Braumoeller 2019) and much of the IR field does not use this dataset so, as noted above, we focus on just the Inter-State data.

[12] (Lacina, Gleditsch, and Russett 2006) devote a section of their paper to exposing anomalies in COW's battle death coding and (Lacina 2009) covers this issue exhaustively for the post-1945 period.

[13] Some analyses of the latter set of authors use the dataset described in (K. Gleditsch et al. 2004) which merges all COW datasets, uses their battle-death numbers and then adds in some further wars to address some of the colonialism-driven omissions described above. This dataset was a step forward from COW, but it still inherits the COW-based incompatibilities that mix battle deaths with excess deaths.

[14] The Mars data improves upon, while not eliminating, the inclusion threshold issue by setting a lower threshold of 500 KIA. Note that Mars also includes a handful of cases for which KIA is coded below 500 either because the high estimate of KIA is above 500 or because killings plus injuries are so high in these cases that the Mars team judged that KIA must have been well above 500 even though were unable to specifically identify more than 500 KIA.

[15] Similarly, declines in maternal mortality rates in recent decades can be explained largely by improvements in technology and organization but this explanation does not negate the fact that there has truly been a decline.

[16] The Taiping Rebellion is absent from COW Inter-State although it appears in COW Non-State with unknown battle deaths and COW Intra-State with approximately quarter of a million battle deaths.

[17] In our quantitative work we date wars by their start year so "post-1950" equates roughly to "after the Korean War" even though this war did not end until 1953.

[18] See Jervis' review of Wells' book (Jervis 2021). (Wells 2019) adds his contention that, contrary to his earlier view, the US was correct to fear the worst about the Soviet military build-up.

[19] (Lyall 2020) codes a range of 543,936 to 718,099 battle deaths for the Korean War and, of course, battle deaths are only part of the full cost of the war.

[20] See any narrative history of the Korean War such as (Hastings 2012).

[21] The last digit of the exponent is lowered in the original text "bring[ing] out their substantial agreement and indicat[ing] their uncertainty" (Richardson 1960, page 7).

[22] The same graphs for the high estimates are visually indistinguishable from figure 1.

[23] We ran discrete, one-sample, Kolmogorov-Smirnov (KS) tests of the hypothesis that war arrival rates follow a Poisson process for the periods 1800 – 2011, 1800 – 1950 and 1951 to 2011 using the iZID package in R (Wang, Aldirawi, and Yang 2019) and obtained p values, respectively, of 0.39, 0.85 and 0.31. This suggests that it is reasonable to model the war arrival process as following a Poisson distribution.

[24] We ran the procedure in reverse by considering the range below, rather than above, each KIA count. Now we can reject at the 2.5% level any no-change hypothesis for wars with low estimates of KIA counts between 0 and S if S is bigger than 2,700. For the high estimates of KIA the same is true for any S bigger than 5,500. These findings are consistent with our contention that failure to reject no-change hypotheses occurs mainly because of low sample sizes rather than the types of wars under consideration.

[25] Recall that higher KIA counts are associated with lower arrival rates.

[26] On the positive side, the curve for a slowdown factor of 1.0, i.e., no slowdown, shows that the probability of falsely "detecting" a slowdown, i.e., a false positive, is negligible.

[27] The non-monotonicity of the graphs is puzzling at first glance. This happens because the tests are binary ("reject" or "fail to reject") and the number of wars must be an integer. Thus, there will be e.g., an arrival rate for which rejection of the no-change hypothesis requires 2 or fewer wars and such that slightly raising the arrival rate slightly does not change the requirement of 2 or fewer wars. The rejection probability is decreasing in the arrival rate within this range.

[28] We apply a quadratic approximation using the slim version of Richard McElreath's rethinking package. In each case we use the same random seed (1) for reproducibility. The probability that a random draw from the posterior is smaller than a draw from the prior is conducted using 10,000 random draws. The fixed random seed is what causes the distinctive sampling humps in the posterior distribution across all three images. These images were generated using the R Shiny application linked to in appendix 3.

[29] A comparison with a uniform distribution would not be rooted in the actual data and would, instead, make simultaneous comparisons with extremely ahistorical 'histories' where almost no wars happened, or where, *on average*, 3 or more wars happen per year.

[30] Posterior estimates can be improved by increasing the number of samples drawn from the posterior, or by repeatedly drawing samples from the posterior to calculate intervals.

[31] Remember that higher lower bounds for KIA counts imply smaller sample sizes which compromise our ability to detect slowdowns that might truly have occurred.