Measuring Militarization and the Link with Interstate Conflict

Maya Mikelson *

Senior Honors Thesis

University of Michigan-Ann Arbor

Abstract: The largest number of conflicts since the Cold War occurred in 2023. The last three years had the most conflict-related deaths in the past three decades (Peace Research Institute Oslo, 2024). The relationship between arms races and war has not been heavily studied since the Cold War. Unlike prior research, which typically uses military expenditures, this paper develops novel militarization measures, separates militarization into stocks and flows (to account for the endogeneity of military expenditure), and uses more recent data and measures to estimate the effect of militarization on conflict. I then modify the Bonn International Centre for Conflict Studies (BICC) Global Militarization Index (GMI) (Bayer & Rohleder, 2022) to investigate how changing factors in the BICC's measure—such as, weighting by Surplus Domestic Product (Anders et al., 2020) and size of the total workforce—impacts the correlation with conflict. I use the militarization flows to account for endogeneity associated with the perceived risk of military conflict. In so doing, I find that greater stocks of military power are negatively correlated with the probability of conflict, providing support for the deterrence hypothesis.

*Correspondence Email: mikelson@umich.com

Contents

Acknowledgments

I want to thank many people who helped me through this project and provided invaluable advice.

First, thank you to my advisor Professor Chris Fariss for his advice throughout this process and help debugging the latent variable model when it was not running or producing meaningful results. His mentorship throughout college was also essential in preparing me to write this thesis.

Next, thank you to Professor Emily Ritter and the Vanderbilt University Research Experience for Undergraduates (REU) in Accountability, Behavior, and Conflict in Democratic Politics (ABCD) funded by the National Science Foundation (award #2150143). That is where I got the idea to investigate militarization and militarized interstate disputes. The REU provided the foundation for this project and allowed me to further develop my research for this thesis. Professor Ritter also provided helpful advice on improving my literature review and research design, which ultimately improved this project as well.

Thank you to Jenny Kuo and Karis Rivers for providing support and answering questions as we struggled through this process together. I am glad I had friends going through the process with me.

Finally, thank you to my parents, Abraham Wickelgren and Kelly Mikelson. Thank you to my mom for her edits and suggestions and helping me improve my writing (and removing the typos dad suggested). Thank you to my dad who was willing to answer my questions about statistics and verify I interpreted the results correctly.

1 Introduction

While the number of state-based conflicts in 2022 was consistent with previous years — 55 conflicts in 38 countries — there were more deaths in those conflicts, specifically 237,000 battle-related deaths. This is the highest number since 1994 according to counts by the Uppsala Conflict Data Program (UCDP) (Peace Research Institute Oslo, 2023).

Militarization is "the relative weight and importance of a country's military apparatus in relation to its society as a whole" (Mutschler & Bales, 2020). Understanding the relationship between militarization and interstate conflict may have important implications for the logic of defense spending and military aid. Examining change in militarization as a potential indicator of an increased (or decreased) risk of interstate conflict could provide important information for anticipating and making conflict less deadly. If militarization is a valuable tool to anticipate conflict, it may be used to focus the United Nations' efforts or indicate where countries could intervene before a conflict starts. I theorize that higher levels of militarization are associated with a lower likelihood of being targeted by another state because it provides a deterrence effect that would increase the cost of conflict.

In 2023, total military expenditures worldwide increased by 6.8 percent from 2022, the largest year-over-year increase since 2009. Europe, the Middle East, Asia, and Oceania had the largest increases, likely motivated over concerns about Russia and Israel (Stockholm International Peace Research Institute, 2024). There are conflicting views about the effect of military spending and arms races on the probability of war. The pacifist views arms races as leading to war because it emboldens a country while others believe having a strong military deters conflict (Gibler et al., 2005; Jackson & Morelli, 2009; Rider et al., 2011). Much of the prior research on militarization examined the impact of arms races on war; however, these studies generally do not include measures of heavy weaponry (Rider, 2013; Stoll, 2017). I theorize that heavy weaponry is a valuable indicator of long-term military investment and the efficacy of that military investment in producing a military force that could potentially deter rivals or give countries more confidence in escalating conflict. I anticipate that splitting militarization into stocks (the accumulated quantities) and flows (the rates at which these quantities change) lead to an improved understanding of the underlying concept of militarization and help to address endogeneity concerns. Military stocks include heavy weaponry and military personnel that require long-term investment, whereas military flows are current military expenditures that can be ramped up quickly in response to a threat. While the direction of causality is difficult to establish, this paper investigates how using stocks and flows can help illuminate the link between militarization and interstate conflict.

A critical first step towards analyzing the relationship between militarization and conflict is selecting a measure of militarization. This paper contributes to current literature by using a novel and robust measure of militarization. It examines a measurement of militarization using the Global Militarization Index (GMI) as a baseline and then develops alternative militarization measures that are more robust for comparison. Developed by the Bonn International Centre for Conflict Studies (BICC) in 2011, GMI is an objective measure of militarization that permits interstate comparisons worldwide. GMI weights military expenditure in proportion to GDP, health expenditure, and military personnel in comparison to the total population and the number of physicians (Bayer & Rohleder, 2022). Because GDP and the number of physicians are likely correlated with wealth and education, weighting by workforce size and Surplus Domestic Product (SDP) creates more accurate measures of militarization. I then develop alternative measures of militarization using SDP and total workforce as weighting mechanisms and compare them using a latent variable model. This allows me to examine underlying concepts of militarization that are not directly measurable but influence the measure. These various measures of militarization are used to examine the impact of changes in militarization on conflicts.

Militarization may be chosen because a country is at a high risk of war rather than randomly assigned, therefore, there is a potential endogeneity problem. To address this problem, I develop separate measures of military stocks and flows. Military stocks examine long-term military investment which is designed to capture the deterrent effect of military strength. The separate flow measures, which are current military spending, partially captures the risk of conflict that a country perceives in it's current environment. By comparing longerterm investment in the military with short-run investment it allows the difference between the deterrence and the reverse causal explanation to be examined. The long-term investment better captures military strength because it takes time to build new military technology, train soldiers, and develop strategic planning. Short-term investments reflect the immediate circumstances but haven't yet had the ability to morph into military strength.

The paper is structured as follows. The next section reviews the relevant literature to provide background on previous research related to militarization and interstate conflict. Section 3 describes the theory and hypotheses underlying the relationship between militarization and conflict. Section 4 explains the methods used to develop new measures of militarization, the primary independent variables, and the data for measuring conflict. Section 5 details the justification for latent variable modeling and regression research methodology for testing the relationship between the various measures of militarization with interstate conflict. Section 6 describes the results, and Section 7 and 8 conclude and provide potential limitations to this research.

2 Relevant Literature

2.1 Arms Races and Conflict

Much of the literature on arms races and militarization with conflict is either from immediately after the Cold War or in recent years, coinciding with when military spending experienced large increases. There is scholarly debate over whether increased military spending provides a deterrent to conflict escalation or encourages escalation by increasing the confidence of countries to win conflicts. The existing literature on arms races and conflict tends to find a positive correlation; however, as Diehl & Crescenzi (1998) point out, the connection between arms races and war may be spurious because countries may anticipate that war is likely and therefore increase their military capabilities to prepare for it, thus reversing the direction of causality. Recent literature makes various attempts to address this endogeneity concern; however, they are not completely satisfactory. As Stoll (2017) notes, the question of whether arms races contribute to or deter conflict is still unresolved.

Gibler et al. (2005) examines the effect of conventional arms races on the likelihood of both militarized disputes and conflict and find that arms races increase the likelihood of a dispute occurring and increase the likelihood that the dispute escalates to a conflict. Gibler et al. (2005) defines an arms race as a period longer than three years where both countries increase their military expenditure or personnel more than 8 percent in a three-year period. Their data is from between 1815 and 1992 and includes 108 rivalries – 71 instances of competitive military buildup and 37 instances of undirected military buildup. They attempt to control for endogeneity by focusing on cases in which militarized disputes escalate to a war, finding that this is more likely in the presence of an arms race (Gibler et al., 2005). Of course, given that not all disputes are equally likely to escalate, it is still possible that countries are more likely to engage in military buildups when disputes are a priori more likely to escalate.

Rider et al. (2011) also finds that arms races are positively correlated with the likelihood of war. They find that arms races that occur in early stages of a rivalry are not associated with an increased likelihood of war; however, arms races that occur later in a long-term rivalry are associated with an increased likelihood of conflict. Following Gibler (2005), they define an arms race as an increase of more than 8 percent in military expenditure or personnel in a three-year period by both states, however this would exclude weaponry. They address endogeneity by using a two-step Heckman Selection Model because the countries in a rivalry are more likely to engage in an arms race. The first stage of the model predicts the participation in a rivalry, and the second stage examines the onset of war (Rider et al., 2011). However, predicting rivalry alone may not be sufficient to eliminate the endogeneity concern. Whether or not there is an arms race, even within an existing rivalry, is not exogenous. The arms race may still be driven by unobserved factors that predict the probability of that rivalry turning into war.

Using a different measurement of arms races, Colaresi & Thompson (2005) examine the effect of increasing military expenditures on war. They define an arms race as when military expenditure is increasing over the past six years and was above the country's average level in the current year. Between 1816 and 1945 and after the Cold War, they find that the existence of an arms race increases the chance of war but during the Cold War, this relationship does not exist. They are aware of endogeneity concerns and take some steps to address it (Colaresi & Thompson, 2005).

2.2 Militarization

In research discussing militarization and conflict, the findings are mixed and sometimes ambiguous which highlights the need to examine under what conditions increasing militarization could precipitate conflict. Unlike studies of arms races, studies of militarization do not select for rivalries but examine the unilateral military buildup (Bayer & Rohleder, 2022). In addition, when examining the effects of militarization, it is typically treated as a continuous variable rather than a dichotomous one, eliminating the need to define a strict cutoff level. Most studies on the role of militarization examine its effects on outcomes other than military conflict.

Jackson & Morelli (2009) use a game-theoretic model to determine that countries have an incentive to mix between aggressive and dovish strategies when deciding on military preparation strategies. Then as the likelihood of winning a war becomes more closely tied to the level of military preparation, the likelihood of war decreases (Jackson & Morelli, 2009). However, this model does not account for the impact of the military preparation choice between periods which means it misses the benefit of buildup in previous periods if the country decides not to spend on the military in the current period.

Militarization between countries that neighbor each other is positively correlated: Collier & Hoeffler (2007) found that as the militarization of one country increases, the militarization of countries that share a border with it also increases. However, they do not find that increases in military spending are statistically significantly correlated with increases in instances of civil war although there is a positive relationship (Collier & Hoeffler, 2007). A positive correlation between military spending and conflict does not establish causality because a common outside factor might induce all countries in a region to increase their militarization, such as an outside threat to all of them or greater tensions between them.

Caruso & Biscione (2022) show that in European countries, increases in militarization are linked to increases in income inequality, using the BICC's Global Militarization Index. The exception to this is military conscription which results in lower income inequality. NATO membership and involvement in an armed conflict are also positively associated with income inequality, potentially because it could lead to less social spending and more military spending. As Caruso & Biscione (2022) discuss, there is a potential endogeneity problem because militarization is chosen by a government; it is not randomly assigned. Therefore, factors that lead a country to militarize might also be driving inequality rather than militarization itself. Caruso & Biscione (2022) address this by applying the Lewbel (2012) IV-GMM approach (Lewbel, 2012). After applying this approach, they still find an effect, although it is much smaller (about one-sixth the size) (Caruso & Biscione, 2022).

High levels of militarization are correlated with both low levels of civil rights protections and increased likelihood of involvement in domestic and international conflicts in NATO countries and Russia. Some of the relationship between militarization and levels of civil rights protections seems to result from democratic transitions. In countries that are transitioning to democracy, or where democratic transitions are delayed, there are lower levels of civil rights protections. However, this is not enough to make a causal claim about the relationship because changes in security could reduce the need for militarization and allow for more focus on protection of civil rights (Shaeva, 2014).

Iheonu et al. (2021) studies the factors that affect the value of the peace index of

43 African countries in 2018. They find that militarization is not statistically significantly related to how peaceful the country is except for the 10th percentile quantile regression where it finds a positive relationship for this cross-sectional analysis. However, the measure for peace is about a lack of violence and various forms of conflict which means it includes civil conflict and government violence against civilians. It also only examines military expenditure and only includes data from 2018 in Africa (Iheonu et al., 2021).

2.3 Theories of Conflict

The Correlates of War (COW) dataset defines Militarized Interstate Disputes (MIDs) as at least "cases of conflict in which the threat, display or use of military force short of war by one member state is explicitly directed towards the government, official representatives, official forces, property, or territory of another state" (Jones et al., 1996). Jones et al., (1996) includes conflicts short of war because the willingness to threaten or display force could also be affected by militarization. Additionally, if it were to be limited to instances of war, the number of conflicts would be very limited, potentially influencing results. In future research, I would also like to look only at wars, but that data is not included in the COW dataset. Countries with higher levels of militarization may be more willing to threaten because they are more confident in their military power.

Prior research has examined many different causes of conflict including type of government, economic system, and trade relationships. For instance, an expectation of economic ties can reduce the risk of conflict (Copeland, 2014); however, when countries produce the same goods, they are more likely to go to war (Chatagnier & Kavaklı, 2017). Several factors specifically predict international intervention in intrastate wars, including demand for oil in the intervening country, oil reserves in the country at war, and constraints on intervention (Bove et al., 2016).

2.3.1 Relationship with Democracy and Alliances

While we do not know why interstate conflicts occur, prior literature provides some theories. When there is a peaceful territorial transition, there is likely to be a decrease in militarization due to a decline in the level of threat a state experiences. Democratization is also more likely once territorial disputes are resolved; however, other factors also are necessary to allow for democracy (Gibler & Tir, 2010). However, this does not explain what happens to militarization while territorial disputes are ongoing. Hegre (2014) reviews the literature on the relationship between democracy, authoritarianism, and conflict. In studies of dyadic relationships, interstate armed conflict is less frequent between two democracies than dyads where at least one country is not a democracy. He finds current studies are unable to identify if that is because there is a relationship between democracy and other qualities that might lead to less violent escalation (Hegre, 2014). While we might expect dyads with two authoritarian countries to then be the most violent, interstate war is most likely when there is a dyad with a democracy and an authoritarian country. Democracies are more likely to initiate conflicts against autocracies, and, when they initiate, they are also more likely to win than when non-democracies initiate (Tangerås, 2009).

Werner (2000) finds that political similarity beyond whether states are democracies or not also led to a decreased likelihood of conflict. She hypothesizes that this is because politically similar states have similar methods of handling domestic issues, therefore, they are less likely to have a dispute arise (Werner, 2000).

In democracies, initiating a militarized conflict can improve an incumbent's chance of winning reelection by improving their approval ratings among people who do not identify as part of the incumbent's party. Conversely, if another country initiates the conflict, then the incumbent sees a decline in approval rating (Singh & Tir, 2018). This could mean that if a democratic leader thinks one of their adversaries will start a war in the future, they may have an incentive to start it earlier. By planning a war in advance, they would have time to invest in the military ahead of time.

However, in studies of dyads, when the mean level of democracy increases, the likelihood of a fatal MID decreases. Countries having equivalent levels of democracy is not enough to decrease the likelihood of fatal MIDs within the dyad (Altman et al., 2021). There are also differences between a target and aggressor state in a dyad and the kinds of alliances they are a part of. Some alliances commit countries to join a conflict only if it is a defensive conflict, meaning if the alliance is only triggered for conflicts over sovereignty or territory, while others commit allies to join offensive conflicts which includes conflicts that do not threaten sovereignty or territory. Leeds (2003) finds that being in an offensive alliance is positively correlated with initiating a conflict while being in a defensive alliance is negatively correlated with the initiation of conflict. Countries are also less likely to initiate a conflict against countries within their alliance. When the potential challenger is more capable than the targeted country, the challenger is more likely to initiate conflict (B. A. Leeds, 2003).

2.3.2 Domestic Conflicts

Studies of civil wars and domestic rebellion examine the relationship with state capacity which is a measure of army size, self-identification with the country, and political attitude. Gibler & Miller (2014) find a correlation between external threats to the state and domestic peace – particularly that a state's military capacity to repress dissent increases when they face certain threats. An important question is if this extends to interstate militarized conflict – if states are more able to repress dissent, then they might not need to go to war to maintain high levels of domestic popularity. This could potentially mean that capacity to repress dissent should be included as a control.

Studies of maritime disputes and conflicts have examined what factors can contribute to the start of a militarized interstate dispute. Mitchell (2020) finds that countries with more naval capabilities are more likely to claim disputed waters and behave more coercively in resolving those disputes unless their opposing country has a similar level of naval capabilities (providing some support for both the arms race and deterrence hypotheses). They also find that democracies and developed countries are more likely to make maritime claims unlike with territorial claims (Mitchell, 2020).

In countries with disparities in resources, the resource-poor country could have an incentive to attack the resource-rich one if they think they can secure access to the resource in a war. Resource-rich countries can discourage war by regulating prices and extraction such that it never makes sense for the resource-poor country to go to war (Acemoglu et al., 2012). In the case where the resource-poor country chooses to go to war, they prepare before invading by increasing militarization. In this case, I would expect militarization to increase prior to a country starting an invasion. In this case, militarization is not causing the conflict, but the desire for resources. This could also result in the other country militarizing and deterring the conflict.

3 Theory and Hypotheses

Deterrence theory posits that countries increasing their militarization discourage other countries from attacking by increasing the cost to the potential attacker in terms of casualties and length of the potential conflict such that the benefits do not outweigh the potential costs. Of course, deterrence is not incompatible with levels of militarization that also enable a country to successfully attack another (Jackson & Morelli, 2009).

Alternatively, others suggest that arms races increase the chance of conflict within rivalries because countries lose control of their arms race or feel empowered by their increased military strength (Sample, 2000). Another explanation for how arms races lead to increased likelihood of conflict is that arms races result in a security dilemma where the other side of the arms race feels more threatened due to the military buildup and, therefore, more likely to take hostile actions (Senese & Vasquez, 2005).

It is hard to distinguish between these theories with simple correlations because countries that expect to be in conflict increase militarization even if the deterrence theory is correct. This means we need to find a way to control for the baseline risk of conflict;

otherwise, it poses an endogeneity concern. Militarization may also indicate risk of conflict even if not causally related because countries see a third factor and are motivated to both increase their militarization and are more inclined to start wars or be attacked for the same reason.

I anticipate that countries increase military spending (a flow) when they anticipate a military conflict. Once I control for this, I expect that a greater stock of military capability (reflected in personnel and heavy weaponry) makes a country less likely to be a target of a military conflict, but potentially more likely to initiate a conflict.

In the first step, I develop a latent measure of militarization. This should allow me to explore whether militarization is informed by underlying characteristics that either cannot be directly measured or are challenging to measure directly but still contribute to the decision to militarize. For instance, this might be neighboring threats, changes in leadership, or conflicts in neighboring countries.

This paper examines under what circumstances does increased militarization increase a country's confidence in conflict and, therefore, make them more likely to initiate and continue conflicts versus making them a more formidable adversary and thereby deterring conflict or attack from others. In addition, greater militarization potentially makes a country a more formidable opponent, therefore, instead of starting a war, the opposing country could decide they are less likely to win (or that winning takes much more effort) and, therefore, it chooses a diplomatic route (making concessions) to resolve a dispute.

I hypothesize that the existing stock of military capacity, measured by prior military expenditure, personnel, and the existing stock of heavy weaponry, results in a lower likelihood of being a target state in an armed interstate conflict because greater militarization reduces the probability that a rival can achieve its aims vis-à-vis the target through military means.

Military Stocks Hypothesis *As the existing stock of military capacity increases, instances of being targeted in an armed interstate conflict decreases.*

On the other hand, I hypothesize that flow measured as current military spending results in an increased risk of disputes in the current year as the flow is a proxy for the likelihood of conflict and has less effect on the overall military strength (as it takes time to transform current military spending into military strength).

Military Flows Hypothesis *As flow of current military spending increases, the risk of armed interstate conflict in the current year increases.*

I further hypothesize that increases in militarization, both in stocks and flows, result in a higher likelihood of a country being the initiator in a MID because they are emboldened by having greater strength to initiate a conflict and because greater spending in the current year is likely an indicator of an interest in initiating a conflict.

Military Stocks and Flows Hypothesis *Increases in militarization, both stocks and flows, increase the likelihood of a country being in a MID.*

4 Data

4.1 Interstate Conflict

My dependent variable is Militarized Interstate Disputes (MIDs) which are defined by the Correlates of War Project as an instance where at least one state threatens, displays, or uses force against another state (Palmer et al., 2015). I use the COW dataset for this variable because it also contains data about which states in each conflict were the initiator. These data are used to analyze how militarization affects a country's decision to initiate a conflict (Palmer et al., 2015). However, in this dataset sometimes all countries that are involved are listed as an initiator. To deal with this, I only use conflicts that have both initiator and target states in the analysis of which country initiated the conflict. This will allow me to run separate logistic regressions testing the effect of the militarization variables on both being an initiator and a target in a military conflict.

While the COW MID dataset has data on intensity level of the conflict, there are not enough instances of conflict to examine the intensity level. Instead, I use a binary variable for if there was a conflict in a given country-year.

4.2 Changes to the Global Militarization Index

The independent variable is GMI, a measure of military expenditure, personnel, and weapons developed by the BICC. To account for economic and population differences by country, the measures are standardized in terms of domestic measures. Military expenditure is measured relative to Gross Domestic Product (GDP) and health expenditure. Military personnel is measured relative to the number of doctors and population size. Heavy weaponry is also adjusted for population. GMI is weighted such that expenditure and personnel receive twice the weight as heavy weaponry. GMI ranges from 0 to 500 and covers 153 countries (Bayer & Rohleder, 2022).

While GMI provides an adequate baseline measure of militarization, in this paper, I explore alternative ways of capturing militarization. First, I replace GDP with Surplus Domestic Product (SDP). First proposed by Anders et al. (2020), SDP measures surplus income beyond the minimum level necessary to sustain the population and can be invested in other goals. SDP is a better indicator of state resources and power than GDP because it excludes the resources necessary for the population to survive which could not be appropriated by the government for military purposes. SDP improves comparisons between states tracking how threatening states could be to others (Anders et al., 2020).

The BICC GMI uses a measure of military expenditure from the Stockholm International Peace Research Institute. However, there are many other measures of military expenditure covering different countries and years. Thus, I use the Global Military Spending Dataset (GMSD), which combines nine different measures of military expenditure to increase reliability and minimize missing values (Barnum et al., 2024).

Instead of measuring military personnel relative to the number of physicians, I measure it relative to the total size of the workforce in each country. Using the military personnel as a fraction of the total workforce more directly focuses on how much weight the military is given in the country. Countries with more physicians per capital are also likely countries with greater wealth and technology. Thus, using number of physicians in the denominator will also end up weighting by wealth and technology as well, potentially biasing the results.

Because the BICC does not release the data they used to develop each part of the indicators and only releases the expenditure, personnel and heavy weaponry indicators, I found sources for each of the data they cite and recreate it. Because I am not making changes to the heavy weaponry index, I still use their index for that in the recreated indices.

4.3 Data Sources for Militarization Index

In recreating the component parts of the measure that the BICC made, I attempted to use the same data source. This was not always possible given accessibility and cost. I used the Stockholm International Peace Research Institute database on military expenditure which reports time series data on military spending from 1949-2023. It reports values in constant 2022 USD, current USD, as a share of GDP and per capita for those dates (*SIPRI Military Expenditure Database*, 2023). The adjusted measure of military expenditure comes from the Global Military Spending Dataset (GMSD) which combines nine different military spending datasets to reduce variability and fill in missing values (Barnum et al., 2024).

The BICC measure of militarization weights military spending by GDP and health spending. The measure of GDP used was created by the World Bank and OECD and provides data for 220 countries and territories after excluding regional groupings between 1960 and 2023 (World Bank and OECD, 2024). BICC's measure of health expenditures uses data from the Global Health Repository from the World Health Organization. I use a combination of health expenditure per capita and as a percentage of GDP as my measure, also using World Health Organization data. Both data sources are for 192 countries between 1991 and 2021 (*Current Health Expenditure (CHE) as Percentage of Gross Domestic Product (GDP) (%)*, 2023; *Current Health Expenditure (CHE) per Capita in US$*, 2023). I calculate total health expenditure from that data by multiplying by the population and GDP, respectively.

The measure of armed forces personnel comes from the International Institute for Strategic Studies (IISS) but was compiled by the World Bank and published by the Our World in Data (International Institute for Strategic Studies, 2024). The data on the number of physicians comes from the World Health Organization (*The National Health Workforce Accounts Database & World Health Organization*, 2024).

4.4 Control Variables

Several factors are frequently discussed in conjunction with both militarization and armed conflict – gender equality, democracy, economic globalization, and alliances. I use these as control variables in the regressions. Gender equality is a measure of how many institutions and programs a country has that promote gender equality in the law, education, healthcare, and the economy with higher numbers indicating more gender equality. It comes from the women's civil liberty index in V-Dem. I measure democracy with V-Dem's ratings of political regime as either a closed autocracy, electoral autocracy, electoral democracy, or liberal democracy. Higher values indicate more democracy (Varieties of Democracy, 2023). Economic globalization is a measure of trade (in goods and services) and financial flows measured from 1 to 100. The index was created by the KOF Swiss Economic Institute. Higher numbers indicate a higher degree of globalization (Dreher, 2006; Gygli et al., 2022). For my measure of alliances, I use the Alliance Treaty Obligations and Provisions Project's State-Year dataset on the number of alliances a country was part of (B. Leeds et al., 2002).

5 Methodology

5.1 Rationale for Latent Variable Modeling

I estimate and compare the different militarization measures using a latent variable model. The latent variable model measures unobservable concepts that can influence a country's decision-making, such as leadership or belligerence of the country or it's neighbors.

It also provides estimates of measurement error which can be useful in ascertaining how much variation there is in the data without missing the intended variation for different years and countries. I use a dynamic model because it allows for variation both between years and countries. A dynamic model uses the normal distribution for the first observation and bases future estimates on a normal distribution of the prior observation (Reuning et al., 2019).

Theta corresponds to the latent estimate generated by the model. I use a dynamic theta instead of a static theta because I expect that the relationship between the variables may change over time as some became more important and others less so. A dynamic theta is also more appropriate for a time series, and any specific variable in time t is not independent from the variable in time t-1. For instance, the measure that compares the number of military and paramilitary personnel to the number of physicians in a country is related to the value in the previous time period. Latent variable models have also been used to assess how human rights violations and increased adoption of human rights treaties correlate over time (Fariss, 2018).

Each indicator of militarization included in the model is a factor that contributes to the latent variable for militarization. The possible indicators are military expenditure measured by SIPRI or GMSD in proportion to GDP, SDP, or health expenditure; military personnel in proportion to the total population, total workforce, or number of physicians; and the weapons indicator. Each model has J indicators of militarization.

5.2 Regressions

My unit of analysis is a country-year between 1990 and 2014 for every country with data in both the COW and GMI datasets, 141 countries. I extend the GMI to years before 1990 in countries with available data (and COW has data starting in 1816). This is because with only 24 years of data, the threshold for statistical significance is much harder to reach, especially given there are not many instances of interstate conflict over that time. I combine the COW and GMI datasets using R and the dplyr package. Because the COW dataset does not include country name as a variable and each dataset uses different three-letter country codes, I use the COW country codes dataset to turn the country codes in the COW dataset into names.

Multiple imputation is used to fill in missing values in the data. This helps ensure the degrees of freedom in each regression is not substantially different, which impacts reliability.

I evaluate the changes in the militarization index through regressions to determine if the changes improve the ability of militarization measures to predict militarized interstate disputes. To compare the two different military expenditure measures, I run 3 sets of 3 regressions for GDP, SDP, and health weighting. I use likelihood ratios to compare each one and determine if SIPRI or GDP is better. I also compare each of these three weights for military expenditure. I do this by two groups of regressions for each of SIPRI and GMSD and examine if GDP, SDP, or health expenditure is better to determine which is most correlated with MIDs. Next, there are 3 different ways of weighting military personnel, with the population, the number of physicians, and the size of the workforce which are compared using a likelihood ratio test.

I plan to analyze the different measures of militarization by running separate logistic regressions comparing a country's militarization index and individual measures of military stocks and flows with a binary variable for if they were engaged in a dispute in a particular year.

To investigate the impact on the initiation of conflict, I plan to run separate regressions using a different dependent variable for if the country initiated the conflict. This also addresses endogeneity issues because it counts cases where military build-up was due to the other countries as not being involved in a conflict.

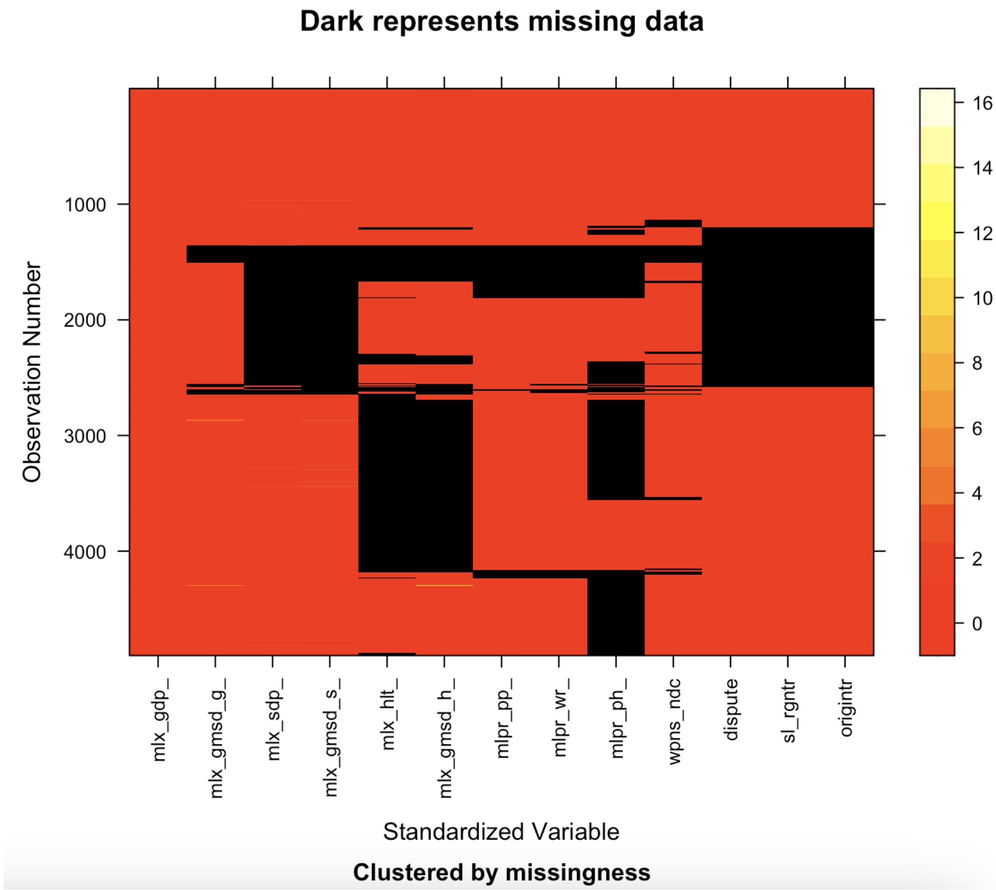
6 Results

6.1 Latent Variable Modeling

A dynamic latent variable model was used as described in Fariss et al. (2022). The latent trait in year t was estimated based on the value in year $t-1$. $\theta_{it} \sim \mathcal{N}(0,1)$ when t is the first country-year for each country in the data. When t is not the first country-year, it follows the formula $\theta_{it} \sim N(\theta_{it-1}, \sigma)$.

The latent variable model failed to converge, meaning it did not find the optimal relationship between the variables to measure the underlying concept of militarization. There should be sufficient data for the number of variables because there are 7712 country-year data points and 10 variables which meets general guidelines stating there should be 10 data points per predictor variable. Even excluding missing data in the 7712 country-years, the smallest number of data points in any of the 10 variables is 2623 which is plenty per variable. Reducing the missing values from the dataset by limiting the data to post-1990, when much of the military personnel data is missing, is shown in Figure 1. The last three columns of missing data are the independent variable for the regression stage and are not included in the latent variable model.

Figure 1: Missing Data post-1990



My initial model included 10 distinct militarization variables. Those 10 variables are: military expenditure weighted by Surplus Domestic Product, GDP, and Health Expenditure using two different ways of calculating military expenditure: Stockholm International Peace Research Institute's and the Global Military Spending Dataset's measure of expenditure; number of military and paramilitary troops as a ratio compared to the population, total workforce, and number of physicians; and the weaponry index. This model failed to converge and the β values were 0 except for the weaponry index. The formula for each $theta$ value is $\theta_{variable} = \alpha_1 + \beta_1 * Variable$ where $Variable$ represents each component of militarization as listed above.

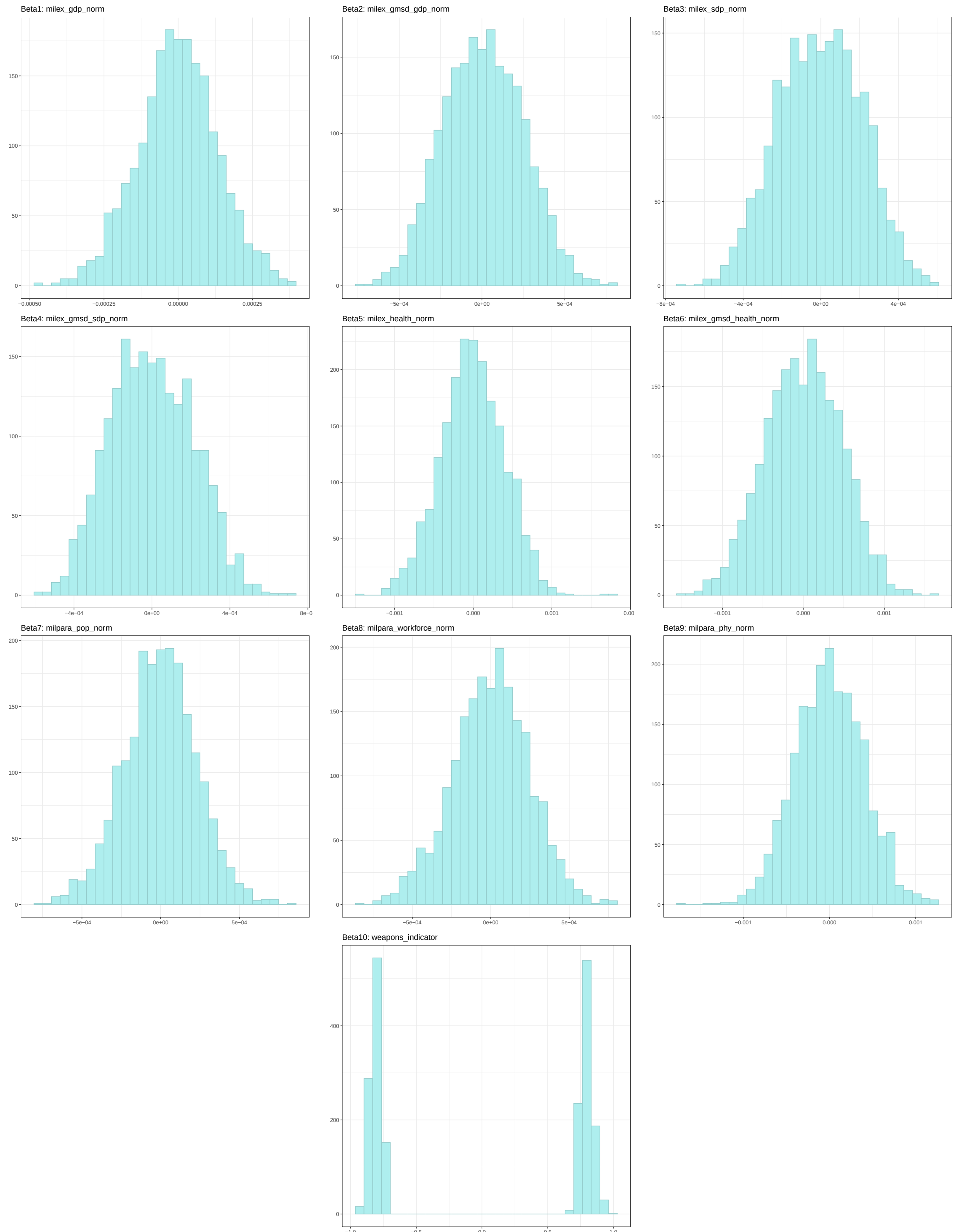
The variable θ was supposed to represents the underlying concept. The model produced estimates of β, the coefficient for θ, and α, the intercept, used to find a linear relationship between θ and each variable. The beta value that the model produced was 0 for each variable except for the measure of weaponry for which it was -0.01. These beta estimates can be found in Table 1. Appendix A has the output for models with different combinations of variables, but ultimately, all of the α and β values were 0 except for the weaponry indicator.

Table 1: Full Model Beta Output

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	42.28	1.04
beta[2]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	4.76	1.30
beta[3]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	3.89	1.42
beta[4]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	3.77	1.44
beta[5]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	17.72	1.08
beta[6]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	4.01	1.40
beta[7]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	30.42	1.05
beta[8]	-0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	23.31	1.06
beta[9]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	1926.72	1.00
beta[10]	-0.01	0.57	0.81	-0.88	-0.81	-0.01	0.80	0.88	2.01	19.90

The distribution of β estimates can be found in Figure 2. In order across the columns, the first plot is for the SIPRI military expenditure measure divided by GDP, the second for the GMSD military expenditure measure divided by GDP, the third and fourth are instead divided by SDP, the fifth and sixth are divided by health expenditure, the seventh is military personnel as a percentage of population, the eighth is as a percent of the workforce, the ninth is in proportion to physicians, and the tenth is the weapons indicator. All the distributions of the estimates of β look roughly normally distributed except for the distribution of the weapons indicator which has two peaks on the left and right and zero in the center. All the distributions are centered at 0 which makes sense given what Table 1 indicates the mean β values are.

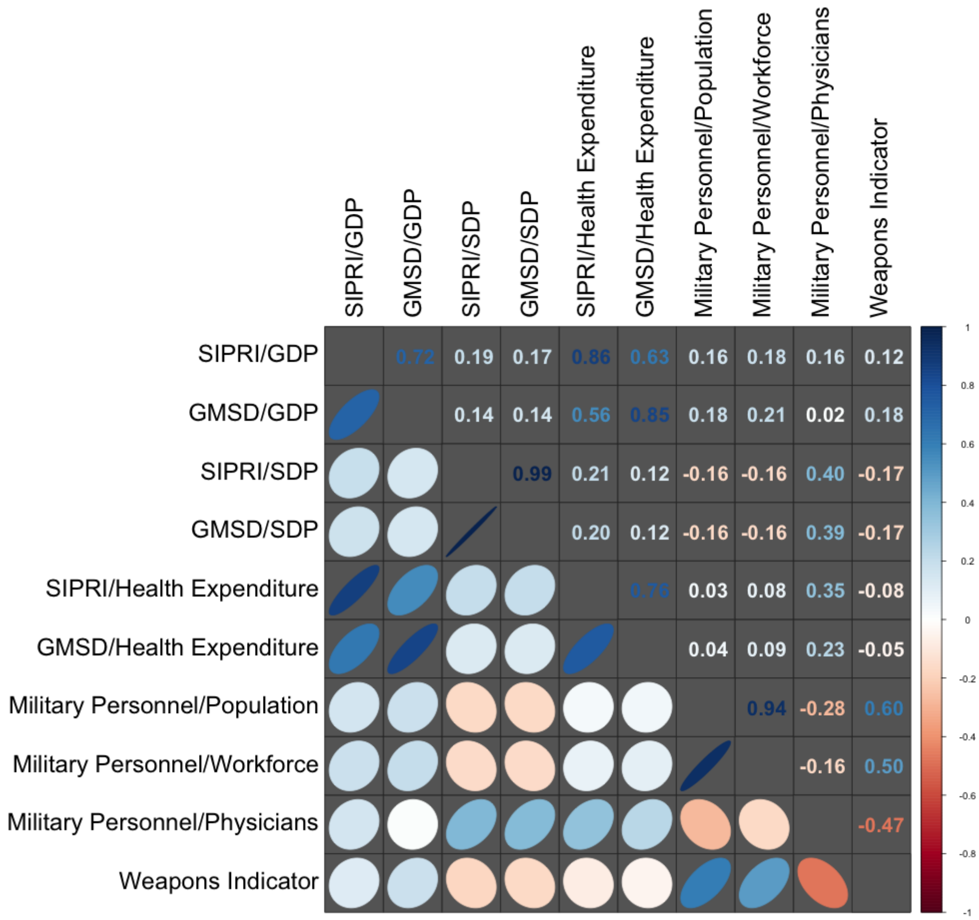
Figure 2: Distribution of Beta Values



The latent variable model has a normal distribution of beta values in the combined model centered around 0 for all of the variables except the weaponry index that is centered around 0 but had two peaks at approximately -0.8 and 0.8.

This could be for a few different reasons, such as, the model may not identify one concept but rather includes several different factors that could not be estimated together. Or the initial values in the model may have too much error to create a measure that could be optimized. Possible other reasons latent variable models fail to converge do not apply in this case, for example, when the data is highly collinear or there is a small sample size. Figure 3 shows the correlation between variables in the latent variable model. The top triangle of the plot shows the correlation coefficient between the two variables, and the shaded based indicates the strength of the correlation. The bottom triangle are ellipses showing the correlation coefficient–narrow ellipses indicate highly correlated variables and ellipses close to a circle represent uncorrelated variables. Very few variables were highly correlated, and versions of the latent variable model were attempted that did not include the collinear variables.

Figure 3: Collinearity between Separated Measures of Militarization

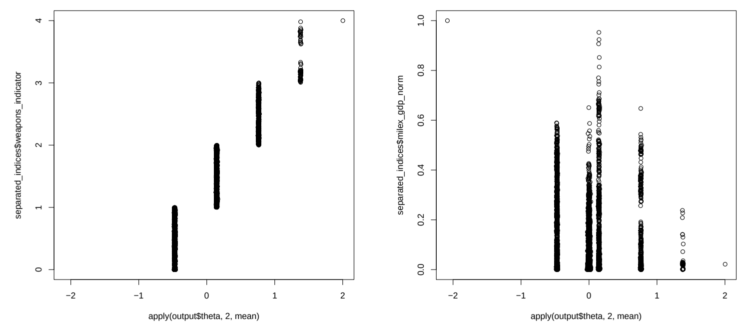


The top triangle shows the correlation coefficients shaded by the strength of the correlation, with dark blue and dark red being higher correlations. The bottom triangle represents those correlations with circles: the more elliptical, the stronger the correlation; the more circular, the weaker the correlation. Most of the variables are not highly correlated with each other except for some of the military spending measures with a few of the other spending measures and military personnel as a percentage of workforce with military personnel as a percentage of the total population.

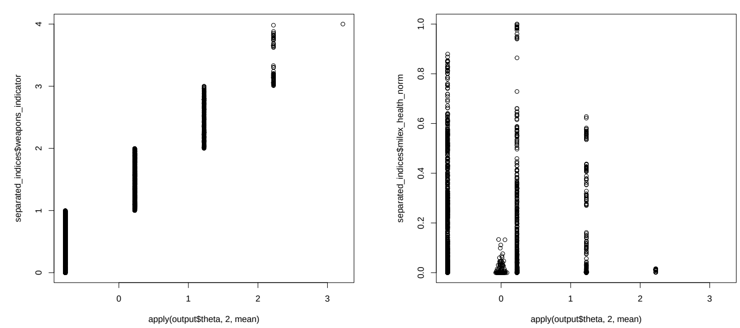
In trying to determine if there were too many indicators in the original latent variable model with all 10 variables for militarization, I ran models combining the measure of weaponry with just one other variable. In these latent variable models, I removed β for weaponry such that a one-unit change in weaponry results in a one-unit change in θ (the latent variable). I hypothesized that simplifying the model and examining one variable with a coefficient in addition to weaponry might result in convergence. The formula for $y_{it\,weaponry}$ was $y_{it\,weaponry} = \alpha_{weaponry} + \theta_{it}$.

However, in the other variable in each of the models, there was a β coefficient following this formula: $y_{itj} = \alpha_j + \beta_j * \theta_{it}$ where j represents the other variable. The results are shown in Figure 4. Each of the scatterplots of the theta values with the weaponry index (the plots on the left) shows four distinct lines indicating that the model produced the expected results because it is generating theta in one-unit increments based on the weaponry variable. However, for the other variables, there is no clear relationship between θ and the other variable. This is because the β values generated by the models are very close to 0 because it could not assess the underlying latent trait in the variable.

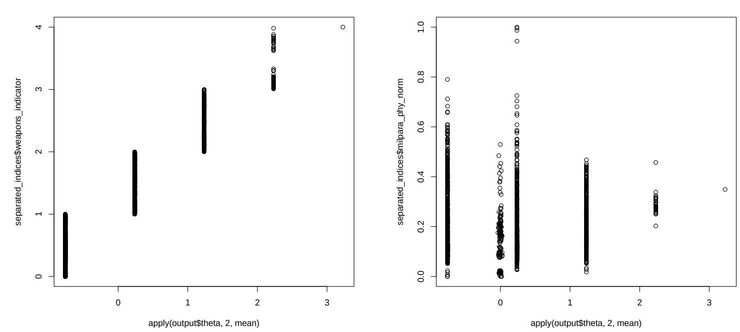
Figure 4: Bivariate Latent Variable Models



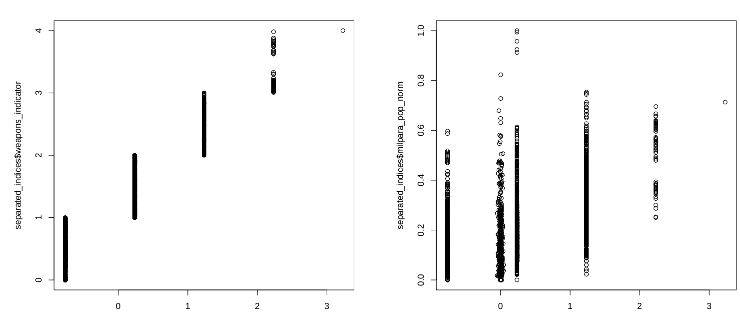
SIPRI/GDP



SIPRI/Health



MilPara/Physicians



MilPara/Population

The graphs on the left indicate the roughly linear relationship between the θ and the weapons indicator increasing by exactly one because of the lack of a β coefficient. The graphs on the right show clustering of values around 0, indicating the latent variable model was unable to determine a linear relationship.

6.2 Regressions

To compare the ability of each measure of militarization from the Global Militarization Index (GMI) with the changes that were made in this paper, I ran logistic regressions grouping by military expenditure and military personnel (the two subcategories of the GMI that changes were made to). Multiple imputation filled in missing values based on the surrounding values as in Rubin (1987) using the mice Package in R (van Buuren & Groothuis-Oudshoorn, 2011). The number of multiple imputations created was five, meaning it created five possible values for the missing numbers. I ran the regressions on each of the five tables and then calculated the coefficient and standard error by combining them. The coefficient estimate is the mean of the coefficient estimates in each table. The standard error was calculated according to this formula:

$$se = \sqrt{\frac{1}{m}\sum_{k=1}^{m} s_k^2 + \left(1 + \frac{1}{m}\right)\sigma_\beta^2}$$

where s_k^2 is the standard error from the data and σ_β^2 is the variance in the coefficients.

The logistic model uses this formula:

$$y_{it} = \frac{e^{z_{it}}}{e^{z_{it}} + 1}$$

where the dependent variable is militarized interstate disputes. y is an indicator variable that takes the value 0 for country i in year t if in country i in year t there was not a militarized interstate dispute (MID). It equals 1 if country i in year t was involved in a MID. z represents the independent variables.

6.2.1 Military Expenditure

For the independent variable, z_{it}, I use linear combinations of different military expenditure variables. $MilEx$ is either the SIPRI or GMSD measure of military expenditure. $Weight$ is either SDP, GDP, or health expenditure. For models 1, 2, 4, 5, 7, and 8, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{MilEx}{Weight}_{it} + \epsilon$$

For Models 3, 6, and 9, the equation is

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{SIPRI}{Weight}_{it} + \beta_2 \cdot \frac{GMSD}{Weight}_{it} + \epsilon$$

Table 2: Disputes and Military Expenditure: SIPRI versus GMSD Comparison

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
SIPRI/GDP	4.86^{***}		3.23^{***}						
	(0.58)		(0.76)						
GMSD/GDP		3.85^{***}	1.97^{**}						
		(0.48)	(0.62)						
SIPRI/SDP				0.62		-1.72			
				(0.33)		(2.83)			
GMSD/SDP					0.62^{*}	2.23			
					(0.31)	(2.66)			
SIPRI/Health							3.02^{***}		1.88^{**}
							(0.54)		(0.67)
GMSD/Health								3.58^{***}	2.31^{**}
								(0.61)	(0.73)
Constant	-1.52^{***}	-1.56^{***}	-1.65^{***}	-0.97^{***}	-0.97^{***}	-0.97^{***}	-1.30^{***}	-1.39^{***}	-1.46^{***}
	(0.09)	(0.10)	(0.10)	(0.06)	(0.06)	(0.06)	(0.09)	(0.10)	(0.10)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

For the initial models comparing the measurement methods, I omitted lagged variables to identify the most significant variables. Including these variables make the likelihood ratio tests more difficult to determine if the current year, lagged years, or the combination raises the bar for statistical significance. Models 1, 2, and 3 all included GDP, either with SIPRI, GMSD, or both, producing positive statistically significant results. Of the models that used SDP, only model 5 was statistically significant. There was a positive significant relationship between GMSD/SDP. Models 7, 8, and 9 included military expenditure in proportion to health expenditure, and the results are positive and statistically significant indicating when countries increase military spending compared to other areas, they are more likely to be involved in a militarized interstate dispute.

The regressions in Table 2 were used in likelihood ratio tests to determine which measures were better predictors. The results are in Table 3.

Table 3: SIPRI versus GMSD Likelihood Ratio Test

	Model Comparison	Test Statistic	df	df2	P-Value	riv
1	Model 1 vs Model 3	9.98	1.00	1310965.30	0.00	0.00
2	Model 2 vs Model 3	18.41	1.00	11941012.03	0.00	0.00
3	Model 4 vs Model 6	0.71	1.00	388.58	0.40	0.11
4	Model 5 vs Model 6	0.37	1.00	359.81	0.55	0.12
5	Model 7 vs Model 9	9.85	1.00	84.78	0.00	0.28
6	Model 8 vs Model 9	7.94	1.00	53.13	0.01	0.38

The first two tests comparing the models with SIPRI and GMSD as a percentage of GDP had p-values of 0.00, indicating that the larger model with all variables was better. The likelihood ratio test of the measures as a percentage of SDP both had large p-values of 0.40 and 0.55 indicating the smaller models were better for those. The last two tests comparing SIPRI and GMSD in proportion to health expenditure was 0.00 and 0.01 indicating that the larger combined model was better. This did not provide conclusive evidence if SIPRI or GMSD was a better measure of military expenditure for examining MIDs.

Table 4 shows the comparison of the denominator of the military expenditure variable. Models 1, 2, 4, 5, 7, and 8 are repeated from Table 2. For Model 10, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{SIPRI}{GDP}_{it} + \beta_2 \cdot \frac{SIPRI}{SDP}_{it} + \beta_3 \cdot \frac{SIPRI}{Health}_{it} + \epsilon$$

For Model 11, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{GMSD}{GDP}_{it} + \beta_2 \cdot \frac{GMSD}{SDP}_{it} + \beta_3 \cdot \frac{GMSD}{Health}_{it} + \epsilon$$

Table 4: Disputes and Military Expenditure: SDP versus GDP Comparison

	Model 1	Model 4	Model 7	Model 10	Model 2	Model 5	Model 8	Model 11
SIPRI/GDP	4.86***			4.54***				
	(0.58)			(0.85)				
SIPRI/SDP		0.62		0.07				
		(0.33)		(0.37)				
SIPRI/Health			3.02***	0.38				
			(0.54)	(0.78)				
GMSD/GDP					3.85***			3.42***
					(0.48)			(0.76)
GMSD/SDP						0.62*		0.23
						(0.31)		(0.33)
GMSD/Health							3.58***	0.64
							(0.61)	(0.96)
Constant	−1.52***	−0.97***	−1.30***	−1.53***	−1.56***	−0.97***	−1.39***	−1.58***
	(0.09)	(0.06)	(0.09)	(0.09)	(0.10)	(0.06)	(0.10)	(0.10)

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

In model 10 and 11, the only statistically significant result is there is a positive correlation of both SIPRI and GMSD as a percentage of GDP. The results are compared in Table 5.

Table 5: GDP and SDP Likelihood Ratio Test

	Model Comparison	Test Statistic	df	df2	P-Value	riv
1	Model 1 vs Model 10	0.14	2.00	78.15	0.87	0.23
2	Model 4 vs Model 10	31.03	2.00	83.61	0.00	0.22
3	Model 7 vs Model 10	16.96	2.00	600.97	0.00	0.07
4	Model 2 vs Model 11	0.47	2.00	79.06	0.62	0.23
5	Model 5 vs Model 11	27.72	2.00	82.89	0.00	0.22
6	Model 8 vs Model 11	12.06	2.00	227.00	0.00	0.12

Comparing model 1 and model 10 shows a p-value of 0.87, indicating that the smaller model containing only GDP is better. The other two comparisons to model 10 have p-values of 0.00, indicating that the larger model is better than using SDP or health expenditure alone. Comparing model 2 to model 11 shows a p-value of 0.62 indicating the model containing only GDP is also better for the GMSD measure. Comparing model 5 and 8 to model 11 show p-values of 0.00, indicating the larger model with all three measures is better.

This is reasonable evidence that military expenditure as a percentage of GDP improves the militarization measure with respect to MIDs.

6.2.2 Military Personnel

Table 6 shows the relationship between MIDs and several military personnel variables. $MilPara$ is the number of military or paramilitary personnel in a country each year. $Weight$ is either the population, the number of people in the workforce, or the number of physicians. For models 12, 13, and 14, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{MilPara}{Weight}_{it} + \epsilon$$

For model 15, the equation is

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{MilPara}{Population}_{it} + \beta_2 \cdot \frac{MilPara}{Workforce}_{it} + \beta_3 \cdot \frac{MilPara}{Physicans}_{it} + \epsilon$$

For model 16, the equation is

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{MilPara}{Population}_{it} + \beta_2 \cdot \frac{MilPara}{Workforce}_{it} + \epsilon$$

Table 6: Disputes and Military Personnel

	Model 12	Model 13	Model 14	Model 15	Model 16
MilPara/Population	2.29***			0.47	0.60
	(0.26)			(1.03)	(0.98)
MilPara/Workforce		1.93***		1.67	1.45
		(0.21)		(0.88)	(0.80)
MilPara/Physicians			0.75*	−0.32	
			(0.33)	(0.38)	
Constant	−1.18***	−1.26***	−0.92***	−1.21***	−1.25***
	(0.07)	(0.07)	(0.09)	(0.09)	(0.07)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

There is a strong statistically significant and positive relationship between military personnel as a percentage of the population and as a percentage of the workforce and engaging in a MID. The relationship between military personnel as a ratio to the number of physicians in the country is statistically significant and positive but weaker than the relationship in models 12 and 13. None of the combined models (models 15 and 16) are statistically significant as shown in Table 6.

Table 7: Military Personnel Likelihood Ratio Test

	Model Comparison	Test Statistic	df	df2	P-Value	riv
1	Model 12 vs Model 15	1.70	2.00	186.04	0.19	0.13
2	Model 13 vs Model 15	0.52	2.00	186.04	0.60	0.13
3	Model 14 vs Model 15	18.50	2.00	6251.60	0.00	0.02
4	Model 12 vs Model 16	2.96	1.00	5086867353975284092108 8.00	0.09	-0.00
5	Model 13 vs Model 16	0.28	1.00	859680582825341521756 16.00	0.60	-0.00

The comparison of the models using a likelihood ratio test is shown in Table 7. The p-value of the comparison of the model with variables in proportion to population and workforce are 0.19 and 0.60, respectively, indicating the smaller bivariate models are better. The p-value for the model with physicians is 0.00 indicating that model 15 with three covariates is better than the bivariate physicians model. Comparing both of the first two models to a model with both their variables together yields p-values of 0.09 and 0.60, indicating that the combination was not better than the bivariate regressions.

6.2.3 Stock and Flow Variables

Using the information from the previous regressions, I examine the relationship between stock variables (previous expenditure, personnel 2 years prior, and weaponry) and MIDs. Table 8 shows the regressions. The equation for models 17 through 20 are:

$$z_{it} = \beta_0 + \beta_1 \cdot \frac{MilEx}{GDP}_{it} + \beta_2 \cdot \frac{MilPara}{Weight}_{it} + \beta_3 \cdot Weapons\ Indicator_{it} + \epsilon$$

where $MilEx$ is either GMSD or SIPRI and $Weight$ is either population or workforce.

Table 8: Lagged Stock Variables

	Model 17	Model 18	Model 19	Model 20
SIPRI/GDP	4.91^{***}	4.88^{***}		
Last 5 Years	(0.60)	(0.60)		
GMSD/GDP			4.48^{***}	4.41^{***}
Last 5 Years			(0.53)	(0.53)
MilPara/Population	1.11^{*}		1.32^{**}	
2 Years Prior	(0.44)		(0.43)	
MilPara/Workforce		0.72^{*}		0.81^{**}
2 Years Prior		(0.29)		(0.29)
Weapons Indicator	0.22^{*}	0.27^{**}	0.12	0.19
	(0.11)	(0.10)	(0.11)	(0.10)
Constant	-2.14^{***}	-2.21^{***}	-2.27^{***}	-2.32^{***}
	(0.16)	(0.18)	(0.16)	(0.18)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

In all four models in Table 8, there is a positive and statistically significant relationship between the average military spending over the last five years with engaging in a dispute in the current year. There is also a positive and statistically significant relationship between number of military personnel in proportion to either the population or the workforce two years before the dispute. This indicates that countries also increase the number of military personnel leading up to a conflict, although it is unclear if it is in anticipation of a conflict or in an effort to deter an opponent. The weapons indicator was not lagged because it takes several years to build a weapons system and that variable already includes long-term military investment. It was only significant in models 17 and 18.

To compare both stock and flow variables, I combined them each into indices weighted in two different ways. One way is weighting each component (expenditure, personnel, weaponry) equally, and the other way uses the BICC's weighting method that weights expenditure and personnel equally and twice as much as weaponry. Regardless of the different weighting, the results were fairly similar as shown in Table 9. For models 21 and 24, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \epsilon$$

For models 22 and 25, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot Flow\ Index_{it} + \epsilon$$

For models 23 and 26, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \beta_2 \cdot Flow\ Index_{it} + \epsilon$$

.

Table 9: Stock and Flow Indices

	Model 21	Model 22	Model 23	Model 24	Model 25	Model 26
Stock Index	0.35^{*}		-0.47			
Even Weighting	(0.16)		(0.36)			
Flow Index		0.51^{**}	0.93^{**}			
Even Weighting		(0.16)	(0.36)			
Stock Index				0.37^{*}		-0.25
BICC Weighting				(0.17)		(0.30)
Flow Index BICC Weighting					0.57^{***}	0.77^{**}
BICC Weighting					(0.17)	(0.30)
Constant	-1.11^{***}	-1.18^{***}	-1.15^{***}	-1.12^{***}	-1.20^{***}	-1.18^{***}
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

In the bivariate models (model 21, 22, 24 and 25) there is a statistically significant, positive relationship between the index and whether there is a dispute that year. In the combined models (model 23 and 26), the flow indices are positively correlated and statistically significant, but the stock variables are not statistically significant. While it was not significant, that the stock variable reversed sign is suggestive that current military expenditures are capturing something different from the stock of military strength. This analysis cannot support the deterrence hypothesis because the stock variable is not statistically significant, but it does suggest that analyses using current military expenditures could be capturing something other than the effect of military strength itself.

Next I tested the models from Table 9 by adding controls for democracy, economic globalization, gender equality, and number of alliances; the results are shown in Table 10. The formula for z in model 27 and 30 is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \beta_2 \cdot X + \epsilon$$

The formula for z in model 28 and 31 is:

$$z_{it} = \beta_0 + \beta_1 \cdot Flow\ Index_{it} + \beta_2 \cdot X + \epsilon$$

The formula for z in model 29 and 32 is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \beta_2 \cdot Flow\ Index_{it} + \beta_3 \cdot X + \epsilon$$

X is a vector of control variables that includes a measure of economic globalization, gender equality, democracy, and number of alliances as defined in Section 4.

Table 10: Stock and Flow Indices with Controls

	Model 27	Model 28	Model 29	Model 30	Model 31	Model 32
Stock Index	0.31		-0.75^{*}			
Even Weighting	(0.17)		(0.38)			
Flow Index		0.53^{**}	1.19^{**}			
Even Weighting		(0.17)	(0.37)			
Stock Index				0.33		-0.40
BICC Weighting				(0.17)		(0.30)
Flow Index					0.60^{***}	0.93^{**}
BICC Weighting					(0.17)	(0.29)
Democracy	-0.04	-0.05	-0.05	-0.04	-0.06	-0.06
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Economic	0.01^{*}	0.01^{*}	0.01^{*}	0.01^{*}	0.01^{*}	0.01^{*}
Globalization	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gender Equality	-1.40^{**}	-1.37^{**}	-1.33^{**}	-1.41^{**}	-1.34^{**}	-1.30^{**}
	(0.44)	(0.44)	(0.44)	(0.44)	(0.44)	(0.44)
Alliances	0.06^{***}	0.06^{***}	0.06^{***}	0.06^{***}	0.06^{***}	0.06^{***}
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	-1.00^{***}	-1.15^{***}	-1.15^{***}	-1.02^{***}	-1.22^{***}	-1.19^{***}
	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.26)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Neither models 27 and 30, with only the stock indices, are statistically significant. Models 28 and 31 with only the flow indices show a positive, statistically significant relationship with militarized interstate disputes when control variables are included. Model 29 includes both the stock and flow indices to evenly weight the components. The stock index has a negative, statistically significant relationship, whereas the flow variable has a positive, statistically significant relationship. This confirms my hypothesis that there is a negative relationship for the stock variables serving as a deterrent; however, in the year of the conflict countries increase the flow of militarization. Model 32 is the same as model 29 but uses BICC's weighting. Model 32 is not statistically significant for the stock index, but the flow index is positive and statistically significant.

6.2.4 Conflict Initiation

To test whether increases in militarization, both in stocks and flows, result in a higher likelihood of a country being the initiator of conflict, I ran regressions comparing the stock and flow variables with the initiator variable.

The logistic model uses this formula:

$$y_{it} = \frac{e^{z_{it}}}{e^{z_{it}} + 1}$$

where the dependent variable is if the country originated a MID. y is an indicator variable that takes the value 0 for country i in year t if country i in year t did not initiate a militarized interstate dispute (MID). It equals 1 if country i in year t did initiate a MID. z represents the independent variables. For models 33 and 36, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \epsilon$$

For models 34 and 37, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot Flow\ Index_{it} + \epsilon$$

For models 35 and 38, the equation is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \beta_2 \cdot Flow\ Index_{it} + \epsilon$$

.

Table 11: Originator of Conflict Stock and Flow Variables

	Model 33	Model 34	Model 35	Model 36	Model 37	Model 38
Stock Index	0.33		-0.78^{*}			
Even Weighting	(0.17)		(0.39)			
Flow Index		0.55^{**}	1.24^{**}			
Even Weighting		(0.17)	(0.38)			
Stock Index				0.35^{*}		-0.40
BICC Weighting				(0.18)		(0.31)
Flow Index					0.61^{***}	0.93^{**}
BICC Weighting					(0.17)	(0.31)
Constant	-1.27^{***}	-1.38^{***}	-1.33^{***}	-1.28^{***}	-1.40^{***}	-1.37^{***}
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

There is not a statistically significant relationship between the stock index evenly weighted and if the country was the initiator of a MID in that year in model 33. However, in model 34 the evenly weighted flow index has a positive and statistically significant relationship with if the country initiated a MID in that year. In the combination of models 33 and 34, both the evenly weighted stock and flow variables are statistically significant. But in this case, the stock index had a negative relationship, and the flow index had a positive relationship which conflicts with what I hypothesized. Both the stock and flow index using the BICC weighting in the bivariate regressions of model 36 and 37 had a positive and statistically significant relationship with initiating a MID. However, the stock index ceased to be significant when those were combined in model 38.

Next, I combined these with the control variables. The formula for z in model 39 and 42 is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \beta_2 \cdot X + \epsilon$$

The formula for z in model 40 and 43 is:

$$z_{it} = \beta_0 + \beta_1 \cdot Flow\ Index_{it} + \beta_2 \cdot X + \epsilon$$

The formula for z in model 41 and 44 is:

$$z_{it} = \beta_0 + \beta_1 \cdot Stock\ Index_{it} + \beta_2 \cdot Flow\ Index_{it} + \beta_3 \cdot X + \epsilon$$

Table 12: Originator of Conflict Stock and Flow Variables with Controls

	Model 39	Model 40	Model 41	Model 42	Model 43	Model 44
Stock Index	0.29		-0.78^{*}			
Even Weighting	(0.18)		(0.39)			
Flow Index		0.52^{**}	1.21^{**}			
Even Weighting		(0.17)	(0.39)			
Stock Index				0.32		-0.37
BICC Weighting				(0.18)		(0.32)
Flow Index					0.57^{**}	0.88^{**}
BICC Weighting					(0.18)	(0.32)
Democracy	-0.14	-0.15	-0.15	-0.15	-0.17	-0.17
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Economic	0.00	0.00	0.00	0.00	0.00	0.00
Globalization	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gender Equality	-1.32^{**}	-1.29^{**}	-1.24^{**}	-1.32^{**}	-1.26^{**}	-1.22^{**}
	(0.44)	(0.45)	(0.45)	(0.44)	(0.45)	(0.45)
Alliances	0.05^{***}	0.05^{***}	0.06^{***}	0.05^{***}	0.05^{***}	0.05^{***}
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	-0.49	-0.66^{*}	-0.65^{*}	-0.52^{*}	-0.71^{**}	-0.69^{**}
	(0.25)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

In model 39 and 42, the stock index does not have a statistically significant relationship regardless of what weighting was used. There is a positive and statistically significant relationship between the flow index and initiating a dispute regardless of what weighting was used, as shown in models 40 and 43.

7 Discussion

This paper sought to improve measures of militarization and examine the correlation with militarized interstate disputes. While the latent variable model did not converge and therefore was not able to produce a latent variable measure of militarization, I was still able to compare some of the changes I made to the BICC's measure of militarization. For the change to military expenditure, I sought to compare using latent variable estimates of military expenditure produced by Barnum et al. (2024). The results were inconclusive whether those were better than SIPRI's measure of military expenditure. I also wanted to compare the measure of military expenditure as a percentage of GDP and in ratio to health expenditure that the BICC uses to it as a ratio of Surplus Domestic Product, a measure created by Anders et al. (2020).

The BICC uses a measure of military personnel in proportion to the number of physicians in a country. I thought that this might measure wealth rather than the actual allocation of the workforce to military pursuits, so I made a measure that examined the proportion of military personnel as a percentage of the total workforce. The measures of military personnel compared to the population and the total workforce were better when examining militarization and MIDs than the measure with physicians, as I anticipated.

Using the improved components of militarization, I created separate stock and flow measures of militarization. When the components of the stock and flow measures were evenly weighted, there was a statistically significant negative relationship between military stocks and a statistically significant positive relationship between military flows and being engaged in a military dispute when control variables were included. However, in the model without controls, the stock index was not statistically significant. This provides support for the deterrence hypothesis: that long-term investment (which measure military strength) decreases the risk of conflict. The fact that short-term investments are positively associated with conflict likely means it represents a proxy for the dangerousness of the environment.

For the dependent variable of initiating a dispute, the relationship was statistically significant and negative between military stocks and statistically significant and positive between military flows, regardless of whether control variables were included. This is a unique way of addressing the endogeneity issue of whether increases in militarization are due to being in a more dangerous environment or an effort to improve deterrence, increase confidence in a potential conflict, or encourage countries to engage in conflict because they are stronger. Because I found a negative relationship with military stocks and a positive relationship with flows, it indicates the deterrence hypothesis is correct because having a higher stock of military capabilities resulted in a lower likelihood of initiating conflict but a recent increase in military flows resulted in an increased likelihood of conflict. Potentially, this could be because when a country is clearly stronger, they do not need to initiate a conflict to extract concessions but can use it to enforce bargaining.

When the BICC's weighting which equally weighted expenditure and personnel measures and weighted weaponry measures with 50% of the importance, there was not a statistically significant relationship between the stock index and either dependent variable. This indicates that weighting expenditure and personnel more heavily does not necessarily make sense when the dependent variable is engaging in or initiating a MID. For other relationships with militarization, it should be evaluated if this weighting makes sense.

8 Limitations and Conclusion

Because none of the latent variable models converged, it meant that the results could not be used in the final regressions with militarized interstate disputes. In the future, more varieties of the latent variable model could be tested to try to get it to converge. In particular, testing different distributions of α, β, and θ could be helpful. While I tested decreasing the size of the standard deviation in the latent variable model and that didn't cause the method to converge, a wider range of possible standard deviations could be tested.

Future studies could investigate offensive and defensive military actions and their relationship with upcoming armed conflict. Offensive and defensive military actions could include things such as troop movements, military planes flying in disputed areas or in territories of their adversaries, and repositioning naval ships in or near border waters. In wars that last multiple years, a country could increase its militarization in response to the start of the war. In my regressions, that would appear the same as militarization being correlated with conflict. A future study should compare changes in militarization during wartime and peacetime.

In the future, a comparison of normalized flow variables and absolute levels of the stock variables would be interesting because deterrence depends on how strong you are, not how strong a country is for it's size and wealth. In fact, a larger SDP/GDP and population probably themselves are deterrents because they suggest the ability to more easily expand one's military capacity in a conflict.

Looking at the difference between militarization and military security would be interesting. While they might be connected, alliance commitments could mean that a country wouldn't score highly on the militarization index but still have allies who would protect them in a conflict and therefore higher military security (Shaeva 2014). Investigating the importance of military security and militarization in decisions on conflict could be interesting.

Future research should include a dyadic study to analyze the effect of disparities in militarization index between two countries on war. Looking at disparities in militarization levels between dyads could indicate a country's confidence when deciding to initiate a conflict with another.

References

Anders, T., Fariss, C. J., & Markowitz, J. N. (2020). Bread Before Guns or Butter: Introducing Surplus Domestic Product (SDP). *International Studies Quarterly*, *64*(2), 392–405. https://doi.org/10.1093/isq/sqaa013

Arena, P., & Joyce, K. A. (2015). Challenges to Inference in the Study of Crisis Bargaining. *Political Science Research and Methods*, *3*(3), 569–587. https://doi.org/10.1017/psrm.2014.42

Barnum, M., Fariss, C. J., Markowitz, J. N., & Morales, G. (2024). Measuring Arms: Introducing the Global Military Spending Dataset [Publisher: SAGE PublicationsSage CA: Los Angeles, CA]. *Journal of Conflict Resolution*. https://doi.org/10.1177/00220027241232964

Bayer, M., Croissant, A., Izadi, R., & Scheeder, N. (2023). Multidimensional Measures of Militarization (M3): A Global Dataset. *Armed Forces & Society*. Retrieved October 3, 2024, from https://journals.sagepub.com/doi/10.1177/0095327X231215295

Bernazzoli, R. M., & Flint, C. (2009). Power, Place, and Militarism: Toward a Comparative Geographic Analysis of Militarization [_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1749-8198.2008.00194.x]. *Geography Compass*, *3*(1), 393–411. https://doi.org/10.1111/j.1749-8198.2008.00194.x

Böhmelt, T. (2016). The importance of conflict characteristics for the diffusion of international mediation [Publisher: Sage Publications, Ltd.]. *Journal of Peace Research*, *53*(3), 378–391. Retrieved October 3, 2024, from https://www.jstor.org/stable/43920596

Colaresi, M. P., & Thompson, W. R. (2005). Alliances, Arms Buildups and Recurrent Conflict: Testing a Steps-to-War Model [Publisher: The University of Chicago Press]. *The Journal of Politics*, *67*(2), 345–364. https://doi.org/10.1111/j.1468-2508.2005.00320.x

Conteh-Morgan, E. (2019). Militarization and Securitization in Africa: The Role of Sino-American Geostrategic Presence [Publisher: SET VAKFI İktisadi İşletmesi, SETA VAKFI]. *Insight Turkey*, *21*(1), 77–94. Retrieved October 17, 2024, from https://www.jstor.org/stable/26776048

Curini, L., & Franzese, R. (2020). *The SAGE Handbook of Research Methods in Political Science and International Relations*. SAGE Publications Ltd. https://doi.org/10.4135/9781526486387

Current health expenditure (CHE) as percentage of gross domestic product (GDP) (%). (2023, December). Retrieved October 27, 2024, from https://www.who.int/data/gho/data/indicators/indicator-details/GHO/current-health-expenditure-(che)-as-percentage-of-gross-domestic-product-(gdp)-(-)

Current health expenditure (CHE) per capita in US$. (2023, December). Retrieved October 27, 2024, from https://www.who.int/data/gho/data/indicators/indicator-details/GHO/current-health-expenditure-(che)-per-capita-in-us-dollar

Diehl, P. F., & Crescenzi, M. J. (1998). Reconfiguring The Arms Race-War Debate [Publisher: SAGE Publications Ltd]. *Journal of Peace Research*, *35*(1), 111–118. https://doi.org/10.1177/0022343398035001007

Dorff, C., & Ward, M. D. (2013). Networks, Dyads, and the Social Relations Model. *Political Science Research and Methods*, *1*(2), 159–178. https://doi.org/10.1017/psrm.2013.21

Dreher, A. (2006). Does Globalization Affect Growth? Evidence From a New Index of Globalization [Publisher: Taylor & Francis]. *Applied Economics*, *38*(10), 1091–1110.

Eibl, F., Hertog, S., & Slater, D. (2021). War Makes the Regime: Regional Rebellions and Political Militarization Worldwide. *British Journal of Political Science*, *51*(3), 1002–1023. https://doi.org/10.1017/S0007123419000528

Fariss, C. J. (2018). The Changing Standard of Accountability and the Positive Relationship between Human Rights Treaty Ratification and Compliance. *British Journal of Political Science*, *48*(1), 239–271. https://doi.org/10.1017/S000712341500054X

Fariss, C. J., Anders, T., Markowitz, J. N., & Barnum, M. (2022). New Estimates of Over 500 Years of Historic GDP and Population Data. *Journal of Conflict Resolution*, *66*(3), 553–591. https://doi.org/10.1177/00220027211054432

Fariss, C. J., & Lo, J. (2020). Innovations in concepts and measurement for the study of peace and conflict [Publisher: SAGE Publications Ltd]. *Journal of Peace Research*, *57*(6), 669–678. https://doi.org/10.1177/0022343320975200

Gannon, J. A. (2023). Planes, Trains, and Armored Mobiles: Introducing a Dataset of the Global Distribution of Military Capabilities. *International Studies Quarterly*, *67*(4), sqad081. https://doi.org/10.1093/isq/sqad081

Gibler, D. M., & Miller, S. V. (2014). External territorial threat, state capacity, and civil war [Publisher: SAGE Publications Ltd]. *Journal of Peace Research*, *51*(5), 634–646. https://doi.org/10.1177/0022343314531003

Gibler, D. M., Rider, T. J., & Hutchison, M. L. (2005). Taking Arms against a Sea of Troubles: Conventional Arms Races during Periods of Rivalry [Publisher: Sage Publications, Ltd.]. *Journal of Peace Research*, *42*(2), 131–147. Retrieved November 25, 2024, from https://www.jstor.org/stable/30042270

Gibler, D. M., & Tir, J. (2010). Settled Borders and Regime Type: Democratic Transitions as Consequences of Peaceful Territorial Transfers [Publisher: [Midwest Political Science Association, Wiley]]. *American Journal of Political Science*, *54*(4), 951–968. Retrieved October 28, 2024, from https://www.jstor.org/stable/20788780

Gin, B., Sim, N., Skrondal, A., & Rabe-Hesketh, S. (2020). A Dyadic IRT Model. *Psychometrika*, *85*(3), 815–836. https://doi.org/10.1007/s11336-020-09718-1

Gross domestic product (GDP) (2024) – processed by Our World in Data. "Gross domestic product (GDP)" [dataset]. World Bank and OECD, "World Development Indicators" [original data]. (2024).

Iheonu, C. O., Odo, K. O., & Ekeocha, D. O. (2021). Estimating the effect of democracy, governance and militarisation on peace in Africa [_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/pa.2253]. *Journal of Public Affairs*, *21*(3), e2253. https://doi.org/10.1002/pa.2253

Jackson, M. O., & Morelli, M. (2009). Strategic Militarization, Deterrence and Wars [Accepted: 2010-03-30T13:54:10Z]. *Quarterly Journal of Political Science*, *4*, 279–313. https://doi.org/10.1561/100.00009047

Leeds, B., Ashley, J., Ritter, S. M., McLaughlin, M., & Long, A. G. (2002). Alliance Treaty Obligations and Provisions, 1815–1944. *International Interactions*, *28*, 237–260.

Leeds, B. A. (2003). Do Alliances Deter Aggression? The Influence of Military Alliances on the Initiation of Militarized Interstate Disputes [_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/1540-5907.00031]. *American Journal of Political Science*, *47*(3), 427–439. https://doi.org/10.1111/1540-5907.00031

Leifeld, P. (2013). texreg: Conversion of statistical model output in R to LaTeX and HTML tables. *Journal of Statistical Software*, *55*(8), 1–24. https://doi.org/10.18637/jss.v055.i08

Levy, Y. (2016). What is Controlled by Civilian Control of the Military? Control of the Military vs. Control of Militarization [Publisher: SAGE Publications Inc]. *Armed Forces & Society*, *42*(1), 75–98. https://doi.org/10.1177/0095327X14567918

Minhas, S., Dorff, C., Gallop, M. B., Foster, M., Liu, H., Tellez, J., & Ward, M. D. (2022). Taking dyads seriously. *Political Science Research and Methods*, *10*(4), 703–721. https://doi.org/10.1017/psrm.2021.56

Mitchell, D. F., & Pickering, J. (2017, July). Arms Buildups and the Use of Military Force. In *Oxford Research Encyclopedia of Politics*. https://doi.org/10.1093/acrefore/9780190228637.013.390

Mutschler, M., & Bales, M. (2020). Global Militarization Index 2020. *BICC*.

Palmer, G., McManus, R. W., D'Orazio, V., Kenwick, M. R., Karstens, M., Bloch, C., Dietrich, N., Kahn, K., Ritter, K., & Soules, M. J. (2022). The MID5 Dataset, 2011–2014: Procedures, coding rules, and description [Publisher: SAGE Publications Ltd]. *Conflict Management and Peace Science*, *39*(4), 470–482. https://doi.org/10.1177/0738894221995743

Peace Research Institute Oslo. (2024). New data shows record number of armed conflicts. *Peace Research Institute Oslo*. Retrieved November 3, 2024, from https://www.prio.org/news/3532

Phillips, B. J. (2015). Civil war, spillover and neighbors' military spending [Publisher: SAGE Publications Ltd]. *Conflict Management and Peace Science*, *32*(4), 425–442. https://doi.org/10.1177/0738894214530853

Poast, P. (2017). (Mis)Using Dyadic Data to Analyze Multilateral Events. *Political Analysis*, *18*(4), 403–425. https://doi.org/10.1093/pan/mpq024

Reid, L., Myrick, R., Kadera, K. M., & Crescenzi, M. J. C. (2021). Conflict Environments and Civil War Onset. *Journal of Global Security Studies*, *6*(2), ogz064. https://doi.org/10.1093/jogss/ogz064

Reuning, K., Kenwick, M. R., & Fariss, C. J. (2019). Exploring the Dynamics of Latent Variable Models. *Political Analysis*, *27*(4), 503–517. https://doi.org/10.1017/pan.2019.1

Rider, T. J. (2013). Uncertainty, Salient Stakes, and the Causes of Conventional Arms Races. *International Studies Quarterly*, *57*(3), 580–591. https://doi.org/10.1111/isqu.12058

Rider, T. J., Findley, M. G., & Diehl, P. F. (2011). Just part of the game? Arms races, rivalry, and war [Publisher: SAGE Publications Ltd]. *Journal of Peace Research*, *48*(1), 85–100. https://doi.org/10.1177/0022343310389505

Ross, A. L. (1987). Dimensions of Militarization in the Third World [Publisher: SAGE Publications Inc]. *Armed Forces & Society*, *13*(4), 561–578. https://doi.org/10.1177/0095327X8701300405

Rubin, D. B. (1987, June). *Multiple Imputation for Nonresponse in Surveys*. Wiley-Interscience.

Sample, S. (2000). Military buildups: Arming and war [Publisher: Rowman and Littlefield]. *What do we know about war*, 167–196. Retrieved November 26, 2024, from https://scholar.google.com/scholar?cluster=12098636486357096933&hl=en&oi=scholarr

Savina Gygli, Florian Haelg, Niklas Potrafke, & Jan-Egbert Sturm. (2022). The KOF Globalisation Index – Revisited. *Review of International Organizations*, *14*(3), 543–574. https://doi.org/https://doi.org/10.1007/s11558-âĂŃ019-09344-2call_made

Schneider, I. (2017). Can We Trust Measures of Political Trust? Assessing Measurement Equivalence in Diverse Regime Types. *Social Indicators Research*, *133*(3), 963–984. https://doi.org/10.1007/s11205-016-1400-8

Senese, P. D., & Vasquez, J. A. (2005). Assessing the Steps to War [Publisher: Cambridge University Press]. *British Journal of Political Science*, *35*(4), 607–633. Retrieved November 26, 2024, from https://www.jstor.org/stable/4092414

Singer, J. D. (1988). Reconstructing the correlates of war dataset on material capabilities of states, 1816–1985 [Publisher: Routledge _eprint: https://doi.org/10.1080/03050628808434695]. *International Interactions*, *14*(2), 115–132. https://doi.org/10.1080/03050628808434695

SIPRI Military Expenditure Database. (2023). https://doi.org/https://doi.org/10.55163/CQGC9685

Stockholm International Peace Research Institute. (2024). Global military spending surges amid war, rising tensions and insecurity. *SIPRI*. Retrieved November 18, 2024, from https://www.sipri.org/media/press-release/2024/global-military-spending-surges-amid-war-rising-tensions-and-insecurity

Stoll, R. J. (2017, September). To Arms, To Arms: What Do We Know About Arms Races? In *Oxford Research Encyclopedia of Politics*. https://doi.org/10.1093/acrefore/9780190228637.013.350

Tangerås, T. P. (2009). Democracy, autocracy and the likelihood of international conflict. *Economics of Governance*, *10*(2), 99–117. https://doi.org/10.1007/s10101-008-0055-6

United Nations Population Division. (n.d.). Population, total. Retrieved October 27, 2024, from https://data.worldbank.org

Use Their Force: Interstate Security Alignments and the Distribution of Military Capabilities - ProQuest. (n.d.). Retrieved October 3, 2024, from https://www.proquest.com/docview/2616966583?%20Theses&fromopenview=true&pq-origsite=gscholar&sourcetype=Dissertations%20&parentSessionId=UhOs7ZG1FIz5VMhMPTZGz442CLbnNzcdT1gDZNsuFHo%3D

Vaccaro, A. (2021). Comparing measures of democracy: Statistical properties, convergence, and interchangeability [Company: Palgrave Distributor: Palgrave Institution: Palgrave Label: Palgrave Number: 4 Publisher: Palgrave Macmillan UK]. *European Political Science*, *20*(4), 666–684. https://doi.org/10.1057/s41304-021-00328-8

van Buuren, S., & Groothuis-Oudshoorn, K. (2011). mice: Multivariate imputation by chained equations in r. *Journal of Statistical Software*, *45*(3), 1–67. https://doi.org/10.18637/jss.v045.i03

Varieties of Democracy. (2023). The V-Dem Dataset. Retrieved February 24, 2025, from https://v-dem.net/data/the-v-dem-dataset/

Werner, S. (2000). The Effects of Political Similarity on the Onset of Militarized Disputes, 1816-1985 [Publisher: [University of Utah, Sage Publications, Inc.]]. *Political Research Quarterly*, *53*(2), 343–374. https://doi.org/10.2307/449285

World Bank and OECD. (2024). GDP (current US$). Retrieved October 27, 2024, from https://data.worldbank.org

Appendices

Appendix A: Latent Variable Model Output

GMSD/SDP and GMSD/Health as the Only Military Expenditure Measure

Table 13: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	898.63	1.01
alpha[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	1141.52	1.00
alpha[3]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	895.43	1.00
alpha[4]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	1035.66	1.00
alpha[5]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	885.02	1.01
alpha[6]	0.72	0.03	0.04	0.67	0.69	0.70	0.75	0.80	2.52	2.73

alpha[1] is GMSD/SDP, alpha[2] is GMSD/Health, alpha[3] is MilPara/Pop, alpha[4] is MilPara/Workforce, alpha[5] is MilPara/Physicians, alpha[6] is the Weapons Indicator

Table 14: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	206.64	1.02
beta[2]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	183.28	1.01
beta[3]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.22	1.04
beta[4]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	193.93	1.02
beta[5]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	140.76	1.02
beta[6]	-0.86	0.02	0.03	-0.92	-0.88	-0.85	-0.83	-0.81	3.56	2.00

beta[1] is GMSD/SDP, beta[2] is GMSD/Health, beta[3] is MilPara/Pop, beta[4] is MilPara/Workforce, beta[5] is MilPara/Physicians, beta[6] is the Weaponry Index

GMSD/GDP and GMSD/Health as the Only Military Expenditure Measure

Table 15: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3757.43	1.00
alpha[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3912.24	1.00
alpha[3]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	1287.54	1.00
alpha[4]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3726.20	1.00
alpha[5]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4117.90	1.00
alpha[6]	0.49	0.01	0.04	0.41	0.46	0.49	0.52	0.56	25.36	1.10

alpha[1] is GMSD/GDP, alpha[2] is GMSD/Health, alpha[3] is MilPara/Pop, alpha[4] is MilPara/Workforce, alpha[5] is MilPara/Physicians, alpha[6] is the Weapons Indicator

Table 16: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	4.04	1.38
beta[2]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	3.16	1.61
beta[3]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	2.27	2.79
beta[4]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	4.01	1.38
beta[5]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	3.60	1.47
beta[6]	0.32	0.40	0.57	-0.71	0.28	0.64	0.66	0.72	2.01	20.38

beta[1] is GMSD/GDP, beta[2] is GMSD/Health, beta[3] is MilPara/Pop, beta[4] is MilPara/Workforce, beta[5] is MilPara/Physicians, beta[6] is the Weapons Indicator

SIPRI/GDP and SIPRI/Health as the Only Military Expenditure Measure

Table 17: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4149.51	1.00
alpha[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4080.90	1.00
alpha[3]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	436.12	1.02
alpha[4]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3625.06	1.00
alpha[5]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3846.32	1.00
alpha[6]	0.47	0.02	0.05	0.36	0.43	0.47	0.50	0.55	6.78	1.39

Table 18: alpha[1] is SIPRI/GDP, alpha[2] is SIPRI/Health, alpha[3] is MilPara/Pop, alpha[4] is MilPara/Workforce, alpha[5] is MilPara/Physicians, alpha[6] is the Weapons Indicator

Table 19: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	3.70	1.44
beta[2]	-0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	4.52	1.32
beta[3]	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	2.22	3.03
beta[4]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	3.50	1.49
beta[5]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	3.22	1.58
beta[6]	0.01	0.47	0.67	-0.73	-0.66	0.00	0.67	0.73	2.01	19.13

Table 20: beta[1] is SIPRI/GDP, beta[2] is SIPRI/Health, beta[3] is MilPara/Pop, beta[4] is MilPara/Workforce, beta[5] is MilPara/Physicians, beta[6] is the Weapons Indicator

SIPRI/SDP and SIPRI/Health as the Only Military Expenditure Measure

Table 21: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3631.01	1.00
alpha[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4100.58	1.00
alpha[3]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	597.56	1.01
alpha[4]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3909.65	1.00
alpha[5]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4136.68	1.00
alpha[6]	0.19	0.11	9.96	-19.14	-6.57	0.23	7.01	19.33	8530.52	1.00
alpha[7]	0.47	0.01	0.05	0.38	0.44	0.47	0.50	0.58	12.70	1.40

alpha[1] is SIPRI/SDP, alpha[2] is SIPRI/Health, alpha[3] is MilPara/Pop, alpha[4] is MilPara/Workforce, alpha[5] is MilPara/Physicians, alpha[6] is the Weapons Indicator

Table 22: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3706.29	1.00
beta[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4108.71	1.00
beta[3]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	3275.35	1.00
beta[4]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	3791.47	1.00
beta[5]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3573.38	1.00
beta[6]	-0.66	0.01	0.03	-0.73	-0.68	-0.66	-0.64	-0.60	23.36	1.19

beta[1] is SIPRI/SDP, beta[2] is SIPRI/Health, beta[3] is MilPara/Pop, beta[4] is MilPara/Workforce, beta[5] is MilPara/Physicians, beta[6] is the Weapons Indicator

Model with Only Expenditure Measures

Table 23: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.01	0.01	4.12	1.70
alpha[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3738.42	1.00
alpha[3]	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.03	57.82	1.05
alpha[4]	-0.02	0.01	0.02	-0.07	-0.04	-0.02	-0.00	0.00	3.05	2.21
alpha[5]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4610.44	1.00
alpha[6]	0.00	0.02	0.04	-0.06	-0.02	-0.01	0.03	0.08	2.60	2.49

alpha[1] is SIPRI/GDP, alpha[2] is GMSD/GDP, alpha[3] is GMSD/SDP, alpha[4] is SIPRI/SDP, alpha[5] is SIPRI/Health, alpha[6] is GMSD/Health

Table 24: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.04	0.06	-0.06	-0.06	0.00	0.06	0.07	2.01	19.11
beta[2]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	4022.78	1.00
beta[3]	0.08	0.10	0.15	-0.01	-0.00	0.00	0.08	0.37	2.02	11.01
beta[4]	0.08	0.18	0.26	-0.35	-0.08	0.13	0.32	0.36	2.01	12.21
beta[5]	-0.00	0.00	0.01	-0.01	-0.00	-0.00	0.00	0.01	6019.56	1.00
beta[6]	0.37	0.00	0.03	0.31	0.35	0.37	0.39	0.44	154.05	1.03

beta[1] is GMSD/GDP, beta[2] is GMSD/GDP, beta[3] is GMSD/SDP, beta[4] is SIPRI/SDP, beta[5] is SIPRI/Health, beta[6] is GMSD/Health

Model with Only Personnel Measures

Table 25: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	2.85	1.77
alpha[2]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	3.12	1.63
alpha[3]	-0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	2.00	49.14

alpha[1] is MilPara/Pop, alpha[2] is MilPara/Workforce, alpha[3] is MilPara/Physicians

Table 26: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	47.55
beta[2]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	47.57
beta[3]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	2.00	3933.42

beta[1] is MilPara/Pop, beta[2] is MilPara/Workforce, beta[3] is MilPara/Physicians

Model with Only Personnel and Weaponry Measures

Table 27: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	9578.04	1.00
alpha[2]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	9835.64	1.00
alpha[3]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	9691.58	1.00
alpha[4]	0.76	0.01	0.06	0.64	0.72	0.76	0.80	0.88	39.29	1.15

alpha[1] is MilPara/Pop, alpha[2] is MilPara/Workforce, alpha[3] is MilPara/Physicians, alpha[4] is the Weapons Indicator

Table 28: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	32.19	1.04
beta[2]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	26.16	1.05
beta[3]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	7630.08	1.01
beta[4]	0.43	0.53	0.75	-0.91	0.36	0.84	0.88	0.95	2.01	18.89

beta[1] is MilPara/Pop, beta[2] is MilPara/Workforce, beta[3] is MilPara/Physicians, beta[4] is the Weaponry Indicator

SIPRI/GDP and Weaponry

Table 29: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	1110.06	1.00
alpha[2]	0.76	0.01	0.02	0.73	0.75	0.76	0.77	0.80	7.10	1.20

alpha[1] is SIPRI/GDP, alpha[2] is the Weapons Indicator

Table 30: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	-0.00	0.01	0.01	-0.01	-0.01	-0.00	0.01	0.01	2.01	24.47

beta[1] is SIPRI/GDP

SIPRI/SDP and Weaponry

Table 31: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3885.73	1.00
alpha[2]	0.76	0.00	0.01	0.74	0.75	0.77	0.77	0.79	40.00	1.07

alpha[1] is SIPRI/SDP, alpha[2] is the Weapons Indicator

Table 32: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	3748.03	1.00

beta[1] is SIPRI/SDP

GMSD/Health and Weaponry

Table 33: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4154.34	1.00
alpha[2]	0.76	0.00	0.01	0.74	0.75	0.76	0.77	0.79	15.01	1.22

alpha[1] is GMSD/Health, alpha[2] is the Weapons Indicator

Table 34: Beta Value

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	-0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.00	3693.74	1.00

beta[1] is GMSD/Health

MilPara/Pop and Weaponry

Table 35: Alpha Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	3999.51	1.00
alpha[2]	0.76	0.00	0.02	0.73	0.75	0.76	0.77	0.80	34.04	1.11

alpha[1] is MilPara/Pop, alpha[2] is the Weapons Indicator

Table 36: Beta Values

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	3887.88	1.00

beta[1] is MilPara/Pop

MilPara/Phy and Weaponry

Table 37: Alpha Value

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
alpha[1]	0.00	0.00	0.00	-0.00	0.00	0.00	0.00	0.00	4017.24	1.00
alpha[2]	0.76	0.00	0.01	0.73	0.75	0.76	0.77	0.79	13.53	1.21

alpha[1] is MilPara/Phy, alpha[2] is the Weapons Indicator

Table 38: Beta Value

	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
beta[1]	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	3628.68	1.00

beta[1] is MilPara/Phy