Air Superiority and Victory in War

Richard Saunders

Florida State University

rjs15d@my.fsu.edu

and

Mark Souva

Florida State University

Abstract

A significant amount of research highlights the limitations and downsides of air power. We do not dispute this research but note that it has not examined the relationship between air power and war outcomes. We argue that air power, in the form of air superiority, is critical to victory in interstate war. To test this hypothesis, we create a new variable that identifies which side, if any, achieved air superiority in wars between 1932 and 2003. We find that air superiority significantly improves a country's probability of winning an interstate war. Further, we find that air superiority is a better predictor of winning a war than other well-known factors such as adoption of the modern system, regime type, and a general measure of military power. Finally, we suggest that air superiority may explain why democracies have a war-fighting advantage.

Introduction

Air power is critical to achieving victory in interstate war, but one might not appreciate this from contemporary international relations research. **?** highlights the limitations of strategic bombing as a coercive strategy. **?**, 126 finds only 16 cases of coercive success in 55 bombing campaigns since 1917. Similarly, **?**, 160 find that only 36% of bombing campaigns end in successful coercion, and that bombing is unlikely to result in a target's compliance with large demands or in the absence of a ground-forces intervention. **?** argues that coercion attempts that employ air power are more likely to fail than other coercion strategies. **?** note that states seem to rely on air power when they do not want to experience significant casualties; the use of air power thus signals low resolve. **?** find that U.S. bombing during the Vietnam War often harmed civilians more than combatants; as a result, the use of U.S. air power increased support for the Viet Cong. Notwithstanding the important role that air power played in the Kosovo War, it alone did not coerce Serbia (**?**). In brief, extant research suggests air power is of limited utility. We do not dispute the specifics of prior research, but contend that the impression regarding the importance of air power is misleading. We argue that air power, in the form of air superiority, is critical to victory in interstate war. Prior research just hasn't examined this topic.

We hypothesize that air superiority significantly improves a country's probability of winning an interstate war. To test this hypothesis, we create a new variable that identifies which side, if any, achieved air superiority in wars between 1932 and 2003. We find that air superiority is a better predictor of war winning than other well-known factors such as adoption of the modern system (**?**), regime type (**?**), civil-military relations (**?**), and general measures of military power (**?**).

Air Superiority

Air superiority is control of the sky over the battlefield. It means that an actor's military forces can operate "without prohibitive interference" by the other side's air force (?). If one side has air superiority, then the other side does not, but it is possible for neither side to attain air superiority. Such a situation is defined as air parity. Air superiority is the first principle of air power (?) because it allows other aircraft and military units to do their job more effectively. In practical terms, air superiority is a near necessary condition for the effective application of air power to any other aspect of warfare. For example, in World War II, unescorted heavy bombers attacking the Schweinfurt ball-bearing factories suffered extreme losses from enemy fighters (?, 150). Similarly, strike-fighters must jettison their bomb-loads, abandoning their mission if they hope to defend themselves when attacked by lightly-armed and agile air superiority fighters. Unarmed reconnaissance, electronic warfare or transport aircraft can do little but hope to flee in the face of fighter opposition. None of these aircraft can do their jobs well, if at all, if air superiority has not first been established. Similarly, when an army is conducting operations in the face of adversary air superiority it is much less effective. To protect itself from air attack, ground forces have to devote more effort to concealment and dispersion. While this can limit the damage of air strikes, it also degrades a unit's maneuverability and force concentration.

Air superiority increases combat power, the amount of force one can apply against an adversary at a particular place and time (?). Generally, the actor with a combat power advantage is likely to win the engagement. Air superiority and a concomitant air power advantage greatly improve the likelihood that one will have a combat power advantage because airpower increases maneuverability and firepower.

Combined arms operations are also critical to generating combat power. In general terms, combined arms operations use two or more weapons systems in such a way that it is very difficult for an adversary to defend itself from both. Combined arms operations do not require air power, but it is often a component. The following excerpt from the U.S. Marine Corps Warfighting Manual (**?**, 95) describes combined arms operations:

"We use assault support aircraft to quickly concentrate superior ground forces for a breakthrough. We use artillery and close air support to support the infantry penetration, and we use deep air support to interdict enemy reinforcements that move to contain the penetration. Targets which cannot be effectively suppressed by artillery are engaged by close air support. In order to defend against the infantry attack, the enemy must make himself vulnerable to the supporting arms. If he seeks cover from the supporting arms, our infantry can maneuver against him. In order to block our penetration, the enemy must reinforce quickly with his reserve. However, in order to avoid our deep air support, he must stay off the roads, which means he can only move slowly. If he moves slowly, he cannot reinforce in time to prevent our breakthrough. We have put him in a dilemma."

To summarize, air superiority has offensive and defensive implications. Offensively, an actor with air superiority is much more likely to have a combat power advantage. Air superiority allows an actor to employ attack, surveillance, bomber, and other aircraft without significant concern that they will be shot down. In addition, air superiority facilitates combined arms operations. Defensively, an actor with air superiority does not have to fear that the adversary will attack their ground troops and can more easily shift resources to stop enemy advances or quickly maneuver ground forces to capitalize on a weak point in the enemy battle line. More generally, what air power does is increase firepower and maneuverability, which facilitates the concentration of forces on a particular area, increasing the probability of a battlefield breakthrough or stopping an adversary's attempted breakthrough. If one side has air superiority, it is more likely to have a combat power advantage and is more likely to win the battle. These considerations lead to our central hypothesis:

In interstate wars, the side that achieves air superiority is more likely to win than the side that does not achieve air superiority or when neither side achieves air superiority.

Research Design

To test our hypothesis, we examine the relationship between air superiority and war outcomes for all interstate wars between 1932 and 2003 inclusive. While airplanes were used in World War I, their use was limited. In our primary analysis, we examine 37 wars and 114 war participants. In practical terms we build on the work of **?** and draw our list of wars and participants from their replication data. The primary difference between the research design of Grauer and Horowitz and other prominent research on war outcomes such as **?** and **?** is that Grauer and Horowitz code outcomes based on a decisive battle. In the next section we explain how this reduces endogeneity concerns. Grauer and Horowitz's dependent variable, *Win*, is a binary indicator of which side won the decisive battle.[1] They note that there is only one case widely viewed as a draw and for that case they code both sides as losing. We employ all of their codings. Our contribution is to add to their data an expert coded indicator of which side, if any, attained air superiority during the decisive battles of these 37 wars.

The variable *Air Superiority* equals two if a country had air superiority over

[1]In sensitivity tests, we examine the outcome of the war. None of the substantive results change.

its opponent(s) in the decisive operation, one if the two sides had air parity, and zero if the opponent had air superiority. To identify which side, if any, had air superiority we consulted a collection of 76 primary and secondary sources that describe the 37 wars in question. In the appendix we describe the sources we used and provide a brief narrative of the air-campaign in each war. We code air superiority in accord with the NATO definition of the concept: "That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea and air forces at a given time and place without prohibitive interference by the opposing force" (**?**). Air superiority obtains if an actor can effectively employ air assets and prevent the adversary from effectively employing its air assets. An actor achieves air superiority when its aircraft can operate effectively over the battlefield and the other side's aircraft cannot. The latter obtains if one side has destroyed or deterred the other side's air force either with its aircraft or land-based defenses (e.g. surface-to-air missles or anti-aircraft artillery). Air superiority does not require one air force to be eliminated from the battlefield entirely. Instead, we look for evidence that one actor prevents its enemy from engaging in air-strikes, air transport, or close air support (CAS) operations during the decisive operation while maintaining the ability to engage in these activities itself. In the event that neither side is able to use aircraft effectively in the battle, we code this as parity. If our sources indicate that both sides in the battle were able to use their air forces effectively in support of their ground forces, we also code this as parity. [2]

We measure air superiority at the time of the decisive operation in a war

[2]Two coders were responsible for examining the available historical documents and making an expert judgment on the question of air superiority. The online appendix contains narrative summaries as well as citations for the primary sources that were consulted. Intercoder agreement is 90.5% with a Krippendorff's Alpha reliability statistic of 0.8535 and P¿—t—0.000 where 0.80 and above is commonly considered highly reliable (Krippendorff, 2004). Table 1 in the appendix reports alternate measures of reliability, including Cohen's Kappa and Scott's Pi. In each case, the test statistic suggests high intercoder reliability.

for two reasons. First, by Grauer and Horowitz's definition, the decisive battle represents a point in time in which the outcome of the war is in doubt. By measuring air superiority at this point rather than over the war in total, we reduce the possibility that our measurement of air superiority is endogenous –simply crowning the ultimate war winner as having won in the air as well. Second, in some wars the side with air superiority changes over time. For example, Germany had air superiority over the Soviet Union for the beginning of World War II, but by the end the situation was the reverse.

In addition to our main variable of interest, we include a number of other variables to control for factors that may influence both victory in war as well as the ability to achieve air superiority. The variable *Modern System* ranges from "0" (no modern system adoption) to "3" (full modern system adoption) (**?**). It is based on the extent to which each combatant's forces employ cover and concealment, dispersion of forces, small-unit independent maneuver, use of combined arms, force concentration at the point of attack, defensive depth, and the ratio of operational reserves to frontline forces. The variable *Democracy* equals one if a country scores seventeen or higher on the Polity IV democracy-autocracy index, zero otherwise. *Anocracy* equals one if a country scores between six and sixteen inclusive on this index, zero otherwise. *Autocracy* is the reference category in our models. Data come from the Polity IV project (**?**). We control for three other factors that may confound the relationship between air superiority and war outcome. *National Capability* is a country's score on the Correlates of War Composite Indicator of National Capabilities (CINC) (**?**). *Troops Engaged* and *Opponent Troops Engaged* measure the number of troops engaged in battle for each side of the conflict. Both measures of troop strength are devised by **?**, 99.

Empirical Results

Figureshows a cross-tabulation between air superiority and victory in war. The relationship is striking. Countries that achieve air superiority win about 80% of the time, much more than one would expect by chance. Indeed, countries that hold air superiority in the decisive battle have lost only three times since the inception of effective military aircraft! [3]

[Figure 1 about here.]

Next, we estimate a series of multivariate models. Once we control for potential confounders, is air superiority still related to victory in war? It is (see), and quite strongly so. Model 1 reproduces the main findings from **?** in our shorter time frame. Adoption of the modern system, democracy, and national capabilities increase the probability of winning. Model 2 adds Air Superiority. [4] Achieving air superiority in the decisive battle is positively and strongly correlated with victory (p¡ 0.001). The effect of modern system remains statistically significant but democracy and national capabilities are no longer significant. We return to these points below.

[Figure 2 about here.]

Air superiority is a better predictor of victory than any other covariate (see). When we compare the AIC for Models 1 and 2, we find that the air superiority model provides a better fit of the data than does the modern system model.[5]

[3] These countries are Italy, which lost to Greece; Germany, which lost to the Soviet Union on the Eastern Front during World War II; and Cambodia, which lost to Vietnam during the War of the Communist Coalition. Alternative codings for two of the three cases are reasonable. Britain provided air support to Greece during the Greco-Italian war, nullifying the Italian air advantage. Similarly, Cambodian air-superiority over Vietnam was largely a product of U.S. air activities against the Viet Cong, which were not coordinated with Cambodian forces. Only Germany's loss to the Soviet Union can truly be explained by overwhelming superiority in other aspects of war fighting (such as raw numbers).

[4] Air superiority and modern system adoption correlate at .5.

[5] We also compare model fit for a model using CINC scores as the only measure of power

We find that the predicted probability of victory for an air inferiority combatant is only 0.18, when holding other covariates at their observed values. In contrast, a country with air superiority has a predicted probability of victory of .81, a substantial increase. By comparison, a state that has adopted no elements of the modern system wins with probability 0.37, while the probability of victory increases to 0.62 when the modern system has been fully adopted. We conclude that air superiority is not only an important determinant of victory in modern war, but that, contrary to Biddle's expectation (**?**, 52-77), air superiority is more crucial to victory than is adopting the modern ground-forces system.[6]

Air superiority explains war outcomes better than a general measure of military power. In Model 1, in which air superiority is absent, the COW CINC measure of power shows a statistically significant and positive relationship with victory in war. However, when we include air superiority in the model, the coefficient associated with CINC declines in magnitude and becomes statistically indistinguishable from zero. At least on the modern battlefield, air superiority and not power in general is the key to victory.

[Figure 3 about here.]

[Figure 4 about here.]

Adding air superiority to the model of battle outcomes renders democracy not significant (Model 2). Model 3 shows that this effect holds when we change the reference category from institutionalized autocracies to all non-democracies. Figur**e**shows the relationship between air superiority and regime type and sheds light on this finding. Democracies are much more likely than other regimes to

and a model replacing CINC with our measure of air superiority. AIC for the CINC-only model is 141.86. For the model using only air superiority, AIC is 96.4. Thus, a model the air superiority variable fits the data significantly better than one using only CINC to measure power.

[6] We also estimate models with an alternative coding of our variable for cases in which our coders disagree. The effects reported for air superiority are stronger in these models.

attain air superiority. Given the importance of air superiority to victory in modern war, this may explain the democratic war-fighting advantage. Indeed, non-democracies with air superiority are more likely to win than non-democracies without air superiority. While this finding is preliminary, it may indicate that the observed democratic war-fighting advantage stems from advantages in aircraft technology or doctrines and force structures that emphasize air superiority. Future research should examine the relationship between air power, regime type, and military outcomes more thoroughly.

Discussion and Conclusion

Over the last twenty years, a great deal of research has cast doubt on the ability of air power to achieve the goals that states set for it. Bombing campaigns are less likely to end in successful coercion (**?**) and a reliance on air power may signal low resolve (**?**). However, these analyses have failed to test whether air forces are effective at achieving their primary goals. We argue that achieving air superiority is usually the primary objective of a country's air force, and that countries that attain air superiority are much more likely to win a conventional war.

Air superiority may also account for the democratic war-winning advantage. After controlling for air superiority, we find that democracies are no more likely to win in war than institutionalized autocracies. Institutionalized autocracies are also more likely than other autocracies to win if they have air superiority.

Finally, the analysis presented here has implications for policymakers. **?**, 130 writes: "A few F-22s (or electronically upgraded F-15s) are necessary to secure the superiority of the U.S. Air Force, but what the force needs above all is a new generation of "bomb trucks." Strike aircraft, or bomb trucks, are valuable, but the strike mission comes second to the air superiority mission and depends upon air superiority for its success. We have shown in this paper that winning control of the skies is crucial to victory. As such, both military expenditures and military doctrine should ensure that an air force's efficiency in air-to-air combat not be compromised for the sake of other missions.

Appendix

Summary statistics Table 1

[Table 1 about here.]

Correlation Table 2

[Table 2 about here.]

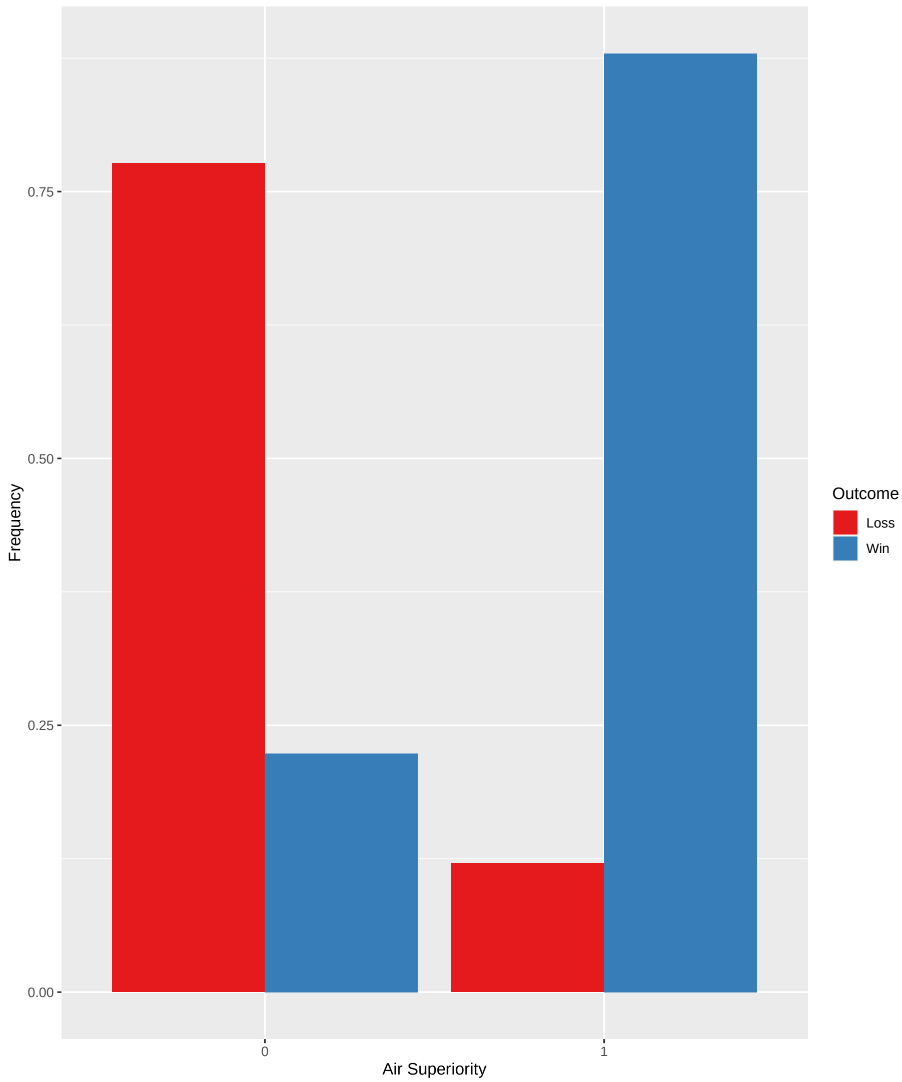
Logistic Regression Estimates 3

[Table 3 about here.]

References

Figure 1: Air Superiority and Decisive Battle Outcome, 1932−2003

Chi−Square Test Statistic = 56.7, P−value = 0.000



Notes: Loss defined as loss or tie, Grauer & Horowitz (2012) data.

No Air Superiority defined as parity or inferiority.

Figure 1: Coefficient Estimates

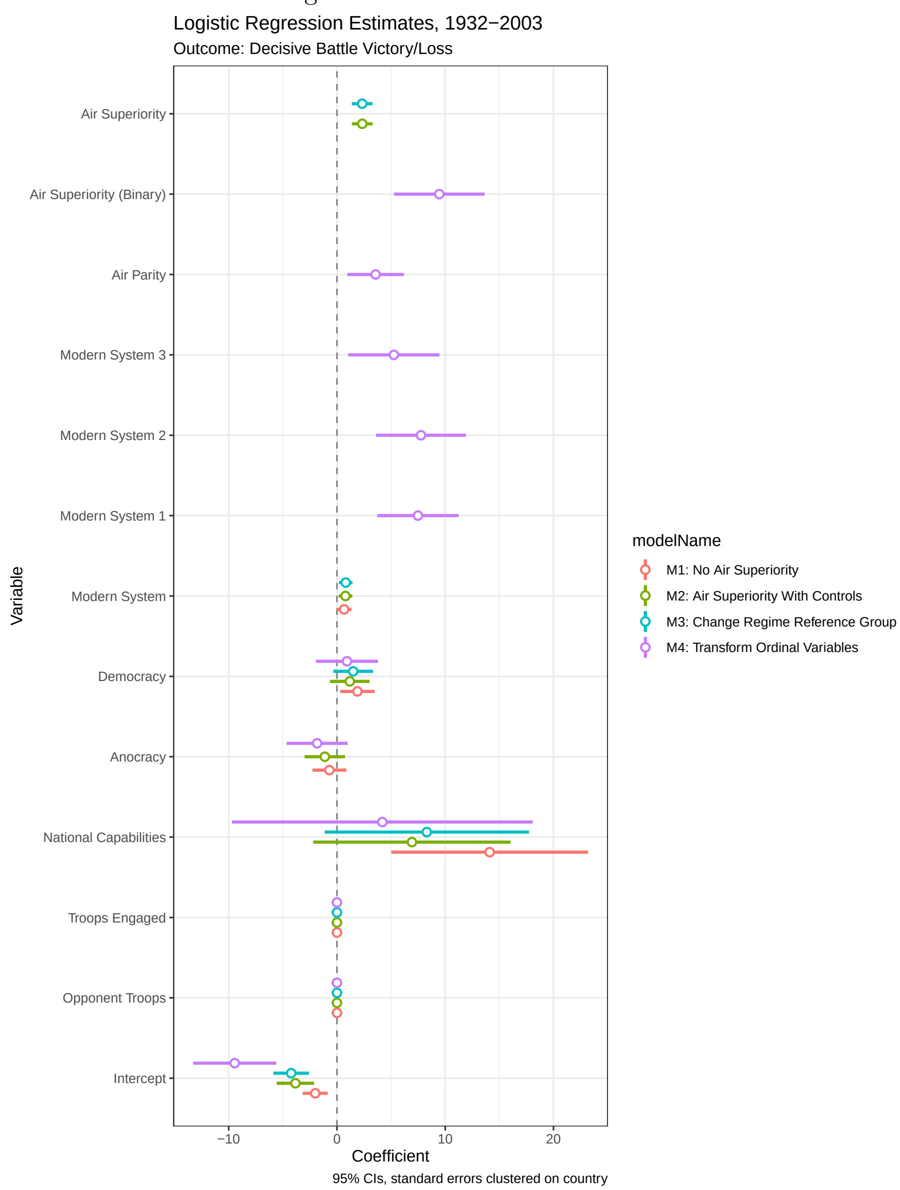


Figure 2: Coefficient Estimates

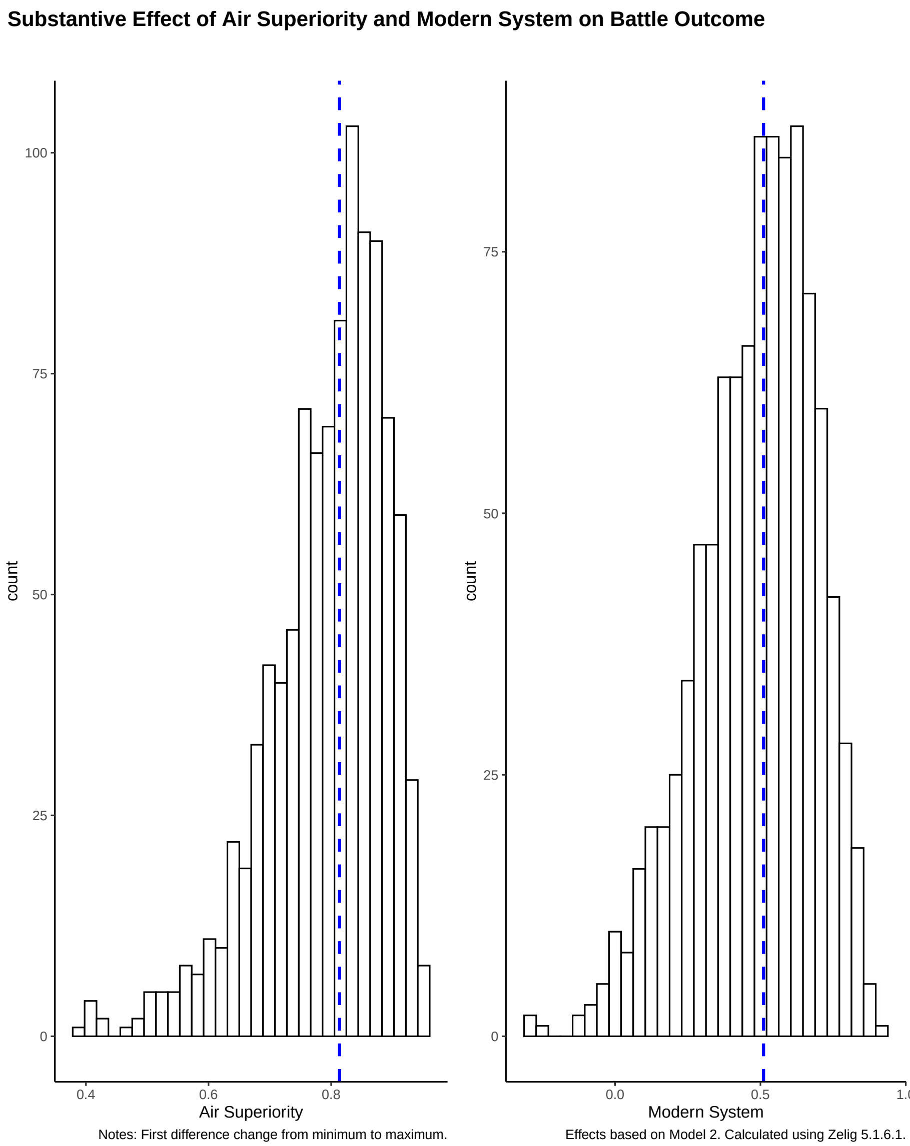
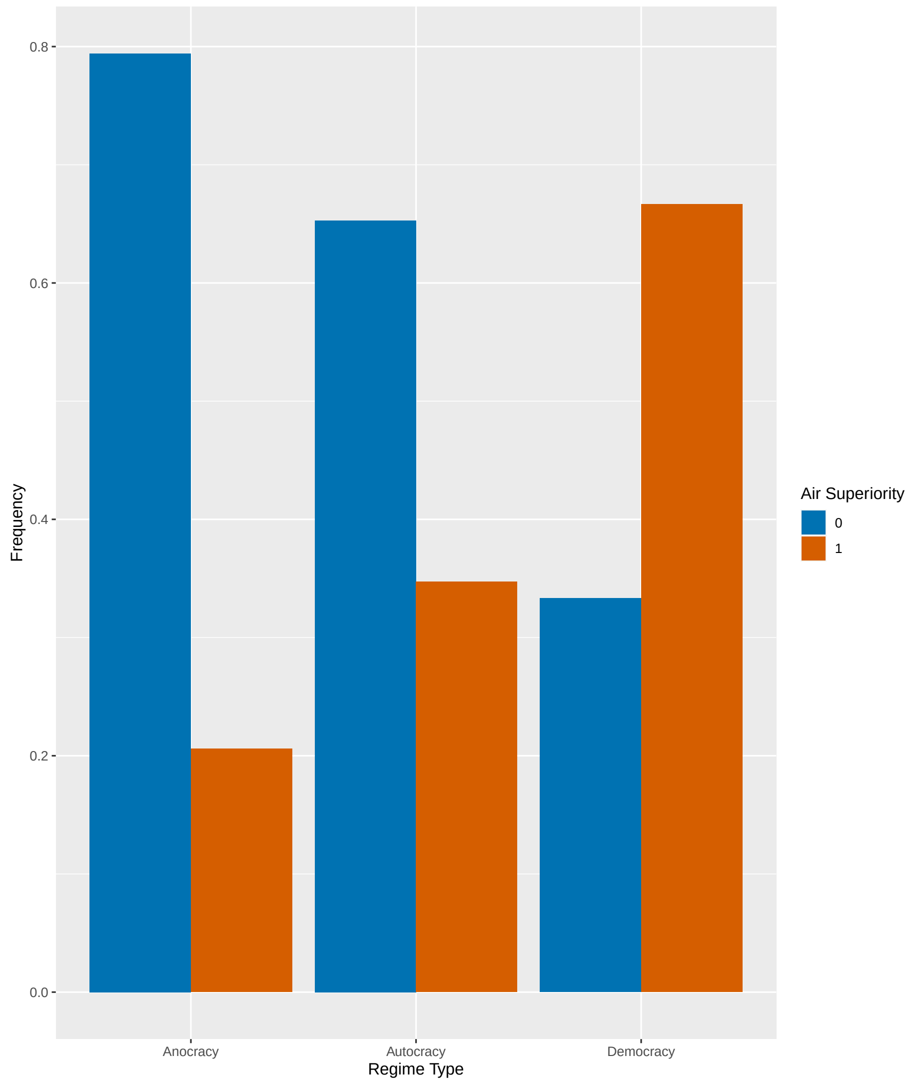


Figure 2: Regime Type and Air Superiority, 1932−2003

Chi−Square Test Statistic = 19.3, P−value = 0.000



Notes: Regime types based on polity2 variable.

No Air Superiority defined as parity or inferiority.

Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Outcome	101	0.48	0.50	0	1
Air Superiority	101	1.02	0.88	0	2
Modern System	101	1.50	1.21	0	3
Democracy	101	0.32	0.47	0	1
Anocracy	101	0.19	0.39	0	1
CINC	101	0.06	0.08	0.0001	0.28
Troops Engaged	101	161,182.10	334,508.90	100	2,300,000
Opponent Troops Engaged	101	169,990.10	331,780.70	100	2,300,000

Table 2: Correlation Matrix

	win	airsup	msadopt	d6	anoc	cinc	troopsengaged	opptroopsengaged
win	1							
airsup	0.75	1						
msadopt	0.51	0.44	1					
d6	0.42	0.37	0.31	1				
anoc	-0.36	-0.21	-0.39	-0.33	1			
cinc	0.46	0.45	0.47	0.15	-0.27	1		
troopsengaged	0.05	0	0.1	-0.05	-0.16	0.24	1	
opptroopsengaged	-0.01	-0.03	0.14	0.05	-0.14	0.19	0.81	1

Table 3: Effect of Air Superiority on Decisive Battle Outcome, 1932-2003

	Decisive Battle Outcome			
	Model 1	Model 2	Model 3	Model 4
	(1)	(2)	(3)	(4)
Air Superiority		2.34***	2.33***	
		(0.53)	(0.54)	
Modern System	0.66**	0.79**	0.81**	
	(0.28)	(0.36)	(0.36)	
Air Superiority (binary)				9.45***
				(3.30)
Air Parity				3.57**
				(1.52)
Modern System 3				5.26*
				(2.96)
Modern System 2				7.76**
				(3.47)
Modern System 1				7.48**
				(3.03)
Democracy	1.89***	1.18	1.50*	0.92
	(0.65)	(0.86)	(0.82)	(1.37)
Anocracy	−0.70	−1.12		−1.83
	(0.88)	(1.08)		(1.77)
CINC	14.11***	6.92	8.30	4.19
	(5.02)	(6.36)	(6.35)	(9.71)
Troops Engaged	0.000002	0.000004**	0.000005**	0.00001**
	(0.000001)	(0.000002)	(0.000002)	(0.000004)
Opponent Troops Engaged	−0.000004*	−0.00001**	−0.00001**	−0.00001*
	(0.000002)	(0.000003)	(0.000003)	(0.00001)
CONSTANT	−2.01***	−3.84***	−4.23***	−9.45***
	(0.58)	(0.92)	(0.87)	(3.19)
Observations	101	101	101	101
Log likelihood	−42.99	−27.19	−27.78	−17.56
Akaike information criterion	99.98	70.37	69.56	57.13

Notes: ***p < .01; **p < .05; *p < .1
Two-tail significance levels; Clustered standard errors