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War, Alliances, and Power Concentration

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Submitted to the Economics Faculty
in partial fulfillment of the requirements for the degree of
Bachelor of Arts in Economics

December 2012

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In this paper, I estimate the relationship between the probability of militarized interstate dispute (MID) and military alliance power concentration. While a significant amount of research has been done in this area, there is no consensus on the role of military alliances in MID onset. One of the overlooked issues in the empirical literature is alliance power distribution, which can have very different effects on MID onset compared to simple alliance power measures. I measure alliance power concentration using the Herfindahl-Hirschman Index (HHI) of market concentration and estimate its effect on MID onset in a dyadic panel dataset.

JEL classifications: F50, F52, F51, F53

Key Words: conflict, international conflict, international organization, security

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I. Introduction

Many scholars mention the paradox of war. This paradox comes from the fact that war is never the best option for countries (Fearon, 1995; Brito and Intriligator 1985; Powell, 2002; Wagner, 1994, 2004). Any outcome attained through war could also have been attained through peaceful negotiations without the waste of resources inherent to war. But if war is inherently inefficient, then why do wars continue to occur? As scholars have attempted to answer this question, they have explored almost every thinkable factor that might influence the probability of countries going to war, including the role of alliances.

This paradox has also inspired the development of multiple theories on the causes of war. However, none of the theories has been universally accepted by scholars. There is a plethora of studies on the causes of war and they often contain divergent results, especially on the role of alliances. While many scholars have analyzed the impact of specific alliance attributes on Militarized Interstate Dispute (MID) onset, no consensus has been reached on their impact. I argue that this is, in part, due to a lack in both the theoretical work as well as the empirical research pertaining to alliances.

Drawing in part from the reasoning of Fearon (1995) who laid out the rationalist explanations for war, I argue that the existing theory on war provides ample groundwork to suggest that the distribution of economic power within alliances can have a significant impact on the collective decision-making process and MID onset.

I develop a novel measure of alliance power concentration that is based on the *Herfindahl-Hirschman Index (HHI) of market concentration.* The power concentration index ranges from zero to one, where one means power concentration in the hands of a single country.

By analyzing the effect of alliance power concentration on the probability of war I hope

to obtain new insights into the causes of war. First of all, the power concentration measure provides balance of power theorists with a better gauge of alliances and whether they can affect the probability of war onset. Secondly, this research may reveal whether power concentration is a key aspect of alliances that has a true impact on the occurrence of war.

II. Literature Review

It is important to note that war and alliance research is rooted in bargaining theory (Powell, 2002). Thomas Schelling first approached war as a bargaining problem in 1960. Schelling addressed war as an outcome in which bargaining fails due to the failure of leaders to coordinate their actions (Schelling, 1960). Throughout much of the literature on bargaining and war, scholars have attempted to answer why leaders fail to cooperate and, instead, go to war.

Fearon (1995) made a substantial contribution to the literature by solidifying a rational theory for war. He attempted to determine why states go to war if it is costly and inefficient. In his research, he states that the two reasons that cause bargaining to fail are the possession of private information and a failure to be able to credibly commit to an agreement. Critical assumptions in his work include the presence of the common knowledge that at least one country has a positive probability of winning a war as well as the existence of a continuous range of attainable peaceful outcomes. Today, these assumptions remain key to work on war and bargaining. In order to rationally explain the occurrence of war, Fearon defines the concept of a rational leader as a leader who sets out to maximize his expected utility given the possible outcomes. Consequently, a leader can rationally choose war if the expected utility derived from war is greater than the expected utility of the peaceful settlements. However, private information causes leaders to have conflicting expectations, which results in the failure to accept a peaceful

agreement. This concept of private or asymmetric information remains a focal point in war and conflict literature.

In addition to Fearon's rationalist explanations for war, the two main theories of war, balance of power theory and transition theory, play key roles in the development of war and alliance literature. Balance of power theory posits that the probability of war is greatest when the power levels of countries varying greatly. This theory also suggests that factors that significantly affect a nation's power level, especially alliances, impact MID onset as well. On the other hand transition theory, states that alliances have no impact on the probability of interstate war. Additionally, transition theorists argue that the probability of war is maximized when countries have close to equal power levels.

Powell (2002) argued that international disputes arise from the decision of how to split the rewards of cooperation, whether peaceful or militarized. His idea is based on the collective action problem previously described by Olson in 1965 since leaders attempt to maximize personal welfare, not social (Olson, 1965). An important implication of Powell's work confirms that wars are inherently suboptimal since any outcome reached through conflict is not Pareto efficient. Contrary to most scholars, however, Powell claimed that the idea of asymmetric information between states lacks the ability to explain why wars occur and attempted to provide alternate explanations to this question.

Ponsato and Sanchez-Pages (2012) address the asymmetric information problem arguing that two layers of uncertainty exist within the bargaining process. First, countries do not know whether their adversary is hostile or lenient. Second, they do not know the probability of military success throughout the potential war. This leads countries to the suboptimal outcomes suggested by Powell (2002) since the agreed upon outcome could have been chosen prior to military action.

This also represents the revelation of information brought about by war that Wagner (2004) addresses. According to Wagner, war may not simply be a failure of negotiations but rather, a form of negotiations.

Dorussen (1999) reexamines balance of power theory and explores the effect of trade as an additional factor of war. He finds that trade can influence the bargaining process and make war less likely between trading partners. Martin et al. (2008) conduct a similar test, but improve upon previous work by separating trade into bilateral and multilateral categories. Their findings suggest that only bilateral trade influences the bargaining process and reduces the probability of war. Nonetheless, Dorussen acknowledges the existence of the war paradox within trading as well since both countries would be better off through trading, but stopping trade is the only credible threat capable to prevent war.

Lemke and Werner (1996) argue that it is only when states have close to equal power that either can rationally expect to win. Additionally, war can only be expected to occur if a country has the willingness and the opportunity to do so. Wagner (1994) argues that the relationship one should expect between the distribution of power and the probability of war is not always clear. By analyzing transition theory and balance of power theory, he argues that the power distribution that maximizes the likelihood of war is somewhere between equality and great inequality. This suggests that neither theory is correct in estimating when war is most likely. Wagner also shows that in a system of small states peace occurs if an alliance of weaker states counterbalances a strong enemy. His theory suggests that alliances should then reduce the probability of war, since the strong state and the alliance as a whole have low probabilities of winning war.

Gartner and Siverson (1996) study the expansion and outcome of wars. They show that states that engage in one-on-one wars are significantly more likely to win those wars than if the

target state receives help. They term a process called the selection effect in which countries specifically choose which countries to attack based on their beliefs of whether or not that target will receive outside help. Moreover, they suggest that countries better estimate the costs of one-on-one wars as opposed to large-scale wars. Their study points to the conclusion that the initiator of war stands the best probability of winning if the war stays bilateral and that expansion does effect the initiator's probability of winning. Consequently, if an adversary is a member of an alliance the expected utility of going to war against that adversary goes down.

Testing balance of power theory, Wagner (1986) focuses on multilateral bargaining in a simple game-theoretic setting. He utilizes noncooperative game theory models each with 2, 3, 4, and 5 actors respectively in order to more closely model real world scenarios. He finds that in all situations there is some equilibrium distribution of power throughout the system in which peace prevails. He points out that stable systems typically have a preponderance of power as opposed to a hegemon who controls the system.

Reed (2000) argues that the shortcomings of empirical analysis as opposed to theory come from model misspecification. Interestingly, he finds that conflict initiation and escalation are linked, whereas many previous papers consider them separate phenomena. This is of much importance to alliance research; alliances have been found to escalate war, but the effect of alliances on war initiation remains ambiguous. Later, Reed (2003) argues that information between countries is just as important as the power ratio. Basing his work off of previous theories on information and war, he attempts to find a measure of the common knowledge information available to countries and does so using attendance and other UN reports. He finds that the information distribution between countries closely reflects the power ratio, and more importantly, it is significantly correlated with war. His finding bolsters the theoretical work

arguing that war only occurs in the presence of information asymmetry. Reed's work takes this reasoning one step further showing that the level of information asymmetry matters as well.

Walt (1985) focuses on a country's choice to join an alliance which either balances the power or bandwagons. Balancing the power refers to joining an alliance which counters the aggressive country in a system. Conversely, bandwagoning occurs when a country chooses to align with the aggressive force and gang-up on a target state. He then lays out the two conditions in which alliances matter: if alliances affect the decision of allies to intervene on one another's behalf in the event of war, and if it allows states outside the alliance to determine that allies will intervene to support one another. Morrow (2000) identifies the decision to ally with another state as a tradeoff between a country's autonomy and security. He concludes that states balance the power more often than bandwagoning since it is a safer outcome. Morrow indicates that alliance agreements explicitly lay out the terms of support and aid not only to the alliance members but to possible aggressors as well. This in turn leads to immediate deterrence even before conflict starts as a result of the revelation of information to the opponent, since it decreases uncertainty about the behavior of alliance members.

However, these contracts may not make public all information about an alliance such as the reliability of its members. Smith (1995) offers a different approach under the assumption that the formation, reliability and efficacy of alliances are all interrelated. Using a three-country game theoretic model, Smith shows that the formation and reliability of alliances comes down to the costs of failing to uphold those alliances. An ongoing problem with identifying the costs of reneging an alliance agreement is that treaties must be self-enforcing so there is typically no formal punishment that can be expected for any country that does not live up to its treaty obligations. Gibler (2008) addresses alliance reliability by accounting for reputations in the

international community. He argues that leaders are concerned with reputations and that existing reputations of countries affect both alliance formation and reliability. He goes on to show that reputation plays a significant role by illustrating that alliances comprised of more reputable countries have higher deterrence power than those with less reputable countries. Furthermore, Gibler indicates that countries with good reputations also have a higher likelihood of forming new alliances. However, Leeds (2003) also states that seventy percent of all alliance formed are reliable since the countries that typically enter alliances have the intentions of fulfilling the treaty obligations.

Konrad and Kovenock (2009) use resource constraints to show that alliances can be beneficial in general. They conclude that problems only arise in the second stage when the two remaining countries must split the winnings. A significant implication of their work is that alliances must be strong, but not too strong, in order to create a stable system. However, their limited model does not allow for the size of an alliance to be altered, which may bias their results.

Huth and Russett (1988) discuss the effect of extended deterrence, or deterrence by a third party, and situations in which it fails. Since an ally to the target state is typically the source extended deterrence, their analysis indirectly offers insight on the behavior of allies during conflict. They conclude that the relative balance of powers, reputation, and defender-protégé relations all have significant impacts on whether deterrence will be effective. This finding emphasizes that not only is power important, but also information about the alliance against which a country may go to war

Levy (1981) narrows alliance research by examining only the alliances of the major powers throughout the past few centuries. While he finds that alliance formation has no

correlation with war involving the Great Powers he firmly establishes that this does not imply that alliances promote peace. Levy emphasizes that alliances reduce the flexibility of the international system, which hinders deterrence and negotiations. According to Levy, alliances in the 20th century are associated with higher levels of war. Leeds (2003) separates alliances into 5 categories in order to analyze the impacts of each. She focuses on defensive pacts, offensive pacts, and neutrality agreements. Surprisingly, she finds that neutrality agreements have the largest impact on the probability of war and increase the chances of war by 57%. She also shows that defensive pacts effectively lower the probability of war by 28%, supporting extended deterrence theories.

In an attempt to explore other aspects of alliances, Oren (1990) studies the impact of alliance size on the probability of war. He explains that the existence of alliances creates additional uncertainty for leaders. In addition, he finds that larger alliances are correlated with higher levels of war. However, he then suggests that alliances contribute to the expansion of war but not necessarily to the initiation of war.

Kim (1989) compares transition theory and balance of power theory while studying the power levels of alliances instead of the individual members of each dyad. Kim finds that alliances actually play a significant role in the probability of conflict amongst nations. An important implication of Kim's work is that war is most likely when alliances have equal power.

In the following sections I review key arguments to develop a theory for the impact of alliance power concentration on war and specify the models used within this analysis. Furthermore, I outline my findings, describe the economic implications and discuss avenues for future research on alliances.

III. Methodology

A. Theoretical Framework and Hypothesis

In 1994 Wagner wrote: "Every possible relation between the distribution of power and the likelihood of war has been defended somewhere in the literature…" (Wagner, 1994, p. 1) However, I argue that an important part of power distribution within the alliance has been largely unexplored. Existing empirical studies do not examine the distribution of power within alliances and its effects on war.

Most scholars have come to support what are now the two predominant theories on war: Balance of Power theory and Transition theory. In line with these theories lies the belief of if and how alliances affect the probability of war. Balance of power theorists argue that alliances are significant determinants of war while transition theorists claim that alliances have no discernible impact. While these theories diverge over how power affects the onset of MID, both balance of power theorists and transition theorists agree that an equal distribution of power amongst countries results in the highest amounts of uncertainty.

Fearon's rationalist explanations for war remain pivotal assumptions within this research. His notion that asymmetric information leads to separating expectations means that the leaders of either country may have a positive expected utility of war. Furthering this idea, Reed (2003) argues that the information distribution between countries is just as important as the power ratio. An important implication of Reed's work is that the power ratio between countries closely resembles the information distribution between them. While neither Fearon nor Reed examined alliances within their research, their theories play an important role in alliance research.

An important component of this theory also comes in part form the work by Gartner and Siverson (1995) who show that leaders best estimate the costs of war when the war is bilateral. Consequently, as the number of countries in a war increases, the quality of information to the

leaders goes down and the cost estimates of war become less accurate. Research has shown that alliances tend to cause an increase in the magnitude of war by causing it to spread to other countries. Then it follows that the presence of alliances decreases the ability to predict expected utility from an increase in the amount of asymmetric information within the system. A simple example of how alliance information affects war is through alliance reliability. The reliability of an alliance affects both the members of the alliance and countries outside of it (Gibler 2000). If outside countries perceive an alliance as unreliable, it is more likely that they may attack under the assumption that they will not have to fight the entire alliance, only the target country (Smith 1995).

Another important chain-link in this theory stems from Oren (1990). Oren analyzed the size of alliances and concluded that larger alliances tend to be involved in war more often than smaller alliances. However, Oren's measurement of the size of an alliance was one-dimensional and included only the number of members within that given alliance. I argue that this measurement of alliance size is insufficient since it does not contain enough descriptive power on the makeup of an alliance. Very different alliances can be represented by the same figure if only a single factor. For example, an alliance between the United States and Canada has a size of two, as does an alliance between Costa Rica and Nicaragua. However, the first alliance is overwhelmingly more powerful than the second. Similarly, measuring alliance power level alone does not reveal across how many countries that power is spread. This dynamic aspect of alliances resembles what rational leaders encounter when in multilateral bargaining situations that may lead to war. In these cases, looking at single characteristics of alliances cuts out important information. The HHI-based measure of alliance power concentration corrects for this bias, since it measures the power distribution within an alliance.

As research has not previously explored alliance power concentration, the concentration of alliance power's expected impact on MID onset can be either positive or negative, with arguments supporting both conditions. Even if alliances are peace promoting, the coefficient for alliance power concentration can be positive. The collective nature of an alliance may deter individual members from engaging in unilateral war unless that member is the dominant member, which would be captured by HHI. On the other hand, alliance power concentration may be negatively correlated with MID onset. Lower HHI scores typically correspond to larger alliances if alliance power is more or less evenly distributed. Keeping in mind Oren's (1990) findings that larger alliances experience more war, this implies that lower levels of power concentration correlate with higher levels of war. Additionally, Gartner and Siverson (1996) show that uncertainty increases when more countries enter into the conflict. This also suggests that the correlation between alliance power concentration and MID onset could be negative, but the true correlation must be determined empirically.

B. Data

The data I analyze was collected from a few databases including: the Correlates of War Project (COW), Maddison Historical Statistics of the World Economy, Polity IV, and Alliance Treaty Obligations and Provisions (ATOP) as well as a dataset compiled by Martin et al. from their research on war and trade. Both COW and ATOP provide alliance data used to compile an alliance obligations for all countries since 1950. The Maddison database provided national GDP data for all countries since 1950, which is the start year for my analysis. Martin and others consolidated variables relevant to determining the probability of war between countries in order to study the impact of trade on the probability of war, which I use as a control set in this study.

I also calculate a new measure of alliances that captures its power distribution and

analyze how this measure affects the probability of war between countries. This index is computed in the same manner as the Herfindahl-Hirschman Index (HHI). Typically, the HHI is used to measure market concentration for firms. However, in this context it serves as a dynamic measure of power concentration within alliances. In order to find this measure, I take the aggregate Gross Domestic Product (GDP) of an alliance and compute each member's share of that total. I then square each member's power share and sum the results together. The resulting number is the HHI of alliance power distribution, which is bounded between 0 and 1. For example, consider the following three alliances.

Table 1: Alliance HHI Calculations using GDP (Power Share)

Factor	**Alliance 1**	**Alliance 2**	**Alliance 3**
Member 1 GDP	\$50,000 (0.5)	\$90,000 (0.9)	\$50,000 (0.5)
Member 2 GDP	\$50,000 (0.5)	\$10,000 (0.1)	\$20,000 (0.2)
Member 3 GDP			\$15,000 (.015)
Member 4 GDP			\$5,000 (.05)
Member 5 GDP			\$5,000 (0.5)
Member 6 GDP			\$5,000 (0.5)
Aggregate GDP	\$100,000	\$100,000	\$100,000
HHI Calculation	$(0.5)^2 + (0.5)^2$	$(0.9)^2 + (0.1)^2$	$(0.5)^2 + (0.2)^2 + (0.15)^2 + (0.05)^2 + (0.05)^2 + (0.05)^2$
HHI	0.5	0.82	0.32

Analyzing the alliances in the table above shows that the HHI varies with a change of the share of power as well as the number of members within the alliance. In alliances where a single member has an overwhelmingly high share of power, the HHI approaches one.

My dataset includes all directed-dyads years from 1953-2000 including countries that have ceased to exist or have changed names. When calculating the probability of war between countries, directed-dyad years are the most appropriate measure since each country pair is only listed once for each year of the analysis. Each of the independent variables is then coded to

match up with the correct dyad. The HHI score for each alliance is included only if a country within the dyad is in the designated alliance in the appropriate year.

Table 2: Variable Definitions

Variable	Description	Source
MID	Occurrence of a Militarized Interstate Dispute of level 3, 4, or 5	Martin et al.
MID45	Occurrence of Militarized Interstate Dispute of level 4 or 5	Martin et al.
HHI	HHI score for alliance power concentration	Maddison Statistic of the World Economy
TOTALALLY	The total number of alliances within the dyad	Alliance Treaty Obligations and Provisions
allied	Mutual Alliance	Martin et al.
ANI	Alliance Distribution	
Ltrl	ln bilateral openness *t* - 4	Martin et al.
Ztl	ln multilateral openness *t* - 4	Martin et al.
Lopenl	Dummy for zero trade *t* – 4	Martin et al.
Muldis	ln distance x ln multilateral openness	Martin et al.
Bildis	ln distance x ln bilateral openness	Martin et al.
Peace	Number of peaceful years	Martin et al.
Votcol	UN vote correlation	Martin et al.
Pol	Sum of democracy indexes	Martin et al.
Totwar	Number of other wars in year *t*	Martin et al.
Diswar	ln distance to nearest war	Martin et al.
Larea	Sum ln areas	Martin et al.
Ldis	Distance between the capitals of the countries in dyad i	Martin et al.
Comlng	Common language	Martin et al.
Contig	Contiguity	Martin et al.
Colony	Ever paired in colonial relationship	Martin et al.
Comcol	Common colonizer	Martin et al.
Fta_f	Free Trade Area (full set)	Martin et al.
Gatt	Number of GATT members in dyad	Martin et al.

Note that in this case the dependent variable MID represents a militarized interstate dispute of level 3, 4, or 5. It is a dichotomous dependent variable with 1 indicating that a MID did occur and 0 otherwise. Likewise, MID45 represents the more violent conflicts, which are militarized interstate disputes of levels 4 and 5. In addition, the variable ANI is coded to indicate how the alliances are spread across the two countries in the dyad. It is coded zero if no alliances

exist, one if either country is in at least one alliance, and two if both countries are in at least one alliance.

When calculating the effects of different factors on the probability of war, previous research has analyzed country dyads over varying periods. These dyads, or country pairs, include all permutations of countries throughout the world. Since this paper analyzes the probability of war, I utilize a dyad-year data set, which groups all dyads together from 1950-2000. I chose this time period for two reasons. First, data availability limits the extent to which this analysis would be accurate dating back further than 1950. Second, and more importantly, bargaining and war may have changed substantially over the past few decades through the development of both military and social technologies. Including statistics from distant years may bias the results and prevent them from being applicable to the present time. Since this paper aims to develop a better understanding of alliances and war, the most up-to-date data provides the most relevant results for policy implications.

C. Model Specification

In order to determine the impact of alliance HHI on the probability of war, I follow Martin et al and use a logistic regression model. The model includes the same control variables as Martin et al. plus my variables of interest such as alliance *HHI* and other relevant measures of alliances. The resulting model is seen as follows:

$$MID_{it} = \propto + \beta_1 HHI_{it} + \beta_2 TOTALALLY_{it} + \beta_3 ANI_{it} + \beta_4 trade_{it} + \beta_5 multitrade_{it} + \beta_6 controlbarbFE_{it} + \beta_7 controlgravFE_{it} + \varepsilon_{it},\ \varepsilon_{it} = a_i + u_{it} \quad (1)$$

In equation 1, above, the dependent variable is MID. This captures all militarized interstate disputes of levels 3, 4, or 5. The severity of conflict increases with the number. Level 3 conflict

includes some display of force without any engagement. A level 4 MID is denoted by the use of force through military engagement in which less than 1,000 people were killed. Finally, level 5 MIDs denote war, which is a military conflict in which over 1,000 total deaths occurred. In equation 2, below, the dependent variable is MID45, which restricts the disputes to only levels 4 and 5. This is done in order to analyze any difference in effect that alliance power concentration has on the severity of conflict.

$$MID45_{it} = \propto + \beta_1 HHI_{it} + \beta_2 TOTALALLY_{it} + \beta_3 ANI_{it} + \beta_4 trade_{it} + \beta_5 multitrade_{it} + \beta_6 controlbarbFE_{it} + \beta_7 controlgravFE_{it} + \varepsilon_{it}, \quad \varepsilon_{it} = a_i + u_{it} \qquad (2)$$

In addition, *trade* and *multitrade* are variables measuring the levels of bilateral trade and multilateral trade respectively. *ControlbarbFE* and *controlgravFE* are arrays of control variables that take into account the political and geographical differences between the countries in each dyad. I employ the same technique as Martin et al. by estimating three identical regression models on both equations 1 and 2, respectively.

D. Data Issues

The data I use present a few obstacles to a straightforward statistical analysis. First of all, the dichotomous nature of the dependent variable causes the logistic fixed-effects regression to drop any dyad in which the countries always or never went to war. As war is not a common occurrence especially within the time period between 1950-2000, this includes a large majority of observations. Unfortunately not much can be done to correct for this anomaly, except for estimating a linear probability model (LPM) with fixed effects that includes all peaceful dyads and a dependent variable (MID) that includes all types of militarized interstate disputes, from

military tensions to actual armed conflicts.

Martin et al. addressed this problem over the same time period and corrected for it by loosening the definition of war. The Correlates of War database contains information on all Militarized Interstate Disputes (MIDs), which are coded 1 to 5 depending on the severity of the dispute. War is categorized as a level 5; however, Martin and others also include level 3 and 4 MIDs to increase the number of observations in which conflict did occur. A complete list the actions determining MID level can be found in Appendices 1A and 1B.

The dataset also contains are missing values for several variables, such as GDP, which influences the calculation of alliance HHI for some alliances. GDP is a commonly used proxy country military power or its potential. However, GDP data is not consistently available for all countries dating back to 1950. If a country does not have GDP data in a year where it should be included in an alliance, that country is dropped from the alliance. Luckily, most of the missing values come from small developing countries that amount to a rather small fraction of total alliance power and HHI computations.

IV. Results and Analysis

Following Martin et al. I estimate a pooled logit, conditional logit with fixed effects, and a linear probability model (OLS) with fixed effects for each of the two dependent variables (MID and MID45). The first three regression models in Table 3 use a broader measure of militarized interstate disputes (MID) and the last three use the most violent measure of MID.

Table 3: Impact of HHI on occurrence of MID and MID45

	Dependent Variable: MID			Dependent Variable: MID45		
Variable	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
Alliance Power Concentration	-0.186	-0.433	0.0413*	0.162	-0.573	0.0311*
	(0.35)	(0.55)	0.02)	(0.43)	(0.62)	(0.02)
Total Number of Allies	-0.00743	-0.00698	-0.00147	-0.0357***	-0.0155	-0.00268***
	(0.01)	(0.01)	0.00	(0.01)	(0.01)	0.00
Dyadic Alliance Distribution	0.193	-0.0623	0.012	0.207	0.0221	0.00561
	(0.16)	(0.21)	(0.01)	(0.18)	(0.23)	(0.01)
ln mult. openness *t*-4	-0.240*	0.256	-0.0142	-0.128	0.0441	-0.00606
	(0.13)	(0.18)	(0.04)	(0.16)	(0.20)	(0.01)
Dummy for zero trade *t*-4	-0.271*	0.256	0.00871*	-0.21	0.297	0.0101**
	(0.15)	(0.17)	0.00	(0.19)	(0.19)	0.00
ln bil. openness *t*-4	1.513***	1.302**	0.220**	1.239***	1.358*	0.0675**
	(0.45)	(0.59)	(0.09)	(0.42)	(0.71)	(0.03)
ln distance x ln mult. open	-0.190***	-0.142*	-0.0253**	-0.180***	-0.171*	-0.00825**
	(0.06)	(0.07)	(0.01)	(0.05)	(0.09)	0.00
ln distance x ln bil. open	0.0387**	-0.0316	0.00174	0.0264	-0.000268	0.000908
	(0.02)	(0.02)	0.00	(0.02)	(0.03)	0.00
Number of Peacful years	-0.0195***	-0.0137***	0.00114	-0.0208***	0.0111***	0.00207***
	0.00	0.00	0.00	0.00	0.00	0.00
UN vote correlation	-0.955***	-0.568***	-0.0270**	-0.911***	-0.597**	-0.0176***
	(0.15)	(0.21)	(0.01)	(0.18)	(0.24)	(0.01)
Sum of democracy indexes	-0.252**	-0.146	-0.000231	-0.392***	-0.246	-0.00255
	(0.12)	(0.18)	(0.01)	(0.15)	(0.21)	0.00
Total number of war in *t*	0.245***	0.257***	0.0515***	0.231***	0.213***	0.0342***
	(0.01)	(0.01)	0.00	(0.01)	(0.01)	0.00
ln distance to nearest war in *t*	0.00769	-0.202**	-0.0118***	-0.00921	-0.0938	-0.00838***
	(0.07)	(0.10)	0.00	(0.08)	(0.11)	0.00
Sum of ln areas	0.168***			0.146***		
	(0.03)			(0.03)		
Mutual Alliance	0.0153	-0.0494	-0.0439	-0.0277	-0.166	-0.0403***
	(0.12)	(0.20)	(0.03)	(0.16)	(0.23)	(0.01)
Log of the distance	-0.849***			-0.878***		
	(0.17)			(0.19)		
Common Language	0.233*			0.0933		
	(0.13)			(0.15)		
Contiguity	1.107***			0.930***		
	(0.17)			(0.20)		
Colony	0.361*			0.424*		
	(0.21)			(0.24)		

Common Colonizer	0.123			0.232		
	(0.17)			(0.20)		
Free Trade Area	-0.23	-0.0695	-0.0361	0.0645	0.379	0.00774
	(0.17)	(0.31)	(0.02)	(0.21)	(0.36)	(0.01)
# of Gatt members in dyad	0.109	-0.325**	-0.00412	-0.0156	-0.514***	-0.000172
	(0.08)	(0.16)	(0.01)	(0.10)	(0.19)	0.00
Constant	-2.054		-0.0396	-1.523		-0.0734**
	(1.38)		(0.06)	(1.56)		(0.03)
N	223788	12770	227613	223788	227613	227613
Adj. R^2			0.147			0.084
Model	Logit	FE Logit	FE LPM	Logit	FE Logit	FE LPM

Note: S.E in parentheses with ***, **, and *, respectively denoting significance at the 1%, 5%, and 10% levels. Model 1 is a pooled logistic regression using random effects that includes the entire sample and control variables with errors robust to heteroskedaticity and serial correlation. Model 2 is a conditional logit with dyadic fixed effects with complete control set. Model 3 is a dyadic fixed effects linear probability model with errors robust to heteroskedacticity and serial correlation. For models 4,5,6, the dependent variable, *MID45*, represents militarized interstate disputes of level 4 or 5 (most violent forms of conflict). The methods regression specifications for models 4, 5, and 6, respectively, match those used in the first three regressions. Year and conflict dummies are not reported in this table.

The control variables included within these models account for geographic, political, economic, and military differences between the countries in each dyad as well as the effects of previous or ongoing wars in the system. The location and composition of countries can make them both more prone and more susceptible to attacks. Countries with vast amounts of land have larger border to protect and often rule an eclectic grouping of cultures and ethnicities. Both of these may contribute to the probability of war breaking out in larger countries (Martin et al., 2008). Following Martin et al., I also include year dummy variables and two types of conflict dummies within the models to act as fixed effects. The first set of conflict dummies (coefficients not reported) accounts for past conflicts between the countries in each dyad. Accordingly, it is coded as 1 in each instance where there was an MID in year *t*-1, *t*-2,...*t*-20. I include this set of conflict dummies since the effects of previous conflicts can be long lasting and produce grudge matches in the future. The second set of conflict dummies (coefficients not reported) accounts

for ongoing disputes that have persisted without break. In other words, the variable is coded 1 if the countries in the dyad were in conflict in year *t*-1 and have continued the conflict into year *t*. It is important to note that the dummy variables in this set are perfect predictors of war, and therefore only included in the linear probability models, since they would dropped from the conditional fixed effects logit models.

The Democratic Peace Theorem, which states that countries with democratic forms of government are less prone to war, (get references) provides ample support for including political factors in the model, specifically the democracy indexes of countries, when estimating the probability of war. Martin et al. (2008) also suggests that analyzing the UN vote correlation of countries gives insight into the political likeness of the countries. Moreover, Reed mentions that countries that are aligned have similar interests, and in turn a lower probability of war.

The results shown in Table 3 indicate that the impact of *HHI* on MID range from positive to negative and significant to not significant. There are only two regression models (3 and 6) where the HHI is significant at the 10% level. In both cases, the coefficients for HHI are positive, which suggests that higher concentration of power in an alliance increases the probability of conflict. This may be a result of the enforcement problems within alliances. Given that a single country holds a majority of power over all other allies, there is no credible force to stop that ally from acting in its own interest instead of the alliance's interest. On the other hand, if the alliance power is more evenly distributed amongst the alliance members, then there is a significant force that makes the alliance treaty enforceable. Any ally who wishes to diverge from the alliance's policies can be forced into compliance by the remaining members. Since no country holds an overwhelming amount of power, this holds true for all countries within an alliance.

Moreover, the significance of *HHI* increased when narrowing the dependent variable to include only the most violent forms of conflict. This suggests that alliance power distribution may play a role in wars and military conflicts, but not in lesser disputes between countries. The significance of the total alliance variable in models 4 and 6 bolsters this argument since it provides evidence that alliances tend to reduce the probability of war.

Table 4 reports the elasticity of each of the alliance variables for models 3 and 6, respectively.

Table 4: Alliance Power Concentration Elasticity

	Model 3	Model 6
HHI	0.414	0.434
Total number of allies	-0.162	-0.41
Dyadic Alliance Membership	0.383	0.248

The elasticity estimates for HHI suggest that power concentration in an alliance has not only a statistically significant but also economically significant positive effect on the probability of MID onset.

V. Economic Implications

Economic theory has shown that war is inherently inefficient. Any outcome attained through war could also have been attained without wasting resources. Financially speaking, war is a large burden for all countries involved. The U.S. has spent close to three trillion dollars in past decade fighting wars. This does not include the destruction of land and capital or population displacement, which are also heavy economic burdens. While this paper does not suggest cuts in

military spending, the results herein may be able to influence policy changes in order to help reduce the occurrence of war.

The results of this analysis have shown that alliance power concentration has a real impact on MID onset, and especially on the most violent levels of conflict. An increase in the frequency of war would mean an increase in war debts, military spending, and loss of resources. Both the money spent on war as well as the resources destroyed could be used for other projects. Many countries across the world, including the United States, have overwhelmingly high debts. Reducing war can lead to a decrease in needless spending and improved economic prosperity. Moreover, previous studies have shown that war decreases the amount of trade between countries not only during the conflict but for years following the conflict as well (Martin et al 2008). Assuming that trade is beneficial for everyone, this means that a second inefficiency is created in the wake of war in addition to war itself.

Additional implications of this research speak to an expansion of the theories pertaining to war and alliances. Since the theory derived in this paper stems from competing theories, some revision to the existing theories may be in order. Updating these theories to include alliances, and specifically alliance power concentration, may be a key in creating more robust empirical models. Moreover, this research has shown that alliance power concentration does affect the probability of violent conflict. This may point to a key concept to be analyzed in the future. Although war is considered a bargaining situation, factors that influence the bargaining process change depending on the severity of the imminent conflict. If this idea can be incorporated more fully into theories on war and conflict, a more accurate understanding of the causes of war may be revealed.

VI. Suggestions for Future Research

Future research may also want to incorporate Leeds' (2003) approach by separating alliances into offensive, defensive, and neutral categories. Solving the ambiguity problem in a similar manner to Leeds may produce more accurate results for the impact of alliance power distribution. Moreover, it may reveal that alliance power concentration influences the efficacy of certain types of alliance (e.g. offensive, defensive, or neutrality pacts).

In addition, researchers may also want to study the occurrence of MID onset on an alliance level instead of the dyadic level. Studying the alliance level may reveal characteristics of alliances as a whole that influence the probability of war. Are alliances with equal power distributions more likely to go to war? Are alliances with great disparity in power concentration less likely to go to war? Answering these questions may also call for future research to include alliance reliability within their models. Developing a better measure of alliance reliability may be useful in furthering research on alliance power distribution.

Another avenue that future researchers may pursue is to incorporate the geographical proximity of alliances into the power concentration measure. The controls in this study accounted for the distance between countries within dyads, but did not factor distance into the power concentration measure. Adding this new factor may create a more accurate measure of power concentration and produce additional insight into the effects of alliances on war onset.

VII. Conclusion

The goal of this research was to discern the impact of alliance power concentration on MID onset. The results of this study confirm that the distribution of economic power within alliances is a significant determinant of war. The model used in this study supports the argument that alliance power concentration is positively correlated with MID onset. This suggests that alliances where a single country holds the majority of power experience a higher probability of war, which is likely due to the inability to credibly enforce alliance obligations on an ally who controls the majority of power within the alliance. Another important finding within this research is that alliance power concentration has a larger impact on the onset of violent conflict. This implies that alliance power concentration may be less important until countries are on the brink of military engagement and, in turn, be a factor of war. Overall, the findings in this research point to the conclusion that alliances do affect the probability of war onset and that the concentration of power within alliances is an influential aspect of alliances.

In addition, the elasticity of alliance power concentration suggests that changes in the power concentration of an alliance have a real impact on the probability of war. Specifically, the elasticity of power concentration on all levels of conflict was 0.414 and on violent conflict it was 0.434. Then as alliance power concentration increases, the probability that the alliance experiences war also increases. As war is inherently inefficient, as well as extremely costly, reducing the power concentration of alliances would results in lower amounts of war and in turn, increased economic activity and growth.

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Appendix 1A.
Levels of Militarized Interstate Disputes (MID)

Table 1: Definition of Militarized Interstate Disputes

Level of MID	Definition	Description
1	No militarized action	No action or threat of action is taken
2	Threat to use force	See following table
3	Display of force	See following table
4	Use of force	Military Conflict in which 1,000 or less deaths occurred
5	War	Military conflict in which over 1,000 total deaths occurred

Appendix 1B.
Description of Displays and Threats of Force

Table 2: Explanations of Displays and Threats of Force

Examples of Displays of Force	Description	Examples of Threats of Force	Description
Alert	An increase in the readiness of a state's regular armed forces	*Threat to use force*	threat by one state to assault the armed forces or violate the territory of another state
Mobilization	Activation of all or part of its previously inactive forces	*Threat to blockade*	Threat by one state to intercept ships, airplanes, or troops to isolate another state and prevent entry or exit from it
Show of troops	Public demonstration of land based military forces, not involcing combat operations	*Threat to occupy territory*	Threat by one state to enforce a military occupation of another state's territory
Show of ships	Public demonstration of naval forces, including purposeful display in waters adjacent to another state's territorial waters	*Threat to declare war*	Threat to enact an official declaration of war on another state
Show of planes	Public demonstration of airborne capabilities (e.g. repeated air space violations)	*Threat to use nuclear weapons*	Threat by one state to detonate a nuclear device within another state's territory
Fortify border	Explicit attempt to publicly demonstrate control over a border area through construction or reinforcement of military outposts to defend of claim territory		
Nuclear alert	Increase in military readiness of a state's nuclear forces		
Border violation	Crossing of a recognized land, air, or sea boundary for a period of less than 24 hours by official forces of one state without any force being used on the territory or any significant demonstration of military force capability		

Table taken from Daniel M. Jones, Stuart A. Bremer and J. David Singer (1996) ."Militarized Interstate Disputes, 1816-1992: Rationale, Coding Rules, and Empirical Patterns." Conflict Management and Peace Science, 15(2): 163:213.

Appendix 2.
Heteroskedasticity and Autocorrelation Tests

Table 1: Heteroskedasticity Test

Method: Breusch-Pagan/ Cook Weisburg Test for Heteroskedasticity		
Null Hypothesis: Constant variance		
Dependent Variable:	MID10	MID450
Number of Observations	227613	
Test Statistic	$2.61*10^6$	
P-value	0.00	

As shown in the table above, a significant test statistic indicates a non-constant variance in the error term. Thus heteroskedasticity is present in the model.

Table 2: Autocorrelation Test

Method: Woolridge Test for Autocorrelation in panel data		
Null Hypothesis: No first order autocorrelation		
Dependent Variable:	MID10	MID450
Test Statistic	761.46	358.28
P-value	0.00	0.00

In this case, the significant test statistic reported in Table 2 indicates that autocorrelation is present within both models.