NATO BURDEN-SHARING AND KEEPING THE PEACE:

CRISIS RESPONSE AND THE MILITARY CAPABILITIES GAP

by

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To my friends and family

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by

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Since NATO was founded in 1949, the issue of burden-sharing has been fiercely debated. Members have argued about what constitutes a fair contribution and who is getting the most benefit. During the early days, America’s monopoly on nuclear weapons led to U.S. overcontribution and free riding by the poorer members. After NATO moved to a flexible response military strategy, conventional weapons became more relevant and burden-sharing came to be more balanced. Since the 1992 Oslo declaration committed the alliance to out-of-area crisis response, burden-sharing has changed again. Using the NATO air operations in the Balkans conflict as a case study, I show that burden-sharing has again shifted towards exploitation of wealthier members. Rather than using military expenditures as a contribution measurement, I examine aircraft and sortie contributions to the combat operations. Based on a Spearman rank correlation test using aircraft contributions, I find evidence that the rich carried a disproportional burden in the conflict. The exploitation was more pronounced when I examined the sorties flown by each nation, showing that the richer members flew their

aircraft disproportionately more than the poorer ones. Examining contributions of the more complex and expensive support aircraft resulted in even stronger evidence of exploitation. In addition, the U.S. became an extreme outlier when I examined the sorties flown by these support aircraft. No other member was able to provide these critical types of sorties. These results endorse the argument that a capabilities gap exists in NATO. When I compared these defense burdens to benefit measurements, I find a lack of concordance between burdens and benefits during the Kosovo air campaign. Many European members received a larger benefit share relative to their aircraft and sortie contributions to the conflict. This suggests less cohesion in the alliance. Analysis of the contributions of support aircraft and sorties provided the strongest evidence of a three-tiered alliance with burden and benefit shares significantly out of balance. The emergence of the capabilities gap indicates that the alliance will face significant policy challenges moving forward.

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ABBREVIATIONS

A

AAA	Antiaircraft Artillery
AB	Air Base
ABCCC	Airborne Command and Control Center
ACC	Air Combat Command
AEF	Air Expeditionary Force
AEW	Airborne Early Warning
AFB	Air Force Base
AFV	Armored Fighting Vehicle
AGM	Air-to-Ground Missile
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AOR	Area of Responsibility
APC	Armored Personnel Carrier
ATC	Air Traffic Control
ATO	Air Tasking Order
AWACS	Airborne Warning and Control System

B

BEL	Belgium
BDA	Battle Damage Assessment

C

C2	Command and Control

CAN	Canada
CAOC	Combined Air Operations Center
CAS	Close Air Support
CBU	Cluster Bomb Unit
CSAR	Combat Search and Rescue
CZE	Czech Republic

D

DEN	Denmark

E

ECM	Electronic Countermeasures
ECR	Electronic Combat Role
ELINT	Electronic Intelligence
EO	Electro-Optical
ES	Spain
EW	Early Warning
EW	Electronic Warfare

F

FAC	Forward Air Controller
FGT	Fighter
FLIR	Forward-Looking Infrared
FR	France
FY	Fiscal Year

G

GBU	Guided Bomb Unit
GDP	Gross Domestic Product
GER	Germany
GPS	Global Positioning System
GR	Greece
GUN	Gunship

H

HARM	High-Speed Antiradiation Missile
HELO	Helicopter
HU	Hungary
HUD	Head-Up Display

I

IADS	Integrated Air Defense System
ID	Identification
IFF	Identification Friend or Foe
IFOR	NATO Implementation Force in Bosnia and Herzegovina
IMF	International Monetary Fund
INS	Inertial Navigation System
IR	Infrared
IS	Iceland
ISR	Intelligence, Surveillance, and Reconnaissance

IT Italy

J

JDAM Joint Direct Attack Munition

JFACC Joint Force Air Component Commander

JTF Joint Task Force

JSOW Joint Standoff Weapon

JTIDS Joint Tactical Information Distribution System

K

KFOR Kosovo Force

KLA Kosovo Liberation Army

L

LANTIRN Low-Altitude Navigation and Targeting Infrared for Night

LD/HD Low Density/High Demand

LGB Laser-Guided Bomb

LOC Line of Communication

LU Luxembourg

M

MANPADS Man-Portable Air Defense System

ME Military Expenditures

MFD Multifunction Display

MLRS Multiple-Launch Rocket System

MTI Moving Target Indicator

MTW	Major Theater War

N

NATO	North Atlantic Treaty Organization
NL	Netherlands
NO	Norway

O

OCA	Offensive Counterair

P

PGM	Precision-Guided Munition
PL	Poland
POL	Petroleum, Oil, and Lubricants
POW	Prisoner of War
PT	Portugal

R

RAF	Royal Air Force
RCS	Radar Cross-Section
RNLAF	Royal Netherlands Air Force
ROE	Rules of Engagement
RPA	Remotely Piloted Aircraft
RWR	Radar Warning Receiver

S

SAM	Surface-to-Air Missile

SAR Synthetic Aperture Radar

SAS Special Air Service

SEAD Suppression of Enemy Air Defenses

SFOR NATO Stabilization Force in Bosnia and Herzegovina

SIGINT Signals Intelligence

STARS Surveillance Target Attack Radar System

T

TACAN Tactical Air Navigation

TANK Airborne Tanker

TF Task Force

TLAM Tomahawk Land-Attack Missile

TOT Time on Target

TR Turkey

TRAN Transport

U

UAV Unmanned Aerial Vehicle

UCAV Unmanned Combat Air Vehicle

UHF Ultra-High Frequency

UK United Kingdom

UN United Nations

US United States

USAF United States Air Force

USMC United States Marine Corps

USN United States Navy

CHAPTER 1

INTRODUCTION

The North Atlantic Treaty Organization (NATO) was established in 1949 as an alliance to balance the growing threat of the Soviet Union. As stated by NATO's first Secretary General, Lord Ismay, the primary goal of the alliance was to "keep the Americans in, the Russians out" (Spangler, 2017, p.1). Per this charter, the alliance thrived during the Cold War. Member states united with the prospect of cooperation and aid for the common defense. Weapons and ammunition were standardized as were tactics and training. NATO states stationed troops inside allied borders for both security and collaboration. In addition to the troops they equipped and trained for this common defense, each nation contributed to a shared budget for command infrastructure and staff. The original intent was that each nation's overall contributions to NATO would be proportionate to its GDP, according to the "ability to pay" principle of public finance. In exchange, member states would benefit from a shared defense. Abbott and Snidal note the success of this cooperation:

> Perhaps the best example of interstate joint production is the NATO military alliance. Common war plans, specialization of military tasks, joint exercises, common equipment and interchangeable parts, and, of course, the conduct of battle are examples of teamwork *par excellence.* NATO's integrated command—operating hierarchically on behalf of member states as residual claimants—organizes, monitors, and disciplines participants in the joint activities of the alliance, probably the most successful in history (1998, p.15).

As the Cold War dwindled and the Soviet Union disbanded, NATO tallied 16 members. When the initial threat that prompted the establishment of NATO subsided, scholars expected NATO to dissolve as well (Peinhardt & Sandler, 2015; Wallander, 2000). Following the collapse of the Soviet Union and the end of the Cold War, pundits alleged that NATO was no longer relevant. Defying this prospect, NATO grew by 75% to 28 members as of 2009 (Sandler & Shimizu, 2014). Additionally, Montenegro joined in 2017, and North Macedonia joined in 2020, bringing the current total to 30 members, (NATO, 2020).

NATO adapted and survived as it welcomed new members. Like any other voluntary international organization (IO), member states chose to belong because the perceived benefits seemed to outweigh the cost of membership. However, as the mission of NATO evolved along with its membership, a new threat to the alliance emerged: arguments over the equitability of member state contributions. It appeared that where the Soviet Empire failed, disagreement over uneven burden-sharing might ultimately succeed in destroying NATO. American Secretary of Defense Robert Gates repeatedly expressed frustration with allies who failed to contribute their fair share to NATO peacekeeping missions (Gates, 2009). Increasingly exasperated, Gates publicly questioned the viability of an alliance whose members avoid bearing not just the financial costs, but also the risks to their military personnel. Finally, in 2011, he argued that uneven burden-sharing had reached an unacceptable level (Sandler & Shimizu, 2014).

The topic of NATO and burden-sharing has become even more relevant following the election of Donald Trump as President. During his campaign, Trump referred to NATO as obsolete, complaining that the U.S. was being taken advantage of by member nations. On May 25, 2017, while visiting Brussels, Belgium, President Trump publicly berated America's NATO allies for not paying their fair share.

Within the academic community, the burden-sharing debate has pervaded for some time along with the usual questions: How much should each member pay? What is fair? How should non-monetary contributions be calculated? Olson and Zeckhauser (1966) initially argued that the United States was forced to bear a disproportionate burden due to the inherent nature of the nuclear umbrella that had developed during the early part of the Cold War. Sandler (1977) explained in his joint product model, that the evolution of the flexible response doctrine of NATO had resulted in more contributions from smaller members, and therefore, more even burden-sharing. What caused the shift back towards more unequal burden-sharing that frustrated both Secretary Gates and President Trump? This is a question of some saliency because even the perception of unbalanced burden-sharing could result in the collapse of an alliance. If NATO truly is at risk, the consequences and repercussions are substantial. NATO provides peace, stability, and cooperation in Western Europe and North America. If we are to ascertain whether Secretary Gates and President Trump are correct, it is critical to correctly capture contributions and benefits. If NATO is at risk as an alliance, what can be done to redress and rebalance burden-sharing? I will address these issues at the end of this project, but first need to establish some context for the discussion.

There are three primary difficulties in the current academic literature on NATO burden-sharing. First, is the question of measurement: How can researchers accurately calculate NATO member nation contributions—how much do they really benefit? The current literature includes a variety of financial measurements as well the number of military personnel maintained by each nation. However, I will demonstrate through the construction of new metrics that these measurements significantly understate U.S. contributions, and that burden-sharing in NATO is even more unbalanced than scholars realize. The second weakness in the current literature is the lack of expert, specific knowledge of military capabilities and the significance of critical technologies. This weakness has led a misunderstanding of the concrete meaningfulness of certain contributions. Finally, even with a good measurement strategy in place, it is difficult to obtain reliable data due to security classification and other barriers. As a result, much of the current research is based in incomplete data.

My solution to overcoming these three shortcomings includes data sets that I compiled from unclassified data on sortie and strike numbers, specifically during NATO operations in the Balkans and Libya. These data sets will facilitate the conception of new metrics, analysis, and examination of meaningful member contributions during important milestones in NATO history.

Because of my first-hand military experience, I have substantive background knowledge to distinguish between meaningful military capabilities and contributions, as opposed to symbolic contributions that matter on paper only. I have participated in

NATO pilot training programs and have personally flown with numerous NATO fighter pilots for nearly three decades. Additionally, I have trained combat pilots with NATO allies in the General Atomics MQ-9 Reaper Remotely Piloted Aircraft (RPA). I have personally seen the difference between meaningful and symbolic contributions from some NATO allies. One striking example comes from a time when I was flying F-15C Eagle fighter jets in a multi-national combat operation with French Mirage 2000 fighters. I was informed that the French pilots were instructed to disengage and avoid combat if they encountered any enemy aircraft, while we were instructed to shoot down any enemy aircraft we met. The French presence was for show only, not to contribute to actual operations against the enemy. Restrictions like these have a meaningful impact in an alliance. Unfortunately, researchers are frequently unaware of these restrictions or misunderstand their true implications.

Using data from contributions to the NATO air operations during the Kosovo conflict from 1995 through 1999, I find that burden-sharing is indeed unbalanced with the wealthier members contributing aircraft and sorties disproportionately. The fact that the wealthier members flew their aircraft more frequently than the poorer members points towards either shirking or a capabilities gap. Exploitation increases when I focus on the critical support aircraft, revealing a three-tiered alliance. My examination of the number of sorties flown by the support aircraft reveals more extreme exploitation and convincing evidence that NATO is suffering from a significant capabilities gap. Finally, I test for a concordance of burdens and benefits during the Kosovo operations and again find discrepancy. This imbalance is especially pronounced for the United States. These findings point to significant policy challenges for the alliance in the future.

My dissertation is organized as follows: Following the introduction in Chapter 1, Chapter 2 will review the literature on NATO burden-sharing to provide a fundamental understanding of the topic and provide context for my contribution. I will explain the difficulties encountered in the current research literature in more detail and discuss how my research improves upon and clarifies the existing efforts. Chapter 2 will also more fully explain the importance of my data, and why my contribution creates new insight in this field of study. In Chapter 3, I will discuss the focus of my core contribution to the study of this topic by explaining how the growing capabilities gap contributes to American over-contribution to NATO. Put simply, some critical contributions can only be made by the United States. Other NATO members lack the ability to make these necessary contributions. Chapter 3 will also introduce my research design. Chapter 4 will introduce NATO's involvement in the air operations in Kosovo. Chapter 5 will provide a detailed case study of the largest combat operation, *Allied Force*. Chapters 6 and 7 will discuss the remaining two operations, *Deny Flight*, and *Deliberate Force*, respectively. Chapter 8 will examine the Kosovo Operations as a whole calculating both burdens and benefits for each member. The implications will be discussed in Chapter 9.

Before moving into my data and case studies, it will be beneficial to review the current literature, and explain how the role of NATO has changed over time.

CHAPTER 2

LITERATURE REVIEW AND THEORY

The literature on NATO and burden-sharing is immense, but a few author's contributions take center stage. I will discuss their recent works in detail but will first introduce a few of these foundational articles and their concepts.

Olson and Zeckhauser (1966) laid the groundwork for this literature with their basic economic theory of alliances. Sandler (1977) added the joint-product model, making the original economic theory much more powerful. Following these, more authors have tested this theory on the behavior of NATO members over the following decades using various approaches to measurement (Hansen, et al., 1990; Hartley & Sandler, 1999; Khanna & Sandler, 1997; Murdoch & Sandler, 1982). Their consensus was that the burden-sharing was imbalanced during the early period of NATO when the United States had the dominant nuclear capabilities. However, after NATO adopted the flexible response doctrine, burden-sharing shifted to a more balanced equilibrium. Sandler and Shimizu (2014) examined how recent developments in NATO doctrine and membership altered the burden-sharing balance again. Using these fundamental concepts, I will discuss the arguments in more detail.

The Economic Model of Burden-Sharing

Burden-sharing in military alliances has been studied by academics from numerous perspectives. While each approach presents some beneficial elements, an economic perspective consistently yields the most insight. Abbott and Snidal explain succinctly that: “Rational states will use or create a formal IO when the value of these functions outweighs the costs…” (1998, p.5). Although it may seem obvious that states form alliances when the perceived benefits outweigh the costs, it was not until Olson & Zeckhauser formalized this concept for use in an economic model of burden-sharing that its power to explain specific alliance behavior was fully realized (Olson & Zeckhauser, 1966). By examining member state contributions and benefits from an economic perspective, Olson & Zeckhauser provide clearer insight as to why larger nations might bear a disproportionate share of the burdens of the alliance.

Examining NATO burden-sharing from an economic perspective has revealed three distinct theoretical phases. The first began with the deployment of nuclear weapons by the U.S. These weapons provided a “nuclear umbrella” that protected all nations allied with the United States. Olson and Zeckhauser suggested that the security provided by membership the NATO alliance was essentially a pure, public good. That is, once provided, it was available to all (non-rival and non-excludable). This set the stage for free-riding by opportunistic members, leading to the *exploitation hypothesis;* that is, larger members of the alliance (such as the U.S.), ultimately bore a disproportionate share of the burden. In other words, the larger, wealthier nations were “exploited,” in effect by their smaller allies. While this appears to hold true during early NATO years under the “Mutually Assured Destruction” (MAD) phase of nuclear response and American hegemony, the shift towards a “Flexible Response” strategy resulted in less exploitation as smaller members of the alliance could contribute shares of non-nuclear military capabilities such as troops, tanks, and airplanes (Gadea, et al., 2004; Khanna & Sandler, 1997; Oneal & Diehl, 1994).

The adoption of the flexible response doctrine by NATO resulted in a shift in the balance of contributions by members. As U.S. hegemony declined, the balance became more equal as more nations acquired nuclear capability, and conventional forces regained relevance. Over time, a second shift manifested as the USSR dissolved. Other threats arose, resulting in a new, more aggressive NATO military posture. During this phase, NATO began engaging in offensive, out-of-area military operations, employing a new "Crisis Management" doctrine (Peinhardt & Sandler, 2015; Sandler & Shimizu, 2014).

To fully appreciate the three critical phases of NATO policy, I will first discuss the economic models of burden-sharing in more detail. The first step is to establish some key definitions. Sandler (2015) summarizes and reviews Olson's ideas about collective action. Olson's most basic concept related to an alliance is *collective action*: "Collective action arises when the efforts of two or more individuals or agents (e.g., countries) are required to accomplish an outcome" (p. 196).

The collective actions of NATO members provide a public good—a collective defense—which presents two dimensions: The first is *benefit non-rivalry*: "For nonrival benefits, a unit of the good can be consumed by one individual without detracting, in the least, from the consumption opportunities still available to others from the same unit. For example, one person's consumption of clean air does not detract from the improved air quality available to others” (p. 197). The second dimension of publicness is *Non-excludability*: “Once provided, a good with non-excludable benefits can be consumed by purchasers and non-purchasers alike, thereby leading to free-riding incentives” (p. 198). The American nuclear umbrella is an example of this, wherein all members benefit from its protection, whether they pay for it or not. In contrast to a pure public good like the nuclear deterrence provided by the U.S., Sandler notes that “When a public good’s benefits display some rivalry and/or excludability, it is an impure public good” (p. 198). General military spending on conventional weapons and troops falls into this category.

The third significant concept is the method by which benefits (or goods) are combined. In an alliance such as NATO, members pool their troops and weapons. From an economic perspective, researchers need to examine how these contributions consolidate. The applicable methods or Ag*gregation Technologies* that are relevant to NATO burden-sharing are:

1. Summation Aggregator: “…a contributed unit adds equally to the aggregate provision of the collective good” (Sandler, 2015, p.198). Some conventional military forces like basic infantry soldiers and tanks fit into this category.

2. Best-Shot Aggregator: “…the largest effort determines the overall quantity of the collective good” (Sandler, 2015, p. 199). The U.S. contribution of the nuclear umbrella would fit this definition because another member adding troops and tanks to the effort does not meaningfully increase the overall effectiveness of the deterrence.

Depending on the aggregation technology and the provided benefits, a group may be classified as *privileged*: “The idea applies to situations where at least one individual or coalition whose perceived benefits from collective action exceed the associated costs, even if these costs are borne solely by the individual or coalition. If a group is privileged, then some subgroup of actors provides the collective action that furthers everyone’s well-being.” (Sandler, 2015, p.199). Oneal and Diehl (1994) find support for the idea that NATO has been privileged for certain periods. These economic concepts will allow clearer analysis of the reasons the balance of contributions and benefits have shifted over time in NATO.

Perhaps Sandler’s most important contribution to this discussion is how he built upon Olson’s economic analysis. Sandler’s 1977 article introduced the *Joint Product Model* into the debate (Sandler, 1977), positing that the security provided by the NATO alliance is not actually the pure public good as previously thought. Not only do defense contributions produce public benefits, but private as well. For example, military troops provide country-specific benefits such as natural disaster relief or specific border protection. Private benefits like these compel smaller nations to contribute more to defense than they otherwise would, according to Olson and Zeckhauser’s pure public good theory. By distinguishing between the *deterrent* and *protective* aspects of defense, Sandler provides an alternate explanation for disparate contributions by member states. This new concept explains why NATO’s shift to a doctrine of flexible response resulted in more even burden-sharing among the members.

By incorporating these basic insights, the study of NATO as a cooperative military alliance can be broken down into three distinct time periods during which burden-sharing and NATO benefits evolved.

Three Phases of NATO Doctrine

The first chapter of NATO doctrine begins with the origins of the Cold War. When the United States provided the only substantial nuclear capability, the equation was simple; the U.S. provided a pure, public good of deterrence to all members (Gadea et al., 2004; Khanna et al., 1998). NATO's article 5 on collective defense famously proclaims that an attack against one ally is considered an attack against all allies. If the Warsaw Pact attacked a NATO member, the American arsenal of nuclear weapons would be unleashed resulting in complete destruction. The resulting nuclear response by the USSR would likely result in the destruction of NATO and its members as well. This era of "Mutually Assured Destruction" (MAD) provided stability during the first phase of NATO Doctrine. From an economic perspective, this was the period of non-rival and non-excludable benefits afforded by the U.S. As a result, other NATO members under-contributed as predicted by Olson and Zeckhauser.

Phase two of NATO Doctrine, evidenced as nuclear capabilities proliferated more broadly, and NATO adopted a policy of *flexible response* in 1967 (Oneal & Diehl, 1994). This meant that rather than a full-scale nuclear war, the NATO military response to Warsaw Pact aggression would be a proportional use of force (Dutheil de la Rochère et al., 2011; Hansen et al., 1990). This new policy shifted the emphasis from nuclear

Intercontinental Ballistic Missiles (ICBMs) to conventional non-nuclear forces, such as troops, tanks, airplanes, and the like. According to Sandler (1977), this meant a shift from an emphasis on *deterrent weapons* (e.g., ICBMs) to an emphasis on *protective weapons* (e.g., soldiers and vehicles). Due to the country-specific private benefits and excludability of protective weapons, contributions by NATO members became more balanced, and smaller nations could no longer free-ride as easily.

The third and current phase involves counterterrorism and out-of-area operations (Peinhardt & Sandler, 2015). This *crisis management* phase of NATO's military strategy began in the 1990s (Auerswald, 2004; Bennett, et al., 1994; Bobrow & Boyer, 1997; Ringsmose, 2010). This phase stemmed from threats beyond the former Warsaw Pact. For example, growing violence in Bosnia and Kosovo threatened NATO members and their interests in a way that required a new type of response. The 1992 Oslo Declaration officially added such peacekeeping to NATO doctrine. Not only did this phase impact burden-sharing, it led to an expansion of membership. This phase is where my contribution to the discussion will be most applicable.

Rationale, Significance, and Implications

My research primarily applies to the third phase of NATO doctrine. This third phase of NATO policy resulted in significant modification to technology requirements as well as an emphasis on the willingness to contribute resources to military operations (Sandler & Shimizu, 2014). This shift resulted in the United States significantly overcontributing once again to NATO relative to the other members. In 2011, the United

States spent more than double all other NATO countries combined (Spangler, 2017). While Spangler notes that the complexity and scale of the U.S. military complicates any economic analysis of relative contributions, he and other authors are overlooking a key point: Even acknowledging the enormous and disparate dollar amounts, the actual amount of America's contribution remains understated in the literature. To put this statement in context, I will address the problems encountered in traditional measurement, and explain why financial measurements and troop counts fail to fully capture the meaningful contributions made during combat operations.

Measurement of Contributions and Benefits

Underpinning the foundation of the Economic Models of Alliances is the question of *measurement*. Military expenditures and GDP are concrete and simple, but do they adequately capture meaningful contributions? Are troop and tank counts better? Weighing these considerations, how should researchers engineer metrics to accurately quantify contributions? These issues represent the primary difficulties in the literature (Sandler & Murdoch, 2000; Sandler, 2006; Solomon, 2004).

I will begin the discussion with the basic measurement of contributions implemented by NATO itself. The defined and accepted measurement of contributions is the ratio of defense spending to Gross Domestic Product (GDP), using 2% as a benchmark. While this metric possesses the virtue of simplicity, it fails to capture relevant factors in the current threat environment. There are several ways this measurement falls short:

1. Quality Matters: A nation spending money on poorly trained, ill-equipped conscripts does not contribute equally to a nation spending on highly trained and motivated volunteer troops. Consider a nation that uses waves of conscripted soldiers, rather than small groups of precision Special Forces. On paper, the costs may appear the same, but the meaningful contribution may be vastly different. This disparity can also be driven by a nation’s culture, not just dollars spent. It is important to assess the actual capabilities and consequent advantages derived from the money spent, not just the amount of money or number of troops.

2. Deployment and Participation Matter: A nation that spends lavishly on its military but restricts the military to domestic soil does not contribute meaningfully to security in the current threat environment. Researchers must consider deployments and participation in peacekeeping operations. For example:
    a. Number of troops deployed
        i. Combatants
        ii. Non-combatants (e.g., medical support)
    b. Number of aircraft deployed
        i. Types of aircraft (e.g., fighters vs support)
        ii. Sorties flown
        iii. Air strikes performed

3. Caveats Matter: A nation that deploys troops yet restricts their operations does not contribute any significant value. Recall the German troops ordered to stay inside the Green Zone, or French fighter pilots ordered to flee when confronted by enemy jets. These troops do not substantially contribute to combat operations. Caveats must be considered using other metric definitional standards such as casualty numbers or the risk level of the missions conducted.

Researchers have attempted to address these issues with varied success. In some cases, authors and academics possess a minimal understanding of the military or military operations. Marton and Hynek (2012) provide a fitting illustration of this limitation: While discussing the asymmetric capabilities of the U.S. and other NATO allies, they submit an example of the U.S. providing money and training for Hungary to develop a Joint Terminal Attack Controller (JTAC) capability. Their position contends that this is an example of leveling the playing field in terms of contributions. However, Marton and Hynek hugely overstate its significance in the context of multibillion-dollar asset dissimilarities. Training and equipping each JTAC costs thousands of dollars at most, while training and equipping each fighter pilot costs tens of millions of dollars, at least. That is not to say that such research and measurement efforts are without value. Hungary might be making a sincere effort to contribute more, but it is important to avoid overstating the value of this contribution.

A new analysis and measurement method demands consideration. The first step is to construct more accurate metrics to perform measurement of the material contributions of each nation in NATO. To achieve this objective, I will use aircraft and sortie contributions rather than military expenditures. Before moving into this analysis, I need to examine the other side of the burden-sharing equation. What are the benefits that the members of NATO receive?

Benefits Received from Membership in NATO

The data derived from the measurement of benefits demonstrate an additional weakness in the literature. The traditional measurements components include population and/or the size of each member's economy, its Gross National Product (GNP). Measurements like these oversimplify the concept. Certain scholars have attempted to address these weaknesses by inserting additional metrics such as exposed border length measurement. Although some of these have merit, many attempts indicate a lack of understanding of current military capabilities and tactics. Overemphasizing benefits like exposed border protection leads to questionable conclusions, such as Canada receiving three times the benefit from NATO membership than Germany (Sandler & Shimizu, 2014). Is this benefit due to the massive geography of Canada that needs defending over the more vulnerable location of Germany? This is not an easy task. My argument proposes that using population and GDP as metrics provides an incomplete picture. Several considerations are listed below:

1. Population and GDP are illustrative, but inadequate by themselves.
2. Exposure to terrorist threats: Eliminating nearby terrorist training camps may decrease the terrorist threat for nations at risk.

3. Refugees: Alliance members bordering a failed state are exposed to a potential flood of refugees. In this case, conflict-approximate members benefit more than remote members like the U.S. and Canada. Proximity to the conflict may be a valid indication of benefits.
4. Exposed borders: There is some validity in the current threat environment, but less than stated in the current literature. The main benefit of securing a border in the current environment is less about enemy troops and more about unauthorized crossing:
    a. Refugee flow (as mentioned above)
    b. Easy terrorist access to transport both people and weapons.

For the purposes of this dissertation, my analysis will follow the benefit models of Sandler and Shimizu (2014) with some minor modifications. I will add a benefit-proxy metric specific to the risk of refugee flow specific to each conflict. This calculation will be based on proximity to the conflict. The theory is that a nation more vulnerable to an influx of refugees benefits more from stabilizing a conflict than nations less at risk. George and Sandler (2018) used a similar spatial approach incorporating distance between NATO members' capital cities as a factor related to the benefits of defense spending. I intend to utilize the George and Sandler method, incorporating a measurement of the distance between each NATO member's capital city and the conflict area. This variable will capture the risk of refugee flow, and the potential benefit of stabilizing the region through military intervention. Table 4.2 illustrates defense burdens and benefit-shares for NATO members during the time of the intervention in Kosovo as calculated by Sandler and Shimizu (2014).

Since the Sandler and Shimizu model is already comprehensive and represents the best model in the literature for capturing benefits, I will focus most of my work on the opposing side of the equation: the measurement of contributions. This is where the current research primarily falls short. To help understand why the contribution side of the equation is so important, I will first address the asymmetric military capabilities of the NATO membership.

CHAPTER 3

NATO'S GROWING GAP IN MILITARY CAPABILITY

Sandler and Shimizu (2014) predict that the growing technology gap contributes to disproportional burden-sharing within NATO. They conclude that Secretary Gates' concerns are valid, and that the future of NATO is at stake. I believe Sandler and Shimizu are correct but underestimate this concern. In other words, the technology and capability gap has grown to a much more significant level than has been previously documented.

Sandler and George (2016) note that the U.S. typically assumes more than 60% of total NATO expenditures. However, this imbalance becomes even more conspicuous when the three medium powers (Germany, the UK, and France) are included with the U.S. In this case, the top four members account for at least 80% of NATO spending, while the bottom contributors who account for only 20% of spending simply cannot afford critical technologies. Even the top three medium-range powers together contribute only a fraction of the U.S. amount, resulting in a significant capabilities gap across the entire alliance.

Critical Capabilities

This gap has put the United States in a difficult position because certain technological capabilities can *only* be contributed by the U.S. due to research and development costs or technological requirements. In the current threat environment, NATO continues to focus on out-of-area operations and combating rogue nations. This shift in policy requires substantially different capabilities than those necessary during the Cold War. Examples of these relevant military capabilities include:

- Heavy Airlift aircraft such as the Boeing C-17 Globemaster III (Approx. $220 Million per Aircraft). These types of planes provide important capabilities:
    - Rapid and flexible troop movement
    - Tanks/heavy equipment movement
    - Ability to land in inhospitable areas
- Air Refueling Tankers such as the McDonnell Douglas KC-10 Extender (Approx. $100 Million per Aircraft). Heavy airlift aircraft, bombers, and fighters all require inflight refueling:
    - Required for deployment support
    - Force projection
    - Sustained combat presence
- Precision Strike Fighters such as the F-22 and F-35 (Up to $250 Million per aircraft and $5-10 Million per mission-ready pilot)
    - Required to perform strikes in populated areas while avoiding collateral damage
    - Ability to strike targets obscured by weather
- Precision Strike Bombers such as the Northrop Grumman B-2 Spirit (More than $700 million per aircraft)
    - Needed for larger scale strikes than those provided by fighter or attack aircraft

- Intelligence/Surveillance/Reconnaissance (ISR) assets (Up to $500 million each)
    - Satellites
    - Boeing RC-135 Rivet Joint
- Command and Control Platforms ($200-500 million each);
    - Boeing E-3 AWACS Sentry,
    - Boeing E-4 Nightwatch.
- Aircraft Carriers (up to $13 billion each)

To explain the significance of these critical capabilities and the disparity within the alliance, I need to emphasize two key points. First, fighter and strike aircraft are generally effective only if they are capable of employing precision weapons in all weather conditions. For example, if a nation supplies fighter jets, those fighters may not be useful without the necessary technological capabilities and crew proficiency to strike targets with minimal risk of collateral damage. The Panavia Tornado strike aircraft employed by Italy, the UK, and Germany is one such case of an aircraft lacking current technological requirements. Second, as previously noted, many of the support aircraft are extremely expensive. Air refueling aircraft demonstrates this: The McDonnell Douglas KC-10 is based off the DC-10 passenger plane. The United States Air Force maintains approximately 60 of these high-dollar airplanes, in addition to other types of refueling aircraft such as the KC-135 and KC-130. The Netherlands, a middle-tier NATO contributor, has a total of *two* of these tankers in their entire Air Force. Similarly, other NATO nations lack certain types of capabilities, and many have none. To compound this imbalance, the United States is the only NATO member currently operating ultraexpensive F-22 Raptor fighters and B-2 Spirit bombers. Increasingly, NATO is becoming dependent on the U.S. for these costly aircraft.

Research Question

My intention is to seek an answer to the questions regarding burden-sharing in NATO, beginning with the assertion by President Trump and former Defense Secretary Gates that the United States over-contributes to NATO. Is the United States contributing disproportionately to NATO? Have we indeed returned to the free riding “equilibrium” that existed in the early phase of NATO under the American nuclear umbrella? Does the United States possess exclusive military capabilities that are necessary for NATO’s out-of-area operations to succeed? To answer these questions, I will use the following research design.

Methodological and Statistical Design

By evaluating specific NATO military operations, I will demonstrate that the U.S. contribution far exceeds expectations, primarily because of its exclusive military capabilities. Without U.S. capabilities, certain NATO operations cannot be considered, and simply will not succeed. This “capabilities gap” in the era of NATO’s crisis management phase has returned burden-sharing to levels that existed during the Cold War and the nuclear umbrella. The United States bears a disproportionate burden as free riding in NATO continues to be a concern.

My research design model will first examine the current state of burden-sharing from two perspectives relying on the basic methodology set forth by Sandler and Shimizu (2014) but with new data. I will apply a Spearman rank correlation (ρ) test to measure the strength and direction of a possible association between two ranked variables, which will allow me to examine the possibility of exploitation of the large allies by the smaller allies.

The Spearman methodology is appropriate for the first test, because it allows a comparison of each ally's ability-to-pay to their burden-share. If these two variables are positively associated, it potentially indicates exploitation. Second, to test the concordance between defense burdens and benefit-shares, I will incorporate a Wilcoxon signed rank test. This test is a non-parametric equivalent of the paired test, comparing two dependent variables to determine whether they derive from populations with the same distribution. In this case, these variables will be benefit-shares and burden-shares.

Using this analysis, I will begin with a test of the exploitation hypothesis as put forth by Olson and Zeckhauser (1966). However, instead of using the literature-standard military expenditures to gross domestic product ratio (ME/GDP) burden-sharing measurement, I will create a new metric by substituting the ratio of aircraft deployed and sorties flown to GDP for each case study. It would be expected based on NATO's ability-to-pay contribution guidelines that a nation with a larger GDP will contribute proportionally more aircraft. However, it is not expected that the contribution of aircraft increases disproportionately with an increase in GDP. In other words, a member with double the GDP of another would be expected to contribute double the aircraft, not four time the number of aircraft. That level of contribution would be disproportionate. For this examination, another reason the Spearman rank correlation (ρ) test is appropriate is because it is robust to outliers and is parametric-free. Its simplicity in ranking actual values, rather than calculating different values, is also beneficial in this case since larger, wealthier allies are compared with smaller, poorer ones.

The alternative (H_a) and null (H_0) hypotheses for this first test will be as follows:

> *H_a: Within the NATO alliance, there is a positive association between allies' GDP and their contribution of aircraft to military operations/GDP*
>
> *H_0: There is no association between these two variables*

Rejecting the null hypothesis would indicate that there is a positive relationship between the NATO allies ranks of Aircraft/GDP and Sorties/GDP to the allies' ranks of GDP. This would lend credence to the claim that the rich allies are being exploited by the poor allies, and that free riding is occurring in NATO.

This examination, however, provides only a partial narrative. Therefore, I will perform an additional test to provide a more complete picture. For example, some nations might contribute more because they benefit more from membership in NATO. This would provide a reasonable explanation and justification for additional contributions rather than simple exploitation. The next test will subsequently examine the balance between costs and benefits.

The alternative (H_a) and null (H_0) hypotheses for the second test will be as follows:

> *$H2_a$: Within the NATO alliance, the distribution of defense burdens and average benefit-shares are different*
>
> *$H2_0$: The distributions of defense burdens and average benefit share for the NATO allies are the same*

Following Sandler and Forbes (1980), as well as Sandler and Shimizu (2014), I will interpret the relationship between an average benefit-share and a between-ally defense burden. The burden metric will be each ally's contribution of aircraft and sorties as a share of the total number of aircraft and sorties provided by all members. The benefit measurement will follow the Sandler and Shimizu (2014) metric with the addition of a refuge-flow measurement as discussed previously. Again, the Wilcoxon signed rank test is non-parametric, and assigns ranks based on the absolute value of the differences between the measures of benefits and burdens. The test then computes the sum of the ranks with positive differences and the sum of the ranks with negative differences. The smaller of these gives the R statistic.

In this test, a large Wilcoxon R statistic favors not rejecting the null hypothesis. If this is the case, I can assume that the defense burdens and the average benefit-shares pull from the same distribution, indicating concordance.

My analysis will begin with the case studies based on NATO's combat operations in the Balkans.

CHAPTER 4

NATO'S FIRST WAR

The Balkan operations provide the largest and highest profile opportunity for a case study in NATO burden-sharing. When NATO F-16 aircraft shot down four Bosnian Serb warplanes violating the no-fly zone on 28 February 1994, it marked the first NATO military engagement since its inception in 1949. As the first war that NATO participated in, this operation was a watershed event in the history of the alliance.

The Balkan campaign became the first true demonstration of member commitment to out-of-area operations as required by the 1992 Oslo Declaration. As discussed in chapter 2, this declaration formalized NATO's role in "crisis management" operations leading to the third phase of NATO doctrine. This shift resulted in increasing concerns of uneven burden-sharing. When examining the balance of benefits vs burdens, this case study is additionally important. It shows that the benefits of the NATO operation would disproportionately go to NATO's European members. In addition to stabilizing the region, a primary benefit of the Kosovo military operations was curbing refugee flow and preventing a violent spillover into neighboring countries. This benefit directly impacted nearby nations, but only indirectly affected overseas members like the U.S. and Canada. This would, in theory, provide incentive for European members to over-contribute relative to the United States and Canada undermining the arguments regarding unbalanced contributions. Instead, I will demonstrate that the United States over-contributed to the Balkan operations because of its unique and necessary capabilities.

As I introduced in Chapter 3, my fundamental argument is that the *capabilities gap* between NATO members inherently leads to overcontribution by the United States. NATO's third phase of doctrine drives a demand for some military capabilities that only the U.S. can provide. Asymmetrical capabilities among the membership of NATO potentially returns the balance of burden-sharing back to the first phase when only the United States possessed intercontinental nuclear capability. During this first phase, the United States built a "nuclear umbrella" over Europe and North America because other members simply did not have the ability to do so themselves. This led to free riding by some members and resulted in uneven burden-sharing. This imbalance has returned in the current third phase.

My first test for uneven burden-sharing is based on the hypothesis that members with larger GDPs contribute disproportionality more than those with smaller GDPs. The baseline agreement among members is that each nation contributes 2% of GDP to their military. As a nation's GDP grows, so does its contribution. However, if nations with larger GDPs contribute more than 2%, burden-sharing becomes unequal, and the larger nations are being exploited. This type of economic analysis was pioneered by Olson and Zeckhauser, then expanded by Sandler and has been the conventional approach for decades. While my hypothesis is similar to those mentioned that used in the economic standard of measurement, I am considering aircraft and sortie contributions instead of military expenditures. If a nation with double the GDP of another contributes double the number of aircraft, then burden-sharing is theoretically even. However, if the nation with double the GDP contributes three or four times the number of aircraft, then that nation is potentially being exploited and burden-sharing is not balanced.

To begin the Kosovo analysis, it is important to first identify and define the military requirements of the operation. NATO employed major air operations as the preferred strategy to reduce the risk to ground troops (Nardulli, et al., 2002; Peters, et al., 2001; Valentino, et al., 2010). The nature of this operation required a sustained, precision-strike capability combined with all-weather targeting technology. Large-scale bombing using imprecise “dumb bombs” was not a feasible option due to the risk of civilian casualties. This meant that the “tip of the spear” for NATO contributions in this campaign would be precision airstrikes. In the context of the NATO alliance, this meant that to meaningfully contribute, each nation would be required to fly strike sorties that inherently put their planes and pilots at risk while accepting the political risk of civilian casualties. To capture this element, I will incorporate the number of sorties flown in addition to the number of aircraft deployed.

The overall requirements necessary to support a Balkan-scale air war were substantial and complex. Colossal numbers of support personnel were transported into the theater, requiring a combination of heavy airlift planes like the C-17 Globemaster as well as medium airlift capabilities provided by aircraft such as the C-130 Hercules. Once on location, troop supply lines required sustaining. To emphasize the importance of support levels, it is worth pointing out that each flight hour of a modern fighter jet such as an F-15E Strike Eagle requires more than 20 man-hours of ground maintenance. A squadron of 24 fighters, for example, would need more than 200 ground maintenance personnel in addition to the pilots and weapon system operators who fly the airplanes. The fact that the conflict occurred in the European members' back-yard brings up an important point related to contribution costs and burden-sharing. Local NATO members should be able to deploy and sustain troops and resources at a much lower cost than either the United States or Canada. Since it was theoretically easier for them to contribute, the European members should have contributed more than nations with long deployment and supply lines. While this point is not captured in my model, it is worth noting. The European members would seem to gather the greatest benefit from intervention and at the same time, it would be easier for them to contribute.

Airborne support was also a constant requirement during the Balkan air war. Fighter jets burn fuel so rapidly, they must be refueled in-flight. Frequently, this is necessary multiple times per sortie. A strike aircraft may not be able to make it to the target area without support from a tanker aircraft like the KC-10 Extender. In addition, Combat Air Patrol (CAP) aircraft could not stay airborne long enough to provide effective protection against enemy aircraft without constant refueling. At times during Operation Allied Force, a CAP was necessary 24-hours per day. Therefore, my models will also include tanker support aircraft and sorties provided by each NATO member.

Airborne Command and Control (C2) was also an essential capability during the Balkan campaign. Using powerful radar systems and teams of controllers, aircraft like the Boeing E-3 Sentry (AWACS) provided essential services for fighter and strike aircraft, supplying information on enemy threats and the status of other aircraft in the combat area. They also provide an airborne platform for commanders to oversee combat operations. Because some NATO members had jointly purchased fourteen E-3 AWACS aircraft, the number of sorties flown by U.S. versus NATO owned planes is indicative of member contributions. While the joint ownership potentially complicates measurement, I will simplify it by giving each member a proportional share of each NATO AWACS aircraft and sortie contributed. This will be covered in detail later in this chapter.

Intelligence, Surveillance, and Reconnaissance (ISR) was a similarly critical capability. This was accomplished using a variety of assets including the Boeing RC-135 Rivet Joint, U-2 Dragon Lady, C-130 variants, remotely piloted aircraft (RPAs), and satellites. These assets provided services such as target selection and bomb damage assessment. Each NATO member's contribution to ISR will also be factored into the calculations.

Electronic Warfare (EW) and Suppression of Enemy Air-defense (SEAD) assets provided jamming services and protection from enemy radar and weapon systems. This protective jamming can make the difference between a successful strike and having a friendly plane shot down by enemy missiles. These assets required extensive engineering and intelligence resources. Special variants of the EA-6B Prowler, F-16CJ Fighting Falcon and EC-130 provide some of these capabilities. The number of electronic warfare support sorties will also be an important measurement of contributions.

Finally, the number of actual fighter strike sorties—the most dangerous missions of the war—provides the most precise metric where it matters. The true colors of a NATO member nation were shown if they were willing to risk their multi-million-dollar aircraft and pilots. A nation that deploys fighters, but does not fly strike sorties, is not contributing as much as a nation that chooses to perform the strike missions. The number of strike sorties flown by each NATO member will be a critical metric of contributions.

The following two tables give insight into the findings of previous approaches compared to this analysis. Table 4.1 describes defense spending as a percentage of GDP for the time periods covering the major air operations in the Balkans. As a reminder, the baseline expectation for each NATO member is 2%. A quick study of this table indicates that there is a large variation in military expenditures both above and below the 2% target.

Table 4.2 indicates burden and benefit shares for the year of Operation Allied Force (1999) as calculated by Sandler and Shimizu (2014).

Table 4.1: Defense Spending as a Percentage of GDP for the Years of the Balkan Operations

	1995	1996	1997	1998	1999
NATO Member					
Belgium	1.6%	1.6%	1.5%	1.5%	1.5%
Canada	1.5%	1.4%	1.3%	1.3%	1.2%
Czech Republic	2.2%	2.0%	1.9%	2.1%	2.2%
Denmark	1.7%	1.7%	1.7%	1.6%	1.6%
France	3.1%	3.0%	3.0%	2.8%	2.8%
Germany	1.7%	1.7%	1.6%	1.6%	1.5%
Greece	4.4%	4.5%	4.6%	4.8%	4.9%
Hungary	0.8%	1.5%	1.7%	1.5%	1.6%
Iceland	NA	NA	NA	NA	NA
Italy	1.8%	1.9%	2.0%	2.0%	2.0%
Luxembourg	0.8%	0.8%	0.9%	0.9%	0.9%
Netherlands	2.0%	2.0%	1.9%	1.8%	1.8%
Norway	2.4%	2.2%	2.1%	2.3%	2.2%
Poland	1.1%	2.6%	2.3%	2.2%	2.2%
Portugal	2.6%	2.4%	2.3%	2.2%	2.2%
Spain	1.5%	1.5%	1.4%	1.4%	1.4%
Turkey	3.9%	4.1%	4.1%	4.4%	5.6%
United Kingdom	3.0%	3.0%	2.7%	2.7%	2.6%
United States	3.8%	3.5%	3.4%	3.2%	3.2%

DOD(2000b)

They find that the U.S. carried a burden share of 55.50 while maintaining a benefit share of only 25.65. My measures of contributions reveal a U.S. burden share that is significantly higher. Across the four models for the combined operations, I find United States' burden shares of 61.51 and 77.93 based on aircraft contributions and sortie contributions, respectively. Focusing on the more technologically complex and expensive support aircraft shows a burden share of 85.73 for support aircraft contribution and 93.36 for the sorties flown by these aircraft. Additionally, when I include a benefit proxy specific to the Balkan operations, I find that the U.S. benefit share drops to 20.76.

Before discussing the models and beginning the calculations, I want to clarify two general issues with the data. The first relates to how I will be calculating GDP and military spending (ME) rankings. The annual reports issued by the DOD to Congress (*Report on Allied Contributions to The Common Defense*) use varying years as a baseline to account for inflation. They also update some of the values year-to-year due to accounting refinements. To standardize and reduce confusion, for the year-by-year analysis, I will be using the report dated March 2000, which is the first report that fully covers the 1999 Operation Allied Force dates. This report lists values in 1999 dollars and will be used for all GDP and ME ranking calculations for all the Balkan Operations.

The second consideration is related to the airplane and sortie data. The number of aircraft contributed to the Kosovo operations occasionally varies between sources. This can be for a couple primary reasons. The first has to do with classification issues.

Table 4.2: Burden and Benefit Shares for select NATO Members during OAF (as Measured by Sandler and Shimizu)

	Defense Burden	Average Benefit Share
NATO Member		
Belgium	0.89	0.67
Canada	2.02	17.27
Czech Rep.	0.44	0.45
Denmark	0.68	0.96
France	9.23	6.87
Germany	7.63	12.64
Greece	1.31	7.68
Hungary	0.26	0.56
Iceland	NA	NA
Italy	5.93	4.10
Luxembourg	0.04	0.04
Netherlands	1.73	1.09
Norway	0.77	2.47
Poland	0.89	1.64
Portugal	0.62	0.63
Spain	2.02	5.07
Turkey	3.08	5.65
United Kingdom	6.95	6.57
United States	55.5	25.65

Sandler and Shimizu (2014) using GDP, Population, Exposed Borders, and Terrorism in Venue Country as Proxies for Benefits. Iceland was excluded due to a lack of defense spending.

Some nations do not want their data to be released for political or security reasons. I will discuss my plan for dealing with missing data when the second model is presented. The second main reason for variation in the data is simply due to different interpretations. For example, if a C-17 heavy cargo plane launches from the United States, delivers its freight, and then returns, some observers would consider it to be a contribution. Others only count aircraft that stay in theater. Since there is no concrete method, different sources have taken various approaches to this problem. As the data is presented, I will be clear about the assumptions behind any conflicting numbers.

Because the NATO air operations in the Balkans were divided into distinct stages, I have an opportunity to examine burden-sharing during three separate sub-case studies. Additionally, I will examine combined contributions to the overall Balkan operation in its entirety.

The three operations in the Balkans each represented an incremental escalation in the conflict that spanned nearly four years:

Operation Deny Flight (12 April 1993 – 20 December 1995)

Operation Deliberate Force (30 August 1995 – 20 September 1995)

Operation Allied Force (24 March 1999 – 10 June 1999)

The first, Operation Deny Flight, was intended to implement a no-fly-zone over Bosnia and Herzegovina to protect civilians from air strikes. As the name implies, it was intended as a defensive operation. After this operation failed to prevent ongoing atrocities and violent escalation, Operation Deliberate Force was implemented to allow for offensive strikes against Serbian ground targets. This more aggressive NATO military operation still failed to provide stability. This ultimately led NATO to execute Operation Allied Force.

Operation Allied Force was the culmination of NATO's Balkan campaign. It was by far the largest and most significant of the three, so; I will start with an overview of this operation. With a much larger data set and many more aircraft, Operation Allied Force will give the most insight into each member's contributions. Following this analysis, I will then examine the other two operations in chronological order. Finally, I will evaluate member contributions to all three operations combined.

With these considerations in mind, I will now begin my examination of aircraft and sortie contributions to Operation Allied Force.

CHAPTER 5

OPERATION ALLIED FORCE

Operation Allied Force remains the largest combat operation in NATO's history. It was designed to stop the ethnic cleansing of the Albanian minority by the government of Slobodan Milosevic. In addition to the humanitarian crisis, a large flow of refugees was destabilizing the region, leading to some security concerns for the European allies. An aggressive and overwhelming air campaign was the preferred solution because it could achieve the desired effect with minimal risk to NATO ground forces and civilian populations. In retrospect, this conflict provides important evidence of each NATO member's willingness and ability to contribute to the alliance during a critical time. 14 of the 19 NATO members contributed aircraft to Operation Allied Force. During the operation, NATO deployed approximately 1,055 aircraft, and flew more than 38,000 sorties. Notably, during air operations, cloud cover was greater than 50% more than 78% of the time (Lambeth, 2001). This factor increased the need for aircraft and/or other assets with all-weather precision strike capabilities.

Table 5.1 gives a broad overview of both aircraft and sorties contributed to this operation. It is noteworthy that the United States flew approximately 30,000 of the 38,000 total sorties, or more than three times the number of sorties flown by all other NATO members combined. Because this conflict occurred in the European allies' backyard, some benefit shares would seem to favor these members more strongly. They clearly have more to gain by keeping the region stable. It is also important to remember that the costs of deploying and sustaining aircraft operations are lower for those nations that are in closer proximity to the operation. European members could theoretically contribute more easily and inexpensively than the U.S., while gaining greater benefits. However, this case study will indicate that the American overcontribution to NATO is more significant than currently stated in the literature and exploitation of the wealthier nations is occurring.

The four models will reveal progressively more exploitation as I examine total aircraft numbers versus sorties contributed and then support aircraft versus support sorties flown. I will show that the wealthier members not only contribute more than their share of aircraft, but they fly them more often than the poorer members. This holds true even when I control for GDP. These findings become even stronger when I focus on the more expensive support aircraft. Before covering the details of the Spearman calculations, I need to discuss some considerations regarding the data in Table 5.1.

It is important to note that Table 5.1 includes some missing numbers in the sortie columns. While most of the sorties are accounted for, roughly 2% cannot be attributed to specific nations. This could be due to classification issues, or simply that these members did not wish to release their data due to political purposes. Fortunately, the missing data will not impact the overall findings. I will explain in detail how I will mitigate this matter when I address Model 2 later in this chapter. First, I will discuss the data from an overall perspective.

Before I begin the statistical analysis, I want to explore the data in Table 5.1 to reveal the big picture. The United States provided 731 aircraft of all types to the operation. The remaining NATO members contributed another 327 combined, while the second largest contributor (France) contributed 84 aircraft. Five members contributed zero aircraft and another five contributed less than ten. In other words, more than half of the NATO membership contributed less than ten aircraft to this operation. A quick glance at the last two columns indicates how many sorties these aircraft flew. When I compare columns three and five, the percentages should be approximately the same if each nation is proportionally flying their aircraft in combat operations.

Comparing the two columns in Table 5.1 showing the percentage of aircraft contributed relative to the percentage of sorties contributed reveals some important findings. The percentages should be roughly the same between these columns. It is especially notable when the percent of sorties flown is lower than the percent of aircraft contributed. This is important for two reasons. First, it could indicate a desire to contribute superficially by keeping aircraft on the ramp, but not put their pilots at risk by flying in actual combat. This falls in the category of caveats and may indicate a desire to shirk responsibility. Second, and more importantly, a member flying fewer sorties could indicate that their aircraft lack key capabilities (such as all-weather precision) that were required during Operation Allied Force. This is the first potential indication of a capabilities gap in NATO.

Table 5.1: Contributions to Operation Allied Force by Aircraft and Sortie Count

NATO Member	Aircraft	Percent	Sorties	Percent
Belgium	14	1.3%	missing	missing
Canada	18	1.7%	missing	missing
Czech Republic	0	0.0%	0	0
Denmark	8	0.8%	missing	missing
France	84	7.9%	2,414	6.3%
Germany	33	3.1%	636	1.7%
Greece	0	0.0%	0	0
Hungary	4	0.4%	missing	missing
Iceland	0	0.0%	0	0
Italy	58	5.5%	1081	2.8%
Luxembourg	0	0.0%	0	0
Netherlands	22	2.1%	1252	3.3%
Norway	6	0.6%	missing	missing
Poland	0	0.0%	0	0
Portugal	3	0.3%	0	0
Spain	7	0.7%	missing	missing
Turkey	21	2.0%	missing	missing
United Kingdom	39	3.7%	1950	5.1%
United States	731	69.1%	30,018	79.0%
*NATO AWACS**	10	0.9%	missing	missing
Total	**1058**	**100%**	**38,004**	**100%**

Data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001). Numbers are approximate due to conflicting accounts and various ways to account for carrier-based and non-theater-based aircraft (for example the B-2s based in the U.S)

As Table 5.1 illustrates, France, Germany, and Italy all flew a smaller percentage of sorties compared to the percentage of aircraft they contributed. In contrast, the Netherlands, the United Kingdom, and the United States all flew proportionally more sorties compared to the number of aircraft they contributed. While this table gives a first glimpses into potential findings, I will continue to break down the contributions further.

As outlined earlier, simply calculating the total number of aircraft provided by each member is not a true measure of meaningful contributions. More important than the *number* of aircraft are the *capabilities* of those aircraft. Specialized and expensive support aircraft such as tankers and complex command/control platforms are mission-critical, while outdated strike fighters lacking all-weather precision capabilities are nearly worthless and increase the risk of civilian casualties. Table 5.2 gives a more detailed breakdown of the categories of aircraft provided by each NATO member.

Table 5.2 is important because it reveals which nations contributed the critical support aircraft. The second column shows the number of fighter/attack aircraft contributed by each nation, while the remaining columns list the support aircraft. Fighter/Attack aircraft were by far the largest contribution across the board. Compared to the larger and more complex heavy bombers and support aircraft, these are the least expensive and easiest to maintain and deploy. Values of zero are primarily located in columns three through six. Scanning these columns reveals only single digit contributions by nations other than the U.S. It is important to emphasize that Operation Allied Force required these critical support aircraft to succeed in its goal to protect civilians from harm. Fighters cannot strike unless they can refuel and are protected and guided by early warning and command/control aircraft. Additionally, some heavily protected targets require larger, heavier weapons that can only be employed by heavy bombers.

Combining all the support aircraft categories from Table 5.2 helps to illustrate the big picture. Of 332 total support aircraft participating in Operation Allied Force, the United States contributed 303, or more than 90% of them. In addition to being mission critical, they are also among the most complex to build and operate. While these numbers give the next level of insight into contributions, there is more to consider. As mentioned earlier, the first column in Table 5.2 indicates the number of small fighter/attack aircraft contributed. It is worth discussing the primary contributors in this category next.

I will discuss specifics for each of the six primary contributors below. The numbers and types of aircraft I will be discussing are referenced in Appendix A as well as Peters, et, al., (2001).

France

With a total deployment of more than 80 aircraft, France was the largest contributor of aircraft after the United States. Like other European members, their primary contribution was fighter aircraft with some (but limited) capability to deliver precision guided munitions. As I will show in the second model, this capability allowed them to contribute relatively more sorties in the strike phase of air operations than the

Table 5.2: Contributions to Operation Allied Force by Aircraft Category

NATO Member	Fighter/Attack	Bomber	Airlift	Tanker	Specialty	Total
Belgium	14	0	0	0	0	14
Canada	18	0	0	0	0	18
Czech Republic	0	0	0	0	0	0
Denmark	8	0	0	0	0	8
France	79	0	1	3	1	84
Germany	32	0	1	0	0	33
Greece	0	0	0	0	0	0
Hungary	4	0	0	0	0	4
Iceland	0	0	0	0	0	0
Italy	57	0	0	1	0	58
Luxembourg	0	0	0	0	0	0
Netherlands	20	0	0	2	0	22
Norway	6	0	0	0	0	6
Poland	0	0	0	0	0	0
Portugal	3	0	0	0	0	3
Spain	6	0	1	0	0	7
Turkey	21	0	0	0	0	21
United Kingdom	30	0	4	3	2	39
NATO AWACS	0	0	0	0	10	10
United States	428	22	43	175	63	731
Total	**726**	**22**	**50**	**184**	**76**	**1058**

Data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters et al., (2001). Note: Includes only FW aircraft. The specialty category includes miscellaneous support aircraft such as Command and Control, Intelligence, Surveillance, Reconnaissance, and Electronic Warfare other European members who were significantly hindered due to poor weather conditions. In the fighter/attack category, France deployed Mirage 2000C Fighters, Mirage 2000D Strike Aircraft, Jaguar Strike Aircraft, Mirage Fl CT Strike Aircraft, Mirage IV P Strike Aircraft, and several Super Entendards. In addition, France also deployed light specialty aircraft such as the Mirage Fl CR Reconnaissance Aircraft. France's support aircraft included three KC-135F Airborne Tankers, one E-3F Airborne Warning and Control aircraft and one C-160G Transport/Specialty Aircraft. Table 5.2 gives a frame of reference for this contribution within the overall context of the operation and Table A-2 gives additional reference for aircraft types and categories.

Italy

Italy contributed a total of 58 aircraft to Operation Allied Force, making it the third largest contributor after the U.S. and France. The Italian Air Force primarily deployed Panavia Tornado Multirole Fighter Aircraft, including Air-to-Air, Strike variants, and Electronic Combat/Reconnaissance versions. In addition, they deployed several AMX light attack aircraft. Like the German support Tornados, the Italian Electronic Combat and Reconnaissance (ECR) Tornados used High-speed Anti-Radiation Missiles (HARMs) to aid in the Suppression of Enemy Air Defenses (SEAD). This allowed other aircraft to safely operate in the target area. The remaining Tornados and AMX were used primarily to fly Combat Air Patrol (CAP) sorties.

Germany

Although Germany contributed far less in terms of strike capability than France, the Luftwaffe still played a relatively important role in the air operations with a contribution of 33 planes. These were primarily used in the SEAD mission. While this is not a direct strike mission, SEAD was still an important part of the overall air campaign as discussed previously. Of Germany's Panavia Tornados, most were ECR while the remaining Tornados were equipped with pods for ISR, focusing on ground units and refugee flows. Although they were able to successfully provide SEAD using the AGM-88 HARM anti-radiation missiles, the German Tornados were not equipped with Precision Guided Munitions (PGM). This severely restricted their ability to contribute to strike missions without risking civilian casualties. Table A.1 shows the stark contrast between France and Germany in contributions to the mission of striking ground targets.

The United Kingdom

The Royal Air Force (RAF) was the third largest European contributor, with a total deployment of 39 aircraft. They provided mostly fighter aircraft including GR-7 and FA-2 Harriers. They also provided Tornado GR-ls. However, most importantly, the RAF possessed PGMs, allowing them to participate in a relatively higher percentage of strike missions as shown in Table A.1.

Unfortunately, RAF aircraft lacked all-weather capabilities, which hindered them during the adverse weather conditions that existed throughout the campaign. RAF support aircraft included three airborne tankers and four cargo aircraft. Two specialty support aircraft were also deployed by the RAF. While important, the RAF support aircraft were only a small portion of the total as shown in Table 5.2.

The Netherlands

The Royal Netherlands Air Force deployed their F-16A multirole fighter aircraft to the Balkans. While these aircraft were equipped with Forward-Looking Infra-Red (FLIR)—allowing them to strike at night—the Dutch, unfortunately, did not have PGMs. Without precision weapons, their night capabilities were not useful due to continued poor weather and concerns about civilian casualties. The Dutch also provided their two KDC-10 airborne tankers.

The United States

The United States supplied by far the most aircraft to Operation Allied Force, including more than 730 of the total 1058 allied planes. The U.S. deployed 428 fighter aircraft, 175 Tankers, 22 bombers, 25 ISR aircraft, 38 specialty aircraft, and 43 intra-theater airlifters.

The United States also employed the largest number of precision strike and all-weather munitions. These advanced weapons were crucial to the success of the operation due to the unfavorable weather and concerns over civilian casualties.

The most significant figure concerning the U.S. contribution is the number of support aircraft deployed in OAF. Among the U.S. aircraft deployed throughout the region, more than 40% were support aircraft. This disproportional number reflects both the growing capabilities gap and the importance of these assets in the types of operations NATO could face in the future. The United States provided most of the electronic warfare support and more than 90% of the necessary airborne refueling capability. It also provided the only heavy bombers and almost all the heavy airlift for Operation Allied Force.

For further detail on the contributions by the middle power members, Table A.1 at the end of this chapter gives an accounting of sorties flown by the five largest aircraft contributors after the United States. The first five rows are missions that can be flown by smaller fighter-type aircraft, while the last three generally require larger and more complex airplanes. Table A.1 shows that the largest number of sorties flown by these members are concentrated in the mission sets that can be flown by simpler fighter aircraft.

While a detailed breakdown of U.S. sorties flown is not available, Larson, et al. (2003) notes that the U.S. flew 53% of NATO’s strike-attack sorties and dropped over 80% of the strike-attack munitions. In addition, the U.S. flew more than 93% of NATO’s support sorties, including all heavy bomber missions and more than 90% of the advanced intelligence, surveillance, and reconnaissance (ISR) missions. Another item of significance revealed by Table A.1 is the smattering of zeros across various mission sets. Besides the United States, the UK was the only NATO member who was able and willing to accomplish every mission-set listed above. Note that this table does not include either heavy airlift or heavy bomb delivery, which was exclusively performed by the U.S.

In addition to the category of aircraft (such as fighter, bomber, etc.), I need to examine the type of aircraft contributed (such as F-15, Tornado, etc.). A study of air combat history reveals the fact that all airplanes are not equal. When technology changes, the previous generations of fighters routinely become obsolete and are no longer fit for combat. Table A.2 list selected aircraft contributions by specific type. In this directory, there are planes with a wide variety of capabilities. For example, the B-2 Spirit stealth bomber and F-117 Nighthawk stealth fighter represent leading edge technology and capabilities. In contrast, aircraft like the F-104 Starfighter first flew in 1956 and was phased out of front-line service by the U.S. Air Force in the 1960s. While a nation contributing a 43-year-old airplane to the operation should be recognized, this contribution cannot compare in performance to a stealth fighter or bomber. While each aircraft contribution is treated equally for the first analysis, it is likely that an obsolete aircraft like the F-104 sat on the ground during bad weather and flew fewer sorties with limited effectiveness than more capable aircraft such as the F-15E Strike Eagle or B-2 Spirit. This finding will be revealed in the second model.

As mentioned earlier, another important takeaway from these tables is that the United States was the only nation that supplied heavy bombers to the operation. In addition to the B-52 and B-1 heavy bombers, the U.S. employed B-2 Spirit bombers based in North America to fly strike missions. This critical contribution required the unique capabilities of these $700M aircraft. The B-2 Bombers proved even more impactful because of inclement weather that limited visibility and obscured the target areas. While other aircraft were prohibited from releasing weapons, the high-tech B-2 used onboard synthetic aperture radar (SAR) to map the target area on run-in. This unique capability provided enhanced accuracy for the GBU-31 Global Positioning System (GPS) guided bombs carried by these bombers. A single B-2 could potentially strike up to 16 targets from 40,000 ft in a single pass (Lambeth, 2001). B-2s performed this task amid weather that grounded other aircraft. In this manner, B-2s were able to strike hardened, enemy ground bunkers and air-defense facilities providing a critical capability to the operation. With this understanding of aircraft capabilities in mind, I will discuss the statistical models.

Using my comprehensive data set built from unclassified DOD and NATO sources, I will next employ the framework discussed earlier to test the hypotheses in four different models:

Model 1 will include the total number of *aircraft* contributed

Model 2 will examine the total number of *sorties* flown

Model 3 will use the number of *support aircraft* contributed

Model 4 will examine the number of *support sorties* flown

Model 1: Aircraft Contributions

My first examination of Operation Allied Force is based on aircraft contributions. While 14 members contributed aircraft, only six of the 19 NATO Members made significant contributions: France, Germany, Italy, the Netherlands, Great Britain, and the U.S. This gives the first potential dividing lines between the United States (the major power), the next five (middle powers), and the remaining 13 (minor powers).

While my preceding discussion focused on the contributions of the top six members, Table 5.1 compiles the contributions from all the NATO allies. As shown in the table, more than half of the allies contributed ten or fewer aircraft and five contributed none.

Before I start the statistical analysis, one important element needs to be addressed. As shown in Table 5.1, NATO jointly provided 10 AWACS surveillance aircraft to Operation Allied Force. As a reminder, AWACS is an acronym for "*Airborne Warning and Control System.*" These aircraft, based on the Boeing 707, are essentially airborne command centers and air traffic controllers. They provide an important capability during an air war by providing oversight and guidance to the fighters and other aircraft flying in combat operations. The NATO AWACS program began in the 1970s as a way for smaller members to fractionally contribute large, complex, and expensive aircraft to the alliance, potentially mitigating the capabilities gap. This leads to the question of how I will accurately measure this shared contribution.

First, it is important to understand that only some of the NATO members have participated in the AWACS program since its inception. It is not part of the overall NATO operating budget; nations choose to participate through a separate funding program. Simply allocating a share of these aircraft evenly across the membership would fail to capture the contributions accurately. Nations that participate in the AWACS program essentially gain partial ownership. To account for this “fractional ownership”, I will add a contribution factor based on initial purchase shares. These shares are based on GAO analysis that was presented to the U.S. Congress as part of the initial purchase of these aircraft by NATO. The acquisition cost shares are shown in Table 5.3 (GAO, 1980). It is worth noting that the United States contributed more than 42% of the initial cost. Arguably, this undermined the intent that these aircraft would be owned more equally across the membership.

Incorporating these fractions into the aircraft contribution data gives the final numbers shown in Table 5.4. Because this calculation includes partial ownership, the aircraft contribution numbers include fractions. With the joint NATO AWACS contributions broken down, I can now calculate the rankings necessary for the statistical analysis. For reference, all the data used in the Spearman calculations as well as the charts in the first model are summarized in Table 5.4.

As introduced in the previous chapter, Model 1 will test the test for exploitation using the ratio of aircraft contributed to GDP, (AIR/GDP) relative to GDP for each case study.

Table 5.3: Acquisition Shares for NATO AWACS

NATO Member	Percent	Contribution Fraction
Belgium	2.74%	0.27
Canada	9.78%	0.98
Czech Republic	0%	0
Denmark	1.67%	0.17
France	0%	0
Germany	30.72%	3.07
Greece	0.66%	0.07
Hungary	0%	0
Iceland	0%	0
Italy	5.59%	0.56
Luxembourg	.09%	0.09
Netherlands	3.29%	0.33
Norway	1.36%	0.14
Poland	0%	0
Portugal	0.08%	0.01
Spain	0%	0
Turkey	0.84%	0.08
United Kingdom	1.06%	0.11
United States	42.12%	4.21
Total	**100%**	**10 Aircraft**

(GAO, 1980). The OAF contribution factor is based on the 10 NATO AWACS that flew in Operation Allied Force. This is the only aircraft contribution from Greece and Luxembourg.

The Spearman rank correlation (ρ) test will be used to test the following hypotheses:

> *H_a: Within the NATO alliance, there is a positive association between allies' GDP and their contribution of aircraft to military operations/GDP*
>
> *H_0: There is no association between these two variables*

Rejecting the null hypothesis would indicate that there is a positive relationship between the NATO allies ranks of Aircraft/GDP and Sorties/GDP to the allies' ranks of GDP. If burden-sharing is equitable, then there should be no association between a nation's GDP and their contribution of aircraft after controlling for GDP. A positive relationship between the NATO allies ranks of Aircraft Contributions/GDP to the allies' ranks of GDP would lend credence to the claim that the rich allies are being exploited by the poor allies and free riding is occurring in NATO.

Using the data in Table 5.4, I can begin the Spearman Rank Correlation analysis to test my hypothesis. But first, it may be helpful to visualize the data to gain a better perspective.

Figure 5.1 simply plots each nation's actual GDP against the total number of aircraft contributed to Operation Allied Force. While this chart cannot reveal exploitation, it does help to illustrate the three-tiered alliance. For clarity in identifying each member, the nations are labeled in accordance with the International Olympic Committee (IOC) conventions using three letter identifiers. The abbreviations summary on page xviii provides a list of each one.

Table 5.4: GDP, Military Expenditures, and Aircraft Contributions to OAF

Member	GDP($B) (1999)	GDP Rank	ME/GDP (1999)	ME/GDP Rank	AIR	AIR Rank	AIR/ GDP	AIR/ GDP Rank
Belgium	251.1	**9**	1.43%	**15**	14.3	**9**	0.0568	6
Canada	621.0	**6**	1.19%	**17**	19.0	**8**	0.0306	10
Czech Republic	53.4	**16**	2.25%	**6**	0.0	**18**	0.0000	18
Denmark	176.1	**11**	1.59%	**13**	8.2	**10**	0.0464	8
France	1431.0	**3**	2.80%	**4**	84.0	**2**	0.0587	4
Germany	2123.9	**2**	1.55%	**14**	36.1	**5**	0.0170	13
Greece	124.7	**14**	4.89%	**2**	0.1	**16**	0.0005	16
Hungary	49.1	**17**	1.63%	**12**	4.0	**13**	0.0815	3
Iceland	9.0	**19**	0.00%	**19**	0.0	**18**	0.0000	18
Italy	1167.8	**5**	2.00%	**10**	58.6	**3**	0.0501	7
Luxembourg	16.9	**18**	0.59%	**18**	0.1	**15**	0.0053	15
Netherlands	380.6	**8**	1.76%	**11**	22.3	**6**	0.0587	5
Norway	150.0	**12**	2.13%	**9**	6.1	**12**	0.0409	9
Poland	143.9	**13**	2.22%	**7**	0.0	**18**	0.0000	18
Portugal	109.6	**15**	2.19%	**8**	3.0	**14**	0.0274	12
Spain	566.0	**7**	1.36%	**16**	7.0	**11**	0.0124	14
Turkey	191.7	**10**	5.53%	**1**	21.1	**7**	0.1100	1
UK	1400.9	**4**	2.58%	**5**	39.1	**4**	0.0279	11
US	8910.0	**1**	3.18%	**3**	735.2	**1**	0.0825	2

GDP and ME Data are from DOD (2000b), Iceland GDP from World Bank (2019). Aircraft contribution data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

Figure 5.1 plainly shows the relative contributions of the United States and the rest of the NATO membership. In pure values rather than ranks, the U.S. is clearly a severe outlier. Additionally, this chart gives an additional perspective on the middle and minor powers. Germany, France, Italy, and the UK. stand out from the remaining members, but are much closer to the smaller powers than they are to the U.S.

My argument is that there is a significant capability gap between the Unites States and other NATO members resulting in unavoidable exploitation of the U.S. by the other members. Without the United States, a NATO operation like Allied Force simply cannot succeed. If the other members attempted a military operation like Allied Force in Kosovo, the losses in terms of both friendly and civilian casualties would be both politically and morally unacceptable. This requires the U.S. to either over-contribute or stand by and watch the operation fail. Removing the U.S. from the equation not only reduces the total number of aircraft, but also eliminates some critical capabilities. Currently, the U.S. is the only nation capable of making certain expensive contributions like B-2s or F-22s.

To further demonstrate the distinction between the three tiers, Figure 5.2 plots the same data, but with the exclusion of the United States. This shows where the remaining members fall along the spectrum.

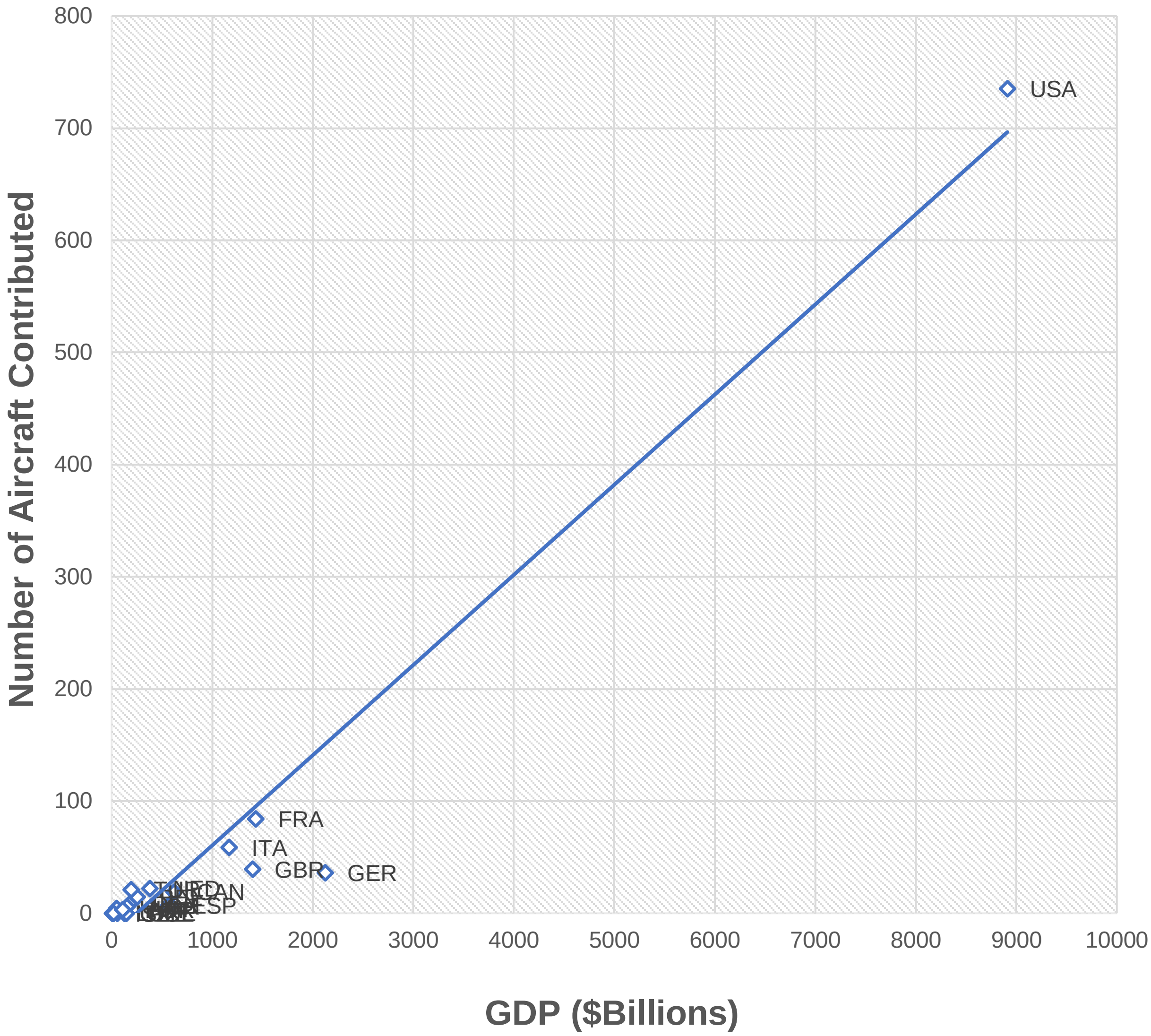

Figure 5.1: Aircraft Contributions to OAF Compared to GDP

Note: Because the U.S. is such an extreme outlier, the minor powers are clustered and overlapping in the lower left portion of the graph. Reference Figure 5.2 for an expanded version of this chart.

Note that the smallest countries who contributed zero aircraft to this operation are lumped together along the bottom of the vertical axis. In addition, it is interesting to see where Canada, Spain, and the Netherlands fall. They are much closer to the “minor powers” of NATO membership than France, Germany, Italy, and the U.K.

Figure 5.2 shows the minor powers clustered in the lower left portion of the graph. The members overlapping in the lower left are: POL, GRE, CZE, LUX, and ISL. Before moving on, it is important to acknowledge that NATO membership includes both rich and poor countries. To account for this fact, the next chart will plot each member’s contributions relative to GDP as a ranking from one to nineteen. This will help to mitigate the effects of outliers on either the wealthy or poor ends of the spectrum.

The ranking data is plotted on the following page in Figure 5.3 along with the Spearman calculation results. Nations with lower GDPs and fewer aircraft contributions will appear in the lower left portion of the graph. Figure 5.3 shows results that are in line with expectations. One would logically expect that wealthier nations would contribute more aircraft than poorer nations. This fits with the basic notion of NATO membership and the ability-to-pay concept.

Clearly, there is a strong relationship between GDP and the number of aircraft contributed by each member.

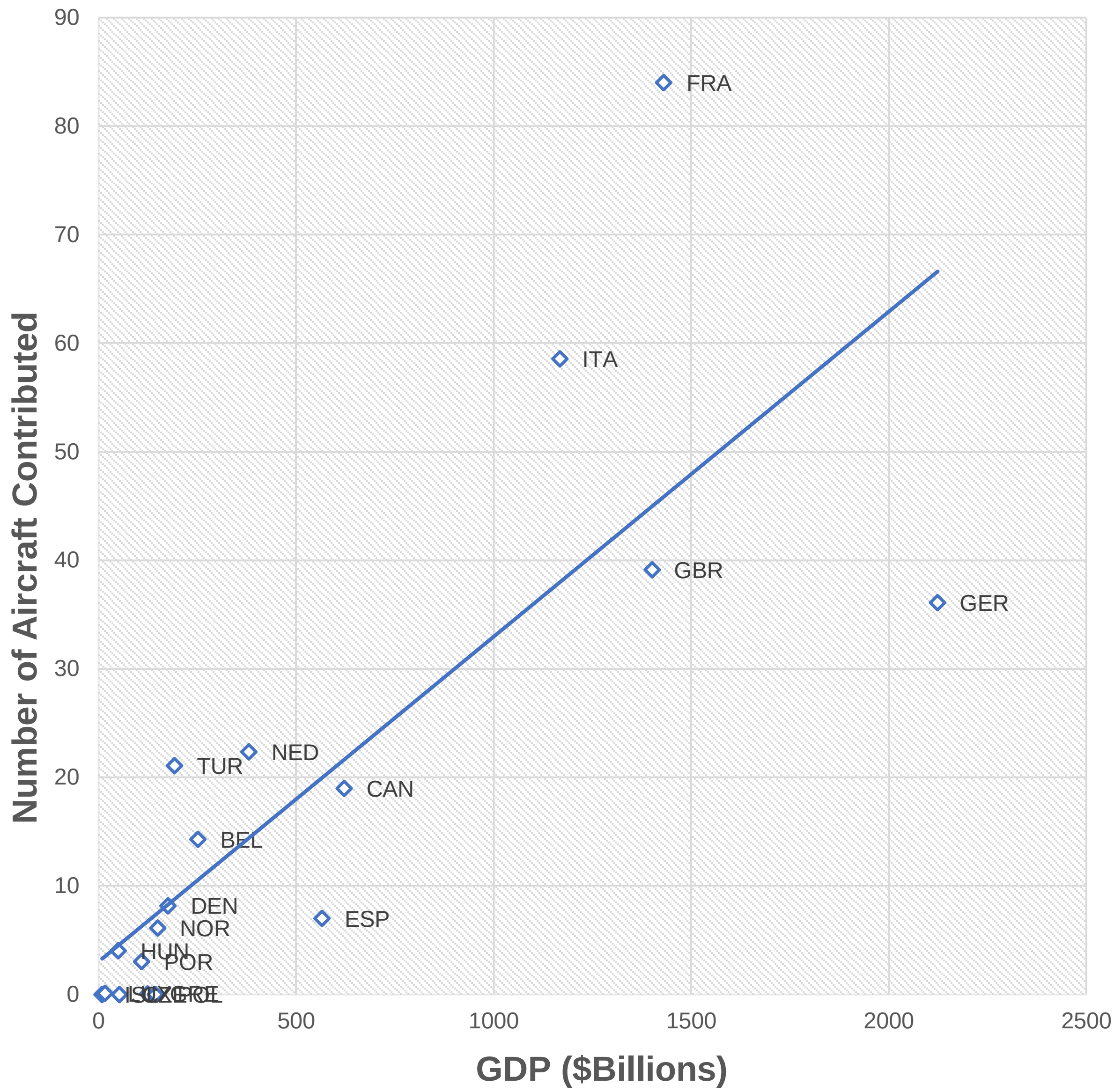

Figure 5.2: Aircraft Contributions to OAF Compared to GDP
(Excluding the U.S.)

With Spearman’s rho of 0.91 and a confidence level above 99.99% I can conclude that nations with larger GDPs contributed more aircraft to Operation Allied Force. Burden-sharing in NATO is explicitly based on the ability-to-pay concept, so it is expected that nations with a higher GDP will contribute more. Therefore, while Figure 5.3 clearly indicates that nations with larger GDPs contributed more aircraft than those nations with smaller GDP, this analysis does not necessarily indicate exploitation.

Exploitation does not occur simply because a wealthier nation contributes more. The question is whether the additional contributions are proportional to the change in GDP. While Figure 5.3 indicates that aircraft contributions rise with GDP, I need to correct contributions for GDP. The basic expectation for membership is to spend 2% of GDP on military expenses. This contribution number is calculated by dividing a nation's total military spending by its GDP. This controls for GDP and levels the playing field in terms of expected contributions. The expected number would be an even 2% across the board. My analysis will accomplish the same goal by taking each nation's aircraft contribution and dividing by its GDP. This controls for GDP and should result in a common value across the board. If burden-sharing is equal, the results would show a flat line with a Spearman's rho close to zero. Instead, I find Spearman's rho = 0.47, with Prob > |t| = 0.04. Figure 5.4 plots these results compared to the baseline expectation. The orange-colored horizontal line in Figure 5.4 represents the median value for aircraft contributions divided by GDP. Conceptionally, this line can be understood to be the rough equivalent of the "2%" line in ME/GDP calculations that are common in the literature on NATO burden-sharing.

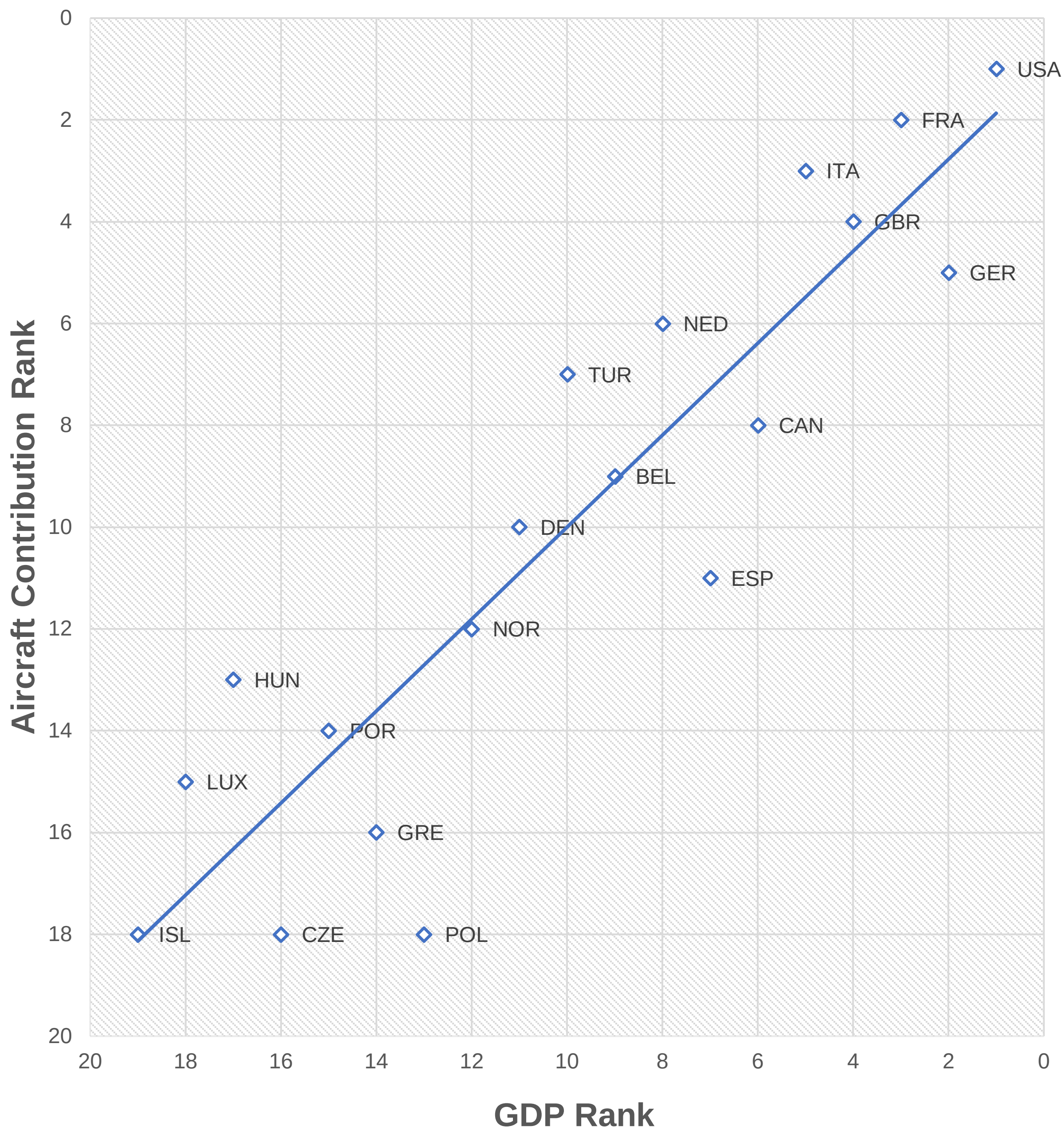

Figure 5.3: Aircraft Contributions to OAF Compared to GDP (Rankings)

Spearman's rho = 0.91
Prob > |t| = 0.00

As discussed earlier, with equitable burden-sharing, the trendline in Figure 5.4 should be near level with Spearman's rho close to zero, showing no relationship between aircraft contributions corrected for GDP and GDP rankings. However, this analysis produces a positive Spearman's rho with a probability factor less than 0.05. This indicates that there is a relationship between a member's GDP and its aircraft contributions to Operation Allied Force even when corrected for GDP. The relationship is positive, indicating that the richer nations are contributing disproportionately more aircraft than the poorer ones. Additionally, most over-contributors are clumped to the right side of the graph. While there are obviously some exceptions, this is the basic relationship that the Spearman's calculations reveal.

Figure 5.4 shows which nations are overcontributing or undercontributing based on their position relative to the orange line. For example, Turkey is the largest over-contributor followed by the United States and Hungary. Canada seems to fall right at expectations while Germany and Spain fall below the median GDP adjusted aircraft contribution. The other important finding to acknowledge from Figure 5.4 is that the nations that contributed above the line tend to be clumped to the right side of the chart where the highest GDPs are located. Again, this indicates support for the exploitation hypothesis.

Figure 5.4 gives insight into possible exploitation during the Kosovo Operations. Using the comparison between each member's GDP and the aircraft contribution corrected for GDP, Spearman's rho is 0.47 with a prob-value of 0.04.

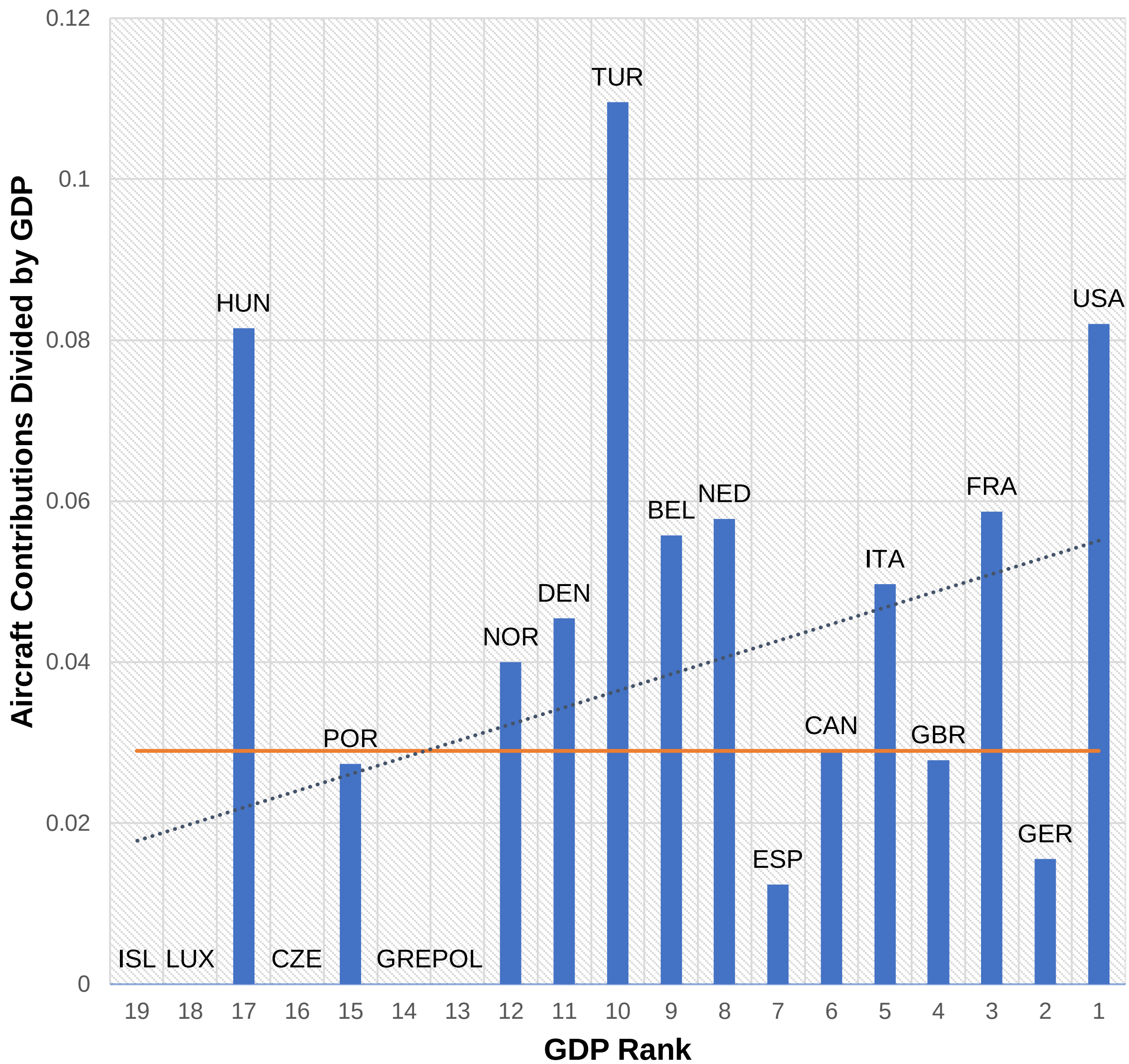

Figure 5.4: Aircraft Contributions to OAF Adjusted for GDP

Note: The horizontal line represents the median aircraft contribution divided by GDP

Spearman's rho = 0.47
Prob > |t| = 0.04

Based on this result, I can reject the null hypothesis with sufficient confidence and conclude that there is a positive association between allies' GDP and their contribution of aircraft to military operations.

This indicates that for the first model, incorporating a simple count of the number of aircraft contributed by each nation, exploitation of the richer countries by the poorer countries is likely to be occurring. This is an important finding because it is based on the generous assumption that every airplane contribution has equal value. This first model is the most stringent test of my argument that a significant capabilities gap in NATO has resulted in uneven burden-sharing. This first model treats all aircraft contributions as equal and does not account for the differences between an outdated, less capable aircraft and an aircraft with more advanced technology. Basing contribution measurement on simple numbers of aircraft (regardless of type) gives the most conservative picture of burden-sharing because it treats each aircraft as an equally valuable contribution regardless of its capabilities or the number of combat sorties it flies. This first model gives the same contribution value to an outdated aircraft like the Panavia Tornado as that of a B-2 Spirit. Not only are the costs of the two aircraft wildly disparate, but so are their capabilities. During the difficult weather conditions and member's aversion to collateral damage, it would be reasonable to conclude that a single B-2 flying daily missions provided more effects against the enemy than dozens of Tornadoes that lacked both precision strike and all-weather capability and were grounded.

Even if I exclude these considerations, I find that exploitation is occurring in NATO and that burden-sharing is uneven. The richer members bore a disproportionate level of costs in terms of aircraft contributions to Operation Allied Force.

The analysis shown in the first model indicates that exploitation is likely occurring, and burden-sharing is indeed unbalanced to some extent. However, it does not test for caveats by nations that force their aircraft to sit on the ground or avoid risky combat sorties while other members accept the burdens of actual combat. It also fails to account for obsolete aircraft grounded by bad weather. It only accounts for the number of aircraft contributed. Since this conservative first model indicates some exploitation, it is likely that the remaining models will indicate this exploitation even more strongly

The next model examines sortie contributions. Tallying the sorties flown will give an even more revealing examination of meaningful contributions than simply counting airplanes sitting on the ramp.

Model 2: Sortie Contributions

The official total NATO count for Operation Allied Force is just over 38,000 sorties. Of these, the U.S. flew 30,018 sorties, including thousands of heavy airlift flights globally. As introduced earlier, Table 5.1 breaks down sortie contributions by each member. However, due to classification or other issues, some nations have not allowed the release of sortie numbers. While this factor presents a potential difficulty in analysis, it can be overcome effectively. The process to mitigate the missing data and calculate these estimates is relatively straightforward. First, members who are known to have contributed zero aircraft obviously could not contribute sorties, so I have listed them as confirmed with zero sorties. The second factor mitigating the classification issue is that the nations with missing data represent an exceedingly small portion of the sorties flown – less than 2%. Starting with NATO's officially released sortie count of 38,018, I can positively account for 37,351 of them. This leaves only 667 sorties unaccounted for. Most importantly, since the statistical analysis will be based on sortie rankings rather than sortie numbers, reasonably accurate estimates are likely to preserve accurate rankings even if the numbers are slightly different than their true value.

Based on the data in Table 5.1, the six major contributors combined flew 37,351 of the 38,004 sorties. This means that Belgium, Canada, Denmark, Norway, Hungary, Spain, Turkey, and the NATO AWACS aircraft flew only 667 sorties total, indicating a contribution of less than 2% combined. In other words, their sortie contributions are dwarfed by the "big six" who flew more than fifty times as many sorties. While the number of members with missing data is large, their total sortie contribution is small.

To work around these classification and missing data issues, I estimated sortie contributions based on the number of aircraft these nations deployed. I assumed that each of these nations flew in proportion to the number of deployed aircraft and distributed the sorties accordingly. While these estimates cannot give an exact determination of sortie contributions, they may help to provide additional insight.

Before moving to the statistical analysis, I also need to distribute the sorties flown by the jointly owned NATO AWACS to the appropriate contributing nation. Using the estimated number of sorties (76), each of the thirteen nations who contributed to the acquisition of the AWACS aircraft will be given a proportional share of the sorties flown by these aircraft. The proportion is based on the fractional ownership illustrated in Table 5.3. These estimates are added to the confirmed totals and included in Table 5.5. Members with an asterisk by their sortie count indicate estimated numbers for these cases. Table 5.5 gives my best estimate for the total number of sorties flown by each nation during Operation Allied Force.

The assumptions used to construct Table 5.5 are reasonable for three reasons. First, they are conservative relative to the underlying theory. My basic argument is that certain critical technologies should result in more demand (and more sorties) for the most expensive and complex aircraft. By assuming that the sortie count is spread evenly across all aircraft contributed by these nations, I am making it more difficult to prove this argument, not easier.

Second, as mentioned earlier, the statistical model I am using is based off *ranks* rather than actual *values*. Minor variations in the number of sorties estimated versus sorties actually flown are unlikely to change the ranking between two nations. Finally, as shown in Table 5.1, more than 98% of the sortie counts are known. The assumptions required to build Table 5.5 involve only 1.8% of the data and are unlikely to change any findings.

Table 5.5: Sortie Contributions to Operation Allied Force (*With Estimates)

NATO Member	Sorties	Percent
Belgium	108.2*	0.3%
Canada	144.1*	0.4%
Czech Republic	0	0.0%
Denmark	62*	0.2%
France	2,414	6.3%
Germany	659.3	1.7%
Greece	0.5	0.0%
Hungary	30*	0.1%
Iceland	0	0.0%
Italy	1,085.2	2.9%
Luxembourg	0.1	0.0%
Netherlands	1,254.5	3.3%
Norway	46.4*	0.1%
Poland	0	0.0%
Portugal	0.1	0.0%
Spain	53.4*	0.1%
Turkey	160*	0.4%
United Kingdom	1,950.8	5.1%
United States	30,050	79.0%
Total	**38,018.6**	**99.8%**

Data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001). Sortie numbers with an asterisk indicate estimates. Note: Percentages and sorties are rounded to the nearest tenth, so the numbers do not add exactly to 100% or 38,004 sorties

To help assess the possibility that these assumptions might skew the results, I will do the analysis both ways, first by using projected sortie numbers proportional to the number of aircraft contributed, then by excluding the missing nations and only using the confirmed data. If the findings are similar, then I can be more confident that the estimates did not skew the results.

Table 5.6 includes the estimated data that will be used to introduce Figure 5.5 and provide context for the Spearman calculations. Table 5.6 reveals the overall nature of U.S. sortie contributions relative to the other members. Of the 36,333 sorties flown, the U.S. flew 30,018, or roughly four times all other members combined. This provides an interesting comparison to the aircraft contribution numbers plotted in the first model.

As I showed in Model 1, America supplied 731 of the 1058 aircraft, or slightly more than two times the number of aircraft of all other members combined. To illuminate the relative implication of these two models, note that the U.S. contributed 69% of the aircraft, but those aircraft flew a disproportionately larger share of the sorties at nearly 80%. This is an important result in the context of burden-sharing and can indicate two clear possibilities.

The first possibility is that the United States was more inclined to let their pilots fly in combat, indicating a stronger willingness to contribute. While other nations wanted to appear to contribute by providing airplanes, they shirked their responsibility to fly those planes in combat.

Table 5.6: GDP and Sortie Contributions to Operation Allied Force
(With Estimates)

Member	GDP($B) (1999)	GDP Rank	SOR (est.)	SOR Rank	SOR/GDP (est.)	SOR/GDP Rank
Belgium	251.1	**9**	108.2	**9**	0.4309	**8**
Canada	621.0	**6**	144.1	**8**	0.2320	**12**
Czech Republic	53.4	**16**	0.0	**18**	0.0000	**18**
Denmark	176.1	**11**	62.0	**10**	0.3521	**9**
France	1431.0	**3**	2414.0	**2**	1.6869	**3**
Germany	2123.9	**2**	659.3	**6**	0.3104	**10**
Greece	124.7	**14**	0.5	**14**	0.0040	**15**
Hungary	49.1	**17**	30.0	**13**	0.6110	**7**
Iceland	9.0	**19**	0.0	**18**	0.0000	**18**
Italy	1167.8	**5**	1085.2	**5**	0.9293	**5**
Luxembourg	16.9	**18**	0.1	**15.5**	0.0059	**14**
Netherlands	380.6	**8**	1254.5	**4**	3.2961	**2**
Norway	150.0	**12**	46.4	**12**	0.3093	**11**
Poland	143.9	**13**	0.0	**18**	0.0000	**18**
Portugal	109.6	**15**	0.1	**15.5**	0.0009	**16**
Spain	566.0	**7**	53.4	**11**	0.0943	**13**
Turkey	191.7	**10**	160.0	**7**	0.8346	**6**
UK	1400.9	**4**	1950.8	**3**	1.3925	**4**
US	8910.0	**1**	30050.0	**1**	3.3726	**1**

GDP Data are from DOD (2000b), Iceland GDP is from World Bank (2019). Sortie contribution data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001). Note: Greece, Luxembourg, and Portugal did not contribute sorties individually, but gained shares due to their contribution to the NATO AWACS program

These members chose not to put their aircraft or pilots at risk; perhaps they were afraid of domestic political repercussions if their aircraft caused civilian casualties. The second possible explanation for excess sorties is that only the U.S possessed certain aircraft that were mission critical. Due to bad weather, some aircraft lacking certain technology were grounded, while others were able to fly. This explanation would provide support to the capabilities gap argument. This result is likely to be due to a combination of these two possible explanations. Some members supplied outdated aircraft that were more likely to cause civilian casualties while also putting their pilots more at risk.

To provide additional help in visualizing the data, Figure 5.5 plots the relationship between sorties and GDP relative to the median. As discussed earlier, the orange line can be roughly thought of as the conceptional equivalent of the 2% ME/GDP contribution number. With perfectly even burden-sharing, all members would be on the line regardless of GDP. Instead, there is a large deviation and a positively sloped trendline with most of the over-contributors falling towards the right side of the graph indicating larger GDPs. The Spearman calculations produce a rho of 0.70 (0.00), again indicating a positive relationship between sortie contributions divided by GDP (SOR/GDP) and GDP. This suggests exploitation of the wealthier members by the poorer ones. It is important to compare the results from this calculation with those from Figure 5.4, which was based on aircraft contributions. In that case, I found a Spearman's rho of 0.47 (0.04) compared to this stronger relationship (0.70) based on the sorties flown by those aircraft. In other words, wealthier members disproportionately

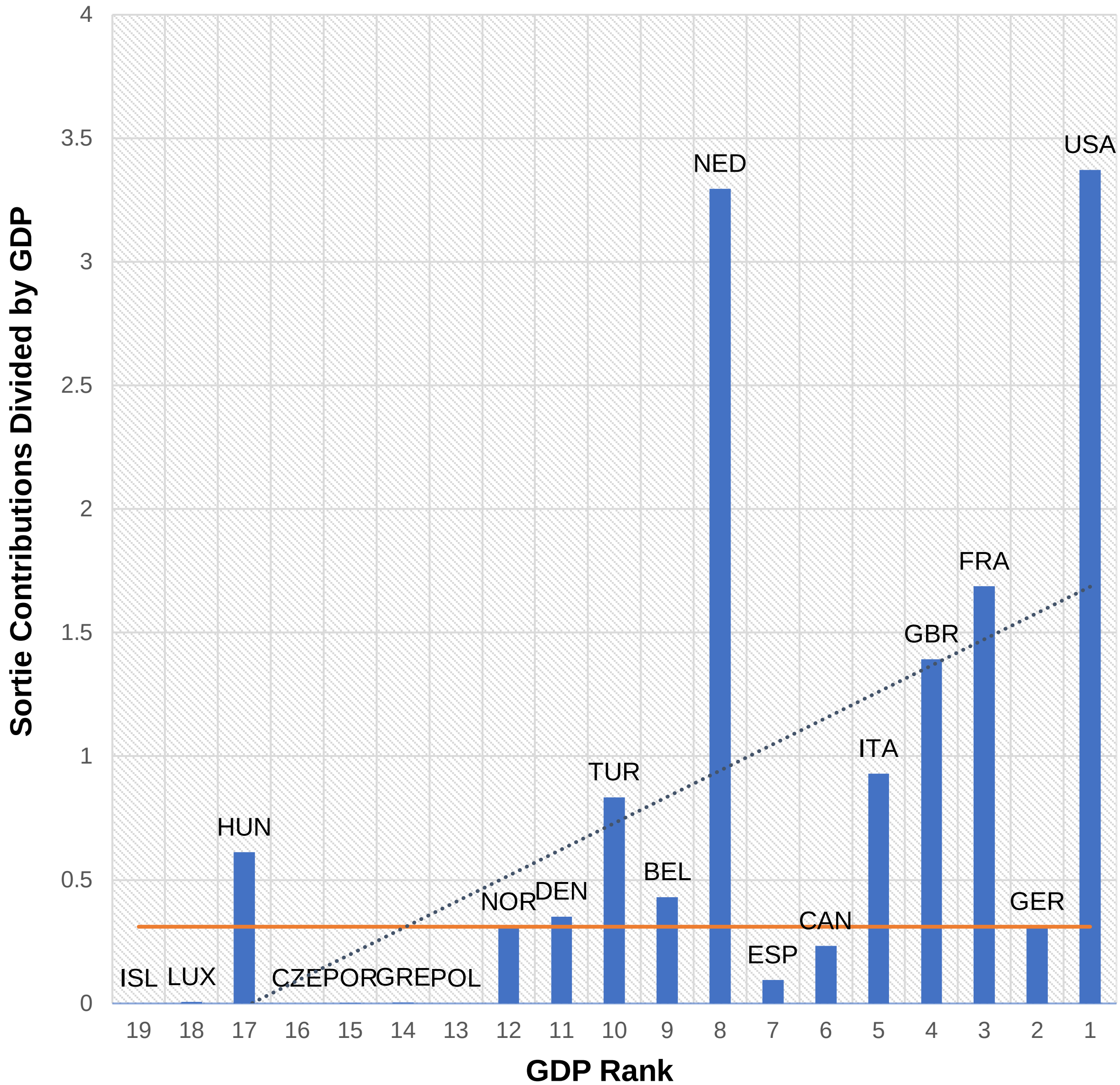

Figure 5.5: Sortie Contributions to OAF Adjusted for GDP

Notes: The horizontal line represents the median sortie contribution divided by GDP.

Spearman's rho = 0.70
Prob > |t| = 0.00

contributed aircraft at a moderate level, but disproportionally flew sorties at a much higher level. As a reminder, the estimated numbers used in this calculation are based on the following assumption: each member flew a proportion of the remaining sorties that is directly proportional to the number of aircraft that they contributed. Since these members contributed aircraft with roughly similar capabilities, the assumption is reasonable that they would fly a proportional number of sorties. Additionally, an advantage of the Spearman rank correlation test is that only the ranking is used. Even if there is some error in estimating the exact number of sorties flown, it is likely that the relative ranks would be accurate. However, to check for any differences, I will perform the same calculation again using only the confirmed sortie numbers. Those members with missing data will be excluded.

The sortie and GDP rankings to be used for the confirmed sortie calculations are shown in Table A.4. Using this data, I performed the statistical analysis for this model. The results are shown in Figure A.3. Excluding estimates for the missing members gives results like those found in Figure 5.5, except that the relationship is even stronger. Spearman's rho increases from 0.70 to 0.82 while keeping the prob factor close to zero. With a Spearman's coefficient of 0.82 and a very low probability-factor, I can reject the null hypothesis with a satisfactory confidence level. This leads to the conclusion that exploitation is likely occurring based on sortie contributions to Operation Allied Force whether I use the estimated sortie data or not.

Comparing Figure 5.4 with Figure 5.5 points to the fact that some of the aircraft contributed flew a disproportionately high number of sorties. Wealthier members not only contributed disproportionally more aircraft, but they flew disproportionately more sorties. This finding is notable because it lends support to the argument that some aircraft contributions were lacking critical technology, or some members were reluctant to let their pilots fly dangerous combat sorties. Exploitation of the wealthier nations is likely occurring based on sortie counts.

Examining Figure 5.5 provides some additional interesting findings. These numbers are corrected for GDP, so balanced burden-sharing would result in all members being close to the horizontal line. Instead, there is a lot of deviation above and below the line, including some surprising results. Note the relative contributions of the Netherlands, Turkey, and Hungary. Figure 5.4 (aircraft contributions) shows Turkey and Hungary as extreme over-contributors along with the U.S., while the Dutch are closer to the median line. However, based on sorties, both Turkey and Hungary drop closer to the median while the Dutch nearly match the United States in overcontribution. This important finding indicates that the Dutch were willing and able to fly combat sorties, while Turkey and Hungary flew relatively fewer sorties. In other words, their planes sat on the ramp while the Dutch were flying. Looking more specifically at the numbers to directly compare the Netherlands and Turkey gives an interesting result. The Dutch contributed 22.3 aircraft (including NATO AWACS) and Turkey contributed 21.1. The Royal Netherlands Air Force flew 1,255 sorties with their aircraft while Turkey flew just 160. This means that the Netherlands flew 7.4 times as many sorties per aircraft than Turkey did. Since they both contributed similar F-16's, it is possible that the Dutch had more desire to contribute than Turkey did. Another interesting takeaway from Figure 5.5 is that Germany is right on the GDP corrected median line, in contrast to Figure 5.4 where they were slightly below the line based on aircraft contributions. This reveals that Germany flew proportionally more sorties with their aircraft than expected.

While total sortie numbers can give a deeper look into meaningful contributions than simple aircraft numbers, this measurement still treats all sorties as equal. As discussed previously, all sorties are not equal. An older aircraft lacking critical technology flying ten sorties will not have as large of an impact as a more advanced aircraft will. Even more significantly, a sortie flown by a 1960's technology fighter cannot be reasonably compared to a sortie flown by a large complex support aircraft like the B-2 or KC-10.

The subsequent models address this concern by specifically focusing on the more expensive support aircraft.

Model 3 Support Aircraft Contributions

The next two models will parallel the analysis in the previous two with the exception that these will focus exclusively on the more complex and expensive support aircraft. An important part of my argument is that a significant capabilities gap exists which drives uneven burden-sharing. Some of the critical combat capabilities needed during an air operation are only affordable by the wealthier members. Models 3 and 4 will focus on support aircraft and sortie contributions, respectively.

Table A.3 provides a breakdown of member contributions by aircraft category. Because so few nations contributed the more expensive and complex support aircraft (The U.S. was the only nation to provide heavy bombers for example), I have consolidated support aircraft contributions of all aircraft types into Table A.4. Only seven of the 19 members contributed support aircraft on their own. However, the ten NATO AWACS aircraft contributed jointly need to be factored in. The rationale for the NATO AWACS program was to allow smaller nations to contribute fractionally towards these expensive support aircraft according to their own resources. This program allowed 15 NATO members to contribute to the support aircraft category even if some contributions were small. For example, Greece gained a contribution share of 0.07 aircraft while Luxembourg and Portugal gained 0.09 and 0.01 aircraft shares, respectively. While some of these numbers remain small, it is important to include these fractional AWACS contributions to see if this program succeeds in mitigating uneven burden-sharing. Before I can accurately calculate the rankings, these NATO AWACS contribution shares need to be added in. Using the acquisition share data from Table 5.3 gives the totals compiled in Table 5.8.

Without adjusting contributions for GDP, Figure A.4 shows how strong the basic relationship is between support aircraft contributions and GDP. Because the U.S. remains a such a significant outlier (as shown in Figure A.4), Figure A.5 plots the data excluding the United States. This shows that Great Britain, France, and Germany are distinguished from the lesser powers while the Netherlands, Italy, Canada, and Spain seem closer to the minor powers which are lumped indistinguishably at the lower left of the chart.

Table 5.7:Support Aircraft Contributions to OAF
(with NATO AWACS Shares)

NATO Member	Individual Support Aircraft	Individual Percent	Support Aircraft w/AWACS
Belgium	0	0.0%	0.3
Canada	0	0.0%	1.0
Czech Republic	0	0.0%	0.0
Denmark	0	0.0%	0.2
France	5	1.5%	5.0
Germany	1	0.3%	4.1
Greece	0	0.0%	0.1
Hungary	0	0.0%	0.0
Iceland	0	0.0%	0.0
Italy	1	0.3%	1.6
Luxembourg	0	0.0%	0.1
Netherlands	2	0.6%	2.3
Norway	0	0.0%	0.1
Poland	0	0.0%	0.0
Portugal	0	0.0%	0.0
Spain	1	0.3%	1.0
Turkey	0	0.0%	0.1
United Kingdom	9	2.7%	9.1
United States	303	91.3%	307.2
Total	322	97%	332.1

Data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).. Individual percent contributions total 97% due to the exclusion of the 3% of aircraft jointly contributed by the NATO AWACS program.

The next graph, Figure A.6 plots the same data as rankings to eliminate the effects of outliers. There is a very strong relationship between GDP and the number of support aircraft contributed. The results are interesting, but keep in mind that this relationship does not necessarily indicate exploitation. NATO burden-sharing agreements are based on the ability to pay concept and contributions are expected to increase with GDP. I need to correct contributions for GDP to test for possible exploitation. After correcting the rankings for GDP and performing the Spearman calculations, I plotted the data as shown in Figure 5.6.

Even when the smaller nations are given full credit for their contributions to the NATO AWACS program, I come up with a Spearman’s coefficient of 0.73 and a probability value of 0.00. This is true despite the fact they this calculation is corrected for GDP.

This indicates the exploitation is likely occurring when it comes to the contribution of support aircraft to Operation Allied Force. It is important to note the comparison with the findings in Figure 5.4 which examined only the total numbers of aircraft contributed. That comparison revealed a Spearman's rho of 0.47 and a prob factor of 0.04. The expensive and complex support aircraft are being supplied even more disproportionately by the wealthier nations.

Table 5.8: GDP and Support Aircraft Contributions to OAF

Member	GDP($B) (1999)	GDP Rank	S-AIR	S-AIR Rank	S-AIR/GDP	S-AIR/GDP Rank
Belgium	251.1	**9**	0.3	**9**	0.0011	**10**
Canada	621.0	**6**	1.0	**8**	0.0016	**8**
Czech Republic	53.4	**16**	0.0	**17.5**	0.0000	**17.5**
Denmark	176.1	**11**	0.2	**10**	0.0009	**11**
France	1431.0	**3**	5.0	**3**	0.0035	**5**
Germany	2123.9	**2**	4.1	**4**	0.0019	**6**
Greece	124.7	**14**	0.1	**14**	0.0005	**13**
Hungary	49.1	**17**	0.0	**17.5**	0.0000	**17.5**
Iceland	9.0	**19**	0.0	**17.5**	0.0000	**17.5**
Italy	1167.8	**5**	1.6	**6**	0.0013	**9**
Luxembourg	16.9	**18**	0.1	**12**	0.0053	**4**
Netherlands	380.6	**8**	2.3	**5**	0.0061	**3**
Norway	150.0	**12**	0.1	**11**	0.0009	**12**
Poland	143.9	**13**	0.0	**17.5**	0.0000	**17.5**
Portugal	109.6	**15**	0.0	**15**	0.0001	**15**
Spain	566.0	**7**	1.0	**7**	0.0018	**7**
Turkey	191.7	**10**	0.1	**13**	0.0004	**14**
UK	1400.9	**4**	9.1	**2**	0.0065	**2**
US	8910.0	**1**	307.2	**1**	0.0345	**1**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019) Aircraft contribution data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

The findings from Model 3 point directly to my argument that a capabilities gap is leading to uneven burden-sharing in the alliance. Just like the nuclear umbrella provided by the United States during the early days of NATO, critical capabilities are primarily being provided by the wealthier nations. Next, I will investigate how these support aircraft were flown during Operation Allied Force.

Model 4 Support Sortie Contributions

With a deeper understanding of the number of support aircraft devoted to Operation Allied Force, I will next examine the sorties flown by these aircraft. As discussed in Model 1, not all aircraft have equal capabilities and may not be able to fly during some operations.

I need to determine if some of the support aircraft flew more sorties than others. Table 5.7 shows that a total of 324 support aircraft were deployed for Operation Allied Force. Combined, these aircraft flew 20,906 sorties, or an average of just over 64 sorties per aircraft.

One of the most critical types of these support aircraft is the airborne tanker. High speed fighters and strike aircraft burn fuel extremely rapidly and require frequent refueling. In some cases, fighters will launch and then head straight to a tanker for refueling before flying their mission. After striking their target or finishing a patrol, they might refuel again before returning home. During some portions of the operation, air refueling aircraft were airborne 24 hours per day.

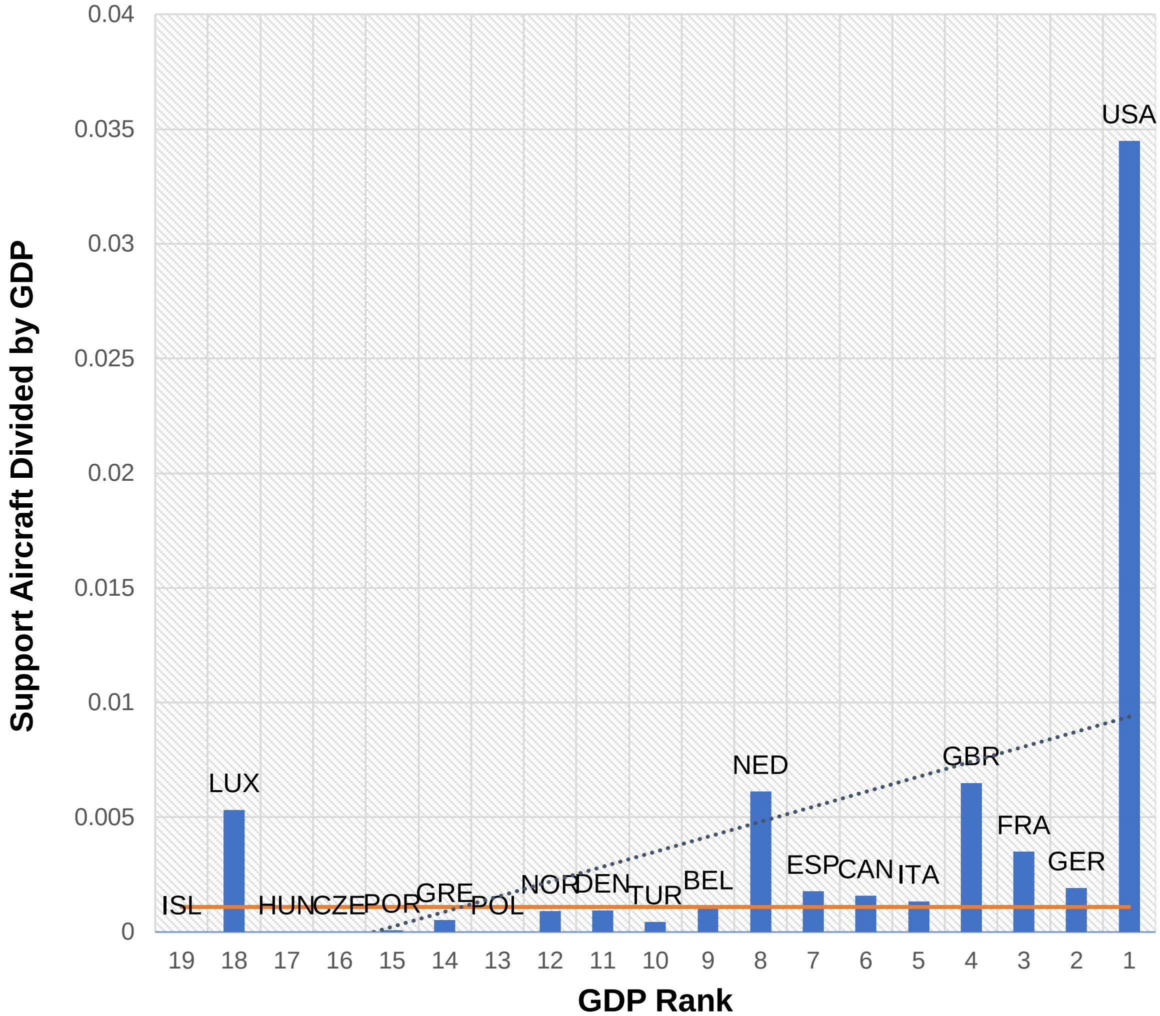

Figure 5.6: Support Aircraft Contributions to OAF Adjusted for GDP

Note: The horizontal line represents the median support aircraft contribution divided by GDP

Spearman's rho = 0.73
Prob > |t| = 0.00

Airborne tanker support required 7,855 sorties during Operation Allied Force, with the United States providing 6,959 or roughly 89% of these sorties. Since the United States was the only contributor of Heavy Bombers, they clearly flew all the heavy bomber sorties with a total of 322 in this category. One note of interest from Table 5.10 is that the United States flew zero Airborne Early Warning System (AWACS) sorties. Although the USAF has 32 of these aircraft, it appears that they chose to let the NATO AWACS take the lead in this category (Keep in mind that the U.S. contribution factor to the NATO AWACS program is over 40%).

Even with the U.S. AWACS aircraft left out, the United States still flew 19,595 of the 20,906 support sorties, which equates to nearly 94%. The basic numbers in Table 5.10 give initial support to my argument that the capabilities gap in NATO results in uneven burden-sharing – especially in this category. Only the United States had the capability to provide all types of these sorties.

To test the data in Table 5.9, I need to calculate rankings and correct for GDP. This data is tabulated in Table 5.10. These are the numbers that will be used in the Spearman calculations. The first step is to plot the relationship between Support sortie rankings and GDP rankings. The results are shown in Figure A.6.

Table 5.9: Support Sortie Contributions to Operation Allied Force

NATO Member	Air Refueling	Heavy Bomber	Airlift	AEW	Electronic Intel	Spec Ops	Total
Belgium	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0
Czech Republic	0	0	0	0	0	0	0
Denmark	0	0	0	0	0	0	0
France	389	0	0	49	71	0	509
Germany	0	0	0	0	17	0	17
Greece	0	0	0	0	0	0	0
Hungary	0	0	0	0	0	0	0
Iceland	0	0	0	0	0	0	0
Italy	90	0	0	0	1	0	91
Luxembourg	0	0	0	0	0	0	0
Netherlands	126	0	0	0	0	0	126
Norway	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0
Portugal	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0
Turkey	0	0	0	0	0	0	0
UK	291	0	0	163	38	0	492
NATO AWACS	0	0	0	76	0	0	76
US	6959	322	11480	0	0	834	19595
Total	7855	322	11480	288	127	834	20906

Data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

The relationship between support sorties and GDP is even stronger than the relationship between GDP and support aircraft. Dividing the support sortie contributions by GDP and performing the Spearman's calculations results in Figures 5.7 and A.7. The results illustrate the strongest evidence of unbalanced burden-sharing yet. With a Spearman's rho of 0.80 and a prob factor of 0.00, there is a very strong relationship between the number of support sorties corrected for GDP and each member's GDP. While Figure 5.6 shows some activity from Spain, Canada, Italy, and Germany, Figure 5.7 obscures most members along the bottom of the Y-Axis except for the Netherlands, the UK, France, and the United States. Because the U.S. skews the data, I will replot the same data without the U.S. to more clearly convey where the other members fall along the line. The results are shown in Figure 5.8. It is important to compare this figure with the analysis of support aircraft presented in Figure 5.6. The relationship based on the number of support aircraft was strong with Spearman's rho of 0.73 (Prob > |t| = 0.00). However, comparing the number of sorties flown shows a significant increase in the strength of the relationship from 0.73 to 0.80. This finding confirms the capabilities gap.

When we compare the total sorties contributed (Figure 5.5) with the support sorties, we can see the impact of the capabilities gap. If a member was able and willing to contribute total sorties at a certain level, but the contribution percentage decreased when we only count support sorties, then we can exclude shirking and conclude that the drop was due to the capabilities gap.

Table 5.10: GDP and Support Sortie Contributions to OAF

Member	GDP($B) (1999)	GDP Rank	S-SOR	S-SOR Rank	S-SOR/ GDP	S-SOR/GDP Rank
Belgium	251.1	**9**	2.1	**8**	0.0084	**8**
Canada	621.0	**6**	7.4	**7**	0.0119	**7**
Czech Republic	53.4	**16**	0	**17**	0.0000	**17**
Denmark	176.1	**11**	1.3	**9**	0.0074	**9**
France	1431.0	**3**	509	**2**	0.3557	**2**
Germany	2123.9	**2**	40.3	**6**	0.0190	**6**
Greece	124.7	**14**	0.5	**12**	0.0040	**12**
Hungary	49.1	**17**	0	**17**	0.0000	**17**
Iceland	9	**19**	0	**17**	0.0000	**17**
Italy	1167.8	**5**	95.2	**5**	0.0815	**5**
Luxembourg	16.9	**18**	0.1	**13.5**	0.0059	**11**
Netherlands	380.6	**8**	128.5	**4**	0.3376	**4**
Norway	150.0	**12**	1	**10**	0.0067	**10**
Poland	143.9	**13**	0	**17**	0.0000	**17**
Portugal	109.6	**15**	0.1	**13.5**	0.0009	**14**
Spain	566.0	**7**	0	**17**	0.0000	**17**
Turkey	191.7	**10**	0.6	**11**	0.0031	**13**
UK	1400.9	**4**	492.8	**3**	0.3518	**3**
US	8910.0	**1**	19627	**1**	2.2028	**1**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Sortie contribution data are compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

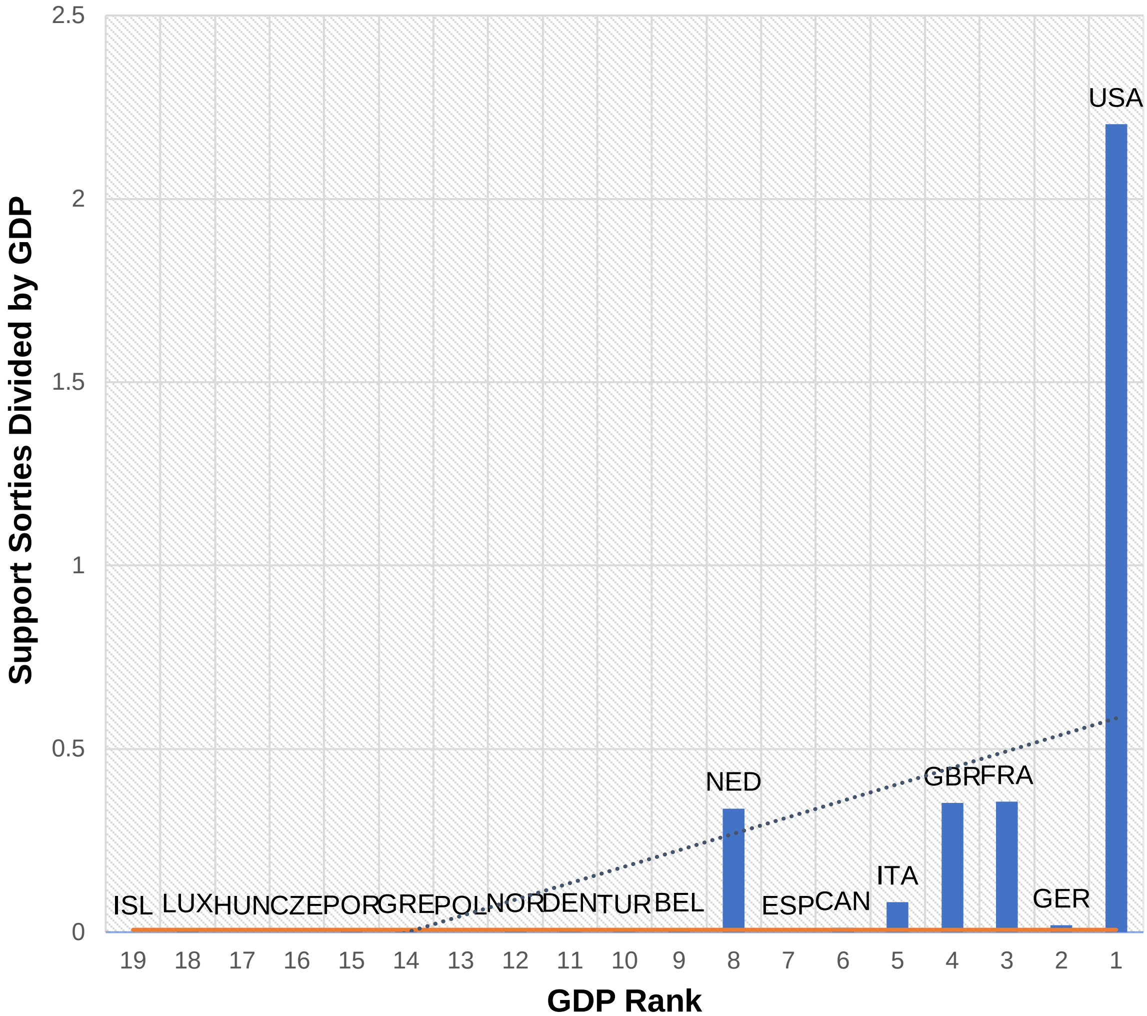

Figure 5.7: Support Sortie Contributions to OAF Adjusted for GDP

Note: The horizontal line at the bottom of the graph represents the median support sortie contribution divided by GDP

Spearman’s rho = 0.80
Prob > |t| = 0.00

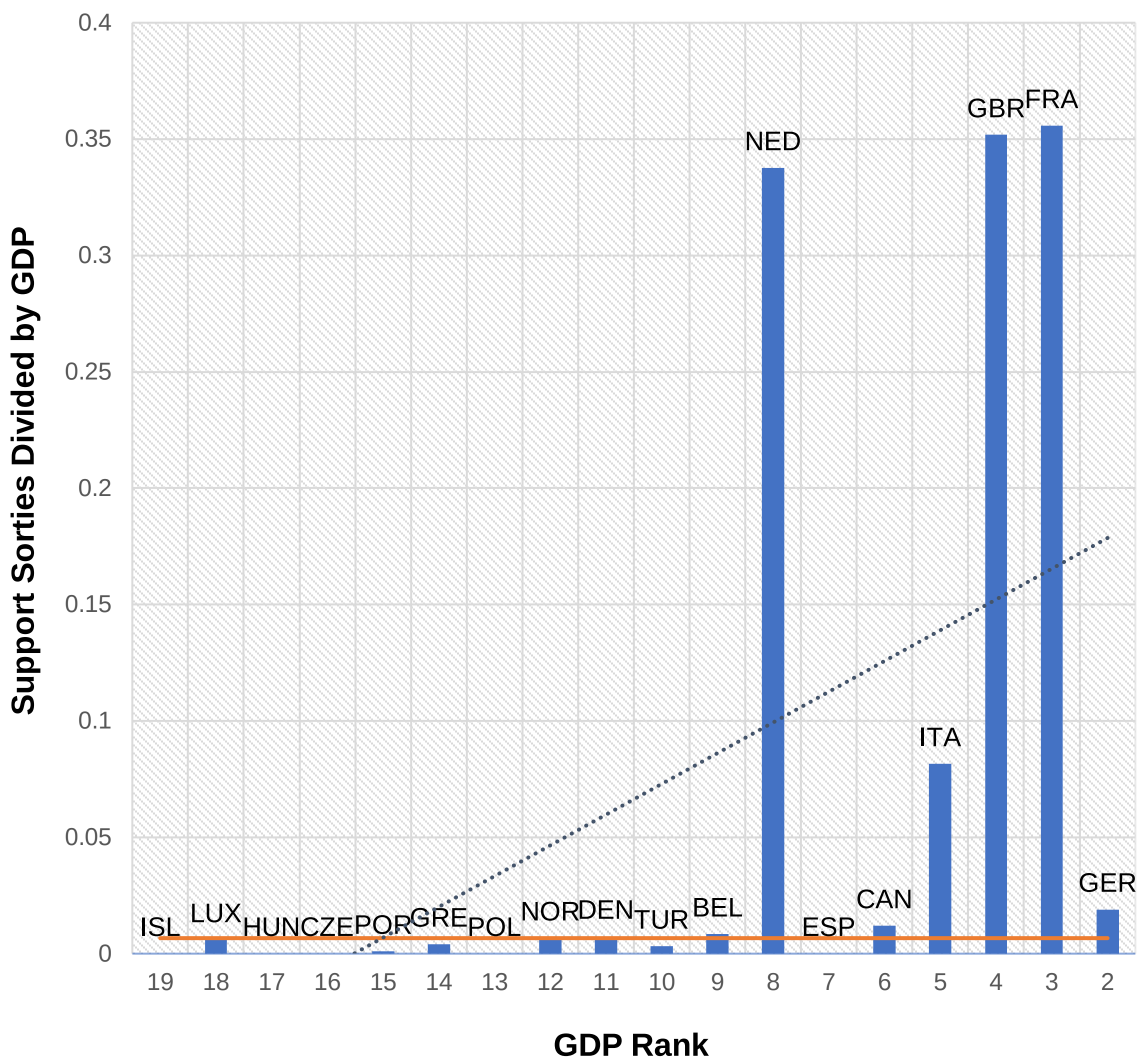

Figure 5.8: Support Sortie Contributions to OAF Adjusted for GDP (Excluding U.S.)

Note: The horizontal line at the bottom of the graph represents the median sortie contribution divided by GDP

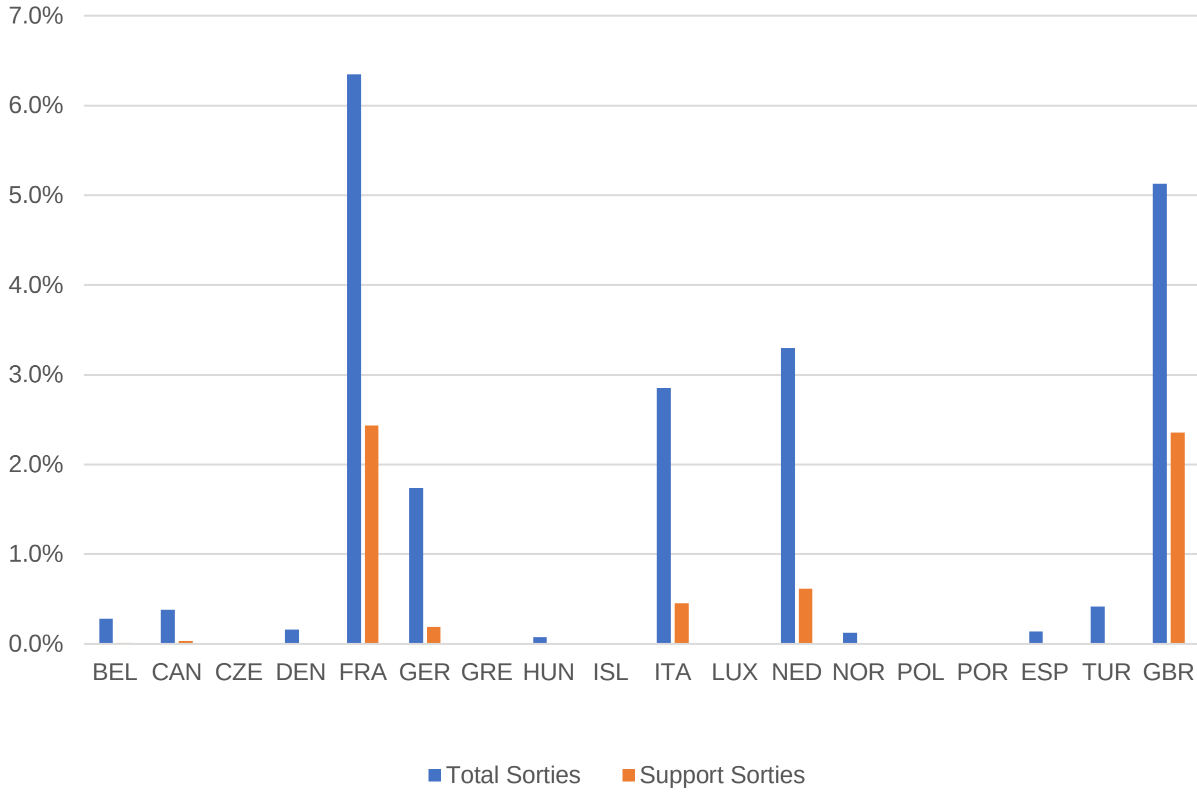

Figure 5.9: OAF Total and Support Sortie Contributions (Excluding U.S.)

Note: The U.S. contribution increased from 79.0% to 93.9%

Another way to interpret this finding is to say that Figure 5.5 indicates what a member was willing to contribute, but Figure 5.7 indicates what they were able to contribute. If a member was simply shirking, then the contribution would remain roughly the same across the two categories. This would hold for both contributors and free riders. Instead, we see decreased contributions from all members except the United

States as shown in Figure 5.9. Contribution levels dropped because these members lacked the capabilities.

The last examination of contributions to Operation Allied Force is based on the number of munitions expended by the members during the conflict. As discussed during the introduction of the models, this is an important number because it represents the "tip of the spear" in terms of combat contributions. To employ munitions, a nation must have both the required technological capability as well as the will to put their pilots and aircraft at risk. Although I do not have the detailed breakdown for all members, I have the combined total and the U.S. numbers.

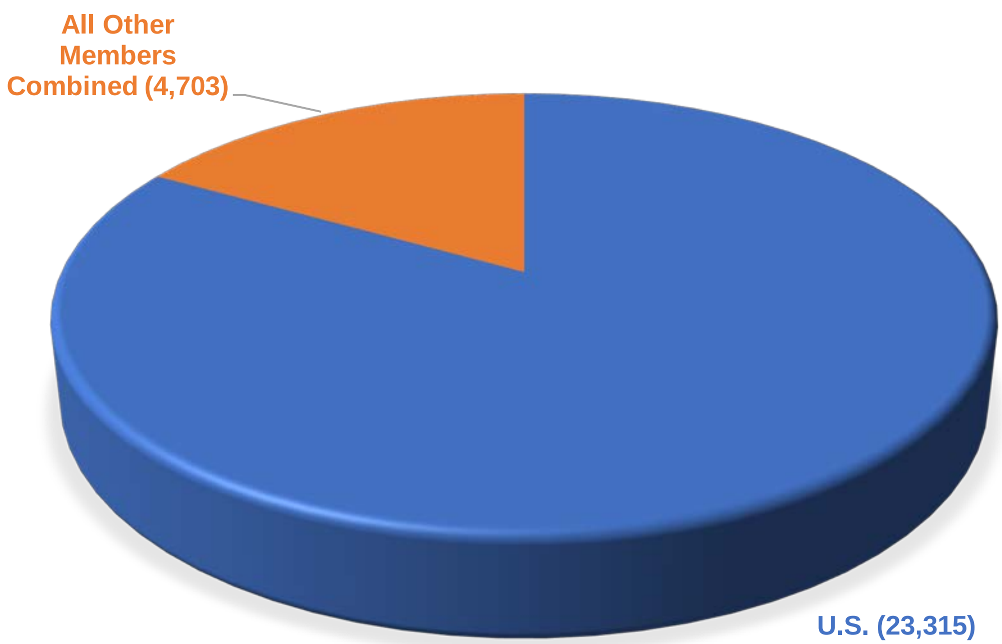

Figure 5.10: Strike Munitions Expended During Operation Allied Force

(Lambeth (2001)

A total of 28,018 munitions was expended by NATO members during the conflict. Of these, the United States employed 23,315, while the remaining members employed a total of 4,703. These numbers illustrate that the U.S. employed more than 83% of the munitions during the operation. This is likely because advanced aircraft with precision strike weapons were necessary in Operation Allied Force. Many other NATO members were simply not able to execute these strike missions. These numbers are plotted for visual comparison in Figure 5.10.

For context, it is worth reviewing the aircraft and sortie contribution numbers. During Operation Allied Force, the United States contributed 69.1% percent of all aircraft and 79.0% percent of all sorties. As previously discussed, the fact that the U.S. flew a disproportionately higher number of sorties with the aircraft it contributed leads support to the argument that the U.S. had exclusive capabilities that were required during the conflict. The fact that the United States employed an even higher percentage of the munitions (83%) provides even more support for this argument. With even capabilities and willingness to contribute across the NATO membership, these three numbers should be equal. The fact that they rise from 69% to 79% and 83% indicates uneven burden-sharing and a significant capabilities gap.

Operation Allied Force Summary

These first four models provide important insights regarding burden-sharing during Operation Allied Force. As the largest and most important NATO military operation in history, OAF provides a unique opportunity for a case study in burden-sharing. Members were asked not only to pay a financial cost and participate in exercises but were also asked to participate in actual combat operations. The results are enlightening. Table 5.11 summarizes Spearman's rho across all four models.

Table 5.11: Spearman Rank Correlation between Contributions and GDP for Operation Allied Force

Total Aircraft Contributions	0.47** (0.04)
Total Sortie Contributions	0.70*** (0.00)
Support Aircraft Contributions	0.73*** (0.00)
Support Sortie Contributions	0.80*** (0.00)

Notes. Numbers in parentheses are prob-values.
***significant at .01 level;**significant at .05 level

My most basic analysis (total aircraft contributions) demonstrates that wealthier nations contributed disproportionately more aircraft, but only moderately so Many of the smaller nations were able to contribute at least a few aircraft. Additionally, the NATO AWACS program helped some nations contribute expensive aircraft that they could not afford individually. If I stop here, I might conclude that burden-sharing in NATO is slightly unbalanced, with wealthier nations being exploited to a small degree by poorer nations. This confirms what previous literature has shown using analysis based on financial contributions.

However, this study, especially the last three models, revealed additional layers to the burden-sharing quandary that were not immediately apparent. The strength of the correlation between contributions and GDP progressively increased across all four models while the prob values decreased. The fact that the wealthier nations flew more sorties per aircraft than poorer members is notable. This raises the obvious question: Why did some nations contribute aircraft, but then let them sit on the ramp instead of flying? As I suggested earlier, this could indicate shirking. Maybe these members felt conflicting political pressures. As NATO members, they wanted to appear to contribute and meet their perceived obligations. They may have also felt international pressure to do their part for a good cause. Therefore, they deployed aircraft to support the operation. However, they might have felt domestic political pressure as well. Their constituency might be concerned about pilots being put at risk of death or capture. Watching service members being killed is difficult for any nation to bear. In addition, it is possible that some domestic pressure was being felt over civilian casualties and collateral damage. Either way, some nations may have decided to keep their planes on the ground to avoid risk. However, an additional explanation could have been due to the capabilities gap I discussed previously. Advanced precision-strike technology was needed due to bad weather and concerns over civilian deaths. Some aircraft could have been grounded because they could not successfully find their target when it was obscured by clouds. Perhaps their target was too close to civilians and they lacked a weapon precise enough to ensure a good hit. The analysis of munitions expended lends support to this possibility, but I cannot confirm the root cause definitively in this model. It is likely a combination of the two considerations.

With an understanding of the relationship between the numbers of aircraft contributed and the sorties flown by those aircraft, I can also make some interesting comparisons between specific members. Turkey and Germany provide a noteworthy contrast. Turkey appears to be significantly overcontributing if I only look at the number of aircraft they deployed, while Germany appears to be undercontributing. However, comparing sorties flown reveals an important change. Turkey kept their planes on the ground more often, flying fewer sorties per aircraft than other members, while Germany flew more sorties. This reveals the fact that Turkey did not actually contribute as much to the operation as it seemed initially, while Germany contributed more. Additionally, there are significant shifts for the Netherlands and the UK. Both members flew their aircraft frequently, generating more sorties and contributing more to the operation than Model 1 was able to reveal. This basic discussion is interesting, but only hints at the magnitude of the capabilities gap. To understand this more clearly, I also need to discuss the types and categories of aircraft being flown in OAF.

Contrasting the models based simply on aircraft contributions (regardless of type) with the models focused on the more expensive support aircraft gives additional insight into burden-sharing during Operation Allied Force. Some nations contributed primarily smaller, cheaper fighter aircraft, while others contributed larger, more expensive support aircraft. Many of these support aircraft are mission critical. Fighters cannot succeed without support from airborne tankers and C2 aircraft. It is obvious that smaller nations have more difficulty in purchasing these types of aircraft, so NATO implemented the joint AWACS program to alleviate this disparity. This voluntary program allows members to participate according to their ability to pay while fractionally contributing to an expensive support mission.

Despite this program, I find that burden-sharing becomes even more unbalanced when I focus on support aircraft. The signs of imbalance indicated by the first models grew stronger in the last two models focused on support aircraft exclusively. While the NATO AWACS program was meant to alleviate this concern, it did not seem to have the desired effect. First, the United States contributed more than 40% of the initial cost rather than letting the other members purchase these aircraft independently. This was the equivalent of the Americans independently providing four of the ten NATO AWACS aircraft that flew during Operation Allied Force. While this program did allow smaller members to contribute fractionally, it did not seem to alleviate uneven burden-sharing because of the over contribution to the program by the U.S. Second, these aircraft are based on 1970s technology. While there have been upgrades over the years, the basic airframe remains a product of older technology. It is possible that other support aircraft had to fill in some of the technology gaps. These findings demonstrate that the burden of providing support aircraft fell disproportionally on those members with the highest GDPs. This fact holds even when controlling the results for GDP.

When I examine the number of sorties flown by these support aircraft, I find that wealthier nations were also more likely to fly their support aircraft. While the joint AWACS program allowed some members to have meaningful aircraft contributions, the study of sorties flown reveals that burden-sharing became more uneven in this category. The plot reveals five members who stand out with significant overcontributions: Great Britain, France, Italy, the Netherlands, and the U.S. These members are all in the top half of GDP rankings for NATO members and flew the vast majority of these missions. Germany and Canada also contribute above the line, indicating that they are meeting or exceeding expectations.

The findings regarding support aircraft sorties provides strong evidence for the argument that a capabilities gap exists in NATO. The minor powers are not able to contribute and fly expensive support aircraft. The joint AWACS program helps to mitigate this fact, but not significantly. I find that wealthier members contributed disproportionately more aircraft of all types to Operation Allied Force. They also flew more sorties per aircraft than poorer nations. The fact that these disparities both grew larger when I focused on support aircraft points even more strongly to the capabilities gap argument.

This analysis lends credence to the claim that burden-sharing in NATO is uneven and a significant capabilities gap exists. The fact that the Spearman's coefficient increased as I assessed total sortie counts as well as support aircraft sortie counts is an important finding. The findings in model 2 (total sorties) supports either the political will argument or the capabilities gap. The results from model 4 (support aircraft sorties) more strongly supports the capabilities gap. If a member was willing to fly their fighters in combat, but their support aircraft sortie contribution dropped, it is likely because they lacked the required capability. Figure 5.9 illustrates this finding.

As discussed earlier, Operation Allied Force was the largest and most important operation in NATO history. However, there were two smaller operations that lead up to OAF. Operations Deny Flight and Deliberate force occurred closer to the beginning of the Kosovo conflict. The next step is to study these operations as well. While Operation Deny Flight was smaller in scale than Operation Allied Force, it still provides another important window into this discussion.

CHAPTER 6

OPERATION DENY FLIGHT

Operation Deny Flight was the first NATO air operation in the Kosovo campaign. After the collapse of Yugoslavia, violence spread rapidly across the region. With shocking brutality, opposing members perpetrated violence against civilians and civilian infrastructure. When it became apparent that ethnic cleansing was occurring at the hands of the Serbian fighters, the U.N. finally mobilized to try to stabilize the situation. When the U.N. failed to restore peace to the region, they asked NATO for assistance. Scenes of mass murder, ethnic cleansing, and systematic rape made clear to the world that a humanitarian crisis was in progress. Refugees were fleeing the violence as the region destabilized. This flow of refugees posed both a humanitarian dilemma for NATO as well as a concrete burden to neighboring countries. In response, NATO members agreed to cooperate in an air campaign supporting the United Nations.

Operation Deny Flight began on 12 April 1993 and concluded on 20 December 1995, lasting roughly 1000 days. It was intended to enforce the Peace Agreement in Bosnia-Herzegovina and achieve three primary mission goals (DOD, 1995):

1. To conduct aerial monitoring and enforce “No-Fly Zone” (NFZ) compliance
2. To provide close air support (CAS) to UN troops on the ground
3. To conduct air strikes against designated targets threatening the security of UN-declared safe areas

Nine of the 16 NATO members individually contributed a total of 231 aircraft. The intent was to prevent the warring parties from using airstrikes against each other while also protecting peacekeeping troops on the ground. NATO provided 8 jointly owned AWACS aircraft, bringing the total number of aircraft employed in Operation Deny Flight to 239. More than 79,000 combat and support sorties were flown during the operation. Individual sortie breakdowns are available by mission type but are not available by member for this operation. Because of this data constraint, I will focus on aircraft contributions as my measurement for this portion of the Kosovo case study. Aircraft contributions by each member are listed in Table 6.1. The United States contributed nearly 42% of the aircraft, while the next largest contributors, France and Great Britain provided just under 14% and 12%, respectively.

While Table 6.1 combines aircraft contributions of all types into a single total, it is also important to examine the different types and categories of these aircraft. As previously discussed regarding Operation Allied Force, Deny Flight was also heavily dependent on support aircraft for its overall success. Fortunately, I have an exact count of the types of aircraft contributed by each member. Since this was the first NATO operation in the Balkans conflict, there were far fewer aircraft involved compared with the closing operation of the war, Allied Force. Table B.1 list the aircraft contributed by each nation along with their intended roles. To assist in comparing relative technologies and capabilities, the year each aircraft was introduced is listed in the last column.

Table 6.1: Total Aircraft Contributions to Operation Deny Flight

NATO Member	Aircraft	Percent
Belgium	0	0
Canada	0	0
Denmark	0	0
France	33	13.8%
Germany	14	5.9%
Greece	0	0
Iceland	0	0
Italy	20	8.4%
Luxembourg	0	0
Netherlands	15	6.3%
Norway	2	0.8%
Portugal	0	0
Spain	11	4.6%
Turkey	8	3.3%
United Kingdom	28	11.7%
NATO AWACS	8	3.3%
United States	100	41.8%
Total	239	99.9%

Aircraft contribution data are compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001). Note: Percentages do not add to 100% due to rounding

While it is possible to upgrade the avionics of aircraft over the years, an older generation airplane will never have the capabilities of a newer one with updated engineering throughout the airframe. For example, the Mirage F-1, shown in Table B.1, first flew in 1973 cannot match the capabilities of a Mirage 2000 with a first flight in 1982. While not an exact indicator, I can use the operational dates as a rough measurement of relative capabilities.

With a list of the types of aircraft contributed, I can consolidate these by category for the statistical analysis. Table 6.2 reveals that fighter and attack aircraft were the primary contribution for all members. The United States was the key contributor in the more expensive and complex support categories shown in the last four columns. The sixth column (*Specialty)* includes Command and Control, Electronic Warfare, and Special Operations aircraft*.* The United States is the only NATO member that individually contributed aircraft in this category.

The NATO allies together flew more than 100,000 sorties during Operation Deny Flight. It is interesting that more than 21,000 of these were training sorties not directly involved with the operational mission. Unfortunately, the breakdown of sorties is not available through unclassified sources, so I am unable to show which nations chose to fly more training flights than actual combat sorties.

Table 6.2: Contributions to Operation Deny Flight by Aircraft Category

NATO Member	**Fighter Attack**	**Airlift**	**Tanker**	**AEW**	**Specialty**	**Total Support**
Belgium	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Denmark	0	0	0	0	0	0
France	30	1	1	1	0	3
Germany	14	0	0	0	0	0
Greece	0	0	0	0	0	0
Iceland	0	0	0	0	0	0
Italy	14	5	1	0	0	6
Luxembourg	0	0	0	0	0	0
Netherlands	12	3	0	0	0	3
Norway	0	2	0	0	0	2
Portugal	0	0	0	0	0	0
Spain	8	1	2	0	0	3
Turkey	8	0	0	0	0	0
United Kingdom	24	0	2	2	0	4
NATO AWACS	0	0	0	8	0	8
United States	62	0	15	0	23	38
Total	172	12	21	11	21	64

Aircraft contribution data are compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001). Note: The Specialty category includes: Command and Control, Electronic Warfare, Special Operations, Gunships, etc.

Table 6.3: Operation Deny Flight Sorties, By Mission

Mission	Sorties	Percent
No-Fly Zone	23,021	23
Strike	27,077	27
Support	29,158	29
Training	21,164	21
Total	100,420	100

DOD (1995)

With this basic outline of contributions in mind, I will move to the first model in this examination.

Model 1: Aircraft Contributions

I begin the statistical analysis of Operation Deny Flight with an examination of total aircraft contributions. While all aircraft contributed to this operation were not equal in terms of technology or capabilities, this number still provides some insight into burden-sharing. Table 6.4 lists the rankings that are used for the Spearman calculations. Note that the NATO AWACS aircraft contributions are distributed among the members using the methodology described in the previous section.

Using the data in Table 6.4, I plotted the relationship between GDP and the number of aircraft contributed to check for evidence of the “three tiers.” The results are shown in Figure B.1. The United States stands out at the upper right of the graph as an outlier on both axes. The middle powers are separated from the minor powers as well. Note that the Netherlands, Spain, and Turkey straddle the line between the minor powers and the middle powers.

To reduce the effects of outliers on both ends, Figure B.2 plots the same data as rankings. Not surprisingly, this shows a strong relationship between the number of aircraft contributed and the member’s GDP. With near certainty, I can say that there is a strong relationship between a member’s GDP and their aircraft contribution. At this early point in the Kosovo operations, the local violence and refugee flows would impact the European members more directly, giving them more benefits to stabilizing the region. It would be reasonable to see the European members contributing relatively more than the North American members.

To help assess this possibility, I have normalized contributions for GDP and calculate the Spearman’s coefficient. The results are plotted in Figure 6.1.

Table 6.4: GDP, ME, and Aircraft Contributions to Operation Deny Flight

Member	GDP($B) 1995	GDP Rank	ME/GDP (1995)	ME/GDP Rank	AIR	AIR Rank	AIR/GDP	AIR/GDP Rank
Belgium	229.6	**9**	1.60%	**12**	0.2	**11**	0.0010	**11**
Canada	558	**6**	1.50%	**14**	0.8	**10**	0.0014	**10**
Denmark	158.2	**11**	1.70%	**10**	0.1	**12**	0.0008	**12**
France	1305.1	**3**	3.10%	**4**	33.0	**2**	0.0253	**3**
Germany	1962.7	**2**	1.70%	**11**	16.5	**5**	0.0084	**9**
Greece	110.7	**13**	4.40%	**2**	0.1	**13**	0.0005	**14**
Iceland	7.1	**16**	0.00%	**16**	0.0	**16**	0.0000	**16**
Italy	1109.8	**5**	1.80%	**8**	20.4	**4**	0.0184	**6**
Luxembourg	14.4	**15**	0.80%	**15**	0.0	**14**	0.0005	**13**
Netherlands	335.7	**8**	2.00%	**9**	15.3	**6**	0.0455	**2**
Norway	133.5	**12**	2.40%	**7**	2.1	**9**	0.0158	**7**
Portugal	95.7	**14**	2.60%	**6**	0.0	**15**	0.0001	**15**
Spain	498	**7**	1.50%	**13**	11.0	**7**	0.0221	**4**
Turkey	159.7	**10**	3.90%	**1**	8.1	**8**	0.0505	**1**
UK	1284	**4**	3.00%	**5**	28.1	**3**	0.0219	**5**
US	7703.5	**1**	3.80%	**3**	103.4	**1**	0.0134	**8**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Aircraft contribution data are compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

Figure 6.1 illustrates the relationship between aircraft contributions corrected for GDP and each nation's GDP. There are two interesting findings that are revealed here. The first is that Spearman's rho came out slightly higher than that in the same analysis of aircraft contributions to Operation Allied Force. In this case, I see evidence of overcontribution by the richer members with a rho of 0.59 compared to 0.47 for Allied Force. The second, related finding of note is that the United States with the number one ranked GDP is only ranked eighth in aircraft contributions when these numbers are adjusted for GDP. The larger rho combined with the ranking of the United States indicates in this first analysis that the wealthier European members were the ones driving contributions, not just the U.S.

Comparing each member's contributions to the horizontal line in Figure 6.1 reveals the members who over contributed. In this figure, the United States is above the mean, but below seven other members including Norway. Notably, the other North American member, Canada also falls surprisingly low in the rankings. This could indicate that the European members had a stronger interest to stabilize the region. These members would theoretically receive larger benefits compared to the more distant North American members. Refugee flow and spillover violence would have been less of a direct cost to the U.S. and Canada. European members faced the threat of refugees flowing across their borders, while the members more distant may have been less concerned with the individual cost of refugees, and more with the broader concerns of stopping Genocide and a humanitarian crisis. I will examine this possibility when I compare the balance of burdens and benefits in Chapter 8.

Because unclassified sortie numbers are not available for Operation Deny Flight, I have skipped Model 2 and move to my third model, which is based on support aircraft contributions. I will show that these findings also hold true when I examine the expensive support aircraft contributed to Operation Deny Flight.

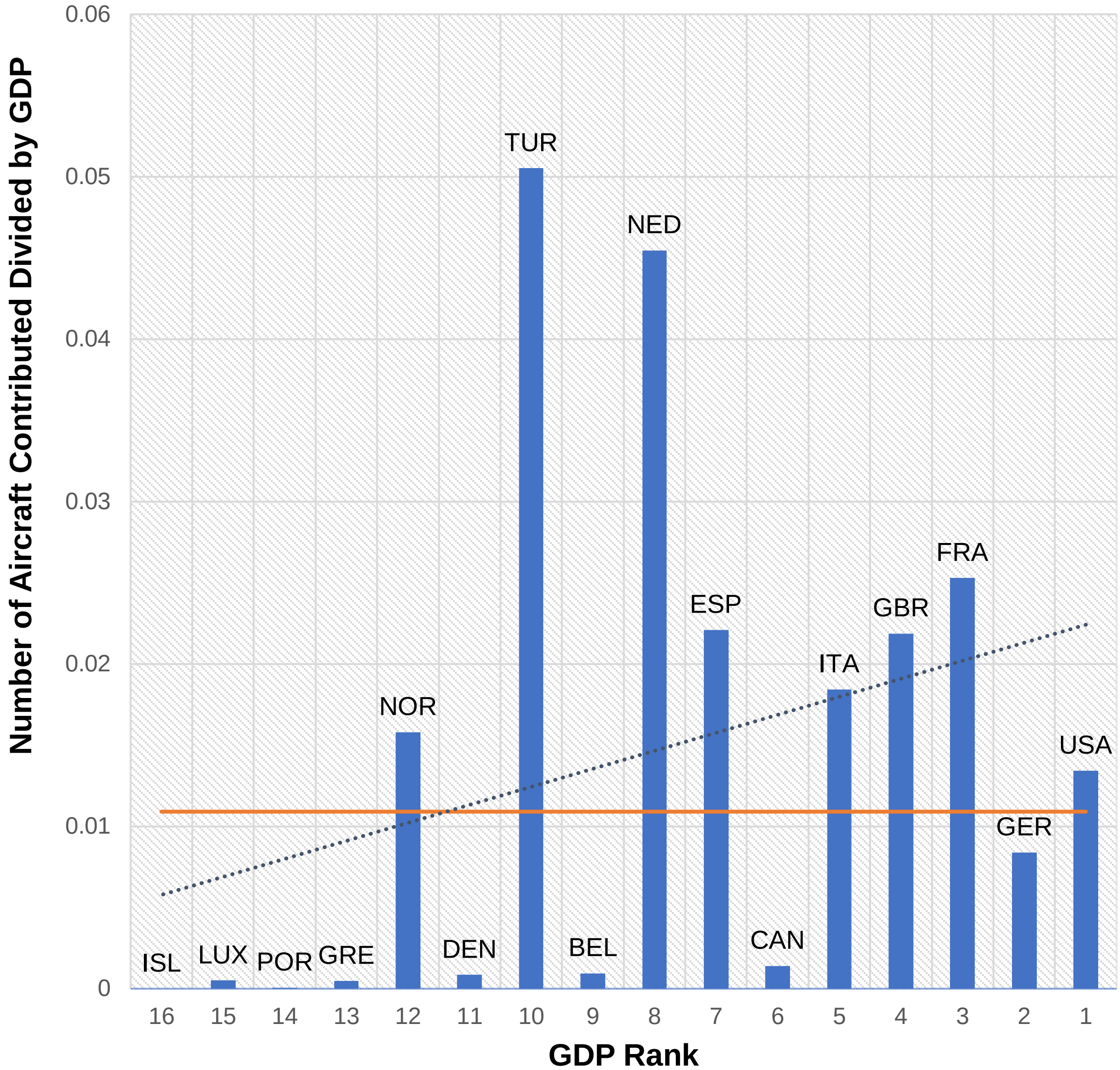

Figure 6.1: Aircraft Contribution to Operation Deny Flight Adjusted for GDP

Note: The horizontal line represents the median aircraft contribution divided by GDP

Spearman’s rho = 0.59
Prob > |t| = 0.02

Model 3: Support Aircraft Contributions

In the previous section, Table 6.2 gives the breakdown of fighter aircraft contributions as well as the various types of support aircraft that were contributed by the members. Combining the different support categories into one column gives the total support aircraft contributions, which are tabulated in Table 6.5. Including shares of the NATO AWACS aircraft gives the total support aircraft numbers in Table 6.6 which I will use for the statistical analysis.

As shown in Figure 6.2, support aircraft contributions are related to GDP with Spearman's rho of 0.57 (0.02). This is an interesting finding. The relationship between GDP and total aircraft contributions is nearly identical with a rho of 0.59 (0.02). Because Deny Flight was such a small operation and the European members had more to gain from the operation, they appear to have contributed accordingly. Additionally, the 8 NATO AWACS were important support aircraft in this operation. This allowed the smaller nations to gain contribution shares of support aircraft.

Table 6.5: Support Aircraft Contributions to Operation Deny Flight

NATO Member	**Fighter/Attack Aircraft**	**Support Aircraft**
Belgium	0	0
Canada	0	0
Denmark	0	0
France	30	3
Germany	14	0
Greece	0	0
Iceland	0	0
Italy	14	6
Luxembourg	0	0
Netherlands	12	3
Norway	0	2
Portugal	0	0
Spain	8	3
Turkey	8	0
United Kingdom	24	4
NATO AWACS	0	8
United States	62	38
Total	172	67

Data are compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

Table 6.6: GDP and Support Aircraft Contributions to Operation Deny Flight

Member	GDP($B) (1995)	GDP Rank	S-AIR	S-AIR Rank	S-AIR/GDP	S-AIR/GDP Rank
Belgium	229.6	**9**	0.2	**10**	0.0010	**10**
Canada	558	**6**	0.8	**9**	0.0014	**8**
Denmark	158.2	**11**	0.1	**11**	0.0008	**11**
France	1305.1	**3**	3.0	**6**	0.0023	**7**
Germany	1962.7	**2**	2.5	**7**	0.0013	**9**
Greece	110.7	**13**	0.1	**13**	0.0005	**13**
Iceland	7.1	**16**	0.0	**16**	0.0000	**16**
Italy	1109.8	**5**	6.4	**2**	0.0058	**4**
Luxembourg	14.4	**15**	0.0	**14**	0.0005	**12**
Netherlands	335.7	**8**	3.3	**4**	0.0097	**2**
Norway	133.5	**12**	2.1	**8**	0.0158	**1**
Portugal	95.7	**14**	0.0	**15**	0.0001	**15**
Spain	498	**7**	3.0	**6**	0.0060	**3**
Turkey	159.7	**10**	0.1	**12**	0.0004	**14**
UK	1284	**4**	4.1	**3**	0.0032	**6**
US	7703.5	**1**	41.4	**1**	0.0054	**5**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Aircraft contribution data are compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), and Peters, et al., (2001).

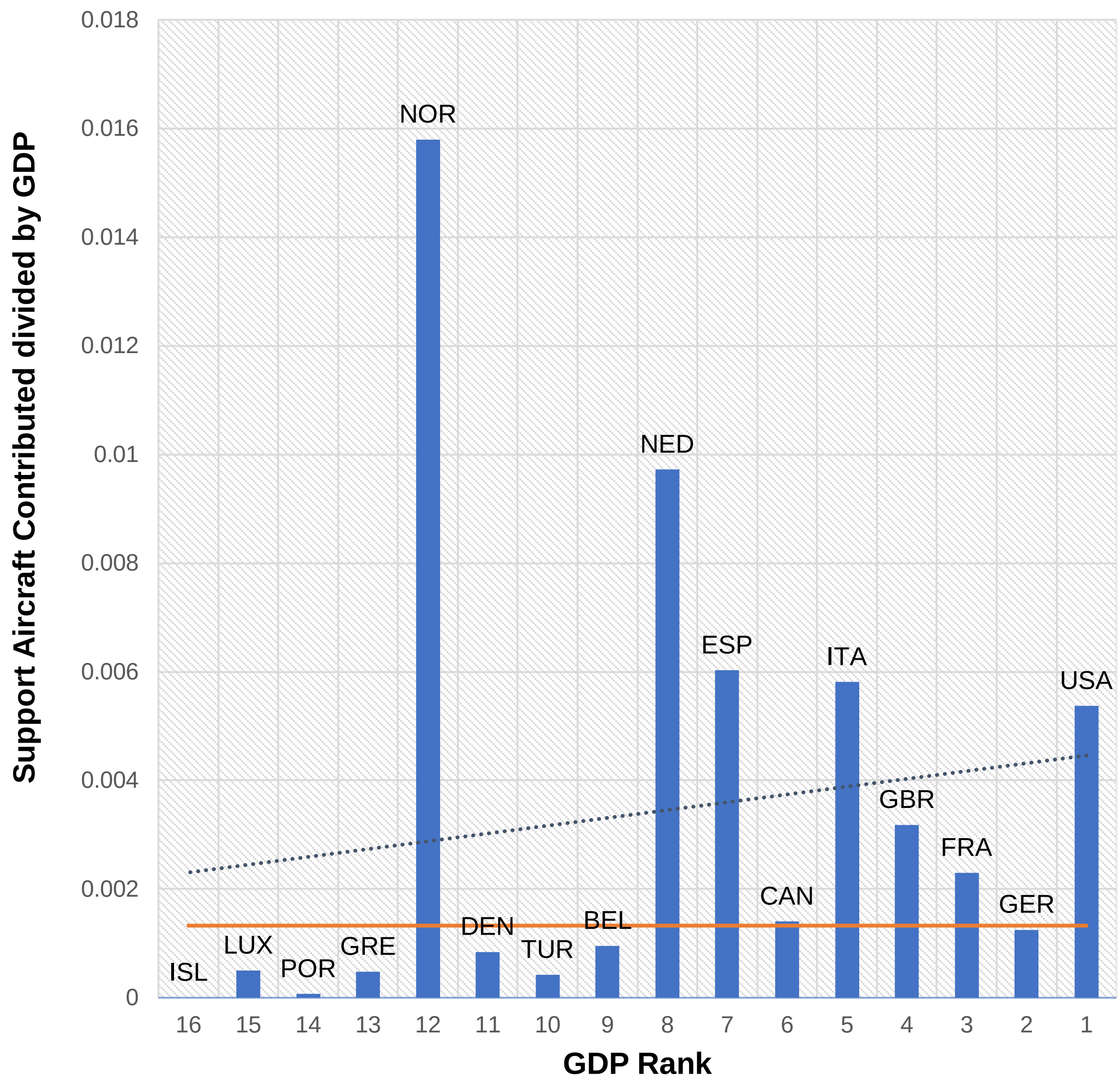

Figure 6.2: Support Aircraft Contributions to Operation Deny Flight
Adjusted for GDP

Note: The horizontal line represents the median support aircraft
divided by GDP

Spearman's rho = 0.57
Prob > |t| = 0.02

Operation Deny Flight Summary

Both of my models examining the first phase of the Kosovo operations indicate that the wealthier nations are being exploited by the poorer ones. Although the United States supplied the most aircraft to the Operation Deny Flight, when I correct this contribution for GDP, I find that the European members contributed on par with the U.S. This finding contrasts with the results of the analysis of Operation Allied Force in Chapter 5 where the U.S. carried a disproportionate burden – especially related to support aircraft contributions. The fact that the middle powers contributed at a similar level in both models provides additional evidence of exploitation, but not the capabilities gap. This gap became apparent during the largest phase of the conflict, OAF.

Table 6.7: Spearman Rank Correlation between Contributions and GDP for Operation Deny Flight

Total Aircraft Contributions	0.59** (0.02)
Support Aircraft Contributions	0.57** (0.02)

Notes. Numbers in parentheses are prob-values.
**significant at .05 level

Since this initial phase was relatively small, and the European members had more to gain, it is not surprising that my analysis confirmed these contribution findings. However, since there is an escalation in the next phase of the conflict, it will be important to show which members were willing and able to add to their initial contribution.

CHAPTER 7

OPERATION DELIBERATE FORCE

Operation Deliberate Force resulted from difficulties in peace enforcement during Operation Deny Flight. Despite the no-fly zone, Bosnian Serb artillery forces were still able to shell designated safe areas that were under the protection of the United Nations. In response, NATO executed airstrikes on ammunition storage facilities in the Bosnian Serb capitol on the 25^{th} and 26^{th} of May 1995. The Serbs responded by taking 370 U.N peacekeepers as hostages and placing them around strategic locations to use as human shields. Additionally, on June 2nd, the Bosnian Serbs used a SA-6 surface-to-air missile to shoot down a U.S. Air Force F-16 flown by Captain Scott O'Grady while he was enforcing the no-fly zone (Owen, 2000). After continued fighting and ongoing genocide, NATO decided to take more aggressive action and implemented Operation Deliberate Force. This campaign ran from 30 August through 20 September 1995.

At the start of Operation Deliberate Force, NATO members had a combined 269 aircraft assigned. To accomplish this more aggressive operation, members were asked to contribute additional forces. By the end of the operation, the number of aircraft had increased by 66 to a total of 305. These numbers along with final sortie counts are listed in Table 7.1.

Table 7.1 provides each member's aircraft contribution and their sortie contribution. A large difference between the two measurements could be a result of the capabilities gap.

Table 7.1: Contributions to Operation Deliberate Force

NATO Member	Aircraft	Percent	Sorties	Percent
Belgium	0	0	0	0
Canada	0	0	0	0
Denmark	0	0	0	0
France	47	15%	280	8%
Germany	14	5%	67	2%
Greece	0	0	0	0
Iceland	0	0	0	0
Italy	20	7%	32	1%
Luxembourg	0	0	0	0
Netherlands	18	6%	194	5%
Norway	0	0	0	0
Portugal	0	0	0	0
Spain	11	4%	125	4%
Turkey	18	6%	74	2%
United Kingdom	28	9%	336	10%
NATO AWACS	8	3%	99	3%
United States	141	45%	2328	65%
Total	305	100%	3535	100%

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Notably, France contributed 15% of the aircraft participating in Operation Deliberate Force, but only flew 8% of the sorties. Similarly, Germany contributed 5%, but only flew 2%, while Italy showed a decline from 7% down to 1% when I compare aircraft contributions with sortie numbers. Turkey showed a similar drop in contribution levels from 6% down to 2%. Spain, the Netherlands, and the U.K. maintained their contribution level at approximately the same values. The United States was the only member whose sortie contribution numbers increased significantly compared to their aircraft contribution numbers with an increase from 45% to 65% respectively. This indicates that the U.S. was either more willing to fly or had critical capabilities that were required during the operation. With this overview, I begin my assessment of the first model.

Model 1 Aircraft Contributions

I examined the total number of aircraft that were contributed by each member to Operation Deliberate Force. Table 7.2 gives the numbers as well as the categories of aircraft that flew in this operation. Table C.1 presents more detail with a breakdown by each type of aircraft. Since Operation deliberate Force was effectively an escalation of Operation Deny Flight, the force structure was remarkably similar at the beginning. However, because of the different nature of the two operations (defensive vs. offensive) each member was asked to contribute more planes to Operation Deliberate Force. As a result, there is an increase from 239 aircraft to a final total of 305, roughly a 25% rise.

Next, I investigated whether each member contributed proportionally more to this offensive operation, or if the medium powers were already near their maximum contribution capability. Additionally, Operation Deny Flight was a defensive operation, while Operation Deliberate Force was an offensive mission. This difference could potentially lead to domestic political challenges and a reluctance to contribute more aircraft or even continue at the same level.

Table 7.2 indicates that there were no major shifts in the balance of aircraft contributed by the membership. There is some minor escalation, but no significant change is apparent. Table 7.3 contains the rankings that will be used in the Spearman calculations.

With the rankings in hand, I compared member contributions to this second phase of the Kosovo operations with the first phase. Figure 7.1 reveals a Spearman coefficient of 0.69 (0.00) and plots the median GDP adjusted contribution value, revealing which members over and under-contributed during Operation Deliberate Force. Turkey, the Netherlands, Spain, and France all seem to be over contributors. The results are very similar to what I found in Figure 6.1 for aircraft contributions to Operation Deny Flight.

Table 7.2: Contributions to Operation Deliberate Force by Aircraft Category

NATO Member	**Fighter/Attack**	**Airlift**	**Tanker**	**AEW**	**Specialty**	**Total**
Belgium	0	0	0	0	0	**0**
Canada	0	0	0	0	0	**0**
Denmark	0	0	0	0	0	**0**
France	42	0	1	1	3	**47**
Germany	14	0	0	0	0	**14**
Greece	0	0	0	0	0	**0**
Iceland	0	0	0	0	0	**0**
Italy	14	5	1	0	0	**20**
Luxembourg	0	0	0	0	0	**0**
Netherlands	18	0	0	0	0	**18**
Norway	0	0	0	0	0	**0**
Portugal	0	0	0	0	0	**0**
Spain	8	1	2	0	0	**11**
Turkey	18	0	0	0	0	**18**
UK	24	0	0	2	0	**26**
NATO AWACS	0	0	0	4	0	**4**
US	72	0	17	0	38	**127**
Total	**172**	**12**	**21**	**11**	**21**	**237**

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001). Note: The Specialty category includes: Command and Control, Electronic Warfare, Special Operations, Gunships, etc.

Table 7.3: GDP and Aircraft Contributions to Operation Deliberate Force

Member	GDP($B) (1995)	GDP Rank	AIR	AIR Rank	AIR/GDP	AIR/GDP Rank
Belgium	229.6	**9**	0.2	**10**	0.0010	**10**
Canada	558	**6**	0.8	**9**	0.0014	**9**
Denmark	158.2	**11**	0.1	**11**	0.0008	**11**
France	1305.1	**3**	47.0	**2**	0.0360	**3**
Germany	1962.7	**2**	16.5	**7**	0.0084	**8**
Greece	110.7	**13**	0.1	**13**	0.0005	**14**
Iceland	7.1	**16**	0.0	**16**	0.0000	**16**
Italy	1109.8	**5**	20.4	**4**	0.0184	**7**
Luxembourg	14.4	**15**	0.0	**14**	0.0005	**13**
Netherlands	335.7	**8**	18.3	**5**	0.0544	**2**
Norway	133.5	**12**	0.1	**12**	0.0008	**12**
Portugal	95.7	**14**	0.0	**15**	0.0001	**15**
Spain	498	**7**	11.0	**8**	0.0221	**4**
Turkey	159.7	**10**	18.1	**6**	0.1131	**1**
UK	1284	**4**	28.1	**3**	0.0219	**5**
US	7703.5	**1**	144.4	**1**	0.0187	**6**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Aircraft data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).)

The members who are contributing more relative to the mean are mainly grouped towards the right side of the graph indicating larger GDPs. Keep in mind that these contributions have been normalized for GDP, so that if each member contributed proportionally to their abilities, the graph would be flat, and all members would be close to the orange line.

Fortunately, I was able to obtain sortie data for this operation. As demonstrated in chapter 5, an examination of sorties produced significantly different results than my examination of aircraft contributions in the first model.

Model 2 Sortie Contributions

Examining the number of sorties allowed me to distinguish the members who were willing and able to operate their aircraft during these riskier missions. As discussed previously, the comparison between the number of aircraft contributed and the number of sorties contributed is a strong indicator of a member's commitment to the operation. An analysis of the data has given important insight that is not available by simply looking at the number of aircraft contributed.

Table 7.4 lists the total sorties flown by each member as well as a detailed breakdown. Eight members flew sorties during Operation Deliberate Force while NATO also flew its AWACS aircraft for a grand total of 3535 sorties.

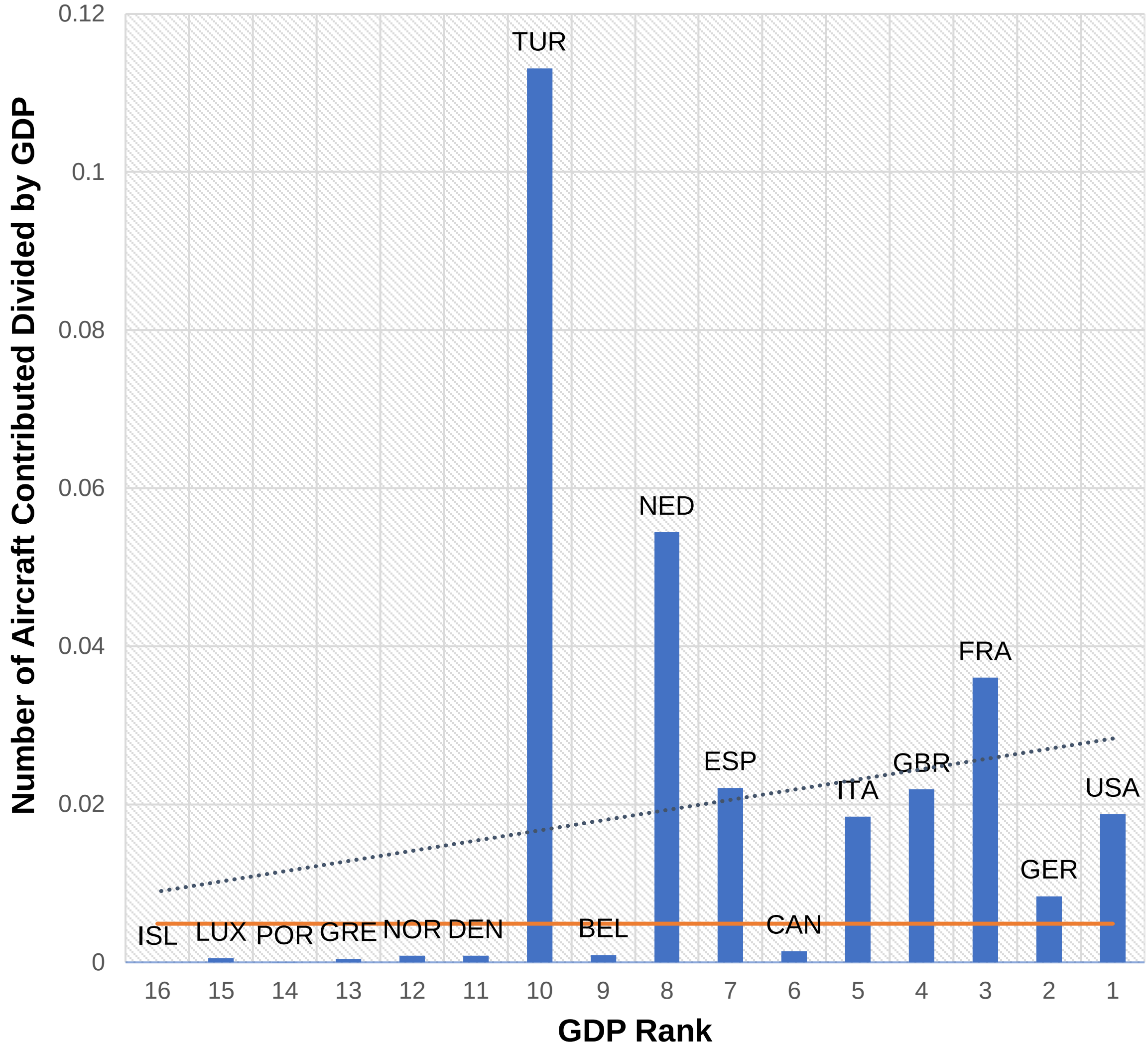

Figure 7.1: Aircraft Contributions to Operation Deliberate Force
Adjusted for GDP

Note: The horizontal line represents the median sortie contribution
number divided by GDP

Spearman’s rho = 0.69
Prob > |t| = 0.00

Figure 7.2 illustrates the comparison between the strike sorties, where ordinance is typically employed and the support sorties. Support sorties are typically less risky, but require larger, more expensive aircraft.

While the chart gives an easy visual comparison between the support and strike sorties, Figure C.2 breaks the strike sortie contribution numbers down by individual member. While this chart is somewhat useful to visualize the strike sortie contributions, the statistical analysis will be more revealing. Table 7.5 includes the data that will be used in the Spearman calculations.

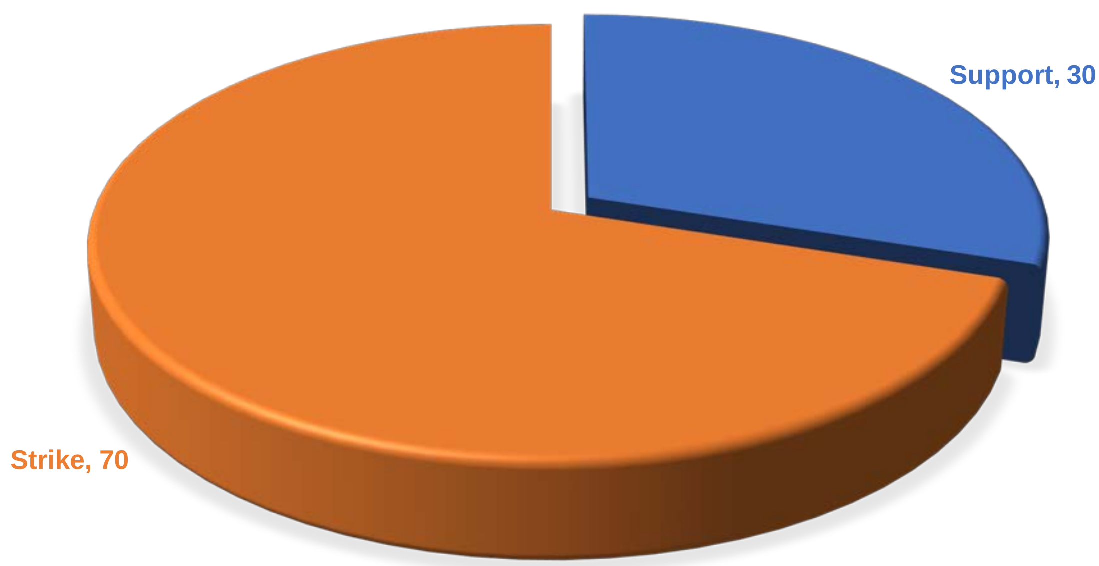

Figure 7.2: Sorties Contributed to Operation Deliberate Force by Type (Percentage)

Owen (2000)

Table 7.4: Contributions to Operation Deliberate Force by Sortie Type

Member	**CAP**	**SEAD**	**CAS**	**ISR**	**Misc. Support**	**Total**
Belgium	0	0	0	0	0	**0**
Canada	0	0	0	0	0	**0**
Denmark	0	0	0	0	0	**0**
France	60	0	109	81	30	**280**
Germany	0	28	3	36	0	**67**
Greece	0	0	0	0	0	**0**
Iceland	0	0	0	0	0	**0**
Italy	0	0	26	0	6	**32**
Luxembourg	0	0	0	0	0	**0**
Netherlands	56	0	86	52	0	**194**
Norway	0	0	0	0	0	**0**
Portugal	0	0	0	0	0	**0**
Spain	0	52	46	0	27	**125**
Turkey	70	0	4	0	0	**74**
UK	80	0	156	61	39	**336**
NATO AWACS	0	0	0	0	99	**99**
US	28	705	935	82	578	**2328**
Total	**294**	**785**	**1365**	**312**	**779**	**3535**

Owen (2000)

Table 7.5: GDP and Sortie Contributions to Operation Deliberate Force

Member	GDP($B) (1995)	GDP Rank	SOR	SOR Rank	SOR/GDP	SOR/GDP Rank
Belgium	229.6	**9**	2.7	**10**	0.0118	10
Canada	558	**6**	9.7	**9**	0.0174	9
Denmark	158.2	**11**	1.7	**11**	0.0105	11
France	1305.1	**3**	280.0	**3**	0.2145	6
Germany	1962.7	**2**	97.4	**6**	0.0496	7
Greece	110.7	**13**	0.7	**13**	0.0059	14
Iceland	7.1	**16**	0.0	**16**	0.0000	16
Italy	1109.8	**5**	37.5	**8**	0.0338	8
Luxembourg	14.4	**15**	0.1	**14**	0.0062	13
Netherlands	335.7	**8**	197.3	**4**	0.5876	1
Norway	133.5	**12**	1.3	**12**	0.0101	12
Portugal	95.7	**14**	0.1	**15**	0.0008	15
Spain	498	**7**	125.0	**5**	0.2510	5
Turkey	159.7	**10**	74.8	**7**	0.4686	2
UK	1284	**4**	337.0	**2**	0.2625	4
US	7703.5	**1**	2369.7	**1**	0.3076	3

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019) Sortie data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

With a Spearman's rho of 0.74 and a probability value approaching zero, I conclude that exploitation is occurring during this portion of the Kosovo operations with the richer nations contributing disproportionately.

To fully examine contributions to Operation Deliberate Force, I compared the results from Figure 7.3 (sorties) with Figure 7.1 (aircraft). Spearman's rho increased from 0.69 to 0.74 while the probability factor went to near zero. Nations with larger GDPs over-contributed sorties at a rate even higher than their aircraft contribution. This provides evidence supporting the capabilities gap argument. Wealthier nations were able to contribute more advanced aircraft that were more capable of flying during this combat operation.

Figure 7.3 provides a visual representation of the sortie contributions compared to the mean value. Because these numbers are corrected for GDP both rich and poor members contributions should be near parity if burden-sharing is equal. Instead the members clustered to the right side of the graph are significantly above the line compared to those at the left side of the graph. Next, I will examine the support aircraft contributions in my third model.

Model 3: Support Aircraft Contributions

As the Kosovo operations shifted from defensive to offensive, the more complex and expensive support aircraft became increasingly necessary. My first two models examined aircraft contributions in total, but the next two models will focus exclusively on support aircraft.

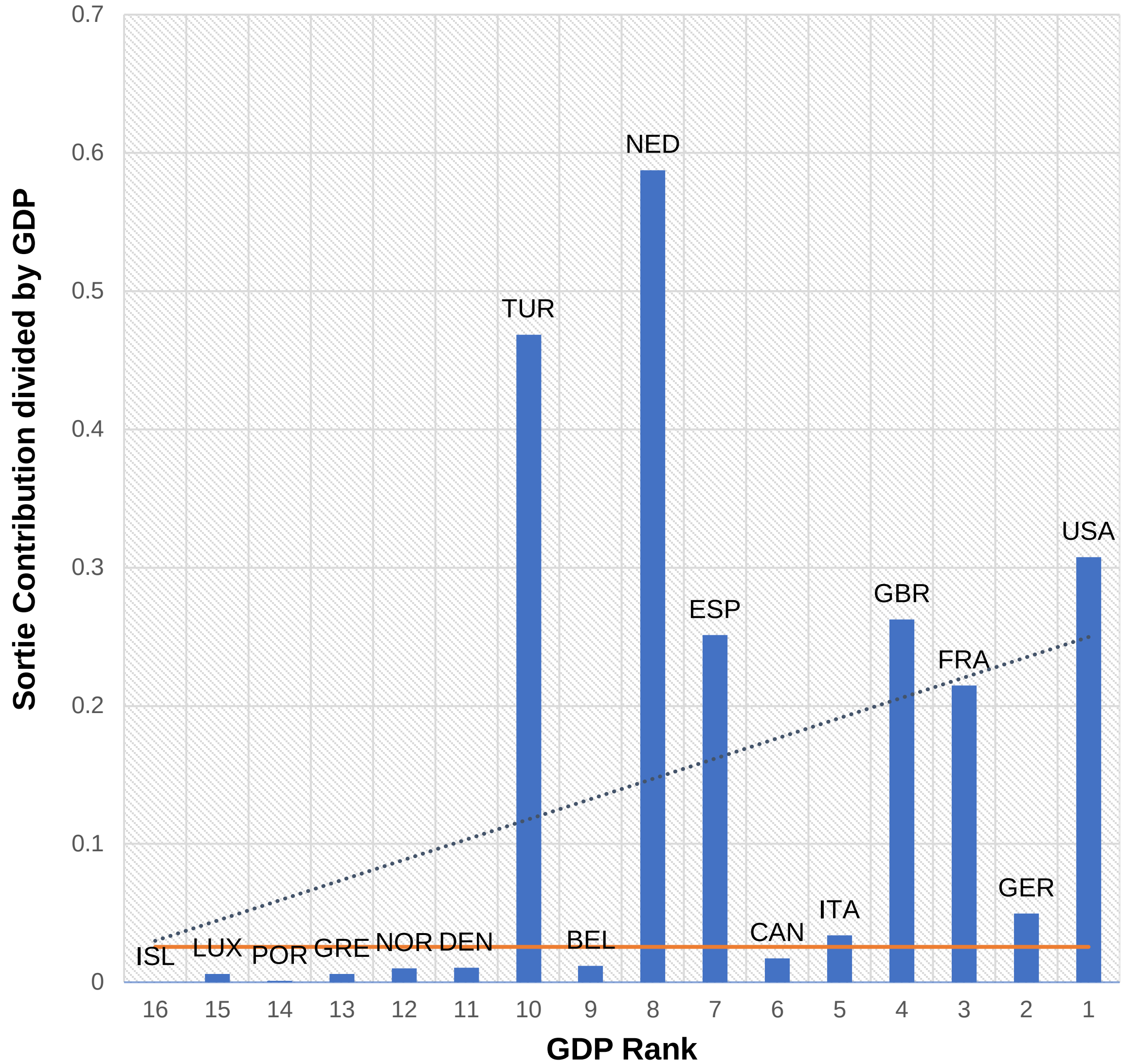

Figure 7.3: Sortie Contributions to Operation Deliberate Force Adjusted for GDP

Note: The horizontal line represents the median sortie contribution divided by GDP

Spearman's rho = 0.74
Prob > |t| = 0.00

Table 7.6 shows that 84 support aircraft were contributed to Operation Deliberate Force by five members in addition to the joint NATO AWACS aircraft. The United States contributed 67 of these while the next largest contributor, the United Kingdom, contributed 8. Consolidating these numbers and giving credit to the members participating in the joint AWACS program gives the data that is shown in Table 7.7. With these numbers compiled, I performed the statistical analysis.

The Spearman calculations from the data in Table 7.7 gives the strongest evidence yet of exploitation. Figure 7.4 reveals a rho of 0.85 with a prob value near zero. In Figure 7.4 the wealthier nations are again clustered to the right side of the graph. There are two important factors to keep in mind when examining this graph. First, I have corrected for uneven GDPs, so the contribution plot should be a level line if burden-sharing is equal. Second, these contribution numbers include the individual shares allocated for the joint NATO AWACS program. Even if individual members cannot afford to purchase an AWACS aircraft individually, they were given the opportunity to contribute fractionally according to their ability. Despite these considerations, I still find strong evidence of exploitation. The next task is to examine the sorties flown by these aircraft in the fourth model.

Table 7.6: Support Aircraft Contributions to Operation Deliberate Force

NATO Member	**Fighter/Attack**	**Support**
Belgium	0	0
Canada	0	0
Denmark	0	0
France	45	2
Germany	14	0
Greece	0	0
Iceland	0	0
Italy	17	3
Luxembourg	0	0
Netherlands	18	0
Norway	0	0
Portugal	0	0
Spain	8	3
Turkey	18	0
United Kingdom	24	4
NATO AWACS	0	8
United States	74	67
Total	**172**	**84**

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Table 7.7: GDP and Support Aircraft Contributions to Operation Deliberate Force

Member	GDP($B) (1995)	GDP Rank	S-AIR	S-AIR Rank	S-AIR/GDP	S-AIR/GDP Rank
Belgium	229.6	**9**	0.2	**9**	0.0010	**8**
Canada	558	**6**	0.8	**7**	0.0014	**6**
Denmark	158.2	**11**	0.1	**10**	0.0008	**9**
France	1305.1	**3**	2.0	**6**	0.0015	**5**
Germany	1962.7	**2**	2.5	**5**	0.0013	**7**
Greece	110.7	**13**	0.1	**13**	0.0005	**13**
Iceland	7.1	**16**	0.0	**16**	0.0000	**16**
Italy	1109.8	**5**	3.4	**3**	0.0031	**4**
Luxembourg	14.4	**15**	0.0	**14**	0.0005	**12**
Netherlands	335.7	**8**	0.3	**8**	0.0008	**11**
Norway	133.5	**12**	0.1	**11**	0.0008	**10**
Portugal	95.7	**14**	0.0	**15**	0.0001	**15**
Spain	498	**7**	3.0	**4**	0.0060	**2**
Turkey	159.7	**10**	0.1	**12**	0.0004	**14**
UK	1284	**4**	4.1	**2**	0.0032	**3**
US	7703.5	**1**	70.4	**1**	0.0091	**1**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019) Aircraft data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

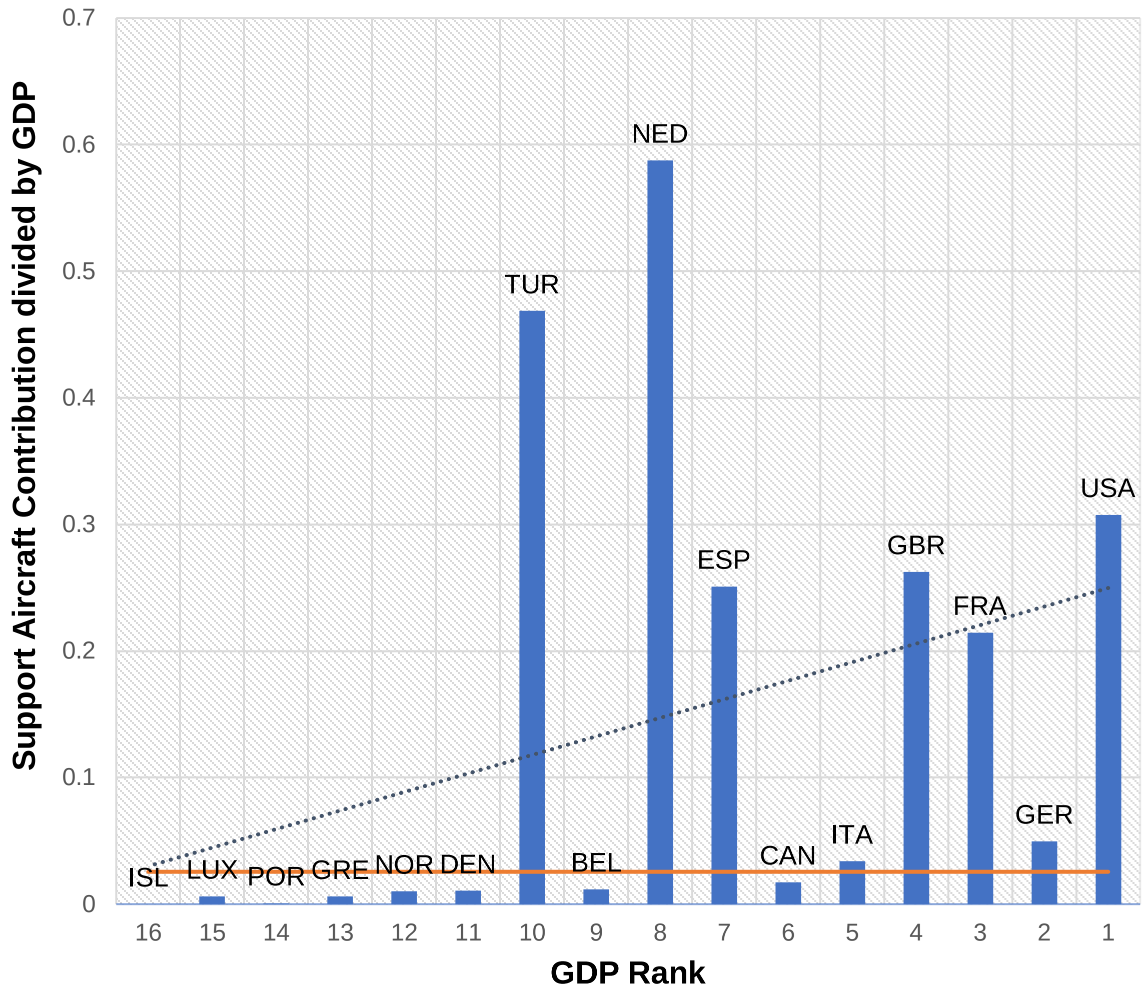

Figure 7.4: Support Aircraft Contributions Operation Deliberate Force Adjusted for GDP

Note: The horizontal line represents the median support aircraft contribution divided by GDP

Spearman's rho = 0.85
Prob > |t| = 0.00

Model 4: Support Sortie Contributions

Model 3 provided strong evidence of exploitation when examining the support aircraft that were contributed to Operation Deliberate Force. My next model will move another level deeper by examining the sorties flown by these aircraft. Figure 7.5 gives a quick glance at the percentage of support sorties flown by each member. Note that there are some minor differences due to Owen (2000) classifying some Tornado sorties as support. Compiling the numbers into a table illustrates the exact breakdown by sortie

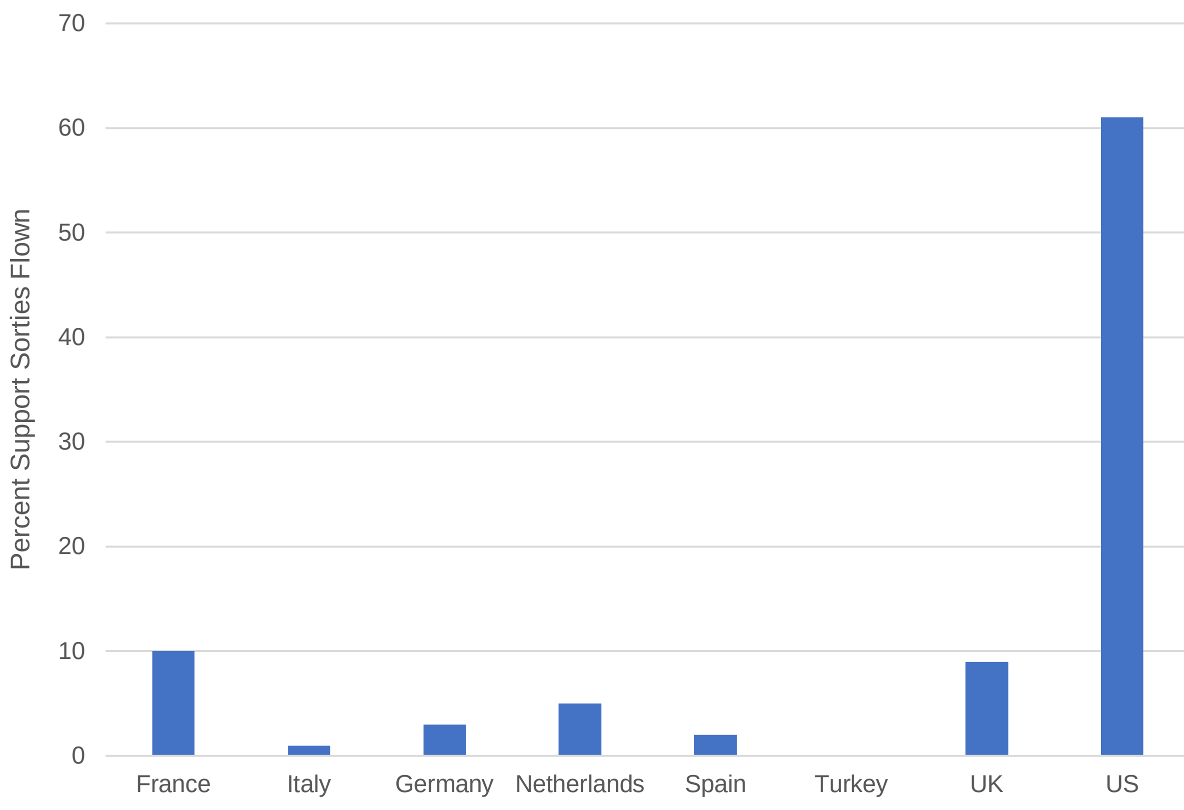

Figure 7.5: Support Sorties Contributed to Operation Deliberate Force (1,065 Total)
Data from Owen (2000)

Table 7.8: Support Sortie Contributions to Operation Deliberate Force

NATO Member	**Fighter/Attack**	**Support**
Belgium	0	0
Canada	0	0
Denmark	0	0
France	250	30
Germany	67	0
Greece	0	0
Iceland	0	0
Italy	26	6
Luxembourg	0	0
Netherlands	194	0
Norway	0	0
Portugal	0	0
Spain	98	27
Turkey	74	0
United Kingdom	297	39
NATO AWACS	0	99
United States	1750	578
Total	**2756**	**779**

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

numbers (Table 7.8). The largest contributors were the U.S. and the NATO AWACS aircraft. Allocating partial shares and calculating the rankings produces Table 7.9 for the Spearman's calculations.

Figure 7.6 includes the results indicating another strong relationship between GDP and contributions. Comparing the support aircraft contributions with the support sortie contributions gives similar results with Spearman's rho coming in at 0.85 and 0.84, respectively. In Figure 7.6 the over contributors are clustered to the right side of the chart indicating those with larger GDPs are disproportionally contributing more.

Next, it is worth summarizing my findings from this phase of the campaign.

Operation Deliberate Force Summary

Table 7.10 combines the Spearman calculations for comparison. Not surprisingly, I find that contributions of both sorties and support aircraft were more strongly related to GDP than total aircraft contributions. These findings provide additional evidence of the capabilities gap. While overall sortie contributions compared to aircraft contributions, indicates the possibility of either shirking or the capabilities gap, the examination of support aircraft points directly to the capabilities gap.

Table 7.9: GDP and Support Sortie Contributions to Operation Deliberate Force

Member	GDP($B) (1995)	GDP Rank	S-SOR	S-SOR Rank	S-SOR/GDP	S-SOR/GDP Rank
Belgium	229.6	**9**	2.7	**9**	0.0118	**7**
Canada	558	**6**	9.7	**7**	0.0174	**5**
Denmark	158.2	**11**	1.7	**10**	0.0105	**8**
France	1305.1	**3**	30.0	**4**	0.0230	**4**
Germany	1962.7	**2**	30.4	**3**	0.0155	**6**
Greece	110.7	**13**	0.7	**13**	0.0059	**13**
Iceland	7.1	**16**	0.0	**16**	0.0000	**16**
Italy	1109.8	**5**	11.5	**6**	0.0104	**9**
Luxembourg	14.4	**15**	0.1	**14**	0.0062	**12**
Netherlands	335.7	**8**	3.3	**8**	0.0097	**11**
Norway	133.5	**12**	1.3	**11**	0.0101	**10**
Portugal	95.7	**14**	0.1	**15**	0.0008	**15**
Spain	498	**7**	27.0	**5**	0.0542	**2**
Turkey	159.7	**10**	0.8	**12**	0.0052	**14**
UK	1284	**4**	40.0	**2**	0.0312	**3**
US	7703.5	**1**	619.7	**1**	0.0804	**1**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019).
Sortie data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

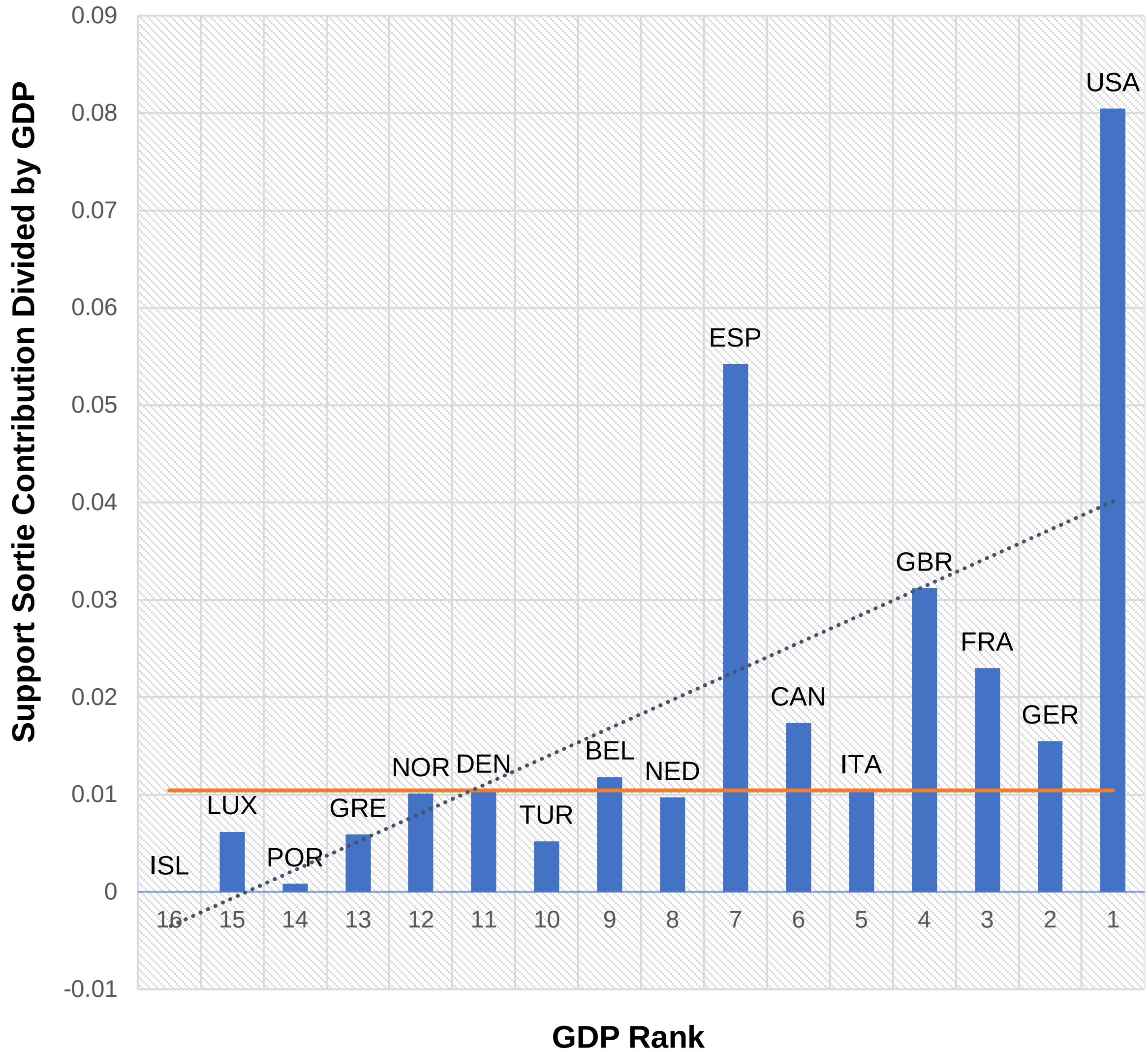

Figure 7.6: Support Sortie Contributions to Operation Deliberate Force Adjusted for GDP

Note: The horizontal line represents the median support sortie contribution divided by GDP

Spearman's rho = 0.84
Prob > |t| = 0.00

Table 7.10: Spearman Rank Correlation between Contributions and GDP for Operation Deliberate Force

Total Aircraft Contributions	0.69*** (0.00)
Total Sortie Contributions	0.74*** (0.00)
Support Aircraft Contributions	0.85*** (0.00)
Support Sortie Contributions	0.84*** (0.00)

Notes. Numbers in parentheses are prob-values.
***significant at .01 level;**significant at .05 level

When the operation shifted from defensive to offensive, precision strike capability became increasingly relevant. In addition, supporting the strike aircraft with extra fuel, command-and-control, as well as electronic jamming protection was critical. The burden of providing these capabilities fell on the shoulders of the wealthier members.

As discussed in chapter 4, there was an additional escalation of the conflict that resulted in the largest campaign – Operation Allied Force. To evaluate the entire Balkan conflict, I took a broader view which I will present in the next chapter.

CHAPTER 8

COMBINED BALKAN OPERATIONS

While it has been worthwhile to examine each of the three Balkan operations in isolation, it is also important to examine the entire four-year campaign comprehensively. I will combine the overall contributions in each of the categories for all four models. The three nations that joined NATO in 1999 (Czech Republic, Hungary, and Poland) were not members during Operation Deny Flight or Operation Deliberate Force and will be excluded from these calculations. Only members who were part of NATO during all three Balkan operations will be included.

The second objective of this chapter is to consider the benefits received by the NATO members. The individual campaign analyses in the preceding three chapters concluded that burden-sharing is uneven with wealthier members bearing a disproportionate share but did not examine benefit shares. The potential exists that these members also received a disproportionate benefit from membership. This chapter will examine that possibility using benefit share calculations from Sandler and Shimizu (2014) with a minor addition to capture benefits specific to the Balkan conflict.

My first task is to add the total contribution numbers from each operation and begin with model 1.

Table 8.1: Combined Aircraft Contributions to the Balkan Campaign

Member	**Deny Flight**	**Deliberate Force**	**Allied Force**	**Total**	**Percent**
Belgium	0	0	14	14	0.9%
Canada	0	0	18	18	1.1%
Denmark	0	0	8	8	0.5%
France	33	47	84	164	10.3%
Germany	14	14	33	61	3.8%
Greece	0	0	0	0	0.0%
Iceland	0	0	0	0	0.0%
Italy	20	20	58	98	6.1%
Luxembourg	0	0	0	0	0.0%
Netherlands	15	18	22	55	3.4%
Norway	2	0	6	8	0.5%
Portugal	0	0	3	3	0.2%
Spain	11	11	7	29	1.8%
Turkey	8	18	21	47	2.9%
UK	28	28	39	95	5.9%
NATO AWACS	8	8	10	26	1.6%
US	100	141	731	972	60.8%
Total	239	305	1058	1598	100%

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Model 1 Aircraft Contributions

As Table 8.1 illustrates, a grand total of 1598 aircraft were contributed by NATO members. Adding the GDP information and computing the rankings provides the data for the Spearman calculations in Table D.1.The results are shown in Figure 8.1.

As expected, I find a relationship between GDP rankings and Aircraft Contribution rankings even when I adjust for GDP. Spearman's rho attains 0.58 with a prob factor of 0.02. Visually presenting the data relative to the mean gives the picture in Figure 8.1. The members contributing above the line are mostly to the right side of the graph indicating larger GDP members tend to be overcontributing. This matches my previous analysis. However, there are some exceptions. For example, Turkey significantly overcontributed despite ranking only 10 out of 16 members in terms of GDP. The second highest GDP member, Germany, in contrast contributed at a level notably below the mean.

Next, I will examine total sortie contributions.

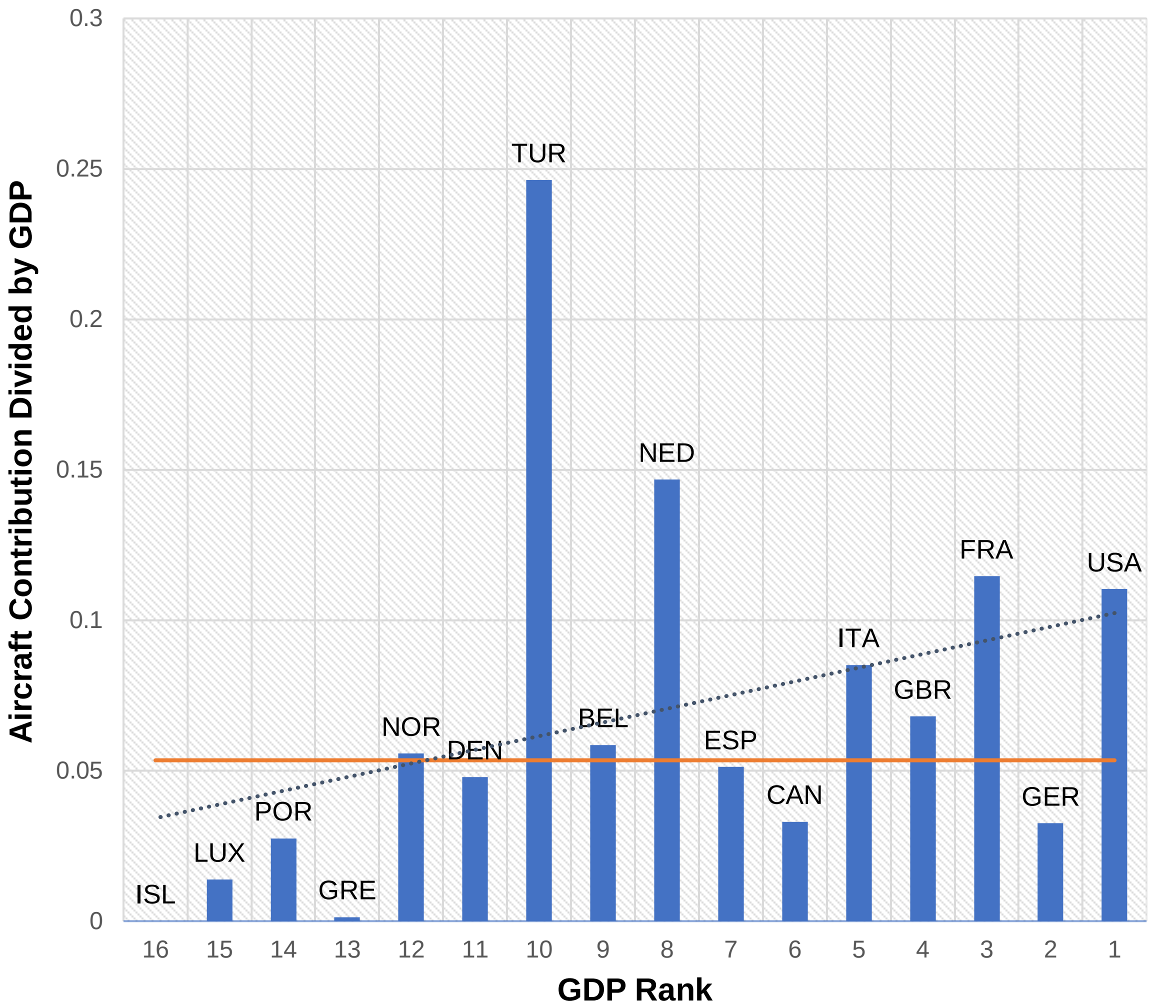

Figure 8.1: Aircraft Contributions to the Balkan Campaign Adjusted for GDP

Note: The horizontal line represents the median aircraft contribution divided by GDP

Spearman's rho = 0.58
Prob > |t| = 0.02

Model 2 Sortie Contributions

The second model will examine the number of sorties flown by the aircraft contributed to the Kosovo operations. As established previously, a comparison of the percentage of aircraft contributed by each member compared to the percentage of sorties flown can be revealing. For example, Turkey significantly overcontributed aircraft relative to its GDP as shown in Figure 8.1. They contributed 2.9% of the aircraft, or more than Belgium, Canada, and Denmark combined. This fact is striking and provides potential evidence that they are overcontributing compared to the richer members. However, the contrast with Table 8.2 based on sorties is even more remarkable. Turkey only flew 0.6% of the sorties in the combined operations. This is an indication of either a capabilities gap or a desire to shirk. To examine this further, I will calculate the rankings and incorporate the GDP data into Table D.2.

Using sortie data instead of aircraft data changes the picture significantly as presented in Figure 8.2. Comparing the results of Model 2 with Model 1 indicates an increase in evidence of exploitation. Spearman's rho increased from 0.58 with a prob factor of 0.02 to 0.71 and a prob factor approaching zero. The significance of this finding was introduced earlier but is worth expanding at this point. Most members were able to contribute aircraft and without any deeper analysis, it appears that burden-sharing is out of balance but only moderately so. I find evidence of exploitation between the rich and poor members that is in line with previous research.

Table 8.2: Combined Sortie Contributions to the Balkan Campaign

NATO Member	**Deliberate Force**	**Allied Force**	**Total**	**Percent**
Belgium	0	108.2	108.2	0.3%
Canada	0	144.1	144.1	0.3%
Denmark	0	62	62	0.1%
France	280	2,414	2,694	6.5%
Germany	67	659.3	726.3	1.7%
Greece	0	0.5	0.5	0.0%
Iceland	0	0	0	0.0%
Italy	32	1,085.2	1,117.2	2.7%
Luxembourg	0	0.1	0.1	0.0%
Netherlands	194	1,254.5	1,448.5	3.5%
Norway	0	46.4	46.4	0.1%
Portugal	0	0.1	0.1	0.0%
Spain	125	53.4	178.4	0.4%
Turkey	74	160	234	0.6%
United Kingdom	336	1,950.8	2,286.8	5.5%
NATO AWACS	99	76	175	0.4%
United States	2,328	30,050	32,378	77.8%
Total	3,535	38,064.6	41,599.6	100.0%

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

However, I find that exploitation is worse, and a capabilities gap emerges when I examine the sorties flown by these aircraft. Comparing the visual presentation in Figure 8.2 versus Figure 8.1 illustrates which members contributed aircraft that were regularly flown during the operations. Turkey dropped significantly, although they did contribute above the median. The United States and the Netherlands were the largest GDP adjusted contributors and were significantly above the median. This indicates that these members contributed aircraft with the necessary technology and that they were willing to fly these aircraft.

While this finding is significant, there is more to learn more by examining the support aircraft and sortie contributions in my next two models.

Model 3 Support Aircraft Contributions

Because the support aircraft tend to be the most expensive and technologically sophisticated equipment in the operations they are also the most difficult for members to purchase and operate. It will be worthwhile to examine the contributions of these aircraft across the three operations. Table 8.3 summarizes these contributions.

A total of 478 support aircraft were contributed to the combined operations. Of these, 399, or more than 80% were contributed by the U.S. Adding the GDP information and finding the rankings reveals Table D.3.

Plotting the data along with the Spearman calculations builds Figure 8.3. The coefficient is 0.46 with a prob factor of 0.08. This does not indicate exploitation as strongly as I have seen in other calculations. While this does indicate that richer members seem to bear a larger share of support aircraft contributions, Figure 8.3 shows two overcontributors towards the left side of the chart. Most notably, however, is the location of the United States. There is a significant overcontribution by the U.S. even when I adjust for GDP. This is a strong indicator that the capabilities gap exists.

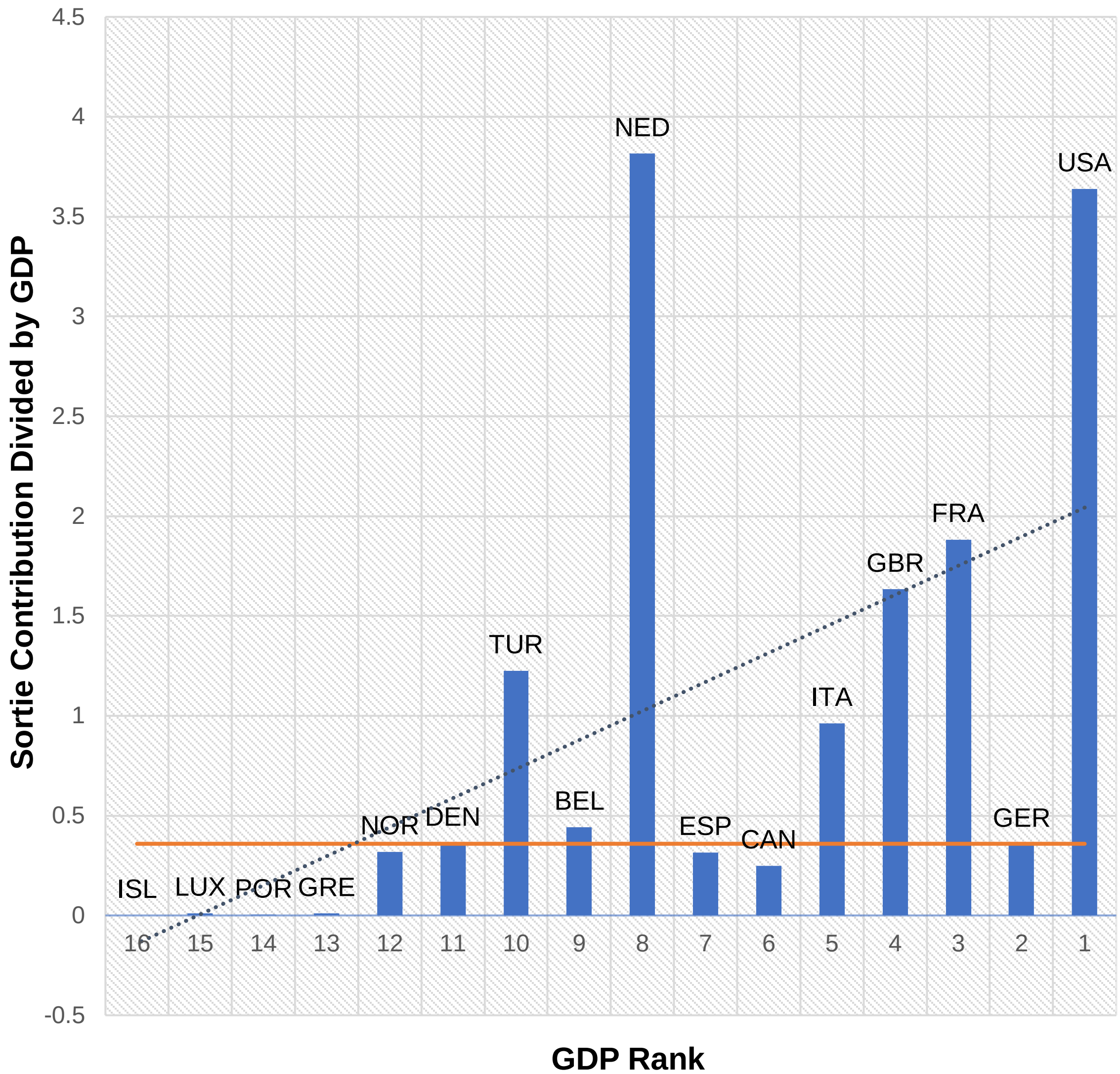

Figure 8.2: Sortie Contributions to the Balkan Campaign Adjusted for GDP

Note: The horizontal line represents the median sortie contribution divided by GDP

Spearman's rho = 0.71
Prob > |t| = 0.00

Table 8.3: Combined Support Aircraft Contributions to the Balkan Campaign

NATO Member	Deny Flight	Deliberate Force	Allied Force	Total	Percent
Belgium	0	0	0	0	0.0%
Canada	0	0	0	0	0.0%
Denmark	0	0	0	0	0.0%
France	3	2	5	10	2.1%
Germany	0	0	1	1	0.2%
Greece	0	0	0	0	0.0%
Iceland	0	0	0	0	0.0%
Italy	6	3	1	10	2.1%
Luxembourg	0	0	0	0	0.0%
Netherlands	3	0	2	5	1.0%
Norway	2	0	1	3	0.6%
Portugal	0	0	0	0	0.0%
Spain	3	3	1	7	1.5%
Turkey	0	0	0	0	0.0%
United Kingdom	4	4	9	17	3.6%
NATO AWACS	8	8	10	26	5.4%
United States	38	67	294	399	83.5%
Total	67	87	324	478	100%

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

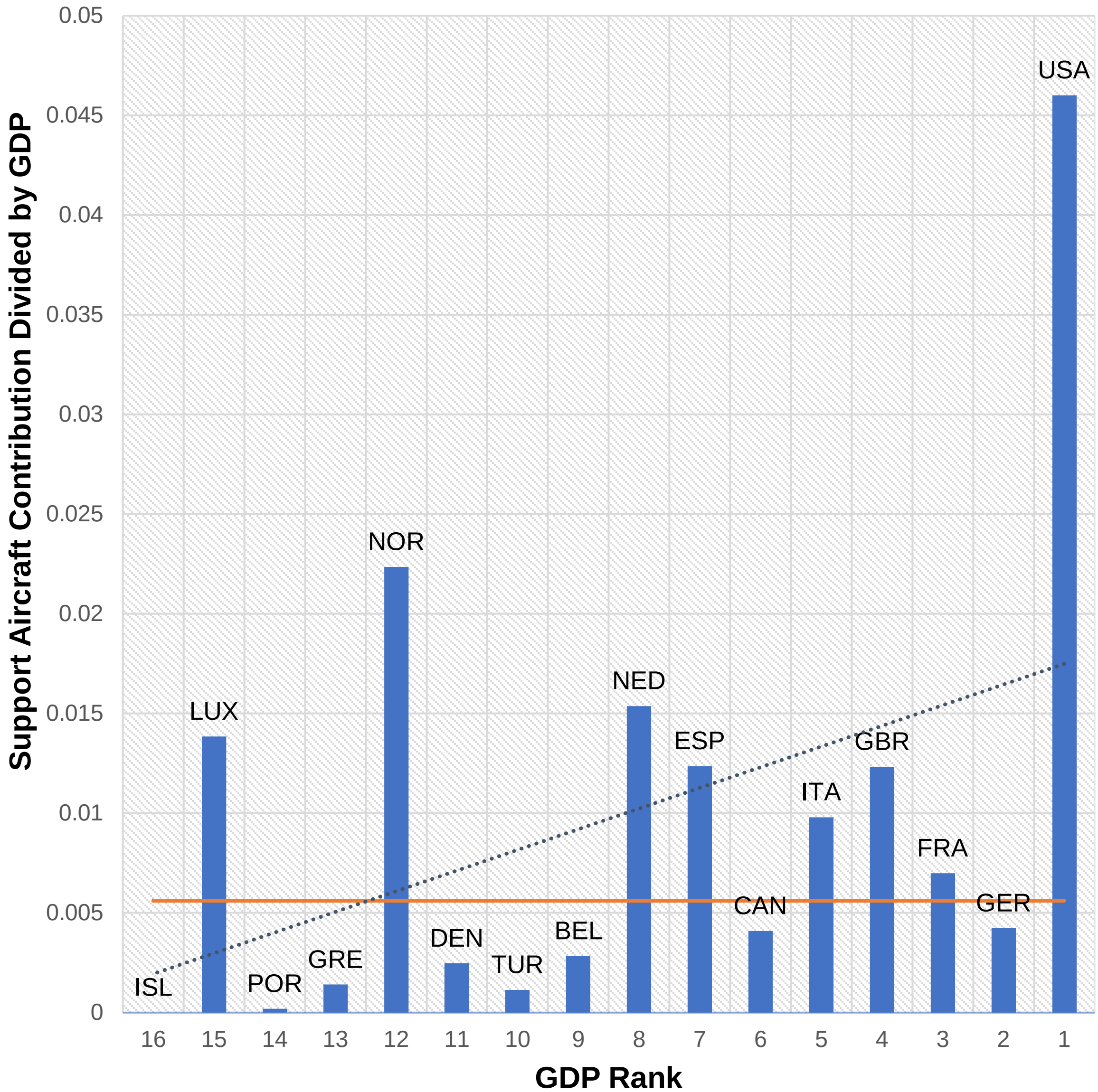

Figure 8.3: Support Aircraft Contributions to the Balkan Campaign
Adjusted for GDP

Note: The horizontal line represents the median support aircraft
contribution divided by GDP

Spearman's rho = 0.46
Prob > |t| = 0.08

Model 4 Support Sortie Contributions

Analysis of Model 4 using combined data from the entire Balkan campaign will give the most comprehensive assessment of the capabilities gap and its impact on burden-sharing in NATO. Because of the nature of complex support aircraft, they can be the most difficult for individual members to purchase and operate. Model 3 (Figure 8.2) shows that the U.S. was an extreme outlier in over-contribution when I test the number of support aircraft contributed. With the exceptions of Luxembourg and Norway, the remaining over contributors are all clustered towards higher GDPs.

Members who fly disproportionately more sorties with these aircraft are doing so because these aircraft were essential and possessed the necessary capabilities. Briefly looking at Table 8.3 compared to Table 8.4 gives an indication of which members flew in relationship to the percentage of aircraft contributed. France and the United States are the only members whose sortie contributions increased relative to their aircraft contributions. This is clear evidence of the capabilities gap. Every other member flew a smaller percentage of sorties with their support aircraft compared to the percentage of these aircraft that they contributed.

Combining these numbers with the GDP data and ranking them provides the final data for the Spearman calculations.

Table 8.4: Combined Support Sortie Contributions to the Balkan Campaign

NATO Member	**Deliberate Force**	**Allied Force**	**Total**	**Percent**
Belgium	0	0	0	0.0%
Canada	0	0	0	0.0%
Denmark	0	0	0	0.0%
France	30	509	539	2.5%
Germany	0	17	17	0.1%
Greece	0	0	0	0.0%
Iceland	0	0	0	0.0%
Italy	6	91	97	0.4%
Luxembourg	0	0	0	0.0%
Netherlands	0	126	126	0.6%
Norway	0	0	0	0.0%
Portugal	0	0	0	0.0%
Spain	27	0	27	0.1%
Turkey	0	0	0	0.0%
United Kingdom	39	492	531	2.4%
NATO AWACS	99	76	175	0.8%
United States	578	19595	20173	93.0%
Total	779	20906	21685	100.0%

Data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Using the data above reveals a Spearman's rho of 0.73 with a prob factor of 0.00, indicating exploitation of the wealthier members by the poorer ones. However, when I plot this data relative to the mean, only four members stand out in this category, with the U.S. being an extreme outlier. Comparing Figure 8.4 with 8.3 gives a clear picture of the members whose support aircraft possessed the necessary capabilities and were flown during the Balkan operations. Figure 8.4 is adjusted for GDP, so if each member contributed in accordance with their ability to pay, they would plot as a flat line. Instead, there are some significant outliers.

As discussed in Chapter 5, if a member's contribution of sorties decreases when comparing total and support sorties, we can conclude that this shift is due to the capabilities gap rather than shirking. A member demonstrates its baseline willingness to either contribute or free ride with their total sortie contribution number. If the contribution level drops when examining support sorties exclusively, then this indicates a capabilities gap. Figure 8.5 plots the change across the membership. As a percentage contribution the United States increased from 77.9% to 93.4% while the remaining members' contribution levels decreased. This is the clearest evidence of the capabilities gap so far.

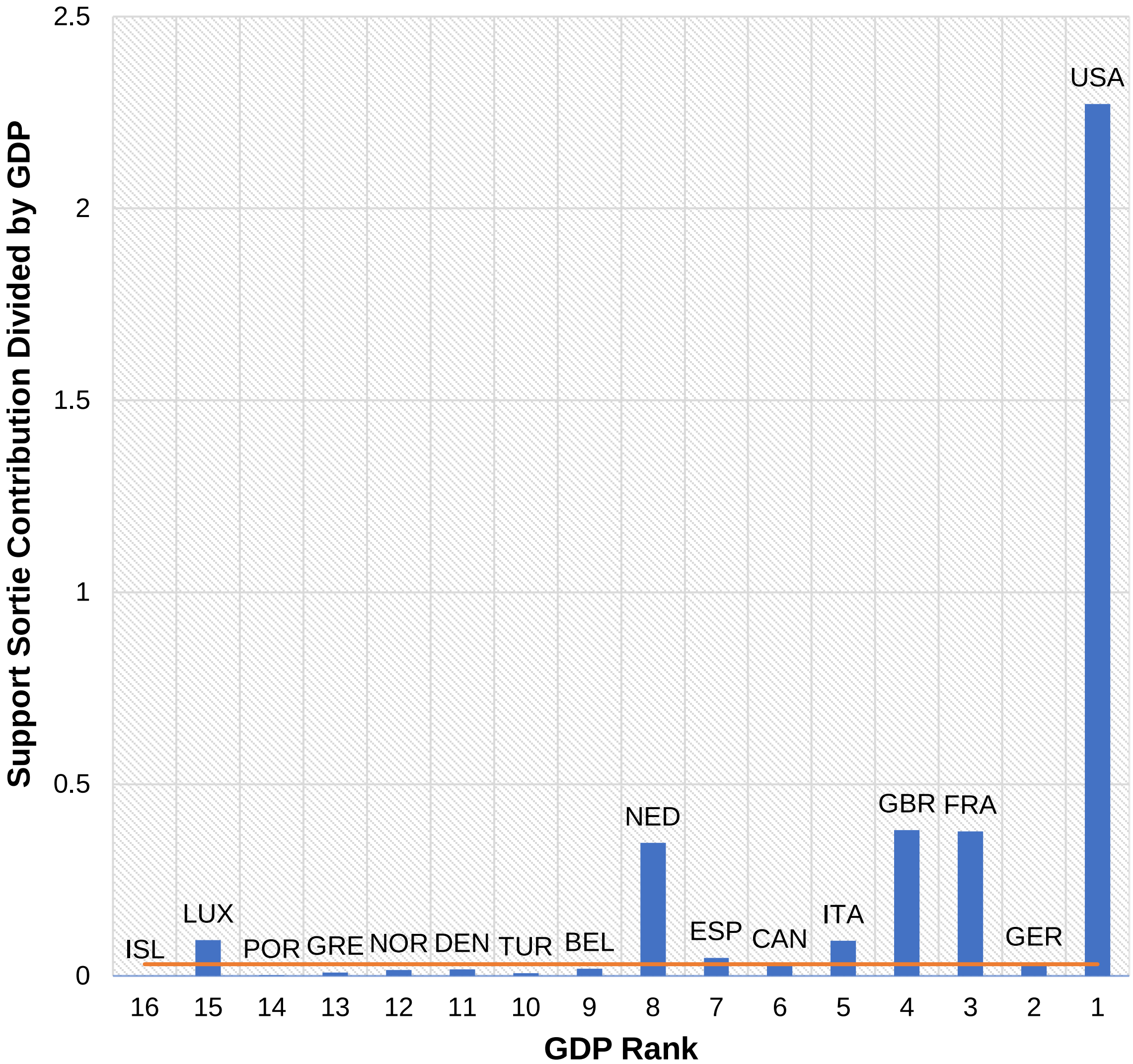

Figure 8.4: Support Sortie Contributions to the Balkan Campaign Adjusted for GDP

Note: The horizontal line represents the median support sortie contribution corrected for GDP

Spearman's rho = 0.73
Prob > |t| = 0.00

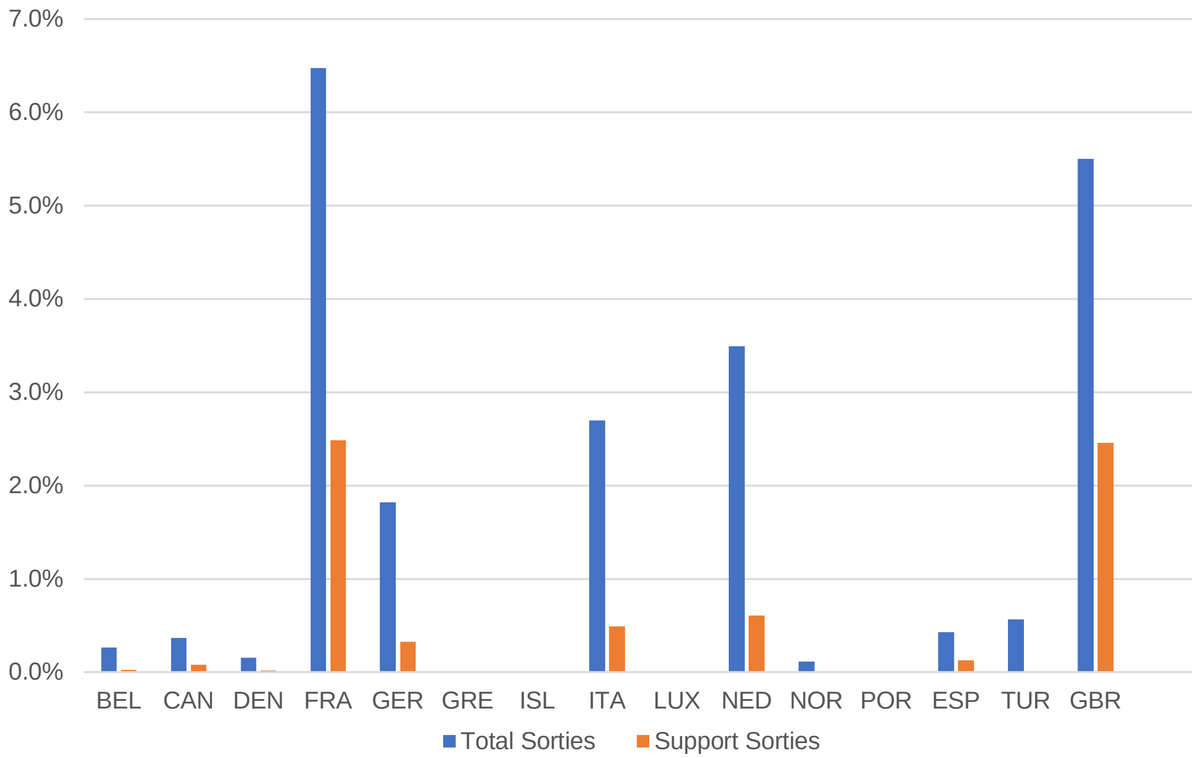

Figure 8.5: Kosovo Campaign Total and Support Sortie Contributions (Excluding U.S.)

Note: U.S. sortie contributions increased from 77.9% to 93.4%

Benefit and Burden Shares

One more consideration needs to be assessed regarding contributions to the Balkan campaigns. It is possible that some members may have contributed more due to perceived benefits. To examine this possibility, I will use the literature-standard benefit measurement developed by Sandler and Shimizu (2014) with a small modification. An additional benefit factor will capture the risk of refugee flow and violence spillover. This measurement will use the distance from each member's capital city to Sarajevo. For reference, the benefit calculations from Sandler and Shimizu are summarized in Table 8.5. Because Operation Allied Force was the conclusion of the campaign, I will use the benefit shares calculated during this time. Also, note that Sandler and Shimizu excluded Iceland from their calculations because they have no defense spending. Although I calculated contribution shares for them in the preceding analysis, I will follow Sandler and Shimizu and exclude Iceland from this portion of the calculations.

Comparing the cost and benefit shares will be done in two ways. First, I will use my burden shares and the benefit shares as calculated by Sandler and Shimizu. Second, I will add my benefit variable mentioned previously. Table 8.5 consolidates the data to be used for the first calculation with the results shown in Table 8.6. The alternative (H_a) and null (H_0) hypotheses for this test will be as follows:

> *$H2_a$: Within the NATO alliance, the distribution of defense burdens and average benefit-shares are different*
>
> *$H2_0$: The distributions of defense burdens and average benefit share for the NATO allies are the same*

Table 8.5: Benefit and Burden Shares during Balkan Operations

Member	Benefit Share (1999)	Total Aircraft Share	Total Sortie Share	Support Aircraft Share	Support Sortie Share
Belgium	0.67	0.92	0.27	0.15	0.02
Canada	17.27	1.29	0.37	0.53	0.08
Czech Rep.	0.45	NA	NA	NA	NA
Denmark	0.96	0.53	0.15	0.09	0.01
France	6.87	10.26	6.48	2.09	2.49
Germany	12.64	4.32	1.82	1.88	0.33
Greece	7.68	0.01	0.00	0.04	0.01
Hungary	0.56	NA	NA	NA	NA
Italy	4.10	6.22	2.70	2.40	0.49
Luxembourg	0.04	0.01	0.00	0.05	0.01
Netherlands	1.09	3.50	3.49	1.22	0.61
Norway	2.47	0.52	0.11	0.70	0.01
Poland	1.64	NA	NA	NA	NA
Portugal	0.63	0.19	0.00	0.00	0.00
Spain	5.07	1.81	0.43	1.46	0.12
Turkey	5.65	2.95	0.56	0.05	0.01
U.K.	6.57	5.96	5.50	3.61	2.46
U.S	25.65	61.51	77.93	85.73	93.36

Benefit shares from Sandler and Shimizu (2014) using GDP, Population, Exposed Borders, and Terrorism in Venue Country as Proxies for Benefits.

(Note: Burden shares are only calculated for members who were part of NATO for the entire Balkan campaign. Iceland was excluded due to a lack of defense spending. Totals may not equal 100% due to rounding.)

Table 8.6: Wilcoxon Signed Rank Correlation of Contributions to the Balkan Campaign and Benefit Shares (as Measured by Sandler and Shimizu)

	Sample Size	Model1 Total Aircraft Share	Model2 Total Sortie Share	Model3 Support Aircraft Share	Model4 Support Sortie Share
R Statistic	15	43(0.33)	24**(0.04)	18**(0.02)	15***(0.01)

(Note. Only members who were part of NATO for the entire Balkan campaign are included. Iceland was excluded due to a lack of defense spending. Numbers in parentheses are prob-values. The critical values for rejecting the null hypothesis of a match between defense contributions and benefit shares are 25 at .05 level and 15 at .01 level. Benefit shares from Sandler and Shimizu (2014) using GDP, Population, Exposed Borders, and Terrorism in Venue Country as Proxies for Benefits. ***significant at .01 level; **significant at .05 level; and *significant at .10 level.)

Model 1 indicates concordance between the defense burden and benefits. I cannot reject the null hypothesis that distributions of defense burdens and average benefit share for the NATO allies are the same. However, when I move to the second model and examine the sorties flown by each member, the balance shifts. With an R Statistic of 24, I can reject the null hypothesis at the 0.05 confidence level and conclude that the contributions no longer match the benefits derived from membership in NATO.

When I focus on the complex and expensive support aircraft, the concordance between benefits and burdens becomes even more divergent. Comparing support aircraft contributions with derived benefits results in an R Statistic of only 18, allowing me to reject the null hypothesis with a prob value of 0.02. When examining the sorties flown by the support aircraft, the numbers drop to 15 and 0.01 respectively indicating that benefits and burdens are not balanced.

It is worth noting that the conflict in the Balkans may have been more significant to some members than others. The benefits of protecting a nearby border from violence or refugee flow may outweigh the benefits of protecting a border that is further away. This perceived benefit difference may have resulted in different contributions. Specifically, the European members would likely benefit more from intervention than the North American members. The preceding example averaged the benefit measurements calculated by Sandler and Shimizu that did not include specifics related to the Bosnian conflict.

To capture this benefit, I will measure the distance between each member's capital city and Sarajevo. The results are shown in Table 8.7. Since members who are closest to the conflict are likely to gain the largest benefit, the proximity benefit share is calculated based on the inverse of the distance in the second column. The total benefit share is simply the average of GDP, Population, Exposed Borders, Terrorism, and Balkan Conflict Proximity.

The results are shown in Table 8.8.

Table 8.7: Benefit Measurement Based on Proximity to the Balkan Conflict

Member	Distance to Sarajevo (km)	Proximity Benefit Share	Total Benefit Share
Belgium	1,310	4.78	1.49
Canada	6982	0.90	14.00
Czech Rep.	754	8.30	2.02
Denmark	1378	4.54	1.68
France	1349	4.64	6.42
Germany	1032	6.06	11.32
Greece	792	7.90	7.72
Hungary	407	15.38	3.52
Italy	529	11.83	5.65
Luxembourg	1132	5.53	1.14
Netherlands	1376	4.55	1.78
Norway	1858	3.37	2.65
Poland	951	6.58	2.63
Portugal	2360	2.65	1.03
Spain	1857	3.37	4.73
Turkey	1273	4.92	5.50
United Kingdom	1620	3.86	6.03
United States	7511	0.83	20.69

Distance between cities from Google Maps (2020). Benefit Shares calculated using GDP, Population, Exposed Borders, and Terrorism from Sandler and Shimizu (2014).

Notes: Total benefit shares are the average of the five proxies. Iceland was excluded due to a lack of defense spending

Table 8.8: Wilcoxon Signed Rank Correlation of Contributions to the Balkan Conflict and Benefit Shares

	Sample Size	Model1 Total Aircraft Share	Model 2 Total Sortie Share	Model 3 Support Aircraft Share	Model 4 Support Sortie Share
Proximity Benefit R Statistic	15	35(0.16)	22**(0.03)	15***(0.01)	15***(0.01)
Total Benefit R Statistic	15	35(0.16)	23**(0.04)	15***(0.01)	15***(0.01)

(Note. Only members who were part of NATO for the entire Balkan campaign are included. Iceland was excluded due to a lack of defense spending. Numbers in parentheses are prob-values. The critical values for rejecting the null hypothesis of a match between defense contributions and benefit shares are 25 at .05 level and 15 at .01 level. Benefit shares from Sandler and Shimizu (2014) using GDP, Population, Exposed Borders, and Terrorism in Venue Country as Proxies for Benefits. Proximity benefit shares based on data from Google Maps (2020). Total benefit share is the average of the five proxies. ***significant at .01 level; **significant at .05 level; and *significant at .10 level.)

When I use the conflict proximity benefit share exclusively, I find that the benefits are not in concordance with burdens for the last three models. However, I cannot reject the null hypothesis for concordance between aircraft contributions and the proximity benefit. When I average the proximity benefit with the other proxies developed by Sandler and Shimizu (2014) I find substantially similar results. The measurement based on aircraft contributions alone does not allow me to reject the null hypothesis at the 0.05 level with an R Statistic of 35 and a prob factor of 0.16. However, the next models allow me to confidently reject the null and conclude that benefits and burden shares are not in concordance.

Given the findings that burden-sharing was uneven, and exploitation was likely occurring in the Balkan campaigns, combined with the evidence that benefits and burdens are not in concordance, it is worth further investigation. Many NATO members came under harsh criticism for their perceived shirking during these three operations.

Combined Balkan Operations Summary

The examination of NATO's operations in the Balkans presents strong evidence that exploitation is occurring in the alliance. When I consider contributions of aircraft in each phase of the conflict, I show that the wealthier members are bearing the brunt of the contributions. This is true even when I correct for GDP. Perhaps even more interesting, when I count the number of sorties flown by these aircraft, burden-sharing becomes even more uneven. This supports the capability gap argument. Some members contributed aircraft that lacked critical technologies such as all-weather and precision strike capabilities. This meant that some aircraft were grounded and not able to contribute many sorties to the operations.

The findings regarding support aircraft were even stronger in support of the exploitation hypothesis. Despite NATO's AWACS program that was intended to allow poorer nations to contribute fractionally towards the cost of expensive support aircraft, I still find that the richer members contribute disproportionally more. This finding supports both the exploitation hypothesis as well as the capabilities gap. Exploring the number of sorties flown by these support aircraft is even more interesting. Comparing Figure 8.2 (sorties) and Figure 8.1 (aircraft) reveals an important difference. While there is still broad exploitation occurring, this is also the strongest evidence of the capabilities gap in this study. The United States’ contribution of support sorties dwarfs the other members even when adjusted for GDP. Not only did the U.S. contribute significant numbers of support aircraft, but these aircraft possessed the necessary technologies to perform the mission.

CHAPTER 9

CONCLUSION

Motivation and Research Question

NATO has come under considerable criticism by Defense Secretary Gates as well as President Trump due to concerns over uneven burden-sharing. They both claim that the United States bears a disproportionate burden while other members fail to contribute a fair share. The goal of my work is to evaluate these claims. Is burden-sharing unbalanced within the NATO alliance? Is there a concordance between burdens and benefits? Furthermore, does a capabilities gap exist within NATO that might drive these concerns? Using new data that includes aircraft and sortie contributions to NATO military operations, I perform Spearman rank correlation tests to check for an association between a member’s GDP and their contributions. Additionally, I test for a relationship between burdens and benefit shares using the Wilcoxon signed rank test.

Findings and Implications

By examining aircraft and sortie contributions to NATO combat operations, I find that burden-sharing is unequal with the wealthier members overcontributing. As I focused on the more complex support aircraft, I found continued exploitation and evidence of a capabilities gap in NATO. These results support the argument that NATO has evolved into a three-tier organization. The United States brings key capabilities to crisis management combat operations that only it can provide. The second tier of membership provides limited support capabilities, while the poorest members can contribute little or even nothing in this category. This fact is most clearly demonstrated by the numbers of support sorties contributed by the membership in my case studies. Except for the United States, these percentages decreased when I examined support sorties because other members lacked the ability to sustain their contribution levels. Additionally, benefit and burden shares were not balanced. During the Balkan Campaign, the U.S. had a support sortie burden share of more than 93% while receiving less than a 21% benefit share. The next wealthiest group of contributors, Germany, France, Great Britain, and Italy had a combined support sortie burden share less than 6% while receiving benefit shares of close to 30%. The remaining members contributed a total of less than 1% of the support sorties required during the Balkan operations. Furthermore, these poorer members received close to half of the total benefit shares. These findings are the strongest evidence yet of imbalanced burden-sharing in the NATO alliance and indicate challenges for NATO in the future.

Previous examinations based on military expenditures have found uneven burden-sharing during the current third phase of NATO doctrine. However, this study has revealed deeper layers due to the comprehensive dataset that includes the specific types of aircraft contributed as well as the specific types of sorties. Beginning with an aircraft count during the early phases of the Kosovo operations, I show that the wealthier members are being exploited; this evidence of exploitation is in line with previous research. There is no strong evidence in the first model of the capabilities gap between the U.S. and the rest of the membership during the first phase. When I adjust for GDP (Figure 6.1) I find that seven other members contributed at a higher level than the United States during Operation Deny Flight. As NATO's Balkan operations expanded, I find continued exploitation and that the U.S. role becomes more important as the second-tier members reach the limits of their capabilities. Once full deployment numbers are reached during Operation Allied Force, the United States is the second largest GDP-corrected contributor behind Turkey (Figure 5.4). These findings are important because they confirm the findings of previous research with new data. In addition, the fact that the middle powers were able to contribute on par with the United States during the smaller phase but fell behind during the largest phase of the operations provides early evidence of the capabilities gap. While this is intriguing, the second model counting sorties uncovers the true significance of my research.

The best illustration of the findings revealed by sortie calculations is to compare Turkey with the United States. During the years of the Balkan operations, Turkey was by far the biggest over-contributor of aircraft when I adjust for GDP. The United States was fourth behind the Netherlands and France (Figure 8.1). However, the results change significantly when I tally the sorties flown by these aircraft. Turkey falls to fifth place while the Dutch and the Americans rise to the first and second place (Figure 8.2). Turkey flew their aircraft less often, while the Netherlands and the United States flew their aircraft more frequently. Due to the poor weather conditions and the desire to avoid civilian casualties, precision strike technology was the preferred strategic response. The fact that some members such as Turkey did not fly as much as others during poor weather could point to the capabilities gap, but it could also indicate shirking. The Turkish pilots may have lacked training, or their aircraft were without key capabilities.

Additionally, military leaders could have been hesitant to risk personnel in less-than-ideal circumstances. Regardless of the reason, I found that some nations left their aircraft on the ramp while others flew them frequently. When I examine sortie contributions, I find that burden-sharing is more uneven than has been shown in previous studies.

The disparity between total aircraft and sortie contributions demonstrates exploitation and points towards the capabilities gap, but also indicates the possibility of shirking. In contrast, the examination of the more expensive and complex support aircraft provides convincing evidence that points directly towards the capabilities gap. An outdated fighter lacking critical technology does not compare to a state-of-the-art B-2 Spirit stealth bomber. While the aircraft contributions may seem the same at first glance, the actual combat value of a B-2 far exceeds that of a 1960s attack aircraft. Analysis of support aircraft contributions such as tankers, heavy bombers and advanced electronic warfare planes revealed not only exploitation, but also revealed the United States as an extreme outlier even when adjusted for GDP (Figure 8.3). Put simply, many members could not contribute these aircraft because they did not have them. This is due the significant military capabilities gap that exists in NATO. The United States was able to contribute these support capabilities across all categories and exclusively in some such as heavy bombers. Many other members were unable to contribute in this category. To put this in context, it is worth discussing the NATO AWACS program. Because the members were aware of this capabilities gap in the 1970s, they implemented a plan to mitigate it. Poorer members would fractionally buy into these expensive support aircraft according to what they could afford. Luxembourg provides an excellent illustration of this principle at work. They gained a GDP adjusted support aircraft contribution share in fourth place after Norway and the Netherlands. Their financial contribution was equivalent to purchasing only one fifth of an AWACS aircraft, but this was significant when considering Luxembourg's relatively smaller GDP. If Luxembourg's example held across the board, the program might be successful at mitigating the capabilities gap and uneven burden-sharing. However, my findings indicate that the NATO AWACS program was not enough to accomplish this goal on its own. A major problem with the program is that the U.S. contributed more than 42% (Figure 5.2) to the acquisition cost of the AWACS aircraft. This type of program can only be successful if all members participate proportionally to their abilities.

Because many of the poorer members do not participate in the NATO AWACS program, I find that exploitation reaches the highest level in my fourth model which is based on the sorties flown by each member's support aircraft. Comparing the differences between the support aircraft contributed to the sorties flown by these aircraft provides additional evidence of the capabilities gap. The United States provided 83% of the support aircraft but flew 93% of the support sorties. Many of the support aircraft supplied by other members lacked key capabilities so the U.S. was required to fly their aircraft more often.

The United States is such an extreme outlier that most other contributions are not distinguishable in Figure 8.4. Only the Netherlands, Great Britain, and France contributed at a level that is perceptible in this graph. Furthermore, their contributions were only one sixth that of the U.S. after I control for GDP. The fact that the U.S. dominated the contributions so heavily in this category is the strongest indication of the capabilities gap in my study. Not only did it possess the support aircraft, but these aircraft included the technology necessary for modern combat operations. The best example is the B-2 Spirit heavy bomber. Due to the poor weather that obscured most target areas, many older strike aircraft were unable to fly and find their target. In contrast, the B-2 was able to strike multiple targets with precision weapons after mapping their targets through the weather using onboard synthetic aperture radar. The United States is the only NATO member that possesses B-2 bombers. These types of exclusive capabilities result in the U.S. flying disproportionally more sorties. Previous studies have found evidence of exploitation; however, my findings indicate a significant capabilities gap. Another important finding from this model is further evidence of the second and third membership tiers. Figure 8.4 revealed only a few members other than the United States who are distinguishable from the baseline.

The Balkans and NATO's Libyan Operations

An important question regarding the findings from my study of the Balkan operations is whether they hold up beyond this specific event. The 2011 intervention in Libya provides an additional case study of NATO crisis management and the opportunity to investigate the generalizability of my findings. The civil war to overthrow the Gaddafi regime resulted in a U.N. Security Council resolution and ultimately NATO military intervention. The air operations in Libya, Odyssey Dawn and Unified Protector, lasted from 19 March through 31 October 2011.

The air war in Libya provides an important contrast to the Balkan experience. NATO's Libyan operations were much smaller in scale, with 26,500 total sorties compared with more than 38,000 sorties flown during Allied Force alone. Additionally, this was intended to be the first NATO air operation where the Europeans were to take the lead role. U.S. Defense Secretary Gates, fed up with European members' previous lackluster contributions, insisted that the conflict in Libya was not of vital interest to the U.S. (Greenleaf, 2013). Therefore U.S. contributions should be minimized. Responding to Secretary Gates' admonishments, combined with disproportionate dependence on American contributions during the Kosovo campaigns, some allies felt pressured to contribute more. The most interesting example is the extraordinary effort of four nations and their F-16s. Table E.1 summarizes the contributions by Belgium, Denmark, the Netherlands, and Norway. Each nation provided just six F-16 fighter jets but flew an astonishingly high number of strike missions. Unfortunately, this pace was not sustainable for so few aircraft. In the middle of the operation, Norway, who had contributed 17% of NATO's strike missions up to that point, announced that it was withdrawing early, considering the burden of continued participation unmanageable (Greenleaf, 2013). The United States ultimately increased their contributions to 117 aircraft to avoid failure of the mission. Table E.2 indicates total allied contributions to the Libyan campaign by aircraft type.

While the original intention was for the European members to take a lead role in this operation, the capabilities gap between the United States and other NATO allies ultimately made this impossible. The United States eventually assumed the lead role:

“The United States filled gaps in ISR platforms, air-refueling aircraft, and drones. Flying only 25 percent of the sorties, America still supplied half of the aircraft, flew 80 percent of the air-refueling and ISR missions, and augmented airborne C2 with 25 percent of the coverage and control (Greenleaf, 2013, p. 38).” The UK and France provided the remaining ISR sorties, providing more evidence that NATO has become a three-tier organization. Greenleaf also notes that the U.S. flew nearly all the SEAD missions and provided CSAR support.

Calculating burden shares for total aircraft contributions reveals a Spearman’s Rho of 0.75 (0.00) indicating that exploitation continued to be a problem in Libya as well as Kosovo.

Concerns about uneven burden-sharing in the Kosovo operations clearly had an impact on some of the members as they began the Libyan campaign. However, the middle powers were unable to succeed without additional U.S. capabilities. While there was a commitment for some members to maximize contributions, exploitation persisted. Ultimately the capabilities gap will need to be closed before burden-sharing can normalize.

Significance and Benefit of NATO

Understanding the nature of alliance formation and dissolution has been an ongoing conundrum for both scholars and political leaders. The importance of a cooperative alliance like NATO is unquestionably significant to global stability and security. The NATO alliance has proven its ability to adapt and evolve to meet new threats over the past 65 years. The addition of new NATO member states and the cooperation between NATO members have contributed significantly to the peace and security of the world. Despite President Trump's assertion that NATO is obsolete, NATO persists and has proven to be remarkably adaptable and resilient. Because NATO survived beyond the end of the Cold War (and subsequently expanded), it unmistakably provides benefits beyond deterrence of the Warsaw Pact. What these benefits will be and how much each member should contribute remain as important questions on NATO's path forward.

Relevant to this point is the obvious question: Why does the United States continue to contribute disproportionately to NATO? Additionally, how long will the U.S, tolerate the imbalance? Perhaps the U.S. wants disproportionate control of the organization to legitimize in its foreign policy goals. Was the Kosovo intervention a demonstration of the United States' unique political personality in power at that time? Perhaps the benefit received by the U.S. was more humanitarian in nature and the president at that time, Bill Clinton placed significant value on stopping the genocide without concern for the costs. These are challenging questions for scholars.

Survival and Policy Implications

Since NATO has survived and evolved, the members see value in the alliance. However, given that membership in NATO is voluntary, member nations participate only when they perceive that membership benefits outweigh the costs. Consequently, the new NATO alliance faces a serious threat to its long-term survival if burden-sharing remains unequal and some members are taken advantage of. This shift in the burden-sharing balance suggests some policy implications.

To ensure the continued viability of NATO, a more comprehensive spending and military capabilities plan must be developed. This new plan must address the most significant problem facing NATO: Due to the sheer cost and complexity of certain types of new military technologies, only the United States can bear this significant financial burden.

One solution to this dilemma is to pool the resources of smaller members to jointly purchase the more expensive weapon systems. A concern with this type of cooperation is the fact that they would be surrendering some sovereignty and military decision-making. While this could be problematic for some, the feasibility of this concepts has already been tested in a smaller scale with the purchase of NATO AWACS aircraft in the 1970s. The fact that this program has continued shows that it has value. Adding a NATO fleet of airborne tankers that allows member buy-in according to their ability to pay would also be valuable. The same concept could be applied to other expensive support aircraft such as heavy airlift and bombers. For these types of programs to benefit the alliance, the U.S. should allow the other members to purchase shares rather than contributing as much as it did to the AWACS program. Recent purchases of the expensive F-35 aircraft provide evidence that some members are willing and able to contribute to this type of program.

In addition, recent technological advances in unmanned weapon systems such as MQ-9 Reapers have brought down the costs of long-range precision strike capability. The price to purchase and operate this type of system can be one tenth that of a traditional manned fighter jet such as the F-35 or F-22. This type of technology may offer a future solution for smaller nations to contribute while minimizing the risk to their pilots and ground troops. Due to their smaller footprint and the fact that they do not need airborne refueling would also reduce the need for some types of support aircraft such as tankers and heavy airlift. In addition, due to their low cost, purchasing a fleet of RPAs could provide similar strike capabilities to a heavy bomber such as the B-2 at a far lower cost.

The goal must be for members to agree upon a path towards rebalancing contributions in a meaningful way. The key is to implement a comprehensive policy that addresses the concerns of uneven burden-sharing. Regardless of the final decisions, something must be done to acknowledge, and mitigate, the threat of uneven burden-sharing within the NATO alliance.

Wrap up and Final Comments

My case studies have demonstrated in detail the cause and extent of U.S. over-contribution to NATO in the current "crisis management" phase of operations. The growing military capabilities gap must be specifically identified and dealt with through better planning and cooperation.

These findings support the arguments of former Defense Secretary Gates and President Trump that uneven burden-sharing has become a reality in NATO. This is likely to be unsustainable over the long-term. Free-riding member states must contribute in a meaningful way if they want to remain members. Their contributions should be proportionate to their ability to pay. In addition, members who contribute on paper, yet place extreme caveats on their military forces must be brought to reckoning. All members must be willing to accept the risks necessary to accomplish the mission.

Future research is necessary to fully understand the current balance of burdens and benefits in NATO as well as explore policy solutions to address any imbalance due to the capabilities gap.

APPENDIX A

SUPPLEMENTARY MATERIALS FOR CHAPTER 5

A.1 SUPPLEMENTARY TABLES

Table A.1:Contributions of “Middle Power” Members to OAF by Sortie Type

Sortie Type	France	Germany	Italy	Netherlands	UK
Combat Air Patrol	458	0	362	656	148
Close Air Support	396	0	358	110	686
Air Interdiction	821	0	90	319	415
Suppression of Enemy Air Defense	0	414	170	0	4
Reconnaissance	230	205	10	41	205
Air Refueling	389	0	90	126	291
Airborne Early Warning	49	0	0	0	163
Electronic Intelligence	71	17	1	0	38

Data compiled from Peters, et al., (2001) Note that table A.1 includes the contributions of the Netherlands as a middle tier power. While there is no clear definition of the line between the three tiers, both Canada and the Netherlands straddle the line.

Table A.2: Selected Types of Aircraft Contributed to OAF

Aircraft Type	Category	Year Introduced
B-52H Stratofortress	Heavy Bomber	1952
B-1B Lancer	Heavy Bomber	1974
B-2A Spirit	Heavy Bomber	1997
KC-10 Extender	Airborne Tanker	1980
E-3 AWACS	Airborne C2	1976
C-17 Globemaster	Heavy Airlift	1991
F-14 Tomcat	Fighter	1970
F-15C Eagle	Fighter	1979
Harrier	Attack	1967
A-10 Warthog	Attack	1972
Mirage F-1	Attack	1973
F-117 Nighthawk	Attack	1981
Jaguar	Fighter/Attack	1973
F-16 Falcon	Fighter/Attack	1974
FA-18 Hornet	Fighter/Attack	1978
Mirage 2000	Fighter/Attack	1978
F-15E Strike Eagle	Fighter/Attack	1985
Tornado	Attack/EW	1979
EA-6B Prowler	EW	1971
F-104 Starfighter	Interceptor	1954

Data are compiled from Lambeth (2001) and DOD (2000a)

Table A.3: Contributions to Operation Allied Force by Aircraft Category

NATO Member	**Fighter/Attack**	**Bomber**	**Airlift**	**Tanker**	**Specialty**	**Total Support**
Belgium	14	0	0	0	0	0
Canada	18	0	0	0	0	0
Czech Republic	0	0	0	0	0	0
Denmark	8	0	0	0	0	0
France	79	0	1	3	1	5
Germany	32	0	1	0	0	1
Greece	0	0	0	0	0	0
Hungary	4	0	0	0	0	0
Iceland	0	0	0	0	0	0
Italy	57	0	0	1	0	1
Luxembourg	0	0	0	0	0	0
Netherlands	20	0	0	2	0	2
Norway	6	0	0	0	0	0
Poland	0	0	0	0	0	0
Portugal	3	0	0	0	0	0
Spain	6	0	1	0	0	1
Turkey	21	0	0	0	0	0
United Kingdom	30	0	4	3	2	9
NATO AWACS	0	0	0	0	10	10
United States	**428**	**22**	**43**	**175**	**63**	**303**
Total	726	22	50	184	76	332

Data compiled from compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Table A.4: GDP and Sortie Contributions to Operation Allied Force

Member	GDP($B) (1999)	GDP Rank	SOR	SOR Rank	SOR/GDP	SOR/GDP Rank
Czech Republic	53.4	**16**	0	**9.5**	0	**9.5**
France	1431.0	**3**	2414	**2**	1.6869	**3**
Germany	2123.9	**2**	636	**6**	0.2994	**6**
Greece	124.7	**14**	0	**9.5**	0	**9.5**
Iceland	9.0	**19**	0	**9.5**	0	**9.5**
Italy	1167.8	**5**	1081	**5**	0.9257	**5**
Luxembourg	16.9	**18**	0	**9.5**	0	**9.5**
Netherlands	380.6	**8**	1252	**4**	3.2895	**2**
Poland	143.9	**13**	0	**9.5**	0	**9.5**
Portugal	109.6	**15**	0	**9.5**	0	**9.5**
UK	1400.9	**4**	1950	**3**	1.3920	**4**
US	8910.0	**1**	30018	**1**	3.3690	**2**

GDP and ME Data are from DOD (2000b), Iceland GDP is from World Bank (2019)
Sortie data compiled from DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).
Note: Members with restricted sortie data are excluded.

Table A.5: Robustness Check
Spearman Rank Correlation between Contributions and GDP
for
Operation Allied Force
Excluding Members with Zero Contributions

Total Aircraft Contributions	0.24 (0.37)
Total Sortie Contributions	0.60*** (0.01)
Support Aircraft Contributions	0.66*** (0.01)
Support Sortie Contributions	0.78*** (0.00)

Notes. Numbers in parentheses are prob-values.
***significant at .01 level;**significant at .05 level

A.2 SUPPLEMENTARY FIGURES

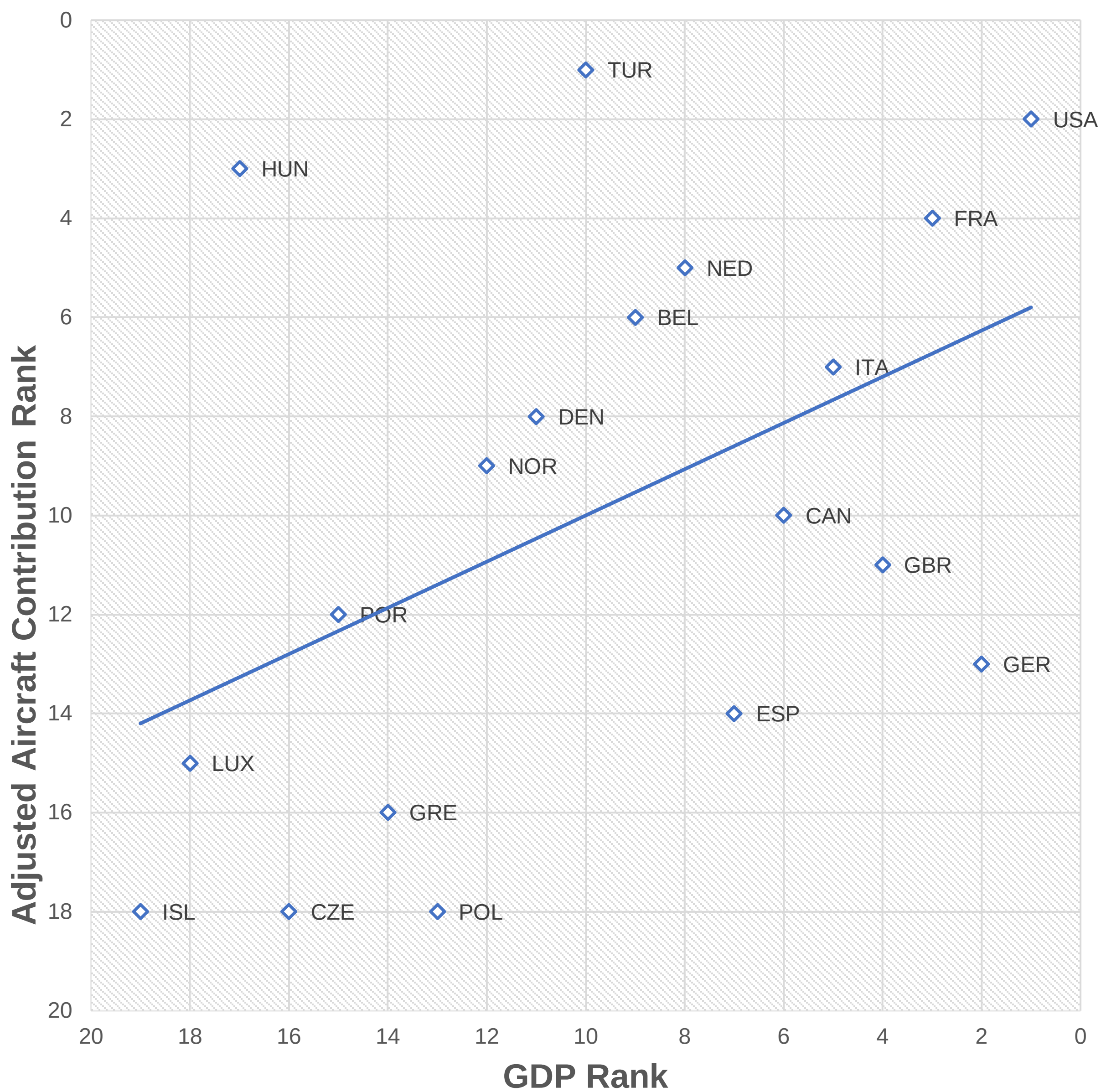

Figure A.1: Aircraft Contributions to OAF Divided by GDP (Rankings)

Spearman's rho = 0.47
Prob > |t| = 0.04

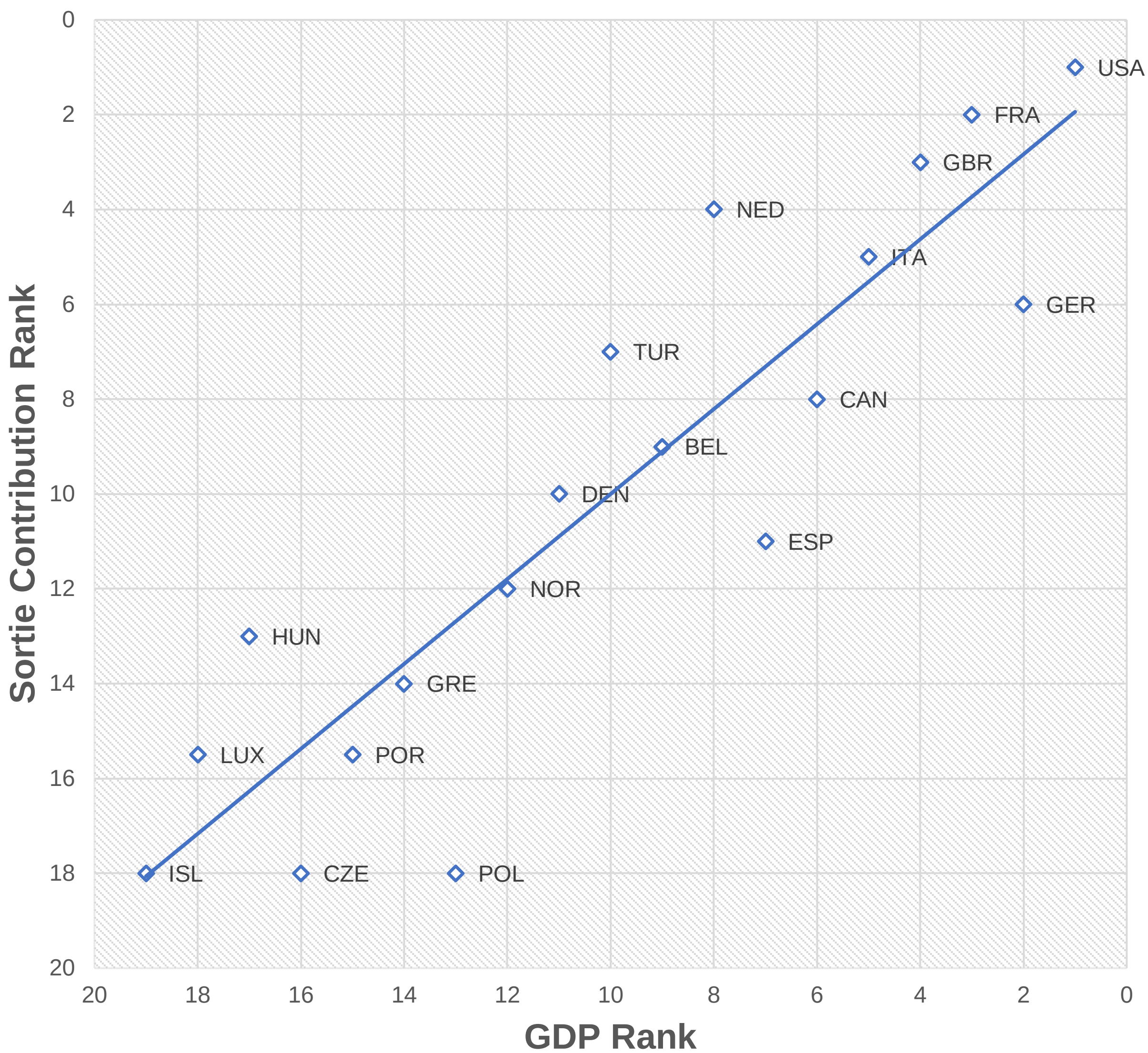

Figure A.2: Sortie Contributions to OAF Relative to GDP
(With Estimates)

Spearman's rho = 0.90
Prob > |t| = 0.00

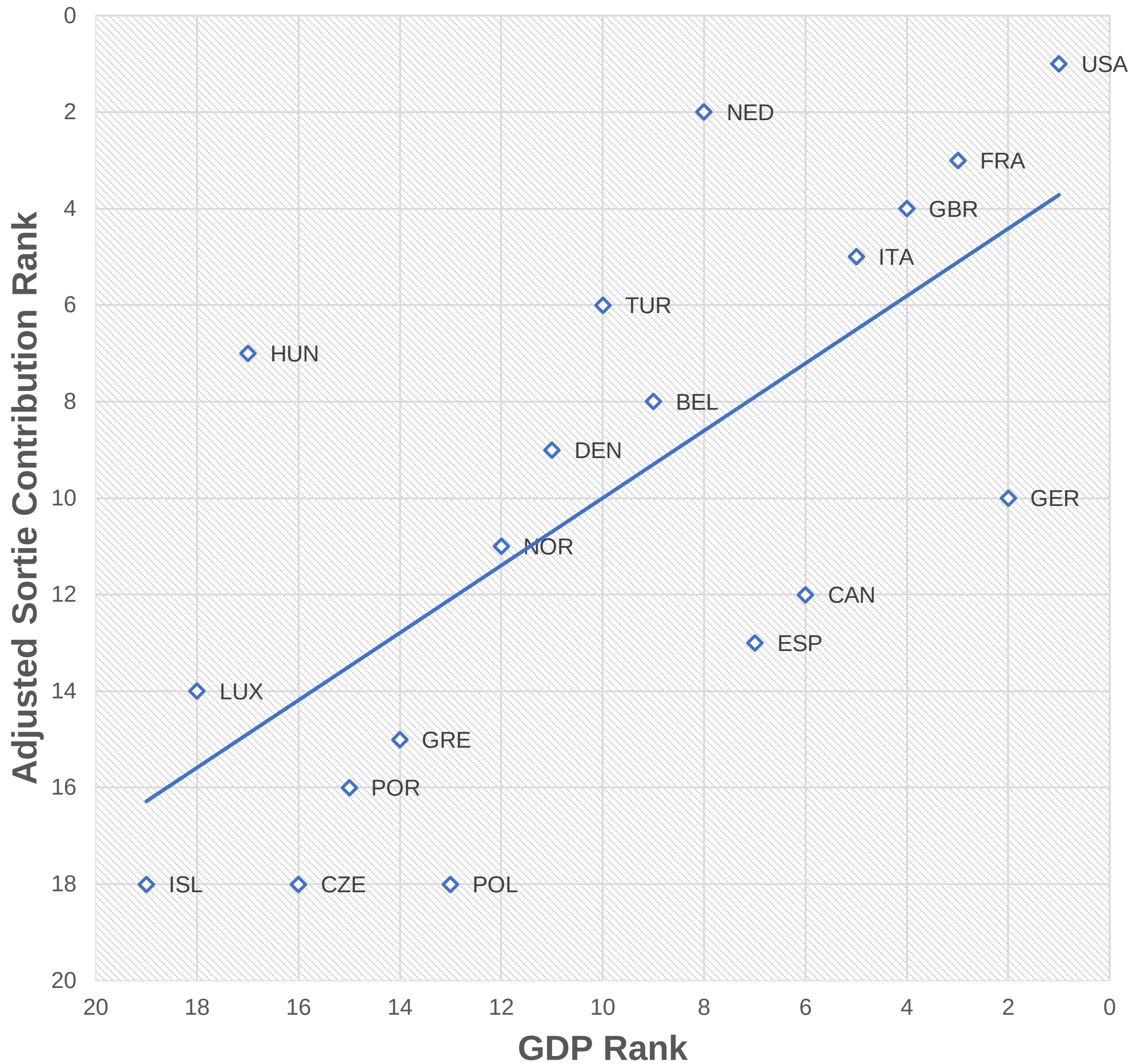

Figure A.3: Sortie Contributions to OAF Divided by GDP
(With Estimates)

Spearman's rho = 0.70
Prob > |t| = 0.00

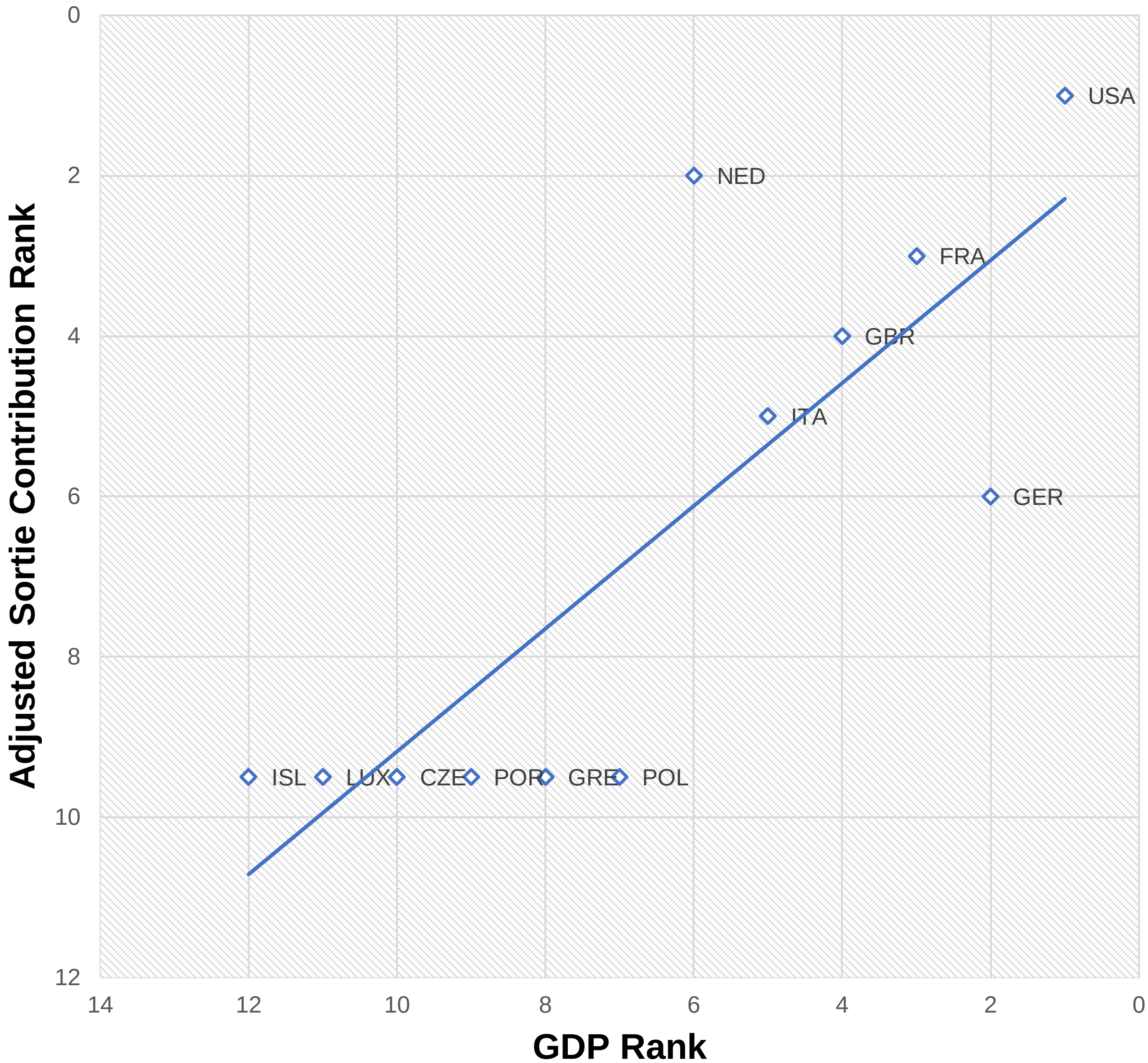

Figure A.4: Sortie Contributions to OAF Divided by GDP (Rankings)

Note: Data includes only the 12 members with confirmed sortie counts.

Spearman's rho = 0.82
Prob > |t| = 0.00

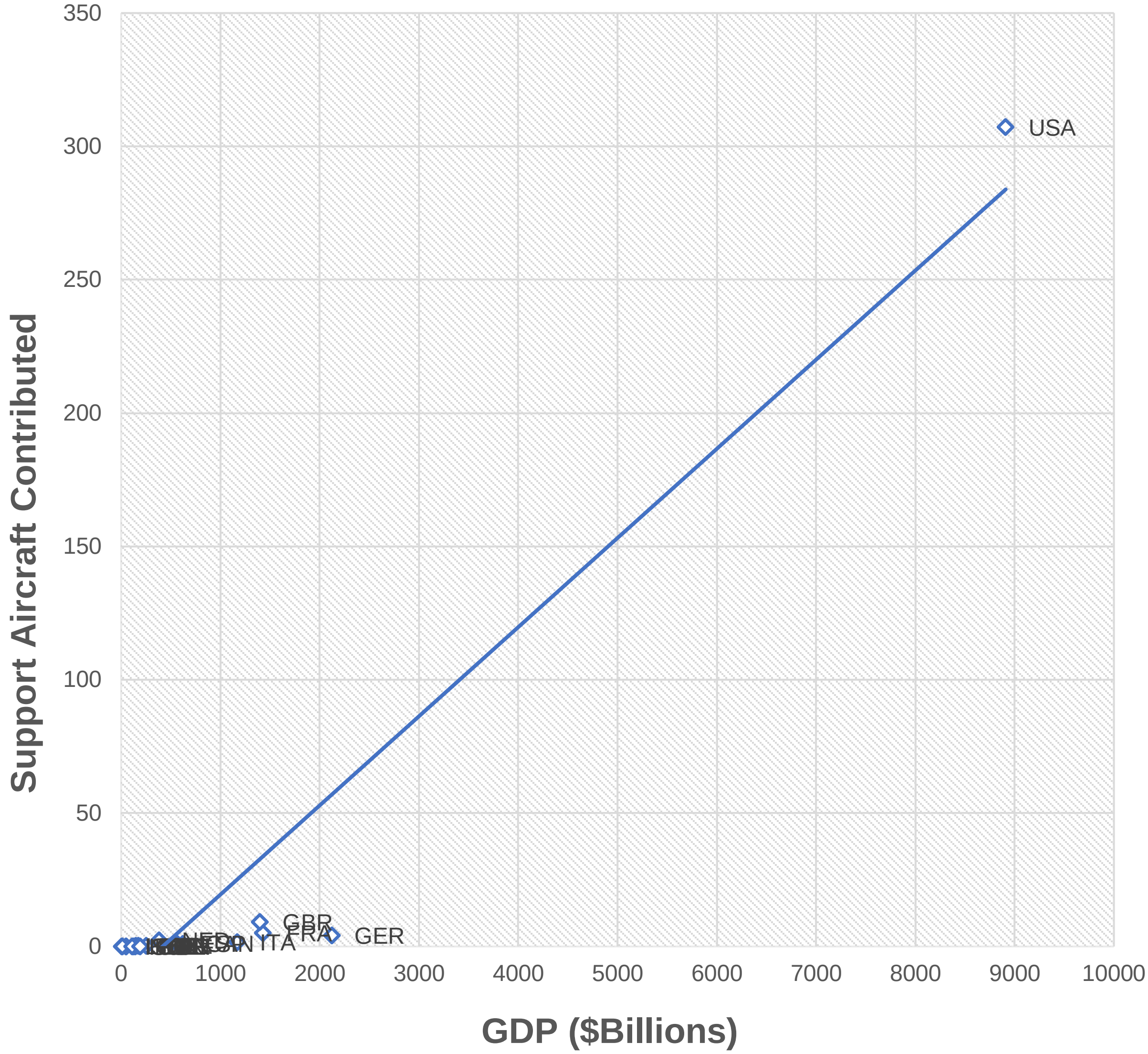

Figure A.5: Support Aircraft Contributions to OAF Compared to GDP

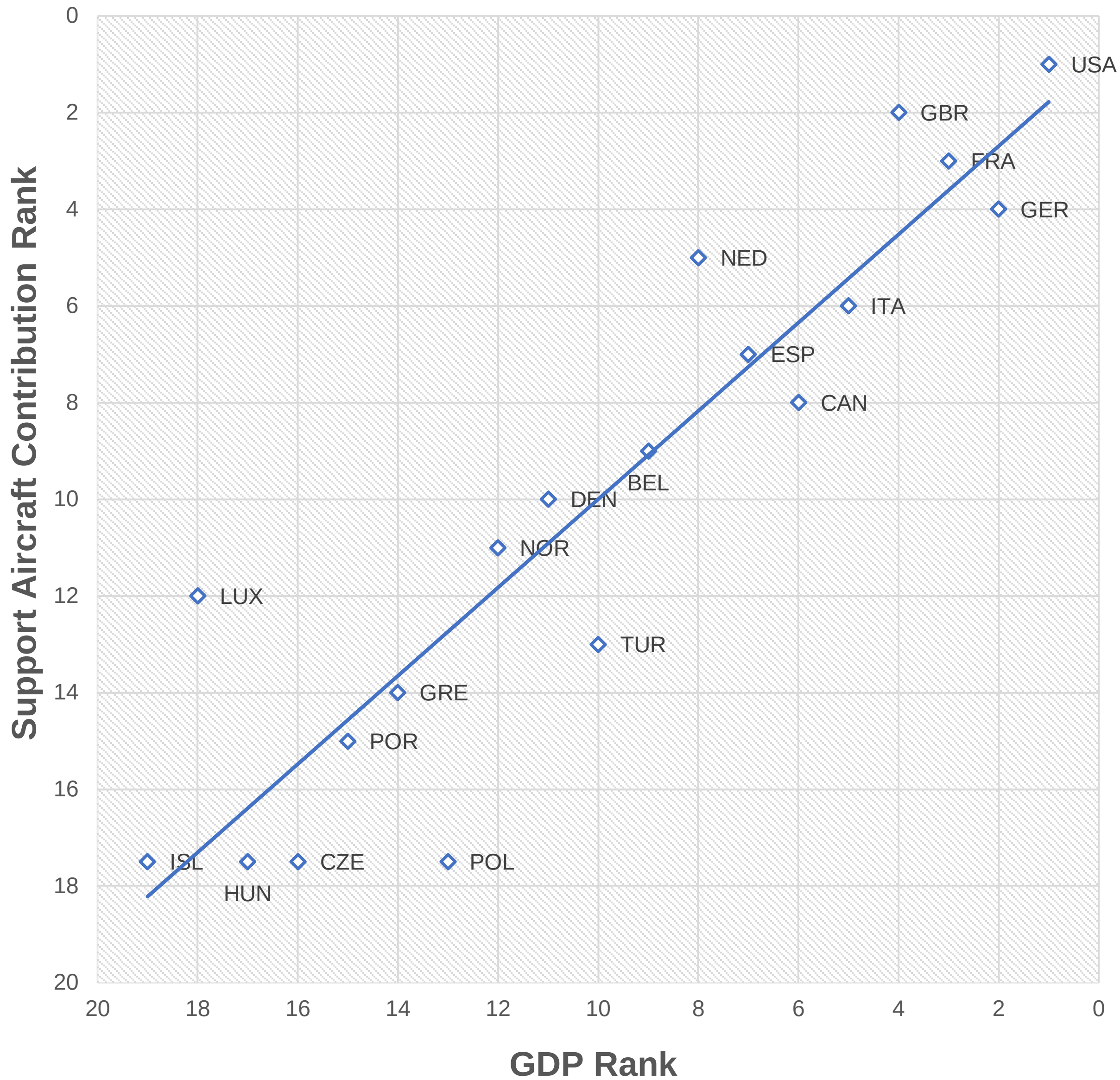

Figure A.6: Support Aircraft Contributions to OAF Compared to GDP (Rankings)

Spearman's rho = 0.92
Prob > |t| = 0.00

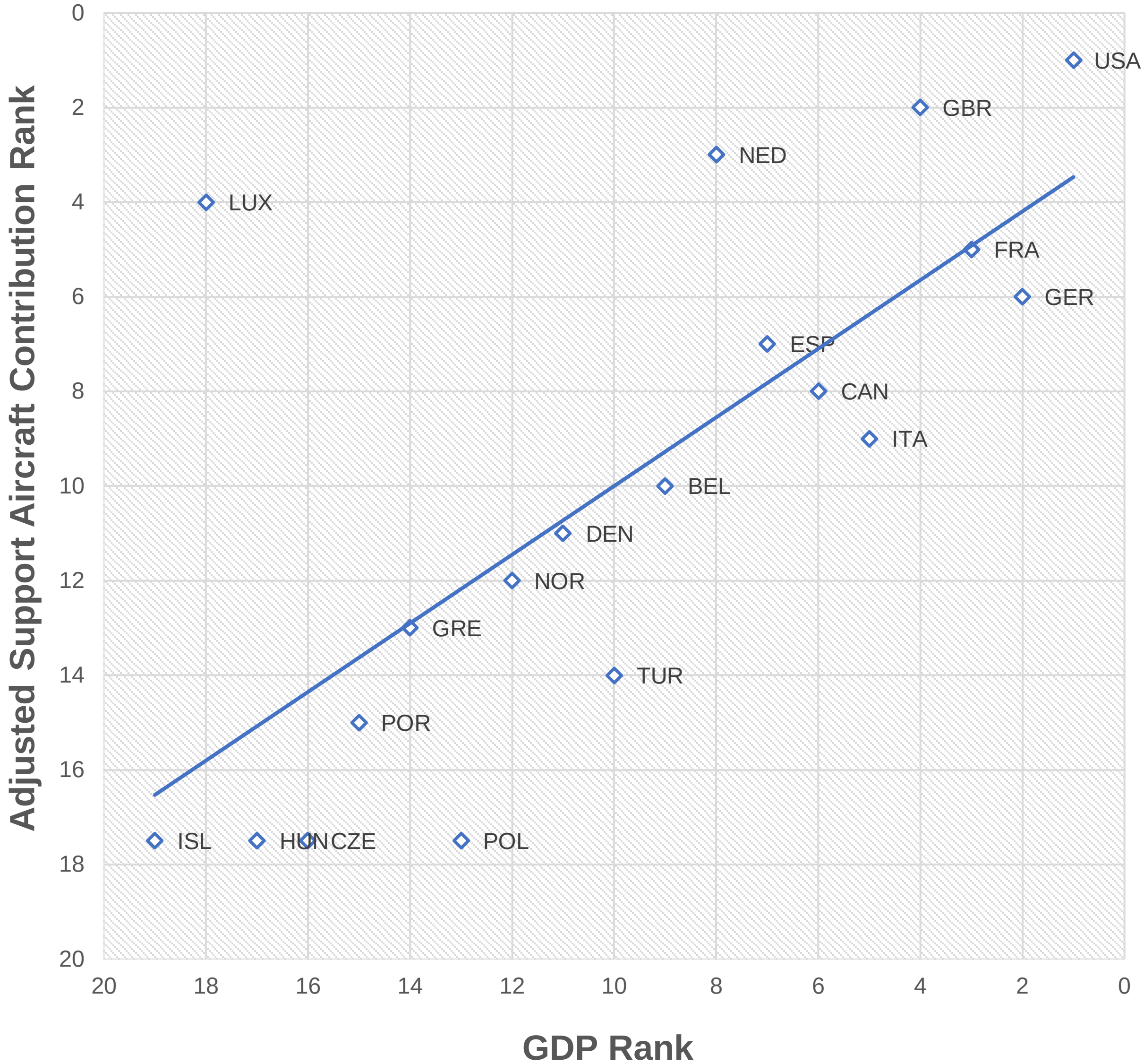

Figure A.7: Support Aircraft Contributions to OAF Divided by GDP (Rankings)

Spearman's rho = 0.73
Prob > |t| = 0.00

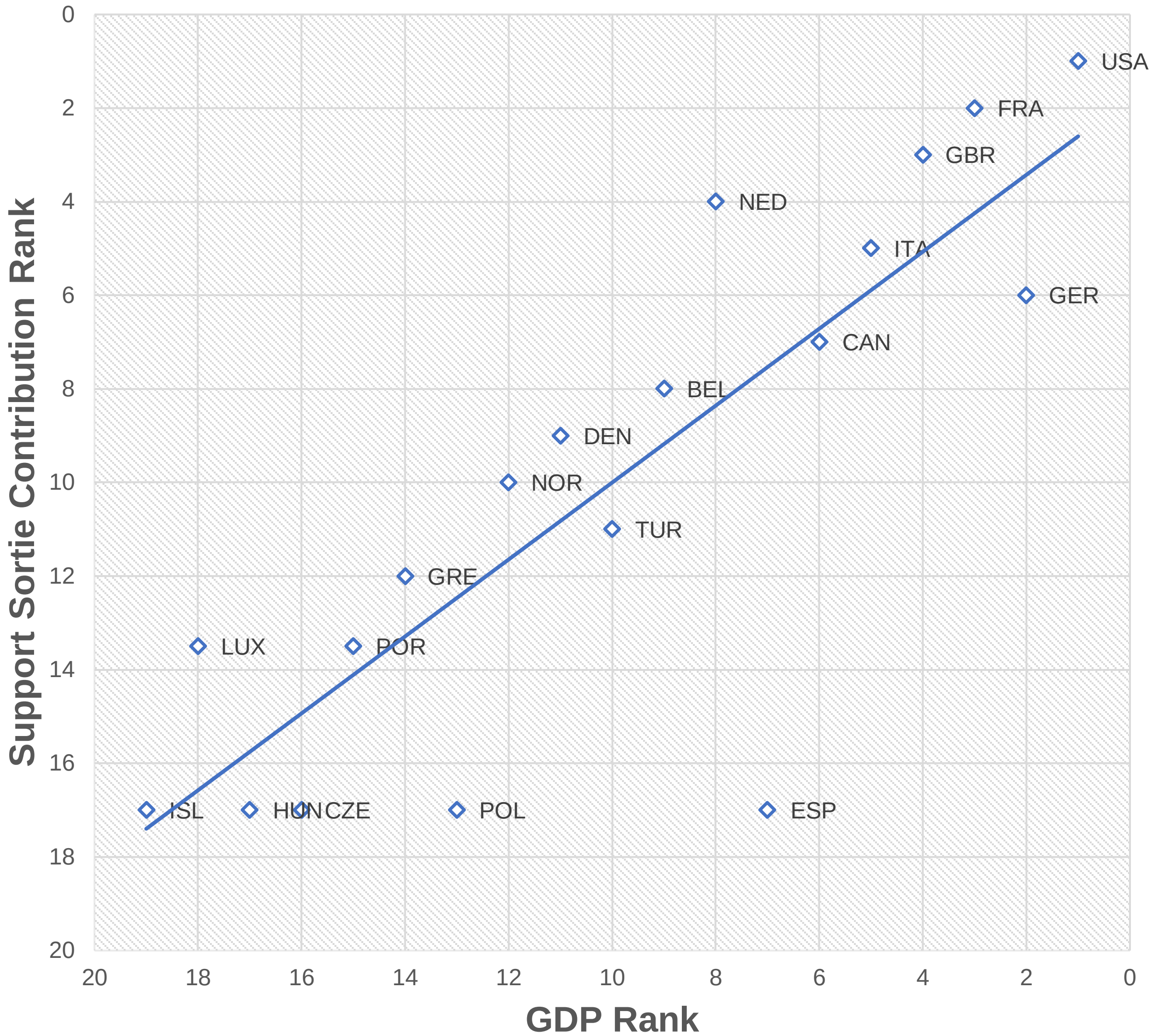

Figure A.8: Support Sortie Contributions to OAF Compared to GDP (Rankings)

Spearman's rho = 0.83
Prob > |t| = 0.00

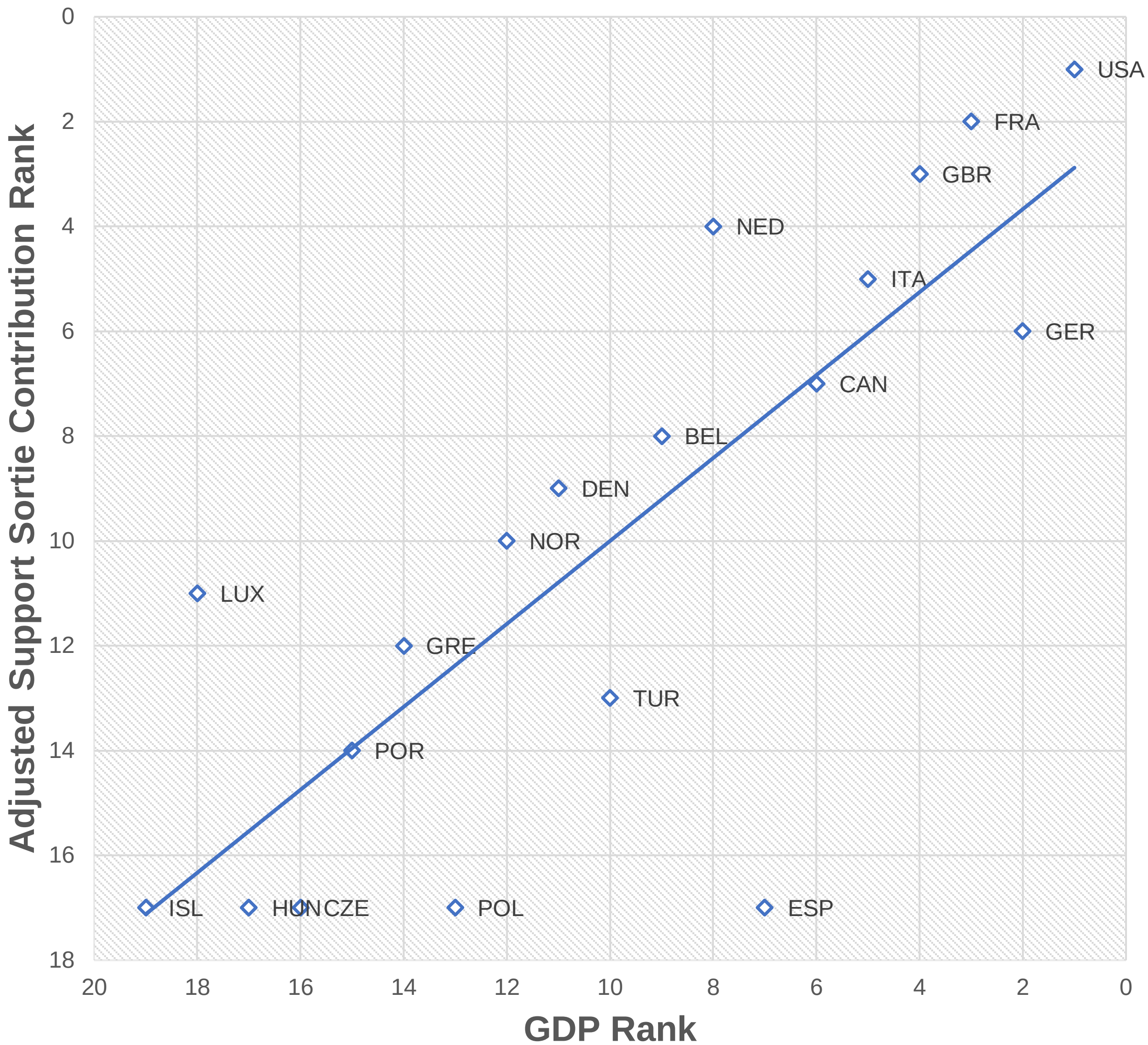

Figure A.9: Support Sortie Contributions to OAF Divided by GDP (Rankings)

Spearman's rho = 0.80
Prob > |t| = 0.00

APPENDIX B

SUPPLEMENTARY MATERIALS FOR CHAPTER 6

B.1 SUPPLEMENTARY TABLES

Table B.1: Contributions to Operation Deny Flight by Aircraft Type

France		
Aircraft	Number Contributed	Year Introduced
Mirage F-1CR Fighter	5	1973
Mirage 2000C Fighter	6	1982
Mirage 2000K/D Fighter/Bomber	4	1982
Super Etendard Fighter/Bomber	6	1978
Mirage F-1CT Fighter/Bomber	3	1973
Jaguar Fighter/Bomber	6	1973
C-135 Airborne Tanker	1	1957
E3F Airborne Early Warning	1	1977
Mystere Falkon 20 Transport Aircraft	1	1965
France Total	**33**	
Germany		
Aircraft	Number Contributed	Year Introduced
Panavia Tornado Fighter	14	1979
Germany Total	**14**	

Table B.1 (Continued): Contributions to Operation Deny Flight by Aircraft Type

Italy		
Aircraft	Number Contributed	Year Introduced
Panavia Tornado Fighter	8	1979
AMX Strike Fighter	6	1989
C-130 Medium Transport Aircraft	1	1956
G-222 Light Transport Aircraft	4	1978
B-707 Airborne Tanker	1	1957
Italy Total	**20**	
The Netherlands		
Aircraft	Number Contributed	Year Introduced
F-16A Fighter	12	1978
C-130 Medium Transport	1	1956
F-27 Light Transport	2	1958
Dutch Total	**15**	
Norway		
Aircraft	Number Contributed	Year Introduced
C-130 Medium Transport	2	1956
Norway Total	**2**	
Spain		
Aircraft	Number Contributed	
EF-18 Fighter	8	1984
CASA 212 Light Transport	1	1974
KC-130 Airborne Tanker	2	1962
Spain Total	**11**	
Turkey		
Aircraft	Number Contributed	Year Introduced
F-16C Fighter	8	1978
Turkey Total	**8**	

Table B.1 (Continued): Contributions to Operation Deny Flight by Aircraft Type		
United Kingdom		
Aircraft	Number Contributed	Year Introduced
FMK-3 Tornado	6	1979
GR-7 Harrier Fighter/Bomber	12	1969
Sea Harrier Fighter/Bomber	6	1969
L-1011 Airborne Tanker	2	1970 (1986 Converted)
E3D AEW	2	1977
UK Total	**28**	
United States		
Aircraft	Number Contributed	Year Introduced
F-15E Strike Eagle Fighter/Bomber	8	1989
FA-18C Hornet Fighter	18	1984
F-18D Hornet Fighter	12	1984
F-16C/D Fighter	12	1978
O/A-10 Warthog Attack Fighter	12	1977
EA-6B Electronic Warfare	16	1971
EC-130 Airborne C2	3	1975
EC-130 Electronic Warfare	2	1975
AC-130 Gunship	2	1968
KC-135 Airborne Tanker	10	1957
KC-10 Airborne Tanker	5	1981
U.S. Total	**100**	
NATO		
Aircraft	Number Contributed	Year Introduced
E3-A AWACS	8	1977
Grand Total	**239**	

(DOD, 1995)

Note: Some discrepancies in aircraft counts exist due to different methods of accounting. For example, some aircraft remain in theater while others drop off supplies then return to their home base. Various sources count these contributions differently.

Table B.2: Robustness Check
Spearman Rank Correlation between Contributions and GDP
for
Operation Deny Flight
Excluding Members with Zero Contributions

Total Aircraft Contributions	0.50* (0.06)
Support Aircraft Contributions	0.48* (0.07)

Notes. Numbers in parentheses are prob-values.
***significant at .01 level;**significant at .05 level; ;*significant at .10 level

B.2 SUPPLEMENTARY FIGURES

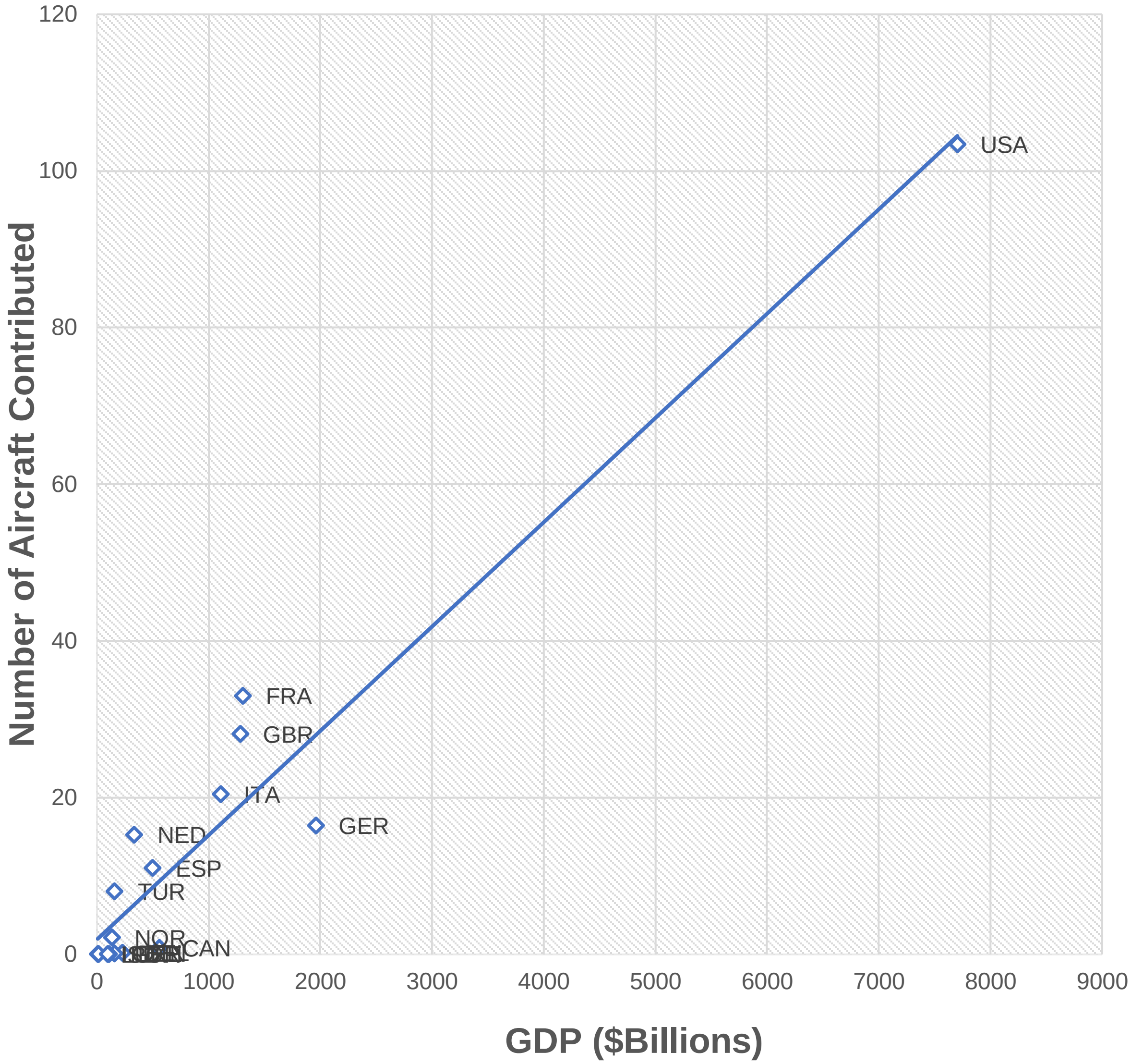

Figure B.1: Aircraft Contributions to Operation Deny Flight Relative to GDP

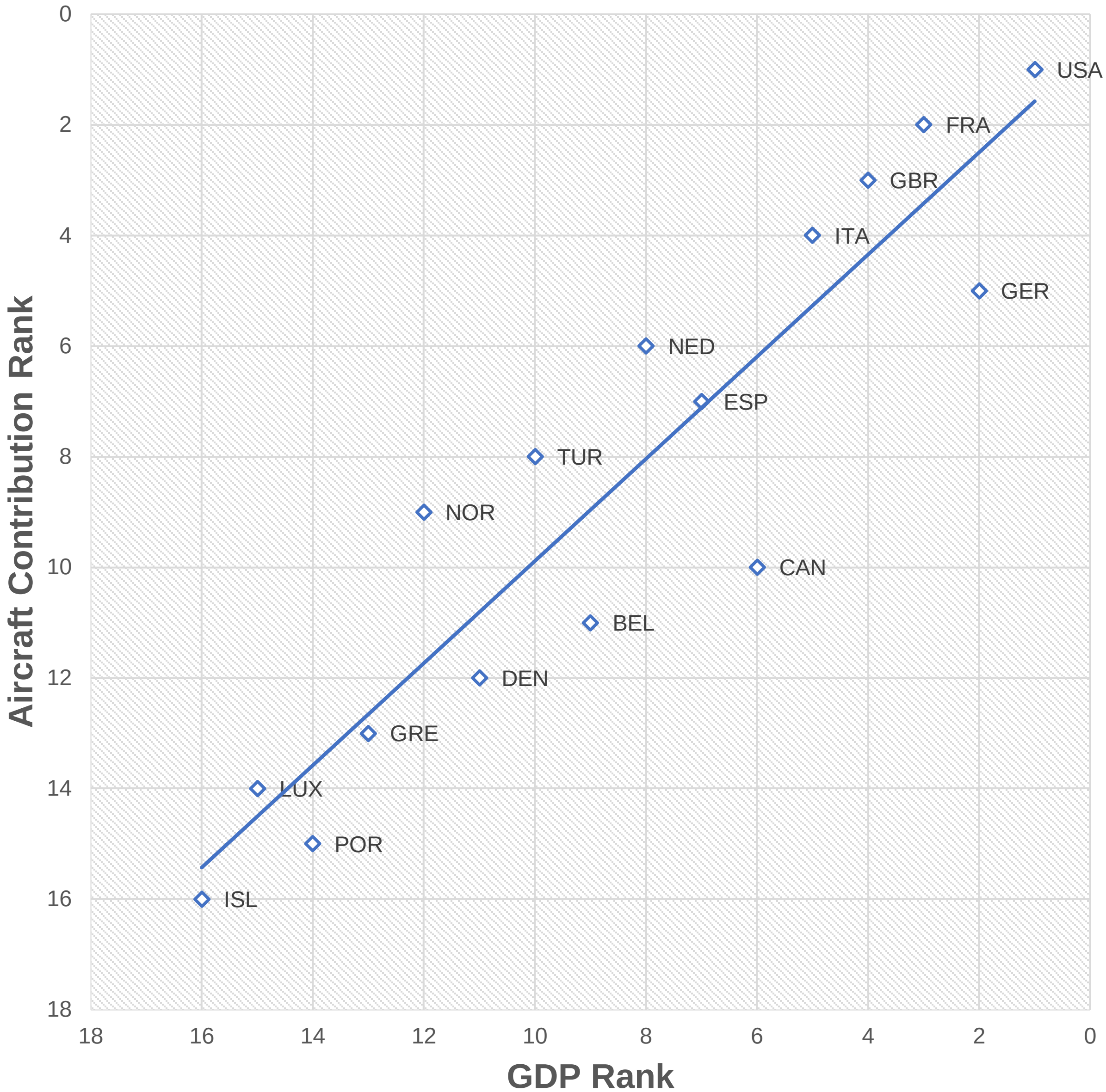

Figure B.2: Aircraft Contributions to Operation Deny Flight Compared to GDP (Rankings)

Spearman's rho = 0.92
Prob > |t| = 0.00

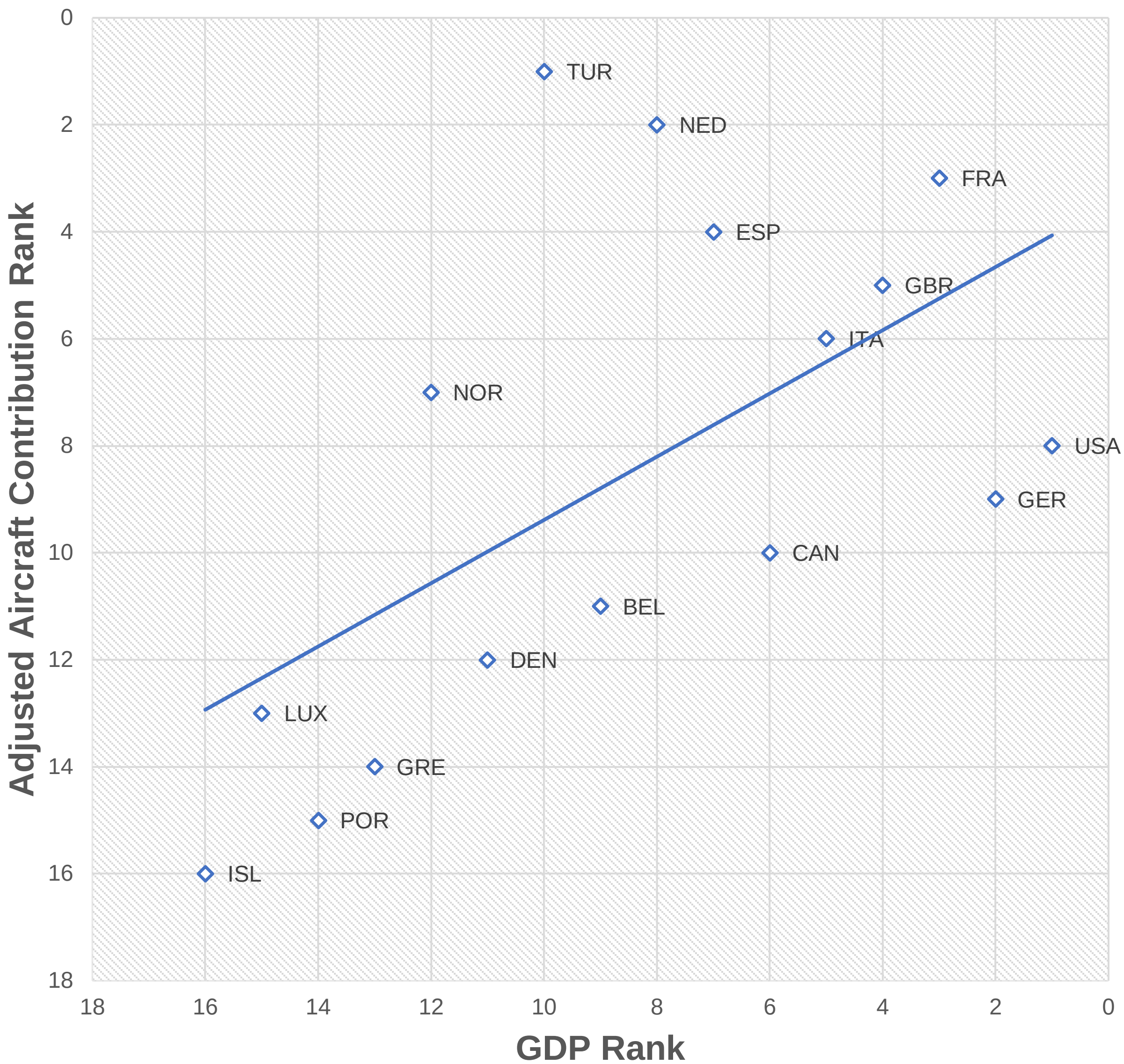

Figure B.3: Aircraft Contributions to Operation Deny Flight Adjusted for GDP (Rankings)

Spearman's rho = 0.59
Prob > |t| = 0.02

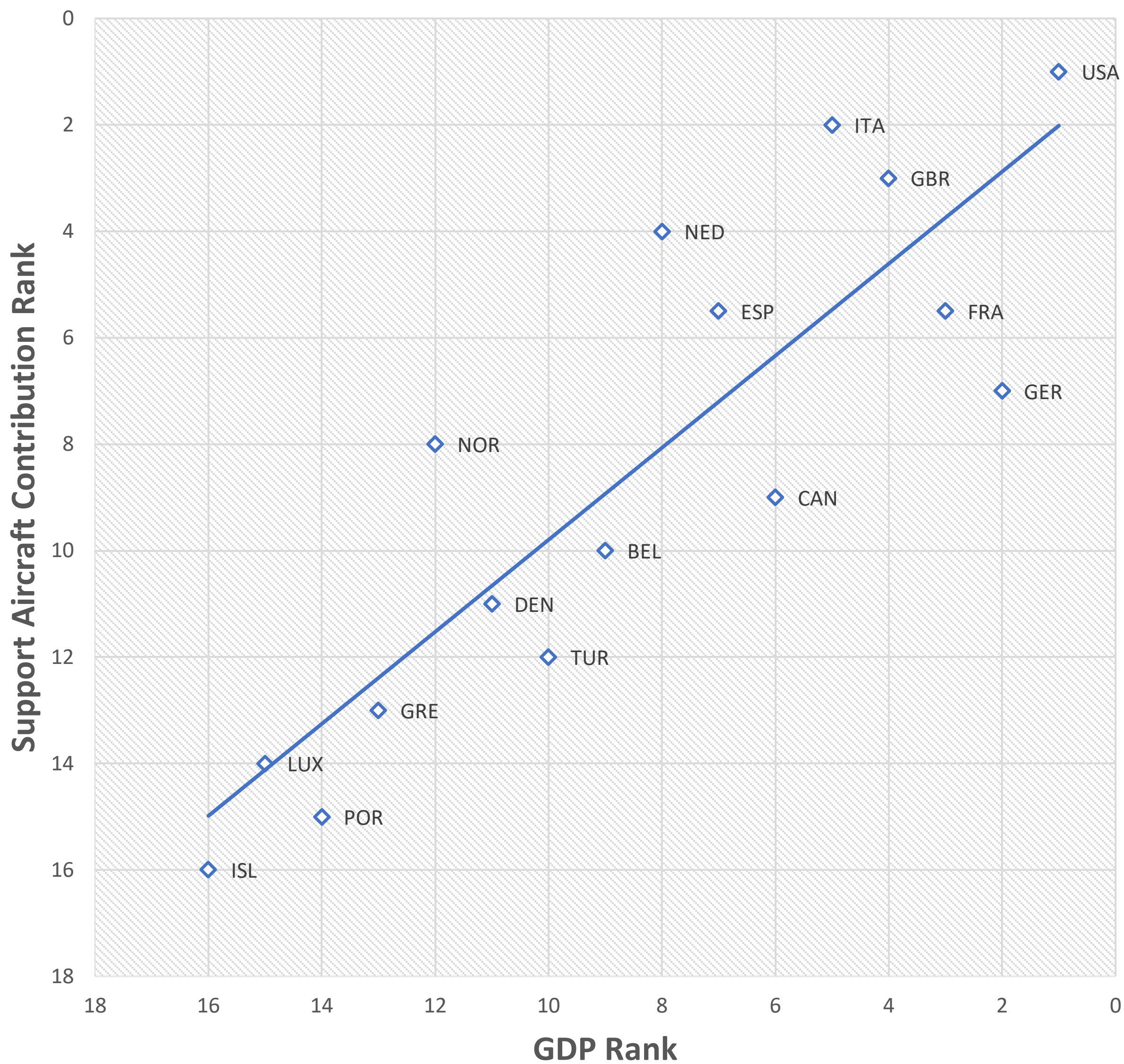

Figure B.4: Support Aircraft Contributions to Operation Deny Flight
Compared to GDP (Rankings)

Spearman's rho = 0.87
Prob > |t| = 0.00

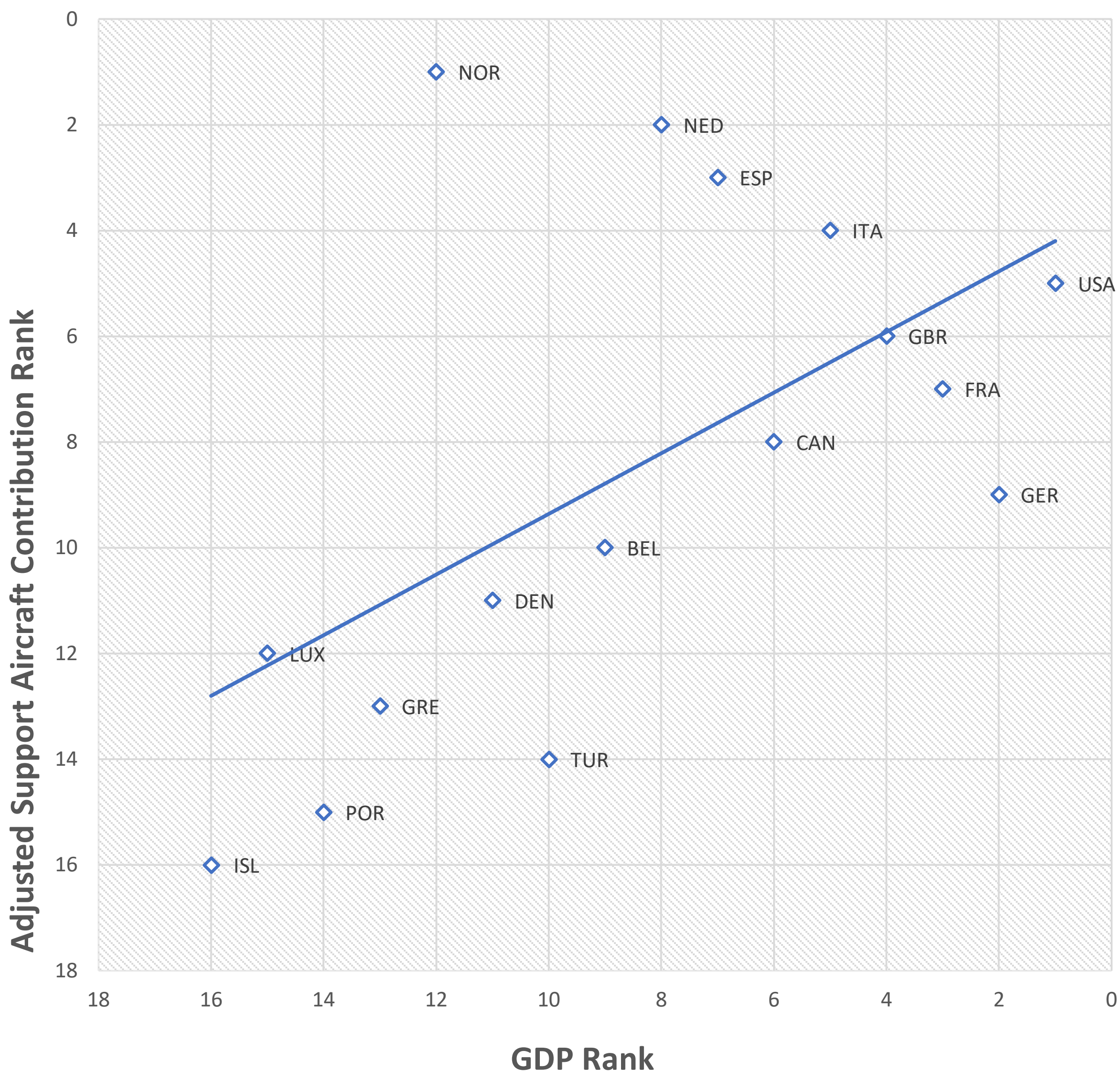

Figure B.5: Support Aircraft Contributions to Operation Deny Flight
Adjusted for GDP (Rankings)

Spearman's rho = 0.57
Prob > |t| = 0.02

APPENDIX C

SUPPLEMENTARY MATERIALS FOR CHAPTER 7

C.1 SUPPLEMENTARY TABLES

Table C.1: Contributions to Operation Deliberate Force by Aircraft Type

France		
Aircraft	Number Contributed	Year Introduced
Mirage F-1CR Fighter	6	1973
Mirage 2000C Fighter	9	1982
Mirage 2000K/D Strike Fighter	9	1982
Super Etendard Fighter/Bomber	6	1978
Mirage F-1CT Ground Attack	3	1973
Jaguar Fighter/Bombers	9	1973
Puma Helicopter	3	1957
C-135 Airborne Tanker	1	1977
E3F Airborne Early Warning	1	1973
France Total	**47**	
Germany		
Aircraft	Number Contributed	Year Introduced
Panavia Tornado Fighter	14	1979
Germany Total	**14**	

Table C.1 (Continued): Contributions to Operation Deliberate Force by Aircraft Type		
Italy		
Aircraft	Number Contributed	Year Introduced
Panavia Tornado Fighter	8	1979
AMX Strike Fighter	6	1989
C-130 Medium Transport Aircraft	1	1956
G-222 Light Transport Aircraft	4	1978
B-707 Airborne Tanker	1	1957
Italy Total	**20**	
The Netherlands		
Aircraft	Number Contributed	Year Introduced
F-16A Fighter	18	1978
Netherlands Total	18	
Spain		
Aircraft	Number Contributed	Year Introduced
EF-18 Fighter	8	1984
CASA 212 Light Transport	1	1974
KC-130 Airborne Tanker	2	1962
Spain Total	**11**	
Turkey		
Aircraft	Number Contributed	Year Introduced
F-16C Fighter	8	1978
Turkey Total	8	

Table C.1 (Continued): Contributions to Operation Deliberate Force by Aircraft Type

United Kingdom		
Aircraft	Number Contributed	Year Introduced
FMK-3 Tornado	6	1979
GR-7 Harrier Strike Fighter	12	1969
Sea Harrier Strike Fighter	6	1969
L-1011 Airborne Tanker	2	1970 (1986 Converted)
E3D AEW	2	1977
UK Total	28	
United States		
Aircraft	Number Contributed	Year Introduced
F-15 E Strike Eagle Fighter	10	1989
FA-18C Hornet Fighter	18	1984
F-18D Hornet Fighter	12	1984
F-16C/D Fighter	12	1978
F-16HTS SEAD Fighter	10	1978
O/A-10 Warthog Attack Fighter	12	1977
EC-130 Airborne C2	5	1975
EC-130 Electronic Warfare	4	1975
AC-130 Gunship	4	1968
KC-135 Airborne Tanker	15	1957
EA-6B Electronic Warfare	16	1971
EF-111A Electronic Warfare	6	1983
KC-10 Airborne Tanker	5	1981
C-21 Light Transport	2	1984
MH-53J Helicopter	6	1968
HC-130 Transport/CSAR	4	1975
U.S. Total	141	(Includes Rotary Wing)

Table C.1 (Continued): Contributions to Operation Deliberate Force by Aircraft Type

NATO		
Aircraft	Number Contributed	Year Introduced
E3-A AWACS	8	1977

(Owen, 2000)

Note: Some discrepancies in aircraft counts exist due to different methods of accounting. For example, some aircraft remain in theater while others drop off supplies then return to their home base. Various sources count these contributions differently.

Table C.2: Munitions Employed in Operation Deliberate Force

Member	Precision	Non-Precision	HARM
USA	622	12	54
France	14	73	0
Germany	0	0	0
Italy	0	50	0
Netherlands	0	136	0
Spain	24	0	2
Turkey	0	0	0
UK	48	47	0
Total	708	318	56

Data compiled from Owen (2000)

Table C.3: Robustness Check
Spearman Rank Correlation between Contributions and GDP
for
Operation Deliberate Force
Excluding Members with Zero Contributions

Total Aircraft Contributions	0.63*** (0.01)
Total Sortie Contributions	0.68*** (0.01)
Support Aircraft Contributions	0.82*** (0.00)
Support Sortie Contributions	0.80*** (0.00)

Notes. Numbers in parentheses are prob-values.
***significant at .01 level;**significant at .05 level

C.2 SUPPLEMENTARY FIGURES

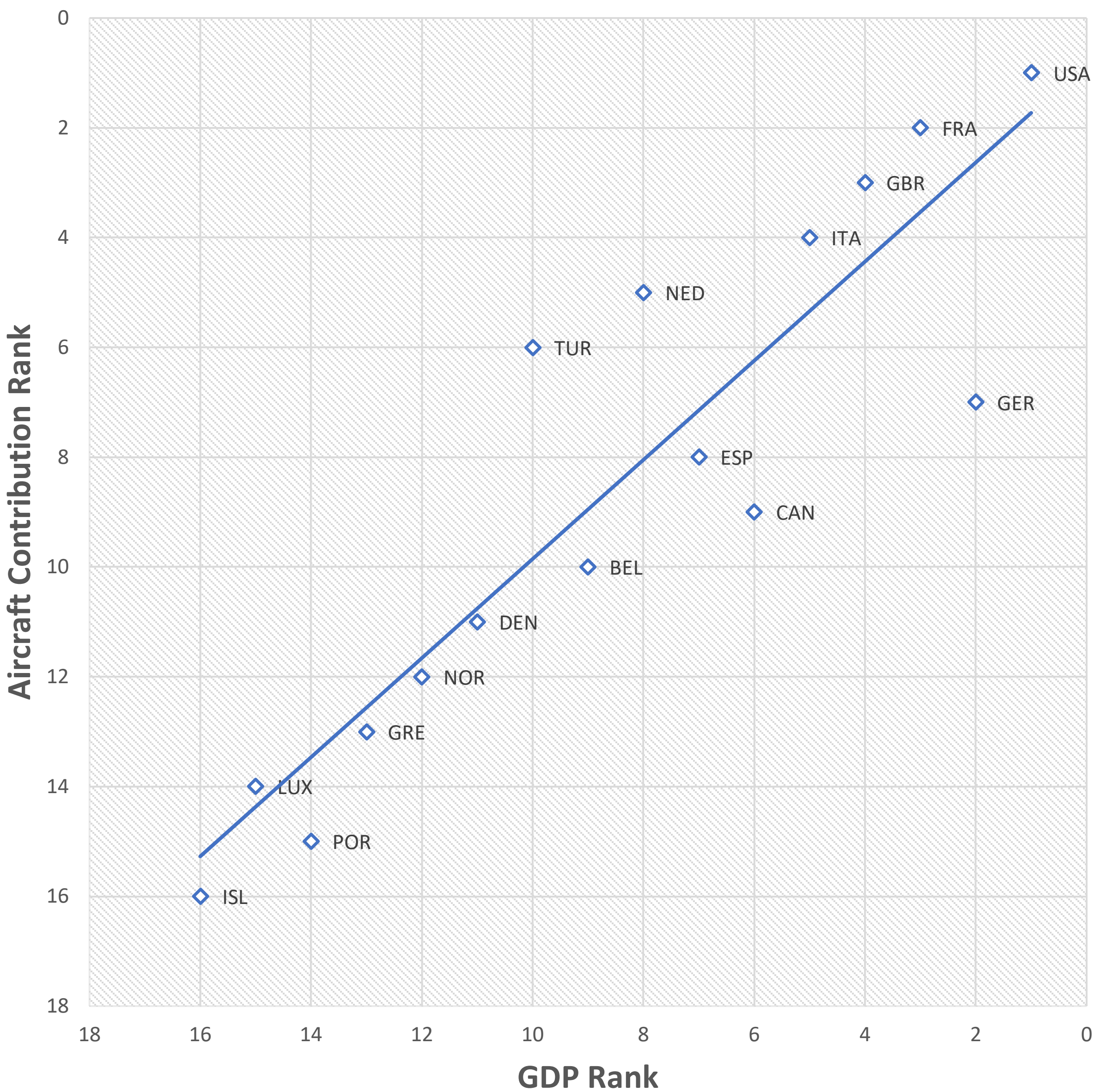

Figure C.1: Aircraft Contributions to Operation Deliberate Force
Compared to GDP (Rankings)

Spearman's rho = 0.83
Prob > |t| = 0.00

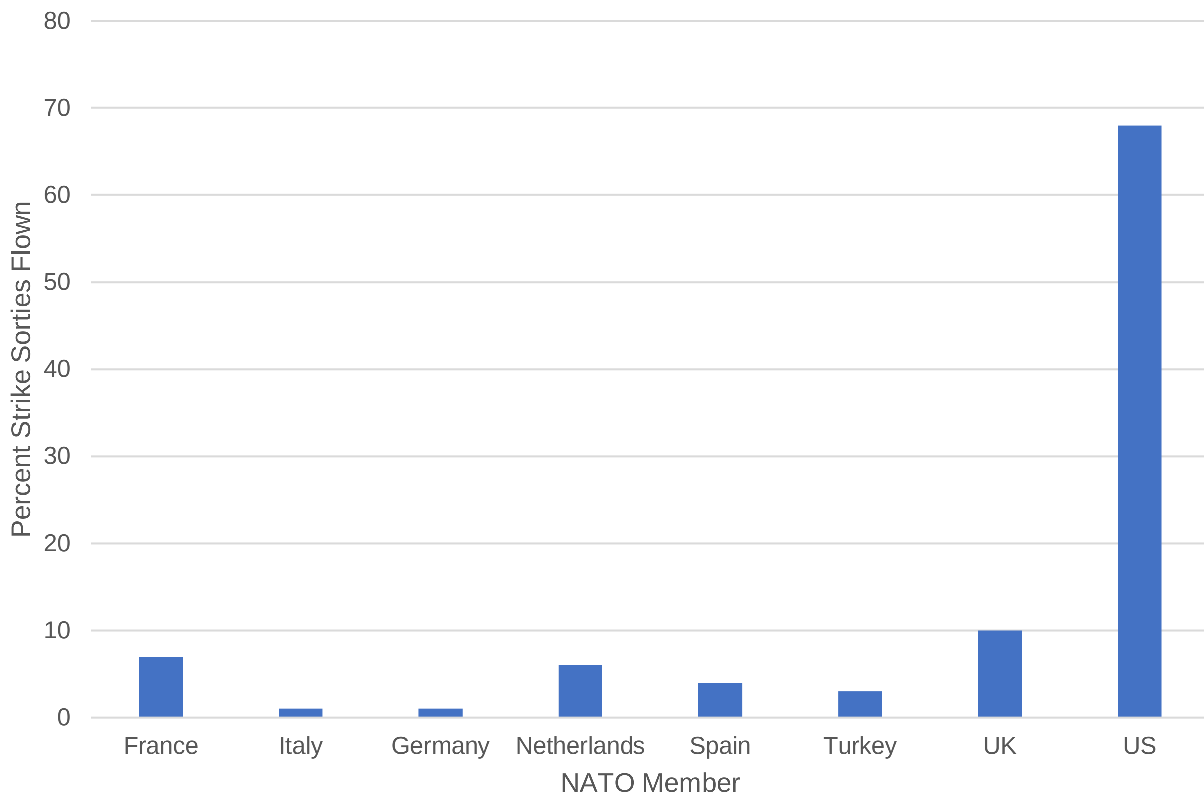

Figure C.2: Strike Sorties Contributed to Operation Deliberate Force
Owen (2000)

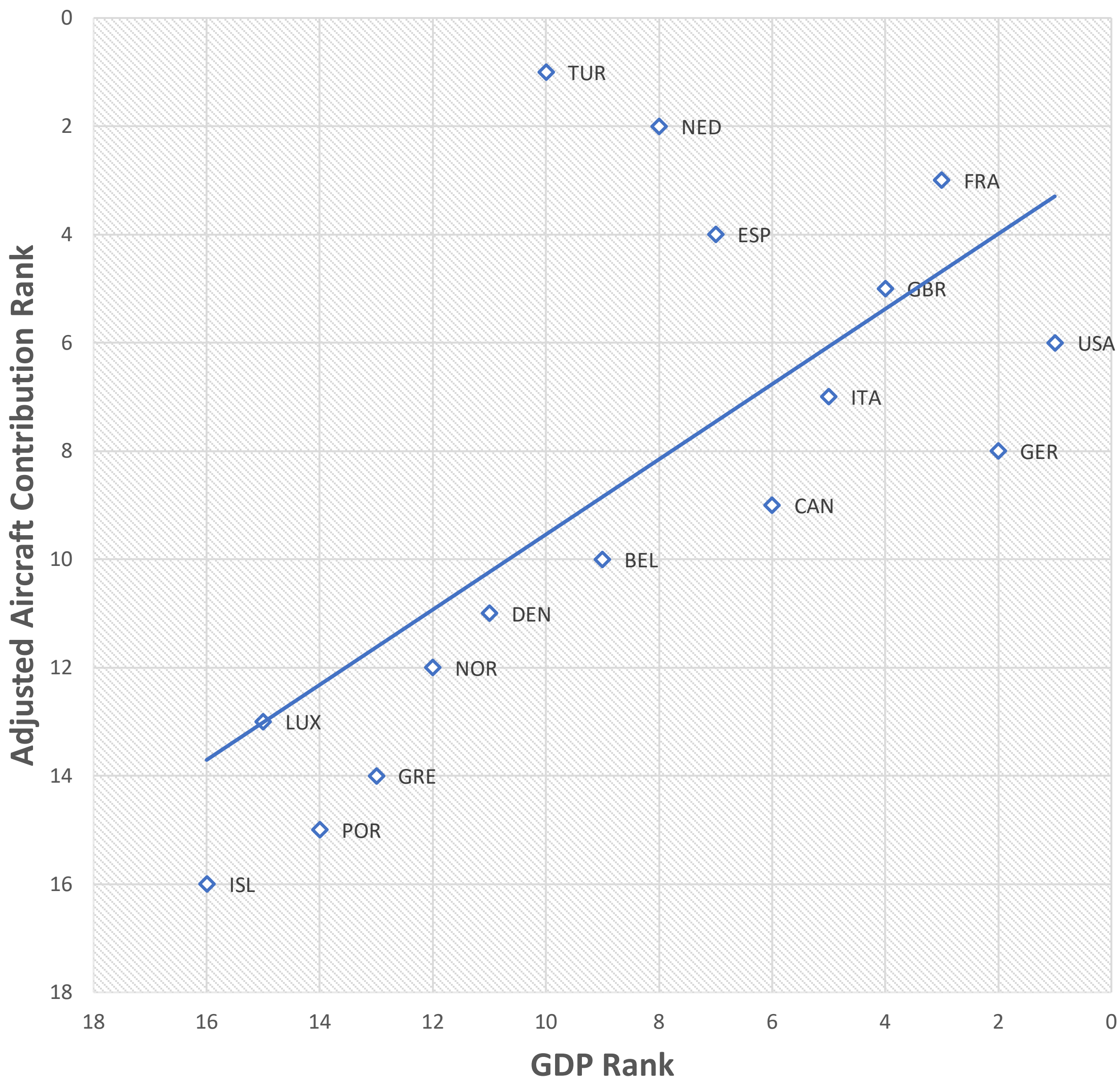

Figure C.3: Aircraft Contributions to Operation Deliberate Force
Divided by GDP (Rankings)

Spearman's rho = 0.59
Prob > |t| = 0.02

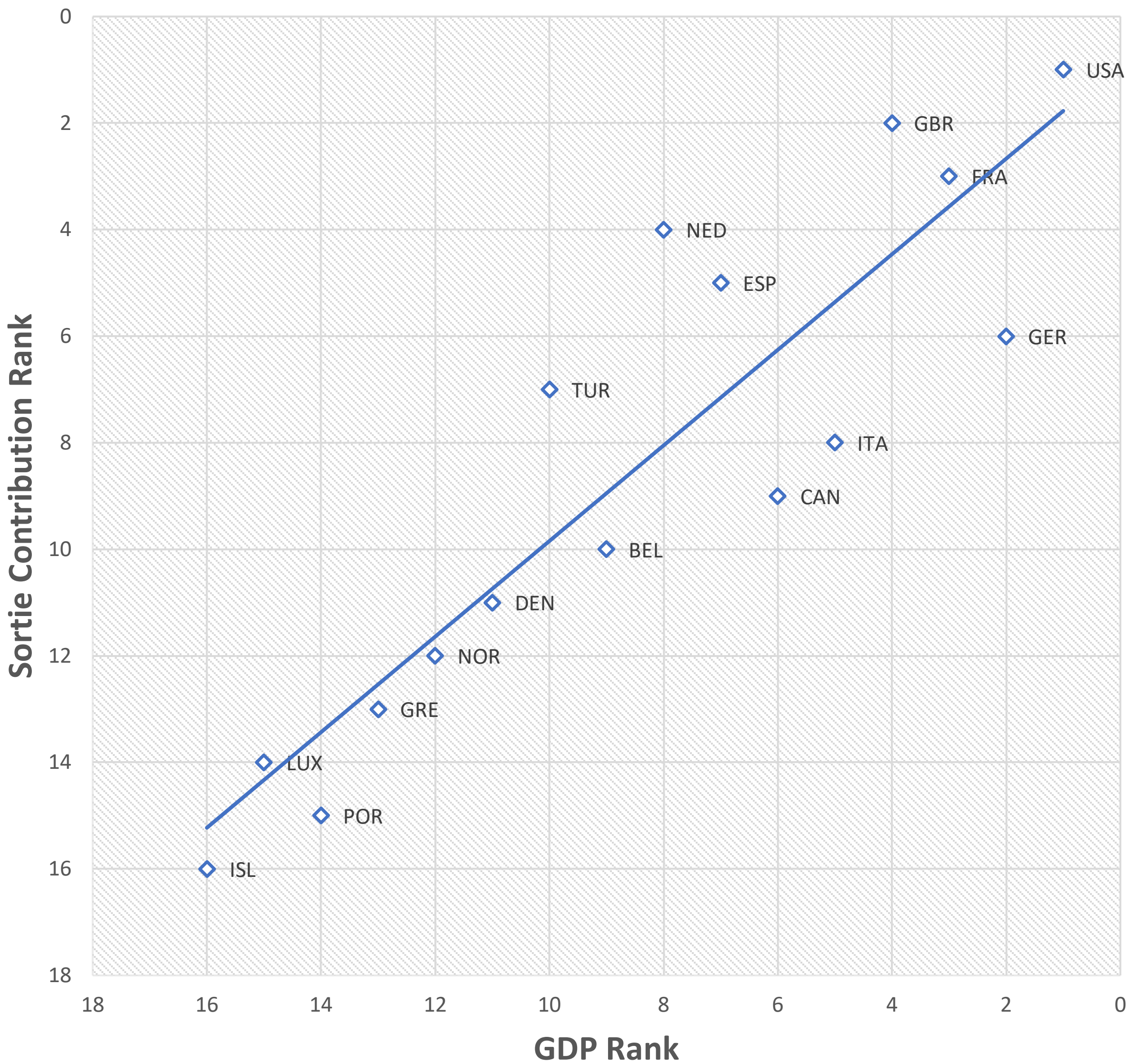

Figure C.4: Sortie Contribution to Operation Deliberate Force
Compared to GDP (Rankings)

Spearman's rho = 0.90
Prob > |t| = 0.00

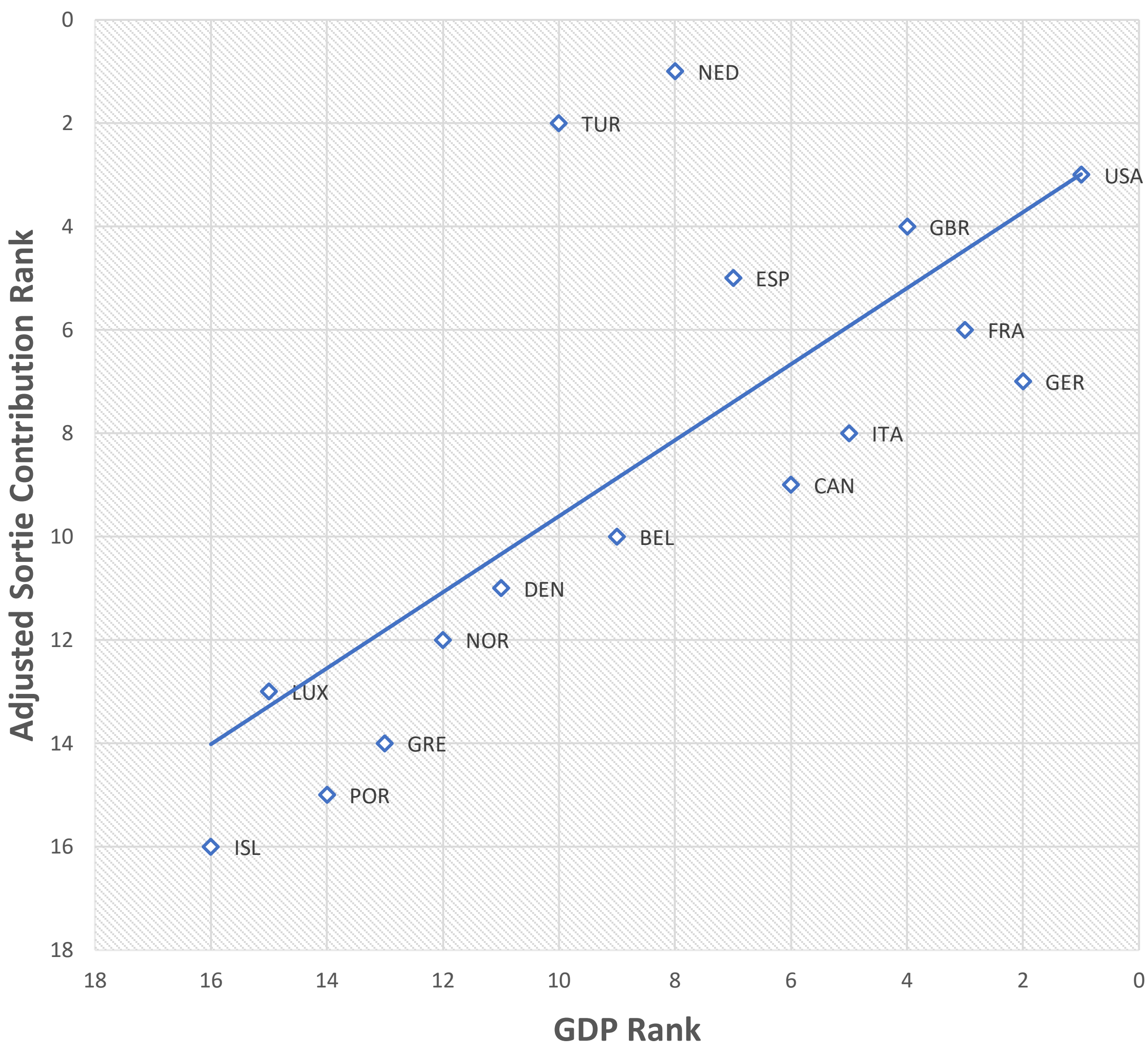

Figure C.5: Sortie Contribution to Operation Deliberate Force Divided by GDP (Rankings)

Spearman's rho = 0.74
Prob > |t| = 0.00

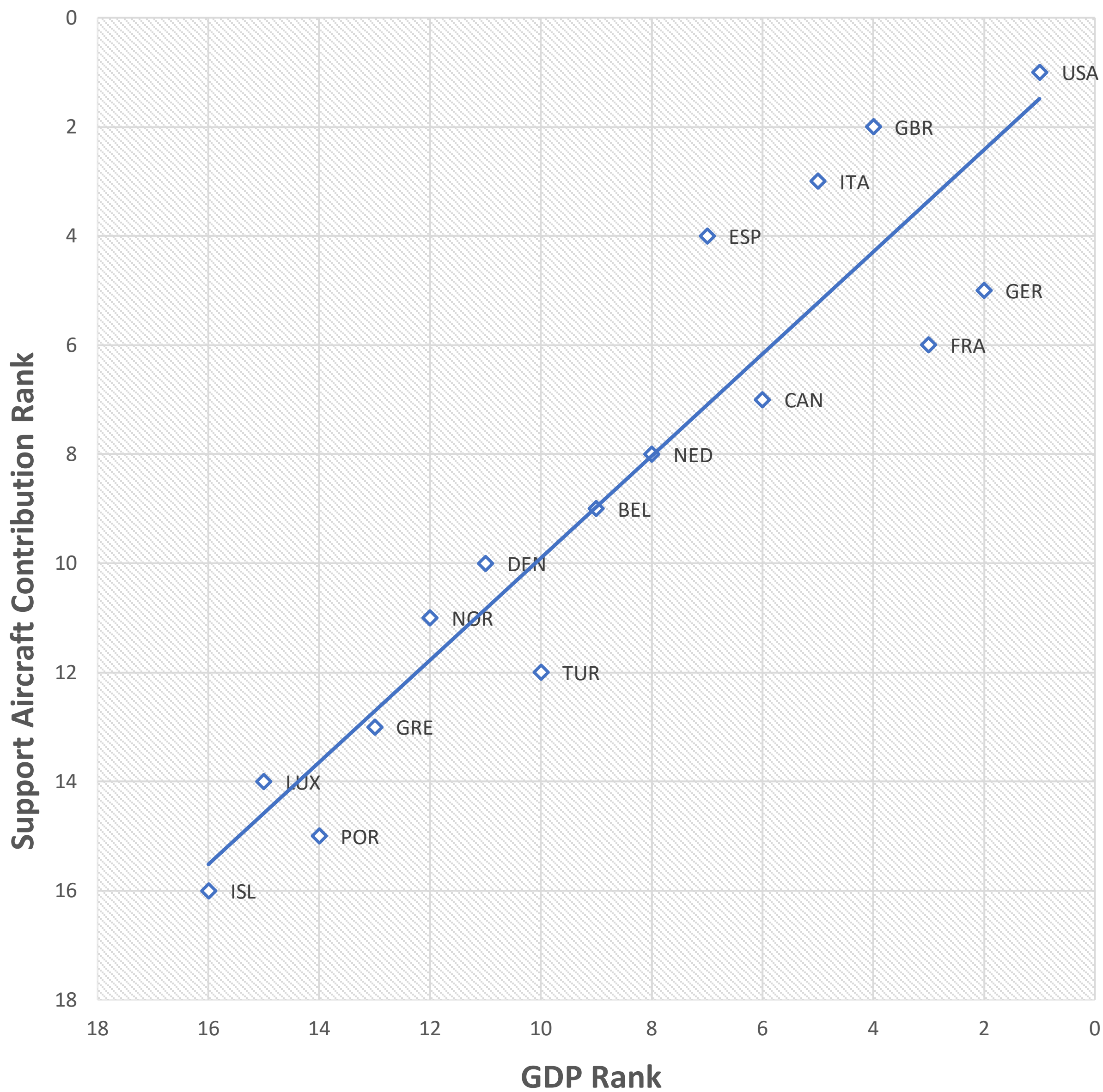

Figure C.6: Support Aircraft Contributions to Operation Deliberate Force Compared to GDP (Rankings)

Spearman's rho = 0.94
Prob > |t| = 0.00

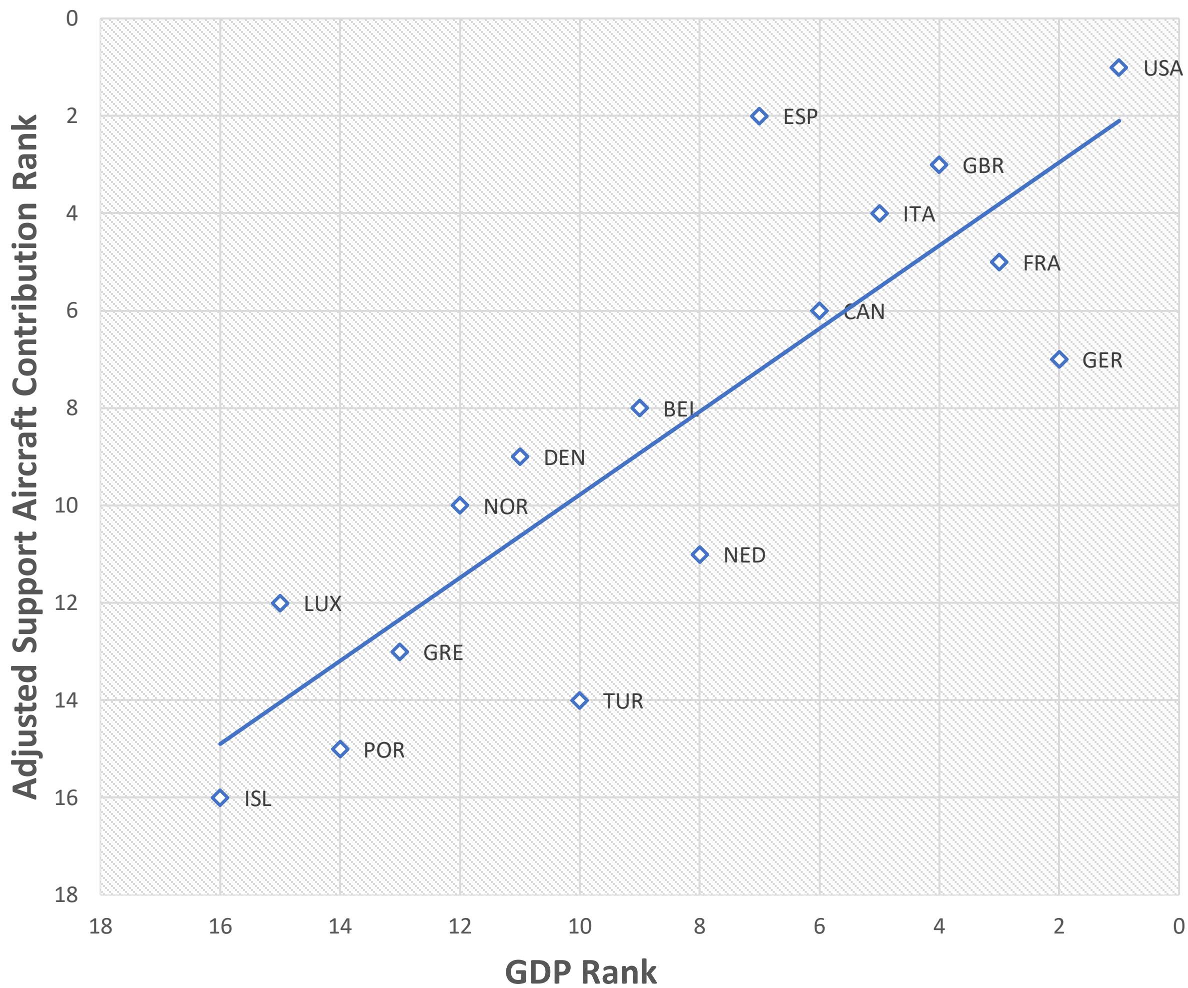

Figure C.7: Support Aircraft Contributions to Operation Deliberate Force Divided by GDP (Rankings)

Spearman's rho = 0.85
Prob > |t| = 0.00

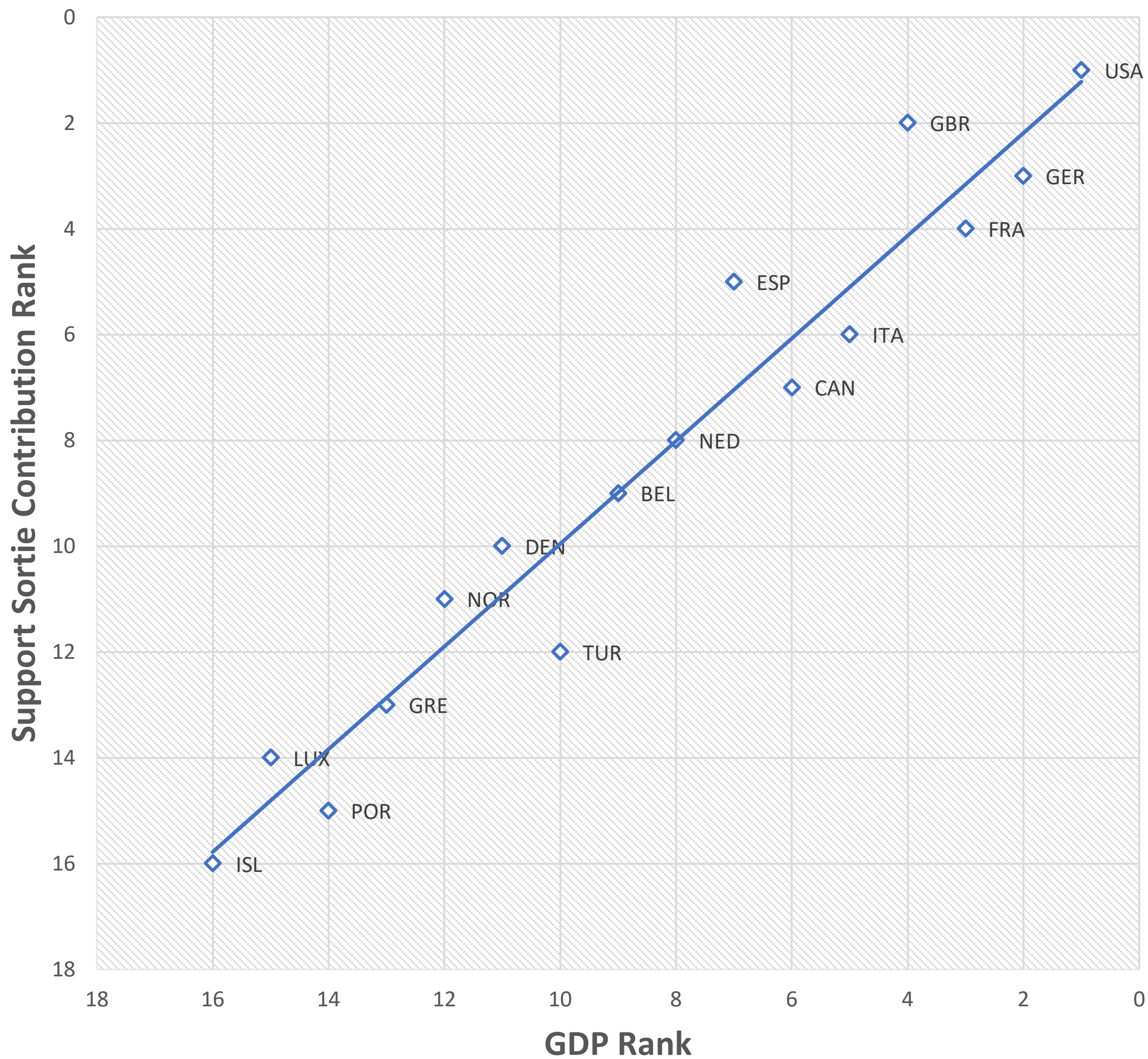

Figure C.8: Support Sortie Contributions to Operation Deliberate Force Compared to GDP (Rankings)

Spearman’s rho = 0.97
Prob > |t| = 0.00

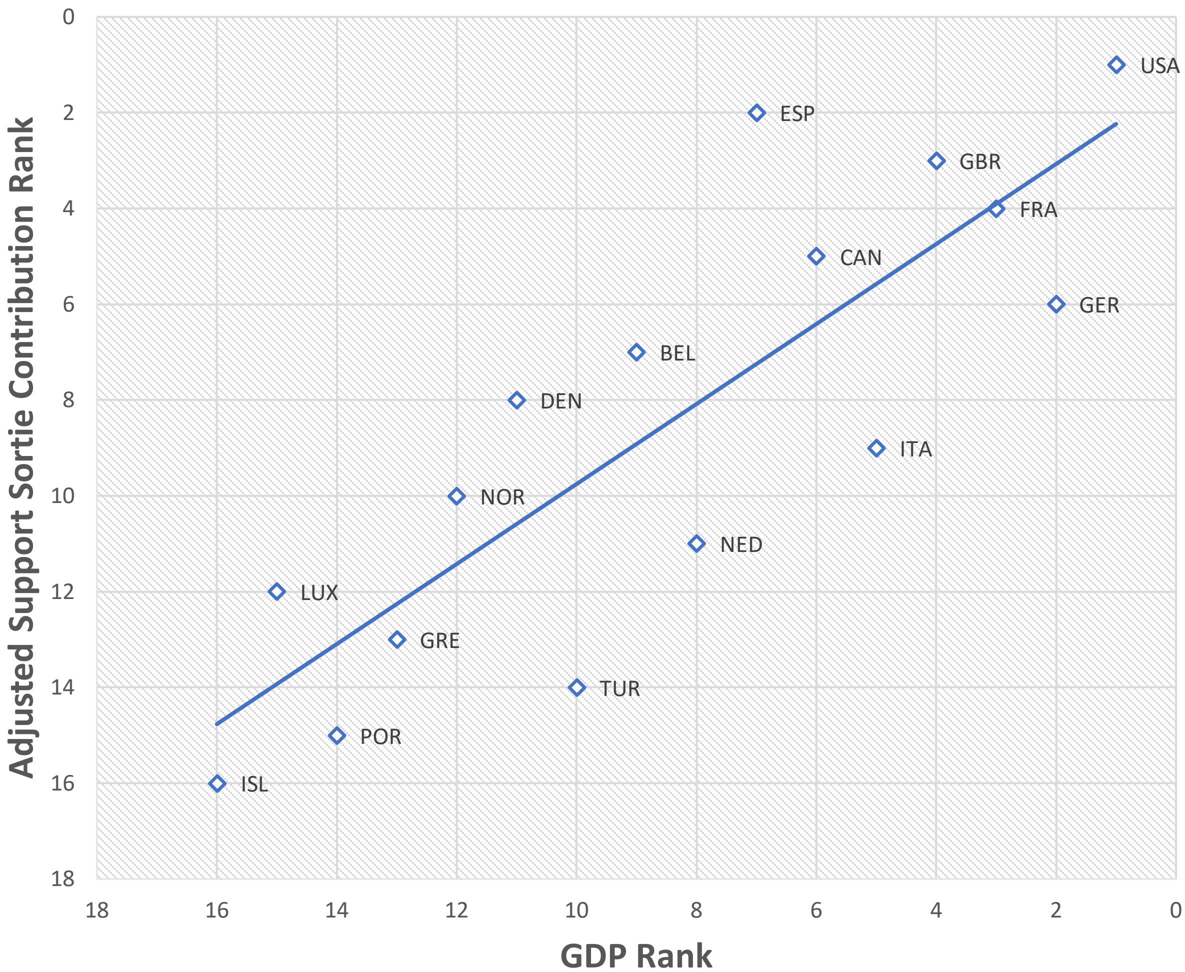

Figure C.9: Support Sortie Contributions to Operation Deliberate Force Divided by GDP (Rankings)

Spearman's rho = 0.84
Prob > |t| = 0.00

APPENDIX D

SUPPLEMENTARY MATERIALS FOR CHAPTER 8

D.1 SUPPLEMENTARY TABLES

Table D.1: GDP, Military Expenditures, and Aircraft Contributions to Balkan Campaign

Member	GDP($B) (1999)	GDP Rank	ME/GDP (1999)	ME/GDP Rank	AIR	AIR Rank	AIR/GDP	AIR/GDP Rank
Belgium	251.1	**9**	1.50%	**12**	14.7	**9**	0.0586	**7**
Canada	621.0	**6**	1.20%	**14**	20.5	**8**	0.0331	**11**
Denmark	176.1	**11**	1.60%	**10**	8.4	**10**	0.0479	**10**
France	1431.0	**3**	2.80%	**4**	164.0	**2**	0.1146	**3**
Germany	2123.9	**2**	1.50%	**11**	69.0	**5**	0.0325	**12**
Greece	124.7	**13**	4.9%	**2**	0.2	**15**	0.0014	**15**
Iceland	9.0	**16**	0.0%	**16**	0.0	**16**	0.0000	**16**
Italy	1167.8	**5**	2.00%	**8**	99.5	**3**	0.0852	**5**
Luxembourg	16.9	**15**	0.9%	**15**	0.2	**14**	0.0138	**14**
Netherlands	380.6	**8**	1.80%	**9**	55.9	**6**	0.1468	**2**
Norway	150.0	**12**	2.20%	**7**	8.4	**12**	0.0557	**8**
Portugal	109.6	**14**	2.20%	**6**	3.0	**13**	0.0276	**13**
Spain	566.0	**7**	1.40%	**13**	29.0	**11**	0.0512	**9**
Turkey	191.7	**10**	5.60%	**1**	47.2	**7**	0.2463	**1**
UK	1400.9	**4**	2.60%	**5**	95.3	**4**	0.0680	**6**
US	8910.0	**1**	3.20%	**3**	983.0	**1**	0.1103	**4**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Aircraft data compiled from compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Table D.2: GDP and Sortie Contributions to Balkan Campaign

Member	GDP($B) (1999)	GDP Rank	SOR	SOR Rank	SOR/GDP	SOR/GDP Rank
Belgium	251.1	**9**	110.9	**10**	0.4417	**7**
Canada	621.0	**6**	153.8	**9**	0.2476	**12**
Denmark	176.1	**11**	63.7	**11**	0.3615	**8**
France	1431.0	**3**	2694.0	**2**	1.8826	**3**
Germany	2123.9	**2**	756.7	**6**	0.3563	**9**
Greece	124.7	**13**	1.2	**13**	0.0092	**14**
Iceland	9.0	**16**	0.0	**16**	0.0000	**16**
Italy	1167.8	**5**	1122.7	**5**	0.9614	**6**
Luxembourg	16.9	**15**	0.2	**14**	0.0112	**13**
Netherlands	380.6	**8**	1451.8	**4**	3.8144	**1**
Norway	150.0	**12**	47.7	**12**	0.3183	**10**
Portugal	109.6	**14**	0.2	**15**	0.0016	**15**
Spain	566.0	**7**	178.4	**8**	0.3152	**11**
Turkey	191.7	**10**	234.8	**7**	1.2250	**5**
UK	1400.9	**4**	2287.8	**3**	1.6331	**4**
US	8910.0	**1**	32419.7	**1**	3.6386	**2**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Sortie data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Table D.3: GDP, Military Expenditures, and Support Aircraft Contributions to Balkan Campaign

Member	GDP($B) (1999)	GDP Rank	S-AIR	S-AIR Rank	S-AIR/GDP	S-AIR/GDP Rank
Belgium	251.1	**9**	0.7	**10**	0.0028	**11**
Canada	621.0	**6**	2.5	**9**	0.0041	**10**
Denmark	176.1	**11**	0.4	**11**	0.0025	**12**
France	1431.0	**3**	10.0	**4**	0.0070	**8**
Germany	2123.9	**2**	9.0	**5**	0.0042	**9**
Greece	124.7	**13**	0.2	**14**	0.0014	**13**
Iceland	9.0	**16**	0.0	**16**	0.0000	**16**
Italy	1167.8	**5**	11.5	**3**	0.0098	**7**
Luxembourg	16.9	**15**	0.2	**12**	0.0138	**4**
Netherlands	380.6	**8**	5.9	**7**	0.0154	**3**
Norway	150.0	**12**	3.4	**8**	0.0224	**2**
Portugal	109.6	**14**	0.0	**15**	0.0002	**15**
Spain	566.0	**7**	7.0	**6**	0.0124	**5**
Turkey	191.7	**10**	0.2	**13**	0.0011	**14**
UK	1400.9	**4**	17.3	**2**	0.0123	**6**
US	8910.0	**1**	410.0	**1**	0.0460	**1**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Aircraft data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

Table D.4: GDP and Support Sortie Contributions to the Balkan Campaign

Member	GDP($B) (1999)	GDP Rank	S-SOR	S-SOR Rank	S-SOR/GDP	S-SOR/GDP Rank
Belgium	251.1	**9**	4.8	**9**	0.0191	**10**
Canada	621.0	**6**	17.1	**8**	0.0276	**9**
Denmark	176.1	**11**	2.9	**10**	0.0166	**11**
France	1431.0	**3**	539.0	**2**	0.3767	**3**
Germany	2123.9	**2**	70.8	**6**	0.0333	**8**
Greece	124.7	**13**	1.2	**14**	0.0094	**13**
Iceland	9.0	**16**	0.0	**16**	0.0000	**16**
Italy	1167.8	**5**	106.8	**5**	0.0914	**6**
Luxembourg	16.9	**15**	1.6	**12**	0.0932	**5**
Netherlands	380.6	**8**	131.8	**4**	0.3462	**4**
Norway	150.0	**12**	2.4	**11**	0.0159	**12**
Portugal	109.6	**14**	0.1	**15**	0.0013	**15**
Spain	566.0	**7**	27.0	**7**	0.0477	**7**
Turkey	191.7	**10**	1.5	**13**	0.0077	**14**
UK	1400.9	**4**	532.9	**3**	0.3804	**2**
US	8910.0	**1**	20246.7	**1**	2.2724	**1**

GDP Data are from DOD (2000b), Iceland GDP from World Bank (2019). Sortie data compiled from DOD (1995), DOD (2000a), Lambeth (2001), Larson, et al., (2003), Owen (2000) and Peters, et al., (2001).

D.2 SUPPLEMENTARY FIGURES

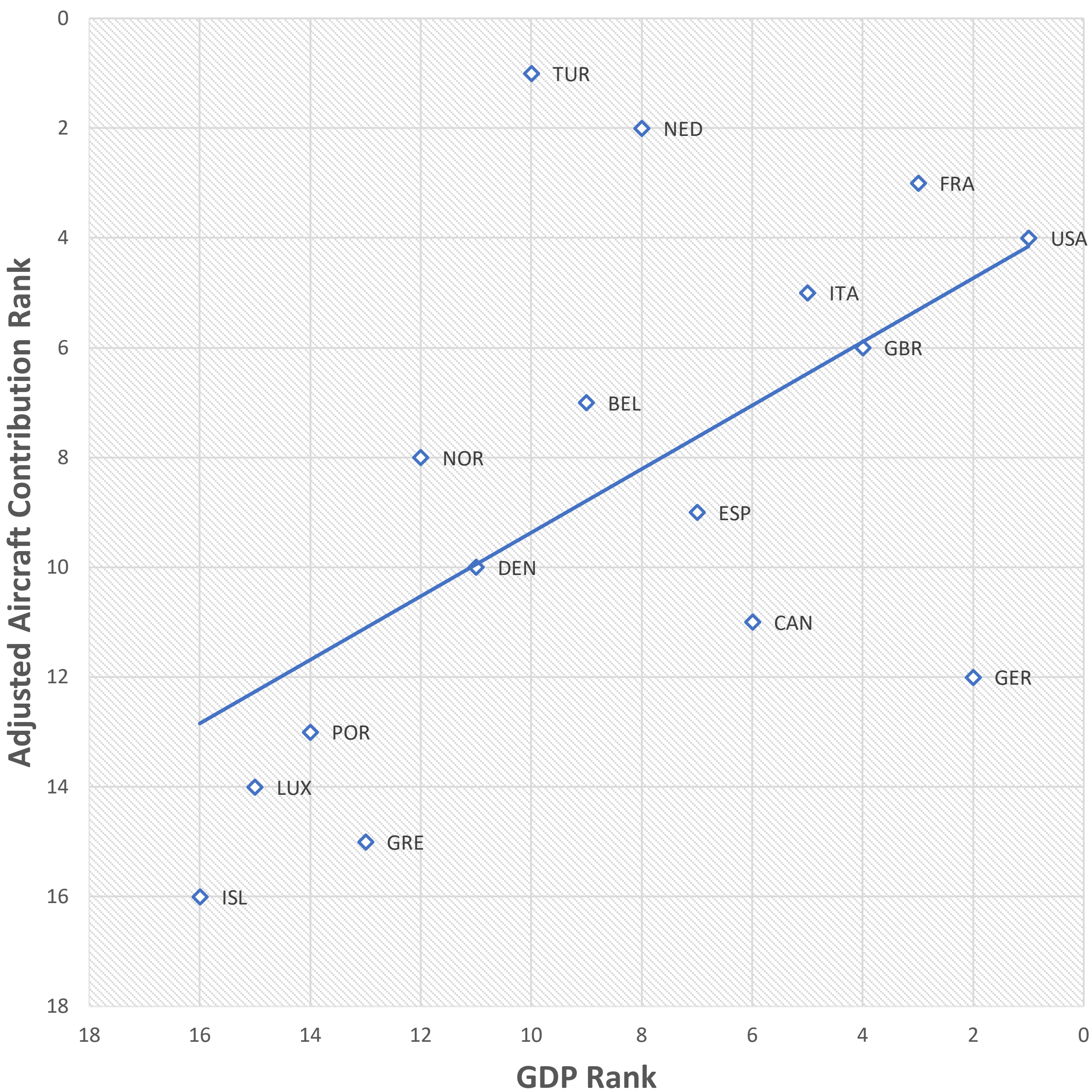

Figure D.1: Aircraft Contributions the Balkan Campaign Divided by GDP (Rankings)

Spearman's rho = 0.58
Prob > |t| = 0.02

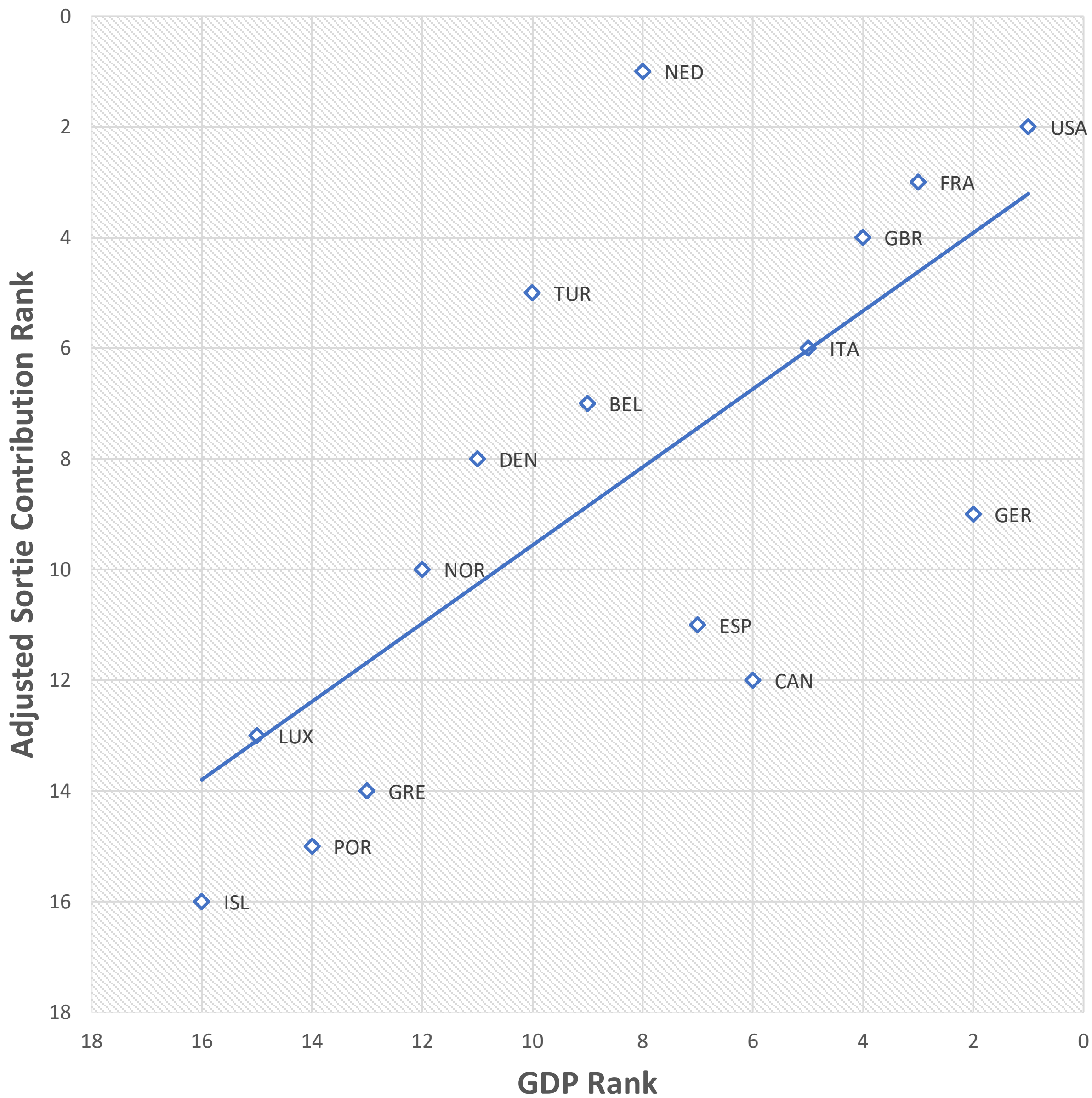

Figure D.2: Sortie Contribution the Balkan Campaign Divided by GDP (Rankings)

Spearman's rho = 0.71
Prob > |t| = 0.00

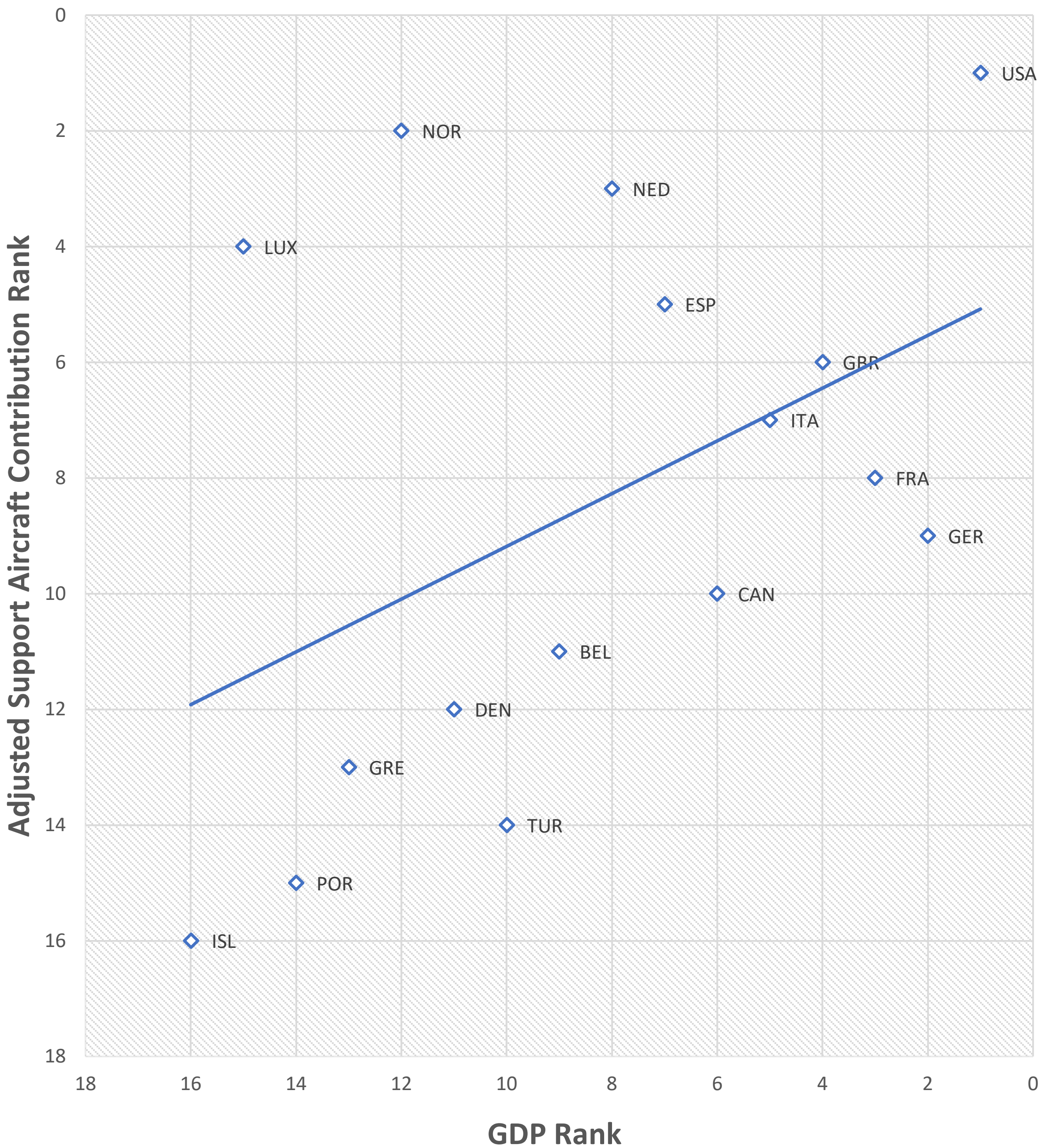

Figure D.3: Support Aircraft Contributions the Balkan Campaign
Divided by GDP (Rankings)

Spearman's rho = 0.46
Prob > |t| = 0.08

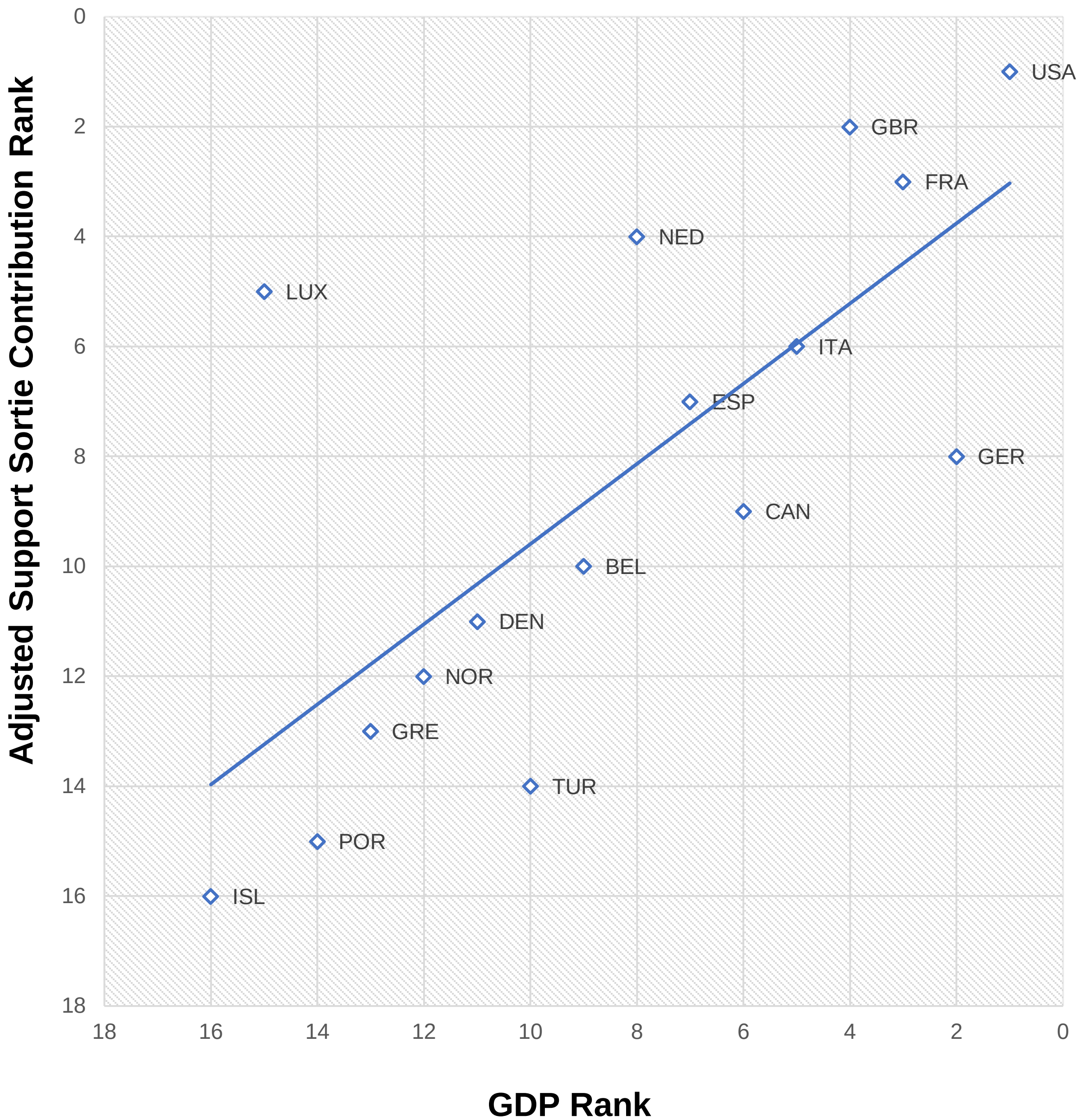

Figure D.4: Support Sortie Contributions the Balkan Campaign
Divided by GDP (Rankings)

Spearman’s rho = 0.73
Prob > |t| = 0.00

APPENDIX E

CONCLUDING SUPPLEMENTARY MATERIALS

E.1 SUPPLEMENTARY TABLES

Table E.1: Contributions to the Libyan Air Campaigns by Selected Members

NATO Member	F-16s Deployed	PGMs Released	Sorties Flown	Flight Hours
Belgium	6	473	620	2589
Denmark	6	923	1,228	4716
Netherlands	6	0	591	2845
Norway	6	588	615	3122

Data Compiled from Mueller (2015)

Table E.2: Contributions to Operations Odyssey Dawn and/or Unified Protector

Belgium	
Aircraft	Number Contributed
F-16AM Fighting Falcon	6
CC-130/130T Hercules Transport	2
Canada	
Aircraft	Number Contributed
CF-18 Hornet Fighter	7
CP-140 Aurora Maritime Patrol Aircraft	2
CC-150T Polaris Transport	2
CC-130/130T Hercules Light Transport	2
Denmark	
Aircraft	Number Contributed
F-16AM Fighting Falcon	6
France	
Aircraft	Number Contributed
Mirage F-1CR Fighter/ISR	2
Mirage 2000 Fighter	17
Super Etendard Fighter/Bomber	6
Mirage F-1CT Attack	2
C-135 Airborne Tanker	6
E3F Airborne Early Warning	1
Rafale Fighter	21
E-2C Hawkeye AEW	2
Tigre HAP Attack Helicopter	4
Gazelle Light Helicopter	20
Atlantique 2 Maritime Patrol	2
Harfang UAV	1
C-160G Light Transport Aircraft	1
Greece	

Table E.2 (Continued): Contributions to Operations Odyssey Dawn and/or Unified Protector

Aircraft	Number Contributed
EMB-145H Erieye AEW	1
Italy	
Aircraft	Number Contributed
AV-8B Harrier Attack	4
AMX Attack	4
F-16ADF Fighting Falcon	4
Tornado IDS/ECR Fighter	12
Typhoon Fighter	8
C-130 Medium Transport Aircraft	1
KC-767A Airborne Tanker	1
The Netherlands	
Aircraft	Number Contributed
F-16AM Fighting Falcon	6
KDC-10 Airborne Tanker	1
Norway	
Aircraft	Number Contributed
F-16AM Fighting Falcon	6
Spain	
Aircraft	Number Contributed
B-707 Transport	1
EF-18A Hornet Fighter	4
CN-235 Light Transport	1
Turkey	
Aircraft	Number Contributed
F-16C Fighter	6
KC-135R Airborne Tanker	2

Table E.2 (Continued): Contributions to Operations Odyssey Dawn and/or Unified Protector

United Kingdom	
Aircraft	Number Contributed
Tornado GR.4 Fighter	20
Typhoon F.2 Fighter	8
Apache AH.1 Attack Helicopter	5
VC-10 Transport	3
Tristar KC.1 Airborne Tanker	1
E3D AEW	3
Nimrod R.1 ISR	1
Sentinel R.1 ISR	2
United States	
Aircraft	Number Contributed
F-15 E Strike Eagle Fighter	20
AV-8B Harrier Attack	12
F-16C Fighting Falcon	12
F-16CJ Fighter	6
O/A-10 Warthog Attack	6
EA-18G Growler Fighter	5
EC-130 Airborne Command/Control	2
EC-130 Electronic Warfare	4
AC-130 Gunship	2
KC-135 Airborne Tanker	15
EA-6B Electronic Warfare	4
EP-3E Aries II ISR	1
P-3C Orion Maritime Patrol	1
KC-10 Airborne Tanker	4
RQ-4 Global Hawk UAV	3
MQ-1 Predator RPA	10
RC-135 Rivet Joint ISR	2

Table E.2 (Continued): Contributions to Operations Odyssey Dawn and/or Unified Protector

United States (Continued)	
Aircraft	Number Contributed
E-8C JSTARS ISR	1
E-3B/C Sentry AWACS	2
B-2 Spirit Heavy Bomber	3
B-1B Lancer Heavy Bomber	2
NATO	
Aircraft	Number Contributed
E3-A AWACS	3

Data Compiled from Mueller (2015)
Note: Some discrepancies in aircraft counts exist due to different methods of accounting. For example, some aircraft remain in theater while others drop off supplies then return to their home base. Various sources count these contributions differently.

Table E.3: Aircraft Contributions to Libyan Campaign

Member	**Aircraft**	**Percent**
Albania	0	0.0%
Belgium	8	2.4%
Bulgaria	0	0.0%
Canada	13	3.9%
Croatia	0	0.0%
Czech Republic	0	0.0%
Denmark	6	1.8%
Estonia	0	0.0%
France	85	25.2%
Germany	0	0.0%
Greece	1	0.3%
Hungary	0	0.0%
Iceland	0	0.0%
Italy	34	10.1%
Latvia	0	0.0%
Lithuania	0	0.0%
Luxembourg	0	0.0%
Netherlands	7	2.1%
Norway	6	1.8%
Poland	0	0.0%
Portugal	0	0.0%
Romania	0	0.0%
Slovak Republic	0	0.0%
Slovenia	0	0.0%
Spain	6	1.8%
Turkey	8	2.4%
UK	43	12.8%
NATO AWACS	3	0.9%
US	117	34.7%
Total	337	100%

Data Compiled from Mueller (2015)

Table E.4: GDP, Military Expenditures, and Aircraft Contributions to Libyan Campaign

Member	GDP($B) (2011)	GDP Rank	ME/GDP (2011)	ME/GDP Rank	AIR	AIR Rank	AIR/GDP	AIR/GDP Rank
Albania	12	**28**	1.53%	**9**	0	**22**	0.0000	**22**
Belgium	492	**11**	1.04%	**23**	8.1	**6**	0.0164	**4**
Bulgaria	52	**22**	1.32%	**12**	0	**22**	0.0000	**22**
Canada	1664	**6**	1.23%	**19**	13.3	**5**	0.0080	**9**
Croatia	60	**20**	1.60%	**8**	0	**22**	0.0000	**22**
Czech Republic	211	**16**	1.07%	**21**	0	**22**	0.0000	**22**
Denmark	326	**13**	1.31%	**13**	6.1	**9**	0.0186	**2**
Estonia	21	**26**	1.68%	**6**	0	**22**	0.0000	**22**
France	2706	**3**	1.86%	**4**	85	**2**	0.0314	**1**
Germany	3537	**2**	1.28%	**17**	0.9	**13**	0.0003	**14**
Greece	273	**14**	2.38%	**3**	1.0	**12**	0.0037	**12**
Hungary	133	**18**	1.05%	**22**	0	**22**	0.0000	**22**
Iceland	14	**27**	0.00%	**28**	0	**22**	0.0000	**22**
Italy	2138	**5**	1.30%	**14.5**	34.2	**4**	0.0160	**5**
Latvia	25	**25**	1.01%	**24**	0	**22**	0.0000	**22**
Lithuania	39	**24**	0.79%	**26**	0	**22**	0.0000	**22**
Luxembourg	55	**21**	0.39%	**27**	0.0	**14**	0.0005	**13**
Netherlands	850	**9**	1.26%	**18**	7.1	**8**	0.0084	**8**
Norway	433	**12**	1.51%	**10**	6.0	**10**	0.0140	**6**
Poland	503	**10**	1.72%	**5**	0	**22**	0.0000	**22**
Portugal	234	**15**	1.49%	**11**	0.0	**15**	0.0000	**15**
Romania	170	**17**	1.29%	**16**	0	**22**	0.0000	**22**
Slovak Republic	92	**19**	1.09%	**20**	0	**22**	0.0000	**22**
Slovenia	48	**23**	1.30%	**14.5**	0	**22**	0.0000	**22**
Spain	1417	**7**	0.94%	**25**	6	**11**	0.0042	**11**
Turkey	854	**8**	1.64%	**7**	8.0	**7**	0.0094	**7**
UK	2476	**4**	2.40%	**2**	43.0	**3**	0.0174	**3**
US	15204	**1**	4.78%	**1**	118.3	**1**	0.0078	**10**

GDP and ME Data are from NATO (2018) in 2000 prices and exchange rates. Aircraft Contribution Data are from Mueller (2015)

Table E.5: NATO Membership Over Time

Member	Year Joined
Belgium	1949
Canada	
Denmark	
France	
Iceland	
Italy	
Luxembourg	
Netherlands	
Norway	
Portugal	
United Kingdom	
United States	
Greece	1952
Turkey	
Germany	1955
Spain	1982
Czech Republic	1999
Hungary	
Poland	
Bulgaria	2004
Estonia	
Latvia	
Lithuania	
Romania	
Slovenia	
Albania	2009
Croatia	
Montenegro	2017
North Macedonia	2020

(NATO 2020)

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BIOGRAPHICAL SKETCH

Brent Sackett was born in Tucson, AZ and grew up in Idaho. He attended AFROTC at Utah State University where he received a BS in Mechanical/Aerospace Engineering. After being commissioned as a second lieutenant in the Air Force, he worked as an engineer analyzing heat transfer in nuclear reactors. In 1991, he graduated from the Euro-NATO Joint Jet Pilot Training Program where he received his wings as an Air Force Pilot. He next went to Langley AFB to fly the F-15 Eagle fighter jet and deployed to various locations across the globe. He flew combat sorties in multinational operations before becoming an instructor pilot in the AT-38B Talon. He spent more than 15 years training NATO fighter pilots the basics of air-to-air and air-to-surface combat. During this time, he graduated from Squadron Officer School, Air Command and Staff College, as well as Air War College. In addition, he received an MA in Homeland Security from American Military University. After completing service in the Air Force, he enrolled at The University of Texas at Dallas where he received an MA in Political Science. He is currently flying as an instructor pilot training American and NATO crews at Holloman AFB.

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