Bringing Cooperation Back In:
A Dynamic Model of Interstate Interaction*

Mark J.C. Crescenzi

Department of Political Science

University of North Carolina, Chapel Hill

crescenzi@unc.edu

Andrew J. Enterline

Department of Political Science

University of North Texas

ajenter@unt.edu

Stephen B. Long

Department of Political Science

Kansas State University

sblong@ksu.edu

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Abstract

In an earlier article (Crescenzi and Enterline, 2001), we develop a formal, dynamic model of the cooperative and conflictual dimensions central to interstate relationships. However, the empirical data employed as inputs into the original model informed only the model's conflictual dimension. Here, we operationalize the conflictual *and* cooperative dimensions of the model, with the latter derived by inputting information on joint participation in inter-governmental organizations (IGOs) for the period 1965-2000. Doing so enables us to trace the joint cooperative–conflictual temporal trajectories of interstate dyads, in addition to capturing the degree and dynamism of these relationships. We demonstrate the flexibility and practicality of the model-derived empirical indicators of interstate interaction with an analysis of dyadic interstate conflict. Our dynamic approach to studying interstate relationships promises to facilitate fruitful contributions to several research agendas in comparative politics and international relations.

1 Introduction

When Egyptian President Anwar Sadat made his historic speech before the Israeli Knesset on November 20, 1977, he signaled to the Israeli government, as well as to the world, a strong desire to end the lethal interstate rivalry between his country and Israel. Indeed, Sadat's efforts, in conjunction with reciprocation by Israeli Prime Minister Menachem Begin, altered radically the trajectory of the interstate relationship between their respective countries, one marked by a total of 36 militarized disputes during the post-WWII period (Diehl and Goertz, 2000: 146). With the codification of this new relationship in the Camp David Peace Accords signed by Sadat and Begin two years later in 1979, the military rivalry between Egypt and Israel essentially ceased to exist, and the two states embarked on a relationship marked more by peace than by war. Still, while the diplomacy of Sadat and Begin transformed the relationship between their two countries rapidly, the transition from a relationship grounded in enmity to one grounded in peace during the intervening years has been gradual.

To date, the literature on interstate rivalry considers the presence or absence of a rivalry in terms that are primarily anchored to the occurrence of militarized conflict occurring between pairs of states (Diehl and Goertz, 2000).[1] Yet, the evolution of the Egyptian–Israeli relationship illustrates the value of bringing cooperative behavior back into the conceptualization of interstate relationships.[2] In a previous article (Crescenzi and Enterline, 2001), we develop a model of interstate interaction reflecting historical, dynamic interstate interactions by combining both conflictual and cooperative behaviors in a single, continuous form. The model is flexible in that it is capable of incorporating an array of interactions between states. In our initial empirical representation, however, the model is abridged empirically with a focus on conflict (see Crescenzi and Enterline (2001: 419–22)). As formulated, this abridged empirical derivative fails to capture relationships in which a militarized interstate relationship dissipates rapidly through peaceful interactions and is reinforced by further cooperative overtures.

Our decision to abridge the empirical operationalization of the model was primarily a function of two issues: (1) data availability and (2) the comparability of the empirical measures derived from the formal model with extant research. Data sources on interstate cooperation were at the time were highly constrained temporally (mostly to the post-WWII period). Furthermore, a principal inspiration for the model was the research on interstate rivalry (e.g., Diehl and Goertz, 2000), and in the interest of comparability with this research, we sought to parallel the rivalry literature's analysis of the modern state system, including the nineteenth and twentieth centuries. To date, not a great deal has changed in terms of the availability of data on interstate cooperation. Yet, the issue of creating empirical referents of the model's two dimensions remains, and herein we develop the cooperative dimension of the interstate interaction model, albeit one that is truncated temporally.

In this article we provide a more informed operationalization of our dynamic model of interstate interaction, and provide a new empirical illustration of the model. Specifically, we show that our measure of interstate cooperation is a significant predictor of militarized interstate dispute onset. More cooperative interactions alter interstate relationships in a way that decreases the probability of militarized interstate disputes even in the context of a generally conflictual relationship. As expected, conflictual interactions alter interstate relationships in a way that increase the probability of future interstate disputes. The results demonstrate the utility of studying interstate relationships as a combination of cooperative and conflictual interaction patterns. While our empirical illustration is limited in scope, this approach to the study of interstate relationships can have important implications for several research agendas in the comparative politics and international relations sub-fields.

2 The Relevance of Cooperation

To some extent, the influence of cooperation on long-term conflictual relationships is examined in the current literature by Bennett (1997, 1998) and Diehl and Goertz (2000) in their studies of how domestic and international system changes (or "shocks") influence rivalry termination by stimulating conditions that are conducive to cooperative interactions between erstwhile interstate rivals. In their analysis of rivalry initiation and termination, Diehl and Goertz (2000) examine the influence of state and system level shocks. The authors find evidence that "... political shocks set the stage for the creation and termination of international conflict, including enduring rivalries. In that sense, they are virtual necessary conditions" Diehl and Goertz (2000: 239). In sum, embedded in the findings of Bennett (1997) and Diehl and Goertz (2000) is the emergence of cooperation between rival states; policy coordination that ultimately concludes their rivalry. Whether the impetus for this cooperation is a civil war or a global war, rival states are more likely to settle their differences when these events occur. While these two studies establish that significant alterations to domestic and political environments can result in significant changes to interstate relationships, they mask the processes that transpire when states shift from conflictual to cooperative modes of interaction.

The emergence of cooperation between adversaries does not necessarily mean that permanent changes will emerge between rival states, or that a rivalry will terminate. The rivalry between the United States and the Soviet Union is a case in point. While a remarkable level of cooperation was achieved by these two states in the early to mid-1970s relative to the levels of hostility during early post-WWII period, this cooperative reciprocity had eroded almost entirely by the election of Ronald Reagan as president of the United States in 1980.[3] These interludes of interstate cooperation do emerge, and properly modeling this behavior can help sort out whether the emergence of cooperation signals an interlude from further conflict (e.g., the United State–Soviet rivalry), or a prelude to the end of a rivalry (e.g., Egypt and Israel). In the following section we discuss how conflictual and cooperative behaviors can be derived from a single, dynamic representation of interstate relationships.

3 The Evolution of Interstate Relationships

Fundamentally, the concept of an interstate relationship is grounded in the degree of familiarity between units, be they states, ethnic groups, family members, or individuals, for example. Familiarity emerges from experience based on a mixture of prior and current interactions. These interactions may run the gamut of behaviors, ranging from conflict to cooperation. As such, familiarity may register both as a negative or a positive input. For example, a state may become more familiar with either the conflictual or the cooperative intentions of another state as time passes. In turn, familiarity provides a basis for subsequent behavior for the parties to a relationship. At the same time, learning occurs in response to momentous events or incremental changes in behavior by a second unit. This process of adaptation can influence the trajectory or evolution of an interstate relationship. In the context of world politics, the literature on learning by states in foreign policy differentiates between "learning about means" and "learning about ends" (Tetlock, 1991; Levy, 1994). Leng (2000: 7) argues that the "distinction [between modes of learning] is important to an investigation of the issue of whether states can draw lessons from experience that lead to changes in beliefs that are necessary to terminate enduring rivalries." Conceived as such, understanding how states, even dyads, learn and behave is central to the management of interstate conflict. In order to accomplish this task, it is necessary to develop some ideas regarding the bases and evolution of interstate relationships.

The literature reflects a tradition that has changed from one in which hypotheses were advanced about how cooperation affected "tension" between nations, to one in which the debate focuses on the methods by which empirical indicators, particularly events data, of conflict and cooperation between states should be combined, primarily in the interest of studying reciprocity. Early work was interested principally in the way cooperative behavior between pairs of states causally affected the likelihood of conflict in a dyad. Scholars were interested in two primary hypotheses, the *structural* hypothesis and the *process* hypothesis (Goldmann, 1980). The structural hypothesis suggested that cooperation is a function of interstate integration, and high degrees of integration could prevent conflict, while the process hypothesis was grounded in the Richardsonian notion of action-reaction, whereby "a change in cooperation is a stimulus, a signal which brings about a response implying a change in tension" (Goldmann, 1980: 32, 41).

For the most part, however, the question of whether and how cooperation and conflict should be combined to represent interstate relationships was never adequately resolved. Emphasis on the structural perspective shifted to the field of international political economy, where scholars focused primarily on the formation of economic and political alliances. Although analysis of the process hypothesis assumed center stage in the conflict processes literature, the methods by which conflict and cooperation were studied varied considerably. While some scholars analyzed the two separately (East and Gregg, 1967; Rosenau and Hoggard, 1974; Ward, 1982; Rajmaira and Ward, 1990), others combined these two streams of interstate behavior (Bobrow et al., 1973; Howell, 1983; Lebovic, 1985; Goldstein and Freeman, 1990; Goldstein, 1991, 1995). Yet, even in studies where cooperative and conflictual behaviors were combined, they were combined in such a way that the "net" behavior of each state comprising a dyad was considered rather than the components themselves. In the following section, we build on these disparate analyses of interstate relationships and formulate what we refer to as a *dynamic model of interstate interaction.* In turn, we follow this formal specification of our model with an empirical illustration employing the empirical referents generated with the model.

4 A Dynamic Model of Interstate Interaction

The first step in constructing our dynamic model of interstate interaction involves identifying the basic dimensions of interstate behavior. Regardless of whether we are concerned substantively with identifying instances of reciprocity or interstate rivalry, for example, we can identify a general set of concepts that will serve as a foundation for our dynamic model of interstate interaction.[4] Specifically, interstate relationships can be characterized by four general dimensions that we draw, in part, from Goertz and Diehl's (1993: 159–160) distillation of the "COW definition" of interstate rivalry: *Accumulation*, *Temporal Distance*, *Degree*, and *Rate of Change*.

Accumulation refers to the simple aggregation of events between two states, providing the fundamental inputs for the relationship. We assume in this model that as events accumulate, each additional event has a decreasing marginal impact on the relationship because information becomes abundant. *Temporal Distance* refers to the time lapsed between events. Here we assume that as an event fades into history, its impact on the interstate relationship diminishes as well. *Degree* represents the need to discriminate between the intensity of events. State visits should not have the same impact as militarized disputes, for example. Finally, the *Rate of Change* in the relationship is an important dimension that evolves over time. We recognize the need to provide a model that describes how the relationship evolves over time, not just the events that take place. Having defined the components representing the dynamic nature of an interstate relationship, we now turn to formalizing a model that incorporates these four dimensions into a single concept.

At the core of our concept of interstate interaction is the assertion that the occurrence of an event between two states represents *growth* in the relationship based on this new information, and the absence of events is characterized by *decay*, or change that results from the lack of new information. These processes of growth and decay are functions of the four dimensions of an interstate relationship outlined in the previous section (i.e., accumulation, temporal distance, degree, and rate of change). In the following subsections, we develop our model of interstate relationship change based on these basic processes of growth and decay and the four dimensions addressed above. Having done so, we combine these two processes into a single, dynamic representation of an interstate relationship, something we refer to as the *Interstate Interaction Model*.

Growth: The Emergence of an Interstate Relationship

The driving force behind the emergence of an interstate relationship is the repeated occurrence of events, regardless of whether these events are conflictual or cooperative. Thus, we include in our model a change in interstate interaction whenever an event between two states is observed. This change, or shock, is shaped by two of the four dimensions of interstate interaction that we outline above. The *degree* of interaction plays an integral role in determining the impact of the shock. As the *degree* of interaction increases, so does its impact on the overall relationship. Second, the impact of these interactions on the interstate relationship is tempered by the elapsed time, or *temporal distance*, since the previous event occurred. Together these two dimensions are represented in the following functional form for a pair of states, or dyad,

$$i_t = i_{t-1} + \beta \frac{Degree_t}{Temporal\ Distance_t} \tag{1}$$

where i_t is the *Interaction Level* for a particular dyad for any given time period, t, i_{t-1} is the dyad's *Interaction Level* in the previous period, and β_1 represents a weight that the researcher can introduce into the function. [5] $Temporal\ Distance_t$ is the duration since the previous interaction, and $Degree_t$ accounts for the extent of the interaction achieved by two states during an interaction. The functional form represented in equation (1) introduces shocks to i_t whenever interactions occur. The shock is intensified by the *degree* of the interaction, but dampened by an increase in the temporal distance from the previous interaction event.

It is evident from the research on reciprocity that the two basic building blocks of interstate interaction are the general categories of conflict and cooperation. Thus, the functional form expressed in equation (1) may be used to model conflictual and cooperative interactions between states. Optimally, we might model these two behaviors within a single function by giving conflictual and cooperative shocks different directional qualities as follows:

$$i_t = i_{t-1} - \beta_1\left(\frac{Degree\,of\,Conflict_t}{Conflict\,Temporal\,Distance_t}\right) + \beta_2\left(\frac{Degree\,of\,Cooperation_t}{Cooperation\,Temporal\,Distance_t}\right) \quad (2)$$

In equation (2), *Degree of Conflict*$_t$ and *Degree of Cooperation*$_t$ reflect the cooperation and conflict in the event, respectively, and *Conflict Temporal Distance*$_t$ and *Cooperation Temporal Distance*$_t$ represent the elapsed time since the last events. Thus, this functional form introduces negative shocks to i_t whenever conflict between the two states occurs, and positive shocks to i_t whenever cooperation between the two states transpires.[6] Such shocks provide new information to the relationship based on new events that occur between the two states. With growth so defined, we now move on to the issue of how interstate relationships change in the absence of such new information.

Decay: The Diminishing Effect of Time

The second fundamental process we wish to capture in our conceptualization of interstate interaction is the manner in which hostilities (or friendships) diminish over time. Here we incorporate the notion of the *rate of change*, as well as *temporal distance*, and the *accumulation* of events, into the process of decay in an interstate relationship. As argued above, in the absence of interaction between two states, the relationship should dissipate. Therefore, in the absence of activity in a dyad, an interstate relationship tends toward a state of neutrality. It is important to note that our underlying assumption here is that in order for an interstate relationship to become more contentious or more cooperative, new events must occur. That is, in the absence of new activity, the relationship cannot continue to escalate or even maintain a constant level of hostility or friendship.[7] We apply a simple decay function to the *Interaction Level* from the previous time period (i_{t-1}) to model this process.[8] This function constantly drives the value of *Interaction Level* toward zero (neutrality) over time.

Given the basic structure of a decay function, the next step is to explore how the rate of this decay may vary across space and time.

We formulate the rate of this decay function using two components. First, we assume that as the interval of inactivity for a dyad increases, so does a relationship's rate of dissipation. Stated differently, as two states enjoy a longer period of peace, they forget their conflictual past at a faster rate. Similarly, the longer two states endure without cooperating, the more rapidly they forget their cooperative past. Secondly, the interaction history in a given relationship is central to the ability of states to "forget the past." That is, as the total accumulation of interactions within a dyad increases, the rate of decay for the dyadic relationship (in the absence of interaction) decreases. As two states develop a history of frequent conflict or cooperation, their propensity to forget past behavior diminishes. Together, these processes are modeled in equation (3):

$$i_t = (e^{-\alpha(\frac{Event\,Temporal\,Distance_t}{Event\,History_t+\lambda})})i_{t-1} \tag{3}$$

where the decay function operates on i_{t-1}, $EventHistory_t$ is the accumulation of occurrences of conflict and cooperation between the dyad up to time t, $EventTemporalDistance_t$ represents the time that has passed since the last event (either cooperative or conflictual), and the parameter α weights the relative impact for the two factors.[9] The exponential decay is accelerated by increases in $Event\,Temporal\,Distance_t$, but is decelerated by increases in $Event\,History_t$.

Combining this decay process with the growth process developed above (see equation (2)) results in the following equation:

$$i_t = (e^{-\alpha(\frac{Event\,Temporal\,Distance_t}{Event\,History+\lambda})})i_{t-1} - \beta_1(\frac{Degree\,of\,Conflict_t}{Conflict\,Temporal\,Distance_t})$$

$$+\beta_2(\frac{Degree\,of\,Cooperation_t}{Conflict\,Temporal\,Distance_t}) \tag{4}$$

As it stands in equation (4), the model generates unbounded interaction levels. One last equation translates these values into a more intuitive range:

$$\text{If } i_t >= 0, \text{ then } I_t = \frac{i_t}{i_t + \gamma},$$

$$\text{If } i_t < 0, \text{ then } I_t = \frac{-i_t}{i_t + \gamma} \tag{5}$$

This transformation accomplishes two objectives. First, it restricts the value of I_t to a range of -1 to +1, thereby providing an intuitive structure to the model and empirical manifestations. Values of I_t that are close to a value of -1 reflect the strongest of interstate enemies, values of I_t that are close to a value of 0 reflect interstate relationships characterized by neutrality, and values of I_t close to +1 reflect interstate relationships characterized by the strongest of friendships. Second, the s–shaped functional form used in equation (5) creates a tapering effect such that as I_t increases towards +1 (or -1), larger shocks are required to continue such growth. Thus, the same shock will have a larger impact when I_t is close to 0 than when it is close to +1.

The logic behind this functional form is that at higher levels of interaction, we expect to see further interaction, and we wish to force the model into requiring more extensive events in order to increase the degree of interaction further; interaction, regardless of type, has a diminishing effect on the extent of an interstate relationship. The parameter, γ, determines the rate of ascent (or descent) from zero to the +1 (or -1) bound.[10] Larger values for γ decrease the rate of change for I_t. This flexibility allows the researcher to customize the bounding function.[11]

On balance, the dynamic model of interstate interaction incorporates all four dimensions of change in interstate relationships under the structure of growth and decay. By defining this interaction dynamic formally, we provide a model that is straightforward, flexible, continuous, and data-independent. Our task in the following section is to operationalize the model and, in turn, present an illustration of the model–derived empirical indicators from the Interaction Level, indicators that we refer to as cooperative and conflictual *Interstate Interaction Scores* (*IIS*).

5 An Empirical Illustration

Data Sample

Perhaps the most difficult challenge in evaluating the role of cooperation in international relations is to see if cooperation between states influences the outbreak of militarized dyadic conflict. It would be less than remarkable to claim that cooperation makes trade more likely, or that cooperation makes treaties more likely. But an assessment of the role of historical cooperation in the onset of militarized violence places us in the realm of lower expectations. Although we have shown that prior histories of conflict are linked strongly to the onset of future violence in our earlier formulation of the model, thus far we have little evidence that suggests cooperation can lower the risk of conflict onset. In this empirical exercise, we set out to test the hypothesis that cooperation reduces the likelihood of militarized violence between nations.

To achieve this goal, we develop a data sample reflecting information on militarized interstate conflict behavior, intergovernmental organization membership, and a set of covariates for all dyads (and a sub-sample of "politically relevant dyads") for the 1966–2000 period with assistance of *EUGene* 3.0.3 (Bennett and Stam, 2000). We employ the non-directed dyad year as the unit of analysis in the sample. Whereas the composite *IIS* would have the conflictual and cooperative components aggregated into a single score (as is captured in equations (4) and (5)), here we keep the cooperative and conflictual elements of the model empirically distinct, so that we can determine their individual contributions toward explaining the occurrence of dyadic militarized conflict.

Dependent Variable

The dependent variable in this study is a dichotomous measure of militarized dispute onset. We rely on the COW MID data (Ghosn and Bremer, 2004) to operationalize this variable, which assumes a value of 1 if the dyad is involved in a new militarized dispute in a given non-directional dyad year and 0 otherwise. Our operationalization excludes dispute joiners and ongoing disputes.

Conflictual Interstate Interaction Score

The conflict component of our *IIS*, hereafter labeled *Conflictual IIS*, is operationalized identically to the way it is measured in Crescenzi and Enterline (2001), with militarized disputes serving as the negative shocks to the dyadic relationship. We allow for the severity of the dispute to influence the degree of this shock, and we use the most severe dispute per year between two states to inform this aspect of the model. Both components are updated on a yearly basis. In the absence of new conflict activity (i.e., the onset of new MIDs), the conflict component of the *IIS* begins to decay toward neutrality (i.e., a value of zero in our constrained coding). In our data sample, the conflict component varies in value from 0.0 to -0.97.

Cooperative Interstate Interaction Score

The cooperative component of *IIS*, hereafter labeled *Cooperative IIS*, is operationalized using joint membership in intergovernmental organizations (IGOs) from Pevehouse, Nordstrom and Warnke (2004). Unfortunately, no currently available data set matches the spatial breadth and temporal range of indictors of interstate conflict events, such as the MID data. Moreover, it is hard to think of a set of cooperative events that parallel the most intense MID scores.[12] Therefore, our reliance on IGO membership is employed herein for illustrative purposes, rather than for matching the event characteristics of the MID data. Specifically, we use decisions by both members of the dyad to join the same IGOs in the same calendar year as a cooperative shock to the dyadic relationship. In order to distinguish between co-joining into large IGOs (such as the United Nations) versus more localized (and we assume more intensely cooperative) settings (such as ASEAN), we weight the joining event by the number of other nations currently in the IGO. Notice that our assumption here is that the cooperation within the dyad is at its peak upon joining the IGO, and time reflects a diminished importance for that particular IGO membership. This is certainly not always the case, as one could argue that the most successful IGOs improve interstate cooperation over time. But it is the most conservative assumption we could make in this regard, and it is not clear that continued membership in an IGO guarantees increases in cooperation over time. Even if cooperation increases initially and is then maintained by the dyad over time, the impact of this cooperation on the overall dyadic relationship may wane over time. As with the conflict component, an absence of new, mutual IGO joining activity causes the cooperative component to decay over time back toward neutrality (zero). This decay slows down as the number of mutual IGO joining events increases, but accelerates as the number of years accumulate without the additional joining of IGOs. In our sample, this cooperative component ranges in value from 0.0 to 0.79.

Illustrating the Conflict & Cooperation Scores

Prior to executing our illustrative empirical analysis, it is important that we demonstrate the univariate qualities of the variable *Conflictual IIS* and *Cooperative IIS*. In doing so, we wish to demonstrate whether and how our empirical derivations of the formal model map to our intuitive understanding of dyadic relationships between well-known pairs of states. To this end, in Figures 1a–1d we plot the cooperative and conflictual *IIS* for four dyads in which the United States is paired with four states: the Soviet Union/Russia, Canada, North Korea, and Iran, for the period 1965–2000.[13] Values of *IIS* on the y-axis ranging between 0 and 1 reflect minimum and maximum values of cooperation between two states comprising a dyad, respectively, while values of *IIS* ranging between 0 and -1 reflect minimum and maximum values of conflict in a dyad, respectively. In turn, the solid line in each figure reflects a particular dyad's cooperative trajectory, while the dashed line reflects a dyad's conflictual trajectory. We discuss the characteristics of each dyad in turn.

[FIGURE 1 ABOUT HERE]

Figure 1a illustrates the cooperative and conflictual trajectories for the United States–Soviet Union/Russia dyad. The relationship reflected in the two interaction scores is one of increasing cooperation in the context of a long-term interstate rivalry, and the slow dissipation of militarized hostilities following the end of the Cold War. In general, Figure 1a maps our intuitive understanding of the evolution of the relationship between the two states comprising the dyad. Furthermore, the trajectory of the cooperative interactions is sensitive to the dynamism of the dyadic relationship. Specifically, during the period of détente in the late 1960s and early 1970s, the figure reflects the first major increase in cooperation, which then levels off and declines slightly through the Reagan Presidency in the early to mid-1980s, yet surges in the 1990s following the end of the Cold War.

Additionally, the United States–Soviet Union/Russia dyad illustrated in Figure 1a is instructive because it underscores the importance of one of the key components of our conceptualization of the interstate interaction scores: *the decay rate assumption*. Specifically, we argue that interstate relationships are subject to some rate of decay, such that past events do not contribute as significantly to current interactions as do more recent events. Clearly, we assume a specific rate of decay, but this rate is manipulable by researchers depending upon their conceptualization of interstate relationships. The effects of our assumption are evident in Figure 1a, particularly in the slow decrease in the severity of conflict measured by the dashed line in the figure after the Cold War. Given the non-militarized, and often cooperative relations between the United States and Russia following the break up of the Soviet Union, especially during the Yeltsin period, our slow decay rate might belie the true relationship between these two states. Whether this is the case, however, is for the researcher to determine.

Figure 1b illustrates the trajectories for cooperative and conflictual interactions for the United States–Canada dyad. While the cooperation measure seems to follow a reasonable trajectory, reflecting a consistently improving relationship between the two nations, the conflictual interstate interaction score for the relationship exhibits perhaps somewhat surprising behavior. Beginning at approximately the year 1975, the conflictual score for the dyad reflects rapidly increasing hostility between the two states, which improves briefly during the 1980s and then worsens again during the mid-1990s. This is a very surprising pattern given the generally cooperative relationship between the two states, one that most observers would not characterize as militarized. The underlying reason for greater than anticipated levels of conflict in this dyad is most likely attributable to militarized interstate conflict grounded in fishing-related disputes between the two countries. This sensitivity to relatively low-level militarized conflict (interactions that one might argue are not standard militarized interstate disputes) demonstrates the importance of data selection when using the dynamic model that we propose here to generate *IIS* from raw data.

Finally, the cooperative and conflictual trajectories of the United States–North Korea and United States–Iran dyads are illustrated in Figures 1c & 1d, respectively. Specifically, the two dyads reflect highly conflictual relationships, yet with consistently low levels of cooperation between the United States and North Korea, and a more significant shift in the balance between conflictual and cooperative interactions in the relationship in the case of Iran following the Islamic Revolution in 1979. The plots in Figures 1c & 1d suggest an interesting application of our particular operationalization of conflict and cooperation. During the 1965–2000 period, it might be reasonable to interpret our operationalization of interstate cooperation as an approximate indication of a state's agreement with the international status quo for the dyads in which the United States is a member. Mutual joining of IGOs for these dyads would indicate a similarity of interests and goals between some state and the United States. Low frequencies of mutual IGO joining events would indicate the presence of dissimilar interests and perhaps exclusion from the international status quo. Interpreted in this fashion, Figures 1c & 1d illustrate either the path of a state consistently excluded from the international status quo (i.e., North Korea), or the path of a state increasingly excluded from the status quo over time (i.e., Iran). In other words, these graphs visually tell the stories of a persistent rogue state and a rogue state in the making.

The dyadic trajectories plotted in Figures 1a–1d illustrate the subtle patterns of interstate relationships that we are unable to observe with traditional operationalizations of interstate rivalry, measures that are grounded solely in militarized interactions and that ignore the effects of cooperative interactions on the broader relationships between states, as well as the variety and degree of cooperative and conflictual dyadic relationships. Having illustrated the basic properties of our measures of interstate cooperative and conflictual interaction derived from our formal model of interstate interaction, we proceed with our empirical illustration of a multivariate model of militarized interstate conflict. [14]

Additional Covariates

In order to ensure that we observe the independent effects of our key independent variables, we employ a number of control variables representing alternative explanations for the onset of militarized interstate disputes. While we have excluded some common variables such as joint democracy, we discuss those decisions below. Here, we focus solely on the variables retained in the presented models, each of which is generated with *EUGene* (Bennett and Stam, 2000). The variable *Contiguity* assumes a value of 1 if the dyad is geographically contiguous by land or across up to 150 miles of water and 0 otherwise. The variable *Major Power* assumes a value of 1 if either power is a major power that year and 0 otherwise. Finally, the variable *Capabilities* is the logged capability ratio of the dyad at time t-1, such that the ratio is the logged result of dividing the larger of the states' COW (Composite Indicator of National Capability) CINC scores by the smaller of the states' CINC scores.

Method

We employ a semi-parametric Cox event history model to estimate our multivariate model of militarized interstate conflict. While our dependent variable, militarized interstate dispute onset, could also be treated as the outcome in a standard logit analysis, we have chosen the event history approach in order to take advantage of the method's capacity to account for rare events. Event history models predict "failures" in a data sample; in this case, new militarized interstate disputes are the events that qualify as failures in a given non-directed dyad-year.

Analysis

We present two variations of our event history analysis, each of which are reported in Table 1. Specifically, the analysis corresponding to Model 1 employs a sample containing all politically relevant dyads (PRDs) for the period 1966–2000, a sub-sample of all dyads that are either geographically contiguous or in which at least one member of the dyad qualifies as a major power according to the COW definition (Correlates of War Project, 2005).[15] The results reported for Model 2, Table 1 illustrate the effects of using a sample comprised of all dyads in the 1966–2000 period.

[TABLE 1 ABOUT HERE]

Of the greatest interest here are the effects of the cooperative and conflictual components of the interstate interaction score (*IIS*) on the probability of militarized interstate dispute onset. In Model 1, the cooperative component of the *IIS* is moderately significant and in the expected direction. The negative coefficient on *Cooperative IIS* is interpreted to mean that as a dyadic relationship becomes more cooperative (i.e., closer to a the maximum bounded value of 1), the probability of militarized interstate dispute onset in a given dyad-year decreases.[16] This negative relationship is consistent with our expectation that even within relationships characterized by relatively strong rivalries (e.g., the United States–Soviet Union dyad during the Cold War), periods of cooperative interaction can decrease the probability of militarized disputes. From the standpoint of statistical significance, the variable *Cooperative IIS* is only moderately statistically significant in Model 1 ($p = 0.049$). Yet, as an illustration, the performance of the variable *Cooperative IIS* suggests how cooperative interactions can enhance our understanding of dyadic relationships and dyadic behavior. Conversely, the negatively signed coefficient for the variable *Conflictual IIS* in Model 1 can be interpreted to mean that as the level of historical conflict in the dyad increases, the probability of militarized interstate dispute onset also increases. While the ranges of the bounded components of the *IIS* make their separate interpretation slightly less intuitive, they maintain the form of the broader measure of which they are parts, in which values near zero for either interaction score represent relationships that are relatively neutral.

In sum, then, the results reported for Model 1 suggests that given the effects of capability, major power status, and contiguity, politically relevant dyads are more likely to engage in militarized interstate disputes when they have histories of conflict, while cooperative interactions decrease their probability of engaging in militarized interstate disputes.[17] As we conceptualize it, these relationships reflect a dynamic process in which the intensity of the interactions changes the degree to which the general tone of their relationship is affected, the effects of old interactions decay over time given the absence of additional interactions, and the effects of additional interactions in sequence diminishes as the number of interactions increases. The control variables in Model 1 also yield some interesting, though unsurprising, conclusions. Briefly, we observe that dyads in which one or both states are major powers are more likely to engage in militarized interstate disputes, as are contiguous dyads. Dyads in which power is imbalanced between the states comprising a dyad are less likely to engage in militarized interstate disputes relative to dyads in which power is relatively balanced.

Turning to the larger sample (Model 2), the coefficient for *Cooperative IIS*, is statistically insignificant. *Conflictual IIS*, by contrast, is still consistent with our expectations in the all-dyads sample, being both negative and highly significant (p=0.000).[18] The results are thus mixed in support of our expectation that cooperation reduces the hazard of conflict. It appears that within the subset of dyads that are most likely to interact, cooperation dampens the hazard of conflict. When evaluating this measure of cooperation with respect to the entire population of dyads in the system, however, this result does not hold. Perhaps this difference is the result of a connection between the political relevance distinction and the cooperation component of the *IIS*. Without sampling for politically relevant dyads, the cooperation component ends up representing interactions that reflect political relevance, which implies an increase in the opportunity for both cooperation and conflict. As a result, it is useful in this case to control for politically relevant dyads.

We conducted numerous robustness checks on these analyses, but perhaps the biggest test of this cooperative component variable is to examine the way it performs relative to a simpler measure of IGO membership. [19] In particular, how does the *Cooperative IIS* score fare compared to a variable that captures simple increase in joint-IGO membership? Recall that this variable measures new joint IGO membership, weighted by the size of the IGOs in which the membership takes place.[20] Models 3 and 4 represent the comparable analyses to Models 1 and 2, using this alternative specification of cooperation (*IGO Membership Change*). Overall, the *Cooperative IIS* score performs better than or as well as the alternative. Only the *Cooperative IIS* coefficient is statistically significant in the PRD sample, and neither coefficient is discernible from zero in the larger sample. [21]

Figure 2 illustrates the impact of a negative versus positive *IIS* on a dyad's cumulative hazard of failure (militarized interstate dispute onset) in the sample of politically relevant dyads. Specifically, we sum the heretofore separate empirical indicators of cooperation and conflict, then generate a dichotomous variable differentiating those dyad-years in which the combined *IIS* is < 0 (i.e., conflict present), from dyad-years reflecting cooperative or neutral values (i.e., the combined *IIS* is ≥ 0). It is evident from visual inspection that dyads reflecting a conflictual *IIS* exhibit a substantially higher cumulative hazard of militarized interstate dispute onset than a neutral or cooperative history. As such, the analysis reported here, particularly the results reported for Model 1, strongly suggest that treating interstate relationships as the outcome of a dynamic process of growth and decay, conflict and cooperation, not only adds theoretical depth to existing work, but also aids in the empirical explanation of significant international events, such as dyadic militarized interstate disputes.

[FIGURE 2 ABOUT HERE]

In light of our empirical illustration, it is important that we emphasize several issues. First, our goal here is to present one illustration of the way in which the components of a fully informed, dynamic representation of interstate interaction might be employed in the study of international relations. Our approach to conceptualizing interstate relationships has a wide variety of applications in the study of research questions in comparative politics and international relations beyond simply the study of dyadic militarized conflict. For example, a number of studies suggest that the degree of militarized conflict in a geographic region influences the evolution of domestic political institutions. Our representation of interstate relations provides a ready barometer of regional relations, one that can be achieved by aggregating dyadic relationships between proximate states, thereby providing empirical insight into the balance of cooperation and conflict within geographic neighborhoods.

Second, the raw data on IGOs that we employ to inform the cooperative dimension of our model are an imperfect solution. In particular, the IGO data are not event data, and therefore are not co-equal with the MID data that we rely upon to inform the conflictual dimension of the model. Yet, one might conceptualize how cooperative events might be coded from IGO memberships, such that the data informing the cooperative half of the model is richer and event–like in performance. For example, one might identify when members of an IGO agree on key resolutions, which would differentiate between mere membership and overt cooperative interaction that might recur at varying frequencies during different intervals.[22]

Finally, as we noted above, the representation of interstate interaction that we propose in Equation (4) is merely one model of many alternatives. Even within the context of the model that we propose, other researchers have significant latitude to modify the model's components to suit their needs. For example, the appropriate rate of decay for the cooperative and conflictual memory components of the model is not patently obvious (e.g., the rate of decay might not be identical for each process), and must be determined by the researcher. Such researcher-determined adjustments are also necessary in terms of weighting different inputs. Neither our formal representation of interstate relationships, nor the data that we generate with it, are the end product of conceptualizing such relationships in this manner; rather, they are the beginning of deliberations.

6 Conclusion

Reacting to, and drawing primarily on, research on interstate rivalry, learning, and reciprocity, we conceptualize interstate relationships dynamically, and principally as a byproduct of conflictual and cooperative interactions between states. Here, we explore empirical manifestations of the conflictual and cooperative dimensions of the model. An empirical illustration demonstrates that even in the context of generally conflictual interstate relations, dyads can reduce the probability of militarized dispute onset by engaging in cooperative interactions.

We close with the suggestion that our approach to conceptualizing interstate interaction enables us to escape a problem that has bedeviled the literature on interstate rivalry for more than decade—i.e., identifying the population of interstate rivalries, and pinpointing their commencement and termination. Rather than seeking to identify decisive start and end points to these relationships, we conceptualize interstate relationships as continuous phenomena, ebbing and flowing in terms of the degrees to which these relationships are marked by conflict or cooperation. Interstate relationships strengthen, fade, move from conflictual to cooperative, and vice versa, all the while remaining active. The search for terminal points is unlikely to prove helpful. Furthermore, imposing precise termination points on interstate relationships is likely to mask the the dynamic transitions that these relationships undergo.

Notes

[1]Hensel (1996) suggests that rivalries can be non-militarized and can emerge when pairs of states compete in, for example, trade. Also, see arguments by Thompson (1995) on the centrality of strategic perceptions in the emergence of rivalries.

[2]Important diplomatic breakpoints and cooperation appear in the relationship between the United States and the Chinese (Goldstein and Freeman, 1990; Goldstein, 1991), as well as the often militarily intense rivalry between North and South Korea following the Korean War.

[3]This erosion is clearly illustrated in Goldstein and Freeman (1990: 42,65).

[4]We owe a special debt of gratitude to Chad Atkinson, Dina Zinnes, and Robert Muncaster of the Merriam Lab, University of Illinois, Champagne–Urbana, for their contributions and encouragement during the development of this model.

[5]This parameter weights the impact of the shock on i_t. It might be the case that researchers will have a theoretical motivation for adjusting β.

[6]Indeed, one could build multiple shocks for each phenomenon. These shocks are then weighted to equilibrate their maximum and minimum values. While this does not completely assuage the problems related to the ordinal character of such information, it constrains the behavior of both shocks to the same range.

[7]This assumption places our approach in contrast to the punctuated equilibrium models discussed in Cioffi-Revilla (1998) and Diehl (1998).

[8]Similar approaches to modeling the decay properties of conflict history are employed by Hegre et al. (2001) in their study of regime changes and civil war, by Partell (1997) in his study of dispute escalation, and by Rakenrud and Hegre (1997) in their study of the hazard of interstate war.

[9]The denominator is adjusted by adding a constant, λ, so that it never assumes a value of zero. We hold the value of α to be positive, in order to ensure a decay toward neutrality.

[10]$\gamma > 0$

[11]The decision to use the bounding function resides with the researcher, based upon how the researcher conceptualizes the accruement of interstate interaction.

[12]Goldstein (1992) offers the best effort in this regard, scaling the cooperative and events in the WEIS data set onto one dimension. But the events data to which this scale applies do not match the scope of the MID data. We do think, however, that Goldstein's scale can be useful in operationalizing the IIS measure with event data generally.

[13]Recall that our formal model of the *Interaction Level* requires at minimum two time points from which to calculate a single score (e.g., a data input for the year 1965 is used to create an interaction score for the year 1966). Therefore, in Figures 1a–1d the plotted values for the conflictual and cooperative interaction scores in the year 1965 are each zero, or neutral.

[14]These figures also illustrate the left-censoring limitations of the model. In this analysis, we assume that dyads start at neutrality until their behavior shocks them out of it. This is less of an issue when the data underpinning the model begin at a natural starting point like 1815, but here the 1965 left-bound for the annual IGO data leads to an obvious issue. In the analysis below, this limitation should bias against support for the hypotheses. We also ran the analysis with data truncated to a 1970 starting point, giving the *IIS* scores time to correct for the initial lack of information. The results were consistent with those reported in table 1.

[15]See the discussion of relevant dyads in Oneal and Russett (1997) and Maoz and Russett (1993).

[16]The bounding function used for both components of the *IIS* in the presented models employs a value of 1 in the denominator.

[17]We find that Model 1 fails both the linktest and Schoenfeld residuals global tests for violation of the proportional hazards assumption, but further investigation reveals that all of the independent variables pass their individual tests when they are interacted with the natural log of time (none of the interactions terms are significant). While we cannot explain the model's failure on the global tests, the next step of investigation commonly pursued shows no clear problem, so we do not believe there is a serious problem indicated by the tests taken as a group given the lack of agreement.

[18]The results for the controls are also similar to those in Model 1.

[19]We performed a number of robustness checks on both models. While variables indicating the presence of an alliance in the dyad and the presence of joint democracy in the dyad are missing from the presented results, we did run models that included these variables. We dropped the variables because we believe that the alliance variable shares substantial common ground with the data that we use to operationalize cooperation, joint entrance into IGOs, since alliances are included as IGOs. We also drop joint democracy here because we believe that democracies are more likely to engage in cooperative behavior (Leeds and Davis, 1999) and thus joint democracy shares common ground with our measure of dyadic cooperation. When we include joint democracy and alliance variables, we find that all three variables (alliance, joint democracy and *Cooperative IIS*) become insignificant, which supports our argument that they are related. When we include joint democracy but not alliance, we find that the significance of *Cooperative IIS* is weakened and joint democracy is insignificant; this also supports our understanding of the connection between these variables. Both alternative models also result in the variable *Major Powers* becoming statistically insignificant. Furthermore, Model 2 fails both the linktest and Schoenfeld residuals global tests for violation of the proportional hazards assumption, and in this case, not all of the

independent variables pass their individual tests when they are interacted with the natural log of *time*. In Model 2, *Cooperative IIS*, *Conflictual IIS*, and *Contiguity* each fail their individual tests, while *Capabilities* and *Major Powers* do not.

[20]We lag this variable one year in the analysis, which is consistent with the other operationalizations.

[21]While we do not recommend including both the *Cooperative IIS* score and *IGO Membership Change* in the same model (it almost certainly violates the notion of independent variables), we did run these models as a final robustness check. In the PRD sample, the *Cooperative IIS* coefficient retains its sign and significance while the control IGO membership coefficient is not statistically significant. In the larger sample, neither coefficient is statistically significant.

[22]The United States and the Soviet Union were each members of the United Nations during the Cold War (as we measure it above, an indication of dyadic cooperation), but their cooperative interactions in terms of resolutions in the General Assembly and Security Council might reveal the low levels of overt cooperation transpiring between the two states during this period.

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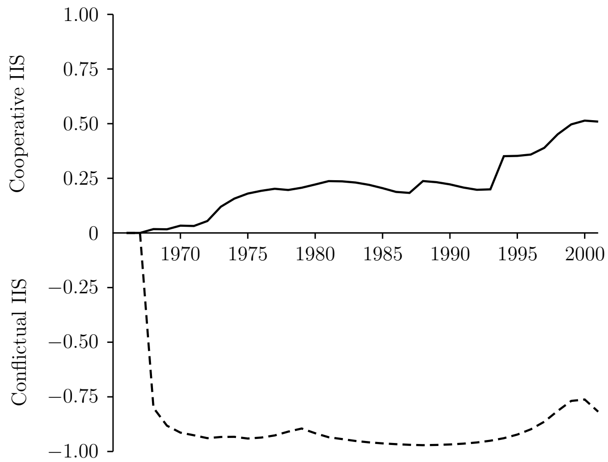
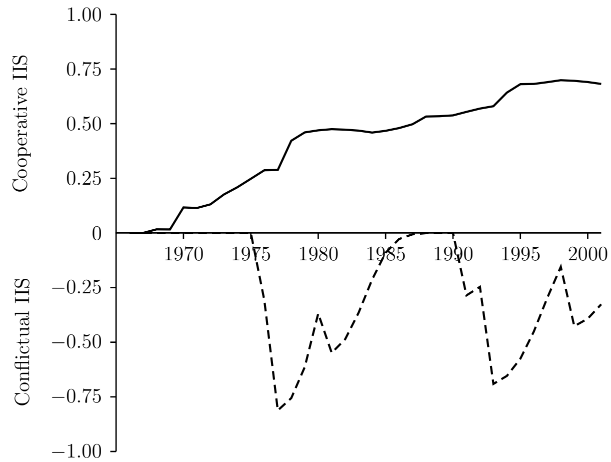
Figure 1: Conflictual & Cooperative Interstate Interaction Scores, Four Dyads (1965–2000).

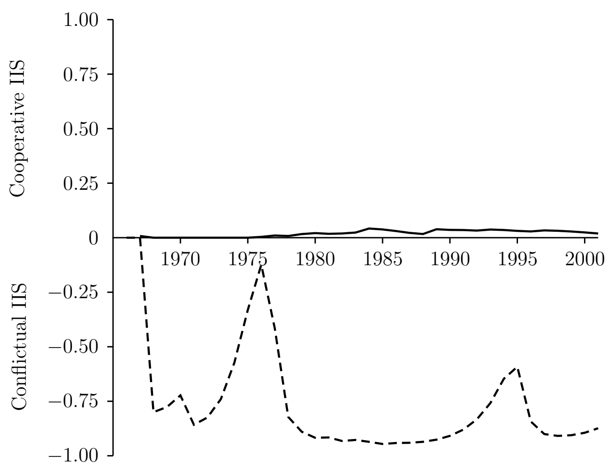
(a) United States–Russia.



(b) United States–Canada.



(c) United States–North Korea.



(d) United States–Iran.

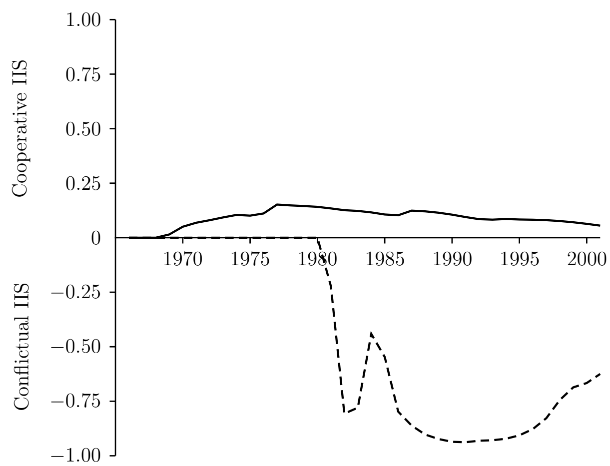


Table 1: Cox Model of Militarized Dispute Onset, 1966-2000.

Variable	1 (PRD)	2 (All Dyads)	3 (PRD)	4 (All Dyads)
Cooperative IIS	-0.529*	0.389		
	(0.269)	(0.276)		
Conflictual IIS	-2.842**	-3.124**	-2.88**	-3.08**
	(0.125)	(0.187)	(0.126)	(0.182)
IGO Membership Change			-0.615	-0.062
			(0.543)	(0.572)
Capabilities	-0.204**	-0.149**	-0.194**	-0.154**
	(0.030)	(0.031)	(0.029)	(0.031)
Major Powers	0.215*	1.124**	0.216*	1.133**
	(0.106)	(0.147)	(0.105)	(0.148)
Contiguity	1.202**	2.737**	1.173**	2.800**
	(0.201)	(0.178)	(0.204)	(0.168)
N (failures)	40,838	440,841	40,838	440,841
	(1012)	(1331)	(1012)	(1331)
Log likelihood	-6058.531	-9819.645	-6030.133	-9821.26
χ^2 (Wald)	2403.24**	3448.02**	2436.15**	3424.27**

Standard errors clustered on dyad in ( ).

Significance (two-tailed):**=.001 level, *=.05.

Figure 2: Nelson-Aalen Cumulative Hazard Estimates.