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# Ties That Bias in International Conflict: A Spatial Approach to Dyadic Dependence from Alliance Ties and Inbetweenness

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Much of international behavior is linked spatially and temporally. Yet, analyses of interstate interactions generally either assume independence among units or resort to technical solutions to dependence that "throw away" relevant information. We detail a more informative and satisfying approach to modeling spatial dependence from extra-dyadic linkages in alliance ties and geographical proximity as specific pathways of conflict contagion. Beyond deterrence, the purpose of alliances is to draw other parties into dyadic contests, but most existing research on conflict onset generally only considers alliance ties *within* an individual dyad or external intervention in the same dispute. We develop new measures on third- and fourth-party alliance ties, demonstrating direct and indirect spatial effects of alliances on conflict onset. Similarly, ongoing contests can spread geographically, but dyads in some locations are much more at risk for conflict onset than others. We provide a new theory of geographic "inbetweenness" in conflict and show that dyads involving specific locations and ties to the ongoing conflict are much more likely to see dispute onset, even accounting for other purely dyadic factors. Beyond the intrinsic interest in the impacts of extra-dyadic position and alliances on conflict, our spatial approach can be applied more broadly to other extra-dyadic ties.

Gran parte del comportamiento internacional está vinculado de forma espacial y temporal. Sin embargo, los análisis de las interacciones interestatales, generalmente, asumen una independencia entre las unidades o recurren a soluciones técnicas para la dependencia que "desechan" información relevante. Detallamos un enfoque más informativo y satisfactorio para modelar la dependencia espacial de los vínculos extradiádicos en los lazos de alianza y la proximidad geográfica como vías específicas de contagio de conflictos. Más allá de la disuasión, el propósito de las alianzas es atraer a otras partes a contiendas diádicas, pero la mayoría de las investigaciones que existen sobre el inicio de los conflictos, generalmente, solo consideran los lazos de alianza *dentro* de una díada individual o la intervención externa en la misma disputa. Desarrollamos nuevas medidas sobre los lazos de alianza de terceras y cuartas partes, para así demostrar los efectos espaciales directos e indirectos de las alianzas en el inicio de un conflicto. De manera similar, las contiendas en curso pueden extenderse geográficamente, pero las díadas en algunos lugares corren mucho más riesgo de experimentar conflictos que otras. Proporcionamos una nueva teoría de la "intermediación" geográfica en el conflicto, y mostramos que las díadas que involucran lazos y lugares específicos con un conflicto en curso tienen muchas más probabilidades de ver el inicio de una disputa, incluso teniendo en cuenta otros factores completamente diádicos. Más allá del interés intrínseco en los impactos de la posición extradiádica y las alianzas en el conflicto, nuestro enfoque espacial puede aplicarse de manera más amplia a otros lazos extradiádicos.

Une grande partie du comportement international est liée à l'espace et au temps. Pourtant, les analyses des interactions interétatiques présupposent généralement une indépendance entre les unités de recours aux solutions techniques à la dépendance qui « gâchent » des informations pertinentes. Nous détaillons une approche plus informative et plus satisfaisante pour modéliser la dépendance spatiale à partir de liaisons extra-dyadiques qui interviennent dans les liens d'alliance et la proximité géographique et jouent le rôle de voies spécifiques de contagion des conflits. Au-delà de la dissuasion, l'objectif des alliances est d'attirer d'autres parties dans des contestations dyadiques, mais la plupart des recherches existantes sur le déclenchement des conflits ne prennent généralement en considération les liens d'alliance *qu'au sein* d'une dyade individuelle ou d'une intervention extérieure dans un même conflit. Nous développons de nouvelles mesures sur les liens d'alliance entre tierces et quatrièmes parties qui démontrent les effets spatiaux directs et indirects des alliances sur le déclenchement des conflits. De même, les contestations en cours peuvent s'étendre géographiquement, mais les dyades de certains lieux sont bien plus exposées au risque de déclenchement de conflits que d'autres. Nous proposons une nouvelle théorie « d'entre-deux » géographique dans les conflits et montrons que les dyades impliquant des lieux et des liens spécifiques avec le conflit en cours sont bien plus susceptibles de connaître un déclenchement de conflits, et ce même en prenant en compte les autres facteurs purement dyadiques. Au-delà de l'intérêt intrinsèque dans les impacts des positions et alliances extra-dyadiques sur les conflits, notre approche spatiale peut être appliquée plus largement à d'autres liens extra-dyadiques.

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## Introduction

The dyad remains the most common unit of analysis for interaction between states and is helpful for analyzing outcomes of interaction or combinations of the actors' characteristics. Yet, there are also potential pitfalls in dyadic analysis. The insight that strategic behavior will be conditioned by expectations about, or reactions to, the behavior of other actors not only leads directly to the conclusion that most interesting phenomena in international relations must be minimally dyadic, but also raises question about purely dyadic research designs. Dyads do not pass one another like ships in the night, independent and largely oblivious of each other. Strategic interaction continues across dyadic boundaries and researchers must consider the potential dependence between dyads.

We focus on two main "pathways" of dyadic dependence in conflict, extra-dyadic alliance ties and "inbetweenness" to other disputants. Formal military obligations normally span dyadic boundaries precisely in order to draw third parties into anticipated or actual dyadic contests (see, e.g., Smith 1996; Leeds 2003; Cranmer, Desmarais, and Menninga 2012; Chiba, Johnson, and Leeds 2015). But despite a broadly acknowledged theoretical connection between alliances and third parties, extra-dyadic alliance ties are generally ignored in existing quantitative research (for an important exception, see Li et al. 2017). We offer new measures identifying third- and fourth-party alliance ties—dyads linked to disputants through alliances with dispute participants or allies of the disputants respectively.

It has long been known that proximity to disputants or geographic position will condition the likelihood that one contest precipitates disputes involving other actors (e.g., Siverson and Starr 1991; Ward and Gleditsch 2002; Reid et al. 2020), but research often fails to specify which dyads are most likely to experience geographical contagion. We develop a theory of conflict "inbetweenness," arguing that dyads involving states located in between the disputant nations are more likely to be drawn into contests. We develop new measures on dyads involving third- and fourth-party relationships relative to ongoing conflict dyads, reflecting our concept of inbetweenness.

We estimate empirically the extent to which extra-dyadic alliance ties and dispute inbetweenness increase the risk of a dispute, over and above "internal" dyadic characteristics. The findings are consistent with our arguments about how dyads are tied together and how ongoing conflict in one dyad increases the risk of outbreaks in other linked dyads. Our approach leverages how dyadic dependence can be considered as a form of spatial dependence. It is well-known that treating serially correlated observations as independent will exaggerate the apparent sample size and induce a downward bias in standard error estimates, suggesting excessive confidence. Less well-known, or often ignored, is how *spatial* dependence between observations yields similarly troubling consequences. Most research to date on spatial dependence in international relations focuses on applications with states as the unit of analysis or relies on ad-hoc approaches to the problem of dependence in dyadic analyses or technical remedies to ensure "consistent" estimates (see, e.g., Mansfield and Bronson 1997; Heagerty, Ward, and Gleditsch 2002; Beck, Gleditsch, and Beardsley 2006; Cranmer and Desmarais 2016).[1]

Technical solutions to spatial dependence may be helpful for many purposes, but modeling processes generating dependence offers several advantages. For example, "robust" standard error estimates may give more realistic indicators of uncertainty, but "white-washing" standard errors is by itself a black-box procedure, not revealing the sources of unequal variances (see, e.g., Leamer 1994; King and Roberts 2015). More can often be learned by trying to model explicitly what gives rise to variation (Braumoeller 2006). We argue that we can understand dyadic interaction better if we try to identify specific extra-dyadic ties, rather than treating dependence merely as a statistical problem or nuisance.

The next section discusses the general problem of dyadic dependence, with specific implications for international conflict. We advocate modeling possible linkages between dyadic observations through pre-specified networks or connectivities. We identify extra-dyadic links through alliances and geographic proximity and estimate the impact of such ties on the likelihood of dyadic conflict onset. In the conclusion, we offer some thoughts on how similar applications to other types of ties can inform conflict research.

## Dyadic Dependence

As the smallest unit capable of capturing social interaction, research on interstate conflict frequently examines dyadic attributes such as interdependence, relative power, and distance to explain crises and war. Some have gone as far as to claim that any theory of international relations must be based on, or evolve from, dyadic explanations (see, e.g., Bueno de Mesquita 1989). Yet, the very appeal of the dyad for strategic theory implies a problem in empirical analyses comparing exclusively dyadic attributes. Many statistical frameworks assume independent observations (or equivalently, that the errors for individual units in a model are independent). Dyadic observations have a complicated dependence structure, since one state enters into a large number of dyads with other states in the international system. More precisely, for $N$ states, we will have $N(N-1)$ directed dyads.[2] At the extreme, flows or actions in a directed dyad $A \rightarrow B$ are likely to be closely related to the "reverse" directed dyad $B \rightarrow A$. For example, Beck, Gleditsch, and Beardsley (2006) show how the volume of trade from $A$ to $B$ is generally very similar to the flow from $B$ to $A$ and also positively correlated with other trade flows involving either $A$ or $B$.

In models of random networks—first studied by Rapoport (1957)—the likelihood of a link between $A$ and $B$ does not depend on whether there is a link from $B$ to $A$. However, real-world networks tend to be either highly reciprocal or directed (see Garlaschelli and Loffredo 2004); in a reciprocal network, a link from $A$ to $B$ is associated with a link from $B$ to $A$ (as in the case of trade). In directed networks, links run only in one direction, as for example citations, where articles normally cite earlier publications but only rarely forthcoming work, or to a less extreme extent migration, where

[1] Cranmer and Desmarais (2016) recommend focusing on the overall network structure and relations between units within networks rather than dyads. Network approaches effectively characterize higher-order dependence in international relations (see, e.g., Hoff and Ward 2004; Hafner-Burton, Kahler, and Montgomery 2009; Cranmer and Desmarais 2011). One could also create explicit multilateral units of analysis (i.e., k-ads; see Poast 2010). However, the extent to which models are helpful depends on the research question and motivation; a model may fit the observed data well, but not yield estimates with a clear substantive interpretation for the question at hand. Diehl and Wright (2016) and Poast (2016) emphasize how dyadic analysis is appropriate for many research questions and theories. We focus on developing measures of specific forms of dependence in dyadic conflict, with a clear substantive interpretation.

[2] If we do not distinguish the direction of behavior (i.e., $A \rightarrow B$ versus $B \rightarrow A$) then we have $[N(N-1)]/2$ "undirected" dyads (i.e., $A \leftrightarrow B$).

large outflows from a country with lower wages to a high wage country are rarely matched by comparable flows in the other direction.

Existing studies offer compelling evidence for dyadic dependence in conflict and its potentially troubling effects. Heagerty, Ward, and Gleditsch (2002) simulate dependent dyadic data and show that "naïve" standard errors assuming independence are too small while window subsampled standard error estimates provide more realistic estimates of the true variance. Beck, Gleditsch, and Beardsley (2006) find that the estimated effect of political factors on trade changes notably depending on whether dyadic dependence is taken into account. The coefficient estimate for democracy in a European sample, for example, increases by about 25 percent in a model with a spatially lagged error structure compared to one assuming independent observations, while the impact of a militarized dispute decreases by over 30 percent.

The problem of dependence in conflict extends beyond the need to account for reverse-directed dyads. A bilateral war between *A* and *B* can give rise to additional dyadic disputes if a third party *C* retaliates against *A*'s aggression to defend *B*. Likewise, *C* may attack *A* anticipating an attack on *B*. In this case, outcomes in the dyad *AC* are clearly not independent of outcomes in the dyad *AB*; war between *A* and *B* affects the likelihood of war between *A* and *C*, and vice versa.

Many analyses offer important insights on decisions to intervene in a contest (e.g., Richardson 1960; Werner and Lemke 1997; Aydin 2008). However, dependence extends beyond intervention in something considered the "same" dispute, an issue that also depends on the specific criteria used to delineate if events are part of "the same" or "different" conflicts. The Militarized Interstate Dispute (MID) data, for example, code many events as belonging to a single dispute number (e.g., World War II, the Mexican American War), while others are treated as separate bilateral disputes, with distinct MID numbers (e.g., Iranian threats to impose a blockade of the Strait of Hormuz in the 1980s). The MID project relies on complex criteria to determine whether an event is part of one dispute or implies a new dispute, including whether incidents involve the "same" incompatibility, are connected in time, display evidence of coordination between parties, whether a previous incident is followed by a formal settlement, and whether the casualties exceed the threshold for a war, in which case individual events are not distinguished.[3] In sum, coding decisions may not correspond to what participants or scholars consider linked or separate disputes, and activity in one conflict dyad can affect behavior and the risk of conflict in other dyads. We can state the dyadic dependence problem as whether the expected values of a particular dyadic flow differ depending on the values of other "connected" dyads. We propose a simple way to convert this problem into a theoretical and empirical opportunity, identifying specific sources of dyadic dependence as determinants of conflict. First, however, we discuss some existing alternative approaches to dyadic dependence.

[3] See Jones, Bremer, and Singer (1996, 174–77) for details. Whether the MID criteria are appropriate depends on one's research question. Fordham and Sarver (2001) note how the MID data can be problematic for many purposes and discuss some possible systematic biases. Applying the criteria will involve some subjective judgment. MIDs prior to 1993 are particularly difficult to reconstruct, given limited documentation. There may also be various nonrandom errors in the application of the MID criteria if more or less information is available for particular events.

## Approaches to Addressing Dyadic Dependence

A common approach to dyadic dependence in the conflict literature is to ignore it altogether. The literature on spatial dependence suggests a number of ways to model such dependence (for overviews, see Schaenberger and Gotway 2005; LeSage and Pace 2008; Ward and Gleditsch 2018). Spatial approaches have contributed much to our understanding about international politics (examples include Franzese and Hays 2007; Plümper and Neumayer 2010; Barthel and Neumayer 2012; Solingen 2012), but applications to conflict have primarily examined dependence between states, not dyads. While spill-ins from neighbors or external influences from connected states are intuitive, identifying spatial dyadic dependence is more complex, as dyadic interactions may not have an obvious physical "location." We discuss our approach to dyadic dependence in conflict data in the next section, after reviewing technical solutions.

Spatial dependence can be treated as a "nuisance." Heagerty, Ward, and Gleditsch (2002) propose a window sub-sampling empirical variance (WESV) estimator that provides consistent standard errors in the presence of spatial dependence, using windows that capture within-cluster correlations and the remaining between-cluster correlations can be disregarded.[4] The advantage of this approach is that it does not require correct model specification—analysts do not need to know what and how dyads may be dependent on one another to generate valid standard error estimates. However, this also implies a major disadvantage, as correcting standard errors does not tell us anything about the processes generating dyadic dependence.

Many studies try to address potential dependence through fixed effects or dummy variables (Green, Kim, and Loon 2001). Mansfield and Bronson (1997), for example, use separate dummy variables for each member of a dyad. However, analysts rarely try to interpret the resulting country or dyad-specific terms, and allowing for intercept differences or slope heterogeneity for dyad members is unlikely to adequately reflect dyadic dependence. Many fixed effects approaches discard all dyads without variation in the response, and the assumption that we cannot learn anything from cases without conflict is extremely restrictive (for an extended discussion, see Beck and Katz 2001; King 2001; Oneal and Russett 2001).

Hoff and Ward (2004) develop a random effects model, decomposing dependence in international interactions into sender and receiver effects. Higher-order dependence, measured as the inner product of vectors representing the placement of each unit in a latent space, reflects unobserved characteristics (see also Hoff, Raftery, and Handcock 2002; Ward and Hoff 2007). Although such models can capture dependence well, the placement of countries on the underlying latent dimensions often lacks a clear substantive interpretation, and such models are rarely applied to test explicit hypotheses. This also applies to data-driven network models more generally.

In sum, technical solutions to dyadic spatial dependence may be helpful for many purposes, but often primarily seek to address the consequences rather than explicate the

[4] The core idea is based on subsampling, defining windows far enough "apart" to be nearly independent, and then approximate an estimate of the variance of sample statistics by averaging over windows or subsamples. This will remain valid even if the model is incorrectly specified or fails to reflect dependence between observations.

sources of dependence as theoretically interesting relationships.

## Using Spatial Networks to Specify Dyadic Dependence

Spatial statistical approaches can be used to model processes that give rise to dyadic dependence. The expected relationships between observations can be specified by a graph or connectivity matrix **W**. This in turn allows assessing if the outcome for a given observation $y_i$ (in this case, a dyad) varies depending on the value of other observations $y_j$ "connected" or dependent on $y_i$. In a regression framework, we can include a right-hand-side covariate $\mathbf{W}y$ and estimate the immediate impact of the value of the response in connected observations on $y_i$.[5]

While states are plausibly linked through attributes such as distance, alliances, or shared cultural ties, specifying connectivity at the dyadic level is more complex. Pairing states creates a large number of dyads, of which perhaps only a few are likely to have notable interactions. Dyadic data are "explosive," as the number of possible interactions $N(N-1)$ increases extremely rapidly with the number of observations $N$. For example, for a world of 180 states, we have 32,220 distinct dyads.

Assuming that everything depends on everything else, so that $N(N-1)-1$ other dyads are equally important to what happens in a dyad *AB*—for example, a dispute anywhere in the system increases the probability of war for all dyads—may be as unhelpful as assuming complete independence. Even if everything ultimately may be related to everything else, some things are bound to be more related than others.

Beck, Gleditsch, and Beardsley (2006) identify dependent dyads with a common member, that is, either *A* or *B*. Even this refinement leads to a considerable number of connected dyads, with dense graphs or adjacency matrices. There will be $4(N-2)+1$ other dyads involving either *A* or *B*. For $N=180$, this means that each dyad will be connected to 713 other common member dyads. An adjacency matrix with 713 entries for each row corresponding to one of the 32,220 distinct directed dyads would have almost 23 million nonzero entries.

Although not couched in these terms, insights from international relations theory can help identify likely sources of dyadic dependence in conflict and reduce the number of plausibly linked dyads to a much smaller set. In our approach, the risk of conflict in a dyad *CD* is dependent on the presence of conflict in a dyad *AB*, if there is some type of tie between the members of dyad 1 (*A, B*) and the members of dyad 2 (*C, D*). In the next two sections, we consider two linkages prominent in research conflict, namely military alliances and ties between dyads based on geographical distance and location.

### Alliance Dispute Connectivity

When two states experience a dispute, how does this affect the likelihood of disputes in other dyads? Alliances are military obligations intended to shape the tendency of states to participate in the disputes or wars of other nations. There is a clear conceptual expectation of spatial dependence; alliances are *designed* to spread conflict across dyadic boundaries. Alliance theory predicts this unambiguously. Of course, the goal is most typically deterrence, preventing disputes from occurring in the first place by increasing the cost of conflict or decreasing the chances of success for a perceived antagonist (Leeds 2011; Kenwick, Vasquez, and Powers 2015). However, efforts to deter conflict may fail and spur reactions from other states, in ways that create dependence between behaviors across dyads. Others have used portfolios of alliance ties to reflect the degree of preference similarity between states (see, e.g., Bueno de Mesquita 1981).

There has, of course, been considerable attention to alliances as predictors of the spread of disputes (Leeds 2005; Vasquez and Rundlett 2016), but empirical analyses have generally treated alliances as a source of conflict diffusion among states rather than at the dyadic level (see, e.g., Siverson and Starr 1991).[6] We normally want to know not just that the United Kingdom was at war, but also who is the opponent (e.g., Argentina or Ireland). Likewise, analyses should help distinguish which of the many other dyads containing a particular state are more likely to be involved in conflict following a dispute in a particular dyad.

Outside studies of intervention, empirical studies of conflict have focused much more on bilateral alliances *within a dyad* as a factor discouraging disputes than the role of alliance ties in triggering conflict *outside the dyad*. Joint membership in alliances (e.g., NATO) could be correlated with other features such as democracy, and thus gives rise to spurious findings about potential pacifying impacts (see, e.g., Farber and Gowa 1995), but whether military alliances promote peace among their members (or not) is at best a peripheral implication of theories of alliance formation.[7] Moreover, formal alliances are problematic as measures of common positions, since formalized commitments often reflect a mix of common and divergent preferences (e.g., Morrow 1991; Gartzke and Gleditsch 2004; Chiba, Johnson, and Leeds 2015).

Theories of alliance behavior stress how promises of military assistance can bolster security against external aggression by tying together the conflict behavior of two or more states. This, in turn, clearly implies that disputes involving a state with an alliance are more likely to draw in that country's allies. Perhaps more than any other implication of alliance theory, mainstream theories are specifically making arguments about extra-dyadic spatial dependence. Studies on how alliances may promote intervention in support of allies or lead to dispute expansion at the dyadic level tend to consider only interventions in disputes with the same MID dispute code (see Gartzke and Gleditsch 2004; Leeds 2005), and not the potential effects of indirect or higher-order alliance ties. Following the core prediction of alliance theory, we surmise that disputes are more likely in dyads connected to active disputants or their allies. Our conjecture will be supported if we find evidence that extra-dyadic alliance ties influence disputes, even after we take into account conventional dyadic covariates.

We create new measures to identify two forms of alliance connectivity beyond a disputing dyad. We call the first type "third-party" ties, where dyads are linked through alliances to the disputants. This encompasses all dyads pairing *A* and the allies of *B* as well as dyads pairing *B* and all allies of *A*. The second set of relationships involves "fourth-party" ties,

[5] The spatial statistical literature often refers to $\mathbf{W}y$ as the "spatial lag" of $y$. This terminology can be unfortunate, since different matrices give raise to different "spatial lags" and **W** need not be based on spatial distance.

[6] Vasquez (2004) includes dummies for extra-dyadic alliance ties, but does not code identities.

[7] The empirical evidence for such effects is also mixed. Bueno de Mesquita (1981) even argues that the risk of conflict increases among allies, although this finding remains disputed (see Ray 1990). Bearce, Flanagan, and Floros (2006) claim that alliances only notably lower conflict internally when members' capabilities approach parity.

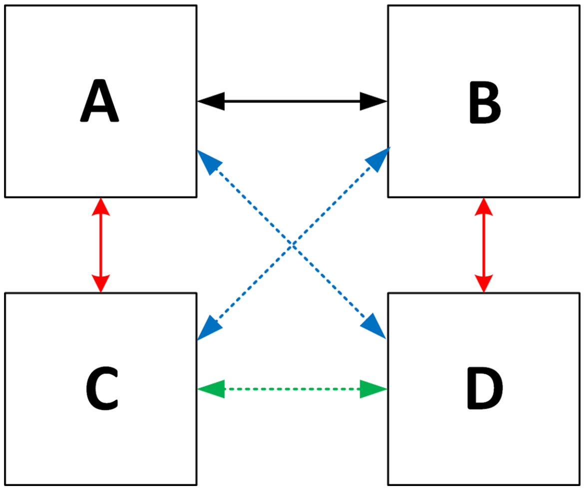


**Figure 1.** Alliance dispute connectivity example. For a dyad of initial disputants *AB* (black solid line), we have first-order alliance ties for dyads *AC* and *BD* (red solid lines). In turn, we have third-party alliance ties for the dyads *BC* and *AD* involving the disputants paired with the opponent's allies (blue dashed lines) and fourth-party ties for *CD* (green dashed line), linked through alliances to disputants, but not including any of the original disputants.

where neither state is one of the direct disputants, but linked through alliances to the disputing parties. This category encompasses all dyads pairing allies of *A* with states that are allies of *B* (but not *A* or *B*). Figure 1 illustrates alliance connectivity dyads for a hypothetical example.[8]

We present an actual example from the MID and Correlates of War (COW) alliance data to clarify the coding and relevance to dispute onsets. In the MID data, the Corfu Channel Incident is listed as a dispute between the United Kingdom and Albania from May 15, 1946 to November 13, 1946. Albania claimed that British ships trespassed their territorial waters and opened fire from coastal fortifications. Britain refused to accept the Albanian demands for prior notification and consent for passage. In October, two British vessels were struck by mines, and the United Kingdom swept the area for mines in November in defiance of Albania. The dispute led the United Kingdom to demand reparations and terminate diplomatic relations with Albania (not restored until 1991). According to the COW data, the United Kingdom was at the time allied with Portugal (alliance #47), Iraq (#100), Egypt (#123), the Soviet Union (#143), and Jordan (#152), while Albania was allied with Yugoslavia (#154). We, thus, have six third-party alliance dyads linked to the dispute between the United Kingdom and Albania, one pairing the United Kingdom with the only Albanian ally (i.e., UK–Yugoslavia), and five dyads pairing Albania with the United Kingdom's allies. There are also five fourth-party dyads that arise from the pairing of Albania's one ally and the five UK allies.

Following the Corfu Channel Incident, we see a MID between the United Kingdom and Yugoslavia in 1946. We submit that this is not an isolated event and that two disputes are meaningfully linked in that the first increased the risk of the second. Although the MID lists the Corfu Channel Incident appear as a single, bilateral MID, many historians tend to see this as an early event at the start of the Cold War (Gardiner 1966; Heuser 1989; Rajak 2010). Albania was very much under the Yugoslav wing in 1946. Yugoslavia played an important role in the Balkans after World War II and intervened in the Greek civil war when Stalin was reluctant to do so. Although the United Kingdom had supported Tito's partisans during World War II, relations quickly soured after the war. Albania officially denied placing mines, instead of blaming Greece and the United Kingdom itself, but it has been alleged that mining in the Corfu Channel was instigated by Yugoslavia (Gardiner 1966). From this perspective, the United Kingdom saw itself responding to the same threat in the two disputes (Heuser 1989). Yugoslavia also interpreted tensions with the West off the coast of Albania and the status of Trieste and its border with Italy in the Northwest as linked issues, and both were discussed when Tito visited Moscow in 1946 (Dimić 2011, 136).[9] The active and independent foreign policies of Yugoslavia and the tension this generated with the West and the United Kingdom in particular accelerated the breakdown of its relations with the Soviet Union, recorded as a MID in 1949. Finally, the contending claims and disagreements on what actually transpired and what was known at the time decisions were made further illustrate the inherent problems for efforts to hard code temporal sequences and dropping subsequent disputes, and the advantages of examining possible dependence empirically.

Third- and fourth-party alliance linkages are not deterministically related to conflict, but we conjecture that higher-order alliance ties significantly increase the risk of conflict and are an important source of dyadic dependence. This will be supported if we find a systematically higher likelihood of observing disputes in dyads with third- or fourth-party alliance ties to states experiencing disputes.

We now turn to examine the relationship between higher-order alliance ties and dyadic disputes. We rely on the dyadic dispute data developed by Maoz (2005), which explicitly reflects dyadic militarized activity. This is important since the standard MID data are themselves not dyadic, but rather list individual participants on side A and side B of a dispute. A simple pairing of multiple states on opposing sides in a dispute can create misleading conflict dyads that are not actually in direct confrontations. Dropping all subsequent participants to a dispute reduces World War II to a bilateral dispute between Germany and Poland and is clearly inappropriate for studying how extra-dyadic ties can give rise to additional dispute dyads.

A comparison of dyadic dispute onsets with higher-order alliance connectivity ties provides strong preliminary support for our conjecture. The odds of a dispute onset are about 3.14 times greater for dyads that are connected to an ongoing dispute through either third- or fourth-party alliance ties than for dyads without such ties. As one would expect given the logic of alliance ties and alliance tightness, the effect of third-party ties is larger, increasing the odds of a dispute by a factor of 8.25. However, fourth-party ties through alliances to disputants also substantially increase the odds of a dispute by a factor of 2.75.

This by itself may not be seen as compelling evidence of dyadic dependence, since observed higher dispute rates could reflect other bilateral attributes. For example, states with shared security concerns are more likely to enter into alliances, and if alliance ties are geographically clustered, we could find more disputes and alliances among

[8] This framework covers all possible direct alliance relationships. There exist additional indirect alliance relationships that may contribute to conflict. States not allied to *A* or *B*, but allied to the allies of either *A* or *B* could be affected by a contest between *A* and *B*. This is a promising area for future research, but we do not explore these ties here.

[9] See https://tinyurl.com/y2xw8jzl.

geographically proximate states. We consider plausible control variables later and show that our results remain consistent when accounting for the standard features considered in most dyadic studies. First, however, we consider a second factor likely to induce spatial dependence, namely geographic distance and position.

### Distance and Dispute Inbetweenness

Existing international relations research has devoted considerable attention to distance as a determinant of dyadic interaction (e.g., Boulding 1963; Buhaug and Gleditsch 2006). All else equal, the likelihood that two states will interact can be considered a declining function of the distance between them. However, distance should also matter for the degree of dependence on other dyads and other theoretical implications of proximity beyond the dyad may evade first impressions. Imagine a fight between two patrons of a crowded bar. It is possible that the fight might spread to others, but it also may not. Third parties may not need to intervene and may consider the contest remote for any number of reasons. One important way that other actors might be drawn into an existing dispute is if they cannot easily avoid it. Patrons that find themselves caught between two pugilists may find it particularly difficult to avoid being drawn into a scuffle. Innocent bystanders who are to one side or behind the initial combatants are unlikely to be struck by accident. They are also less likely to know one or both disputants. However, anyone standing close to opponents is more likely to be drawn into a fight. Nations engaged in conflict may project power to a third state, perhaps in order to reach and damage or control their primary adversary's territory. More than one country near or in between adversaries may also find that they have a stake in the dispute, caring which side wins because of the proximity of the two initial disputants. This logic parallels that for alliances, implying a strong role for third-party involvement in the conflict and a slightly weaker effect for fourth-party diffusion.

We focus on geographical distance in the context of a dispute between two parties *A* and *B*. We know from existing research that *A* or *B* are more likely to fight *each other* if the two states are geographically closer. However, among the many geographically close dyads, some are likely to be much more relevant than others in the context of an ongoing dispute between *A* and *B*. In particular, a third state *C* that finds itself "in between" disputants may be dragged into conflict with either *A* or *B* by virtue of its geographical position. Similarly, a fourth party, *D*, may be induced to fight with *C* if a contest between *A* and *B* produces new tensions in a region or creates an opportunity or incentives for *C* and *D* to act to settle existing scores.

Panel (a) in figure 2 illustrates third-party inbetweenness for a conflict between *A* and *B* with regard to dyads involving two other states *C* and *D*, that is, *AC*, *AD*, *BC*, and *BD*. A conflict between *AB* may signal trouble for *C*, as both *A* and *B* may attempt to make sure that *C* behaves in particular ways or remains compliant with their demands, or that the territory of *C* is not made available to or taken by the other party. By contrast, *D* is less likely to become relevant in the event of a conflict between *A* and *B* as it is less directly "in between" in interactions between *A* and *B*. Hence, we predict that *AC* and *BC* are more likely to fight in the event that *AB* experiences a dispute than *AD* and *BD*. Note how inbetweenness *is not* the same as the distance between two dyad members. In panel (a), the distance between *B* and *D* is less than the distance between *B* and *C*, yet conflict is more likely in *BC* given conflict in *AB* and *C*'s inbetweenness relative to *AB*.

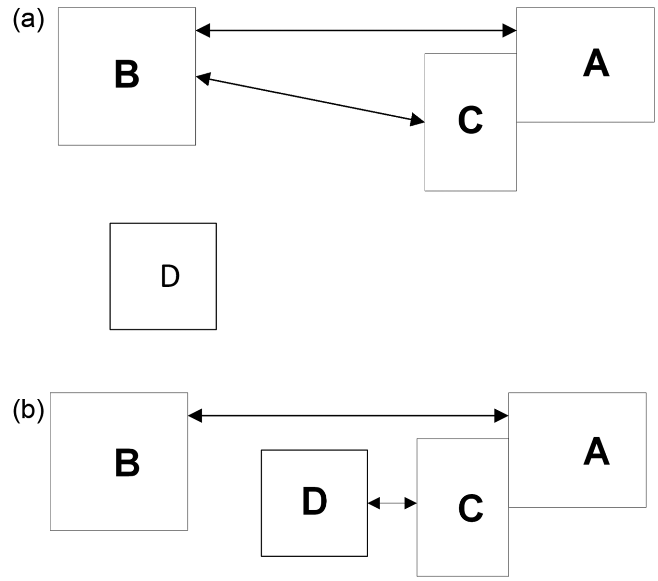


**Figure 2.** Dyadic inbetweenness examples. In Panel (a), *BC* has high inbetweenness given its position and *B*'s dispute with *A*, even if the distance *BC* exceeds that of *BD*. In Panel (b), the dyad *CD* has high inbetweenness scores for the individual members, since both are close to *AB*, and thus a high maximum for the dyad. Moreover, *C* and *D* are relatively close to one another.

Restricting inbetweenness strictly to the geographic interval between *A* and *B* is overly limiting and contrasts with our notion of fourth-party ties highlighted for alliances. In Panel (b) in figure 2, we show how the dyad *CD* is located in a close position relative to *AB*. We submit that this is likely to lead to a higher propensity for conflict compared to dyads geographical remote to *AB*. The intensity of this relationship will depend on the proximity of *C* and *D* to *AB* as well as the distance between *C* and *D*. While the effect may be less direct or intense for *CD* than for *AC* or *BC*, we nevertheless expect that fourth-party inbetweenness will heighten the likelihood of disputes, especially when *C* and *D* are close to a dyadic dispute.

Examples of third-party inbetweenness and its effects on warfare abound. Germany in 1940, for example, did not have territorial claims against the Netherlands per se, and the Netherlands remained neutral when Britain and France declared war on Germany in 1939. However, Germany chose to invade the Netherlands on May 10, 1940, given its strategic importance. Sandwiched between Germany/Prussia and Russia/Soviet Union, Poland has likewise throughout its history found itself under fire due to its strategic geographical position. German and Soviet/Russian claims on Polish territory are not independent objectives, but very much conditioned on the relations with the other larger country on the other side of Poland (e.g., Stent 1998). We posit similar implications for parties in ongoing disputes in dyadic relations with other states, either as a result of the issues in the dispute itself or as a result of conflict externalities.

As an example of fourth-party inbetweenness, consider the so-called Orzel incident between Poland and Estonia in September 1939 (see, e.g., Crowe 1993). Germany and the Soviet Union have been involved in a number of prior disputes, including a MID in 1938. Based on the above discussion, we should expect this to increase the risk of a militarized incident in an in-between dyad such as Poland and

Estonia. The Orzel incident provides an apt example. Estonia seized the Polish submarine Orzel in Tallinn, in apparent contravention of the Hague Convention of 1907 on neutral ports, plausibly due to German pressure to do so. The crew subsequently conspired to escape, overpowering the Estonian guards, and set off at night after sabotaging the portlights and evading fire from Estonian forces. The Soviet Union subsequently accused Estonia of facilitating the escape of the Polish submarine, challenging the neutrality of Estonia. The event was then used as a pretext to demand military bases on Estonian soil, threatening war if Estonia did not comply, ultimately leading to the Soviet annexation of Estonia (Smith et al. 2002). We submit that this Estonia–Poland dispute arises from inbetweenness to German tensions with the Soviet Union, first by driving the Polish submarine to Tallinn in the first place and the pressure on Estonian authorities to seize the vessel. The example also illustrates the many subjective judgments involved in determining whether an event is best considered part of a larger dispute versus separate incidents.

Our concept of dyadic dependence includes new conflicts that results over issues emerging out of the triggering disputes, as well as the impact of ongoing disputes in aggravating existing tension between other countries. A state may raise a diplomatic protest over the fallout of conflicts such as stray bombings or refugee flows induced by conflict or perceived insecurity, or ongoing conflict may allow other states to seize on a window of opportunity to settle other scores with a rival. We have evidence consistent with dyadic dependence if conflict in *AB* increases the risk of conflict in other dyads. We assess the risk of additional dyadic disputes in *AC/BC* and *CD* following a dispute in *AB* and the degree to which *C* or *D* is geographically in between the disputants.

International relations research has devoted a great deal of attention to strategic aspects of the geographical position such as the notion of buffer states and shatter-belt location (see, e.g., Mackinder 1904; Fazal 2004). However, most empirical studies either explore the frequency of conflict by region (Lemke 2002; Bennett and Stam 2003) or examine the likelihood of conflict in particular states, given specific characteristics of their geographical position (e.g., Hensel and Diehl 1994; Tir 2003). As such, measures reflecting fundamental concepts of political geography have yet to be incorporated into dyadic studies of conflict.

We measure the inbetweenness of dyads based on the members' geographical position relative to a dispute dyad. More specifically, we look at the inbetweenness of third state *C* relative to *AB* by looking at the relationship between the three dyadic distances in a triad *ABC*—that is, *Distance*(*AC*), *Distance*(*BC*), and *Distance*(*AB*). If a state *C* is on, or close to, the shortest path from the capital of *A* to the capital of *B* in a dispute dyad, then the ratio of *Distance*(*AB*) relative to (*Distance[AC]* + *Distance[BC]*) should be close to 1.[10] States that constitute big "detours" from the shortest path *Distance*(*AB*) have values closer to 0. We scale these country values to the dyadic level by considering the maximum inbetweenness score to any ongoing dispute in that year. The inbetweenness score will be 0 if no disputes occur in the system in a given year. The dyadic inbetweenness ratio is also set to a value of 0 for the main disputants *AB*, which helps ensure that we do not simply pick up a high inbetweenness ratio for the original dispute. We use the coordinates of the capital cities as the reference points for each of the three states. Distances between capital cities data are commonly used in existing studies of international conflict. Although they have some limitations (see, e.g., Gleditsch and Ward 2001), they provide for measures of distance between locations with some meaningful mass or core. By contrast, measures of outer borders may reflect points in the periphery that may have no or low population or are largely inaccessible.

In the case of fourth-party inbetweenness, we use a measure of proximity to ongoing disputes based on the highest inbetweenness scores for the two states in a dyad to any ongoing dispute, not including the disputants themselves (i.e., dyads CD not involving A or B, in figure 2). Given the important role of distance in opportunities for conflict, we primarily expect a high risk of conflict for dyads *CD* with a high proximity to an ongoing dispute defined in this way that themselves are also close. We thus interact the maximum *CD* inbetweenness ratio with the logged distance between *C* and *D*. We expect that *CD* dyads with a high inbetweenness to an *AB* dispute and low dyadic geographical distance should be more likely to experience conflict, over and beyond dyadic attributes and geographic distances.

Turning to the data, we find that a higher third-party inbetweenness score dramatically increases the risk of a contest. The difference between an inbetweenness ratio of 0 and an inbetweenness ratio of 1 is associated with a difference in the odds of a dispute by a factor of almost 27.[11] For fourth-party ties, we expect the impact to differ with distance. The odds of a dispute increase by a factor of 14.3 for a dyad with contiguous capitals with a maximum inbetweenness ratio of 1, compared to one at 0. We show below that the apparent positive impact effect of extra-dyadic ties arising from inbetweenness is not merely an artifact of failing to control for other bilateral characteristics that are associated with conflict.

We now demonstrate the importance of our two measures of extra-dyadic ties more systematically by evaluating the relative impact of extra-dyadic ties in a standard model of dyadic conflict, based on Oneal and Russett (1999). This is an appropriate baseline, since it includes the full population of dyad years for the period 1950–1992. Common sample delimitations such as "politically relevant" dyads that are either contiguous or involve a major power would be inappropriate for assessing dyadic interdependence.

Oneal and Russett include a series of right-hand side dyadic covariates that may influence the risk of a dispute, such as joint democracy, lower and higher dependence scores (i.e., trade over GDP), whether states are contiguous, distance between their capitals, formal alliances, the capability ratio of the larger to the smaller state, whether a dyad includes a major power, as well as the Beck, Katz, and Tucker's (1998) non-parametric approach for temporal dependence based on the number of consecutive years of peace. We refer readers to Oneal and Russett (1999) for information on data and variable construction as well as the theoretical rationale for the model. The dependent variable is conflict onset and we drop subsequent years of a dispute.

In the results below, we lag the extra-dyadic ties measures by one year, in line with other right-hand side variables in the Oneal and Russett study. Using time-lagged ties provides

[10] The triangle inequality measure is positive and bounded by 1 for point data such as capital cities. For other distance data based on larger units such as minimum distances between countries, the triangle inequality will not necessarily hold (the ratio could be much more than 1), but the approach can be used with a similar interpretation as long at least one nonzero distance appears in the denominator.

[11] Most dyads are remote and have low inbetweenness scores far below 1, but even a value of 0.67 (the 95th percentile) implies an increase in odds by a factor over 9.

**Table 1.** Oneal and Russett model of dispute onset

| *Variable* | $\beta$ | *Naïve SE* | *WSEV.1 SE* | $\beta$*/WSEV.1 SE* |
|---|---|---|---|---|
| Intercept | 0.517 | 0.29 | 0.439 | 1.508 |
| Joint democracy | −0.003 | 0 | 0.001 | 1.871 |
| Lower of dependence ratios | −51.855 | 14.817 | 30.286 | 2.039 |
| Higher of dependence ratios | 1.52 | 1.377 | 2.276 | 1.649 |
| Contiguous | 2.46 | 0.094 | 0.142 | 1.512 |
| Intercapital distance, logged | −0.592 | 0.036 | 0.062 | 1.732 |
| Major power in dyad | 1.912 | 0.091 | 0.336 | 3.667 |
| *A* and *B* allied | −0.532 | 0.082 | 0.205 | 2.492 |
| Capability ratio, logged | −0.231 | 0.027 | 0.056 | 2.058 |
| $N = 271{,}262$ | | | | |
| Log likelihood = −4478.81 | | | | |
| LR $\chi^2 = 5112.4$ | | | | |
| $\text{BIC}^{\prime} = -4949.76$ | | | | |

*Note*: Coefficients for the peace years terms are omitted from the table.

**Table 2.** Model with extra-dyadic ties

| *Variable* | $\beta$ | *WSEV.1 SE* | $\beta$*/WSEV.1 SE* | $\Delta\beta$ *(%)* |
|---|---|---|---|---|
| Intercept | −1.458 | 0.416 | −3.502 | −382.197 |
| Joint democracy | −0.002 | 0.001 | −3.955 | −24.475 |
| Lower of dependence ratios | −43.499 | 23.827 | −1.826 | −16.113 |
| Higher of dependence ratios | 0.831 | 2.417 | 0.344 | −45.349 |
| Contiguous | 2.232 | 0.116 | 19.25 | −9.234 |
| Intercapital distance, logged | −0.361 | 0.057 | −6.326 | −39.026 |
| Major power in dyad | 1.057 | 0.24 | 4.403 | −44.684 |
| *A* and *B* allied | −0.715 | 0.229 | −3.122 | 34.316 |
| Capability ratio, logged | −0.209 | 0.059 | −3.557 | −9.43 |
| Third-order alliance tie | 0.789 | 0.189 | 4.181 | NA |
| Forth-order alliance tie | 0.444 | 0.174 | 2.558 | NA |
| MID inbetweenness ratio | 1.072 | 0.184 | 5.835 | NA |
| Max(A,B IBR) | 2.977 | 0.487 | 6.108 | NA |
| Max(A,B IBR) × ICD, logged | −0.453 | 0.087 | −5.179 | NA |
| $N = 271{,}262$ | | | | |
| Log likelihood = −4263.45 | | | | |
| LR $\chi^2 = 5543.14$ | | | | |
| $\text{BIC}^{\prime} = -5317.94$ | | | | |
| $\Delta\text{BIC}^{\prime} = 368.18$ | | | | |

*Note*: Coefficients for the peace years terms are omitted from the table.

a more conservative approach and ensures that we do not consider any onset in linked dyads that occurs prior to the dispute onsets that we code as activating third-party links, although we may miss simultaneous disputes that occur later in the same year as the original onset in a linked dyad. We show in the online supplementary appendix that using contemporaneous measures of extra-dyadic ties returns similar results, with larger coefficients for extra-dyadic ties. Time-lagged extra-dyadic links also help to avoid problems with estimation in the presence of simultaneity (see Beck, Gleditsch, and Beardsley 2006).

We first estimate the standard Oneal and Russett model. The results are shown in table 1 and serve as a baseline model for assessing the contribution of our extra-dyadic variables on conflict onset. These estimated coefficients are identical to those reported by Oneal and Russett. The second column of table 1 reports the standard, or "naïve," standard errors, assuming that all the dyadic observations are independent of one another. In the third column, we report window subsampled standard error estimates, with a correction for the intercept (WSEV one-step, hereafter WSEV.1), using a window size of 6.[12] As in Heagerty, Ward, and Gleditsch (2002), the WSEV.1 estimates are considerably larger than the naïve standard errors. The fourth column gives the ratio of the WSEV.1 SE to the naïve SE, and the WSEV.1 SEs are on average about 2.1 times larger. Differences in the standard errors suggest dependence between observations; the risk of war is not exclusively captured by attributes within dyads, but also involves relationships with other dyads. However, this does not itself tell us much about how this dependency originates or what kind of linkages affect the risk of war.

In Model 2 in table 2, we add to the baseline model our new measures of third- and fourth-party alliance ties and third- and fourth-party dispute inbetweenness. Since we estimate a model positing dependence as the risk of onset is conditional on the response in other related dyads, we report only the WSEV.1 standard error estimates and

[12]The WSEV estimator tends toward a negative bias for the intercept due to truncation from the window size and substitution. The one-step estimator provides a correction for the downward bias, based on re-estimating without the particular subsample (Heagerty, Ward, and Gleditsch 2002).

not SE estimates assuming independence. Column three of table 2 reports the ratio of the estimated coefficients to their WSEV.1 standard error estimates. Column four indicates the percentage change of the estimated coefficients in Model 2 relative to the coefficients in Model 1, that is, $[(\beta_{m2} - \beta_{m1})/\beta_{m1}] \times 100$.

As can be seen from the coefficient estimates in the first column of table 2, the third-party and fourth-party alliance ties all have a positive impact on the risks of a dispute onset. Likewise, the MID inbetweenness ratio is also positive, in line with our expectations. Finally, for the term for maximum inbetweenness in a dyad not including the original disputants—that is, Max(1,2 IBR)—we also find a positive coefficient, but the interactive term with intercapital distance is negative, indicating that the impact declines with further distances separating states 1 and 2. The net effect remains positive until the intercapital distance exceeds about 1,300 km. These results are consistent with our expectation that extra-dyadic alliance and proximity ties to ongoing disputes can increase the risk of conflict onset in a dyad, over and beyond purely dyadic characteristics of member states. Since our results here rely on time-lagged measures of extra-dyadic ties (as the other covariates in the Oneal and Russett data), all triggering disputes will start before any dispute onset in a linked dyad, and thus cannot simply reflect reverse ordering.

Moreover, the size of the extra-dyadic coefficients implies a substantial increase in the risk of disputes. The added risk of dispute from a third-party alliance link is greater than the decrease associated with a bilateral alliance. The estimated impact of a state having both third- and fourth-party alliance ties to a dyad in a dispute (over half of the dyads with third-party alliance ties also have fourth-party ties) actually exceeds the estimated impact of the dyad including a major power. These results provide strong support for our claim that extra-dyadic alliance ties matter in understanding the dyadic risk of violent conflict. The pacifying effect of bilateral alliances among members is at best a secondary motive relative to the ability of alliances to deter aggression and ensure support in the event of a conflict. Our results reveal that alliances are important not so much for creating peace among friends as pitting friends against enemies, including enemies of friends. Our approach provides a simple way to capture the flow of militarized conflict across dyadic boundaries, via third- and fourth-party alliance ties, in line with insights in alliance theory.[13]

Just as alliances serve to connect dyads and help us identify where we are more likely to see the diffusion of disputes, the likelihood of additional conflicts is also influenced by the geographical position of a dyad. Whereas previous work has considered only the distance between members of a dyad, our results also suggest that the geographical position of a dyad relative to an ongoing dispute can have a substantial effect on the likelihood of disputes. We break down inbetweenness into two components, namely third-party ties pairing each of the original disputants *A* or *B* with other states *C* or *D* that are close to the shortest line between *A* and *B*. The coefficient estimate indicates that values approaching a ratio of 1 will have an increase in risk comparable to dyads with a major power. Our second component pertains to fourth-party inbetweenness or cases of dyads *CD* not involving parties to an original dispute *AB*, but where either *C* or *D* has a high inbetweenness value to an ongoing dispute, and *C* and *D* are geographically close. Overall, our results support our conjecture that geographical inbetweenness is a meaningful influence on risk of war and important links between dyads. Dyads involving third parties that are more "inbetween" relative to the members of an ongoing dispute dyad are much more likely to experience conflict onset than dyads that are in a more peripheral position. This is the case even for dyads *CD* without a common member in the original dispute dyad, although larger distances between dyad members mitigate the risk of conflict from inbetweenness to the states in a disputing dyad.

Turning to column 4, the change in the effect on the log-odds of an event can be seen as an approximate measure of how sensitive our inferences are to including higher-order alliance ties, even if the net predicted risk of conflict will depend on the baseline and values of other covariates in a nonlinear model. Beyond the substantive importance of extra-dyadic linkages in their own right, it is clear from column 4 that many estimated coefficients change notably when we expand a purely dyadic model to include extra-dyadic ties. In this case, for example, we find that the size of the coefficient estimate for major powers is attenuated by almost 45 percent when we add extra-dyadic ties, whereas the negative coefficient estimate for dyadic alliances increases by almost 35 percent. One way to interpret the resulting change in the estimated impact of major power status is that the variable really represents international involvement. Major power status is sometimes interpreted as states that are particularly likely to resort to force, but the definitions tend to be highly atheoretical and typically tell us nothing about why major powers are more likely to become involved in conflict. Major powers tend to have more military alliances and hence enter into more dyads linked by alliances. Our results suggest that these alliances, in turn, entangle major powers in a greater number of conflicts, as higher-order alliance ties lead to a greater likelihood of contagious conflict. Similarly, states with high capabilities are better able to exercise war-fighting strategies involving strategic territory.

Even though coefficients do not shift signs across specifications here, the size and standard errors change when we include extra-dyadic ties. In table 2, the standard error estimate for the lower dependence ratio, for example, is lower in the model with the extra-dyadic ties, making the ratio of the coefficient to its standard error higher in the model with extra-dyadic ties (−1.83) than in the purely dyadic model (−1.71).

Standard significance tests and measures of model evaluation such as the difference in the $LR - \chi 2$ suggest that adding third- and fourth-party alliance ties as well as our inbetweenness score makes a significant contribution to the model. However, dyadic models of conflict onset with annual observations have a very large apparent *N* and degrees of freedom. Some argue that standard significant tests are inappropriate in very large samples, since even minor differences are likely to be statistically significant from 0, even if the substantive differences implied by the estimated coefficients are trivial (e.g., McCloskey and Ziliak 1996).

The Bayes factor, or the ratio of the posterior odds for one model against another, provides one way to evaluate whether extra-dyadic ties contribute notably to our knowledge about the outbreak of disputes. Let $M_1$ denote the baseline dispute model derived from Oneal and Russett with purely dyadic attributes and let $M_2$ denote the model with extra-dyadic ties. Raftery (1995, 134) proposes approximating the Bayes factor for some model $M_k$ through

[13] Our results here use all alliances in the COW data. We show in the supplementary appendix that we find similar results for estimates relying only on defense pacts.

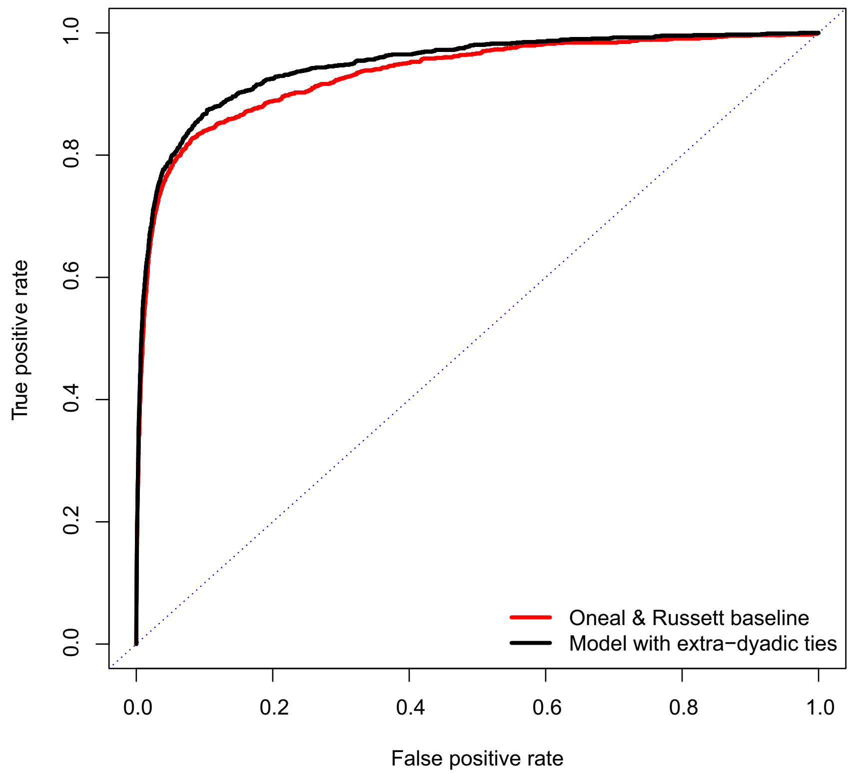


**Figure 3.** Receiver-Operating-Characteristic (ROC) plot, comparing the predictions of the full Model 2 with the baseline Oneal and Russett Model 1.

a Bayesian Information Criterion ($BIC'$), defined as:

$$BIC'_k = -\chi^2_{k0} + p_k \ln(n),$$

where $\chi^2_{k0}$ is the likelihood ratio test statistic for $M_k$ against the null model, $M_0$, $p_k$ is the number of degrees of freedom, and $n$ is the number of observations. Unlike standard significance tests, $BIC'$ "penalizes" models that consume more degrees of freedom and large samples. A negative $BIC'$ provides evidence for model $M_k$ over the null. $M_2$, the expanded model in table 2 with extra-dyadic ties, must fit at least as well as the baseline model $M_1$, since the exclusively dyadic model $M_1$ is a subset of $M_2$. However, whether we should prefer $M_2$ over the more parsimonious $M_1$ hinges on whether the fit is "sufficiently" improved to warrant the loss of four additional degrees of freedom. The Bayes factor approximation for one model $M_A$ over another model $M_B$ is simply the difference between $BIC'_A$ and $BIC'_B$. In this case, we have $BIC'_{M1}$= −4,962.27 (see table 1) for the baseline model $M_1$ and e $BIC'_{M2} = -5{,}317.94$ for the model with alliance ties and dispute inbetweenness. Since both $BIC'$s are negative, they do notably better than the null model. However, as $BIC'_{M2}$ is smaller yet than $BIC'_{M1}$, model $M_2$ with transnational factors has stronger support from the data than the purely dyadic model $M_1$. The Bayes factor approximation given by the difference between $BIC'_{M2}$ and $BIC'_{M1}$ is 368.18, far above the threshold of 10 that Raftery (1995, 139) characterizes as "very strong" evidence in favor of one model over another. Hence, we conclude that the model with extra-dyadic ties provides additional information on the distribution of conflict and an increase in the fit that is not trivial relative to the additional degrees of freedom consumed.

Another way to evaluate the differences in overall model performance is to look at the model's ability to correctly assign higher probabilities of conflict to those dyad years that actually experience conflict without generating too many cases of high probabilities of conflict among dyadic observations where we do not see disputes. We first consider whether the models can classify a dispute as more likely than peace in a given year given the observed covariates, that is, $Pr(y_{i,t} = 1 | x_{i,t} \geq 0.5)$. We find that the model with extra-dyadic ties correctly identifies 88 cases out of a total of 1,078 disputes at this threshold, while the purely dyadic Oneal and Russett baseline model only calls 57 disputes correctly. But a single year is a relatively short time interval, and a probability less than 0.5 can still imply a high probability of an event over a longer interval (see, e.g., Esty et al. 1998; King and Zeng 2001).

For example, an event with a probability in one year of 0.3 is less likely than not to occur in one year, but more likely than not over a two-year interval (since $(1 - 0.3)^2 = 0.49$). The optimal prediction threshold depends on the relative cost of missing a conflict that occurs relative to incorrectly predicting conflicts that do not occur. A Receiver-Operating-Characteristic (ROC) plot is helpful to compare how well models can classify conflict outcomes and non-conflict outcomes based on the predicted $Pr(y_{i,t} = 1) \geq C$ for a range of thresholds C. The vertical axis indicates the share of 1s correctly identified, while the horizontal axis provides the share of incorrect 1s predicted by the model. Each point on the ROC curve thus indicates the share of correct and incorrect 1s for a particular prediction threshold criteria C. Figure 3 compares the predictions from the baseline model (red line) to the full model with the extra-dyadic ties (black line). The higher the ROC curve is above the 45-degree line, the better the model fit. The ROC line for the model with extra-dyadic ties (Model 2) is always above the ROC line for the baseline Model 1. Hence, Model 2 does notably better than Model 1, irrespective of the prediction threshold.

Clearly, introducing extra-dyadic ties helps account for which dyads seem more likely to experience disputes. It is also instructive to consider which dyads are flagged as more likely to see conflict. Consider, for example, Iraq around the first Gulf War. After the invasion of Kuwait, Iraq becomes involved in a large number of disputes with neighboring countries such as Bahrain, Saudi Arabia, Qatar, and Turkey. In the baseline model with only bilateral ties, the predicted conflict risks in dyads pairing Iraq with other states do not change following the invasion of Kuwait, while the model incorporating extra-dyadic ties assigns higher probabilities to these cases, reflecting likely candidates for conflict in the wake of the initial Iraq–Kuwait dispute, given the high inbetweenness scores. The analyses here suggest that extra-dyadic factors predict a notably higher risk of disputes, in line with the argument that disputes often result from features or processes in other dyads.

## Discussion and Conclusions

Whereas much of the early development of the field looked to individual states or the international system as a whole in seeking to explain world politics, attempts to capture bilateral interaction through dyads have increasingly become the dominant unit of analysis. The turn to the dyad as the modal unit of analysis has been extremely productive for research, helping to foster a wave of cumulative research that has generated many important findings. However, the concerns over strategic interaction that led researchers to consider dyads in the first place strongly suggest that looking exclusively at bilateral dyads is insufficient to understand the full implications of strategic interaction. Individual dyads are in practice unlikely to be independent of one another, and the outcomes in one dyad are often strongly linked by ties to other dyads. We have shown how extra-dyadic alliance ties and dispute inbetweenness condition the risk of war and prospects for peace within dyads. This dyadic dependence cannot be reduced to attributes of individual dyads, but it is possible to identify the sources of dependence directly and include these in dyadic analysis.

By thinking carefully about how dyads are linked in ways that disseminate conflict, we can develop specific hypotheses about various sources underlying the observed dependence between dyads. We believe that the approach detailed here can be informative for other types of extra-dyadic ties and for outcomes other than militarized disputes. It provides a stepping stone for looking at other sources of extra-dyadic interdependence in interstate conflict data, as well as linkages between conflict within states and conflict between states. Dyadic data allow us to specify and test hypotheses about a large and diverse range of dyadic linkages. For example, ties between states such as ethnic ties and majority–minority dynamics can help understand the relationship between domestic and interstate conflict. Contiguous dyads where one of the members experiences a civil war are more likely to experience interstate disputes (see Gleditsch, Salehyan, and Schultz 2008). Furthermore, an inspection of cases where the two forms of conflict coincide suggests that civil conflict either involves or generates contentious issues and externalities that often lead to tension between states. Outbreaks of civil conflict are more likely when ethnic groups cross state boundaries (e.g., Gleditsch 2007). There is considerable evidence that interstate conflict is more likely when ethnic minority groups are majorities in other states (see Davis and Moore 1997; Gartzke and Gleditsch 2006). Refugee flows can further contribute to the spread of conflict (see Rüegger 2017). Hence, we can think of ethnic ties as links that may be activated in the context of an ongoing conflict or interactions (see Woodwell 2004; Cederman et al. 2013) and examine whether a domestic conflict or issue involving one group in one state makes conflict more likely in dyads combining this state with other countries where the group is present and perhaps politically privileged.

More generally, looking to extra-dyadic ties brings us closer to common concepts of how international interactions are formed and evolve. Researchers and observers alike think of conflict in terms of "hot spots" of contentious issues and multiple linked actors. The 2006 confrontation between Israel and Hezbollah, for example, led Israel to take violent action against Hezbollah strongholds in Southern Lebanon, raising the fear of potential conflict and tension in other dyads, including states sympathetic to Hezbollah, notably Syria and Iran. The conflicts in Bahrain, Syria, and Yemen have spurred additional conflicts among other Sunni–Shiite dyads in what Lynch (2016) calls the new Arab wars. Incorporating such linkages in dyadic models can bring dyadic empirical research closer to our notion of a world of dense linkages between actors and help us better understand why and when dyads see crises and engage in conflict

## Supplementary Information

Supplementary information is available at the *International Studies Quarterly* data archive.

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