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Gravitating toward War

Preponderance May Pacify, but Power Kills

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Countries have better abilities and stronger incentives to engage in militarized conflicts the larger and more powerful they are. The article applies Zipf's notion of a "gravity model" to the risk of interstate conflict and argues that the empirical relationship between size and distance and conflict is stronger than any other identified in dyadic statistical studies of interstate conflict. Most empirical studies of interstate conflict fail to take size properly into account. The article shows that controlling for size variables improves the estimation of other variables of interest, and it explores the impact of omitting size variables for the investigation of the power preponderance versus power parity debate. The results indicate that even though a power capability ratio variable suggests asymmetric dyads are less conflict-prone, the risk-increasing effect of power itself means that a unilateral increase of power in one country increases the risk of conflict.

Keywords: *interstate conflict; gravity model; country size; power preponderance; power parity; model specification; omitted variable bias*

1. Introduction

Military power—the ability to project physical force—is an essential factor in any explanation of militarized conflict. Power is a necessary condition for war: for a war to occur, the belligerents must be able to bring a minimum number of soldiers and weaponry to a joint location—power kills. In addition to this "absolute" amount of power brought to bear in a conflict, the relative power of the belligerents is also

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likely to affect the nature of the conflict and even whether there will be any military action at all.

In this article, I show that the empirical study of interstate conflict has not paid sufficient attention to the "absolute" aspect of power. To demonstrate this, I make use of the gravity model of interaction. The gravity model is widely used by economists to predict volumes of trade flows between countries: the volume of trade is proportional to the product of the two countries' GDP and inversely proportional to the distance between them. However, the gravity model was initially suggested to predict other types of social interactions. I show that militarized conflict is not only most frequent between countries that are geographically close to each other—they are also more frequent between larger countries.

That large countries like the United States engage more often in interstate conflict than small ones may seem trivial. Still, most quantitative studies do not include size as a control variable. This omission has serious consequences: variables that are both related to the dependent variable and correlated with explanatory variables may be affected by omitted-variable bias. If size in terms of GDP or population is an important predictor of interstate conflict and is omitted as a control variable, then its impact will be captured by variables such as the power capability ratio, since any operationalization of this concept deals with size in some form. The major power dummy routinely included in quantitative studies of war is not sufficiently precise to avoid this bias. Here, I systematically analyze the impact of controlling for the gravity model for the study of power parity and conflict. I show that the argument has important implications for the interpretation of the variable estimates. The results obtained here clearly show that relations of power preponderance are less conflict-prone than relations of power parity only when interpreted as a description of how a dyad's total capabilities are distributed. If dyads that differ in terms of their total size are compared, size differences are more important than asymmetry differences. Hence, any attempt to increase asymmetry by increasing one state's size or power will unambiguously lead to a higher risk of conflict in the dyad.

The article is organized as follows: In the next section, I argue that the frequency of militarized disputes are well described by the gravity model. I then review the empirical literature on power preponderance and power parity and show how it fails to take absolute levels of power into account. I develop a specification of a gravity model of conflict and analytically deduce how one should test hypotheses regarding absolute and relative power. Finally, I demonstrate the validity and importance of the argument using data for all pairs of countries in the 1885 to 2001 period.

2. The Gravity Model of Conflict

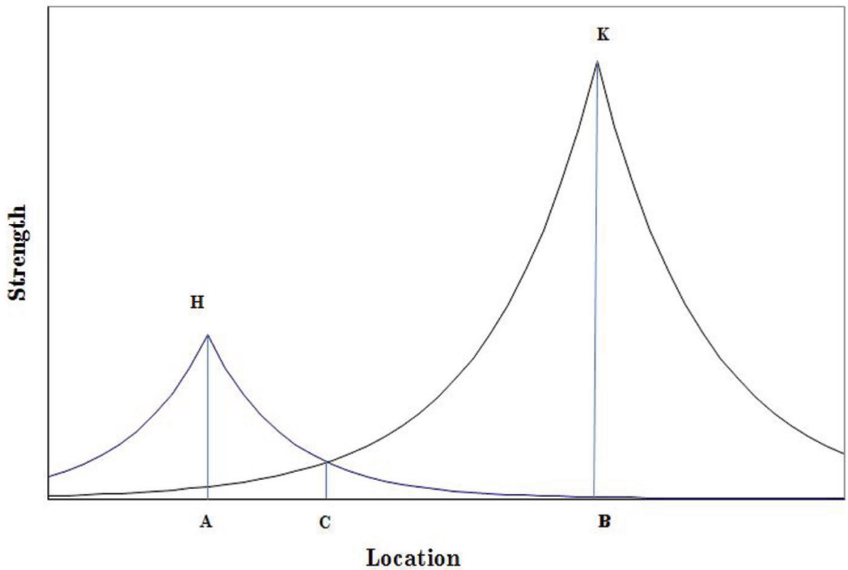
Newton's original gravity model is specified as $\frac{M_1 M_2}{d}$, where $M_{1,2}$ are the masses of two bodies and d the distance between them. Zipf (1946) shows that the number of persons that move between any two cities with populations P_1 and P_2, respectively, and separated by the distance D is proportional to the ratio $\frac{P_1 P_2}{D}$. The gravity model is widely recognized as a superior empirical description of bilateral trade patterns. Deardorff (1998) reviews various theoretical explanations for the gravity model relationship. He shows that it is consistent with a Heckscher-Ohlin model of trade and "suspect[s] that just about any plausible model of trade would yield something very like the gravity equation." Arguably, the extent to which two states form alliances and become joint members in international organizations also follows a gravity pattern (see Hegre 2005).

But the gravity model is not restricted to positive interactions (Gleditsch and Singer 1975). Militarized conflict is also likely to be much more frequent between pairs of countries that are large and geographically proximate. Such dyads have both better opportunities for militarized conflict and a stronger potential for being sufficiently motivated to escalate disagreements to a level where military forces are deployed and lives are lost. This is well recognized for geographical proximity (see Buhaug and Gleditsch [2006] for a review). Distance and contiguity variables are routinely included in empirical models of interstate conflict. Countries that are close to each other are *able* to bring an amount of military units against each other sufficiently large to cause a high number of battle deaths. Distance increases the costs of bringing militarized units against each other just as it increases the costs of transporting traded goods. Hence, if we conceive of a country as allocating a fixed proportion of its military resources to each of the other countries in the world, it will be able to bring fewer military units to a distant country. If the distance is sufficiently large, two countries will not be able to allocate a sufficient amount of military units to produce a single battle death.

Just as a model of trade volumes takes into account both supply and demand, a model of conflict must take into account both belligerents' *ability* and *motivation* to fight. Neighboring countries also have more to fight over. Countries are more likely to allocate military resources to counter countries that are able to inflict damage on them. In addition to concerns about local military power balances, countries are most likely to fight when they have conflicting interests. Interests are most likely to conflict between contiguous and proximate countries. Most wars are over territory and are fought out among neighbors (Vasquez 1995; Gleditsch 1995).

However, countries are also more likely to get into serious militarized conflicts the *larger* they are. Size affects states' opportunity to fight each other. Distance is more of an opportunity constraint for small countries than for large countries. Boulding (1962, 229–33) models military power at a given location as a function of a country's home strength (its strength at its home base) and the distance from the home base to the location. Each nation's strength declines as it moves away from its home base. The extent to which strength is reduced with distance is modeled by a loss-of-strength gradient (LSG). Figure 1 illustrates the relationship. The horizontal axis represents the distance between two countries A and B, and the vertical axis a country's

Figure 1
Boulding's (1962) Loss-of-Strength Gradient



military power at a given location. Country A's home strength is represented by the vertical line AH, and B's home strength by BK. The slopes of the lines extending from H and K are the countries' LSGs. Here, I model the LSG using a distance discount factor. The decrease is then proportional to the log of distance from the home base:[1] A's strength S_x^A at location x is given by $S_x^A = S_{x_o}^A \delta(x - x_o)$. The larger the two countries' home strengths, the greater the chance that they are able to jointly bring together a sufficient amount of military units to produce a serious militarized dispute. Hence, for a given distance between two states, the two states have better opportunities to fight the more powerful they are. Halfway between A and B, for instance, both states are able to mobilize a nonnegligible amount of military force. Country B is also able to mobilize at A's home base.

But just as large countries are both large producers and large consumers, size affects states' motivations for fighting in addition to their abilities. Pairs of large countries with vast territories, long joint borders, and a high number of indirect relationships through joint neighbors are more likely to have strongly conflicting interests than small countries. Moreover, Boulding's (1962) LSG implies that countries should be more concerned with any military moves done by countries that are either proximate or large, and the most about countries that are both proximate and large. Considerations of other states' motivations, again, affect states' strategic calculations and their perceived opportunities for fighting: countries are likely to allocate most of their military resources such that they optimize their defense against the most immediate threats: their neighbors and the large powers. This means that less resources are left for more distant threats and that their ability to wage wars decreases even more with distance than implied by the transportation costs only.

The size of a country also affects other countries' motivations for waging wars with them. The gravity model of trade implies that the larger a country is, the more important it is as a market for another country, or as an exporter of goods to it. In "guns versus butter" models (e.g., Powell 1999; Garfinkel and Skaperdas 2000), military investment is generally increasing in the amount of resources in the two contenders. Decisions made within a country are more likely to seriously affect another country the larger it is.

In contrast to civil war studies, indicators of size beyond a "major power" dummy variable are routinely omitted in empirical studies of interstate war.[2] There are only a few exceptions, and they have not had any impact on the modeling strategies of later studies: Werner (1999) comes very close to the control variable strategy advocated here as she estimates the dyadic "hazard rate for peace" as a function of the power of the two states as well as the distance between them. She uses the log of the states' Composite Index of National Capability (CINC) scores to measure power, to model that "states with few resources are much less able to project those resources abroad than states with greater resources" (p. 718). The estimates are statistically significant and indicate that war is more frequent among powerful countries. In their analysis of the determinants of interstate war duration, Bennett and Stam (1996) also include the countries' total population and number of soldiers as explanatory variables. They systematically find at least one of those to significantly increase the duration of wars. This means that wars are likely to be more lethal where the warring parties are populous, since the number of fatalities is roughly proportional to the duration of wars (Lacina 2006).

Below, I show that the absolute capabilities of countries are strongly related to their propensity to engage in war. I look at three sources of military power: demographic size, military investments, and the productive capacity of the underlying economy. Populous countries form larger markets, produce more goods, and may enlist more soldiers. Countries' military strength is to a large extent dependent on their population sizes. In addition, per capita military capabilities partly depend on the amount of resources states decide to allocate to the military. However, the ability to spend on the military obviously depends on per capita economic production (Kennedy 1988). Gartzke (2007, 172) elaborates on how economic development increases countries' ability to project force. At the same time, however, economic development also tends to reduce the incentives for using force (Rosecrance 1986; Mousseau 2000; Hegre 2000). Consequently, Gartzke predicts that economic development should increase the risk of conflict only for nonneighbors.

In the next section, I argue that the common omission of size variables creates a risk of omitted-variable bias in studies addressing the power parity versus power preponderance debate.

3. Power Parity versus Power Preponderance

Does peace depend on a balance of power? Advocates of the "balance-of-power" argument (e.g., Wright 1965; Morgenthau 1967; Waltz 1959) claim that "equality of power destroys the possibility of a guaranteed and easy victory and therefore no country will risk initiating conflict" (Lemke and Kugler 1996, 5). When there is power preponderance, Waltz (1959, 232) argues that wars occur "because there is nothing to prevent them." According to this argument, the risk of war between two states is lowest when they are approximately of equal size. In classical deterrence theory, peace through mutual deterrence only occurs with a balance of power (e.g., Intriligator and Brito 1984; see Zagare and Kilgour [2000] for a review).

Advocates of the "power preponderance" position, on the other hand (Organski and Kugler 1980; Blainey 1988; Lemke 2002) argue that "*parity* is the necessary condition for major war" (Lemke and Kugler 1996, 4). The relationship between power balance and uncertainty about outcomes is also important in this argument: since it is more uncertain who will win a contest between equally powerful contenders, wars may occur. Fearon (1995) argues that war between two states should occur only when at least one of them is uncertain about the capabilities or the resolve of the other, or when they have difficulties committing to a negotiated outcome. When the power balance clearly favors one of the states, this uncertainty (although not the commitment problem) is negligible, and pairs of states characterized by power preponderance will on average be more peaceful. Reed (2003, 637) argues that the variance or uncertainty of a challenger's estimate of the distribution of power is larger the closer the states are to parity. In his formal model, this increased uncertainty is translated into a higher risk of conflict between the two states. Zagare and Kilgour (2000) show that effective deterrence does not necessarily require power parity.

The "power preponderance" argument is closely related to Organski's (1958) "power transition" argument: major wars occur when one major power overtakes another. A similar logic underlies the argument of Powell (1999) and Werner (1999): since demands are chosen strategically, "potential belligerents must compare what they currently have with what they *reasonably* can demand" (Werner 1999, 723). Hence, "conflict ensues as a consequence of a perceived disparity between the status quo distribution of benefits and the underlying distribution of power" (Werner 1999, 723). Power transitions often bring about such disparities and will therefore be associated with a heightened risk of war. In the absence of power transitions, however, the results of these studies do not generate any unambiguous predictions for the relationship between parity and conflict. It is reasonable to believe that in most cases the distribution of power and the distribution of benefits are correlated. If so, a disparity between the distribution of benefits and of power may occur for any distribution of power.

In many treatments of both these arguments, the focus is primarily on relations between major powers. Power arguments are in principle equally applicable to any rivaling pair of states, but in practice relations between minor powers are influenced by major powers that take an interest in their interactions. Still, where major powers are indifferent about the outcome of a minor power conflict, the local power distribution alone is likely to have an impact on the form the conflict takes. Power distribution arguments should therefore apply at least to some extent to all pairs of states.

3.1. Absolute versus Relative Power

Recent empirical studies of the determinants of the risk of war tend to support the "power preponderance" argument. Bremer's (1992) pioneering study found that pairs of states where the CINC score of the more powerful state is more than 10 times higher than that of the weaker state have had fewer interstate conflicts. This finding has been replicated in a number of studies comparing the war risks in dyad years (e.g., Bueno de Mesquita and Lalman 1992; Oneal et al. 1996; Russett and Oneal 2001; Lemke 2002; Reed 2003; Hegre 2004).

These studies fail to take into account the crucial distinction between absolute (or nominal) and relative power, however. A closer look at Lemke (2002) is instructive, since Boulding's (1962) LSG forms an important part of his argument. Lemke defines a "local hierarchy" that "identifies the members of such international sub-systems [that are] able to interact militarily with each other" (p. 68). The ability to interact is a function of the absolute capabilities of the two states. Among pairs involving dominant powers within such local hierarchies, Lemke finds parity to increase the risk of war. But he ignores an important implication of the LSG that a "gravity model of conflict" (and Lemke's own argument) implies: since his restricted sample includes only dyads where at least one state is a locally or globally dominant power, parity as he defines it implies that the other state in the dyad is always a serious contender, that is, also a large state. Their *combined ability* to wage war is then always larger than in dyads where there is no parity. But the gravity model of conflict states that the better two states can reach each other, the higher is the risk of war. It is not possible in Lemke's model to identify how much of the increase in war risk is due to parity and how much is due to size.

The same problem occurs in the dyad-year empirical studies referred to above. The model of Russett and Oneal (2001) is the most widely used template. The studies based on this design typically include an asymmetry measure based on the CINC scores of the two states in the dyad. The "capability ratio" is the logarithm of the ratio of the CINC score of the more powerful country to that of the less powerful. But the capability ratio is obviously correlated with the capabilities of the weaker state. In Oneal and Russett's (2005) data set, average log capability ratio is 3.60 (a ratio of 37) if the least "capable" country in the dyad is in the lowest decile. If the smallest country in the dyad is in the highest decile, average log capability ratio is .55 (a ratio of 1.7). The correlation between the log capability ratio and the log capabilities of the smaller country is –.50. By extension, the problem is the same if the unit of analysis is a pair of alliances (e.g., Kim 2002): if the study does not control for the size of the countries or the alliance, there is no way of telling whether the estimated effect of the asymmetry variable is due to asymmetry or to the size of the smallest alliance or country in the pair. I show this formally in the next section.

Although Intriligator and Brito (1984) argue that mutual deterrence is possible in symmetric relationships provided that the costs of war are sufficiently high, these costs are modeled relative to the size of countries. This study and other theoretical contributions to the study of parity and war discussed above, then, consequently tend to ignore the issue of *absolute* size. In guns-and-butter models such as Garfinkel and Skaperdas (2000) and Powell (1999, chap. 2), on the other hand, the investment in guns and, accordingly, the intensity of conflict do increase in the resource endowment of the states.

4. Specifying a Gravity Model of Conflict

The unit of analysis in this article is the nondirected dyad-year, or a pair of countries observed in a given year.[3] The standard control model in studies such as Russett and Oneal (2001) is

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{10} + \beta_{1C}C_{ij} + \beta_{1D}\ln D_{ij} + \varepsilon_{1ij}, \tag{1}$$

where C_{ij} indicates whether the two countries are contiguous to another, and D_{ij} is the distance between them.[4] The ε_{1ij} term subsumes a set of other controls that I will ignore for the time being. Throughout this article, I will refer to the largest country in the dyad (in that year) in terms of military capabilities as country i and the smallest as j in subscripts to variables that measure characteristics of a country.[5] I refer to the size of the population of the largest country in the dyad as P_i and that of the smaller country as P_j.

In log form, the gravity model of trade is often formulated as

$$\ln T_{ij} = \gamma_0 + \gamma_{Pi}\ln P_i + \gamma_{Pj}\ln P_j + \gamma_{I_i}\ln I_i + \gamma_{I_j}\ln I_j + \gamma_C\ln C_{ij} + \gamma_D\ln D_{ij} + \eta_{ij}$$

where I_i and I_j are the average incomes (GDP per capita) of countries i and j.[6] We may specify a gravity model of conflict along the same lines. First, the discussion above implies that the magnitude of war should follow the same pattern. A plausible model of the magnitude of war is

$$\ln W_{ij} = \lambda_0 + \lambda_{M_i} \ln M_i + \lambda_{M_j} \ln M_j + \lambda_C C_{ij} + \lambda_D \ln D_{ij} + \eta_{ij}$$

where W_{ij} is the number of fatalities in the war. Since the focus of this article is on "political" interactions rather than economic ones, I include information on military capabilities in the model rather than income (in addition to population size). I refer to countries' military capabilities (CINC scores) in absolute form as M_i and M_j.

Most empirical studies of militarized conflict define the dependent variable as the probability of conflict defined dichotomously in terms of a fixed threshold Y, for example, *at least* $Y = 1{,}000$ battle deaths: $p_{ij,W} = p(\ln W_{ij} > \Upsilon)$. The latent probability of war may be related to the (linear) model of the magnitude of war by means of a logit model: $\ln\left(\frac{pw}{1-pw}\right) = \ln W_{ij} + \beta \mathbf{X} + \varepsilon_{ij}$. This leads to the following model:[7]

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{20} + \beta_{2Mi} \ln M_i + \beta_{2Mj} \ln M_j + \beta_{2C} C_{ij} + \beta_{2D} \ln D_{ij} + \varepsilon_{2ij}. \qquad (2)$$

To be able to distinguish between size in terms of population and differences between countries in terms of military investments and technology, it is useful to introduce a per capita version of the capability measure: $m_i = M_i/P_i$. An extended model for the probability of war is then

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{30} + \beta_{3Pi} \ln P_i + \beta_{3Pj} \ln P_j + \beta_{3m_i} \ln m_i + \beta_{3m_j} \ln m_j + \beta_{3C} C_{ij} + \beta_{3D} \ln D_{ij} + \varepsilon_{3ij}.$$

Since this is a log-log model, the $\beta_{P_{i,j}}$ terms estimate by how much an increase in population size leads to an increase in the odds of conflict for a given per capita capability level. In addition, the $\beta_{m_{i,j}}$ terms estimate how much the risk increases if the countries increase their per capita military capabilities (at least after taking power asymmetry into account).

4.1. Power Asymmetry and Omitted Variable Bias

The estimates for an explanatory variable in a statistical model may be biased if another variable is omitted that is correlated both with the dependent variable and with the explanatory variable of interest. In this section, I show how some simple algebraic manipulations can separate the size effects from the effects of size asymmetry.[8]

The standard definition of the capability ratio variable in my notation is $\ln A_{ij} = \ln M_i - \ln M_j$. A simplification of the standard specification is

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{40} + \beta_{4A} \ln A_{ij} + \beta_{4C} C_{ij} + \beta_{4D} \ln D_{ij} + \varepsilon_{4ij}. \qquad (4)$$

But if the risk of disputes between the two countries is increasing in their military capabilities, this will be captured by the error term $\varepsilon_{4ij} = \beta_{4Mi} \ln M_i + \beta_{4Mj} \ln M_j + \xi_{ij}$. Since $\ln A_{ij} = \ln M_i - \ln M_j$, there must be correlation between the error term and the explanatory variable $\ln A_{ij}$ and a potential for serious omitted variable bias.

The obvious solution is to control for the size variables. But since the log capability ratio is a linear function of the two capability variables, a model including all three variables $\ln A_{ij}$, $\ln M_i$, and $\ln M_j$ cannot be estimated. I explore two solutions to this below. In the first, I take the size of the smaller country as a measure of the size of the dyad. In the second, I set the sum of the sizes as the size of the dyad.

To explore the first solution, I include $\ln A_{ij}$ in the model while controlling for $\ln M_j$:

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{50} + \beta_{5A} \ln A_{ij} + \beta_{5Mj} \ln M_j + \beta_{5C} C_{ij} + \beta_{5D} \ln D_{ij} + \varepsilon_{5ij}. \tag{5}$$

β_{4A} is a direct and consistent estimate of the effect of power asymmetry as defined above. Will this model also produce consistent estimates for the absolute size variable? We can find this out by substituting $(\ln M_i - \ln M_j)$ for $\ln A_{ij}$ and collect terms:

$$\begin{aligned}\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) &= \beta_{50} + \beta_{5A}\left(\ln M_i - \ln M_j\right) + \beta_{5Mj} \ln M_j + \beta_{5C} C_{ij} + \beta_{5D} \ln D_{ij} + \varepsilon_{5ij} \\ &= \beta_{50} + \beta_{5A} \ln M_i + \left(\beta_{5Mj} - \beta_{5A}\right) \ln M_j + \beta_{5C} C_{ij} + \beta_{5D} \ln D_{ij} + \varepsilon_{5ij}. \qquad (5b)\end{aligned}$$

This shows that model 5 will produce inconsistent estimates for the size variables—there is a trade-off between getting consistent estimates for size and directly estimating the effect of power asymmetry. We do not have to estimate model 5*b* to obtain an estimate for β_{5A}, however—the estimate may be derived from the original gravity model of conflict since the reparameterization obtained in (5*b*) has the same form as (2). The β_{2Mi} estimate is therefore also an estimate for β_{5A}. Simply estimating the gravity model is the second solution to the identification problem.

But if the β_{2Mi} estimate (controlling for $\ln M_j$) is also an estimate for β_{5A}, we cannot be certain that it estimates the effect of asymmetry and not that of the size and capabilities of country *i*, over and beyond *j*. The alternative formulation is to define asymmetry as $\ln A_{ij} = \ln M_i - \ln M_j$ as before, but control for the joint size $\ln M = \ln M_i + \ln M_j$ of the two countries:

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{60} + \beta_{6A} \ln A_{ij} + \beta_{6M}\left(\ln M_i + \ln M_j\right) + \beta_{6C} C_{ij} + \beta_{6D} \ln D_{ij} + \varepsilon_{6ij}. \tag{6}$$

However, rearranging (6) yields

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{60} + (\beta_{6M} + \beta_{6A}) \ln M_i + (\beta_{6M} - \beta_{6A}) \ln M_j + \beta_{6C} C_{ij} + \beta_{6D} \ln D_{ij} + \varepsilon_{6ij},$$

and we see that this model has the same form as model 2. Hence,

$$\beta_{2M_i} = \beta_{6M} + \beta_{6A}$$
$$\beta_{2M_j} = \beta_{6M} - \beta_{6A}.$$

Solving these equations, we find that $\beta_{6M} = \frac{\beta_{2M_j} + \beta_{2M_i}}{2}$ and $\beta_{6A} = \frac{\beta_{2M_i} - \beta_{3M_j}}{2}$.

The sum of the log capabilities is the same as the logarithm of the product of the capabilities. For a given sum $M_i + M_j$, this product is larger the smaller is the difference between M_i and M_j. The sum $\ln M_i + \ln M_j$ is therefore correlated with asymmetry conceptualized as $(M_i - M_j)$. I will therefore also investigate the model

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{70} + \beta_{7A} \ln A_{ij} + \beta_{7M} \ln\left(M_i + M_j\right) + \beta_{7C} C_{ij} + \beta_{7D} \ln D_{ij} + \varepsilon_{7ij}. \qquad (7)$$

5. Estimating the Gravity Models

These expectations were tested in a standard dyad-year setup based on the data set of Oneal and Russett (2005).[9] The data set includes one observation for every pair (dyad) of countries for every year. The data set includes information on all pairs of countries for the 1885 to 2001 period. Oneal and Russett (2005) is the source for the variables described below where nothing else is indicated. See Russett and Oneal (2001) for a detailed description of the data set.

5.1. Variables and Measurement: Dependent Variables

Fatal MIDs and Wars

The dependent variable variable in Oneal and Russett (2005) draws on Maoz's (2005) dyadic version of the Correlates of War's (COW's) military interstate disputes (MIDs) and wars data sets. As do Oneal and Russett, I restrict the analysis to onset of "fatal MIDs"—militarized interstate disputes that lead to the death of at least one person. I also estimate alternative models where the dependent variable is the onset of dyadic war with at least 1,000 battle deaths per year.

5.2. Variables and Measurement: Independent Variables

Population

The population variables $\ln P_{i,j}$ are the natural log of total population in thousands for countries i and j. The variable originates from the COW military capabilities data set.

Military Capabilities

The COW military capabilities index (Singer, Bremer, and Stuckey 1972) is based on data on states' total population, urban population, energy consumption, iron and steel production, military expenditures, and size of the armed forces. The COW project calculated each state's share of the world's total for each of these subindices. The CINC index is constructed as the unweighted average of each of these shares. The theoretical range for the index is [0, 1]. In practice, the log capabilities index $\ln M_i$ ranges from -11.5 to -0.957.

Democracy

Democracy data were taken from the Polity data set (Jaggers and Gurr 1995). Dem_i is the Democracy-Autocracy index for the larger country, Dem_j that for the smaller. Dem_{ij} is the product of Dem_i and Dem_j.

Direct Contiguity

Contiguity takes the value 1 if two states either share a land boundary or are separated by less than 240 kilometers of water.

Distance

Distance is the great-circle distance between the two states' capitals (or major ports for the USA, the USSR/Russia, and Canada).

System Size

Raknerud and Hegre (1997, 390–91) show that in dyadic studies, the probability of dispute for "low-relevance" dyads must be dependent on the number of states in the system.[10] Consider the logistic model

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_0 + \beta_C C_{ij} + \varepsilon_{ij}.$$

When there are N_0 states in the system, the constant β_0 specifies the predicted log odds of conflict in the nonneighboring states, and the $\beta_0 + \beta_C$ term the predicted log odds in neighboring states. When the number of states increases from N_0, the number of neighboring dyads increases as a linear function of $N_t - N_0$, but the number of nonneighboring dyads increases as a quadratic function. If β_0 is constant, then the country-level probability of conflict increases for each new country. This is not plausible—there is no reason to believe that the risk of conflict involving Peru intensified just because East Timor became independent. We should therefore expect β_0 to be smaller in large state systems. An adaption of Raknerud and Hegre's solution to this problem is to add the variable $\ln\left(\frac{N_0}{N_t}\right)$ to the model, where N_0 is the lowest number of states in the system in the period of analysis, and N_t the number of states at a given time t. $\ln(\frac{N_0}{N_t})$ is set to zero for neighboring countries. In the extended model

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_0 + \sigma \ln\left(\frac{N_0}{N_t}\right) + \beta_C C_{ij} + \varepsilon_{ij},$$

σ must be negative, and its magnitude specifies by how much the risk of conflict in nonneighboring dyads decrease when the number of states increase.

Proximity of War

Raknerud and Hegre (1997) and Beck, Katz, and Tucker (1998) argue that temporal dependence in binary time-series cross-section (BTSCS) designs may be handled by adding a function of time since previous conflict in the dyad to the set of explanatory variables. I use the decay function suggested by Raknerud and Hegre here. Proximity of war is defined as $2^{-py/\alpha}$, where py is the number of years since last conflict and α a half-life parameter. I set $\alpha = 1$, assuming that the risk-increasing effect of a previous war is halved every year.

5.3. Measuring Size

Size affects both the motivation and the ability to wage wars. Size, then, should not be measured exclusively in terms of military power. I will take demographic and military size into account in the empirical analysis. The size of the population is the most fundamental size variable, since both military power and nonmilitary importance in terms of cultural, strategic, and economic factors are increasing functions of population size. Above, I defined per capita military capabilities as $\ln M_i = \ln M_i - \ln P_i$. Table 1 shows the estimated relationship between $\ln M_i$ and $\ln P_i$ for the year 2000. $\ln P_i$ accounts for 86 percent of the variation in $\ln M_i$. The elasticity of the CINC score $\ln M_i$ to population is one or slightly above. The remainder of the variance is the per capita military capabilities for the country. To minimize collinearity in the models estimated below and ease interpretation, I disaggregate the CINC score into what is explained by population and what is explained by the other components in the CINC score (urban population, energy consumption, coal and steel production, military expenditures and military personnel). The variable is disaggregated simply by calculating the per capita CINC scores.

Table 2 reports descriptive statistics for the most important variables in the models analyzed below.

5.4. Estimating the Models

In Hegre (2005), I show that the number of battle deaths in war follows a gravity model pattern. Since the severity of war follows a gravity model pattern, the probability of war onset should also follow one. The results of estimating the gravity

Table 1
Estimated Relationship between Military Capabilities (ln M_i) and Population (ln P_i), All Countries, 2000 (Ordinary Least Squares)

Dependent Variable	Military Capabilities Coefficient	($\ln M_i$)(*SE*)
$\ln P_i$ (Population$_i$)	1.071***	(.032)
Constant	–16.54***	(.285)
R^2	.859	
N	184	

***$p < .01$.

Table 2
Descriptive Statistics, Size Variables

Variable	Mean	Standard Deviation	Minimum	Maximum	*N*
$\ln P_i$	9.84	1.34	5.39	14.1	488,918
$\ln P_j$	8.11	1.21	4.88	13.8	488,918
$\ln M_i$	–5.49	1.65	–11.5	–.957	488,918
$\ln M_j$	–7.33	1.49	–11.5	–.957	488,918
$\ln m_i$	–15.3	.887	–17.2	–11.0	488,918
$\ln m_j$	–15.4	.947	–17.2	–10.7	488,918
$(\ln M_i + \ln M_j)$	–12.8	2.60	–22.3	–2.9	488,918
$\ln (M_i + M_j)$	–5.17	1.49	–10.4	–.689	488,918
$\ln A_{ij}$	1.84	1.77	–4.74	10.3	488,918

models of conflict (models 2 and 3) are presented in Table 3. In column A, I replicate the standard model without size variables (model 1). Columns B and C report the results for model 2 using total military capabilities as the only size variable, for fatal MIDs and wars, respectively.

The estimates clearly support the idea of a gravity model of conflict. The two capabilities variables are positive and significant for both dependent variables. The estimates for $\ln M_i$ and $\ln M_j$ are somewhat larger for wars than for MIDs—distance and size are less constraining for MIDs than for large-scale wars. The size variables are of considerable substantive importance. A one-standard-deviation increase in the CINC score of the larger country increases the estimated risk of fatal MID by 35 percent and the risk of war by 44 percent. Increasing the capabilities of the smaller country by one standard deviation increases the risks by 81 and 124 percent, respectively.[11]

In columns D and E of Table 3, I decompose the CINC score into population and per capita military capabilities (model 3). Both population variables $\ln P_i$ and $\ln P_j$ are positive and significant, as is per capita capabilities of the smaller country ($\ln M_j$). Even though $\ln M_j$ accounts for only a minor fraction of the capabilities variable, it has considerable effect on the risk of conflict—increasing per capita military

Table 3
Estimates for Gravity Models of Conflict, 1885-2001

	A. Model 1	B. Model 2	C. Model 2	D. Model 3	E. Model 3
Dependent variable	MID	MID	War	MID	War
ln M_i		.180***	.223***		
Military capabilities$_i$		(.054)	(.084)		
ln M_j		.400***	.541***		
Military capabilities$_j$		(.051)	(.085)		
ln P_i				.307***	.385***
Population$_i$				(.061)	(.093)
ln P_j				.449***	.445***
Population$_j$				(.059)	(.087)
ln m_i				–.116	–.148
Mil. cap. per capita$_i$				(.090)	(.125)
ln m_j				.307***	.654***
Mil. cap. per capita$_j$				(.072)	(.103)
Democracy$_i$	–.017	−.034***	−.064***	−.027***	−.050***
(Polity index)	(.012)	(.011)	(.021)	(.010)	(.019)
Democracy$_j$	−.030**	−.048***	−.054**	−.040***	−.050***
(Polity index)	(.011)	(.011)	(.021)	(.011)	(.021)
Democracy$_{ij}$	−.0089***	−.0085***	−0.014***	−.0083***	−.014***
(Joint democracy)	(.0013)	(.0013)	(.0030)	(.0013)	(.0030)
C_{ij}	1.41***	1.62***	.553*	.888***	.112
Contiguity	(.354)	(.286)	(.313)	(.343)	(.434)
ln D_{ij}	−.452***	−.661***	−.440**	−.796***	−.540***
Distance	(.097)	(.079)	(.139)	(.103)	(.147)
ln N_t	−1.03***	–.240	−.781***	−.657***	−1.10***
System size	(.221)	(.190)	(.286)	(.220)	(.325)
Brevity of peace	2.50***	2.65***	3.16***	2.62***	3.10***
	(.153)	(.151)	(.227)	(.148)	(.227)
Constant	−3.09***	1.23	−.480	−4.85***	−4.12***
	(.790)	(.755)	(1.05)	(1.36)	(1.91)
Pseudo-R^2	0.242	0.281	0.274	0.290	0.281
Log pseudo-ll	–3,060.64	–2,902.52	–725.29	–2,865.95	–718.10
N	446,100	446,100	446,100	446,100	446,100

Note: Robust standard errors in parentheses. MID = militarized interstate dispute.
$*p < .10$. $**p < .05$. $***p < .01$.

capabilities of the smaller country by one standard deviation increases the risk of fatal MID by 34 percent and that of war by 86 percent. A pair of countries that is at the 75th percentile for all four size variables is 3.7 times more likely to have a fatal militarized dispute than a pair of countries at the 25th percentile. Increasing per capita capabilities in the larger country does not affect the risk of conflict, though.

About half of the variance in the per capita capabilities variable is due to economic development as measured by GDP per capita. These results confirm one half

Table 4
Out-of-Sample Predictions, Models with and without Size Variables, 1885–2001, Average over Twenty Sample Splits

	Average Frequency of Predicted Disputes						
	Model 1, without Size Variables			Model 2, with Size Variables			
Actual Outcome	$p > .50$	$P > .25$	$p > .10$	$p > .50$	$p > .25$	$p > .10$	Total
Dispute	1.2	7.1	32.8	3.1	22.9	50.9	281.9
% true positives	0.43	2.52	11.62	1.08	8.12	18.06	0.13
No dispute	1.0	10.9	154.2	7.6	45.9	186.3	222,781
% false positives	0.0004	0.005	0.069	0.003	0.021	0.084	99.87
Total predicted	2.2	18.0	187.0	10.7	68.8	237.2	
% correct predictions	55.8	39.6	17.5	28.6	33.3	21.5	

of the argument in Gartzke (2007)—economic development increases the ability to project force.[12]

5.5. The Case for Control Variables

Adding variables entails costs. In general, estimates become less precise, and collinearity problems often arise. In this case, though, the advantages of including size variables clearly exceeds the disadvantages. First, the estimates for the size variables are clearly significant. In this case, previous studies of power parity and conflict are likely to suffer omitted-variable bias. I address this at length below. Second, the size variables are clearly antecedent to most conceivable variables to include in studies of interstate behavior (cf. Ray 2005).

Third, note that the pseudo–log likelihood increases by more than 160 points from model 1 to model 2 when adding just two variables. No other variables routinely used in dyadic studies have such explanatory power. Removing distance and contiguity from model 1, for instance, reduces log likelihood by 110 points. Removing the democracy variables decreases it by 64 points. Decomposing size further increase log likelihood by 36 points in model 3.

Table 4 further demonstrates the importance of size variables by comparing the out-of-sample predictive performance of models 1 and 2.[13] To produce these results, I estimated the models on a random sample of half of the dyads. Using these estimates, I generated predicted probabilities of onset of fatal MIDs. I then compared the predicted outcome (the outcome with estimated probability larger than .5) with the observed outcome for the other half of the dyads. I repeated this process twenty times to even out the impact of individual random splits of the sample.

The left half of Table 4 cross-tabulates this prediction variable with the observed dispute outcome for model 1 without size variables. The left-most column shows that only an average of 1.2 of 281.9 disputes in the prediction samples were correctly predicted by model 1. The low number is to some extent due to the rareness of conflict onsets. In the second and third columns, I regard an onset as predicted if the estimated probability exceeds .25 or .10 rather than the conventional threshold. This corresponds roughly to predicting onset within a four- or ten-year period. There are 32.8 onsets correctly predicted "within the decade."

The right half of Table 4 shows the corresponding figures for model 2. The predictive performance of this model is considerably better—3 times higher in the case of $p > .25$. The $p > .10$ predictions "correctly" predict as much as 18 percent of the MID onsets.

The improved predictive performance means that model 2 generates more false positives than model 1. This is shown in the lower half of the table. For the $p > .10$ predictions, however, model 2 yields a higher rate of correct predictions.

One may argue that the increase in log likelihood only leads to a modest increase in pseudo-R^2—from .24 to .28. This increase in explained variance, however, is sufficiently large to provide a final reason to control for the size variables. Inspecting what happens to the estimates for the democracy variables show that they remove a large amount of noise, allowing other patterns to be discerned more clearly.[14] The "joint democracy" variable changes only little from model 1 to model 2. The estimates for the country-level democracy scores emerge much more clearly, however. The estimate for "Democracy$_i$" change from −.017 to −.034. When taking into account the interaction capacity of several powerful democracies, these results suggests a monadic democratic peace. The same sharpening of estimates is also evident for "Dem$_i$."

5.6. Omitted-Variable Bias: Is Power Parity Associated with Peace?

Since the capability ratio variable $\ln A_{ij}$ is a linear function of the two states' capabilities $\ln M_i$ and $\ln M_j$, they must be correlated. Previous studies including the capability ratio variable therefore suffer from omitted-variable bias. Table 5 investigate the extent of this bias by comparing model 4 with the fully specified models (models 5–7).

Column A presents the results from the standard model 4 that includes contiguity and distance in addition to asymmetry and control variables. The estimate is negative and significant, and the magnitude of the estimate is close to previous studies. The pseudo-R^2 of this model is .243. The result has a seemingly straightforward interpretation: the more asymmetric in terms of power a dyad is, the lower is the risk of conflict. Pakistan with $\ln M = -4.41$ in 2000 has a 13 percent higher risk of fatal MID with Iran ($\ln M = -4.47$) than with India ($\ln M = -2.74$). China ($\ln M = -2.10$) has 3 times lower risk of conflict with Bhutan ($\ln M = -9.28$) than with Russia ($\ln M = -2.16$), and the risk of conflict between China and Russia is

Table 5
Estimates for Power Symmetry and Militarized Conflict, 1885–2001

	A. Model 4	B. Model 5	C. Model 6	D. Model 7	E. Model 7′
Dependent Variable	MID	MID	MID	MID	MID
$\ln A_{ij}$	–.077*	.180***	–.110***	–.279***	–.148*
Asymmetry$_{ij}$	(.043)	(.054)	(.043)	(.041)	(.087)
$\ln A_{ij}^2$					–.035*
Asymmetry squared$_{ij}$					(.019)
$\ln M_j$		.580***			
Military capabilities$_j$		(.062)			
$(\ln M_i + \ln M_j)$			.290***		
Total military caps.			(.031)		
$\ln (M_i + M_j)$				.567***	.574***
Total military caps.				(.062)	(.063)
Dem$_i$	–.014	–.034***	–.034***	–.033***	–.034***
Democracy$_i$	(.012)	(.011)	(.011)	(.011)	(.011)
Dem$_j$	–.031***	–.048***	–.048***	–.048***	–.047***
Democracy$_j$	(.011)	(.011)	(.011)	(.011)	(.011)
Dem$_{ij}$	–.0089***	–.0085***	–.0085***	–.0085***	–.00085***
Joint democracy	(.0013)	(.0013)	(.0013)	(.0013)	(.0013)
C_{ij}	1.43***	1.62***	1.62***	1.61***	1.62***
Contiguity	(.353)	(.286)	(.286)	(.289)	(.286)
D_{ij}	–.434***	–.661***	–.661***	–.675***	–.661***
Distance	(.097)	(.079)	(.079)	(.081)	(.081)
$\ln N_t$	–1.04***	–.240	–.240	–.276	–.249
System size	(.220)	(.190)	(.190)	(.191)	(.190)
Brevity of peace	2.50***	2.65***	2.65***	2.64***	2.64***
	(.153)	(.151)	(.151)	(.151)	(.151)
Constant	–3.10***	1.23	1.23**	.911**	.786
	(.782)	(.755)	(.755)	(.755)	(.758)
pseudo-R^2	0.2430	0.2813	0.2813	0.2813	0.2808
log pseudo-ll	–3057.54	–2902.52	–2902.52	–2907.65	–2904.82
N	446,100	446,100	446,100	446,100	446,100

Note: Robust standard errors in parentheses. MID = militarized interstate dispute.
$*p < .10$. $**p < .05$. $***p < .01$.

estimated to be roughly the same as that between Mali ($\ln M = -7.65$) and Burkina Faso ($\ln M = -7.57$).

However, Table 3 demonstrated that the last comparison cannot be correct. The China-Russia dyad is estimated to be 24 times more conflict-prone than the Mali–Burkina Faso dyad because the countries are so much larger.[15] In column B, I control for the capabilities of the least powerful country (model 5). Above, I demonstrated that the estimate for $\ln A_{ij}$ in model 5 is the same as the estimate for $\ln M_i$ in model 2. A comparison between the estimates in column B, Table 5 with those in column B,

Table 3 shows that this holds. Also note that except for the estimate for $\ln M_j$, all other estimates are identical in the two models.

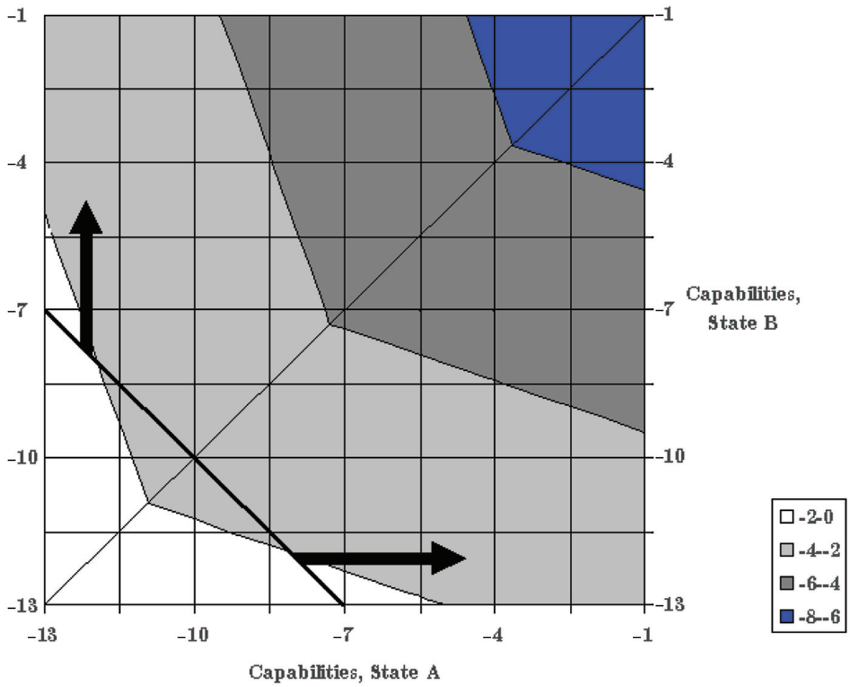
Compared to the model in column A, the estimate for $\ln A_{ij}$ in column B has changed sign to be positive and statistically significant. Is it true that power preponderance *increases* the risk of militarized disputes? Not necessarily, since the estimate for $\ln A_{ij}$ is a function of both the asymmetry in the dyad and of the size of the more powerful country. I report in column C the estimate for $\ln A_{ij}$ where I control for the total capabilities ($\ln M_i + \ln M_j$) in the dyad. In this specification, the estimate for $\ln A_{ij}$ is again negative and significant. In column D, I control for $(M_i + M_j)$. In this version of the model, the power asymmetry estimate is even more strongly negative and significant.

Some studies have indicated that the relationship between asymmetry and conflict is curvilinear (e.g., Oneal 2006, 88). In column E, I add the square of $\ln A_{ij}$ to the model. This leads to a moderate improvement in pseudo-ll. The estimates indicate that the effect of asymmetry is increasing somewhat as asymmetry increase, but only marginally.

The four sets of estimates in columns A through D demonstrate the difficulty of making inferences regarding the effect of power asymmetry. It is impossible to compare dyads in terms of relative power levels without also taking absolute power levels into account. The results in column B tell us that if we take a dyad and hypothetically increase asymmetry by increasing the power of the largest country, the risk of militarized conflict increases. Conversely, if we increase asymmetry by decreasing the power of the least powerful, the predicted risk decreases since the estimate for $\ln M_{ij}$ is larger than that of $\ln A_{ij}$. According to these estimates, military investments in one country unambiguously increases the risk of conflict, whereas disarmament decreases it. The results in columns C and D inform us that a territory with a given amount of capabilities will be less risk-prone if it is split into one large and one small state than if it is split into two equally powerful ones.

It is worth noting that the substantive importance of asymmetry is considerably smaller than that of absolute size. In all models in Table 5, the estimates for $\ln A_{ij}$ are less than half the size of the corresponding estimates for the size variables, despite the variables' standard deviations being roughly comparable. This is evident in Figure 2, which plots the estimated relative log odds of war as a function of the capabilities of the two states in the dyad.[16] Darker shades represent a higher estimated risk of conflict. The least powerful dyads are located in the lower left corner of the figure. The capabilities of state A is represented by the x axis, that of state B by the y axis. The perfectly symmetric dyads are situated along the diagonal from this corner to the upper right one. The most asymmetric dyads are found close to the lower and left axes. The lines between the colored areas are iso-risk lines—lines with similar estimated log odds of fatal MIDs. The iso-risk lines are concave since symmetric dyads are more conflict-prone than asymmetric ones.

Figure 2
Predicted Log Odds of Fatal Militarized Interstate Dispute (MID), by Capabilities of States *i* and *j*



The black line drawn from the (−13, −7) coordinate to (−7, −13) connects dyads that have total capabilities equal to −20. One may think of this line as representing all possible distributions between two states of a given set of resources. The 50-50 distribution (at the diagonal) has the highest risk of dispute. When moving along this line toward either the *x* or the *y* axis, the estimated risk of conflict decreases with increasing power asymmetry. The two arrows in the chart, on the other hand, shows what happens if one country increases capabilities while the power of the other is held constant. This leads to an increase in asymmetry that also increases the total size of the dyad. The figure shows that a movement along one of the arrows *increases* the risk of conflict. Preponderance may pacify, but power kills.

One important caveat to this discussion should be noted. I showed above that population size explains 86 percent of the variation in the power index. Hence, most variance in power is due to demographic factors, not by any deliberate governmental policies (apart from wars of conquest).

6. Conclusion

I have shown that an analogy to the gravity model of the volume of trade provides a good empirical description of the severity and risk of militarized disputes between countries. Militarized conflict is not only most frequent between countries that are geographically close to each other—they are also more frequent between larger countries. I show that a set of size variables—based on countries' population and their military capabilities—significantly and strongly increases the probability of militarized disputes between countries. Including the four size variables lead to an increase in log likelihood of about 200 points. This improvement in goodness of fit cannot be neglected. The size variables are indisputably associated with the probability of militarized disputes between countries.

Despite their obvious importance, most quantitative studies of conflict do not control for size apart from including dummy variables for whether the dyad consists of one or two major powers. The implications of this strong empirical relationship are therefore not trivial. Omitting an important predictor of interstate conflict such as size means that its impact will be captured by variables that are closely related to size. This applies to several important variables in the literature on interstate conflict, such as trade dependence, income per capita, and power preponderance. This article explored the impact of omitting size variables in studies of power preponderance. Elsewhere (Hegre 2008), I explore the importance for the trade and conflict literature. I argue that size variables should form part of any fully specified model of interstate conflict, just as population size has become an indispensable item in civil war studies.

The analysis of power or size asymmetry and the risk of militarized disputes shows that this relationship is far from straightforward. Although I replicate the finding that the power capability ratio variable is negatively associated with conflict, the risk-increasing effect of power itself complicates the interpretation of this result. Among potential allocations of a given territory between two states, the most asymmetric constellations are least conflict-prone. But any attempt to increase asymmetry by increasing the power of the larger and more powerful one is estimated to increase the risk of interstate disputes. Conversely, any attempt to increase asymmetry by decreasing the power of the least powerful one decreases the risk of conflict. Still, two-sided power reductions would be even more beneficial seen from the perspective of reducing the overall risk of militarized disputes. Lemke and Kugler (1996, 4) claim that "*parity* is the necessary condition for major war." Although the results obtained in this article supports their position re the balance-of-power proponents, a more appropriate conclusion is that "*power* is the necessary condition for large-scale war."

Notes

1. Wohlstetter (1968) gives a detailed exposition on why military power decreases with distance and proposes a curvilinear decline. Bueno de Mesquita (1981, 105) also uses a logarithmic function of distance for the loss-of-strength gradient.

2. Most recent quantitative studies of the risk of civil war at the country level include a population variable (e.g., Collier and Hoeffler 2004; Fearon and Laitin 2003).

3. I take the common nondirected dyad-year design as the point of departure here to maximize comparability with previous studies. It may not be the best design, however (cf. Bennett and Stam 2000; Hegre 2004).

4. I follow Russett and Oneal (2001) and specify a logistic regression model. Other models have been suggested as more appropriate. In particular, several of the theoretical approaches discussed above involve strategic interaction. Signorino (1999) and Signorino and Tarar (2006) demonstrate that failure to reflect this in statistical models may lead to invalid conclusions. Acknowledging that this may affect the results provided here, I choose to present my argument in terms of the simplest and most common models and state without further justification that the omitted-variable bias discussed here also applies to more complex models.

5. Referring to the largest as i and the smallest as j greatly eases the argument developed here. See Hegre (2005) for a discussion.

6. It is more common to include $\ln G_i$ than $\ln I_i$. But since $\ln I_i = \ln G_i - \ln P_i$, these formulations contain exactly the same information. See Hegre (2008) for a more detailed discussion of this specification.

7. Parameters are subscripted according to the following convention: First, a number indicates which of several related models the parameter belongs to. Second, the variable name is used to identify which variable the parameter relates to. Hence, β_{2Mi} refers to the parameter for country i's capabilities in model 2.

8. In Hegre (2008), I show how the failure to control for size variables creates a different set of problems for studies of trade and conflict such as Russett and Oneal (2001).

9. Thanks to John Oneal for sharing a more extensive version of this data set than the publicly available replication data set.

10. Oneal and Russett (2005) adopt this extension to the standard specification. The formulation developed here is a refinement of the variable used in these earlier studies.

11. By "risk" I here mean odds of onset of conflict. Since the baseline probability of militarized interstate dispute (MID) onset is very low, this is virtually identical to the probability of onset.

12. These results do not allow us to evaluate the other half of Gartzke's (2007) argument: that development increases the risk of conflict only for nonneighbors.

13. See Ward and Hoff (2007) for a discussion of using out-of-sample predictive performance to assess model specifications.

14. To illustrate why this happens, consider regressing persons' height on parents' height for a small sample. If we control for persons' gender, we obtain two parallel regression lines with moderate nonexplained variance. If we omit the gender variable, variance increases and we need more data to obtain significant estimates.

15. Figures based on estimates in column B, Table 3.

16. The figure is based on the estimates in column B, Table 3. The baseline is a dyad where both states have $\ln M_i = \ln M_j = 0$.

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