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Diabolus Ex Machina? A Comparative Case Study to Test Whether Automatic Weapons Can Disproportionately Benefit Irregular Forces

Harrison Durland

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Harrison Durland
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Bachelor of Arts degree in International Studies
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University of Mississippi

Advisor: Dr. Benjamin Jones

Second Reader: Dr. William Schenck

Third Reader: Dr. Susan Allen

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Abstract

Researchers in the field of irregular conflict have observed that irregular forces such as insurgents and guerrillas have been victorious or forced draws in a greater percentage of conflicts over the past century compared with the century prior. More generally, researchers and practitioners have sought to better understand why seemingly weaker, irregular forces are able to win some wars against enemies who have significant material and other conventional advantages. This thesis engages with some of the literature in this field and focuses on what appears to be a particularly understudied issue: the potential role of shifts/innovations in military technology. Specifically, this study argues that machine guns can enhance the military effectiveness of irregular forces on balance even when both sides have access to/use machine guns. Due to the lack of data necessary for a large-N/statistical study of machine guns' correlation with irregular conflict outcomes, this thesis relies on a comparison between periods of the Second Boer War and the German East Africa Campaign of WWI. This comparative case study offers limited, slightly mixed, but overall positive support for the hypothesis with regards to these cases. Although the findings do not directly mean that machine guns have played a non-trivial role in the observed pattern of irregular conflict outcomes, the findings bolster the plausibility of this claim and suggest that more research is warranted.

Introduction and Overview

The past two centuries have brought an enormous degree of technological innovation and development in many fields, not least of which is military technology. Partially as a result of this, major powers such as the United States enjoy significant material advantages (e.g., technological sophistication and quantity) over many smaller and weaker actors in the realm of conventional warfare—especially against non-state actors such as insurgents. Despite these disadvantages, however, weaker actors such as insurgents and guerrilla forces have not just managed to achieve some success, they have actually won or forced draws in a much greater percentage of conflicts over the past 100 years compared with the 100 years prior, representing an important puzzle in conflict outcome research.[1]

The existing research has focused on a variety of explanations such as increasing casualty aversion among counterinsurgent (COIN) forces and the effectiveness of irregular tactics and strategies in general (e.g., avoiding decisive battles, relying on surprise attacks). Many of these explanations seem to address large parts of the puzzle, offering valuable insights in understanding the outcome trends. However, very little scholarship in this field has examined the potential effects of the major innovations in military technology that rose to prominence around WWI—around the same time that insurgent success rates began to increase. This lack of literature is particularly strange given the existence of concepts/theories for conventional war[2] which hold that the technological shifts leading up to and following WWI have increased the

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[1] Jason Lyall and Isaiah Wilson, "Rage Against the Machines: Explaining Outcomes in Counterinsurgency Wars," *International Organization* 63, no. 01 (January 2009): 67, https://doi.org/10.1017/s0020818309090031;
Ivan Arreguín-Toft, "How the Weak Win Wars: A Theory of Asymmetric Conflict," *International Security* 26, no. 1 (July 2001): 93–128, https://doi.org/10.1162/016228801753212868;

[2] As I argue/illustrate in this thesis, the fact that these concepts/theories were primarily developed through/applied to the study of conventional war does not make them irrelevant to irregular conflict.

importance of tactical choices (e.g., use of cover, concealment, dispersion) while reducing the significance of material disparities.[3] One of the only studies that does focus on such technological shifts argues that increased *COIN reliance* on mechanization (e.g., motorized and armored vehicles) since WWI has *worsened* COIN effectiveness.[4] However, this thesis focuses on a different technological innovation—one which mechanization/armor is often credited as effectively countering: fully automatic weapons such as machine guns.

Specifically, the hypothesis of this thesis holds that the increase in irregular forces' (e.g., insurgents', guerrillas') access to/usage of "man-portable, fully-automatic weapons" ("PAWs") should tend to increase their "military effectiveness" (battle-death exchange ratio and achievement of tactical goals) *even when regular forces' access to/usage of PAWs similarly increases*, with all else being equal.[5] I argue that this should occur as a result of PAWs increasing the effectiveness of tactics (e.g., ambushes) that irregulars rely on to reduce the *impact/significance* of material disparities in battle, while not uniquely benefiting regular forces' tactics (e.g., static defenses) enough to offset the advantages offered to irregular forces. In this way, I argue that PAWs can serve as "equalizers"—a term with many potential interpretations but which I just use in this thesis to refer to technology which disproportionately/asymmetrically enhances the effectiveness of the materially weaker/irregular force even when both sides have access to the technology.[6]

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[3] As further discussed later, see: Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton University Press, 2004).
[4] Lyall and Wilson ("Rage Against the Machines…"), as described later.
[5] There are a few caveats here that are described in more detail later, such as the somewhat-implied condition that the irregular forces are actually using irregular tactics and strategies.
[6] Notably, under this definition a technology may still be an "equalizer" even if it does not actually cause both sides to become "equal"; it just requires that the technology provide disproportionate benefits for the weaker/irregular side.

After discussing the literature on the empirical puzzle of insurgent/irregular conflict outcome trends (including the lack of literature on the possible role of technological shifts) and describing my theoretical argument in more detail, I test the hypothesis through a comparative case study. Specifically, I compare the 1901-1902 guerrilla phase of the Second Boer War (Anglo-Boer War or simply "the Boer War"), during which machine gun access/usage was rather low, to the 1917-1918 guerrilla phase of the German East Africa Campaign (GEAC), during which machine gun access/usage was much higher. In summary, the findings of the *quantitative* analysis do not offer clear evidence for or against the thesis (due to control variable variations), but the combination of the *qualitative* and quantitative analyses provides limited, mixed, but net-positive evidence for the hypothesis. As discussed throughout this thesis, such findings do not necessarily mean that PAWs played a significant role in the shift in insurgent/irregular outcome trends over the past century, but they do provide reason to suspect that some technologies had a non-trivial role in this shift. Thus, the findings suggest that some technological shifts likely warrant more attention in the form of empirical testing to assess whether or to what extent they affected irregular conflict trends.

Chapter I: Literature Review

This literature review seeks to cover four main points. First, it *briefly* notes the empirical puzzles regarding insurgent/irregular success in general and particularly in the last century. Second, it provides an overview of the main explanations that have been offered/identified by the existing research in response to these puzzles, and then provides reasoning for further research (especially in light of the arguments/findings of this thesis). Third, this review highlights the surprising lack of almost any scholarly attention to either the specific hypothesis tested in this thesis (regarding PAWs) or even the broader concept/notion that some technologies have served as military "equalizers" in irregular conflict—despite the existence of multiple conceptually similar or related theories/debates. Finally, this review briefly responds to the little existing literature that seems to dismiss/challenge the notion that shifts in access to technology could be partially responsible for the observed trends in irregular success.

Explaining Insurgent Success and Outcome Trends

A sizable amount of research exists regarding various aspects of asymmetric conflicts, such as their initiation and outcomes. In recent decades, the literature has particularly highlighted an apparent trend in outcomes: weaker actors such as insurgents and other non-state actors seem to be winning or forcing draws in an increasing percentage of conflicts since the early 1900s, especially compared to the 1800s.[7] Even prior to the emphasis on this puzzling and significant observation, researchers and practitioners have sought to understand "how the weak win wars"

[7] Lyall and Wilson, "Rage Against the Machines…";
Ivan Arreguín-Toft, "How the Weak Win Wars…"

against foes that supposedly should dominate them according to most measures of conventional military power.[8] The literature frequently highlights a few researchers and arguments.[9]

Strategies, Tactics, and Force Employment

In his influential article "How the Weak Win Wars: A Theory of Asymmetric Conflict," Ivan Arreguin-Toft argues based on empirical data and case studies that "strategic interaction" is a crucial factor in explaining the shift in the weak's victory trends.[10] More specifically, he argues among other things that weaker actors benefit from using an "indirect" (irregular/guerrilla) strategy when the stronger side uses a "direct" (conventional) strategy.

Aside from Arreguin-Toft, plenty of other authors have highlighted the importance of strategic and tactical choices. Samuel Huntington, David Galula, and Colin Gray, for example, all emphasize that in guerrilla warfare the weaker side attempts to avoid open confrontations and otherwise tries to pick its battles.[11] Such sentiment is widely echoed by other authors discussed further in.[12] One article by Jason Lyall and Isaiah Wilson, however, particularly stands out for suggesting a causal link between the shifts in outcome patterns and the rise of mechanization in counterinsurgency. They argue that COIN mechanization (such as tanks/armor and other

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[8] For example, Mack's influential article "Why Big Nations Lose Small Wars: The Politics of Asymmetric Conflict" was published in 1975. Citation: Mack, Andrew. "Why Big Nations Lose Small Wars: The Politics of Asymmetric Conflict." *World Politics* 27, no. 02 (January 1975): 175–200. https://doi.org/10.2307/2009880.

[9] One review of the literature which covers some similar issues can be found on p. 17 of Noriyuki Katagiri, *Adapting to Win: How Insurgents Fight and Defeat Foreign States in War* (De Gruyter, 2015), https://ebookcentral.proquest.com/lib/olemiss/reader.action?docID=3442447&ppg=1.

[10] Arreguín-Toft, "How the Weak Win Wars."

[11] Huntington is quoted on p. 7 of *Adapting to Win…*;
David Galula, *Counterinsurgency Warfare: Theory and Practice* (New York: Praeger Publishers, , C, 2006);
Colin Gray is quoted in chapter 1 of Jeffrey Record, *Beating Goliath: Why Insurgencies Win* (Washington, Dc.: Potomac, 2009), https://muse.jhu.edu/chapter/1151411/pdf.

[12] See Paul Brooker, *Modern Stateless Warfare*, p. 29: "The only solution to the problem was to adopt strategies that allowed insurgents to exploit their traditional advantage of being a hidden enemy who is 'everywhere and nowhere'. This is what the pressure, propaganda and provocation strategies allowed an insurgency to do; they were potentially stealthy strategies that were especially well-suited to camouflaging and disguising the insurgent band in an urban environment incorporating perhaps millions of other human beings." Paul Brooker, *Modern Stateless Warfare* (Basingstoke: Palgrave Macmillan, 2010).

motorized vehicles) is a major cause of COIN's increasing rates of failure, as it has led to isolation from the populace which contributes to "information starvation" and alienation, among other issues.[13] Many of these authors who argue the importance of strategic/tactical choices also draw heavily on insights from the next issue: politics.

Politics: Resolve, Restraints, and Responsibilities

"Politics" is admittedly being used in a broad sense here, and the following concepts are somewhat intertwined with the previous points about strategy and tactics, but it still helps to distinguish these factors related to perceptions and will power. The first major issue here is that of asymmetric resolve: in his article "Why Big Nations Lose Small Wars," Andrew Mack suggests that incumbent/governmental forces tend to not see the conflict quite as important in the face of casualties or other expenses, whereas insurgents tend to be much more committed to prevailing in what they perceive to be a more-existential conflict.[14] This issue of asymmetric commitment/interests has also been augmented and broadened by arguments regarding casualty aversion, as explained by Max Boot[15] and Andrew Ballow.[16] This concept is similar to the second issue: restraints. In short, researchers such as Gil Merom[17] and Paul MacDonald[18] argue that

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[13] Lyall and Wilson, "Rage Against the Machines…";
[14] Mack "Why Big Nations Lose Small Wars…";
Gabor Santa, "Conditions for Adopting an Irregular Defense Strategy," 2014, https://apps.dtic.mil/dtic/tr/fulltext/u2/a607587.pdf: "From a weaker side's perspective motivation has a meaningful importance to offset the material and numerical superiority";
Also see: Jeffrey Record, "Why the Strong Lose," 2005, https://apps.dtic.mil/dtic/tr/fulltext/u2/a490798.pdf.
[15] For example: Max Boot, *Invisible Armies: An Epic History of Guerrilla Warfare from Ancient Times to the Present* (New York: Liveright Publishing Corporation, 2014), pp. 75 and 79.
[16] Andrew Ballow, "Why Irregulars Win: Asymmetry of Motivations and the Outcomes of Irregular Warfare," 2016, https://apps.dtic.mil/sti/pdfs/AD1030693.pdf.
[17] The following source references Merom: William Patterson, "Democratic Counterinsurgents: How Democracies Can Prevail in Irregular Warfare," 2014, https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1084&context=gpis_etds.
[18] Paul K. MacDonald, "'Retribution Must Succeed Rebellion': The Colonial Origins of Counterinsurgency Failure," *International Organization* 67, no. 2 (April 2013): 253–86, https://doi.org/10.1017/s0020818313000027.

democracies and COIN forces more broadly have had to increasingly restrain their use of force due to political (e.g., domestic and international) scrutiny.

The third issue, asymmetric responsibilities, could arguably be considered a foundational concept for understanding the success of many irregular forces. Essentially, this refers to the idea that COIN forces must defend otherwise soft and exposed "value" targets such as public officials and civilians, infrastructure, resources, etc. rather than just their own troops and equipment ("force" targets), whereas the insurgents tend to be much more free to hide among civilians or in remote areas. In doing so, the insurgents can reduce their reliance on conventional defense against a conventionally superior enemy, while also striking at weak targets when convenient.[19] This concept, which has been expressed or implied by a variety of authors,[20] will be revisited later in the theory section but is important to mention here given how it interacts with other arguments (e.g., strategy).

Other Explanations: External Support and Geography

Aside from the issues of strategy/tactics and politics, researchers have highlighted additional explanations for insurgencies' success both in general and increasingly over the past century. For example, researchers such as Kalyvas, Balcells, Connable, Libicki, and Record have argued that external/foreign support has played a key role in insurgency outcomes.[21] Such

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[19] Record, "Why the Strong Lose": "a direct defense is an invitation to swift defeat [...] because attempted territorial defense plays to the conventional enemy's superiority in firepower."

[20] Aside from Record (ibid), see for example: Galula, *Counterinsurgency Warfare*, p. 7;
Nicholas Grossman, "Robotics and the Future of International Asymmetric Warfare" (2013), https://drum.lib.umd.edu/bitstream/handle/1903/14947/Grossman_umd_0117E_14814.pdf?sequence=1&isAllowed=y;

[21] Stathis N. Kalyvas and Laia Balcells, "International System and Technologies of Rebellion: How the End of the Cold War Shaped Internal Conflict," *American Political Science Review* 104, no. 3 (August 2010): 415–29, https://doi.org/10.1017/s0003055410000286;
Ben Connable and Martin Libicki, "How Insurgencies End," 2010, https://www.rand.org/content/dam/rand/pubs/monographs/2010/RAND_MG965.pdf;
Jeffrey Record, *Beating Goliath*, ch. 2.

support when provided to insurgents can include sanctuaries (e.g., bases in other countries), funding, equipment, etc. Incumbents can also receive support from external actors, which may be key in some situations given that state capacity/weakness is also a relevant factor.[22] Additionally, a variety of authors have argued that geographical factors such as the shape, size, and terrain of a country can significantly help insurgents/guerrillas who are trying to flee/hide, conduct ambushes, or establish safe havens in the country.[23]

Summary of Explanations and the Reason for Further Study

Ultimately, this review is not intended to be exhaustive, especially since there is a sizable list of factors that have been identified as potential or partial explanations for why insurgents have managed to succeed either in general and increasingly so in the past century. However, the discussion above highlights some of the key issues that are frequently cited as factors, especially strategy/tactics, casualty aversion, asymmetric responsibilities, and external assistance.

Despite all of these existing explanations, there definitely seems to be reason for further research and theory. First of all, the existence of so many explanations—and some authors' skepticism over the importance of some explanations[24]—highlights that the debate is not "settled." More generally, if one finds that there is a concept which has been widely ignored in the literature but which *plausibly* may have an impact, it generally warrants some further

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[22] Kalyvas and Balcells, "International System and Technologies of Rebellion."

[23] Galula, *Counterinsurgency Warfare*;
See also: James D. Fearon and David Laitin, "Ethnicity, Insurgency, and Civil War," *American Political Science Review* 97, no. 01 (February 2003): 75–90, https://doi.org/10.1017/s0003055403000534;
Sebastian Schutte, "Geography, Outcome, and Casualties," *Journal of Conflict Resolution* 59, no. 6 (March 19, 2014): 1101–28, https://doi.org/10.1177/0022002713520534.

[24] For example, MacDonald challenges many explanations (e.g., "The decline in incumbent victory in counterinsurgency warfare, therefore, stems not from problems in force structure or strategy…") in "Retribution Must Succeed Rebellion";
Patricia Sullivan similarly expresses skepticism and/or desire for deeper explanations in "War Aims and War Outcomes," *Journal of Conflict Resolution* 51, no. 3 (June 2007): 496–524, https://doi.org/10.1177/0022002707300187.

consideration. Even if one supposes that the factors discussed above are the primary correlates or determinants of the trends/outcomes, the argument identified here may at least help to develop a more nuanced model and/or better explain why they matter—which may be useful for trying to conduct similar analysis elsewhere (e.g., potential/future conflicts, emerging technologies[25]).

Additionally, the hypothesis I present and examine here does not necessarily conflict with many of the explanations offered by others. Instead, as just hinted, the argument here seems to build on explanations such as the importance of asymmetric resolve and strategy/tactics. However, there is at least one explanation in the literature which stands out as controversial, yet which is meaningfully related to the argument/topic of this thesis.

Lyall and Wilson: Mechanization vs. Shifts in the Lethality of Military Technology

Lyall and Wilson's mechanization argument and dataset are frequently mentioned and praised/uncritically used in a variety of studies.[26] However, a variety of scholars/studies have also criticized their study,[27] arguing that: 1) one of the major theoretical arguments it makes for a causal relationship (namely, that foraging armies are more effective at gathering information) relies on an "ahistorical" understanding of the strengths and weaknesses of foraging[28]; 2) it

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[25] In particular, see later discussion regarding T.X. Hammes, who emphasizes the concept of the "fourth industrial revolution."

[26] This study builds upon Lyall and Wilson's findings: Jeffrey A. Friedman, "Manpower and Counterinsurgency: Empirical Foundations for Theory and Doctrine," *Security Studies* 20, no. 4 (October 2011): 556–91, https://doi.org/10.1080/09636412.2011.625768.
See also: Schutte, "Geography, Outcome, and Casualties";
Alec Worsnop, "Organization and Community: The Determinants of Insurgent Military Effectiveness" (2016);
It is also praised and used in *Adapting to Win.*

[27] Aside from those mentioned further on in the paragraph, see:
Eric Jardine, "The Insurgent's Dilemma: A Theory of Mobilization and Conflict," 2014, https://curve.carleton.ca/system/files/etd/4043e1a5-90ab-4835-bafe-96274c75ce2a/etd_pdf/d3b6d1a966edc8d105099d2655b91146/jardine-theinsurgentsdilemmaatheoryofmobilization.pdf;
MacDonald, "Retribution Must Succeed Rebellion";

[28] Ivan Arreguín-Toft, "Contemporary Asymmetric Conflict Theory in Historical Perspective," *Terrorism and Political Violence* 24, no. 4 (September 2012): 635–57, https://doi.org/10.1080/09546553.2012.700624.

conflates a country's degree of mechanization with actual force employment/tactics[29]; 3) its case study (of two U.S. Army Divisions in Iraq) fails to address conflicting narratives from different cases (Divisions) in the same war.[30] Criticisms such as these collectively argue that Lyall and Wilson improperly conflated correlation with causality when they suggest that mechanization worsened COIN performance relative to if COIN forces had chosen not to mechanize.[31]

Despite these problems, Lyall and Wilson do appear to correctly recognize that some kind of shift happened in the early 20th century, given the strong decline in COIN performance in the period of mechanization (which they code as beginning in WWI). Additionally, part of the argument they offer regarding COIN separation from the populace (i.e., that this makes it more difficult to achieve legitimacy among the population) has some merit. The problem particularly arises when Lyall and Wilson identify mechanization as a major *cause* of COIN forces' failures, with the implication that they would be better off if mechanization had not occurred. However, mechanization was not the only shift that occurred around WWI: other technological innovations such as the machine gun (which greatly increased the lethality of individuals/small groups) also began to come to prominence, while the overall 20th century saw apparent increases in casualty aversion (as noted above). When considering why militaries continue to use mechanized/armored troops, the remark of one source is particularly striking: "Without the advantages provided by vehicles, counterinsurgents would find any move into an insurgent-held area costly, and the heavy casualties such a move would entail could give insurgents a perceived victory."[32]

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[29] Raphael Moyer, "Death Before Dismount?: Mechanization, Force Employment, and Counterinsurgency Outcomes in Iraq," 2011, https://dspace.mit.edu/bitstream/handle/1721.1/64491/727242822-MIT.pdf.
[30] Niel A. Smith and Nathan W. Toronto, "It's All the Rage: Why Mechanization Doesn't Explain COIN Outcomes," *Small Wars & Insurgencies* 21, no. 3 (September 2010): 519–28, https://doi.org/10.1080/09592318.2010.505484; Moyer, "Death Before Dismount?".
[31] Smith and Toronto, "It's all the Rage."
[32] Moyer, "Death Before Dismount?" p. 29.

Ultimately, all of this raises the *possibility* that mechanization may not (entirely) be the root problem, but rather could be more of a valuable "medicine" with painful side effects in response to a deeper/more-central "disease" (the presence of which might even be obscured by the suppressive effects of the medicine): other shifts in the conflict landscape such as the significant increase in weapon lethality under certain conditions (as argued by Biddle, who is discussed later). This thesis, unfortunately, is unable to thoroughly test this explanation against the theory offered by Lyall and Wilson, due in large part to the fact that there does not appear to be any dataset which tracks combatants' access to/usage of technologies such as machine guns, mortars, IEDs, etc. over the past 200 years. However, mechanization does become relevant in the control variable analysis, warranting some critical discussion of Lyall and Wilson's claims. More broadly, Lyall and Wilson's analysis seems to illustrate the low amount of attention paid *directly* to shifts in the character of military technology available to both regular forces *and* irregulars as an explanation for shifts in outcomes.[33] This leads into discussion by a variety of authors, including Sieg, Hammes, Biddle, and the overall RMA literature.

The Question of Technology

Hans Martin Sieg and the "Transformation of Military Power"

In 2014, researcher Hans Martin Sieg articulated some of the key points of the concept I examine in this paper—to the extent that his article may in fact be the most focused/similar discussion of this general concept of "equalizer" technology. In short, he argues that the

[33] To be clear: Lyall and Wilson ("Rage Against the Machines") do at one point mention the "surging lethality in weapons systems" (p. 74) as a reason for militaries' push for mechanization, yet they do not focus much on this potential justification/problem, instead insisting that "the advent of mechanization would have deleterious consequences for a military's ability to wage COIN" (p. 73).

combination of shifts in technology (e.g., light arms and explosives) and cultural norms/values (e.g., willingness to accept casualties) could be an important causal explanation for shifts such as the trend of decreasing COIN success rates.[34] Especially on the first point, he argues that shifts in technology can at times favor the strong, but that technology's "evolution can also create options that favor the weak."[35] Sieg supports his analysis through references to some historical cases (wars in Iraq and Sudan) as well as other forms of theory-based argumentation. However, he importantly does not conduct in-depth case studies or other empirical tests. Additionally, he makes some problematic assertions regarding the necessity of technology in certain tactics/strategies,[36] whereas this thesis just argues that technological shifts can enhance the effectiveness of certain tactics/strategies in a way which favors the irregular actors.

T.X. Hammes, the Convergence of Technology, and the RMA Literature

After Sieg, T.X. Hammes is one of the next closest comparisons for my arguments. He suggests that a variety of present and potential technological shifts (e.g., drones, 3D printing,

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[34] Hans Martin Sieg, "How the Transformation of Military Power Leads to Increasing Asymmetries in Warfare? From the Battle of Omdurman to the Iraq Insurgency," *Armed Forces & Society* 40, no. 2 (March 26, 2013): 332–56, https://doi.org/10.1177/0095327x12466228.

[35] Sieg, "How the Transformation of Military Power"

[36] To very briefly summarize the issues here, Sieg argues that the 19th-century Mahdist army in Sudan did not employ modern guerrilla strategies because "they lacked the necessary tactical options" (p. 337) due to the limited available technology in terms of "weapons, communications, transportation, and infrastructures" (p. 337). However, many of his factual/analytical claims about what the Mahdist army could or could not do (e.g., the entirety of p. 338) are made without any apparent reference to sources. Additionally, his overall argument that the guerrillas chose more-conventional strategies largely due to a lack of technology seems to ignore a range of alternative explanations. For example, see Katagiri, *Adapting to Win:* "Insurgents of all sorts had no intellectual text to resort to when devising a strategy for the weak, which is partly why, combined with material weakness, many of them lost extrasystemic wars throughout the nineteenth century." See also Mack, "Why Big Nations Lose Small Wars" (quoting Katzenbach): "'By and large, it would seem that what made the machinery of European troops so successful was that native troops saw fit to die, with glory, with honor, en masse, and in vain.'" More directly in contrast with Sieg's argument, many insurgencies featured irregular tactics long before the advent of modern technology, as Max Boot describes throughout *Invisible Armies* (e.g., the Jewish zealots ambushing Roman columns along mountain paths). Sieg makes some responses by suggesting that geography was the reason that some irregular forces managed to conduct irregular warfare in earlier times, but these responses suffer from the same lack of sources mentioned earlier.

artificial intelligence) could significantly increase the capabilities/effectiveness of smaller actors, including insurgents.[37] However, similar to Sieg, Hammes does not use in-depth case studies or other empirical testing. He also does not give much attention to the potential benefits for stronger powers, meaning that the technologies may not actually serve as "equalizers" (as I define the term). At times, Hammes' analyses largely resemble the concept of "Revolutions in Military Affairs" (RMAs),[38] which includes a variety of related arguments/claims.

There is substantial disagreement on the concept of RMAs, ranging from their definition/nature (e.g., whether they actually involve technological shifts), causes, significance, and even the concept's legitimacy altogether.[39] This analysis will not try to settle the disagreements or take sides, but it is important to highlight parts of this literature because a few researchers here have made arguments suggesting that shifts in technology and tactics could have equalizing effects. For example, one report by the RAND Corporation notes that RMAs disrupt "core competencies" of dominant powers.[40] Other researchers who have touched on or

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[37] Aside from the sources mentioned in following notes, see for example:
T.X. Hammes, "Defending Europe: How Converging Technology Strengthens Small Powers," *Scandinavian Journal of Military Studies* 2, no. 1 (2019): 20–29, https://doi.org/10.31374/sjms.24;
T.X. Hammes, "Cheap Technology Will Challenge U.S. Tactical Dominance," National Defense University Press, 2016, https://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-81/Article/702039/cheap-technology-will-challenge-us-tactical-dominance/;

[38] In part, this can be seen in his frequent references to shifts attributable to the "Fourth Industrial Revolution," such as in "Technology Converges; Non-State Actors Benefit," Hoover Institution, 2019, https://www.hoover.org/research/technology-converges-non-state-actors-benefit.

[39] See a variety of sources:
Theodor Galdi, "Revolution in Military Affairs? Competing Concepts, Organizational Responses, Outstanding Issues," www.iwar.org.uk, 1995, http://www.iwar.org.uk/rma/resources/rma/crs95-1170F.htm;
O'Hanlon, *Technological Change and the Future of Warfare* (pp. 21-22);
Andrew F Krepinevich, "Cavalry to Computer: The Pattern of Military Revolutions," The National Interest, June 24, 2014, https://nationalinterest.org/article/cavalry-to-computer-the-pattern-of-military-revolutions-848;
Williamson Murray, "Thinking About Revolutions in Military Affairs," 1997, https://apps.dtic.mil/dtic/tr/fulltext/u2/a354177.pdf;
Richard Hundley, "Past Revolutions, Future Transformations: What Can the History of Revolutions in Military Affairs Tell Us about Transforming the U.S. Military?," 1999, https://www.rand.org/content/dam/rand/pubs/monograph_reports/2007/MR1029.pdf.

[40] Hundley, "Past Revolutions, Future Transformations"

constructed relevant arguments regarding technology's impacts include Andrew Krepinevich,[41] Clifford Rogers,[42] Michael Horowitz,[43] Arquilla (and O'Hanlon in response),[44] and Max Boot.[45] Much of the literature in this field focuses on conventional warfare, but there are some exceptions: Paul Brooker, for example, suggests that emerging technologies (e.g., nanotechnology, biotechnology) may enhance the destructive capabilities of non-state actors.[46]

Despite having some similarities with varying parts of the diverse RMA literature, however, the analysis in this thesis is still relatively unique in its combination of context/setting (irregular conflict as opposed to conventional/state war), scope and methodology (specifically focusing on an individual technology through *empirical case studies* rather than just *theorizing* on each of a wide range of technologies), and its hypothesized causal mechanism (enhancing the effectiveness of strategies/tactics which mitigate the impact of disparities in material variables). Another concept which also focuses on technology's impacts but actually has a sizable literature is that of the "offense-defense balance."

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[41] Krepinevich, "Cavalry to Computer," p. 4. Among other lessons, Krepinevich remarks: "In a sense, military revolutions may offer major opportunities for relatively small or "medium-sized" powers to steal a march on greater powers, or even for one great power to challenge an array of its peers."

[42] See chapter 2 of *The Dynamics of Military Revolution*, wherein Clifford Rogers suggests that "technological development was a significant contributing factor" in 14th-century England's military development. Macgregor Knox and Williamson Murray, *The Dynamics of Military Revolution, 1300-2050* (Cambridge: Cambridge University Press, 2001).

[43] Michael Horowitz, *The Diffusion of Military Power : Causes and Consequences for International Politics* (Princeton, Nj: Princeton University Press, 2010). In this, Horowitz primarily looks at how technological innovations *spread*, which results in reducing *dyadic* disparities in technology (e.g., by reducing the financial costs of complex platforms).

[44] Michael E. O'Hanlon, "Beware the RMA'nia!"",," Brookings, 1998, https://www.brookings.edu/research/beware-the-rmania/. Here, O'Hanlon provides a quote from Arquilla, who warns that pursuing "the latest technological advances [...] will no doubt lead to the erosion of existing advantages through a process of diffusion to others." In response, however, O'Hanlon is more agnostic, suggesting that such an outcome "is not inevitable."

[45] Max Boot, "The Paradox of Military Technology," 2006, http://thenewatlantis.com/wp-content/uploads/legacy-pdfs/TNA14-Boot.pdf: Here, Boot broadly argues that "modern technology is both the great separator and the great equalizer in military affairs."

[46] Brooker, *Modern Stateless Warfare*.

A Conceptual Cousin: Literature on Technology and the Offense-Defense Balance

At least for decades,[47] various researchers have examined the idea that some technologies or overall technological periods/eras favor the "offense" or "defense," such as by making it easier to take vs. defend territory, launch devastating first strikes, etc. Some of the articles in this literature have been recognized as highly influential,[48] even though the overall concept has been the subject of a great deal of debate/criticism.[49] Putting aside the question of its validity, however, the reason to note it here is to highlight some of the similarities of its features to those of the concept identified in this thesis, while contrasting the disparity in attention given to the two concepts. In terms of their similarities, both theories have extensions/applications which argue that even if two combatants have roughly comparable access to some technology, the technology can have asymmetric effects in terms of which side it benefits more: the offense/defense theory suggests that this is either the attacker or defender; the concept I describe and examine suggests that a given technology may disproportionately benefit the

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[47] One article by Glaser and Kaufmann claims that Robert Jervis "originally described" the *theory*, but researchers such as Jack Snyder have pointed out that the overall idea of offensive/defensive dominance was a feature of thinking among practitioners even leading into World War I. In fact, Jack Levy notes that even Carl von Clausewitz articulated some aspects of the theory in his book, *On War*.
Charles Glaser and Chaim Kaufmann, "What Is the Offense-Defense Balance and Can We Measure It?" *International Security Spring* 22 (1998): 4–44, https://web.stanford.edu/class/polisci211z/2.1/Glaser%20%26%20Kaufmann%20IS%201988.pdf;
Jack Snyder, "Civil-Military Relations and the Cult of the Offensive, 1914 and 1984," *International Security* 9, no. 1 (1984): 108, https://doi.org/10.2307/2538637;
Jack S. Levy, "The Offensive/Defensive Balance of Military Technology: A Theoretical and Historical Analysis," *International Studies Quarterly* 28, no. 2 (June 1984): 219, https://doi.org/10.2307/2600696.

[48] Consider for example Robert Jervis, "Cooperation Under the Security Dilemma," *World Politics* 30, no. 2 (1978): 167–214, https://doi.org/10.2307/2009958;
James Fearon called it "one of the most influential articles on international relations written in the last 25 years": James D Fearon, "The Offense-Defense Balance and War Since 1648," 1997, https://web.stanford.edu/group/fearon-research/cgi-bin/wordpress/wp-content/uploads/2013/10/The-Offense-Defense-Balance-and-War-Since-1648.pdf.

[49] For a general example, see: James W. Davis et al., "Taking Offense at Offense-Defense Theory," *International Security* 23, no. 3 (1998): 179, https://doi.org/10.2307/2539342;

stronger/regular or weaker/irregular combatant. Yet, the latter concept has received almost no attention, whereas the former has been the primary focus of numerous articles.[50] It is particularly interesting to note this lack of literature despite the existence of theories/concepts such as Biddle's "modern system," which touches on many of the major parts of the theoretical argument offered in this thesis.

Biddle, the Modern System, and Systemic Shifts

Researcher Stephen Biddle has repeatedly written on what he calls "the modern system of force employment" (or just "the modern system").[51] This concept mainly refers to the implementation of tactical actions such as the use of cover and concealment, dispersing one's troops, suppressing enemies, independent small-unit maneuvers, and combined arms.[52] Without getting too deep into all of the specific details and claims, Biddle uses both detailed case studies and statistical evidence to argue that particularly since the early 1900s, armies' effective implementation of the modern system has become increasingly crucial in determining outcomes of conflicts.[53] Biddle has primarily applied the analysis to conventional war[54]—and those

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[50] As just a small sample, see:
Stephen Van Evera, "Offense, Defense, and the Causes of War," *International Security* 22, no. 4 (April 1998): 5–43, https://doi.org/10.1162/isec.22.4.5;
Fearon, "Offense-Defense Balance and War";

[51] For example:
Biddle, *Military Power*;
Stephen Biddle, "The 2006 Lebanon Campaign And The Future Of Warfare: Implications For Army And Defense Policy," n.d., https://indianstrategicknowledgeonline.com/web/THE%202006%20LEBANON%20CAMPAIGN.pdf;
Biddle does not mention it as much by name in "The Determinants of Nonstate Military Methods," but he does frame parts of his analysis around the theory in that article. Stephen Biddle, "The Determinants of Nonstate Military Methods," *The Pacific Review* 31, no. 6 (November 2, 2018): 714–39, https://doi.org/10.1080/09512748.2018.1513550.

[52] Biddle, *Military Power*.

[53] Biddle, *Military Power*.

[54] Biddle does touch on the concept's application to American counterinsurgency operations against the Taliban and Al-Qaeda in the conclusion of *Military Power*. Also, Biddle's more recent article "The Determinants of Nonstate Military Methods," was a departure from this trend.

conclusions are not without critics[55]—but his end conclusions are not the primary reason to highlight Biddle here. Rather, some of the key arguments and observations in his chain of reasoning—namely, those relating to how technological shifts increase the importance of tactics which reduce the impact of material variables—are particularly relevant to this thesis.

In explaining the value of the modern system, Biddle writes that it "works by exploiting properties of military technology that have changed little since 1918…"[56]; "Weapon lethality, while increasing against all targets in absolute terms, has grown much faster against massed targets in the open than dispersed targets in cover. Over time, this difference in growth rate has steadily widened the difference in vulnerability between massed, exposed targets and dispersed, covered ones."[57] Thus, Biddle argues that "systemic"[58] shifts in technology have greatly heightened the significance/impact of force employment (e.g., tactics) while generally reducing the significance of material disparities (e.g., manpower, technological sophistication, etc.) when combatants are using aspects of the modern system (e.g., cover, concealment, dispersion).[59] Ultimately, my thesis' theoretical argumentation extends Biddle's analysis by connecting it with other arguments more specific to asymmetric/irregular conflicts.

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[55] See various:
Michael Horowitz and Stephen Rosen, "Evolution or Revolution?," *Journal of Strategic Studies* 28, no. 3 (June 2005): 437–48, https://doi.org/10.1080/01402390500137317;
Daniel Urchick, "Advanced ISR Sensors and Their Impact on 'Military Power,'" Defence IQ, March 16, 2017, https://www.defenceiq.com/defence-technology/articles/advanced-isr-and-its-impact-on-military-power.

[56] Biddle, *Military Power*, p. 52. Notably, this is the year of the first conflict that Lyall and Wilson (who even reference Biddle) code as mechanized. See the dataset of "Rage Against the Machines."

[57] Biddle, *Military Power*, p. 53.

[58] As Biddle writes in *Military Power* (p. 15): the systemic analysis/approach "focuses on the gross 'state of the art' in the international system at any given time, rather than the particulars of individual states' holdings." It stands in contrast with dyadic analysis (see p. 16), which emphasizes comparisons between two combatants (e.g., "who has better technology?").

[59] In the conclusion of *Military Power* (p. 190), Biddle writes that "Technology's effects are thus secondary to force employment's [....] The effects of numerical preponderance [...] are determined largely by force employment. Gross resource advantages matter only if they can be exploited via modern-system force employment, and many states cannot do so."

Responding to Some Skepticism of Technology's Impacts

Very few (if any) sources have directly challenged this thesis' argument, presumably in large part due to how little literature has covered it. Still, plenty of sources have expressed generic and specific skepticism towards some of the claimed impacts of technological changes on warfare, especially in response to arguments from the RMA literature.[60] However, one researcher, Paul MacDonald, warrants attention for considering—and dismissing—the idea that shifts in *access* to technology may have played a role in the change in insurgency outcome trends.[61] To summarize: MacDonald argues that because COIN forces still dominate when fighting against insurgents who fight *conventionally*, shifts in access to technology cannot explain why insurgencies have been succeeding more often. In response, one should first note that MacDonald primarily focuses on shifts in *access* (i.e., disparities between combatants) rather than systemic/overall technological shifts.[62] More importantly though, he fails to address the issue of insurgents' military effectiveness when *avoiding* "direct confrontations on the battlefield,"[63] which is a key issue in Sieg's article[64] and this thesis.[65] Going beyond this specific

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[60] For example, see:
Adam Wunische, "Nothing New: Why the 'Revolution' in Military Affairs Is the Same as the Old One," The National Interest, September 2, 2019, https://nationalinterest.org/feature/nothing-new-why-revolution-military-affairs-same-old-one-77266;
George Raudzens, "War-Winning Weapons: The Measurement of Technological Determinism in Military History," *The Journal of Military History* 54, no. 4 (October 1990): 403, https://doi.org/10.2307/1986064.;
Additionally, Biddle has expressed some criticism of RMA advocates who emphasize extraordinary changes, especially those who claim that the present-day or near-term technologies are or will be "revolutionary." See Biddle, *Military Power*, pp. 196-199.

[61] MacDonald, "Retribution Must Succeed Rebellion" — Specifically, his subsection "Changing Lethality of Insurgent Forces."

[62] He does not seem to acknowledge a distinction between a dyadic vs. systemic approach to analyzing technology, but his analysis on this point almost entirely relates to comparing insurgents' weapons to their enemies' rather than analyzing the character of changes in weapons (e.g., from flintlock to fully-automatic rifles) over time.

[63] Quote from MacDonald, "Retribution Must Succeed Rebellion" p. 261.

[64] It is worth noting that MacDonald's article was published prior to Sieg's, so he may not have had a chance to consult such version of this argument.

[65] To be fair, MacDonald may not have been trying to respond to the kind of "equalizer" argumentation offered in this paper, but rather just to argumentation by researchers such as Mann and Kaldor (whom he references). However,

criticism from MacDonald, it may be the case that some insurgencies/irregulars are still largely unable to win specific battles or inflict high casualties, but as discussed more in my theory chapter, one should ask why—including whether a COIN's military "effectiveness" in such narrow terms as casualty exchange rates is achieved at the cost of political legitimacy or broader military effectiveness.

Summary of Literature Regarding Technology's Impacts on Irregular Military Effectiveness

Proving that *some* literature does exist is much easier than proving the opposite claim. However, my review of the literature has not found any studies which conduct substantive empirical evaluation or testing of either my argument regarding PAWs or just the general concept of "equalizer" technology in insurgent/irregular outcome trends, whether through in-depth case studies or statistical analyses.[66] Aside from this criterion, with the sole exception of the article by Sieg, the existing studies/articles that mention or come close to this concept also:

1. Do not focus on the concept of *systemic* shifts (as opposed to decreasing *material disparities* in access to technology)[67];
2. Primarily focus on how the technological shifts could (grossly) help the weaker/irregular side without seriously considering how the shifts might also benefit the stronger/regular forces[68];

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the phrasing he uses does broadly attack the notion that technologically-driven changes in insurgent lethality can help explain the changes in insurgent victory, warranting some response/discussion. Additionally, his dismissal is the closest criticism of the argument here that I could find.

[66] For example, Boot, "The Paradox of Military Technology";
Sieg's article ("How the Transformation of Military Power…") also arguably falls in this category, given how shallow the case analysis is.

[67] See for example: Michael Mann, "The First Failed Empire of the 21st Century," Review of International Studies 30, no. 4 (September 29, 2004): 631–53, https://doi.org/10.1017/s0260210504006266.

[68] Sources such as Hammes (e.g., "Technology Converges; Non-State Actors Benefit") are illustrative of this.

3. Only briefly discuss, assert, or dismiss the concept in the context of a separate analysis but do not seriously examine/explain the concept (especially not as a broader idea)[69]; or
4. Focus on the use of technology for actions such as recruitment or political influence rather than on military engagements (which involves a different causal process and result).[70]

Overall Literature Review Conclusion

The puzzle of increasing "weak" or insurgent success rates over the past century (as well as the more general question of how weaker actors have managed to succeed) has received substantial attention over the past few decades, including numerous proposed explanations. As suggested by the continued attempts to explain the puzzles, however, the debate has not been fully settled: there is still plenty of disagreement over the significance of factors such as COIN mechanization and force restraints, for example. It appears that a singular or simplistic explanation will not suffice for understanding this puzzle, even though some factors such as the importance of irregular strategy/tactics seem to have solid merit. However, the overall literature has widely neglected to discuss and examine the idea that shifts in the character of military

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[69] For example, Anthony Craig and Brandon Valeriano, "Power, Conflict, and Technology: Delineating Empirical Theories in a Changing World," 2017;
Also see: Emily O. Goldman and Richard B. Andres, "Systemic Effects of Military Innovation and Diffusion," Security Studies 8, no. 4 (June 1999): 79–125, https://doi.org/10.1080/09636419908429387.

[70] See for example:
Ballow, "Why Irregulars Win";
Frank Zimmerman, "Why Insurgents Fail: Examining Post-World War II Failed Insurgencies Utilizing The Prerequisites Of Successful Insurgencies As A Framework," 2007, https://apps.dtic.mil/dtic/tr/fulltext/u2/a467709.pdf;
While these analyses share some important similarities with my analysis, my argument still differs in suggesting that some technologies can reduce the *importance* of material disparities in combat. In contrast, many of the arguments regarding information/communication technologies suggest that the technologies can influence *political effectiveness* or can reduce the *degree* of material disparities between sides in an overall conflict.

technology (e.g., machine guns) could also help to explain the shifts in the outcomes of asymmetric conflicts such as insurgencies. Such a gap is particularly striking when compared with the amount of attention devoted to theories such as the offense/defense balance and Biddle's "modern system." Ultimately, this thesis seeks to aid/improve the research in this field by highlighting the gap, laying out some theoretical reasoning, and examining the argument for a specific technology through a comparative case study.

Chapter II: Theoretical Arguments and Expectations

This theory chapter seeks to accomplish a variety of things: First, I briefly touch on the military vs. political aspects of success, then justify my focus on military effectiveness. As I emphasize throughout this chapter, the specific hypothesis which I test is just limited to military effectiveness (which is operationalized in the methodology chapter and is not conflict outcome), *but* based on arguments in the existing literature (e.g., COIN casualty aversion) there is reason to believe that when irregular military effectiveness increases it also increases their likelihood of success. Second, I will build on the explanations noted in the literature review and more deeply analyze the drivers of irregular/insurgent military effectiveness, paying particular attention to the outsized importance of small/surprise engagements and tactics. Third, I will take a deeper look at the characteristics and effectiveness of these irregular tactics, with a particular emphasis on ambushes as an example. Fourth, I will discuss some of the concepts/arguments that provide reason to expect that PAWs should enhance the net effectiveness of these surprise attacks even when both sides have the technology. Fifth, I will also briefly touch on ways in which PAWs might be expected to help the regular forces (e.g., in static defense). Sixth, based on the two previous points (which will become further fleshed out in the qualitative analysis) I describe my theoretical expectations and hypothesis. Lastly, I take a step back from the specific hypothesis/focus of this study (PAWs) and briefly highlight how the theoretical argument in this paper could fit into a broader category of concepts/arguments regarding “equalizer” technology, which has remained largely undeveloped and disorganized in the literature.

Understanding the "Success" of Irregular Forces: Military Effectiveness and Politics

Defining "success" for irregular forces depends partially on their goals and other characteristics. Such success does typically imply effecting some form of political change (e.g., the existence or enforcement of laws) as an end goal, with changes in military actions (e.g., foreign troop presence) typically being an important part of that process.[71] However, as the German East Africa Campaign illustrates, at least some irregular campaigns are not so focused on "political" changes directly. The literature review highlighted a wide variety of explanations for how irregular forces tend to succeed, some of which particularly relate to military decisions and effectiveness (e.g., tactics and strategies). However, given that multiple scholars and practitioners have argued that counterinsurgency is primarily about politics rather than military force, one may question whether such a focus on military effectiveness is justified. David Galula, for example, has given the estimate that COIN is "80% political" and only "20% military action," while others have assigned even less weight to the military.[72] Some researchers argue that an insurgency can even be largely militarily ineffective yet still win as a result of political actions.[73] This definitely raises questions regarding the notion that increases in military effectiveness, which this thesis tests with regards to a specific pair of cases, would have meaningful effects on war outcome in the broader range of cases which this thesis does not test.

In short, my response is that while it is true that politics are often very important, one cannot entirely divorce political effectiveness from military effectiveness: COIN military failures

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[71] US Government, "Guide to the Analysis of Insurgency," Homeland Security Digital Library, January 1, 2012, https://www.hsdl.org/?abstract&did=713599.
[72] Steven Mount, "The Other Side of COIN," 2009, https://apps.dtic.mil/dtic/tr/fulltext/u2/a510710.pdf.
[73] Jason Lyall and Isaiah Wilson, "'Rage Against the Machines' Codebook and Replication Information," 2009.

reasonably may cause political problems leading to a loss of local support for the government; COIN casualties could provoke harsh/brutal reprisals or restrictions which undermine the COIN's political effectiveness; COIN casualties could lead to a loss of domestic political support and eventual withdrawal in cases of foreign intervention; etc. Similarly, even the fear of *potential* losses could induce one side to avoid actions (e.g., patrols, meeting with or protecting local officials) that would complement its political activities. Thus, if PAWs do increase irregular military effectiveness, one would expect this to also have political ramifications, especially when small increases in COIN casualties are amplified by casualty aversion.

As to whether the issue is worth studying more generally, I would also argue that research should seek to understand any relevant parts of the puzzle, and this part of the irregular effectiveness puzzle appears to be particularly understudied (whereas technology influencing political effectiveness/mobilization has already been studied, as mentioned in the literature review). Furthermore, many other researchers have similarly found/argued that the military dimension of these conflicts is important or worth studying.[74]

[74] For example, Arreguin-Toft ("How the Weak Win Wars"), Jeffrey Record (*Beating Goliath*), Andrew Mack ("Why Big Nations Lose Small Wars"), and others have emphasized the potential significance of military/conflict trends;
See also: Maryum Alam, "When Does Counterinsurgency Work? An Analysis Of Counterinsurgency Campaigns After 1945," accessed November 17, 2020, https://www.hofstra.edu/pdf/library/maryum_aum.pdf: "Countering the military, or kinetic, movements of insurgent organizations is often the most urgent and important security threat that states seek to address."

The Significance of Small/Surprise Engagements in Irregular Military Effectiveness

Unlike in conventional warfare that emphasizes "decisive battles"[75] or just medium to large scale engagements in which territory/resources are captured or casualties are inflicted, many[76] irregulars' military success/survival is influenced much more by their effectiveness in small, surprise engagements—including ambushes, hit-and-runs (HARs), and remote attacks—as well as their overall strategy which is "designed to avoid a decisive defeat."[77] The reasoning for this primarily draws on an interaction between four of the major explanations/points regarding irregular forces' success: asymmetric interests and casualty aversion, COIN conventional superiority, the effectiveness of irregular strategies and tactics, and asymmetric responsibilities:

First, COIN casualty aversion magnifies the significance of small engagements beyond the specific military outcomes (e.g., attrition rates), especially in foreign occupations: pictures/stories of dead soldiers can motivate a government to scale back its COIN efforts[78] even if it has not lost many major battles or is otherwise doing fine from a conventional perspective. The COIN force may not always "give up" or retreat in response to such attacks, but their casualty aversion may drive the COIN force to pursue slower, less thorough, more indiscriminate, or otherwise less effective approaches which undermine the COIN/national government's image, and/or it may lead to more monetary costs that can weigh particularly

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[75] Martijn Kitzen, "Western Military Culture and Counterinsurgency: An Ambiguous Reality," Scientia Militaria - South African Journal of Military Studies 40, no. 1 (May 25, 2012), https://doi.org/10.5787/40-1-982: "In essence, Western military culture is about fighting large-scale decisive battles with armies of other states."

[76] This does not always apply to late-stage insurgencies which are trying to overthrow/replace an existing government, wherein the primary COIN supporter cannot just be "deterred away" (unlike in some foreign occupations).

[77] Dennis Drew, "Insurgency and Counterinsurgency: American Military Dilemmas and Doctrinal Proposals," 1988, https://apps.dtic.mil/dtic/tr/fulltext/u2/a193323.pdf.

[78] P. 11 of Rod Thornton, *Asymmetric Warfare : Threat and Response in the Twenty-First Century* (Cambridge: Polity Press, 2008).

heavily in the cases of foreign occupations.[79] This in turn can reduce the need for insurgents to rely on medium to large scale attacks that might normally be considered "decisive" (e.g., by eliminating large portions of the enemy).[80] The asymmetry in casualty aversion (i.e., that insurgents are often more willing to suffer) is also an important part of this, as it means that regular forces cannot just slightly out-attrit their way to victory.[81]

Second, COIN forces' material or "conventional" superiority in terms of equipment and/or manpower can significantly limit irregular forces' practical options for inflicting casualties or otherwise achieving military objectives: massed assaults on COIN strongholds can be difficult to conceal or coordinate, risk large numbers of irregulars at one time, and may (depending on the COIN in question) play into the strengths of the COIN forces, with their armor, air power, artillery, fortifications, etc.[82] Although it does not make larger attacks

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[79] Hammes, "Technology Converges…": "While coalition forces developed more effective tactics, techniques, and procedures to defend against this type of attack, doing so required the dedication of enormous resources and severely restricted coalition operations.";
Paul B Rich and Isabelle Duyvesteyn, The Routledge Handbook of Insurgency and Counterinsurgency (London Routledge, Taylor & Francis Group, 2014), https://www.routledgehandbooks.com/doi/10.4324/9780203132609: "Within the strategy of insurgency, the weak organization seeks to postpone resolution of the conflict while it adjusts the power balance in its favour.";
Speaking somewhat generally, Arreguin-Toft in "How the Weak Win Wars" writes that "In asymmetric conflicts, delay favors the weak.";
Also see pp. 11-12 of *Asymmetric Warfare*, where Thornton discusses impatience.

[80] Again, this depends to some extent on the type of insurgencies. In cases where the COIN force may be more easily coerced into giving up (e.g., in fighting some foreign occupiers), this holds true throughout much of the insurgency. In cases where the COIN force is a domestic government that cannot just "withdraw," this may just primarily be relevant in the earlier stages of insurgencies, when the insurgents do not have the ability to overthrow the government.

[81] Santa, "Conditions for Adopting…": "From a weaker side's perspective motivation has a meaningful importance to offset the material and numerical superiority";
Also see: Record, "Why the Strong Lose."

[82] P. 15 of Drew, "Insurgency and Counterinsurgency," which is echoed/cited by Raymond Hain, "The Use and Abuse of Technology In Insurgent Warfare," accessed November 17, 2020, https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Chronicles/Hain.pdf;
See for example p. 6 of *Asymmetric Warfare* (Thornton), referencing Jonathan Tucker's article, "Asymmetric Warfare" (1999). Also see p. 128 of *Asymmetric Warfare*.

impossible,[83] this conventional superiority does tend to (punitively) restrict insurgents/irregulars to smaller engagements and remote attacks that are short/limited, use surprise, attack weaker targets (including civilians), etc.

Third, although irregulars' options tend to be limited with regards to larger attacks, smaller engagements and remote attacks have remained viable. In line with the reasoning advanced by Biddle regarding force employment, despite some COIN forces' large material advantages, irregulars still can be effective when they employ cover, concealment, dispersion, coordination, and other actions in executing small engagements such as ambushes and hit and runs.[84] As noted in one more-mathematical analysis of irregular war, "The local superiority required on the part of the attacker is greatly reduced if ambush tactics are used."[85]

Finally, unlike in traditional, conventional warfare, where both combatants usually emphasize controlling territory (among other things) so as to defend civilians/infrastructure, obtain/deny strategic positions, seize/protect resources, and so on,[86] irregulars do not need to put *such* an emphasis on static or conventional defense due to their asymmetric responsibilities[87]: whereas a weak conventional combatant may be crushed when it tries to defend its static populace or territory, insurgents can more often disperse or flee in the face of such attacks. Of

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[83] For example, large-scale attacks could be carried out by later-stage insurgencies and/or those receiving significant external assistance.

[84] Consider for example the effectiveness of Chechen insurgents in the First Chechen War: Douglas Baker, "The Relevance Of Armor In Counterinsurgency Operations," 2012, https://apps.dtic.mil/dtic/tr/fulltext/u2/a562878.pdf.

[85] S. J. Deitchman, "A Lanchester Model of Guerrilla Warfare," Operations Research 10, no. 6 (December 1962): 818–27, https://doi.org/10.1287/opre.10.6.818.

[86] See for example: Robert Piddock, "The Need For Conventional Warfare As The Us Military Addresses The Environment & Threats Of The 21 St Century" (2009);
To some extent, see: "Irregular Warfare (IW) Joint Operating Concept (JOC)," 2007, https://www.jcs.mil/Portals/36/Documents/Doctrine/concepts/joc_iw_v1.pdf?ver=2017-12-28-162020-260

[87] See a variety of sources, including:
Record, "Why the Strong Lose";
Galula (*Counterinsurgency Warfare*); Grossman ("Robotics and the Future"); Thornton (*Asymmetric Warfare*, ch. 1 *passim*).

course, in some cases insurgents may attempt to repel, hinder, or at least punish such invasions.[88] Nonetheless, insurgents' greater flexibility in *defending* limits the significance of some of the advantages that COIN forces have in medium to large scale attacks—advantages which might plausibly be bolstered by shifts in some technology, such as PAWs. Additionally, the insurgents' comparative lack of static infrastructure and other similar responsibilities also means that COIN forces cannot as easily rely on hit-and-run or remote attacks to the same degree as insurgents.[89]

In short, these points together seem to greatly elevate the military significance of insurgents' effectiveness in small, surprise engagements and tactics, as well as their ability to inflict casualties overall (as opposed to being able to hold territory). Thus, even though this thesis could not directly test for PAWs' "equalizer" effects on overall conflict outcomes, there is reason to believe that if PAWs do increase irregulars' relative effectiveness in these small/surprise engagements, one would expect the irregulars to be more likely to succeed in the overall conflict—*even if the same shift* increases COIN forces' capabilities in some ways.

A Deeper Look at Small/Surprise Engagements

Thus far, I have argued for the importance of small, surprise engagements in irregulars' military success; this section will focus more on the character and the factors/drivers of their outcomes.[90] When considering the purpose and nature of some of these engagements, one can imagine a variety of reasons why PAWs would tend to benefit the assailants. There are different types of surprise attacks, but by focusing on the stereotypical cover-based ambush (e.g., hiding in

[88] For a discussion of such hybrid warfare, see for example: Frank Hoffman, "The Rise of Hybrid Wars," 2007, https://www.potomacinstitute.org/images/stories/publications/potomac_hybridwar_0108.pdf.
[89] Thornton, *Asymmetric Warfare*, ch. 1, *passim*.
[90] As mentioned previously, "remote attacks" (e.g., roadside IEDs, brief mortar volleys) also have an important place in insurgencies, but they are not the focus of this paper.

cover along a path and attacking the passing patrols/convoys from cover) one can gain a sense of why surprise engagements are useful and what makes for an effective attack. Based on these insights, one can then theorize on why PAWs would seem to asymmetrically help the ambushers.

The Purposes of Ambushes

One of the most basic purposes of ambushes is to inflict losses on enemies in terms of troops and equipment,[91] which can lead to reduction of fighting capability, public image/credibility, morale, etc. Such attacks can also be employed against non-military targets, including infrastructure or civilians. However, ambushes and similar attacks can also be important for simply harassing enemies, including to delay, divert efforts/resources, or deter.[92] This means that the attacks can still be considered effective even if they do not inflict high casualties, so long as they support the broader conflict strategy.

This is actually a key point which goes beyond smaller engagements: actions or even just *capabilities* can be considered impactful even when they are not "used" in battle or when they do not have a visible/direct impact (e.g., inflicting casualties). If a force is afraid to leave its areas of control due to the threat of ambushes, for example, this can cause the casualties directly inflicted by such attacks to decrease. However, it may impair the COIN force's ability to conduct operations, undermining its likelihood of success in the overall war.[93]

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[91] See for example: United States Marine Corp, "Basic Officer Course Ambush Patrols B2H0373XQ-DM Student Handout," accessed November 17, 2020, https://www.trngcmd.marines.mil/Portals/207/Docs/TBS/B2H0373XQ-DM%20Ambush%20Patrol.pdf;

[92] See for example: "The Tactics of Insurgent Groups in the Republic of Chechnya" (https://pdfs.semanticscholar.org/396c/7d56e73e72d09bf253288cb70306ae3cd0a1.pdf?_ga=2.73666194.1049143683.1513795069-802322798.1513795069);
Also see: https://www.trngcmd.marines.mil/Portals/207/Docs/TBS/B2H0373XQ-DM%20Ambush%20Patrol.pdf

[93] See for example: Record, "Why the Strong Lose."

Components of Successful Ambushes

When conducting an ambush, there are some important components/variables in success. Based on military training materials and related sources, one can identify a list of factors which are particularly relevant to this analysis.[94] Among other things, the ambushing force ideally:

1. Identifies an opportune target (based on the target's value, vulnerability, location, etc.);
2. Remains concealed/undetected until the optimal time for attacking;
3. Inflicts a high amount of damage or disruption in a short time period (during the initial, surprise phase of the attack);[95] and ultimately
4. Is able to
    a. Either neutralize the enemy or force the target to retreat,
    b. Stall or disrupt the enemy (especially in the case of supply convoys and/or columns that are pursuing the irregulars),
    c. Flee/hide if the target gains battle superiority (e.g., begins maneuvers to trap/flank the attackers), or
    d. Otherwise maximize its casualty exchange or "loss-effectiveness" ratio.[96]

In short, the ambusher's use of cover and concealment can mitigate an ambushed force's firepower, whereas the ambushing force's firepower can be highly effective against the exposed and potentially even massed target.[97] Ideally, this sudden, concentrated attack will produce

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[94] USMC, "Basic Officer Course…";
United States Department Of The Army, *U.S. Army Counter-Insurgency Warrior Handbook* (Guilford, Connecticut: Lyons Press, An Imprint Of Rowman & Littlefield, 2014);
[95] See p. 214 of the *U.S. Army Counterinsurgency Warrior Handbook*: "The ambush should be initiated with a mass casualty-producing weapon (claymore, machine gun, or similar system)."
[96] This could even include actions as drastic as using suicide bombings instead of retreating—especially if fleeing is unlikely to succeed and/or the suicide bombing could inflict high casualties.
[97] These are general principles identified by Biddle in *Military Power*, regarding the impact of cover and concealment.

enough disorder and/or casualties such that an ambushing force which may have originally/otherwise been outmatched can overwhelm the target,[98] but even if the ambush does not accomplish this it should ideally be able to inflict higher casualties on the targets than the ambushers receive.

Theorizing on Impact of PAWs Vis-a-Vis Ambushes

With some of these concepts/components in mind, one can theorize as to why technology such as PAWs seemingly would increase the effectiveness of ambushes—even when both the ambusher and ambushed have the technology. To begin broadly and simplistically, one can imagine two hypothetical ambushes of 5 insurgents against a foot patrol of 30 COIN soldiers. Suppose that practically everything about the hypotheticals remains the same[99] except that in hypothetical A both sides are armed with bolt-action rifles whereas in hypothetical B both sides have automatic rifles and some machine guns: one would intuitively expect that insurgents should be significantly more effective in the second scenario.[100] One seemingly intuitive reason for this is that with weapons with low rates of fire, each ambushing soldier will only be able to fire roughly one to three shots before the ambushed force can recover from the surprise, try to find cover, and focus their still-overwhelming firepower on the assailants while they maneuver to neutralize them. In contrast, the PAWs-equipped ambushing force should be able to inflict significantly higher casualties due to their increased rate of fire, which translates to increased

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[98] "FM 7-85 Chapter 6 Special Light Infantry Operations," www.globalsecurity.org, accessed November 17, 2020, https://www.globalsecurity.org/military/library/policy/army/fm/7-85/ch6.htm:
"Small, well-trained, disciplined forces, with limited weapons and equipment, can destroy much larger enemy forces."

[99] Including training quality, non-firearm equipment, force tactics, etc.

[100] Sieg devised a similar hypothetical in "How the Transformation of Military Power..." (p. 336).

lethality. As Biddle writes, "Modern weapons are so lethal that even a handful can wipe out much larger formations if the latter are caught in the open and fail to suppress hostile fire."[101] Still, this is just a hypothetical for general illustration; the following subsection will more deeply explore PAWs' potential impacts and link them with the components of ambush success listed in the previous section.

A Deeper Conceptual Analysis of PAWs' Impacts

To continue the point about increased rate of fire, fully automatic weapons appear to substantially increase the ambushers' potential effectiveness given how it allows such a high degree of firepower in a short time period even with small numbers of assailants.[102] This increased rate of fire means that when holding the number of ambushers constant (among other variables), PAWs should allow an ambushing force to take on larger/stronger targets (which relates to component 1) with less chance of being overwhelmed/neutralized (components 4a and 4c), because the enhanced lethality enables inflicting greater casualties in the initial surprise portion of the attack before the targets can react (component 3), which could help tip the subsequent battle in favor of the attackers (component 4a). In cases where battle superiority is not achieved, one may expect PAWs to be useful for laying suppressing fire to support some retreat (component 4c)—although as noted later, automatic weapons can also be used by the targeted force to suppress the assailants to deny such a retreat or enable their own maneuvers. Furthermore, even if component 4a and 4c are not well achieved (i.e., an ambushing force is neutralized), if the PAWs enable the ambushers to achieve a higher casualty ratio they could be considered beneficial.

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[101] Biddle, *Military Power*, p. 69. Immediately after this sentence, he lists the example of "A 1915 machine gun [...]"
[102] Biddle writes in *Military Power* (p. 69): "A 1915 machine gun could fill the space in front of it with 400-600 bullets per minute [...] a single gun could slaughter whole battalions if they tried to rush it in the open."

However, PAWs also seem to enable a group to achieve as much or more firepower with fewer soldiers than a larger group with semi-automatic (let alone bolt-action) rifles. The use of smaller groups with PAWs seem to offer some additional advantages: fewer troops should be easier to move and conceal (component 2)—during both preparation (e.g., movement to an ambush site), immediately prior to execution (i.e., when the enemy is visible and approaching), and if/when a retreat is necessary. The use of fewer troops may even allow ambushes in areas/on paths that do not have concealment for, e.g., four times as many troops (components 1 and 2). Using fewer troops also means risking fewer lives such as in case the ambush goes awry or if the ambushers are already expecting/accepting death (component 4d). Using fewer troops per ambush could also potentially enable an insurgency to set up more potential ambush points or conduct simultaneous attacks by splitting their forces (component 1). One could continue identifying plausible/theoretical benefits (e.g., requiring fewer people in the loop leads to a lower chance of leaks via informants/etc. (component 2)), but the potential benefits from decreased casualty risks, greater concealment, and enhanced firepower appear to be important and readily understandable, and thus should serve to illustrate the point.

Some Contrary Considerations

Although it is easy to focus on PAWs' potential benefits for insurgents, these gross benefits do not only apply to insurgents, given that COIN forces also can and do conduct ambushes.[103] Secondly, the analysis above does not make a full "net evaluation" of PAWs' effects on ambush outcomes (i.e., when both sides have them). Lastly, the analysis above does not focus on the potential role of PAWs outside of these small engagements/attacks, such as in static

[103] Military manuals such as the *U.S. Army Counterinsurgency Warrior Handbook* provide instructions on setting ambushes.

defenses (e.g., checkpoints) or larger assaults. To briefly address the first point: the nature of irregular conflict (with asymmetric responsibilities) tends to make it easier for irregular forces to conduct surprise attacks, and insurgents also appear to *rely* more heavily/frequently on such ambushes and targeted attacks for inflicting losses/setbacks against their adversaries (for reasons described earlier). Thus, shifts in the factors that increase the assailants' effectiveness in these engagements would seemingly tend to benefit insurgents more than COIN forces.

With regards to the second point, there are some readily understandable ways in which the PAWs may not work so "ideally" for the ambusher and could even grossly help the ambushed forces when they have/use PAWs. First of all, automatic weapons do require significantly more ammunition (if their high rate of fire is utilized), which can be an issue in transportation and can particularly be a problem for resource-strapped insurgencies. More broadly, employing the high rate of fire—especially by untrained or undisciplined users—can lead to greater inaccuracy/waste (among other issues) and thus reduce the weapons' effectiveness.[104] Additionally, if the ambushed force is using armored vehicles, this can substantially limit the effectiveness of PAWs *alone* (i.e., when not deployed in combination with anti-armor units/equipment)[105]—but such a shift in COIN force employment (i.e., mechanization) may come with the downsides such as what Lyall and Wilson have described (and the question of the effects of/interactions with other, anti-armor technology would need coverage in a separate study).

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[104] One can read the sentiment of one writer here: Carlos Marighella, "Minimanual of the Urban Guerrilla — Ch 5," www.marxists.org, accessed November 17, 2020, https://www.marxists.org/archive/marighella-carlos/1969/06/minimanual-urban-guerrilla/ch05.htm;

[105] See for example: Baker, "Relevance of Armor in Counterinsurgency Operations";
Also see Biddle, "The determinants of nonstate military methods";
Perhaps most significantly, see Moyer, "Death Before Dismount?"

Turning to the potential *benefits* of machine guns for the ambushed force, various military field manuals among other sources have noted that in responding to an ambush, it is crucial for the ambushed force to react with a high volume of fire so as to suppress the assailants.[106] Building on this, one source understandably states that "Full automatic fire enhances the ability of Army units [...] to react to an enemy ambush [....]"[107] Among other effects, such actions may help an ambushed force maneuver to better defend itself and/or suppress enemies while awaiting help (e.g., another patrol, artillery, or air support). One could likely continue pointing out similar issues, but in summary, even these limitations and counter-arguments do not appear to generally outweigh the seemingly-large advantages that PAWs provide to ambushing forces.

Lastly, there is the important question of how PAWs might impact either side's effectiveness in *other* engagements/tactics/strategies and how this may impact overall conflict outcomes. Some might argue, for example, that PAWs enable COIN forces to operate more checkpoints and/or risk fewer soldiers per checkpoint, which could increase their likelihood of success. This opens up a much more complex (and seemingly more case-specific) question, and as such it cannot be thoroughly addressed in this subsection alone; it will be addressed in more detail in the qualitative analysis. However, some of the analysis thus far—especially that in the "Significance of Small/Surprise Engagements" subsection—has partially addressed this in a broad sense. First, that subsection argues that irregular strategies/tactics mitigate the impact of material advantages in operations such as large-scale assaults, which limits the impact of

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[106] "FM 7-85 Chapter 6 Special Light Infantry Operations";
United States Marine Corps, "FMFRP 12-25," 1990,
https://www.marines.mil/Portals/1/Publications/FMFRP%2012-25%20%20The%20Guerrilla%20and%20How%20to%20Fight%20Him.pdf.

[107] Arthur Osborne and Seward Smith, "Analysis Of M16A2 Rifle Characteristics And Recommended Improvements," 1986, https://apps.dtic.mil/dtic/tr/fulltext/u2/a168577.pdf. Notably, however, this source also says that fully automatic fire enhances the soldiers' ability to conduct ambushes.

advantages provided by PAWs in these areas. Second, PAWs' effects in attacks such as ambushes and HARs should be particularly amplified (or simply "not restricted") because of the element of surprise: their targets are often exposed and will be delayed in returning fire (often against a concealed foe in cover).[108] When used in (some) defensive positions or typical combat, one would expect the attackers to be more prepared and thus use more cover or suppressing fire, which should mitigate PAWs' impacts. Third, to the extent that this argument does have weight, one must still weigh such effects against PAWs' effects/significance in surprise attacks, which earlier analysis emphasizes as particularly valuable for the irregulars.

Expectations, Hypothesis, and Partial Conclusion to this Chapter

In summary, my theoretical reasoning/analysis would expect that when insurgent or guerrilla forces use irregular strategies and tactics, the availability/use of PAWs should enable the insurgents to achieve higher battle-death exchange ratios or tactical/battle success (e.g., forcing retreats, stalling progress) in surprise engagements, *ceteris paribus* (with important caveats noted below). My analysis expects this to hold true even when both sides have access to the technology, which would mean that such technology serves as a partial "equalizer" because it increases the effectiveness of the irregular strategies/tactics that are designed to mitigate the impact of disparities in material capabilities. If the expectation of increased combat effectiveness holds true, one would subsequently expect this to increase the likelihood of overall insurgency success—at least when COIN casualty aversion is meaningfully high. Still, *the only hypothesis*

[108] Consider for example the modeling in Deitchman, "A Lanchester Model":
"When the battle starts, *odd* [the ambusher] fires on *even* [the ambushed party] with *even* in full view. *Even's* loss rate is thus proportional to the number of *odd* men firing. The ambusher is hidden, however, and so *even* will return the fire blindly into the area which *odd* occupies."

that will be tested in this thesis is that a significant increase in PAWs access/usage by both sides should cause an increase in the irregular force's military effectiveness (as defined later).

The emphasis on *ceteris paribus*, though, relates to a possibility separate from the issue of battle-death exchange ratios: my theoretical analysis also recognizes that the mere *threat* of such attacks could lead the COIN force to respond by changing its tactics or force employment in ways which help it avoid increased casualties, yet which also make COIN victory less likely, less thorough/complete, slower, or more monetarily costly. For example, it may be that the COIN forces conduct fewer raids or shallower patrols, use more-expensive armored vehicles, rely more on remote attacks (e.g., drone strikes[109]), and/or delegate more manpower responsibility to less-trained or less-disciplined local troops/militias rather than risking the COIN force's own "ground troops." This is why I will examine military effectiveness beyond *just* battle-death exchange ratios alone.

Building on the previous paragraph, I will lastly emphasize that this hypothesis does not expect a positive *imperfectly controlled* correlation between PAWs access/usage and insurgent battle-death exchange ratios. In fact, the two variables could very well have a negative correlation due to a myriad of other variables such as improvements in other COIN equipment (e.g., night vision goggles, aerial surveillance and bombing) yet still have the hypothesized causal relationship.

[109] Some sources suggest that drone strikes can be counterproductive in the long term, despite their appeal in avoiding casualties. For example, see p. 10 of Alam, "When Does Counterinsurgency Work?"

The Broader Concept of Technologies as Potential Equalizers

To be clear, this thesis only engages in some hypothesis testing for a specific type of technology: PAWs. *However*, one can situate the argument and framework employed here within a broader category of concepts/analyses: how some technologies or technological shifts might serve as "equalizers" in conflict or security more broadly. (Alternatively, some innovations/shifts may have the opposite effect in that they magnify/exploit disparities in power/effectiveness, but that is beyond the scope of this analysis.) An important part of the framework used here to evaluate the concept of "equalizers" is the emphasis on *shared/comparable* shifts in technology access/usage (i.e., for both the regular forces and irregular forces), as opposed to merely considering "what happens when the irregular force's access to/usage of this technology increases?" Crucially, the condition of shared/comparable shifts forces the researcher to examine why a technology held by both sides may have such asymmetric effects, rather than seeking cases where the explanation is simply "Side X's technology was superior, which gave them an advantage." This is explained in more detail in the methodology chapter.

In the case of PAWs, the proposed explanation is that they enhance the net effectiveness of *tactics/strategies* (e.g., ambushes, hit-and-runs) which *reduce the impact* of overall material disparities, such as in equipment quantity/quality, manpower, and other factors that are often considered important in conventional combat effectiveness. One could also imagine how some other technologies such as RPGs and mines similarly enhance the effectiveness of these tactics/strategies against mechanized COIN forces, but that is beyond the scope of this analysis.

However, it appears that "enabling or enhancing the effectiveness of tactics/strategies..." is not the only reason some technological shifts might serve as equalizers. One could reasonably

also point to technological shifts that reduce entry barriers for some technologies (e.g., weaponized commercial drones), as Hammes has done.[110] In a related sense, a technological innovation/shift for something with diminishing marginal returns might also benefit the weaker side (depending on the specifics of the situation) since it may mean that a larger force cannot efficiently use its fiscal advantages to simply "out-scale" an enemy in using the technology. Along another line of reasoning, one could also consider the concept of "counters," wherein shifts appear to disrupt the specific technological advantages held by one side (e.g., German use of submarines to undermine the British dreadnought fleets in WWI).[111]

Ultimately, these and other arguments/concepts may be distinct in a variety of ways, but they share some common theoretical features (at least in their implication): they hold that some technological shifts/innovations can *reduce the degree or impact of disparities in various capabilities*, whether that is technological sophistication, equipment/troop count, human capital (e.g., training), resources, etc. Some of these "equalizer" concepts have been mentioned by researchers and practitioners, as noted in the literature review. Crucially, however, I could not find any scholarship which draws these analyses together in a way that highlights and categorizes their theoretical similarities (unlike the many articles which explicitly point out the body of research and analysis devoted to offense/defense theory). Such a task is outside the scope of this thesis, but this study has touched on a few of these analyses while highlighting the disorganized and seemingly-underdeveloped body of research related to the concept of "equalizer vs. divider" technology.

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[110] Refer back to the subsection in the literature review that introduces/discusses his research.

[111] For some discussion on this, see for example Keith Carter, "Technology Strategy Integration," 2012, https://apps.dtic.mil/dtic/tr/fulltext/u2/a562732.pdf.
For broader discussion, see the RAND study that addresses the concept of disrupting "core competencies": Hundley, "Past Revolutions, Future Transformations."

There are a variety of potential/plausible justifications for formalizing and categorizing this concept and literature, including to better understand/explain the puzzle of trends in irregular conflict outcomes. However, this concept seems like it could be particularly relevant in the conditions/uncertainties of the modern world, including future innovations (as opposed to just historical shifts). For example: in order to improve America's military effectiveness, various commentators have emphasized the importance of constantly innovating.[112] This sentiment definitely appears to be reasonable as general guidance, but it bears noting that our current era has seen significant technological proliferation, especially with regards to non-physical technology (e.g., software),[113] which raises concerns that some American military innovations could be mimicked by America's adversaries. More generally, some commercial innovations will be beyond America's control. Thus, it seems that some sort of theoretical framework as well as a base of historical knowledge on past innovations (e.g., "what kinds of technology have had equalizing effects, and why?") would be useful in guiding discussion, research, and forecasts as to the potential impacts of emerging technology. Although work by Hammes and various parts of the RMA literature have touched on some of these issues from a theoretical perspective, I could not find any empirical tests of the kind that I do in this study, and even on the theoretical level

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[112] See for example the sentiment expressed by:
David Drabkin and Michelle Johnson, "The U.S. Military Must Win the Battle for Innovation," Nextgov.com, 2019, https://www.nextgov.com/ideas/2019/04/us-military-must-win-battle-innovation/156282/;
Daniel M. Gerstein, "The Military's Search for Innovation," www.rand.org, August 13, 2018, https://www.rand.org/blog/2018/08/the-militarys-search-for-innovation.html.

[113] Krepinevich, "Cavalry to Computer": "the competitive advantages of a military revolution are increasingly short-lived.";
Bob Work, "Remarks by Deputy Secretary Work on Third Offset Strategy," U.S. DEPARTMENT OF DEFENSE, 2016, https://www.defense.gov/Newsroom/Speeches/Speech/Article/753482/remarks-by-d%20eputy-secretary-work-on-third-offset-strategy/. Specifically, see his discussion surrounding: "we believe we're in a world of what we call "fast followers."";
Benjamin Locks, "Bad Guys Know What Works: Asymmetric Warfare and the Third Offset," War on the Rocks, June 23, 2015, https://warontherocks.com/2015/06/bad-guys-know-what-works-asymmetric-warfare-and-the-third-offset/.

much of the existing work lacks conceptual clarity/coherence or engagement/interaction regarding this issue. Ultimately, it seems that a more-organized literature on the concept of "equalizer" technology would be of meaningful value to both researchers and decision-makers, such as by providing insights on whether/which future military technologies may be equalizers.

Chapter III: Methodology

The Impracticality of a Statistical Analysis

Ideally, this study would include a statistical/large-N approach to evaluating whether PAWs have been "equalizers" by collecting data on regular and irregular forces' access to/usage of PAWs throughout the past 200 years, so as to detect any relationships between their access/usage and success rates. Put simply, this approach did not appear to be possible given what seems to be a complete lack of any dataset for such weaponry access/usage in irregular conflicts combined with the fact that compiling such a dataset was completely beyond the capabilities of this author.[114] Additionally, although such an approach would seemingly have some substantial advantages if conducted correctly, there would also be concerns that such an approach is premature given the weak base of theoretical research regarding equalizer technologies to guide the research (e.g., how variables should be operationalized, whether certain variable interactions should be included in regressions). Regardless of the deeper question of whether such an approach is warranted, however, the fact that it was currently not feasible necessitated a more focused, case-study approach. This thesis will therefore use a comparative case study of the last two calendar years ("guerrilla phases") of both the Boer War and the German East Africa Campaign of WWI, for reasons explained in the following chapter.

The following section on the dependent variable will explain more of the methodology, especially with regards to the use of both quantitative and qualitative analyses in the comparative case study. Further down, the independent variable section will explain the "equalizer" concept

[114] As emphasized in the next chapter, just finding data for the two cases in this thesis alone proved to be quite difficult and time consuming, and my initial/preliminary research into other cases suggests that both of these cases were much easier to collect data for than the median among cases from 1800 to 1950.

and the approach for evaluating whether PAWs constitute an example of such a technology (while defining/operationalizing the independent variable). The control variable analysis, however, will be covered entirely within the comparative case study chapter, as the discussion is so closely tied to the details of the cases in question.

The Dependent Variable (DV)

DV Conceptualization

Because the hypothesis holds that an increase in PAWs access/usage *disproportionately* benefits the military effectiveness of the irregular side in these conflicts, the dependent variable at the most conceptual level is "an irregular force's military effectiveness relative to the military effectiveness of the regular force." Military effectiveness is a complex/debated term, but in this analysis I am just using the term to refer to the ability of an actor to achieve its tactical and strategic military goals through military force/actions (e.g., inflicting casualties, intimidation/deterrence). That is to say, I am defining military effectiveness as a "result" in a given context (i.e., against a given enemy) rather than an index of context-less "input" characteristics or "factors" (e.g., training).[115] Given that *in general* two enemy combatants' tactical and strategic goals will conflict,[116] one can actually simplify the conceptual definition of the DV to "net irregular military effectiveness" or even just "irregular military effectiveness" for

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[115] Some sources opt for the latter approach. For alternative/more-nuanced conceptualizations of "military effectiveness," see for example:
Worsnop, "Organization and Community";
Claes Egnell, "The Missing Link: Civil-Military Aspects of Effectiveness in Complex Irregular Warfare," 2007, https://www.diva-portal.org/smash/get/diva2:398802/FULLTEXT01.pdf;

[116] *Technically*, it is possible for *some* of the goals of two combatants to not conflict (e.g., during cold conflicts and ceasefires), but this is not very significant for the analysis I conduct here: my main focus is on what causes one side to prevail where conflict in goals do exist.

short (so long as one understands the "comparative results" aspects of the phrase). The following subsections will go into more detail on the operationalization.

DV Quantitative Operationalization: BDXR

Ultimately, for the *quantitative* analysis I will simply be operationalizing the DV as the battle-death exchange ratio (BDXR), but the operationalization for the qualitative analysis is more complex. To begin with the quantitative operationalization of BDXR: first, one must understand the usage of the term "battle deaths" (BDs). Unlike some casualty counts, this figure only refers to the number of combat troops (as opposed to porters/carriers) "killed in action" (KIA)—except in some secondary estimates where I include some soldiers who later "died of wounds" (DOW) received in combat.[117] Thus, this number excludes all other casualties, including deaths from disease, wounded, captured, missing, etc.

Estimates are created for each combatant in the conflicts by aggregating information/estimates on their battle deaths during the relevant guerrilla periods. However, the quantitative analysis will provide a variety of estimates (e.g., "KIA only," "KIA+DOW," medium/high estimates) in order to grapple with the occasionally limited, conflicting, imprecise, and otherwise unclear information. Part of this is to check for robustness of the results under different measures and assumptions (e.g., KIA vs. KIA+DOW), but sometimes this is simply due to the way some data is reported (e.g., Belgian records only reporting combined KIA+DOW).

Once these estimates have been created, the "exchange ratio" is found by simply dividing the number of regular-force BDs by the irregular-force BDs. Thus, a higher BDXR indicates that an insurgent was more "militarily effective" (per my limited operationalization here). The

[117] These exceptions are explained and labeled when I conduct the analysis in the following chapter.

quantitative analysis will compute a variety of results using different combinations of estimates, then highlight which estimates are the main or "best" (based on their conceptual relevance, their reliability, and control variable considerations).

Justification for BDXR

There are three main objections one might level against this operationalization: first, why not focus on war outcomes; second, why only focus on personnel casualties as opposed to battle outcomes, survival duration, sabotage success/damage, or other metrics; third, why only focus on "battle deaths" (as opposed to all/other casualties)? With regards to the first objection, there are two points to make: these two conflicts are not sufficiently comparable along certain control variables related to politics (e.g., motivation for fighting), and these two conflicts involve relatively low casualty aversion on the regular sides compared with modern conflicts (and thus, even if PAWs increase the irregulars' BDXRs, this may not be enough to offset the regulars' conventional advantages). With regards to the second point, there are three responses: structured and consistent data on things like battle outcomes and sabotage success/damage are plainly not available (and may not be very insightful in the case of battle outcomes[118]), other authors have used *loss*-exchange ratios to operationalize military effectiveness (albeit primarily for conventional war),[119] and again the variations in control variables make "survival duration" a

[118] Put simply, if battle outcomes do not refer to casualty exchange ratios or just casualties in general, they typically refer to either holding or capturing some territory, but momentary "capture" of territory is not very insightful in irregular conflicts. Other operationalizations will tend to be difficult.

[119] Eric Fowler, "Culture and Military Effectiveness: How Societal Traits Influence Battle Outcomes," 2016, https://doi.org/10.25777/fnbr-nx39;
Charles Miller, "Destructivity: A Political Economy of Military Effectiveness in Conventional Combat," 2013, https://dukespace.lib.duke.edu/dspace/bitstream/handle/10161/7111/Miller_duke_0066D_11750.pdf;jsessionid=6E8123D08F112F9E0FD59EFA8F91490D?sequence=1;
Michael Beckley, "Economic Development and Military Effectiveness," Journal of Strategic Studies 33, no. 1 (February 2010): 43–79, https://doi.org/10.1080/01402391003603581;

poor measure in this case.[120] The third objection is more substantive, but there are two main responses: first, the conceptual relevance of deaths from disease to military effectiveness is tenuous (at least for the purposes of this analysis),[121] and including this can particularly add problems when comparing between two wars fought in different climates and which involve different numbers of total troop ratios, such as with the comparative case study here; second, KIA is the most consistently reported combat-related casualty type across the wars and combatants, compared with other battle-related casualties.

Having said all of this, I will acknowledge that these points as a whole do raise some valid concerns even if it is true that other metrics simply are not feasible/reliable in a quantitative analysis. This is one reason why I am also conducting a qualitative analysis.

The Qualitative Approach to Evaluating the DV: Tactical Effectiveness

Even if BDXR appears to be the best singular proxy/metric for irregular military effectiveness (based on data availability, conceptual relevance, and objectivity of the metric), it is

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For an example that operationalizes military effectiveness in terms of loss-exchange ratios, see: Sameer P. Lalwani, "Size Still Matters: Explaining Sri Lanka's Counterinsurgency Victory over the Tamil Tigers," Small Wars & Insurgencies 28, no. 1 (January 2, 2017): 119–65, https://doi.org/10.1080/09592318.2016.1263470.

[120] As noted later, Lettow-Vorbeck continued his campaign with some notable success/determination up until he received confirmation that Germany had surrendered in 1918, at which point he soon thereafter surrendered. See Paul von Lettow-Vorbeck, *My Reminiscences of East Africa*. www.gutenberg.org, 2016, http://www.gutenberg.org/files/51746/51746-h/51746-h.htm.

[121] A measure which includes disease deaths opens the door to a variety of alternate causes for shifts in military effectiveness such as "dyadic disparities in medicine quality/usage" (in addition to the factors mentioned immediately after this footnote). On some level, one could plausibly figure PAWs as a contributing factor to an increase in "overall-death exchange ratios" (ODXRs), such as if 1) one finds that PAWs enable irregular forces to more effectively delay/evade their pursuers, and 2) the irregular forces' BDXR is less than the "disease-death exchange ratio" (DDXR): under such conditions, the BDXR's weight in the ODXR is reduced by the DDXR (since prolonging the war by evading conflict contributes to greater disease deaths relative to battle deaths). To further illustrate the problem by stretching such an approach to an extreme: consider the possibility that if disease deaths are included, a small guerrilla band of 100 combatants could have a high ODXR without ever inflicting a single battle-casualty on their 10,000-strong enemy simply by fleeing and letting disease take its toll on their more-numerous pursuers: if both sides have similar "disease-deaths per capita," the DDXR will essentially become the troop ratio (in this case 1:100). When attempting to analyze the effects of PAWs on military effectiveness, this would be very problematic.

far from perfect. In fact, there is a particular concern that such a metric could be biased or otherwise misleading[122]: a regular force might still be willing to suffer higher casualties in order to achieve some military objective, such as when trying to achieve a quick end to a war, and still be more "militarily effective" than if it had fought a longer (but more casualty-efficient) war. On the other end of the spectrum, a regular force might be so casualty averse that it engages in strategies which reduce the casualties suffered but also reduce the likelihood of overall victory (setting aside considerations such as that a casualty averse electorate might call for withdrawal if casualties are not reduced) or which at least lengthen the war, such as by not aggressively pursuing an enemy or not patrolling in certain areas.

Thankfully, such problems were not clearly/overwhelmingly present in this case group, in that in both cases the regular forces seemed to apply *generally* comparable amounts of pressure (as opposed to vigorously attacking the guerrilla forces in one case vs. taking up heavily defensive positions in the second case). Still, in order to better address such possibilities by going beyond the simplistic measure of BDXR, the qualitative analysis will try to focus on the military effectiveness of some types of tactics that played prominent roles in one or both of the conflicts. Although this issue of differing tactics/pressure could be interpreted partially as a control variable, it is closely related to the broader conceptual definition of the DV, military effectiveness (i.e., ability to achieve tactical/strategic goals), which is why it is primarily covered in the qualitative analysis. Notably, there are reasons to think that the shift in PAWs access/usage may have affected the choices in tactics/strategies. The operationalization of "effectiveness" in

[122] One source concludes its analysis of this methodological issue (in the context of conventional war) as such: "In short, whether armies' battle deaths are high or less tells us very little about how cohesive, tactically proficient, and operationally sophisticated that army is, in the absence of any other contextual information." - Elisabeth Rosemary Caitlin Talmadge, "Explaining Military Effectiveness : Political Intervention and Battlefield Performance," dspace.mit.edu, 2011, https://dspace.mit.edu/handle/1721.1/68942.

this analysis will admittedly be rather loose, including both BDXR (but with less emphasis on specific numbers) as well as combatants' ability to achieve their tactical/strategic goals, such as mobility restriction (on both sides) and the ability to quickly eliminate/attrit the guerrillas (who in contrast were often seeking longer-term survival/protraction rather than *just* high BDXR). Ultimately, by having different operationalizations for the quantitative and qualitative analyses, the main weakness of each operationalization (conceptual validity and operational objectivity, respectively) can be mitigated by the other's strength in this regard.

The Independent Variable (IV)

IV Definitions: Qualifying "PAWs" and Quantifying "PAWs Intensity"

Empirically testing the hypothesis of PAWs being "equalizers" *in part* requires evaluating a group of cases in which there is a shift in the irregular sides' PAWs access/usage. Because I only hypothesize that increased *irregulars'* PAWs access/usage improves irregulars' effectiveness (whereas I hold that comparable increases in *regular* PAWs access/usage *grossly* hurts irregulars' effectiveness[123]), the independent variable of this analysis technically just refers to each irregular force's PAWs access/usage in a conflict. However, even finding a strong, positive, causal relationship between such an IV and the DV would not necessarily qualify PAWs as "equalizers," since the key aspect of this concept is that of *asymmetric/disproportionate* benefits: in order to determine whether PAWs are equalizers, one must show that the DV increases even when the regular forces across the two cases also experience a comparable increase in access/usage. This is why it was important (albeit difficult) to choose two cases

[123] This is in contrast to how Lyall and Wilson argue that increased *regular* mechanization helps *irregulars*/hurts the regulars.

across which the comparisons between regulars' and irregulars' PAWs access/usage do not excessively vary. Ultimately, the evaluation of the IV (irregulars' PAWs access/usage) is closely tied with evaluation of an important control variable: the regular side's PAWs access/usage.

Defining/Qualifying PAWs

Before getting into the issue of operationalizing and measuring "access/usage," one must conceptualize and operationalize "man-portable, fully-automatic weapons." Although this may generally be an intuitive category of weapons (e.g., machine guns, submachine guns, fully automatic rifles), the Boer War involved weapons which cannot be so intuitively categorized (mainly, the heavy Maxim machine guns and the "pom-pom" autocannons).

First, by "fully-automatic weapon," I am referring to weapons which not only have high individual cyclic rates (i.e., rate of firing two rounds in succession) but also do not require manual trigger pulls or lever cranking for every shot and which, when also considering their ammunition capacity and reload speed along with the cyclic rate, can have a moderately high *effective* rate of fire. To be more precise, one could set the cyclic rate cutoff at roughly 350 rounds per minute (rpm),[124] but it is difficult and unnecessary to identify a *specific* cutoff for effective rate of fire for purposes of this analysis. Ultimately, nothing about this definition is meant to be counterintuitive; it is mainly just meant to outline criteria that exclude multi-barrel "volley guns" (e.g., the French *mitrailleuse*), crank-operated weapons (e.g., Gatling guns), and

[124] Britannica defines machine guns as having a cyclic fire rate greater than 500 rpm: "Machine Gun," in Encyclopædia Britannica, 2019, https://www.britannica.com/technology/machine-gun.
However, this appears to be a bit high and arbitrary, and importantly for this analysis, it would seem to exclude some conceptually relevant weapons such as the 1895 Colt "potato digger" machine gun which was used in the Boer War but had a somewhat low rate of fire (estimates vary around 400 rpm). Sources for the estimated fire rate:
David Deasey, "Machine Guns in the Boer War," www.bwm.org.au, 2011, https://www.bwm.org.au/mgs.php;
Peter Suciu, "The National Interest: Blog," The National Interest, 2020, https://nationalinterest.org/blog/buzz/meet-%E2%80%9Cpotato-digger%E2%80%9D-machine-gun-163456.

most importantly for this analysis, the so-called "pom-pom."[125] The Maxim machine gun is one of the first notable weapons to meet this criterion, and it was used by both sides in the Boer War.

There is also the qualification of "man-portable," which is more ambiguous than the previous. The conceptual basis for this operational distinction is that, theoretically speaking, one can reasonably expect that heavier and bulkier weapons are more difficult to transport (from a campaign point of view, e.g., marching), more difficult to maneuver (from a tactical point of view, e.g., retreating, flanking) and more difficult to conceal (such as when setting ambushes). Still, the operationalization is rather fuzzy: ideally, one could just say "*not* those weapons which are largely bound to machines/vehicles (e.g., carriages, ships) even in battle, as opposed to those which can at least be transported for short distances by hand and set up/used separately from those machines/vehicles." Light machine guns (e.g., the Lewis gun in the GEAC) fully fit in the latter category, as they should from a conceptual/theoretical standpoint. However, the problem is that Maxim machine guns (especially those used in the Boer War) seem to squarely straddle this distinction: they were very heavy, weighing over 50 pounds even without their water-coolant jackets[126]; many of these weapons were transported and used on carriages (especially initially),[127]

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[125] These guns were varyingly called "Maxim-Nordenfelts" (see De Wet's writings) and "Vickers-Maxims" (see British accounts such as *The Times History*…), apparently due to the original manufacturer being acquired by the Vickers family in 1897. As *The Times History*... (v. 6, p. 489) notes, the gun filled "the gap between" machine guns and horse-drawn artillery and was "universally known as the pom-pom." In short, I do not consider pom-poms to qualify as PAWs primarily due to their low effective rate of fire combined with their weight. Regarding their rate of fire, estimates widely vary, including 30, 60, and 200 rpm (often without differentiating between cyclic and effective fire rates, which may help to explain the variation), but the general sense is that the *effective* rate was substantially less than machine guns (sources, respectively for each estimate: *The Great Boer War* (p. 44); David Deasey, "Pom Poms in the Boer War"; Spencer Jones, "The Influence of the Boer War…").

[126] Daniel Kenda, "Lessons Learned from the Use of the Machine Gun During the Russo-Japanese War and the Application of Those Lessons by the Protagonists of World War I," 1992, https://apps.dtic.mil/dtic/tr/fulltext/u2/a437022.pdf;
Deasey, "Machine Guns in the Boer War".

[127] "The Great War - Machine Guns," www.globalsecurity.org, accessed November 17, 2020, https://www.globalsecurity.org/military/world/europe/history/machine-guns-great-war.htm;
Kenda, "Lessons Learned";

and their weight and size were repeatedly cited as limitations on their use/effectiveness.[128] Yet, Maxim guns could be dismounted from carriages, transported short distances by carriers, and placed on tripods to set up for a concealed attack.[129] Thus, it seems conceptually problematic to wholly disqualify them as PAWs for purposes of establishing IV variation (and PAWs intensity variation in general). For greater precision, one *could* create tiers of PAWs to "weight" weapons differently based on their qualities (e.g., size, mass, accuracy, reliability), but for the purposes of this analysis such an endeavor is unnecessary (and would be highly subjective): even when I characterize these Maxims as PAWs equivalent to later machine guns, the quantitative difference between the two conflicts shows there is clear IV variation.

Measuring "Access/Usage": PAWs Intensity

Operationalizing access/usage[130] by merely counting and comparing the machine guns possessed by each side in each conflict fails to address some important conceptual/theoretical

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One source does state that "Some British units were known to dismount their guns leaving the carriages as decoy targets." Source: Deasey, "Machine Guns in the Boer War."

[128] "The machine gun performed poorly in South Africa, with the unwieldy weapons making perfect targets for Boer artillery and riflemen." - Spencer Jones, "The Influence of the Boer War (1899-1902) on the Tactical Development of the Regular British Army 1902-1914," 2009, https://core.ac.uk/download/pdf/1933109.pdf.

[129] Ian Cross, "The Ordnance and Machine Guns of the British South Africa Company 1889 - 1896 Part Two: 1895-1896," samilitaryhistory.org, 2014, http://samilitaryhistory.org/vol163ic.html;
Great Britain Royal Commission on the War in South Africa, Appendices to the Minutes of Evidence Taken Before the Royal Commission on the War in South Africa: Presented to Both Houses of Parliament by Command of His Majesty, Google Books (H.M. Stationery Office, 1903), https://play.google.com/books/reader?id=OTY6AQAAMAAJ&hl=en&pg=GBS.PA346 (p. 346).

[130] At this point, one might begin to think it is better to simply use one term or the other, but the juxtaposition of the two terms (access and usage) tries to cover some potential conceptual concerns: for example, it is possible that the regular forces in two conflicts have nearly the same levels of access to the technology but the regulars in one conflict use it much more in combat (or the technology is not really used in either war), perhaps because 1) the access/possession of the technology—and the associated *threat* of its usage—was enough to deter actions which would warrant using the technology (e.g., some hypothetical irregulars never bothering to use drones because they know that the regular forces' anti-drone systems will make this strategy ineffective—but this causes the anti-drone systems to never be "used"); or 2) in the first conflict the regulars simply were not using the technology as optimally as possible, such as if the weapons were assigned to units who did not often see combat (an issue touched on in this subsection). Ultimately, this is not *such* a significant issue in this case (with PAWs), but it still does have some relevance, and it appears better to use the combined label of "access/usage" when not using the term which was intentionally operationalized as a combination of the conceptually relevant parts of "access" and "usage": "relevant PAWs intensity."

concerns. For example, when analyzing PAWs' association with BDXRs, it is important to control for troop counts: if one were to simply focus on the count of weapons, this would risk errors in reasoning—especially when the number of troops varies significantly between cases, since greater numbers of troops *tend* to distort/dilute the possible role of the equipment in question. For example, if some conflict "A" involved 100,000 troops but took place early in the development/proliferation of PAWs and thus only involved 100 machine guns, it might involve the same number of PAWs as a later, smaller conflict "B" which consists of 1,000 troops and 100 machine guns. However, it would not make conceptual sense to consider that "access/usage" did not change across the conflicts: one would generally expect that when there is a lower troop to equipment ratio, the equipment will *tend* to have a greater effect on the results (e.g., loss exchange ratios, conflict outcome), *ceteris paribus*.[131]

At the same time, simply adjusting based on the *total number* of "troops" ignores the fact that not all "troops" (especially for regular militaries) are employed in equivalent combat roles. In the Boer War, for example, at one point Kitchener had roughly "200,000 troops," but over 85% of these troops were used for basic logistical and guard work—and even of the 22,000 troops "available for the columns pursuing the Boer commandos," "only 13,000 served in combat units."[132] The problem, thus, is that if the PAWs are strategically distributed to a minority of troops that frequently encounter the enemy (e.g., the pursuing columns)—i.e., where the PAWs will experience a high amount of usage—a naive ratio that just compares "total number of troops to total number of PAWs" will under-appreciate the role of PAWs in the conflict.

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[131] Admittedly, this assumption may or may not be shaky for some technologies such as nuclear weapons, wherein the effects *might* be far more logarithmic (i.e., the increase in weapon stocks may have diminishing marginal impacts after a small minimum is reached)—but for the question of troop-level equipment such as machine guns in the conflicts in question, these niche concerns do not appear to be so significant.

[132] Leopold Scholtz, *Why the Boers Lost the War* (London Palgrave Macmillan Uk, 2005), p. 105.

Trying to reconcile concerns such as these is not easy; at some point one must make a tradeoff between conceptual precision, theoretical significance/relevance, feasibility (especially given data limits), and overall efficiency. Thus, I will focus on the concept of "relevant PAW intensity," (or just "PAWs intensity") which tries to capture the extent to which they appear in combat situations (e.g., in pursuing columns), relative to the troops in those situations. Operationalizing this necessitates some subjectivity, but one can make rough estimates by comparing the ratio of troops to the number of operable[133] PAWs among fighting companies and columns. Although this lacks some measurement and conceptual precision, it is sufficient for the purposes of 1) demonstrating the shift in irregular access between the two wars (for IV variation purposes), and 2) *loosely* comparing differences in PAWs intensity between the *two sides within each* war (for control variable purposes). I also choose it because it is the way that much of the available data is reported (i.e., at the company, brigade, or other group levels rather than as aggregate totals for the entire military).

[133] This modifier will briefly come into play later; basically, this qualifier seeks to address maintenance and ammunition issues that are not particularly unique to or caused by the characteristics of PAWs (e.g., their tendency to use high amounts of ammunition).

Chapter IV: Comparative Case Study

Case Choice Explanation

Goals in Case Selection

In general, the ideal set of cases for comparison testing (or simply "case group") would be one in which the IV increases across the cases, but the relevant control variables stay constant—with the partial exception of the regular forces' PAWs intensity, as explained in the methodology chapter. This all relates back to a major theoretical question driving this analysis: "supposing both the irregular and regular combatants' intensities increased by roughly similar[134] amounts, would one side benefit more than the other?" Of course, one may expect that such situations in their purest form are rather uncommon (since one would expect the richer, bigger, and otherwise materially advantaged regular side to have more access to the technology as well as better capabilities for exploiting or enhancing it), but the goal is to try to understand the core effect prior to the adjustments of other factors (e.g., partially asymmetric access/usage due to financial or technical barriers).

Ultimately, based on this model case group, I opted to focus on the Boer War and the GEAC because they appeared to form one of the *best* case groups for testing this thesis out of the available options, in part based on the conflicts' sizable English historiography, *sufficient* similarities in control variables, and substantial increase in the IV *along with* a substantial increase in the regular side's PAWs intensity. However, this case group is far from ideal in many ways: it only appears to be one of the "best" because every other case group I explored was

[134] As discussed in the control variable section, a more conceptually accurate (but wordier and more difficult to evaluate) formulation would be "... increased in a way which did not alter the overall degree/proportion of material disparities between the two sides…"

severely deficient along certain criteria, such as those listed in the next subsection. In fact, the problems with this case group (especially with regards to control variable variation) are one of the primary reasons that I opted to focus on battle-death exchange ratios instead of irregular win/loss/draw outcomes directly.

Difficulty in Case Selection

Searching for suitable case groups has offered one potential explanation as to why so little empirical research exists on this issue: such case groups seem to be very scarce due to the desired case comparison criteria being inherently difficult to meet. To summarize/simplify these issues:

1. Even when considering the overall population of asymmetric/irregular conflicts in the past two centuries (as opposed to just focusing on case groups that have variation in the IV), the number of well-comparable conflict pairs is relatively small since there are so many potentially significant and diverse variables to control for.[135]

[135] Consider for example: overall tactics and strategies (such as preferring small engagements over massed assaults, the latter of which saw a noteworthy amount of usage in the 19th century); insurgent purpose/goal (e.g., to expel a *foreign* occupier, to replace the domestic government); insurgent ideology (e.g., royalism, nationalism, communism)—especially as it relates to the insurgents' ability to gain popular support, recruit soldiers, and have its fighters carry out acts on the battlefield requiring high levels of dedication (e.g., suicide missions); COIN force mechanization (e.g., tanks, airpower) and overall equipment quality (e.g., that of great power COIN forces vs. governments of developing countries)—something which in itself has multiple variables of note (e.g., helicopters); relative equipment (e.g., do the insurgents largely have to resort to spears or bolo knives against rifles?); geography (e.g., open plains, dense jungles, urban environments); COIN casualty and brutality aversion (e.g., is the COIN force willing to suffer tens of thousands of casualties and create dreadful civilian internment camps as in the Second Boer War?); international pressure/scrutiny on the COIN force (as especially seen in the Indonesian National Revolution, as well as in the Algerian War of Independence); shifts in insurgents' non-PAWs technology (e.g., accessibility to effective industrial/commercial explosives); variance in the quantity and quality of COIN troops—especially in relation to variance in the quantity and quality of insurgents (e.g., war veterans); political and social networks of insurgents (especially with regards to things like "underground networks," such as with the IRA); the levels of external support to the COIN and/or insurgent forces (although this is mainly just relevant as it relates to a variety of other variables, perhaps with the exception of things such as "foreign sanctuary"); etc.

2. Some of the important control variables tend to systemically "correlate" (at least from a binary perspective) with specific time periods (e.g., mechanized COIN militaries did not exist prior to mechanization but became widespread in the early 20th century), with the result being that conflicts with large time gaps between them tend to be largely incomparable.
3. Conflicts with small time gaps between them tend to have little variation in *both* the regulars' and irregulars' PAWs intensity (and in general, conflicts with small time gaps tend to have little variation in PAWs intensity for either side).
4. Especially up to the mid-20th century (and even in some conflicts after that), irregulars' PAWs access/usage *tended* to lag substantially behind that of their regular foes; the major exceptions to this tended to be cases where the irregulars were receiving substantial external support (such as from Communists or the Allies during WWII), which tended to muddle the analysis.
5. On the separate question of analyzing shifts within a single conflict (e.g., comparing a time period before and after insurgents receive shipments of automatic weapons), this was largely not a viable option because such a shift tended to accompany shifts in many other variables (since it was generally the result of external support) and the regular forces in the "before" would typically already have much higher PAWs intensities.

There were other, lesser issues in trying to find a suitable case group, but the combination of the above five points (especially two and three together) posed enormous impediments to finding a viable case group: *in general, conflicts in which both sides had substantial PAWs*

intensity tend to be incomparable with conflicts in which neither side had PAWs or the intensity was low.

There are a few reasons why the Boer War and GEAC group stood out as an exception to this rule: first, the two conflicts occurred in an unusual and relatively unique window in PAWs and irregular conflict history (roughly 1900-1920). This time period saw a large, widespread, and fairly sudden increase in PAWs intensity among most major/regular powers, which largely took place around/during WWI. However, some of the regular militaries at the turn of the century (e.g., the British in the Boer War) were not *too* radically different from the regular militaries at the end of this period (e.g., the British in WWI). Second, unlike most other conflicts in this period (which often involved poorer native populations[136]), the conflicts involved two similarly-unusual irregular combatants, in that both were militaries/soldiers of governments which had *initially* been able to afford machine guns for their militaries (before the governments were overthrown and the wars shifted to irregular conflict).

I highlight these difficulties in case selection to preface my introduction of the cases with an emphasis on the necessity of making tradeoffs—and that I was not just trying to choose cases which seemed favorable to my hypothesis. Ultimately, I had to make substantial tradeoffs between primary concerns such as comparability, IV variation, theoretical relevance, and data availability. In the end, this case group is not "ideal," but in light of the problems noted above, it is remarkably decent and may in fact be the best case in that it appears to be one of the only cases that did not have severe/unacceptable deficiencies in any of these primary concerns.

[136] This observation is based on information from Lyall and Wilson's dataset for "Rage Against the Machines."

Introduction to the Cases

[137]

General Case Description/Overview: Second Boer War

The Second[138] Boer War (or simply "the Boer War") occurred between 1899 and 1902 in modern day South Africa. At the time, the South African Republic ("Transvaal") and the Orange Free State were two "Boer"[139] republics located northeast of the British Cape Colony (see map).

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[137] Photo credit: "Boer War | National Army Museum," www.nam.ac.uk, n.d., https://www.nam.ac.uk/explore/boer-war.

[138] Regarding the potential question of why I did not compare the First Boer War with the Second: the answer is multifaceted, but two of the major reasons are: 1) there was significant variation in the force ratios between the First and Second Boer wars (i.e., the Boer troops outnumbered the British in the First, but were vastly outnumbered after the early phase of the Second), which heavily undermined comparability; and 2) the PAWs intensity in the guerrilla phase of the Second Boer War was still very limited, meaning that IV variation would be very low and thus difficult to analyze. Secondary concerns include the temporal overlap between irregular and regular (e.g., siege) warfare in the First Boer War combined with the war's shorter overall duration.
The second major point is discussed further on in this thesis; for sources on the first point, see for example:
"there were 1,800 British soldiers and 7,000 Boer commandos in the whole Transvaal" - Stanley Palmer, "The Transvaal Rebellion: The First Boer War, 1880-1881 (Review)," 2006, https://muse-jhu-edu.umiss.idm.oclc.org/article/204113/pdf;
"First Anglo Boer War," South African History Online, June 2, 2017, https://www.sahistory.org.za/article/first-anglo-boer-war.

[139] This is a Dutch term with a meaning largely similar to "farmer." Source: "Boer," in Encyclopædia Britannica, 2019, https://www.britannica.com/topic/Boer-people.

[140] The causes of the war are various and debated,[141] but they are not particularly important for this analysis.[142] The Boers saw that the British were preparing for war, and thus launched a preemptive attack on the British colony in late 1899. The Boers had some initial success in battles even while fighting somewhat conventionally, but they engaged in multiple unsuccessful sieges early on and as time went on, the British troops swelled in number and began to drive the Boers back, beginning in early to mid 1900.[143] That year, the British marched on the states' capitals and eliminated most conventional resistance.[144] However, in 1900, the Boers increasingly adopted irregular/guerrilla strategies, notably including the formation of "Kommandos" (or simply "commandos"; Boer guerrilla militia groups) that attacked and were hunted by British forces for the following years—even as many conventional Boer troops surrendered. Suffering through thousands of casualties, the British persisted in its campaign, eventually implementing harsh measures such as civilian internment camps and scorched-earth tactics. Ultimately, the Boer commandos surrendered in mid 1902.

The Boer War "Guerrilla Phase": Its Asymmetric Nature and Time Period

To be theoretically relevant, the case comparison needs to focus on conflicts in which one side faces some substantial material disadvantages (e.g., less resources) and emphasizes irregular

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[140] The Editors of Encyclopedia Britannica, "South African War | Definition, Causes, History, & Facts," in Encyclopædia Britannica, October 4, 2018, https://www.britannica.com/event/South-African-War.
[141] Editors of Encyclopedia Britannica, "South Africa War."
[142] In short, some of the major explanations/factors offered include the discovery of gold in the Transvaal, increased British migration into the Boer republics and subsequent political discrimination against these "uitlanders" by the Boer governments, and a failed British coup against the Transvaal government (the "Jameson Raid"), which culminated with the Transvaal government issuing an ultimatum, which the British refused. For sources, see: "BBC - History - The Boer Wars," Bbc.co.uk, 2011, http://www.bbc.co.uk/history/british/victorians/boer_wars_01.shtml; "The South African War," www.nationalarchives.gov.uk, accessed November 17, 2020, http://www.nationalarchives.gov.uk/pathways/census/events/britain5.htm#; "Second Anglo-Boer War - 1899 - 1902," South African History Online, n.d., https://www.sahistory.org.za/article/second-anglo-boer-war-1899-1902;
[143] For this and surrounding; see e.g., Scholtz, *Why the Boers Lost the War*.
[144] For this and surrounding; see e.g., Pakenham, *The Boer War*.

tactics and strategies (e.g., lack of emphasis on holding territory). As noted above, the war was not entirely characterized by such conditions: in the beginning of the war the Boers outnumbered the British, and during the first year the Boers engaged in multiple city sieges. However, many observers hold that the guerrilla phase of the war began in 1900 with the activities of commandos such as Christiaan De Wet's. De Wet himself actually pushed back on the idea that the Boers were "guerrilla" forces at the end of the war, but this was largely based on his disdain for the term's connotations rather than the actual nature of his force.[145] Rather, many sources readily characterize the later part of the conflict as irregular/guerrilla in nature.[146] Ultimately, the overall case is theoretically relevant and, as discussed later, is sufficiently comparable with the GEAC.

Now, the question becomes "what time period should this analysis focus on?" Because the guerrilla and conventional resistance overlapped,[147] some sources list different months within 1900 as the beginning of the guerrilla phase.[148] However, due to the limited availability of data, for the quantitative analysis I will focus on the period of January 1901 to the end of the war.

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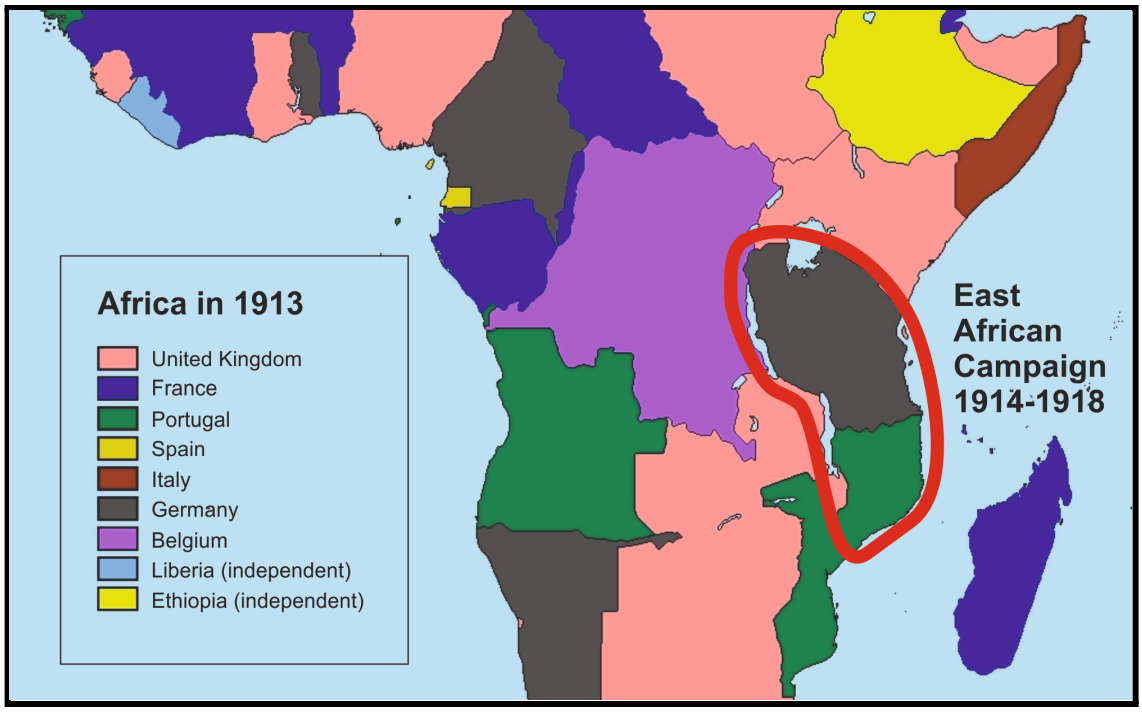
[145] For an explicit explanation of this point, see: Andre Wessels, "Boer Guerrilla and British Counter-Guerrilla Operations in South Africa, 1899 TO 1902," Scientia Militaria - South African Journal of Military Studies 39, no. 2 (November 5, 2011), https://doi.org/10.5787/39-2-110, p. 7. "this denial should be understood in the light of the fact that the term "guerrilla" had negative connotations at the cusp of the nineteenth/twentieth century, being associated with banditry."
For De Wet's commentary on the "epithet" of "guerilla," see: Christian Rudolf De Wet, *Three Years' War*, (New York, 1902), https://hdl.handle.net/2027/hvd.hwx2nv, p. 228.

[146] John Arquilla devotes a chapter to Christiaan De Wet and his guerrilla tactics in *Insurgents, Raiders, and Bandits*; Wessels writes in "Boer Guerrilla and British" that: "With hindsight, it is clear that most of the Boer commandos operating in the field after March 1900 were, at least to some extent, guerrilla units."
Farwell writes that "it was a guerrilla war" (p. 324) and writes that the "last eighteen months of the war is the story of innumerable small engagements […]" (p. 325). Source: Byron Farwell, *The Great Boer War* (Barnsley, South Yorkshire, England: Pen & Sword Military, 2009).

[147] Wessels, "Boer Guerrilla and British," p. 8.

[148] This source lists March 1900: Wessels, "Boer Guerrilla and British";
This source lists Sept. 1900: Andrew Mcleod, "The Psychological Impact of Guerrilla Warfare on the Boer Forces During the Anglo-Boer War," 2004, https://repository.up.ac.za/bitstream/handle/2263/28050/Complete.pdf?sequence=12.



[149]

General Case Description/Overview: German East Africa Campaign

The German East Africa campaign (GEA campaign, or GEAC) was a conflict fought as a part of World War 1 between colonial powers including Germany, Britain, Belgium, and Portugal. However, the war was quite different from the iconic trench warfare that characterized the European theater. The conflict occurred between 1914 and 1918 across parts of eastern Africa (e.g., modern day Tanzania, Mozambique, Kenya), as pictured above. The German forces were led by Paul von Lettow-Vorbeck, and they fought essentially alone against the local Allies and their colonies—although Portugal did not get involved until early 1916[150] and Belgium largely ended its "direct participation" in late 1917.[151]

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[149] Image source: "East Africa," Away from the Western Front, n.d., https://awayfromthewesternfront.org/campaigns/africa/east-africa/.
[150] Ross Anderson, "World War I in East Africa 1916-1918" (2001), http://theses.gla.ac.uk/5195/1/2001AndersonPhD.pdf.
[151] Anderson, "World War I in East Africa."

Lettow-Vorbeck's stated goal in prosecuting the campaign was to divert as much Allied resources away from the European theater as he could,[152] rather than to achieve a conventional victory, since the colony was too isolated against the Allies to expect conventional success.[153] For some time, the GEA forces managed to hold their ground by repelling various conventional attacks, while also conducting raids/sabotage in the neighboring Allied colonies.[154] Eventually, however, the Allies' force size and equipment quantity/quality increased, and the allies conducted some successful conventional invasions into GEA. However, Lettow-Vorbeck responded by adopting a more-mobile guerrilla strategy which eventually involved invading Portuguese Mozambique in 1917.[155] The Allied forces pursued and tried to corral Lettow-Vorbeck's forces, who in turn tended to avoid large, set-piece/protracted battles by harassing their enemies and staying on the move/retreating. By late 1918, Lettow-Vorbeck's forces had been substantially weakened but they continued fighting until they surrendered following notification that continental Germany had surrendered in WW1.[156]

The GEAC "Guerrilla Phase": Its Asymmetric Nature and Time Period

Irregular warfare in the form of raids and sabotage as well as significant material disparities (especially in manpower) was apparent throughout the war, especially after 1914.[157]

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[152] Lettow-Vorbeck, *My Reminiscences*, *passim* (including p. 75).
[153] This sentiment is expressed by a variety of sources; see for example discussion by historian Nigel Jones, "The Unexpected Guerrilla," HistoryNet, February 5, 2018, https://www.historynet.com/the-unexpected-guerrilla.htm; See also John Arquilla, *Insurgents, Raiders, and Bandits : How Masters of Irregular Warfare Have Shaped Our World* (Chicago: Ivan R. Dee ; Lanham, MD, 2011), pp. 145-146.
[154] See a variety of sources, including: Arquilla, *Insurgents, Raiders, and Bandits*;
Micheal Clodfelter, *Warfare and Armed Conflicts : A Statistical Reference to Casualty and Other Figures, 1618-1991 / 2 1900-1991, Bibliography, Index.*, 1st ed. (Jefferson, Nc U.A.: Mcfarland, 1992), pp. 753-754;
Anderson, "World War I in East Africa."
[155] See Clodfelter, *Warfare and Armed Conflicts* (1st ed.) pp. 753-754.
[156] Lettow-Vorbeck, *My Reminiscences of East Africa.*
[157] Among other sources, see: D.M. Keithly, "Khaki Foxes: The East Afrika Korps," Small Wars & Insurgencies 12, no. 1 (March 2001): 166–85, https://doi.org/10.1080/714005382.

As one source notes, it may be true that the German East Africa *Army* was not traditionally "irregular" in composition, but the German force was generally outnumbered and operated (tactically and strategically) "as guerrillas do."[158] The war began to take on an increasingly irregular form especially in response to the successful Allied invasions in 1916. Vorbeck wrote that even prior to this, his low supplies made it imperative to "restrict [himself] principally to guerilla warfare."[159] Yet, at least one analysis argues that Vorbeck abhorred guerrilla warfare[160] and refused to fully abandon conventional warfare *until 1917*.[161] Overall, this case is unusual in some regards, but a variety of sources (including some participants in the war) recognize that the overall tactics and strategies in the 1917-1918 period were at least irregular if not outright "guerrilla,"[162] making this period relevant to the hypothesis and broader theoretical analysis.

The more difficult question is what the time period to focus on for the quantitative analysis should be. In short, I will focus on the period from January 1917 to the end of the war. This choice is partially based on the points made in the previous paragraph, but also heavily based on the availability of battle-death data and the force improvements by Allied forces (e.g., increases in PAWs intensity) which made this period more comparable with the guerrilla phase of the Boer War.

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[158] "Keithly, "Khaki Foxes," p. 167.
[159] Lettow-Vorbeck, *My Reminiscences*, p. 63.
[160] Jon Nesselhuf, "General Paul von Lettow-Vorbeck's East Africa Campaign: Maneuver Warfare on the Serengeti," 2012, https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.917.7500&rep=rep1&type=pdf, p. 3: "His experience overseas increased his dedication to conventional warfare in proportion to his abhorrence of guerrilla warfare."
[161] Nesselhuf, "General Paul von Lettow-Vorbeck's," pp. 4-5.
[162] Among other sources, see: Edwin Palmer Hoyt, *Guerilla ; Colonel Von Lettow-Vorbeck and Germany's East African Empire.* (Macmillan, 1981), (as implied by the title);
Arquilla, *Insurgents, Raiders, and Bandits*;
John Stratis, "A Case Study in Leadership - Colonel Paul Emil von Lettow-Vorbeck," 2002, https://apps.dtic.mil/dtic/tr/fulltext/u2/a404449.pdf;
Angus Buchanan, *Three Years of War in East Africa.* (New York, 1969), https://hdl.handle.net/2027/inu.30000047742907, p. 22.

Measuring the Irregulars' and Regulars' PAWs Intensities

It is very difficult to precisely estimate PAWs intensity throughout the conflicts for certain combatants, but based on available reports of weapon counts and seizures at various points in the wars, one can create a general estimate that is sufficient for the purposes of this analysis. "Outset" figures are available for both wars, but these are better understood just as contextual figures since the relevant question is the intensity during the guerrilla phase of each conflict. Table 1 summarizes the primary estimates for each combatant, as explained in the following subsections.

Table 1: Summary of Combatants' PAWs Intensities

War	Force	PAWs Intensity Estimate (as a %)	Data Availability
Boer War	Boers	1500:1 (0.07%)	Low
Boer War	British	800:1 (0.13%)	High
GEAC	Germans	55:1 (1.8%)	Medium-high
GEAC	British	65:1 (1.5%)	Medium
GEAC	Belgians	150:1 (0.7%)	Medium-low
GEAC	Portuguese	150:1 (0.7%)	Low

Paws Intensity Estimation: Boer War

Estimating the Boers' PAWs intensity is notably more difficult than estimating that of the British, but one can still make sufficiently-decent estimates. To contextualize the estimates for

the later period of the war, the Boers at the outset reportedly had between 25 and 40 machine guns (not including the so-called "pom-poms") across roughly 30,000 to 40,000 troops.[163] Thus, at the outset of the conventional period of the war, the intensity seems to have been *loosely* around 1,000 troops per machine gun.

Skipping ahead to the final months of the conventional phase of the war, in late March of 1900 Christiaan De Wet (who began switching to a guerrilla campaign at this time)[164] was leading a group of "1,600 men with … a Maxim machine gun."[165] Additionally, in July of 1900 a group of approximately 1,500 Boer soldiers who refused to accept their governments' surrender carried "two Maxims" as they escaped.[166] Combining these two figures creates a ratio of approximately 1000:1 troops per machine gun. Over time, however, it is unclear how such ratios shift, as well as what the situation was like among other groups: there are multiple reports of the Boers using and seizing pom-poms from the British, but reports regarding the machine guns are scarcer. Christiaan De Wet provides little help in this regard, seemingly much more focused on his Krupps field guns and "Maxim-Nordenfelts" (what De Wet called pom-poms).[167] It seems that the only time De Wet mentions using a "quick-firing" gun (which seems to have been a machine gun rather than a pom-pom given that he compared it to a "Maxim-Nordenfeldt")[168] was in an attack which he writes involved roughly 650 Boer troops, but this was in mid 1900.[169] One source, however, mentions some instances when various Boer groups captured Maxim guns

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[163] Andrew Wessels, *The Anglo Boer War*, pp. 24-25.
[164] Wessels, "Boer Guerrilla and British."
[165] Farwell, *The Great Boer War*, p. 257. To clarify, this was not a reference to a pom-pom: the broader quote is "... a column of 1,600 men with five guns, a Maxim machine gun, and a pompom out of Brandefort."
[166] Farwell, *The Great Boer War*, p. 305. Again, this was not a reference to pom-poms: the broader quote is "... carried out a pompom, two Maxims…"
[167] De Wet, *Three Years' War*, *passim* (i.e., searched via search function in Babel.Hathitrust.org).
[168] De Wet, *Three Years' War*, p. 105.
[169] De Wet, *Three Years' War*, pp. 98-105. To be clear, I also used Babel.Hathitrust to search for mentions of "machine" (guns) and "Maxim" guns, but I found no relevant results for either in *Three Years' War*.

during 1901 (comprising at least four Maxims in total)[170] but the overall troop counts of these groups are sometimes unclear (as is the usage of PAWs).[171] Additionally, one problem that reportedly plagued the Boers was lack of ammunition,[172] which is a particularly serious issue for weapons like machine guns (which naturally tend to use high amounts of ammunition per weapon). In short, it seems that there is no "great," precise estimate for the Boer force's machine gun intensity, but the dearth of historical attention paid to these weapons on the Boers' side during the guerrilla phase further suggests the intensity was low. Thus, I will presume a *loose* estimate of roughly 1500:1. As noted later, precision is less important at such low intensities.

Clearer data exists regarding the British armaments, but even this data indicates that their machine gun intensity varied substantially based on the column/division in question. For example, many columns had hundreds of troops (a few even over 1,000 troops) yet carried no machine guns, while some columns had troop to machine gun ratios closer to 200:1.[173] In sum, no singular figure can precisely describe the quantitative nature of machine gun intensity over each region and time period throughout the war, *but* one can draw a rough estimate that is sufficient for the purposes of the comparison in this analysis. Based on this data, it seems reasonable to use the estimate of 800:1 for the British during the relevant periods of the war.[174]

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[170] Ben J Viljoen, *My Reminiscences of the Anglo-Boer War* (Cape Town, C. Struik, 1973), https://www.gutenberg.org/files/25049/25049-h/25049-h.htm: page numbers are not available, but see "we found a Maxim", "captured two good Colt-Maxims", and "Hussars left behind a Colt-Maxim".

[171] In one case, it seems that the author was in a commando of "800 men" and that this group had "a Colt-Maxim" (p# not available) — Viljoen, *My Reminiscences*.

[172] This is partially discussed by Scholtz in Scholtz, *Why the Boers Lost*, p. 91.

[173] See for example the column under Spens: p. 223 of Frederick Maurice, *History of the War in South Africa, 1899-1902.*, 1906, https://catalog.hathitrust.org/Record/001260327, v. 4.

[174] The source for the variety of data on columns is Maurice, *History of the War* (v. 4, *passim*).

Paws Intensity Estimation: GEAC

Starting with the Germans: at the outset of the war (again, just to put the later numbers in context), the average PAWs intensity across the GEA military seems to have been roughly 100:1.[175] For 1916, various reports provide estimates ranging from >100:1 to <200:1, with variations depending on the source, timeframe, and the scope of the estimate (e.g., a specific regional command vs. the overall GEA military).[176]

The phase of the war that this analysis focuses on, however, begins with 1917. Throughout the war, one can find scattered accounts of the German forces capturing machine guns from the enemy,[177] and this is particularly evident in the German raids against the Portuguese forces starting in 1917. One source notes that a group of seven companies in mid-1917 had 16 machine guns, which would seem to be an intensity of <90:1 (presuming there were still roughly 200 troops per company).[178] At times, Lettow-Vorbeck had problems with

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[175] Edward Paice, *World War I - the African Front : An Imperial War on the African Continent*, Kindle Edition (2008):
"The average peacetime establishment of a Feldkompanie was three German officers, two German NCOs, one medical officer and 160 African NCOs and askari. Each self-contained unit was equipped with two to three machine-guns [...]"

[176] W D Downes, *With the Nigerians in German East Africa*, 1919, https://archive.org/stream/cu31924027831860/cu31924027831860_djvu.txt:
(Note: I have tried to fix transcription errors that were in the original text) "From this we find that the German forces in February of that year were estimated at 14,000 native rank and file, 2000 Europeans, 60 guns and 80 machine-guns, though the number of machine-guns and native rank and file was under-estimated";
Paice, *World War I - the African Front*:
"Total Schutztruppe strength (all districts): sixty companies with ninety-six machine-guns [....]" (Note, a company tended to be roughly 200 fighting troops, according to this source.);
Paice, *World War I - the African Front*:
"Total strength of North-East Command: approximately 800 Europeans and 5,200 askari with forty-seven machine-guns";
Anderson, "World War I in East Africa":
"Otto's force numbered some eight companies with 950 rifles, 14 machine guns".

[177] For example, the Germans captured sixteen machine guns at the Battle of Tanga (in 1914): Lettow-Vorbeck, *My Reminiscences*. Other examples—typically involving much less than sixteen at one time—can be found scattered throughout *My Reminiscences* and other sources, such as Anderson, "World War I in East Africa."

[178] Anderson, "World War I in East Africa."

securing enough ammunition for his German weapons,[179] and thus was particularly eager to capture the Allied weapons (which used different ammunition). Notably, Lettow-Vorbeck's forces captured a relatively significant number of Lewis guns: by the time that Lettow-Vorbeck's forces surrendered in November of 1918, their troop count was approximately 1,280 and they reportedly had in their possession "24 Maxims, and 14 Lewis guns."[180] Simply looking at the raw quantity of weapons, this constitutes a PAWs intensity of approximately 35:1. However, in light of the reported/recurring problems with overall ammunition shortages, such a figure may be misrepresentatively high. Additionally, this was only at the end of the war; the Belgians estimate that in November 1917, Lettow-Vorbeck's numbers were roughly 2,320 troops with 30-35 machine guns, which represents a ratio of roughly 70:1.[181] Going back to early 1917, the Belgians list an overall estimate of roughly 8,400 German troops with 63 machine guns, which would represent a ratio of roughly 133:1.[182] Yet, they also estimate that in one battle in June 1917, the Germans' PAWs intensity was roughly 400 troops to 8-10 PAWs (~45:1).[183] Thus, in trying to summarize the overall time period, I will use an estimate of approximately 55:1.

Turning to the Allied forces, one can again start with the outset of the war for context. However, at this point, the British were poorly equipped in terms of machine guns (and were

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[179] See for example Lettow-Vorbeck, *My Reminiscences*, p. 218.
[180] *The Times History of the War. [German East Africa]*, *Hathi Trust* (London: "The Times," 1914), https://catalog.hathitrust.org/Record/008926017, v. 19, p. 72:
(Note: I have tried to fix transcription errors that were in the original text) "The force surrendering included Dr. Schnee and Major Kraut. It numbered 30 officers, 125 other Europeans, 1,155 askari, 1,516 porters, 482 Portuguese natives, 282 followers, 13 headmen and 819 women, with one field gun, 24 Maxims, and 14 Lewis guns."
[181] Belgium Armée Etat-major général section l'historique, *Les Campagnes Coloniales Belges 1914-1918*, 1927, v. 3, pp. 241-242.
[182] Belgium, *Les Campagnes*, v. 3, p. 21.
[183] Belgium, *Les Campagnes*, v. 3, p. 103.

occasionally undermanned)—especially in relation to the German forces.[184] One soldier in British East Africa (BEA) described the situation as "overwhelmingly in favour of the Germans," estimating that in his area the British only had one working machine gun for 800 total troops.[185] In short, historians have described the British allocation of machine guns in 1914 as "miserly."[186]

However, British machine gun intensity significantly increased over the following years (even as the troop count increased). Based on estimates from Paice, the machine gun intensity had increased to roughly 350:1 in January of 1916.[187] In August of 1916, one source notes one British force had 1,550 troops with 20 machine guns (intensity of ~80:1).[188] In early 1917, one fighting group is described as having 600 troops and 10 machine guns,[189] and in April 1917, the British forces received an additional 400 Lewis guns.[190] By September 1917, the British were organizing columns with *rifle*[191] to PAW ratios of *roughly* 30:1.[192] Yet, in one battle (namely, the one mentioned above in June of 1917), British intensity was roughly 90:1.[193] Ultimately, a

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[184] Paice, *World War I - the African Front*:
"[Lettow-Vorbeck] not only had a considerable superiority over British East Africa in manpower but also in machine-guns and artillery."
[185] Buchanan, *Three Years of War*, p. x.
[186] Jones, "The Influence of the Boer War."
[187] Paice, *World War I - the African Front*:
"At the end of January the troops already in, or en route to, British East Africa exceeded 27,000 in number [...] with eighty machine-guns."
[188] Charles Hordern, *Military Operations : East Africa* (London : H. M. Stationery Office, 1941), https://hdl.handle.net/2027/mdp.39015030679016, p. 445.
[189] Richard Sneyd, "East African Campaign 1914 – 1918 Faridkot Sappers & Miners," 2012, https://gweaa.com/wp-content/uploads/2012/02/Campaign-East-Africa-Copy-for-GWAA-site.pdf.
[190] Sneyd, "East African Campaign."
[191] The source for this information frequently reported force sizes in terms of "rifles" (and other weapons) instead of typical troop counts. The number of rifles therefore tends to be less than the actual troop count, but this does not make this number useless (so long as one recognizes it is an undercount).
[192] Anderson, "World War I in East Africa":
"No 3 Column would have three battalions totalling 1,300 rifles, 17 machine guns, 18 Lewis guns [...;] No 4 Column would have four battalions and a machine gun company with 1,250 rifles, 29 machine guns, 29 Lewis guns, [...;] Force Reserve had two battalions each of 800 rifles, 12 machine guns, 16 Lewis guns."
[193] Belgium, *Les Campagnes*, v. 3, pp. 103-104.

reasonable estimate to use for British machine gun intensity during the 1917-1918 period appears to be *roughly* 65:1.

Data for Belgium and Portugal is more difficult to come by. One can reference some estimates for the overall Belgian forces, such as 11,150:65 (~170:1) in February 1916,[194] and 135:1.[195] One (seemingly atypical) column in 1915 consisted of 236 troops with 3 machine guns. [196] However, in the aforementioned battle in June 1917, their intensity was roughly 165:1.[197] In short, a rough estimate of 150:1 for 1917 appears to be sufficient for its use in this analysis.

Regarding Portugal, one can find one instance where a force of "900 Portuguese native troops" with at least "6 machine-guns" (150:1) was defeated by Lettow-Vorbeck's forces in 1917.[198] Another isolated incident, this time in mid-1918, involved *at least* 400 Portuguese troops and five machine guns.[199] Another German attack in mid-1918 on "a lone Portuguese company yielded several machine guns."[200] In short, it seems likely that Portugal's machine gun intensity was much less than Germany's and Britain's, but it is difficult to give an estimate much more accurate than *roughly* 150:1. This is admittedly imprecise, but the main point is to emphasize Portugal's comparatively lesser intensity.

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[194] Hordern, *Military Operations*, p. 400.
[195] Paice, *World War I - the African Front*:
"The askari were largely raised from the ranks of the 15,000-strong paramilitary Force Publique [...] 112 machine-guns [....]" It is unclear to what extent this is applicable for 1917 (as with the February 1916 estimate).
[196] Belgium, *Les Campagnes*, v. 1, pp. 227-228.
[197] Belgium, *Les Campagnes*, v. 3, pp. 103-104.
[198] Downes, *With the Nigerians*.
[199] Source: Paice, *World War I - the African Front*, ("By nightfall most of the 400 Portuguese troops [...]"). Note: These numbers seem to be unrepresentative of the actual total number of troops and machine guns, but serve as a best (and seemingly sufficient) estimate in lieu of more clear information: the 400 number simply is described as the number of troops defending a specific building in the area of battle; the number of machine guns simply refers to those that were captured by the Germans (which does not specify if there were more that were destroyed by the Portuguese or if any were taken while fleeing). Notably, Paice shortly thereafter says that after the British joined this battle (and the combined Portuguese-British force was completely routed), Lettow-Vorbeck's forces found on the battlefield and in storage "ten machine-guns".
[200] Source: Anderson, "World War I in East Africa."

Summary of IV Analysis

Ultimately, the analysis here cannot produce precise estimates, but this is not the goal nor is it necessary; the rough estimates provide two key insights: 1) PAWs intensity on both sides of the conflicts significantly increased from the Boer War to the GEAC; 2) the proportions in intensity between the regulars and irregulars across the two cases are not wildly different (i.e., it is not as if the irregular sides shift from a nominal 2% disadvantage to a 2% advantage). On this second point, the fact that the Germans have a PAWs intensity which is much greater than that of the Belgians and Portuguese (and which is slightly greater than that of the British) does raise some concerns which I try to account for in the examination of BDXRs. Yet, even if not "ideal" with regards to IV variation, one can still use this case group for quantitative analysis.

Comparability and Control Variable Variation

Summary of Case Similarities

At first glance, the two cases may look like they are not well comparable: the Boer War involved a world power, Britain, against two young Boer republics, whereas the GEAC involved Britain (and some of its allies) fighting in the context of WWI against the colony of another major power, Germany. Despite these apparent differences, however, when one actually examines the cases—and particularly when one only focuses on the last two years of each conflict—they will find that the cases are much less dissimilar than they initially appear. For

example, GEA was almost completely cut off from external/homeland support[201] (perhaps even more so than the Boers, who received some foreign volunteers[202]), and the GEA troops (like the Boers) were vastly outnumbered by the regular forces within two years of the war outbreak. Additionally, the fact that the GEAC was fought as part of WWI did likely impact the war outcome, but such variations do not appear to have significantly impacted the wars' BDXRs.

Overall, in fact, the two cases are *relatively* similar given how diverse the historical set of insurgencies/asymmetric conflicts are. This is particularly true when comparing this case group to other case groups involving a substantial increase in the PAWs intensities of both the regular and irregular forces. Aside from the points mentioned above (external support and troop counts), both conflicts involved the same primary regular force, Britain, albeit with some secondary allies in the GEAC; both conflicts took place during a time period that emphasized trains and horses (although the GEAC involved some *nascent/limited* aviation and mechanization); both conflicts saw a pattern of initial semi-conventional success by the Boers/Germans, followed by a swell of manpower by the British/Allies which reversed the situation and drove the Boers/Germans to adopt increasingly irregular, guerrilla strategies and tactics; the Boers and Germans' forms of guerrilla warfare were generally "above-ground" but conducted primarily in undeveloped, non-urban areas, as opposed to more-underground insurgencies which operated in more-urban/civilian-populated environments (e.g., the Irish War of Independence); neither conflict was completely technologically imbalanced (e.g., a "spears/knives vs. rifles" situation). Inevitably, however, there are some relevant differences between the two cases which likely impact the DV in both the quantitative and qualitative analyses.

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[201] "External resupply was largely denied to the Germans apart from two small blockade runners." — Anderson, "World War I in East Africa."
[202] Mcleod, "The Psychological Impact of Guerrilla Warfare."

Which Differences are Relevant, and to What Extent?

An exhaustive list and analysis of all of the plausibly-relevant control variable discrepancies between the two cases simply is not feasible. However, I will try to highlight the most noteworthy discrepancies (or supposed discrepancies) between the two conflicts. Ideally, the existing literature would provide insight as to which variables should be the most relevant in this regard. There are a variety of articles and books regarding the determinants/correlates of "military effectiveness" (e.g., loss-exchange ratios, war outcomes). Unfortunately, however, those studies which focus on such factors in insurgencies/irregular conflict tend to focus on overall conflict outcomes (rather than loss-exchange ratios),[203] whereas those studies which focus on loss-exchange ratios generally focus on conventional wars (rather than irregular conflict),[204] with some limited exceptions.[205] Thus, it is difficult/tenuous to directly cross-apply some specific correlates from these analyses to the present case comparison.

Still, I will use some of the insights from this literature in combination with sentiment/analysis from participants of and historians/scholars covering the two cases here as well as general theoretical reasoning in determining which variable variations to highlight and in loosely assessing their implications. Although I cannot provide precise/numerical estimates of how the variations affect the DV in the quantitative analysis, I do bring together the variables

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[203] Jason Lyall and Isaiah Wilson, "Rage Against the Machines: Explaining Outcomes in Counterinsurgency Wars," *International Organization* 63, no. 01 (January 2009): 67, https://doi.org/10.1017/s0020818309090031;
The following study does focus on both outcomes and "casualties" of irregular conflicts, but the latter is actually just a measure of total (aggregate/shared) casualties as opposed to casualty *exchange ratios*: Schutte, "Geography, Outcome, and Casualties".

[204] Fowler, "Culture and Military Effectiveness";
Miller, "Destructivity";
Beckley, "Economic Development and Military Effectiveness";

[205] For example, there is one study that applies a few quantitative analyses to a specific modern insurgency, that of the Tamil Tigers in Sri Lanka: Lalwani, "Size Still Matters." It finds that greater COIN force to rebel force ratios is (generally) statistically significantly associated with better loss-exchange ratios for the COIN forces.

that I analyze and list them in a summary table which tries to express and compare the expected effects in non-numerical degrees. Additionally, I reference these variations when I conduct and interpret the results of the qualitative analysis.

There is one final note to make before turning to the detailed control variable analysis: some of the variations in control variables (e.g., geography, motivation/commitment) should be mostly if not entirely independent of any hypothesized effects of the IV. However, shifts in combatants' PAWs intensities could also be partially responsible for some of the shifts in other variables, such as the use/non-use of certain tactics as well as ammunition availability/supplies. Thus, just because some variable differs between the two conflicts does not mean any hypothesized effect of this shift on BDXR is unattributable to PAWs: if for example, tactics such as harassment ambushes were used more often in one conflict because they were deemed to be more effective when conducted with machine guns, it would not make sense to say that the effects of such a shift on BDXR are not at all attributable to shifts in irregulars' PAWs intensities.

Motivation/Commitment, Goals, and the Blockhouses/Drives

There are some obvious differences between the two conflicts in terms of variables such as motivation and goals: whereas the Boer guerrillas continued fighting so as to preserve or reclaim independence/autonomy, the GEAC was fought in the context of WWI by the remnants of the GEA military by a commander whose stated goals were to preoccupy the resources/attention of the Allies (and who surrendered shortly after confirming that continental Germany had surrendered[206]); the British in the Boer War engaged in brutality against civilians in

[206] Lettow-Vorbeck, *My Reminiscences.*

part to deter the Boers from continuing to fight, whereas such actions would not have had the same effect against the GEA colony; etc. However, although these are certainly relevant variations for an analysis focused on war outcomes, their relevance on military effectiveness as operationalized through BDXR is more difficult to discern.

One may reasonably feel that this analysis should somehow account for the fact that the GEAC occurred during WWI—i.e., when the Allied (and German) militaries were especially distracted with events in Europe—whereas the Boer War occurred when Britain was able to focus much more on the conflict in question. One might particularly point to the extensive infrastructure system of the blockhouses in the Boer War combined with the organized drives as an example of such commitment. Ideally, one could identify each way that the conflicts differed in this regard (especially so as to avoid double-counting, as well as to achieve a more accurate understanding in general)—and I do explore some of these specific points in the following subsections (e.g., troop quantity and quality). However, such an "ideal" analysis would be rather complex/lengthy and still some relevant effects may "slip through the cracks" (i.e., not be covered by the individually identified points).

Thus, so as to avoid/reduce unintentional bias in favor of my hypothesis, I will account for the blockhouse and drive systems not just as individual disadvantages to the Boers (relative to the Germans) but more generally as a broader symbol of greater British willingness to spend money, use better human capital (e.g., engineers) to solve problems, and/or some other relevant disadvantage(s) not covered by the other subsections. Thus, this should have decreased the Boers' BDXR relative to the Germans'.

Troop Quantity

Although the estimates vary with source and time, it is reasonable for purposes of this analysis to characterize the force ratio in the Boer War as roughly around 10 British troops for each Boer soldier (10:1) during the '01-'02 period.[207] In contrast, during the '17-'18 period in the GEAC, the force ratio was roughly around 30-50 Allied troops per German soldier (30:1 will be used as the estimate).[208] Regardless of the precise numbers used, it is thus clear that the Boers enjoyed a much better overall force ratio compared with the Germans in their respective guerrilla phases. The implications of this are not exactly straightforward with regards to the quantitative analysis (since a greater overall force ratio can but does not necessarily translate to a better

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[207] "In this way the resistance of about 20,000 Boer bitter-enders was to continue for almost two more years, in what is known as the guerrilla phase of the war." — "BBC - History - The Boer Wars," Bbc.co.uk, 2011, http://www.bbc.co.uk/history/british/victorians/boer_wars_01.shtml;
Amery L S, *The Times History of the War in South Africa : 1899-1902* (London: Low, Marston, 1909), https://hdl.handle.net/2027/uc1.32106008399195, v. 5, p. 251: (Note: I have tried to fix transcription errors that were in the original file) "The Boer strength and was as great as ever [...] there were still at large about 44,000 men and lads; but many of these were incapable of taking the field; nor were there ever at one time more than 13,000 in fighting trimand fighting fettle";
In contrast, the British had roughly 200,000 troops (beginning with Kitchener's time in command). — Scholtz, *Why the Boers Lost*, p. 105.

[208] The estimates for the GEAC vary much more than in the Boer War: one source which very likely overstates Allied troop counts writes that around the 1917-1918 period, "Lettow's slowly dwindling force of 2,000 troops, and as many supply carriers, journeyed across Mozambique pursued by 200,000 Allied soldiers." — Nesselhuf, "General Paul von Lettow-Vorbeck's";
Another source which is unclear about time frames and personnel scope writes that Lettow-Vorbeck "tied up 130,000 Allied troops that could have fought on the Western Front." -
Taylor Harper, "Marching through Hell :: The British Soldier in the First World War 's East African Campaign," 1995,
https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=2727&context=theses;
Only focusing on *British* (i.e., excluding Belgian and Portuguese) soldiers "in the field," Edwin Hoyt writes that by January 1918, "the British outnumbered the Germans in the field by more than twenty to one." — *Guerilla*;
"Manpower levels [fluctuated], but in 1916 the imperial forces amounted to 27.000 British and South African troops, 14.000 Indian sepoys, and 7000 African soldiers" (which would equate to nearly 50,000 troops) — Timothy H. Parsons, "Mobilising Britain's African Empire for War: Pragmatism vs Trusteeship," Journal of Modern European History 13, no. 2 (May 2015): 183–202, https://doi.org/10.17104/1611-8944-2015-2-183;
Referring to the overall ('14-'18) GEAC (and potentially also including carrier corp and/or logistical personnel), Keithly writes that " the British Empire at various points in time had over 100 general officers in the field commanding a total of perhaps 200,000 men. Some estimates run as high as 250,000." — Keithly, "Khaki Foxes."
"British troop strengths there [in the GEAC] peaked at 58,000 in August 1916 [....]" — Anderson, "World War I in East Africa."

BDXR[209]), but it should be more likely to harm the Germans' BDXR relative to the Boers' than vice-versa. For the qualitative analysis, this should also make mobility/survival (e.g., avoiding encirclement) more difficult for the Germans, *ceteris paribus*—as noted in the qualitative analysis section.

However, force ratios are not the only relevant metric: it is also important to consider the regular force's troop spatial density (i.e., total count per area). In short, based on estimates from the sources listed for the force ratios, it seems that the regular side's troop count in the Boer War was *roughly* 2-4 times greater than that in GEAC. The implications of this for the quantitative analysis are difficult to determine (although it seems to favor the Germans, since it gives them more options for maneuvering and avoiding unfavorable battles), but with regards to the qualitative analysis this should make mobility/survival easier for the Germans (relative to the Boers). If the area of the conflict were proportionately smaller, this should largely offset such a variation, but as the next sub-section notes, the opposite is the case.

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[209] This relates to some complex/disputed issues in military science, especially those relating to the "Lanchester Equations" or the "3-to-1 rule," which hold that having greater force ratios (even on the attack) should reduce one's casualty ratios. However, these rules primarily refer to force ratios at the engagement level rather than the overall conflict/theater level; even if a regular force has advantages in the latter, this does not guarantee that they will be able to achieve superiority in each engagement, since the irregulars may be able to pick and choose battles against weak targets. Additionally, as noted, the validity of concepts like the "3-to-1 rule" have been the subject of great debate, and thus will not be integrated deeply in this analysis. For more on this debate, see for example:
Christopher Lawrence, "Comparing Force Ratios to Casualty Exchange Ratios," Dupuy Institute, 2009, http://www.dupuyinstitute.org/blog/2018/12/14/comparing-force-ratios-to-casualty-exchange-ratios/: "[T]here does not appear to be a direct cause and effect between force ratios and exchange ratios.";
John J. Mearsheimer, "Assessing the Conventional Balance: The 3:1 Rule and Its Critics," International Security 13, no. 4 (1989): 54, https://doi.org/10.2307/2538780: "In sum, the 3:l rule has not been proven by a scientific survey of a representative sample of relevant cases, but it does have substantial evidentiary support.";
Two papers fail to find a statistically significant association between troop balance and loss-exchange ratios: Beckley ("Economic Development") and Miller ("Destructivity").
Importantly, however, these analyses are also generally focused on conventional combat.

Geography

There are two major geographical aspects of each conflict to focus on: the size/area of the conflict and the terrain (e.g., topography and flora). Starting with the area of the conflicts, the exact numbers widely vary depending on how one chooses to measure this (including the time periods in question), and datasets such as by Lyall and Wilson do not track/measure this variable,[210] so I will provide an (informal) estimation. In particular, I will simply highlight that it generally appears that the *overall* GEAC (i.e., including the smaller raids into neighboring colonies as well as Lettow-Vorbeck's large expedition-raid into Mozambique and Rhodesia) was greater than the size of the *overall* Second Boer War, perhaps on the scale of *roughly* 100%-200%—but this *heavily* depends on what area one includes.[211] Precise numbers are fairly irrelevant, however, since I also cannot precisely specify how this affects the quantitative analysis (except that this seems more likely to favor than undermine the Germans' BDXR, since it provides an irregular group with more room to maneuver and forces their pursuers/occupiers to spread their lines more thin). With regards to the qualitative analysis, the greater area should help the Germans' mobility/survivability, as I describe in more detail in that section.

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[210] See Lyall and Wilson's dataset for "Rage Against the Machines."

[211] "Boer War" Encyclopedia.com, 2014, https://www.encyclopedia.com/history/asia-and-africa/southern-african-history/boer-war: "The territory of the Transvaal alone (111,196 square miles) almost equaled that of the British Isles.";
J. Scott Keltie, "Orange Free State," SpringerLink, 2020, 863–66, https://doi.org/10.1057/9780230270299_39: "The area of the Free State is estimated at 48,326 square miles";
"Taking Sides In The Boer War," www.americanheritage.com, 1976, https://www.americanheritage.com/taking-sides-boer-war: "The two South African republics covered an area of 160,000 square miles [....]";
The following source appears to take into consideration more than just the actual area involved in fighting, but it is difficult to tell for sure: Chad Quayle, "To Live Like a Pig and Die Like a Dog: Environmental Implications for World War I in East Africa," 2009, https://apps.dtic.mil/sti/pdfs/ADA513469.pdf: "Combatants fought across over 800,000 square miles of terrain that now encompasses much of Kenya, Tanzania, Burundi, Congo, Mozambique, Malawi, and Zambia."

In terms of terrain, again one cannot rely on specific, formal/objective measurements, since the terrain in each campaign was a mixture of various African environment types, especially including thick bush, open plains, and hills/mountains.[212] However, the general sentiment one finds is that although both terrains were described as favoring the irregulars,[213] the terrain in the GEAC (especially during the '17-'18 period) was generally composed of more "thick bush"[214] (even though parts of South Africa such as the Bushveld were described as "ideal terrain for guerrilla activity"[215]). Given how important terrain is in guerrilla/asymmetric warfare, [216] it is particularly important to examine this factor. Yet, the variations between the two wars do not seem to *heavily* favor the Germans, especially since the Boers often considered and used terrain effectively when they tried to choose their battles/ambushes (and thus the *overall/average*

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[212] Quayle, "To Live Like a Pig": "Vegetation throughout the East African theater of operations varies enormously and significantly affected military operations. In the south swamps and tropical vegetation impeded mobility. Similar vegetation existed near the shores of lakes and streams throughout East Africa. In the north, vast expanses of arid wasteland punctuated by thorns created obstacles to the movement of large formations. Across the plains, open grasslands constituted the defining feature";
Discussion of Boer War terrain can be found scattered throughout various sources, but one source in particular does a good job of differentiating between the various regions' geography and flora (especially in differentiating the "Highveld," "Bushveld," and "Bankenveld"): Mcleod, "The Psychological Impact of Guerrilla Warfare."
[213] Scholtz, *Why the Boers Lost*, p. 90: "There is no doubt that the larger part of the Boer republics and the two British colonies were well suited to guerrilla warfare from the *geographical point of view*." [Italics in original];
Regarding the terrain's favorability to irregulars in the GEAC, see for example:
S. H. Sheppard, *Some Notes on Tactics in the East African Campaign*, *Hathi Trust*, 1919, https://catalog.hathitrust.org/Record/006148513, pp. 140-141; and
Quayle, "To Live Like a Pig";
[214] One source estimates that bush covered roughly 90% of the area in the conflict, but it is unclear whether this is accurate or if it may have only been referring to a specific portion of the campaign: Sheppard, *Some Notes on Tactics*, pp. 140-141;
Still, the notion/sentiment that "thick bush" was much more prevalent/central in the GEAC than in the Boer War becomes clear when reading through assorted skirmishes/battles in the conflicts in question. Sources for these accounts are listed throughout this, such as *The Times History*…, Maurice, *History of the War*, *My Reminiscences of East Africa*, "Marching through Hell… " etc.
[215] Mcleod, "The Psychological Impact of Guerrilla Warfare."
[216] Mcleod, "The Psychological Impact of Guerrilla Warfare": "outstanding knowledge of the terrain is of the utmost importance.";
Scholtz, *Why the Boers Lost*, p. 90.

composition of the area is not very insightful).[217] Additionally, although thick bush (as opposed to the *Highveld's* plateaus and kopjes[218]) tends to facilitate concealment and close-range surprise ambushes, as the Allies in the GEAC painfully discovered, open ground can also be prime for harassment actions/ambushes due to the long sight lines and lack of cover for marching/assaulting troops (as will be further illustrated/discussed in the qualitative analysis).[219] Ultimately, the terrain discrepancies likely should have increased the Germans' BDXR relative to the Boers' in the quantitative analysis; the effects for the qualitative analysis are more complicated, but likely involve increasing German survivability.

Non-PAWs Equipment

Due to the fact that the time gap between these two conflicts is relatively small, the degree of variation in non-PAWs equipment is actually *relatively* minor. Although one might expect the differences to be significant given that the irregular force in the GEAC was the colony of a world power, when only focusing on the last two calendar years of each war, the variations are not very significant: on balance, they do not heavily/unacceptably distort the quantitative or qualitative analyses. However, there are still a few meaningful areas of variation in the equipment possessed by combatants.

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[217] Phillip Reiman Major, "Analysis of British Tactical Adaptation as Related to Execution of Operations During the Boer War," 2001, https://apps.dtic.mil/sti/pdfs/ADA407605.pdf: "The Boeren knowledge of terrain was used to his advantage in the selection of defensible terrain";
"The Boers of the [Western Transvaal] region made good use of the broken, bushy terrain in harassing the enemy." — Mcleod, "The Psychological Impact of Guerrilla Warfare."

[218] Kopjes are typically-small hills that stand out in otherwise-flat plateaus, and often offer good views of the surrounding plains.

[219] Although the qualitative section will explore this further, one can see for example David Passmore, Jasper Knight, and Stephan Harrison, "Military Geography: Landscapes of the Anglo-Boer War," 2015: "the Boers were adept at exploiting the enhanced fields of view and good cover for gun and rifle positions afforded by kopjes";
Another source writes that "the flat, barren terrain and clear atmosphere [...] make rifle fire highly effective, particularly at long range." - Jones, "The Influence of the Boer War."

Rifles: Smoky vs. Smokeless

With regards to rifle quality, there is one key characteristic to focus on, which is the issue of "smoky" vs. smokeless rifles. Many rifles from the 1800s used black powder cartridges which, when fired, produced a cloud of smoke which not only tended to reveal one's position but also could obscure the aim of the shooter.[220] As Baden-Powell and Lettow-Vorbeck (and others) strongly argued, smokeless weapons were overall very superior to smoky rifles—especially in the tactical and terrain conditions of the Boer War and GEAC.[221] The Boers notably had many smokeless rifles to begin the Boer War whereas their British foes largely did not,[222] which gave the Boers a substantial edge. By the '01-'02 period, though, things had begun shifting somewhat, since the British increasingly came to use smokeless Lee-Enfield rifles while the Boers eventually began running out of ammunition for their smokeless Mauser rifles and thus increasingly used a mixture of stolen British smoky and smokeless rifles (for which they could steal ammunition).[223] Still, it seems that on average during the '01-'02 period, the Boers had at least a parity if not a slight advantage in smokeless rifles (seeing as how the British still adopted a mixed approach[224]). Nearly the inverse situation was to be found in the GEAC: the Germans initially substantially relied on old smoky rifles whereas the British relied more on smokeless

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[220] "The weapon emitted a dense cloud of smoke on firing, simultaneously obscuring the target and revealing the firer's position." - Anderson, Ross. *Forgotten Front: The East African Campaign 1914-1918*. The History Press. Kindle Edition.

[221] Baden-Powell, *War in Practice.*, Kindle Edition, 1903, pp. 16, 54, 190;
Lettow-Vorbeck, *My Reminiscences*: "Against an enemy provided with modern smokeless equipment the smoky rifle was, not only at the long ranges obtaining in the open plain, but also in bush-fighting, where the combatants are often but a few paces apart, decidedly inferior.";
Alsager Pollock, "Smokeless Powder and Entrenchments," Royal United Services Institution. Journal 47, no. 305 (July 1903): 805–8, https://doi.org/10.1080/03071840309417533, p. 806/*passim*.

[222] Wessels, *The Anglo-Boer War 1899-1902*…, p. 25.

[223] Mcleod, "The Psychological Impact of Guerrilla Warfare," p. 169;
Wessels, *The Anglo-Boer War 1899-1902*…, p. 25.

[224] Details on British (and Boer) weapons specifically in the '01-'02 period are hard to come by, since many sources only focus on the initial imbalance in smokeless rifles. Still, for more information, see: T Pakenham, *The Boer War* (Weidenfeld, 1979), p. 461.

rifles.[225] By the '17-'18 period, this had changed as the Germans increasingly captured/received [226] and used smokeless rifles against the Allies (who were still/increasingly using smokeless rifles[227]), but ammunition troubles and smokeless ammunition demands of machine guns often restricted the Germans' usage of smokeless rifles/ammunition.[228] In short, it seems that the Boers had an advantage in this regard, which should increase their BDXR relative to the Germans', *but* the fact that machine guns appear to have played a role in this (by using up smokeless ammunition in the GEAC) means that one should only partially/slightly consider this factor in the BDXR comparison.

Horses

Horse usage was very prevalent in the Boer War for cavalry and especially for mounted infantry towards the end of the war (on both sides).[229] In the GEAC, however, horses were more difficult to use effectively due to the terrain and climate—especially the tse-tse fly which inflicted substantial casualties on such animals through disease—although cavalry was still used to *some* extent.[230] Yet, there is also the possibility that weapons such as PAWs are partially to

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[225] Hordern, *Military Operations*, p. 69;
Nesselhuf, "General Paul von Lettow-Vorbeck's," p. 56;
Regarding Belgium: according to (Belgium, *Les Campagnes*, v. 1, p. 35), the Belgian *Force Publique* at the start of the war shipped and used a mix primarily consisting of smokeless Mausers and old, smoky Gras rifles.
[226] Of the few things that the two blockade runners were reportedly able to smuggle were some smokeless rifles. - Downes, *With the Nigerians* https://archive.org/stream/cu31924027831860/cu31924027831860_djvu.txt, pp. 117-118. However, as noted by Lettow Vorbeck (see sources below), they still struggled with having sufficient supplies for their operations.
[227] The Portuguese army often used weapons it received from Britain, and thus "[Portuguese] Infantry men received the reliable Lee-Enfield rifle." - https://digital.library.unt.edu/ark:/67531/metadc115143/m2/1/high_res_d/thesis.pdf;
Belgian force composition/usage is difficult to estimate, but according to Belgium, *Les Campagnes*, v. 1, p. 38, the Belgians shipped an additional 2,500 Mauser (smokeless) rifles/carbines (and no additional smoky weapons).
[228] Lettow-Vorbeck, *My Reminiscences*, p. 218;
Hoyt, *Guerilla*, p. 381.
[229] See for example Mcleod, "The Psychological Impact of Guerrilla Warfare" [passim].
[230] Lettow-Vorbeck, *My Reminiscences*;
Hoyt, *Guerilla*, p. 245.

blame for the apparent decrease in usage/effectiveness (especially in battle).[231] Ultimately, the net effects of this on the quantitative analysis seem limited/unclear, but it does seem to have a slight impact on the qualitative analysis, especially with regards on the viability of charge/swarm-style ambush tactics' effectiveness.

Mechanization, Armor, and Aviation

WWI saw the rise/introduction of many relatively new military technologies, including in the area of mechanization, armor, and aviation. Providing precise estimates/numbers regarding the extent of these technologies in the GEAC is difficult, but also unnecessary: it is clear that the Allies (particularly the British) had a greater degree of superiority/advantages in this field over their irregular foes in this regard compared with the regulars (British) in the Boer War. Lyall and Wilson's dataset actually treats both conflicts as the same with regards to mechanization, but this is simply due to a lack of precision (since their dataset only measures the makeup of a military at the outset of a war as opposed to the actual usage of mechanization during a conflict).[232] In the Boer War, the British did have some *limited* means of aerial reconnaissance such as balloon observation,[233] some armored trains,[234] and even some ox-drawn "armoured waggons" (which

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[231] As is referenced in the qualitative analysis, see for example C. De Jong, "Lessons from the Boer War," *Scientia Militaria - South African Journal of Military Studies* 19, no. 4 (February 22, 2012), https://doi.org/10.5787/19-4-375:
"[...] the horse was soon phased out in combat due to the increased firepower (machine guns) and was replaced for transport purposes by motor lorries." (Parentheses in original);
Additionally, although not specifying machine guns in particular, Baden-Powell wrote after the Boer War that "It is certain that in future cavalry will be more and more required to act on foot as riflemen. The immense power of modern small arms demands this." Baden-Powell, *War in Practice*, p. 185.

[232] Lyall and Wilson, "'Rage Against the Machines' Codebook and Replication Information," 2009:
"Mechanization level is a scaled index that records the prewar soldier-to-mechanized vehicle ratio in the state's military." p. 3.

[233] It is unclear if this played a non-trivial role in the '01-'02 period. See Farwell, *The Great Boer War*, p. 45.

[234] Mcleod, "The Psychological Impact of Guerrilla Warfare," pp. 138, 273;
"Although these "mobile blockhouses" did, in fact, pose a threat to the guerrillas, they were too few and too cumbersome to play a decisive role in the overall counter-guerrilla strategy" — Wessels, "Boer Guerrilla and British.";

Baden-Powell considered to be quite useful when used).[235] In contrast, the Germans in the GEAC by the '17-'18 period seem to have had only a trivial amount of "mechanization,"[236] whereas the Allies had aviation, mechanization, and armor to an even greater degree than the British did in the Boer War. Notably, their equipment included some actual planes which could drop (limited) "bombs" on camps and conduct surveillance,[237] motorized trucks for moving men/supplies,[238] and armored cars (not just trains) for use in battles.[239] As noted varyingly by the listed sources, each of these technologies was limited by factors such as terrain, and it is important to stress that their availability was still quite limited in comparison to what militaries had in WWII, for example. However, they all were generally considered/reported to have meaningfully helped the Allies. This may seem to stand in contrast to the findings of Lyall and Wilson (who suggest mechanization actually hurts COIN effectiveness), but there are four major responses: 1) Lyall

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[235] Baden-Powell, *War in Practice*, Kindle Edition, 1903, pp. 139-140.

[236] Lettow-Vorbeck's force was reportedly able to capture a few motorized vehicles late in the war, but the overall information shows that the Allies still had a clear advantage in this regard. Related to this latter characterization, see Anderson, "World War I in East Africa": "Owing to their physical isolation from the homeland, mechanization was never an option for the Germans. However, the British used the earliest cars and trucks to good advantage whenever possible.";
For an example of where Lettow-Vorbeck managed to capture some vehicles in the '17-'18 period, see Lettow-Vorbeck, *My Reminiscences*, p. 287.

[237] Downes, *With the Nigerians*;
Lettow-Vorbeck, *My Reminiscences* "I remember one day when four aeroplanes, against which we could do nothing, circled over our camp for hours and dropped bombs";
Hugh Clifford, *The Gold Coast Regiment in the East African Campaign, by Sir Hugh Clifford* ... (London: J. Murray, 1920), https://www.gutenberg.org/files/52522/52522-h/52522-h.htm: "the whole area, seen from above, was revealed as one continuous expanse of grass and tree-tops, devoid of all distinguishing landmarks. [...] The infantry patrols had generally to smell out such danger-points for themselves.";
Aerial bombing and surveillance was being used in 1917: "Scheduled for 9 August, the offensive began with aerial bombing [...]" - Anderson, Ross. *Forgotten Front: The East African Campaign 1914-1918*. The History Press. Kindle Edition;

[238] Anderson, "World War I in East Africa."

[239] Hoyt, *Guerilla*, p. 267;
"In contrast, their new tactic of immediately launching infantry cut-off groups as soon as a German patrol was detected was proving effective. This was further enhanced through the use of armoured cars and mounted infantry in the pursuit, making the escape of the raiders difficult and dangerous. In response, the Germans increased the strength of their fighting patrols [...] but still found it increasingly difficult to operate." - Anderson, Ross. *Forgotten Front: The East African Campaign 1914-1918*. The History Press. Kindle Edition;
For some examples/anecdotes regarding Allied use of "armoured trains," see Hordern, *Military Operations*, *passim*.

and Wilson only focus on war outcomes, rather than casualty exchange rates;[240] 2) Lyall and Wilson's operationalization of mechanization only refers to pre-war force composition as opposed to usage in conflict, and according to Lyall and Wilson's dataset both conflicts were not "mechanized";[241] 3) multiple studies and arguments have directly challenged Lyall and Wilson's causal inferences/claims that *usage* is harmful (as described in the literature review); 4) even if Lyall and Wilson's claim is assumed to be true in general (and that it hurts "military effectiveness"), the sentiment of historians and participants suggests that it did not hold true in this specific conflict.

Ultimately, the implications of this for the qualitative analysis is multifaceted, helping the regulars in the GEAC in a variety of ways such as by partially undermining the effectiveness of irregular tactics like ambushes and improving the regulars' mobility, but the implications for the quantitative analysis are straightforward: this should have decreased Germany's BDXR in the GEAC relative to the Boers' in the Boer War. Still, in both of these regards, these effects were likely attenuated by factors such as the terrain and the still-limited intensity of the technology (compared to conflicts in the mid-20th century and onwards).

Troop Quality/Characteristics

Comparing overall human capital/troop quality between the two sides in both conflicts would be very difficult, subjective, and tedious, given the wide range of characteristics to consider, etc. However, one can glean some overall insights from looking at some general

[240] Lyall and Wilson, "Rage Against the Machines";
[241] Lyall and Wilson, "'Rage Against the Machines' Codebook and Replication Information," 2009: "Mechanization level is a scaled index that records the prewar soldier-to-mechanized vehicle ratio in the state's military." p. 3.

sentiment and a few key characteristics, namely those relating to discipline and motivation, knowledge (primarily of terrain), and campaign/combat skills. To be clear, the point of comparison is not always comparing the irregulars directly to each other, but rather, the comparison is often between how the irregulars compared against their respective regular foes.

For example, the German troops (including the askari) appear to have been more disciplined compared with their regular foes than were the Boers (who generally were considered to be undisciplined—especially in comparison to the British).[242] However, the Boers proved to be highly capable of independent/decentralized action, as partially illustrated by the independent operations of regional kommandos and small groups.[243] Additionally, the Boers were considered to be meaningfully better marksmen and better at tactically using terrain/cover than their adversaries (especially initially)[244]; the Boers were especially considered better mounted soldiers than the British mounted infantry, with the Boers having grown up accustomed to caring for, relying on, and using their mounts.[245] Still, the German troops were also generally considered to

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[242] See for example p. 44 of *The Great Boer War* (Pakenham): "If a man did not like his field cornet or commandant, he simply left his unit and joined another. [...] Unauthorized leave-taking was the bane of every Boer general's existence."

[243] See for example p. 44 of *The Great Boer War* (Pakenham): "Sir Redvers Buller was to complain that Boer units were like those living organisms which can be cut apart without destroying the individual life of the fragments."

[244] Scholtz, *Why the Boers Lost*, p. 91: "The average Boer nevertheless had a vastly superior tactical ability than his British counterpart. The British soldier had a rather limited period of training. He received little practice in marksmanship and was not able to display much initiative";
Peter Robinson, "The Search for Mobility During the Second Boer War," Journal of the Society for Army Historical Research, 2008, https://www.jstor.org/stable/44231577: "[The Boers] had a natural ability to create defensive positions using their expert skills as hunters not only to entrench but to use cover and concealment effectively and launch surprise attacks. Time and time again British troops whether cavalry, yeomanry, M.I. or infantry were caught off guard by such positions, giving the Boer commando the initial advantage.";
Mcleod, "The Psychological Impact of Guerrilla Warfare": "Their natural knowledge of the terrain, their ability to shoot accurately with the new Mauser rifles and their considerable horse riding skill compensated in some measure for other failings."

[245] One source, for example, summarizes/quotes the sentiment of other sources in saying that "The Boers were 'the finest natural mounted infantry in the world' and they were 'bred to the saddle and the gun'." - Robinson, "The Search for Mobility."

be more trained/experienced than their adversaries *initially*; by the '17-'18 period they were likely at least comparable with their British adversaries.[246]

With regards to the troops' familiarity with the terrain/geography, the Boers were generally described as having had better familiarity with the geographical area (e.g., the location/nature of physical features in the land) as well as with living/campaigning on the veld than their regular, occupying adversaries.[247] However, this advantage did diminish (albeit not entirely) during the '01-'02 period as the British gained more experience and also enlisted the help of the Boers who had already surrendered and who taught the British military "how the commandos operated, where they normally sought shelter and how they used the terrain."[248] The Germans were similarly more familiar with their own territory/terrain than the regular force pursuing/invading them,[249] but during the '17-'18 period the Germans with Lettow-Vorbeck were forced out of their home territory into Mozambique and Rhodesia, with which the German forces

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[246] Admittedly, sources are less explicit/clear about the German skills, but they tend to emphasize the training instituted by Lettow-Vorbeck and the colony's military experience suppressing the Maji-Maji rebellion a decade prior—all in contrast with the lack of experience of the Indian and other British troops *initially*. See for example:
J.P. Cann, "Mozambique, German East Africa and the Great War," Small Wars & Insurgencies 12, no. 1 (March 2001): 114–43, https://doi.org/10.1080/714005376: "The Germans had the advantage of knowing the country and having trained in the African environment";
"Above all, he [Lettow-Vorbeck] led a strong and well-trained force with good morale and the will to fight." — Anderson, "World War I in East Africa";
Regarding the British soldiers in the Battle of Tanga, "The staff officers who had participated in the debacle of November 3 [1914] realized that the Indian force they directed was neither trained nor morally equipped for what was to come [....]" — Hoyt, *Guerilla*, p. 86.

[247] Farwell, *The Great Boer War*, p. 44;

[248] For the listed quote, see: Mcleod, "The Psychological Impact of Guerrilla Warfare," p. 266;
However, that same source also gives examples of where the Boers achieved success due to their "better use of the terrain" even during the '01-'02 period: Mcleod, "The Psychological Impact of Guerrilla Warfare," p. 131.

[249] See for example remarks by Hoyt, *Guerilla*, p. 92;
See also: Kenneth Adgie, "Askaris, Asymmetry, and Small Wars: Operational Art and the German East African Campaign, 1914-1918," 2001, https://apps.dtic.mil/dtic/tr/fulltext/u2/a392278.pdf.

were not very familiar.[250] Thus, it seems the Boers had a slight comparative edge over the Germans in this regard.

One could continue examining/comparing various characteristics, but to summarize: both wars began with the irregulars generally being much more competent/prepared for combat than the regulars, but as the campaigns dragged on, the regular troops' quality improved[251] while the irregular forces shed the less-motivated troops so that they were left with hardened, committed cores.[252] There were variations in comparative (irregular vs. regular) troop strengths/weaknesses between the conflicts, but on balance when comparing only the guerrilla phases in the wars, it seems that the variations in comparative quality slightly increase the Boers' BDXR in relation to the Germans'—with one major/outstanding exception: the Portuguese troops in the GEAC are widely castigated (by historians and British participants[253]) as uniquely incompetent.[254] In fact, the sentiment on this point is so strong that it seems to warrant a separate set of BDXR estimates that discount or entirely exclude Portuguese battle deaths from measurement. Additionally, there

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[250] See for example: Adgie, "Askaris, Asymmetry, and Small Wars": "Ultimately, Lettow-Vorbeck chose to return to German East Africa feeling that the British knowledge of their local terrain presented a disadvantage to the Schutztruppe."

[251] Regarding British troops in the Boer War, see for example the entire paper devoted to British lessons/adaptation in response to (and during) the Boer War: Jones, "The Influence of the Boer War" (e.g., "the British gradually learned from their defeats and changed their approach");
Regarding Allied troops in the GEAC, see for example:
"The Indian troops of 1914 were nowhere near the standard of those of 1916–17 who had been hardened in battle elsewhere." - Anderson, Ross. *Forgotten Front: The East African Campaign 1914-1918*; and
Arquilla, *Insurgents, Raiders, and Bandits*, pp. 152-153.

[252] Regarding the Boer War, this is fairly general sentiment, but for example see: Scholtz, *Why the Boers Lost*, p. 91.
Regarding the GEAC, see for example: "by the end of 1917 [Lettow-Vorbeck's forces were] reduced to a hard core of the most experienced and determined troops." - Anderson, Ross. *Forgotten Front: The East African Campaign 1914-1918*.

[253] Anderson, Ross. *Forgotten Front: The East African Campaign 1914-1918*. (Epilogue): Quotes a message from van Deventer, in which he remarks on the incompetence of Portuguese troops.

[254] "The last of the four powers involved in the East African campaign, the Portuguese also emerge as by far the weakest and least effective" — Anderson, "World War I in East Africa";
One source summarizing the problems with the overall Portuguese military writes that: "The army was thus without proper funding, and robbed of this wherewithal, experienced a severe decay. It was in no way ready to go to war and, when it did, was never given the opportunity to succeed." — Cann, "Mozambique, German East Africa."

is not nearly as much negative sentiment towards the Belgians, but it is also unclear whether their troops were as skilled as the British, if only because not as much English attention is usually paid to them (perhaps given their smaller and shorter role). Thus, for the sake of erring on the side of caution, their battle deaths will also be excluded in most analyses.

Comparative PAWs Intensities

Accounting for variation in PAWs intensity is an important part of assessing whether the technology does or does not have a true "equalizing" effect. For example, it would be problematic to compare a case in which the regular and irregular intensities were "high; none" (respectively) to a case where the intensities were "high; high": in this situation, the changes in effectiveness could just be due to the fact that the irregular forces in the second case were at less of an overall material/technological disadvantage.

Unfortunately, there does not appear to be any "ideal" formula or model for case group variation in PAWs intensity. On the one hand, one *might* expect that the ideal case group would consist of two cases across which the irregular forces' PAWs intensity increases *but* also across which the "proportion of intensities"[255] (herein just "intensity proportionality") in each individual conflict stays relatively constant.[256] Yet, at the basic level, this clearly cannot handle a case where the intensity proportionality is zero or infinite, since a "proportional increase" from such a case would only involve one side's intensity increasing; expanding on this flaw, it ultimately appears

[255] Specifically: "The quotient of the irregulars' PAWs intensity divided by the regulars' PAWs intensity."
[256] To illustrate: consider a case where the regular forces' PAWs intensity is 1000:1 and the irregular forces' PAWs intensity is 1500:1. In such a situation, one would say that the regular forces' PAWs intensity was 33% greater than that of the irregular forces. Thus, it *might* seem that a good comparison case would similarly have a regular force which has a PAWs intensity that is at least 33% greater than that of the irregular forces—while also having significantly higher intensities on each side (e.g., 100:1 and 150:1, respectively). However, as the text goes on to explain, there are problems with this approach.

that the complex nature of the determinants of military effectiveness[257] combined with the condition that the two sides are materially unequal (especially in terms of troop count, but also in terms of other equipment intensity and quality) means that one cannot devise a formula for "methodologically ideal variation in regulars' PAWs intensity." To try to summarize this problem without diving into complex (and highly abstract/hypothetical) equations, if PAWs are considered impactful in general then an equal absolute increase in PAWs intensity (which is a material factor) will *generally* decrease the significance of some of the other material factors that originally made the two sides unequal—thereby reducing the degree of overall material inequality.[258]

However, despite these methodological complexities, one can still gather a *loose* sense of the *magnitude* of the variation in this case group. Even though this ignores some of the potential problems mentioned above, it is more helpful than not to approach the cases by considering "how much worse off were the Boers due to their PAWs inferiority against the British than if PAWs intensity had been equal" in conjunction with "how much better off were the Germans due to their PAWs superiority against the British/Allies than if PAWs intensity had been equal."

As noted in the IV section, in the Boer War's guerrilla period, the British PAWs intensity was roughly 0.13%, whereas the Boers' PAWs intensity was *roughly* 0.07%. Thus, in this war the

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[257] For example, if one were trying to create an equation/model to determine effectiveness, would one *add* factors such as "troop quality" and "equipment" or should these factors be *multiplied*? Is it a mixture of both? What about other factors, such as troop quantity (especially if one supposes that *per-unit* effectiveness increases with greater quantity, as mentioned in the troop quantity subsection)? Ultimately, this is all mentioned just to highlight how such an equation is far too complex and situation-specific to be covered in this paper.

[258] To simplify the underlying logic here (for illustrative/explanatory purposes), suppose that "comparative material capabilities in equipment" was simply a *sum* of variables such as "rifle superiority," "artillery superiority," and "supply superiority (e.g., ammunition, rations)," and "machine guns superiority," such that *regular force's material advantages* = $(R_1\text{-}R_2) + (A_1\text{-}A_2) + (S_1\text{-}S_2) + x(M_1\text{-}M_2)$. Even if M_1 and M_2 (representing regular and irregular machine gun intensity, respectively) were to increase by the same factor "x", this would likely either reduce or increase the overall sum, since the impact of the first three factors is reduced.

British technically had twice the PAWs intensity of the Boers, but the actual nominal percentage difference (roughly 0.06%) was very low. In contrast, in the '17-'18 period of the GEAC the British PAWs intensity was likely around 1.5%, whereas the German PAWs intensity was likely around 1.8%. (The Portuguese and Belgian intensities were likely between 0.5% and 1%, which is more of a problem, but these forces' battle deaths are excluded or discounted in many of the BDXR estimates.) These figures suggest that the Germans had an advantage in machine guns in their war relative to the Boers in theirs, which likely should have increased the Germans' BDXR relative to the Boers'. This is especially based on the widely echoed sentiment that machine guns were highly effective weapons in the GEAC.[259] However, it is important to emphasize that the intensity disparities in the Boer War seem to have had relatively limited effects (i.e., if British intensity had been as low as the Boers', the change in BDXR likely would have been fairly small), partially because the overall intensity was so low (and thus other factors likely played a more significant role in determining BDXR). Additionally, machine guns during the Boer War were often used much less effectively, maintained poorly, and of generally worse quality than those in the GEAC (e.g., they jammed more often),[260] which means that quantitative differences

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[259] "The fire-fighting weapon par excellence in the bush is the machine-gun" - Sheppard, *Some Notes on Tactics*, p. 152;
Robert Dolbey, *Sketches of the East Africa Campaign*, 2003, https://www.gutenberg.org/files/10362/10362-h/10362-h.htm: "This war became a fight of men and rifles, and, above all, the machine-gun."

[260] This is not to say they were never effectively used; as noted in the qualitative analysis, they were sometimes useful for certain tasks. However, it seems clear that the nominal percentage difference in intensity was not as significant as the same difference would have been in the GEAC. Much of the sentiment regarding machine guns' poor performance in the Boer War is summarized by Jones, "The Influence of the Boer War":
"How best to employ machine guns in the Boer War was a tactical problem to which no definite answer was ever found. [...] Reliability was also an issue, with jams and breakdowns frequent throughout the campaign. [...] Lack of technical training within the gun crews meant that repairing mechanical problems in the field was difficult and sometimes even impossible.";
Similarly, one can reference Deasey, "Machine Guns in the Boer War": "There appeared to be three key problems with the Maxims in particular. They were the weight of the equipment on conventional carriages, lack of understanding of how to deploy the weapon and a serious problem with stoppages."

between the British and Boers likely had less impact than the same difference in the GEAC would have had.

Control Variable Variation Summary, With Table

In short, it seems that the German forces were likely meaningfully better off in relation to the Boers during the guerrilla phases of their respective conflicts, but both sides had some advantages. While the Boers had moderate advantages (relative to Germany) in force to force ratios, troop quality, and a less well-equipped foe in terms of mechanization, armor, and aviation, the Germans also had some moderate advantages in the regular force to area ratio, terrain, relative PAWs intensity, and potentially even a less committed foe. The table below attempts to draw together these various considerations and *loosely* characterize how much the cases differ from each other with regard to each variable, assess the significance of these variables with regard to BDXR, and subsequently "estimate" (non-numerically) the expected effects of the control variable variation. It is very important to not take the table too literally/precisely[261]; its main purpose is just to compactly convey the general sentiment of the previous subsections. In this sense, the table reflects the sentiment that the German forces were better off on balance in that it marks more pluses ("+") for the Germans than for the Boers; it is not intended to be precise at the level of the exact number of pluses.

[261] For example, one should not assume that the advantages were purely additive and linear rather than, for example, sometimes interactive and/or logarithmic. However, on such points I did not see any specific reasons/arguments that would change the overall conclusion (that the Germans were better off).

Table 2: Summary of Expected Effects of Control Variable Variation on BDXRs

Variable	Advantaged Irregular (Extent of Variation)	BDXR Significance	Rough BDXR Adjustment
"Commitment" (exemplified by blockhouses and drives)	Germans (Medium)	Medium-Small	++ Germans
Force to force ratio	Boers (Med.-Small)	Medium	++ Boers
Reg. force to area ratio	Germans (Medium)	Medium	++ Germans
Smokeless Rifles	Boers (Small)	Medium	(Little net effect[262])
Terrain	Germans (Med.-Small)	Medium-High	++ Germans
Horses	(Unclear[263])	(Unclear)	(Unclear)
Mech., Armor, Aviation	Boers (Med.-Small)	Medium-High	++ Boers
Troop quality	Boers (Small)	High	++ Boers
PAWs intensity	Germans (Med.-Large)	Medium-High	+++ Germans

[262] As noted in the sub-section devoted to this variable, it seems that the Boers had a slight advantage in this relative to the Germans, *but* it seems that the Boers derived this relative advantage (i.e., the Germans experienced this disadvantage) partially because of machine guns. Thus, it seems that a full "+" mark is unjustified.

[263] Horses were more prevalent in the Boer War, but the significance of this is unclear. One could reason that because the Boers were more skilled with using a horse than their enemies, the presence of horses offered one additional dimension in which the irregulars could have an advantage over their regular foes. However, one could also potentially reason that the horses helped the British to more swiftly hunt their targets (even if the targets were also sometimes able to use horses to escape). In the end, it seems slightly more likely that this factor helped the Boers relative to the Germans, but I will opt to err against my hypothesis, so as to avoid potential confirmation bias.

Quantitative Analysis: Battle Death Estimates and BDXR Comparisons

This section provides some data/estimates on battle deaths across the two wars and compares them in order to determine BDXRs for the irregular forces in the two wars. For some combatants, data/estimates were easy to find/make, but for others it is much more difficult. Thankfully, however, the available data/estimates on the most important combatants is generally sufficient for the purposes of conducting this analysis. The data/estimates will be collected and summarized in tables towards the end of this section.

Battle Death Data/Estimates

Boer War

There are a few key figures/reports regarding casualties for both sides during the Boer War. For the Boers, there are direct monthly estimates of the number of Boers killed from January 1901 to May 1902 (inclusive), which sum to 2,619.[264] These estimates do come from the British, which raises some concerns of overestimation, although no clear evidence was found suggesting this was an overestimation. To put such a figure in context, it represents roughly 66% of total Boer KIA during the overall war (3,990, per one estimate),[265] during a time period that represented just over 50% of the war duration (by months). Unfortunately, no other serious estimate for this period could be found to compare with the British estimate, but it warrants highlighting that this figure does seem reasonable given how, as one lengthy study of the war notes, "it is undisputedly true that the Boer forces suffered heavy losses during the last 17 months of the war."[266] Thus, this study will use the figure of 2,619.

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[264] Maurice, *History of the War*, v. 4, p. 705.
[265] This figure is reported by Andre Wessels, *The Anglo Boer War* [p. 79].
[266] Mcleod, "The Psychological Impact of Guerrilla Warfare," p. 282.

Turning to the British, there do not appear to be similarly formatted estimates (i.e., a monthly table), but with minimal deductive reasoning one can derive a figure for the KIA during the '01-'02 period. Specifically, one can find this by subtracting the reported tally of British KIA up to and including December 1900 (3,540[267]) from the reported total for the entire war (5,774[268]). This returns an estimate of 2,234 British KIA during the '01-'02 period. (Using the same process and sources, the estimate for "died of wounds" is 886.)

GEAC

Estimating battle deaths for the forces during the GEAC is difficult except for the British. Thankfully, the British reported their monthly KIA (and DOW) in a table: from January 1917 to November 1918 (inclusive), their total KIA was 1,510.[269] (DOW was reported as 501.) Turning to the other allies, however, there are more difficulties. Seemingly the best (and only) estimate I could find for Belgian casualties lists the combined counts of KIA and DOW during the "Campagne de Mahenge (1917)" as 148.[270][271] Regarding the proportion of KIA vs. DOW, if one assumes that the Belgians had roughly the same proportions as the British (which was roughly 75% KIA, 25% DOW, based on the figures above), this would equate to 111 KIA, 37 DOW.

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[267] "The Total Losses," London Evening Standard, January 5, 1901, https://www.britishnewspaperarchive.co.uk/viewer/bl/0000183/19010105/084/0006.
[268] Amery, *Times History of the War*, v. 7, p. 25
[269] Great Britain, *Statistics of the Military Effort of the British Empire during the Great War, 1914-1920.* (1922; London: H. M. Stationery off, n.d.), https://hdl.handle.net/2027/umn.31951001694102h, pp. 300 and surrounding. As per the DV operationalization, the figure I list excludes non-combatants such as followers.
[270] Belgium, *Les Campagnes*, v. 3, annex-p. 438; for a non-tabulated format, see v. 3, pp. 267-268.
[271] This figure may seem somewhat low, and it is possible that this figure does not include *all* relevant Belgian battle deaths during the '17-'18 period, but it is important to remember that Belgium largely ended its participation in 1917. In short, I could not find any clear indication that significant numbers of relevant battle deaths were excluded. Additionally, the table presented in *Les Campagnes* v. 3, p. 438 does seem to add up to the total number of Belgian casualties that is generally reported, so it seems unlikely that significant amounts were excluded (e.g., for not being part of the "Mahenge Campaign" specifically). Ultimately, however, the Belgian battle deaths are not very central to the analysis.

The most difficult combatant to find data on is by far Portugal, although thankfully this estimate is not important due to the fact that the primary BDXR estimates for the GEAC exclude Portuguese BDs. Still, it is still helpful to provide a few estimates for Portuguese BD, for the purposes of context (e.g., in case one determines that complete exclusion is overblown). In short, there does not appear to be any "good" estimate, but this analysis will use a low-bound estimate of Portuguese KIA in the '17-'18 period of roughly 350.[272]

Finally, one can estimate German KIA. Unfortunately, there do not seem to be any direct estimates/reports of total German KIA during the '17-'18, but one can produce a few estimates that are reasonable for the purposes of this analysis. First, the total reported/estimated German KIA for the overall war ('14-'18) is around 1557.[273] Upon searching through available German KIA estimates/reports for a variety of battles and engagements in the '14-'16 period, one can find *at least* 570 German KIA.[274] If this estimate is assumed to be an accurate *minimum* (and the 1557 total KIA is accurate), this would mean that the *maximum* number of German KIA in the '17-'18 period would be 987. It is important to stress that this is assuming that 100% of the KIA not included in the 570 count occurred in the '17-'18 period, which is an unreasonable assumption, since there are almost certainly a variety of other engagements in the '14-'16 period that were not reported or which I simply did not find in my search (which was not intended to be

[272] This should be interpreted as close to a "minimum bound," since it is merely a rounded sum of casualties from two relatively major battles in the '17-'18 period, Ngomano (25 Nov., 1917; roughly 187 estimated KIA) and Kokosani (1 July, 1918; roughly 105 estimated KIA), in addition to a few other reports of battles (e.g., Oizulo Hills) that are also reported by Anderson ("World War I in East Africa") and Lettow-Vorbeck (*My Reminiscences*).
[273] "Translation of von Lettow-Vorbeck's diary," Microfilm collection, reference 49538. This report lists 267 Europeans "killed" and 1290 Askaris "killed." It does not specify KIA vs. DOW.
[274] This is derived from a combination of sources, each *passim*:
Hordern, *Military Operations*;
Buchanan, *Three Years of War*;
Ludwig Deppe, *Mit Lettow-Vorbeck Durch Afrika*, Kindle Edition (Wolfenbüttel Melchior, Historischer Verl, 2013);
Belgium, *Les Campagnes*;

exhaustive). If one instead assumes a lower proportion such as 80%, the number for the '17-'18 period would be approximately 790, which this analysis will treat as the "medium-low" estimate.

Table Summary of BD Estimates; Calculating and Comparing BDXRs

Table 3 provides a summary of the information provided above. Tables 4.1 and 4.2 use the information from Table 3 to produce a set of BDXR estimates.

Table 3: Boer War and GEAC Battle Death Main Estimates Summary Table

War	Combatant (Version)	KIA (+ DOW)
Boer War	Boers	2619
Boer War	British	2234 (+ 886)
GEAC	Belgium	111 (+ 37)
GEAC	British	1510 (+ 501)
GEAC	Portuguese	350
GEAC	Germans (High)	987
GEAC	Germans (Medium-Low)	790

Table 4.1: Boer War BDXR Estimates

Est. ID	Equation and BD Estimate Types	BDXR
1A	**(British KIA)/(Boer KIA)**	**0.85**
1B	**(Brit. KIA+DOW)/(Boer KIA)**	**1.19**

Table 4.2: GEAC BDXR Estimates

Est. ID	Equation and BD Estimate Types	BDXR
2A-i	**(Brit. KIA)/(Germans High KIA)**	**1.53**
2A-ii	**(Brit. KIA)/(Germ. Med.-Low KIA)**	**1.91**
2B-i	**(Brit. KIA+DOW)/(Germ. High KIA)**	**2.04**
2B-ii	**(Brit. KIA+DOW)/(Germ. Med.-Low KIA)**	**2.55**
2C	*(Allied KIA)/(Germ. High KIA)*	*2.00*
2D	*(Brit KIA + 0.25*(Belg. KIA + Port. KIA))/(Germ. High KIA)*	*1.65*

The main estimates to focus on are bolded (whereas 2C and 2D are provided primarily for context). Importantly, when comparing BDXRs so as to measure for variation in the DV, there are just two main sets of estimates to focus on: the estimates restricted to British KIA and the estimates that include British KIA and DOW. Regarding the former, comparing estimate 1A to the range created by 2A-i and 2A-ii shows a nominal increase in the range of roughly 0.68 to 1.06, which in relative terms represents an increase of nearly 80% to 125%. When including DOW, the relative increase in BDXR only slightly attenuates: comparing estimate 1B to the range created by 2B-i and 2B-ii shows a nominal increase in the range of roughly 0.85 to 1.35, which in relative terms represents an increase of roughly 70% to 115%.

Interpretation and Summary of Quantitative Results

Regardless of the exact estimate used, the data collected and provided here suggests that the Germans clearly had a better BDXR in their guerrilla conflict than the Boers. Such an outcome is in line with the hypothesis, which holds that irregular military effectiveness (as

measured by BDXR here) should increase as both irregular and regulars' PAWs intensities also increase. Unfortunately, however, one cannot draw solid conclusions regarding any potential causal effects of machine guns, including whether they serve as "equalizers," due to variations in control variables that on balance likely also contributed to the Germans' superior BDXR. Thus, unless one assigns specific numerical values to the impacts of these variations, one cannot separate the effects of these variations from any hypothesized effects of shifts in PAWs intensities.[275] However, this uncertainty over the effect is one of the primary reasons why the following qualitative analysis was also conducted.

[275] In fact, if there is an effect, it could even be slightly negative (yet offset by the other variables, including the Germans' greater PAWs intensity proportionality).

Qualitative Analysis: Impact on Tactics' Effectiveness

In order to better understand whether PAWs actually served as "equalizers" by *contributing* to the shift in BDXR as well as whether they have equalizer effects beyond the simplistic/rigid measure of *BDXR* (e.g., by impacting mobility and survivability), this section of the analysis will take a more qualitative approach to the analysis. More specifically, this section will analyze PAWs' impacts on some of the major types of tactics used in the two wars, so as to better evaluate whether PAWs tended to help the guerrillas achieve their tactical/strategic objectives—a measure more in line with the conceptual definition of military effectiveness.

The two major categories of tactics to examine are surprise attacks (e.g., ambushes) and static defense (e.g., blockhouses). Ultimately, this section will try to characterize the nature, usage, and impact/value of these tactics, then analyze the variation in their effectiveness in relation to the variation in PAWs intensity on *both sides* (so as to better evaluate net effects). Unfortunately, it is difficult to objectively determine the empirical association of PAWs with shifts in the tactics' effectiveness, due to the lack of detailed/consistent coverage of many of the relevant engagements across the two wars (e.g., every small skirmish and raid). However, one can emphasize the sentiment of historians and participants in combination with examples and basic reasoning (including some directly from participants, such as Baden-Powell) to improve one's evaluation of the hypothesis' accuracy. At the end of this section, a table is provided that briefly summarizes/characterizes the overall findings of the qualitative analysis.

PAWs' Effects on Surprise Attacks: Swarms, Ambushes, Hit-and-Runs, etc.

The first major set of tactics/engagements to examine are surprise attacks such as ambushes and hit-and-runs. These are often recognized as hallmark guerrilla activities, since they involve some degree of surprise to reduce/flip local material disparities (e.g., concentrated attacks on smaller targets followed by dispersion so as to avoid capture) or to reduce the impact of local material disparities (by using cover/concealment and fleeing before the enemy has time to effectively leverage their material advantages). Thus, it seems that if one would expect PAWs to asymmetrically benefit guerrillas, this would be a primary way in which they do. The following subsections will describe the nature/characteristics of these types of tactics, examine their usage and effectiveness across the two cases, and attempt to assess the impact of PAWs on these tactics—and thus, on the military effectiveness of the combatants in the overall conflicts.

Nature/Characteristics of Surprise Attacks in the Two Conflicts

One should first recognize the non-monolithic nature of surprise attacks, especially in these two conflicts. To simplify much of the complexity/variations in attacks, one can discern *at least* two major subcategories of ambush/attack tactics used by the combatants: "charge/swarm-style" attacks vs. "cover-based/hit-and-run/harassment" ambushes. The distinction between these two can be fuzzy at times (particularly when an ambush uses elements of both), and both did use or attempt to use some element of surprise, but the *primary* distinguishing feature is the initial, heavy use of cover in the latter as opposed to *immediately* charging/advancing with the former. Secondarily (i.e., not *inherently* but typically), the charge/swarm-style attacks tended to involve the use of mass and seek to kill/capture a substantial number of enemies (i.e., achieve a "decisive" victory), whereas the cover-based

ambushes *tended* to use relatively small numbers of troops and put a greater emphasis on minimizing losses than on achieving a "decisive" victory—and thus tended to involve retreating before becoming encircled or otherwise overwhelmed.

Turning to consider the trends across the two cases, one finds that the conflicts were not wholly different with regards to the types of ambushes employed—i.e., they both used a mixture of these major types of surprise attacks—but there are a few relevant differences. In particular, it appears that Boers would charge and overwhelm convoys or other targets of various sizes through troop parity or superiority *more often* than the Germans did in the GEAC (especially when excluding the campaign in Mozambique, which was especially conducted against the Portuguese). This is not to say that this was the "most common" form of such attacks; it seems that independent unit (e.g., "lone sniper") harassment of British columns[276] as well as hit-and-runs that used pom-poms and/or rifle fire[277] were the most frequently-occurring skirmishes in the Boer War. Yet, there are also multiple significant instances where the Boers achieved force parity/superiority and engaged in mounted charges against a large (>1000- or 100s-strong) column/convoy.[278] *Crucially*, however, British columns also at times engaged in similar charge/swarm raids against smaller Boer kommandos, especially as seen in Colonel

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[276] See for example the discussion here: Deneys Reitz, *Commando : A Boer Journal of the Boer War* (1930; North Charleston, S.C.: Createspace, n.d.), https://catalog.hathitrust.org/Record/001872983, p. 270.
[277] Amery, *The Times history*, v.6, p. 489;
[278] Pakenham, *The Boer War*, p. 589 mentions multiple such attacks conducted by De la Rey;
Stephen M. Miller, "British Surrenders and the South African War, 1899–1902," *War & Society* 38, no. 2 (January 29, 2019): 98–114, https://doi.org/10.1080/07292473.2019.1566980: See for example the attack conducted against Benson;
It is less clear whether these engagements involved numerical superiority, but another example of an ambush conducted via horseback charge (albeit an unsuccessful one) is attested to by: Viljoen, *My Reminiscences* (in particular, see "In December, 1901");
Another such ambush/swarm was conducted in September 1901 by Botha against a British column led by Gough - Source: Pakenham, *The Boer War*, p. 562-563;
More generally, one source notes that the Boers had a tactic of "charging in spread formation, firing from the saddle in 'Arab fashion'" — Jong, "Lessons from the Boer War."

Rawlinson's night/dawn raids—which Pakenham even writes were "almost indistinguishable from the tactics now adopted by the Boers."[279]

In contrast, the German ambushes, harassment, and related engagements in the GEAC are more consistently/significantly described as harassment from cover by a smaller force against a larger force, followed by the retreat of the smaller force.[280] Characterizing these tactics in general, Hoyt is particularly illustrative: "When the British arrived, the [German] machine gun crew opened fire, cleared the area [...] and were off to a new position before [...] the British machine gunners opened fire."[281] In fact, these encounters were so frequent that they became known among British officers as "the usual trap."[282] Although one can find a few examples of German ambushes culminating in (bayonet) charges,[283] these rarely (if ever) compare to the mass, mounted ambushes/charges in the Boer War. Rather, historians and participants frequently emphasize Lettow-Vorbeck's "ambushes and [...] stubborn rear guard actions [....]"[284] The *precise* relative frequencies here are not very important, but what is crucial to note is that although the British in the GEAC also reportedly engaged in some of these ambushes/harassment from cover, [285] one finds that across both wars the British did not put as much emphasis on these kinds of ambushes from cover as did their irregular foes. Instead, the British tended to emphasize the charge/swarm style tactics or other, more-conventional tactics (e.g., pursuit and encirclement via columns).

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[279] *The Boer War* [p. 572]
[280] See for example the description by Arquilla, *Insurgents, Raiders, and Bandits*, pp. 148, 151;
[281] Hoyt, *Guerilla*, p. 258.
[282] Hoyt, *Guerilla*, pp. 258, 262.
[283] Downes, *With the Nigerians*, p. 277: "The Germans delivered a bayonet charge against the Baluchis' left flank [....]" It is important to remember that such charges could more easily advance under/through cover in bush terrain, especially where there is tall grass (e.g., elephant grass).
[284] *The Great War in Africa* (Farwell) [p. 309]
[285] Buchanan, *Three Years of War*, pp. 18-19; p. 168.

Usage and Effectiveness of Surprise Attacks

Again, objective "measurements" are not very practical given the lack of consistent data, but one can discern some sense of this from the sentiment of participants and historians (combined with reference to illustrative examples and some theoretical reasoning). In short, it appears that the charge/swarm-style tactics were decently effective at inflicting large amounts of losses quickly or achieving other tactical goals in the Boer War,[286] but crucially, this was true for *both sides*, and quickly inflicting larger numbers of losses generally favored the more-numerous British. Even De Wet recognized that the British "had made a whole series of *coups*" using the tactic of "tiger-springs" on Boer camps at night.[287] Because these engagements were rarer in the GEAC, it is difficult to make comparisons, but as discussed further down, sources suggest that machine guns reduced their effectiveness, and reasoning would suggest that this helps explain why they were less prominent in the GEAC.

In contrast, the cover-based/harassment ambush tactics were considered highly effective at *efficiently* inflicting casualties (in terms of BDXR) and/or slowing pursuers in the GEAC—seemingly more so than in the Boer War. Hoyt in particular suggests that the Germans' tactics (described above) tended to kill substantially more British soldiers than they cost the Germans while also slowing down the pursuing columns.[288] One British soldier emphasized that the Germans could fight "series of very stubborn rear-guard actions" which, in one case, restricted an entire day's progress to "only two miles."[289] Such rearguard actions were also

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[286] Some of the most significant/remarkable instances of Boer successes are described by the following sources:
Pakenham, *The Boer War,* p. 589 mentions multiple such attacks conducted by De la Rey;
Miller, "British Surrenders": See for example the attack conducted against Benson;
[287] *The Boer War* [p. 574]
[288] Hoyt, *Guerilla*, pp. 258, 262.
[289] Clifford, *The Gold Coast Regiment*, p. 271.

employed in the Boer War,[290] but historians/participants overall do not seem to put as much emphasis on their effectiveness in the Boer War *compared with* in the GEAC. Notably, the British drives managed to inflict meaningful losses in terms of degrading the Boers' capability to fight even if the drives were not always effective at achieving their immediate/purported goals in the Boer War (e.g., "bagging" the leaders).[291] Additionally, one of the weapons that the Boers' liked to use to open ambushes, the pom-pom, was described as mediocre at inflicting casualties (although it did reportedly have a significant "morale effect").[292]

Assessing the Role/Impact of PAWs for Surprise Attacks

Having addressed these points, one can address the role machine guns had, beginning with the charge/swarm-style ambushes: as one may expect, machine guns appear to have substantially undermined the viability/effectiveness of these tactics on balance. *Part* of the reduction in cavalry usage most likely was attributable to changes in terrain and climate (and associated livestock diseases), as noted in the control variable analysis. However, as one source plainly suggests in response to the Boer War, the horseback charge was largely phased out "due to the increased firepower (machine guns) [sic] [....]"[293] Other sources similarly note that "mobility, one of the prime assets of the cavalry soldier, would of necessity be severely restricted by [...] the machine gun."[294] These swarms were frequently used against column/commando

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[290] De Wet himself writes that he would sometimes mass together "two or three hundred burghers" to face the pursuers and cause them to stop, bring forward and use their guns, and send out flanking parties. In response, the Boers would "quietly withdraw out of sight" while the British tried to encircle or assault the then largely-empty position. However, he does also write that "It sometimes happened, in these rearguard actions, when the position was favourable, that the enemy were led into an ambush [....]" - De Wet, *Three Years' War*, p. 213.
[291] For some varying discussion of this, see sources such as *A Handbook of the Boer War*, 2005, https://www.gutenberg.org/files/15699/15699-h/15699-h.htm, and Viljoen, *My Reminiscences*;
For an example of where such rearguard actions failed/were overwhelmed, see De Wet, *Three Years' War*, p. 217.
[292] Amery, *The Times history of the war*, v. 6, p. 489;
[293] De Jong, "Lessons from the Boer War." Parentheses in original.
[294] Robinson, "The Search for Mobility";
One participant in the conflict suggests "the deadly machine-gun that enfiladed or swept every open space" was one

camps and convoys, but regarding camps, participants in the GEAC suggested that machine guns made it easier to quickly turn a camp "into a veritable fortress"[295]; regarding convoys, one participant in the Boer War (Baden-Powell) writes that machine guns could be "specially [sic] useful for the protection of a convoy," and describes one instance in which it was used to scare off some ambushing Boers.[296] Additionally, although it was not in the GEAC specifically, Lettow-Vorbeck's troops found machine guns to be highly effective at responding to swarm-style ambushes by Africans ("natives") in the GEA colony prior to WWI.[297] Overall, this is in line with the common understanding of machine guns' effects, namely the ability to inflict significant casualties against exposed and massed forces. Ultimately, although the ambush target may be exposed, with charge/swarm tactics this means that the ambusher also tends to be exposed—particularly if the direct path to their target involves stretches of exposed/open ground.

In contrast, PAWS appear to have significantly benefited the cover-based/harassment ambushes *on balance*. Historians and participants consistently emphasize the significance of machine guns in these types of engagements: in describing the German ambushes, Hoyt plainly states that "The machine guns were the key"[298]; machine guns were often used to open ambushes with a "devastating burst" from concealed positions[299]; after the Boer War, Baden-Powell

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of the reasons that "the mounted arm was robbed of much of its utility." — Dolbey, *Sketches of the East Africa Campaign*.

[295] R. T. Ridgway, "With No. 2 Column," 1922, https://hdl.handle.net/2027/uc1.b3017940?urlappend=%3Bseq=35, p. 24.

[296] Baden-Powell. *War in Practice*, p. 196. Unfortunately, he does not describe this specific story in a substantial amount of detail, but he appears to suggest that the Boers were advancing on their position (given how he says the British "mounted troops seemed likely to be driven in").

[297] Nesselhuf, "General Paul von Lettow-Vorbeck's":
"Commanders headed the column with a loaded machine gun team and Askaris trailed behind, marching rifles loaded. Columns responded to ambushes by saturating attackers with machine gun fire while the Askaris arranged themselves into a hedgehog formation around the column's supplies. [...] The Schutztruppe's tactics inflicted high casualties, but defeating ambushes rarely ended rebellions."

[298] Hoyt, *Guerilla*, p. 258.

[299] Anderson, "World War I in East Africa";
In coming to this conclusion, Anderson references the firsthand account of "With No. 2 Column," p. 25.

recognized that "Machine-guns can open such a terribly rapid and accurate fire on advancing troops as to make certain zones practically impassable."[300] Again in reference to innovations such as machine guns, Baden-Powell also wrote that "the improved power of defence permits of comparatively smaller bodies being used for the purpose" of advance-guard and rear-guard actions.[301] One 1918 military report emphasized that "surprise effect" is "one of the most important factors in war," and that "For surprise effect upon group targets, the machine gun is greatly superior to rifle fire."[302]

Thus far, these points have primarily emphasized the benefits for the ambusher, but there are some ways in which PAWs could help the ambushed party, and this overall tactic does have *some* vulnerabilities to countermeasures. For example, Baden-Powell observed that machine guns could help in the Boer War by providing "reconnaissance by fire" in situations where they could not see their assailants (e.g., isolated snipers harassing their columns in thick terrain).[303] This is in addition to the previously-mentioned points he makes regarding the protection of convoys in general. Additionally, against more-sustained ambushes, light machine guns were considered particularly helpful for flanking maneuvers by providing mobile and dense firepower.[304] Regarding countermeasures, the British found non-PAWs technology such as the Stokes mortar to be particularly helpful for dislodging machine gun nests once they could get a range on them.[305]

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[300] Baden-Powell, *War in Practice*, p. 31.
[301] Baden-Powell, *War in Practice*, p. 173;
Also, see similar sentiment from Joel Boyd, "The Royal Regiment of Artillery in the Boer War," 1964, https://core.ac.uk/download/pdf/215270021.pdf: machine guns increased firepower such that "fewer men were required to hold a portion of the terrain [....]"
[302] *Tactical Use of Machine Guns*, 1918, https://hdl.handle.net/2027/uc1.c2670602, pp. 2-3.
[303] Baden-Powell, *War in Practice*, pp. 45-46.
[304] Anderson, "World War I in East Africa";
[305] Anderson, "World War I in East Africa." It is worth noting that, according to Anderson, "The Germans found [the Stokes mortar] difficult to counter and disliked its effects

However, these counter-benefits and weaknesses are mitigated by a few key issues. In particular, one researcher notes that the machine guns' lethality/effectiveness was substantially limited by the Boers' use of cover/concealment.[306] Non-PAW counters such as the Stokes mortar similarly faced problems when the enemy was hidden.[307] Additionally, with regards to the points about flanking maneuvers and situations where the mortar teams could spot their targets, these are not very relevant against the mobile/harassment actions described above, which were specifically designed/used to avoid encirclement and artillery targeting/zeroing. Such points reflect the view of one soldier in 1910: "The golden rule for machine gun tactics is: *conceal your guns, utilise cover, and operate by surprise, for surprise is the essence of tactical success.*"[308] Thus, in the GEAC, "usually it was the side which laid the ambush which scored most heavily."[309]

In summary, it appears that PAWs' benefits to the force conducting a cover-based/harassment ambush tended to substantially outweigh PAWs' benefits to the ambushed party. In fact, this seems to hold true even if the ambushed party has more PAWs: even if this eventually helps with suppression of the ambusher, the initial element of surprise (i.e., the exploitation of asymmetries in cover and concealment as well as the target response delay) provides an early advantage to the ambusher, who may often be able to simply retreat to a new

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Intensely."

[306] Jones, "THE INFLUENCE OF THE BOER WAR": "However, when committed to action against a well-armed and carefully concealed opponent in South Africa, results were disappointing. The Boers fought from behind cover and refused to provide the kind of massed target that the Dervishes had done in the Sudan." Later, Jones notes that "The machine gun performed poorly in South Africa, with the unwieldy weapons making perfect targets for Boer artillery and riflemen. Jams and breakdowns were extremely common [....]"

[307] One firsthand account described it as effective in some engagements/skirmishes where the enemy machine guns could be located, but notes that in an engagement shortly thereafter, it was not very effective because the enemy's position was hidden among elephant grass. - Clifford, *The Gold Coast Regiment*.

[308] R. V. K. Applin, "Machine Gun Tactics in Our Own and Other Armies," *Royal United Services Institution. Journal* 54, no. 383 (January 1910): 34–65, https://doi.org/10.1080/03071841009418491. (Italics in original)

[309] Buchanan, *Three Years of War*, pp. 18-19

position whenever his current position is compromised—thus potentially enabling an outnumbered group to achieve a higher BDXR while also slowing or disrupting pursuers/convoys. When combining this point with the observations regarding the tactics' asymmetric use as well as their ability to reduce the impact of material disparities between the two parties through the use of surprise and by slowing the mobility of larger pursuers, one can conclude that systemic increases in PAWs intensity likely substantially helped the irregulars in this regard.

PAWs' Effects on Static Defense Tactics

One of the key strategies/tactics for a counter-guerrilla force is to restrict the movement of the irregular forces, so as to prevent their escape and to defend territory against raids.[310] Given the machine gun's iconic association with the category of tactics I will label "static defense tactics" (e.g., in trenches and other fortifications) and given how much emphasis the British placed on measures such as the blockhouses against the Boers, it seems that a net analysis of PAWs' effects would be quite one-sided/incomplete if one did not consider their effects on these static-defense tactics. Thus, this subsection will outline the broader concept of these tactics (including why they are generally distinct from the cover-based ambush tactics), illustrate this concept with examples such as the blockhouse, examine their effectiveness within (or based on examples from) the two cases, and subsequently attempt to evaluate the impact of machine guns on these kinds of tactics.

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[310] See for example:
Mcleod, "The Psychological Impact of Guerrilla Warfare"; and
Scholtz, *Why the Boers Lost*, pp. 88-89.

Nature/Characteristics of Static-Defense Tactics

To explain the concept, it helps to begin with the concrete description of blockhouses: these were chains of small, loop-holed buildings (typically made of iron, stone, concrete, and/or other material) connected by barb-wire/etc. fences and manned by small groups of troops (typically less than 15).[311] Together, they formed long chains to impede the movement of Boers. Looking beyond the issue of blockhouses specifically, this category includes other fixed or semi-fixed movement-control tactics/defenses, such as checkpoints, outposts, trenches, pillboxes, etc.—especially those placed at chokepoints, such as bridges or mountain passes. Still, it is easiest to focus on blockhouses specifically because they were so prominent in the Boer War, and this is where much of the historiography focuses.

Speaking about the concept of static defenses and mobility denial more broadly: the tactic of staggered harassment also sometimes seeks to *impede* mobility, but there are some significant differences between blockhouse-type defenses and the mobile/staggered-ambush style "defenses" which are illustrated in the Boer War and GEAC. First, static-defense tactics tend to sacrifice much of the mobility and concealment—and with this, the "surprise effect"—of the cover-based ambush tactics to provide defenders with cover and pose widespread impediments/hazards to enemy mobility (e.g., barbed wire, walls, ditches). Second, whereas the harassment ambush tactics prioritize inflicting high casualty exchange ratios and/or *delaying/disrupting* a pursuer (but not necessarily indefinitely blocking, diverting, or defeating them), these static defense measures put a greater emphasis on blocking, diverting, defeating, or

[311] E. H. Bethell, "The Blockhouse System in The South African War," *Professional Papers of the Corps of Royal Engineers*, 1904, https://hdl.handle.net/2027/nyp.33433109948178?urlappend=%3Bseq=385;
R. M. Holden, "The Blockhouse System in South Africa," *Royal United Services Institution. Journal* 46, no. 290 (April 1902): 479–89, https://doi.org/10.1080/03071840209418999.

at least limiting the supply mobility[312] of the enemy, which could include individuals, raiding parties, and large groups/convoys. Alternatively/additionally, as was especially the case with the blockhouses in the Boer War, these tactics were used in combination with other tactics (e.g., pursuing columns) to trap and defeat attackers.

Usage and Effectiveness of Static-Defense Tactics

Views on the effectiveness of these tactics in the Boer War varies among participants and historians. De Wet notably criticized the blockhouses as the "policy of the *blockhead*" due to his repeated success at escaping the blockhouse lines.[313] Despite his jeers, however, a fair analysis of the conflict shows that although the blockhouses were far from perfect at stopping breakthroughs, they eventually proved to be impactful in limiting the movement of small groups/individuals, impeding supply movement of larger groups (e.g., cattle and wagons), and helping the "drives" which together with the blockhouses helped to demoralize, capture, or otherwise attrit the Boers.[314] Additionally, they also significantly helped to defend railways and communication lines against small-group saboteurs.[315]

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[312] Mcleod, "The Psychological Impact of Guerrilla Warfare";
"Along the entanglement to within 100- yards of each blockhouse a deep trench is dug which prevents wagons ever getting across, even if the wire is cut." - Holden, "The Blockhouse System";
There are also some occasions where the blockhouse lines (in conjunction with other tactics) could not prevent all of the Boers from escaping, but they did manage to prevent the Boers from bringing their valuable cattle. See for example Arquilla, *Insurgents, Raiders, and Bandits*, p. 141.

[313] De Wet, *Three Years' War*, pp. 260-261.

[314] Mcleod, "The Psychological Impact of Guerrilla Warfare";
"The vast geography of South Africa meant that these operations [drives] only became truly effective after the 'Blockhouse' system was introduced. The construction of large blockhouse lines deprived the Boers of mobility and allowed the British to pin them against fixed fortifications." - Jones, "The Influence of the Boer War";
"The blockhouse lines were a key element of the imperial defence of the strategically important areas [....] It increased the strain on the Boer commandos and added to the rate of attrition by rendering each crossing of the blockhouse lines a hazardous undertaking." — Rodney Constantine, "A Case Study of the Republican and Rebel Commando Movement," 1996, https://open.uct.ac.za/bitstream/handle/11427/9264/thesis_hum_1996_constantine_rj%20%281%29.pdf?sequence=1&isAllowed=y.

[315] Among other sources/quotes, see for example: "Before the blockhouse system began, the Boers succeeded in destroying 45 major railroad bridges, 180 culverts, and 45 locomotives. Once the blockhouse system was in place, the Boers were virtually unable to sabotage the railways." — Grant Steffan, "Forts and Blockhouses: Field

Still, the blockhouses' shortcomings and weaknesses should be highlighted, at least wherein it is relevant to the later analysis of the impact of PAWs. As De Wet and many other Boers demonstrated, the blockhouse lines were not wholly impassable: smaller groups could still sneak through at some places at night,[316] and in one drive De Wet even managed to break through "no less than three blockhouse lines."[317] Additionally, if enough Boers massed together they could easily overwhelm many blockhouses at night by suppressing the fort with concentrated rifle fire.[318] Especially with the latter point, the weaknesses of being conspicuous (as touched on by Baden-Powell) arise: without the element of surprise/concealment, the small number of troops were susceptible to being suppressed (even when using loopholes)[319] by enemies who massed together and used cover or the guerrillas simply avoided the area/battle altogether. Additionally, participants and historians note that if the Boer groups in question had had any artillery with them, the blockhouses could have been easily destroyed.[320] Finally, one must recognize that the

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Fortification in the Rear Area," 1993, https://apps.dtic.mil/dtic/tr/fulltext/u2/a289003.pdf; and
"The British blockhouse lines also became a serious deterrent to guerrilla actions in the region." — Mcleod, "The Psychological Impact of Guerrilla Warfare."

[316] See for example the account by Viljoen in *My Reminiscences*: "We naturally kept as far from the blockhouses as possible, quietly cut the barbed-wire fences stretched all along the line, and succeeded in crossing it without a shot being fired."

[317] Pakenham, *The Boer War*, p. 582.

[318] See the following account for example: "Each garrison had about twelve men and each attacking Boer party numbered about one hundred. [...]" — Miller, "British Surrenders";
Arquilla (*Insurgents, Raiders, and Bandits*, p. 140), writes that De Wet occasionally "was able to achieve local superiority long enough to escape, sometimes even to wait for pursuers to come to the breach he had made, ambushing them upon their arrival";

[319] Baden-Powell (*War in Practice*) writes that blockhouses "were so conspicuous and so limited in size, that the enemy could always see exactly what force they had opposed to them. [...] concentrated rifle fire could be brought to bear on them, and a certain proportion of the bullets fired would be likely to enter the loopholes."

[320] "They would be untenable directly a gun of any sort was brought against them. [sic]" — Baden-Powell, *War in Practice*;
"The Boers lacked the artillery which could have destroyed the blockhouses easily." — De Jong, "Lessons from the Boer War";
Speaking generally, Holden ("The Blockhouse System in South Africa") writes that blockhouses are "suited chiefly to mountain warfare in wooded country where it is not always easy to bring artillery to bear upon it, and the artillery itself is of inferior power."

blockhouses relied on dense troop and infrastructure to area ratios;[321] if gaps were left in the lines and the defenders' positions were discovered, the enemy could just exploit the gaps and avoid the defenders, since the guerrillas are typically not trying to capture the position/territory.

Thus far, the discussion has primarily focused on the Boer War, and the main reason for this is that these tactics did not feature so prominently in the GEAC—or at least, not in its historiography. There are a few examples of isolated/limited blockhouses, such as guarding bridges and "other strategic targets,"[322] as well as some areas of so-called "permanent piquets,"[323] but concerted efforts at restricting mobility through mass infrastructure and manpower seem comparatively limited in the GEAC (or at least, in its guerrilla phase). There are certainly some situations where Allied forces try to block the Germans' movement, which did seem to be at least roughly as effective as British efforts during the Boer War, although sometimes the Germans simply harassed (e.g., fired mortars at) the defenders but ultimately avoided them[324]; sometimes the Germans would "besiege isolated outposts."[325] If it is indicative of their movement control, the British were at least able to push Lettow-Vorbeck's forces in various directions (similar to the drives against the Boers, but with Lettow-Vorbeck's forces being more centralized than the Boers, which were certainly more split across regions), but they were also largely unable to actually encircle and "bag" the Germans.

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[321] More than 50,000 troops were used to man over 8,000 blockhouses that stretched across the countryside. For example, see estimates from Andre Wessels ("Boer Guerrilla and British"): "Some 60 000 soldiers were used as blockhouse guards [....]"

[322] Sneyd, "East African Campaign";
Lettow-Vorbeck (*My Reminiscences...*) reports that early in the war (e.g., 1914) the Allies were "securing the occupied country by a system of block-houses."

[323] Sheppard, *Some Notes on Tactics*, p. 147.

[324] See for example Lettow-Vorbeck's account of his actions in Fife, *My Reminiscences*, pp. 309-310.

[325] Nesselhuf, "General Paul von Lettow-Vorbeck's."

The key observation for the overall GEAC, though, is that the Allies do not seem to have clearly been better (and in fact *may* have been worse) at restricting the Germans' mobility in comparison with the British against the Boers: German raiding parties continued to have success even as late as 1917,[326] and Lettow-Vorbeck's overall group managed to invade and trek through Mozambique and British Rhodesia in the '17-'18 period. This is almost certainly influenced by some of the control variable variation: on the one hand, the greater regular to irregular force ratios in the GEAC (vs. the Boer War) should have helped the allies with mobility control, but on the other hand such advantages were probably outweighed by the combination of Portuguese weakness, more "thick bush" terrain (which helped conceal movement), and smaller regular troop density (per area). Yet, the Allies in the GEAC also had significantly higher PAWs intensity than the British in the Boer War, which prompts the more-critical evaluation of their effectiveness in static defense.

Assessing the Role/Impact of PAWs for Static Defense

Unfortunately, I could not find any substantive data/information on machine gun usage in the Boer War blockhouses, but it is clear that machine guns were not "standard" (e.g., one per fort or every other fort), given that British machine guns in the Boer War reportedly totaled less

[326] Speaking about the overall war period (and reflecting general historiographical sentiment), David Katz writes that "Raiding was an activity the Germans engaged in often with great success and to the extreme irritation of the British." — David Brock Katz, "A Clash of Military Doctrine: Brigadier-General Wilfrid Malleson and the South Africans at Salaita Hill, February 1916," Historia 62, no. 1 (May 1, 2017): 19–47, https://doi.org/10.17159/2309-8392/2017/v62n1a2;
In 1917, "One sizable *Schutztruppe* unit continued to operate behind enemy lines around Iringa and periodically wreaked havoc. At one point it broke straight across the British line of communication, severed it, and then seized considerable amounts of supply. Another subcolumn, operating farther to the north, also ruptured the main line of communication, and conducted threatening raids into British East Africa." — Keithly, "Khaki Foxes."

than 400[327] whereas there were roughly 8,000 blockhouses.[328] Some less-academic, modern sources have casually/offhandedly suggested that machine guns were sometimes used,[329] but historians and participants provide little to no information about this while instead emphasizing the importance of modern "rifles."[330] Thus, evaluating the impact of PAWs again requires some reliance on contextually-enriched and participant/historian-informed theoretical reasoning,

Greater PAWs intensity in these conflicts very likely did/would have helped static defense tactics in some ways, but *on balance* these benefits seem to have been moderate at best. On the one hand, PAWs in general improved the lethality of users which helped to restrict/punish movement across open terrain[331] while also enabling the use of fewer soldiers to guard positions [332]—as noted for previous tactics. However, the blockhouses seem to have achieved some substantive success even without PAWs under certain conditions—and importantly, in many of the conditions/situations where blockhouses reportedly failed/were weak, it seems that PAWs would not have been very effective.

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[327] See data from Great Britain, *Minutes of Evidence Taken before the Royal Commission on the War in South Africa: Presented to Both Houses of Parliament by Command of His Majesty.*, *Hathi Trust* (London: Printed for H. M. Stationery off., by Wyman and sons, limited, 1903), https://catalog.hathitrust.org/Record/001260315, pp. 189-190. This data suggests that the total number of machine guns initially possessed and/or shipped to theater during the war totaled 339, and this is without even subtracting machine guns which were rendered inoperable.

[328] Amery, *Times History of the War*, v. 6, p. 337.

[329] Mike Hanslow, "Blockhouses of the Boer War," www.bwm.org.au, accessed November 17, 2020, https://www.bwm.org.au/blockhouses.php;
Johan van den Berg, "The Evolution of the Blockhouse System in South Africa," 2009, http://www.theheritageportal.co.za/sites/default/files/The%20Evolution%20of%20the%20Blockhouse%20System%20in%20South%20Africa%20-%20Natasha%20Dicey.pdf.

[330] "Again, the blockhouse lines could not have been held at all except with modern arms, and were a means of taking advantage of the great power of the rifle on the defensive." — Bethell, "The Blockhouse System in," v. 30, p. 290;
"Advantage was taken of the power of the modern rifle [....]" — Maurice, *History of the War*, v. 4, p. 575.

[331] "Machine-guns can open such a terribly rapid and accurate fire on advancing troops as to make certain zones practically impassable." - Baden-Powell, *War in Practice*.

[332] Boyd, "The Royal Regiment."

This relates back to the points regarding the weaknesses and shortcomings of the blockhouses and related tactics, including when the guerrillas could sneak by undetected or when they massed together to overwhelm points in the lines through suppression and assault. In the latter situations, where the loopholes or other vantage points are consistently peppered with fire, PAWs likely offer some help, but especially when the attack occurs during the night or dusk/dawn and the irregulars use cover/concealment (as the Boers sometimes did[333]), the impact of PAWs would be substantially limited (given the difficulty in shooting at unseen targets while being suppressed). These mass Boer attacks were also reportedly conducted with rifles; if the Boers had access to more PAWs, it seems that the Boers would have been able to effect greater suppression against the static defenses with even fewer troops. Additionally, the blockhouses (and some other static defense tactics) were varyingly susceptible to artillery and mortars.[334] Against such threats, it seems PAWs typically would be of limited assistance (especially when the attackers are firing from cover/concealment using indirect fire). Ultimately, the analysis here suggests that increased PAW availability/intensity likely enhanced the effectiveness of these static defense tactics on balance, but the benefits to defenders are mitigated by some factors (e.g., lower effectiveness against enemies who are concealed/in cover) and even *partially* offset by the benefits occasionally provided to attackers.

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[333] See for example the account given by Hordern, *Military Operations*, pp. 483-484.

[334] Previous sources already emphasized the blockhouses' weakness to artillery; regarding mortars:
One source writes that an improvised mortar weapon was effective against a "blockhouse" in the Spanish-American war, although further details are unclear. — Virgil Ney, "Evolution of the US Army Infantry Mortar Squad: The Argonne to Pleiku," 1966, https://apps.dtic.mil/dtic/tr/fulltext/u2/645160.pdf;
However, a more generic and formal U.S. Marine Corps publication states that "60-mm HE fires will not penetrate a properly constructed fortification with overhead cover [...]" - United States Marine Corps, "Tactical Employment of Mortars," 1992, https://www.trngcmd.marines.mil/Portals/207/Docs/TBS/MCWP%203-15.2%20Tactical%20Employment%20of%20Motars.pdf. (For reference, the Stokes mortar which was used in the GEAC fired 81-mm rounds).

Summary of Qualitative Analysis, with Table

In comparing the characterizations and lessons from historians and participants with the context of specific examples and overall trends within each war, one can certainly identify ways in which PAWs helped each side. The key question of this thesis, however, is whether the increase in PAWs intensities benefited the irregulars more than the regular forces across the Boer War and GEAC, on balance. On the one hand, the increase in PAWs intensity did seem to provide some net benefits to static defense tactics (even though it is difficult to measure such a relationship across the two conflicts), which should predominantly benefit the regular forces (since the irregular forces were far less able to use such tactics, among other issues). Machine guns also appear to have provided benefits to regulars when they faced charge/swarm-style surprise attacks, especially in the case of the Boer War, but it also seems to have helped (or, it seemingly would have helped) the irregulars when they were the target of these kinds of tactics. Here, the net benefits appear to be more neutral.

However, PAWs seemed to have had the most-positive net effects for the cover-based/hit-and-run/harassment tactics that were considered crucial to the irregulars' survival across both wars (in addition to being an effective/efficient way to inflict pain on the regular forces).[335] Overall, it seems that the differential effectiveness between the static-defense tactics and the cover-based/harassment ambush tactics is the result of multiple factors, but at the center of it is the element of surprise combined with the asymmetric objectives: concealed ambushers can wait in cover for pursuers and use PAWs more effectively than their targets as a result of PAWs' greater lethality against massed and exposed units (as well as the response delay

[335] In addition to the points mentioned previously, it is worth highlighting De Wet's remarks regarding the necessity of these harassment/rear-guard actions: "Had we not acted in some such way as this, all my men would have been taken prisoner in this and in many other marches." - De Wet, *Three Years' War*, p. 213.

in returning fire). Ultimately, the following table is offered to illustrate/summarize these insights by characterizing the strategic relevance and overall usage/availability ("value") of the three tactics for each side, then describing the overall/net effects that PAWs had on the effectiveness/success of this tactic.

Table 5: Summary of PAWs Impacts on Tactics' Effectiveness and Asymmetric Benefits

Tactic	Value to Reg.	Value to Irreg.	PAWs' Effects	Net Benefits
Charge/Swarm	Medium	Medium	Undermined	(Neutral)[336]
Cover-based (etc.) Ambush	Low	High	Strongly enhanced	**Greatly benefits irregulars**
Static Defense	High	Little to none	Partially enhanced	**Moderately benefits regulars**

[336] Given the points made in the qualitative analysis, there are some reasons to think that the value of these tactics to regulars is slightly higher than to irregulars. For example, this tactic made it easier to "trade punches," benefiting the side that can withstand more punches—which in these cases tended to be the regulars with their superior numbers. If this is true, this would mean that PAWs actually slightly benefited the irregulars in these cases. (Later in the 20th century, especially when casualty aversion/asymmetries in interests were more significant, being able to "trade punches" would seem to greatly benefit the more-resilient irregulars, but this incurs much more complex questions about whether such tactics would have been viable in the face of *other* technological innovations, such as aerial surveillance and bombing.) However, because the net effects of PAWs on these tactics are difficult to objectively assess, I opted to err on the side of "neutrality" (i.e., no asymmetric benefit).

Conclusion: Findings, Potential Implications, and the Need for More Research

The period leading up to and following WWI is rightly recognized as a significant point in the evolution of military technology[337]: innovations in weapons such as machine guns "made it possible for armies to mete out unprecedented destruction."[338] Importantly, some of these innovations have been quite accessible and valuable for irregular forces, unlike some other major military innovations (e.g., aircraft, tanks). Yet, despite the existence of theories such as Biddle's "modern system" which describes how these shifts in technology have had significant impacts on the importance of tactics—as well as the general recognition that tactics and strategy are often a crucial part of irregulars' survival/success—the literature on irregular conflict outcomes appears to have largely overlooked the notion that some technological shifts may have had "equalizer" effects in irregular conflicts.

The case comparison conducted by this thesis appears to provide some support for the hypothesis that machine guns can serve as equalizers in irregular conflict. The quantitative analysis of overall battle-death exchange ratios for the two conflicts returns results which are in line with the hypothesis' expectations (i.e., the irregular force's BDXR increased as PAWs access/usage increased) *but* which cannot reliably/confidently be interpreted as support for the hypothesis since the variations in control variables could be alternative explanations for the observed shift. *However*, the qualitative analysis finds more-direct evidence for the hypothesis

[337] Consider discussion by Lyall and Wilson ("Rage Against the Machines") as well as by Biddle (*Military Power*).
[338] Max Boot, *War Made New : Weapons, Warriors, and the Making of the Modern World* (New York, New York: Gotham Books, 2007), p. 196.

by suggesting that the increase in PAWs intensity seemingly improved the irregulars' effectiveness by enhancing the effectiveness of their cover-based ambush/harassment tactics more than it uniquely benefited the regulars' static defense capabilities. Although these two approaches do not perfectly complement each other's flaws, each one does mitigate some of the other's flaws, and together they provide meaningful information to use in updating one's assessment of the hypothesis' validity.

Unfortunately, a variety of research limitations (e.g., the lack of weapons-usage data for irregular conflicts, the theoretical difficulty in finding viable case comparisons, the lack of literature on the theoretical argument) precluded more-direct/extensive testing of the notion that technological shifts such as machine guns played a meaningful role in the shift in insurgent/irregular outcome trends over the past century. Even if the hypothesis/findings are accurate with regards to the cases analyzed here, there are at least two major concerns with trying to extrapolate from these two cases: 1) the peculiarities of these conflicts or the various technological shifts *after* these conflicts (e.g., the greater emphasis on airpower and armor) plausibly may have reduced the impact of PAWs on military effectiveness; 2) shifts in military effectiveness (as I have operationalized it here) do not *necessarily* translate to shifts in *outcome*. However, on the latter point, the existing arguments in the literature (e.g., COIN casualty aversion) provide good reason to believe that greater military effectiveness would have a non-trivial impact on the likelihood of insurgent success. As for the former point, this is a more complex issue that goes beyond the scope of this paper, but it is worth noting that PAWs retain great significance/usage in modern irregular conflict generally and ambush tactics specifically. Furthermore, there are even some reasons to think that some shifts (e.g., increased COIN

brutality aversion) may have made PAWS even more disproportionately beneficial to irregulars.[339] If nothing else, the theoretical concepts and observations presented here highlight a largely-unexamined issue which seems to warrant additional research.

Indeed, a little more than a century after the conclusion of WWI and its illustration of the destructive power of the machine gun, the world is facing a flurry of emerging and disruptive technologies ranging from additive manufacturing to biotechnology to artificial intelligence and so on, as briefly mentioned in the literature review.[340] Although it is important to avoid overhyping or being dazzled by emerging technologies, it is also important to examine their potential effects—some of which could very plausibly be asymmetric in favor of irregular actors (if they are able to access the technology). However, the literature reviewed largely seems to lack empirical/historical research that could potentially inform analyses of emerging technologies, such as by testing analytical frameworks/methodologies, providing historical analogies/lessons for concepts, and contributing (loose) base rates for Bayesian analysis. Ultimately, this analysis does not even attempt to provide answers for future technologies, but it has attempted to highlight a seemingly-ignored area for further exploration.

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[339] Consider for example the argument that COIN brutality aversion makes it easier for irregulars to hide among civilians (since the COIN forces are not willing/able to round up and intern the civilians as the British did in the Boer War): this would plausibly make mobility control measures like the blockhouses less effective/viable while also forcing the COIN forces to interact with the civilian population in ways that further expose them to ambush. In such a situation, the benefits that PAWs provide for such static defense tactics would likely be further limited while the impact on cover-based/harassment ambushes would be amplified.

[340] For example, see the arguments by T.X. Hammes such as in "Technology Converges; Non-State Actors Benefit," Hoover Institution, 2019, https://www.hoover.org/research/technology-converges-non-state-actors-benefit.

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