"Hot Hands" and Cold Wars:
A Reassessment of the Stochastic Model of Rivalry

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In a recent article, Erik Gartzke and Michael Simon criticize the academic literature on enduring rivalries and propose a stochastic model as an alternative. They argue that the literature on rivalries has simply assumed the existence of meaningful connections between militarized disputes, rather than testing for such connections empirically. Additionally, they suggest that empirically observed rivalry-like processes can be accounted for by a stochastic process.

I argue that Gartzke and Simon's article is flawed both theoretically and empirically. An examination of published research on rivalry reveals that this research has already accomplished many of the tasks that Gartzke and Simon call for. The evidence for this stochastic model is also found to be weaker than initially claimed, both failing to account for observed rivalry processes and being outperformed by the evolutionary model. I conclude by reassessing what the study of rivalry has gained from the introduction of the stochastic critique, and by suggesting possible directions for future research.

Paper presented at the 2001 Annual Meeting of the American Political Science Association, San Francisco. The author wishes to thank Sara Mitchell, the participants in the FSU International Relations Workshop, and especially Erik Gartzke and Michael Simon for their valuable comments and suggestions. All errors and interpretations, of course, are those of the author.

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Enduring interstate rivalries such as the Cold War competition between the United States and the Soviet Union have captured the attention of observers worldwide. A common assumption about such rivalries is that there is something about earlier confrontations in the long series of conflict that leads to or worsens the later confrontations. A recent article by Erik Gartzke and Michael W. Simon (1999) calls this assumption into question, making an analogy to the "hot hand" phenomenon in athletics. Athletes occasionally appear to perform much better (or worse) than usual, but the apparent hot (or cold) streaks can often be accounted for by a simple application of probability theory. Along the same lines, Gartzke and Simon claim that the observed processes of "rivalry" in the past two centuries -- or lengthy series of militarized disputes between the same two adversaries -- can best be explained by a stochastic process rather than by the dispute-to-dispute causal linkages that are commonly assumed.

In developing their critique, Gartzke and Simon offer the study of rivalry a valuable service, by opening for question a central assumption that guides this entire line of research but that has not always been addressed in past research. Gartzke and Simon (1999: 794) conclude that further study is warranted by their simulation and results, and hope that their efforts stimulate further assessment of the study and application of enduring rivalries; there can be little doubt that they have achieved these goals. The present study examines Gartzke and Simon's theoretical and empirical critique of current research on rivalry. As will be seen, the theoretical critique of existing literature that justified Gartzke and Simon's argument for the stochastic model is misplaced, addressing a small fraction of rivalry research and overlooking the most important theoretical and empirical work on rivalry over the past decade. Furthermore, the evidence for their stochastic model is much weaker than it first seemed, and its results are outperformed by more theoretical alternatives when a more appropriate comparison is used. In short, Gartzke and Simon's critique has made an important contribution to the rivalry literature, but with results that they did not intend; a comparison of the stochastic model of rivalry with existing models serves to highlight and strengthen the value of existing research on rivalry.

Theoretical Problems in Rivalry Research

Erik Gartzke and Michael Simon (1999) offer three broad critiques of existing research on interstate rivalry. First is a critique of research design, involving selection problems in the study of enduring rivalries while excluding non-rival cases. Research on rivalries has also been unable to account for the initial militarized disputes in each rivalry, and has accepted the key element of dispute-to-dispute relationships by assumption rather than by careful analysis. If accurate, these issues would amount to a devastating critique of the current theoretical and empirical literature on interstate rivalry. As will be seen, though, these critiques are misplaced, and have generally been addressed by prominent research on rivalry.

Indeed, these critiques of the rivalry literature lack a clear target. Throughout their article,

Gartzke and Simon address "the enduring rivalries approach" as if agreement existed on a single theoretical framework that can account for the origins and dynamics of rivalries. Yet there is no single theoretical "enduring rivalries approach" in existing research on rivalries, any more than there is a single theoretical "interstate war approach" that is widely accepted as explaining the origins of interstate war. Rather, research on war attempts to explain the phenomenon with reference to power transitions or power parity (Kugler and Lemke 1996), crisis bargaining (Leng 1993), territorial issues (Vasquez 1993), and numerous other factors. Similarly, research on rivalry employs multiple theoretical approaches, ranging from Goertz and Diehl's punctuated equilibrium model to Hensel's and Maoz and Mor's evolutionary models, Vasquez' focus on territorial issues and power politics, and Bennett's focus on rational bargaining processes. While each individual theoretical explanation for war (or for rivalry) may be imperfect, very few meaningful criticisms can be imagined that would apply to all research on war (or on rivalry).

Selection Problems

One important criticism leveled by Gartzke and Simon involves a supposed tendency for rivalry-related research to focus scholarly attention exclusively on enduring rivalries, omitting from analysis all other cases that do not meet some predetermined definition of rivalry. For example, Gartzke and Simon (1999: 779) suggest that for rivalry research to progress, "it must justify why researchers should only examine certain cases," and must "do more than point to the density of conflict events." Similarly, they argue that research on rivalries has (at least implicitly) simultaneously claimed both that dyadic rivalries show different patterns of interaction than non-rivalry relationships, and that "the dispute sequences that they study are symptomatic of the larger question of the causes of conflict" (Gartzke and Simon 1999: 796). They later conclude their article by urging scholars to use great caution in "[using] enduring rivalries as a convenient sampling technique for studying conflict generally" (Gartzke and Simon 1999: 796)

Admittedly, this charge is relevant for studies that use populations of enduring rivalries to test (non-rivalry) propositions about interstate conflict. For example, Geller (1993) uses a set of enduring rivalries to test hypotheses on power differentials and war, and Huth and Russett (1993) use enduring rivalries to test propositions on general deterrence. Even here, though, it is not clear that most researchers expect the results for rivalries to mirror those of the broader population of nation-states; they more typically choose rivalries as a population because of specific theoretical concerns that suggest that no relationship should be expected for non-rival adversaries. For example, Huth and Russett (1993: 63-64) go to great lengths to emphasize that their population of enduring rivalries offer an appropriate population for testing propositions on general deterrence, with the implication that these rivalries are quite different from non-rival dyads. Similarly, Geller (1993: 178-179) suggests that "an analysis of the influence of power balances on the dispute patterns of these [rival] dyads may provide information on the structural mechanics of the most conflict-prone interstate relationships," and notes that past research on similar topics may have been weakened by including both rival and non-rival dyads in the same study. In short, even

research using rivalry as a case selection mechanism does not appear to justify this approach by claiming that the results will be representative of the larger setting of world politics.

It is also worth noting that a great deal of rivalry research has included non-rival cases, in order to avoid this line of criticism. For example, Goertz and Diehl (1995: 38-39) explicitly argue that the effects of political shocks are not limited to dyads that will eventually qualify as enduring rivalries: "Political shocks will produce new conflicts that may or may not mature into enduring rivalries. Other factors, most unconnected with political shocks, seem to influence whether a proto-rivalry will become an enduring one." In their empirical analyses, Goertz and Diehl (1995: 43, 49-50) examine both enduring rivalries and "proto-rivalries," or conflictual relationships that go beyond what might be termed "isolated conflict" but that never meet the full set of criteria for enduring rivalry; their results when including other conflict types are generally quite similar to the analyses reported for enduring rivalries.

Similarly, research using an "evolutionary approach" to rivalry (e.g., Hensel 1996, 1999; Maoz and Mor 1998b) does not limit analysis to cases that eventually meet some conflict density threshold to qualify as enduring rivalries. Indeed, one of the primary purposes of the evolutionary approach is to study all conflictual dyads, with the goal of understanding which of them eventually become rivalries and which do not; this would be impossible without the inclusion of cases in which conflict occurred but ended short of enduring rivalry.[1] While studies that use rivalry as a case selection mechanism may exclude non-enduring rivals from analysis (albeit often for specific theoretical reasons), then, research on the origins or dynamics of rivalry generally includes non-rival cases and is not vulnerable to this criticism.

Accounting for Initial Disputes

As described by Gartzke and Simon (1999: 783), research on rivalries treats international conflict as both an independent variable and a dependent variable, essentially studying the temporal diffusion of conflict and arguing that "war begets war, that international disputes contribute to the disputes that follow." Such research is thought to "neglect to incorporate a variety of other potential causal variables, implying that previous disputes are themselves the primary explanation of subsequent disputes within conflict dyads." (Gartzke and Simon 1999: 785) This emphasis on the causal role of past disputes appears to constitute a serious weakness of rivalry-related research, which appears to be unable to account for the initial outbreak of militarized conflict when there is no past conflict to use as an explanatory factor: "current research on enduring rivalries by itself cannot account for enduring rivalries. Other theoretical explanations for international conflict must be used to account for initial disputes in series." (Gartzke and Simon 1999: 785-786) Gartzke and Simon extend this line of argument by suggesting that whichever factors can account for the initial

[1] It is also worth noting that evolutionary measurements of rivalry status at any given point in time are based on past conflict behavior up to the time in question, rather than based on thresholds that may not be crossed until twenty or more years have passed. Under an evolutionary measurement of rivalry, a dyad that eventually qualifies as an enduring rivalry typically begins with one or more decades of conflictual relations in the "early" and "intermediate" rivalry phases and only enters the "advanced" phase upon reaching the threshold for enduring rivalry (Hensel 1996: 49-51).

dispute may also be able to account for later disputes in the series, without the need to consider linkages between individual disputes.

Yet such criticisms appear to be exaggerated. In the study of interstate war, for example, theoretical approaches that emphasize dispute or crisis escalation to war are unable to account for the initial outbreak of disputes or crises. Yet few scholars would deny that crisis bargaining strategies can make a difference in distinguishing disputes that escalate to war from those that end short of war (e.g., Leng 1993). The focus on certain stages in the overall conflict process should not be taken as evidence that the entire research agenda is flawed. Very few scholars can claim (and even fewer can claim convincingly) to offer a comprehensive and well-tested theory that can account for the entire process of conflict from the initial development of a non-militarized conflict of interest through the outbreak, escalation, and aftermath of militarized conflict over this issue and the final resolution of the issue in question. Indeed, the stochastic model that Gartzke and Simon propose to explain conflict and rivalry processes appears to overlook most of this process.

It is also important to note that the major theoretical arguments for the origins of rivalry do offer explanations for the initial dispute in a series. Goertz and Diehl's (1995, 2000) punctuated equilibrium model makes very specific claims about political shocks generating the initial confrontation, although allowing additional factors to influence the prospects that each such confrontation will then become a proto- or enduring rivalry. Both Hensel's (1996, 1999) and Maoz and Mor's (1996, 1998a, 1998b) evolutionary arguments also begin with states disagreeing over one or more issues, and argue that conflict can begin as states attempt to achieve their goals over these issues. Once interaction over the issue has begun, the history of interaction comes to play an ever more prominent role in subsequent attempts to manage or settle it.[2] Similarly, theoretical arguments by Vasquez (1993), Bennett (1998), and Thompson (1995) also begin with contention over one or more issues. In none of these cases does the theoretical argument begin after the first dispute has already occurred; each approach offers its own explanation for the outbreak of the first dispute as well as for potential changes in relations afterward. Although these arguments about the role of issues or political shocks in the initial dispute are not always tested empirically, it is important to recognize that they constitute important elements of the evolutionary and punctuated equilibrium approaches.

Dispute-to-Dispute Linkages

As Gartzke and Simon note, the existing literature on interstate rivalry holds that militarized disputes within rivalry-like series are causally related to each other. Gartzke and Simon (1999: 778-779) argue that rivalry-related research has simply assumed the existence of causal linkages between militarized disputes, without explicitly developing or testing specific hypotheses about

[2] Empirical analysis of the role of contentious issues in the initial dispute has been limited by the lack of systematic data on issues outside of militarized conflict. Hensel (2001a) has begun to test propositions about the management of contentious issues, though, using data from the Issue Correlates of War (ICOW) project. This data, which is still being collected, offers the hope of better empirical analyses of the entire conflict and rivalry process, beginning with the existence of a contentious issue and addressing both the initial dispute in a series and the recurrence of conflict (perhaps ending in either the emergence of rivalry or the settlement of the issue).

such linkages. They later (1999: 784) criticize past research on rivalry for "assign[ing] causation by caveat," or simply assuming that disputes lead to disputes rather than testing this proposition.

Attempting to address the possibility of dispute-to-dispute linkages, Gartzke and Simon (1999: 783-785) discuss three potential relationships between individual disputes in a series. It is possible that one dispute could increase the probability of subsequent conflict, that one dispute could decrease this probability, or that there is simply no relationship between disputes. Somewhat surprisingly, though, Gartzke and Simon's theoretical critique and Poisson simulation address only the first of these options, focusing on the simple assumption that past conflict can only increase the probability of future conflict.

The lack of attention to alternative (or multiple) forms of dispute-to-dispute relationships is especially surprising because Gartzke and Simon (1999: 781) cite research suggesting that different past dispute outcomes can produce different effects on the probability and timing of future conflict (e.g., Maoz 1984; Hensel 1994). This entire body of research is overlooked in the remainder of their theoretical arguments and in their simulation. The decision not to consider the possibility of different effects from different dispute outcomes means that Gartzke and Simon are unable to address an important element of the evolutionary approach to rivalry (or of research on recurrent conflict). I am not aware of any theoretical arguments in the literature on either recurrent conflict or interstate rivalry that claim that all past conflict always increases the probability of future conflict, as suggested by Gartzke and Simon. Rather, the evolutionary approach developed both by Hensel and by Maoz and Mor (as well as the entire body of literature on recurrent militarized conflict) suggests that the impact of past conflict depends on details of that conflict; different dispute outcomes or other specific characteristics may produce very different effects on subsequent relations.[3]

In short, Gartzke and Simon attempt to demonstrate that existing research on rivalry has failed to consider the possibility of causal connections between militarized disputes through empirical analyses. As it turns out, though, this possibility has been addressed through the development and testing of hypotheses on recurrent conflict and on the evolution of rivalry; Gartzke and Simon even cite some of the relevant studies. Furthermore, while ignoring relevant past research, their own approach is to address the question by assumption -- the very problem for which they attempt to criticize past research.

The Stochastic Model of Rivalry

Following their critique of previous research on rivalry, Gartzke and Simon suggest a stochastic explanation to account for the origin of rivalry-like dispute series on the basis of a truly

[3] While one element of Hensel's (1996, 1999) evolutionary approach is the general expectation that more past conflict should generally predict to more future conflict, which is consistent with Gartzke and Simon's approach, Hensel also indicates quite explicitly that this general impact of past conflict is only one part of the model. The full evolutionary model also allows for reinforcing or competing effects based on specific characteristics of past conflict, such as differences based on previous dispute outcomes or issues, and indicates that these specific effects may outweigh the general expectation that conflict will beget more conflict.

random process.[4] This model suggests that conflict clusters or series are produced by a stochastic process in which episodes of conflict are not causally related to each other in any way. Gartzke and Simon (1999: 789) attempt to model the frequency of apparent rivalries in "a world in which there is a certain probability of dyadic conflict every year, year after year." In such a world, all dyads have an equal probability of engaging in militarized conflict or rivalries in any given year, and the occurrence of one militarized dispute has no causal impact on the occurrence or nonoccurrence of subsequent conflict. In other words, the model argues that there should be nothing that distinguishes one dyad (or type of dyad) from another; every dyad-year across the entire history of the interstate system should have exactly the same probability of seeing militarized conflict.[5]

Such a stochastic approach differs substantially from past research on rivalry. Each of the previous theoretical approaches to the study of rivalry -- whether Goertz and Diehl's punctuated equilibrium model, either Hensel's or Maoz and Mor's evolutionary model, Vasquez' issue-based model, or other similar models -- assumes that the context of rivalry is different from other types of international contexts. This is perhaps most obvious in the evolutionary approach, which is explicitly based on the existence of specific causal relationships between conflict; both the general history of past conflict between two adversaries and specific details of their most recent confrontations are hypothesized to affect future conflict propensities in systematic ways. Research using the punctuated equilibrium or issues approaches also assumes that the context of rivalry differs from non-rivalry contexts, with conflict between enduring rivals seen as generally more frequent and more intractable than that between non-rival adversaries.

Gartzke and Simon use a Poisson simulation to evaluate the stochastic model of rivalry. Their simulation attempts to determine how many rivalry-like dispute series we would expect to see based on a stochastic process, with the general goal of determining whether or not there is evidence of an empirical connection between individual militarized disputes. They consider six different measures of rivalry, but the remainder of this paper will focus on the rivalry definition introduced by Goertz and Diehl (1995), which has been used in recent research on rivalries much more frequently than the other definitions examined by Gartzke and Simon. This definition is also worth examining because it produces the best results for the stochastic model, which predicts 45.4 rivalries, while a total of 45 are identified by Goertz and Diehl (Gartzke and Simon 1999: Table 2). This offers a much more fair evaluation of the stochastic model than a definition such as Wayman's, which predicts 2686.4 rivalries under the stochastic model when only 276 were observed (and which has never been used in research outside of Wayman's initial article).

According to Gartzke and Simon's Table 2, there are 20,718 eligible dyad-years in the interstate system between 1816-1976. A total of 1529 militarized disputes are known to have

[4] Gartzke and Simon also suggest what might be termed an exogenous model of rivalry, suggesting that some other factor can account for each militarized dispute in a rivalry-like series. The simulation that makes up much of their paper, though, is based exclusively on their stochastic model. The exogenous model receives very little attention in Gartzke and Simon's article, and thus will not be addressed until later in this paper.

[5] Of course, as Gartzke and Simon note, having an identical probability does not imply an identical distribution of observed conflict behavior.

occurred in those dyad-years, producing an annual probability of 0.074 that a dispute will break out in any dyad-year. Adding their conditional logic of rivalry outbreak to this initial probability, in order to determine the probability that any given dispute will culminate in an "enduring rivalry," they produce a probability of 0.004 that any given dyad-year will give rise to a militarized dispute that becomes an enduring rivalry. After excluding "ineligible" dyad-years during which a new rivalry could not begin (which amounts to leaving out the final twenty years of each possible dyad because a new dispute in those years would not have sufficient time to meet Goertz and Diehl's minimum rivalry duration criterion of twenty years), Gartzke and Simon end up with a total of 11,001 eligible years. Based on the 0.004 probability noted earlier, their stochastic model predicts a total of 45.4 rivalries between 1816-1976, which compares quite favorably with the 45 rivalries identified by Goertz and Diehl.

On the basis of this near-perfect performance of the stochastic model in the simulation, Gartzke and Simon (1999: 794) conclude that "the number of dispute series identified as enduring rivalries is in fact consistent with the number generated by a stochastic process," and they find it "remarkable that a model intentionally constructed so that disputes are unrelated so nearly replicates observed series of disputes." They then argue (p. 796) that scholars need to document that their lists of rivalries are not arbitrary before using these lists in research, since their simulation appears to call into question the assumption that rivalries are generated by a systematic rather than random process.

At first glance, Gartzke and Simon's simulation appears to call into question the entire scholarly literature on enduring rivalries. As will be seen, though, this simulation is deeply flawed, both in its theoretical justification and in its methodological implementation. The simulation was designed in a way that is unable to address many of the theoretical arguments made in research on rivalry, and that is unable to distinguish between a stochastic process and more theoretical processes appearing in the rivalry literature. Furthermore, it does not accurately replicate the measurement of rivalries in the observable world; when adjustments are made so that the simulation and actual data use the same operationalization of rivalry, the simulation predicts barely one-third of the observed rivalry sequences.

Theoretical Evaluation of the Stochastic Model

The primary goal of Gartzke and Simon's simulation is to determine whether the observed frequencies of enduring rivalries under various definitions could be accounted for by a stochastic process. In their own words, "we test whether militarized disputes in series, characterized as enduring rivalries, are *most likely* the product of a process lacking significant temporal association" (Gartzke and Simon 1999: 788; italics added). By answering this question, they seek to determine whether or not individual militarized disputes are directly related to each other. Yet it is not clear that aggregated frequency counts at the level of the entire interstate system can tell us much about a possible linkage between individual disputes. Furthermore, the results of this aggregated systemic simulation are no more compatible with the stochastic approach than with the evolutionary,

punctuated equilibrium, or issues approaches.

This should be clear when we consider the specific theoretical arguments of various approaches to rivalry. Hensel's (1994, 1996, 1999) evolutionary model includes two distinct relationships between confrontations. The first portion of the model, concerning the general impact of past conflict, predicts increased conflict between adversaries with a longer history of past conflict. The second portion of the model concerns specific details of past conflicts, and predicts that the impact of any given confrontation on subsequent relations between the adversaries will depend on the outcome and other characteristics of that confrontation. Thus, even after considering the amount of past conflict, the evolutionary model suggests that past disputes with certain characteristics can decrease future conflict in their aftermath. Because the aggregated approach employed by Gartzke and Simon does not include any provision for dispute outcomes (or for other characteristics of individual confrontations), it is unable to address the full evolutionary model, and it is unable to determine whether or not such apparently random series of disputes could also be accounted for by dispute outcomes. Even if the aggregated result appears consistent with a random process, this result can not rule out that in certain cases a past dispute increases the probability of future conflict but in other cases a past dispute decreases this probability, producing very little net effect in the aggregate. The only way that a dispute-to-dispute relationship could safely be rejected would be to examine the probability of conflict in dispute-level analyses -- hopefully incorporating dispute characteristics such as outcomes -- rather than aggregated analyses that could disguise multiple opposing relationships.

Gartzke and Simon's simulation is also unable to rule out the impact of factors identified by the punctuated equilibrium or issues approaches. Goertz and Diehl (1995, 2000) suggest that dispute series (whether proto-rivalries or full enduring rivalries) are difficult both to begin and to end, typically requiring the disruption of a political shock before they can begin and another shock before they can end. Gartzke and Simon's aggregated simulation can tell us nothing about the possible role of political shocks. It is very possible that in the absence of political shocks such as the world wars, many of the proto-rivalries in Goertz and Diehl's studies would have become enduring rivalries, producing many more than the 45 observed enduring rivalries (and that the rivalries that were observed would have lasted for much longer periods of time). It is also possible that more or fewer rivalries would have occurred had there been more or fewer shocks at the national, regional, or global levels. In either case, Gartzke and Simon's aggregated simulation is unable to reject political shocks (or Goertz and Diehl's punctuated equilibrium model more generally) as a better explanation for the observed conflict patterns, as it makes no provision for different patterns or relationships in the presence or absence of shocks. Even if both approaches appear to generate the same number of rivalries overall -- which, as will be seen shortly, is not the case -- evidence that these rivalries cluster around a small number of political shocks rather than being roughly evenly distributed over time and space would still offer greater support for the punctuated equilibrium model than for the stochastic model.[6]

[6] Similarly, evidence that other conflict patterns such as militarized dispute severity are affected by political shocks would also offer greater support for the punctuated equilibrium model than for the stochastic model.

An issues explanation for rivalry, advocated by scholars such as Vasquez (1993, 1996), Bennett (1998), and Thompson (1995), would suggest that rivalries are likely to continue (all else remaining equal) until the underlying issues at stake are resolved to both sides' satisfaction.[7] A stochastic process can tell us nothing about the probability or timing of issue resolution. It is possible, then, that the observed number of rivalries is associated with the number of contentious issues of one or more certain types in the international system. As with the punctuated equilibrium model, additional information such as the spatial and temporal clustering of rivalries among states contending over (for example) territorial issues would offer greater support for the issues approach than for the stochastic approach, even if both would predict the same overall number of rivalries across the entire system.

The results predicted by Gartzke and Simon's Poisson simulation, then, are unable to distinguish between what could have been expected by chance from what could have been expected based on the outcomes of past conflict (some of which can decrease conflict propensities), the occurrence of political shocks, or the frequency and resolution of issues. In short, these results are unable to provide evidence that is more consistent with the stochastic model than with any of its major theoretical competitors that have been proposed and tested in past research on rivalries. Indeed, past studies have provided greater information that is more consistent with these other approaches than with the stochastic model, casting doubt on this model as the *most likely* explanation for the observed dispute series that Gartzke and Simon sought.

Methodological Evaluation of the Stochastic Model

The preceding discussion suggests that even if multiple models predicted the same overall number of rivalries, additional information appears to favor alternative models over Gartzke and Simon's stochastic model. As it turns out, though, this stochastic model does not fare anywhere near as well as its authors claim. The methodology used in Gartzke and Simon's simulation dramatically inflates the expected number of rivalries by reproducing Goertz and Diehl's measure of rivalry inaccurately. This flaw leads to the erroneous conclusion that a stochastic process could indeed have produced as many rivalries as have been observed in the international system since 1816, when in reality the observed totals are quite different from the predictions of a stochastic model. This problem can be demonstrated in two different ways, first by adjusting Gartzke and Simon's estimate to match Goertz and Diehl's definition, and then by adjusting Goertz and Diehl's observable total of rivalries to match Gartzke and Simon's definition.

Adjusting Gartzke and Simon's Estimate

[7] Under Bennett's (1998) model, rivalry is likely to begin over issues that are important enough that the perceived costs and risks of protracted military competition outweigh the satisfaction that could be obtained by settling the issue peacefully. Vasquez (1996: 532-533) suggests that issues are "the foundation upon which rivalry rests," and Thompson discusses how both positional and spatial issues can lead to rivalry. Issues are also important to the origins of rivalry under Hensel's (1996, 1999) evolutionary approach, although that approach also suggests a greater role for previous interactions between the adversaries over these issues after the initial confrontation has begun, rather than just focusing on the type of issue or its salience for decision makers.

Goertz and Diehl's (1995: 33) definition of enduring rivalry requires that at least six militarized disputes occur between two adversaries over a period of at least twenty years, which Gartzke and Simon accurately adapt to their simulation. There are a number of additional details, though, that Gartzke and Simon's simulation fails to reproduce. Goertz and Diehl's rivalries may last well beyond the first twenty years, and it is impossible for a new rivalry to begin between two adversaries who are currently involved in an ongoing dispute series. It is impossible for a new enduring rivalry (or dispute series) to begin within fifteen years of the final militarized dispute in a previous dispute series, because a new dispute in these fifteen years would have the effect of prolonging the previous series rather than beginning a new one. Also, it is impossible for a new enduring rivalry (or dispute series) to begin within fifteen years of any militarized conflict -- whether in an enduring rivalry, proto-rivalry, or "isolated conflict" relationship -- for the same reason. Gartzke and Simon's estimate of the number of enduring rivalry-like series that would be predicted by a stochastic process is dramatically inflated by not removing these years in which a new rivalry could not possibly have begun.

It must be remembered that any rivalry -- whether observed empirically or predicted by the stochastic model -- must have some duration, during which the dyadic adversaries in question can not become involved in another concurrent rivalry series. Such time periods, though, are not excluded from the simulation's list of "eligible" periods in which a new rivalry could begin. Thus, two given countries are evaluated for the probability of a rivalry in a given year, based on the aforementioned probabilities of an initial militarized dispute occurring, and if it occurs, the probability of further conflict that would qualify under Goertz and Diehl's measure of enduring rivalry. Whether or not those countries are found to begin a militarized dispute or rivalry in that year, they are then evaluated for the same question the following year, the year after that, and so on through the end of the dyad's eligible years. The problem is that if the underlying stochastic process generates a rivalry in a given dyad-year, then the entire predicted duration of that rivalry must be made ineligible for future conflict, as two countries can not engage in multiple rivalries with each other at the same time.[8] Imagine, for example, that the stochastic model predicts that a rivalry (with at least six militarized disputes over at least twenty years) will begin in a given dyad-year corresponding to Israel and Syria in 1948 (or any other two states in any other year). In the current simulation, dyad-years representing Israel and Syria from 1949 through 1967 would remain eligible for additional rivalries, although such an additional rivalry would be logically impossible under any of the rivalry measures considered by Gartzke and Simon.

Based on Gartzke and Simon's (1999: 789-792) description of their methodology, they search for rivalry-like dispute series that meet Goertz and Diehl's minimal enduring rivalry criteria of lasting twenty years and including at least six militarized disputes. The general problem of ineligible dyad-years is compounded when we consider the possibility that any given rivalry may

[8] It could be argued that details of specific dyad-years are not relevant for a simulation of rivalries across the entire interstate system over a period of nearly two centuries. Yet this systemic simulation is based on a set of eligible dyad-years, in which new rivalries could potentially begin. If this set of eligible dyad-years is inflated substantially, as this paper contends is the case with Gartzke and Simon's simulation, then the systemic analysis will produce misleading estimates of the number of rivalries that could reasonably be expected from a stochastic process.

last much longer than this minimum of twenty years. For example, Goertz and Diehl (1995: 33) note that the 45 rivalries in their data set last for an average duration of 43 years, more than twice the minimum twenty-year period required by Gartzke and Simon's model (and thus more than double the problem for simulated predictions of rivalry onset).

Similarly, there is a period of fifteen years after the conclusion of each "rivalry" series in which a new initial dispute (and thus new potential rivalry) can not occur, because a dispute occurring in such a year would only prolong an existing dispute series under Goertz and Diehl's definition. This is distinct from the twenty years at the end of each dyad that Gartzke and Simon (1999: 791) already remove because a new dispute then would not have twenty years before 1976 in which to meet Goertz and Diehl's duration criterion. For example, if a given enduring rivalry series ends with a final militarized dispute in 1953, then an additional dispute between 1954-1968 would meet Goertz and Diehl's criteria for extending the same rivalry rather than beginning a new rivalry, so another rivalry can not begin in these fifteen years.

The problem worsens further when we consider episodes of militarized conflict that do not lead to enduring rivalry-level series. Goertz and Diehl (1995: 32) note that less than half of all militarized disputes occur within what they identify as enduring rivalry relationships, meaning that there is a large population of dyad-years that are not eligible for a new dispute (and thus a new rivalry) because they are already included in existing dispute series that never reach the level of enduring rivalry. When we remember that a period of time after the final stochastically-generated dispute in each series must be removed from eligibility for new disputes or rivalries, along with the other adjustments discussed above, it should be clear that a large fraction of the currently "eligible" dyad-years -- perhaps as many as half -- must be removed from their simulation, dramatically reducing the predicted number of rivalries.[9]

In order to quantify this problem, let us focus initially on enduring rivalries alone. Even if each rivalry were to last for exactly twenty years, then 900 of the 11,001 "potential enduring rivalry" dyad-years listed in Gartzke and Simon's Table 2 are actually ineligible if 45 rivalries are predicted by the model; this number would more than double if the average rivalry duration predicted by the stochastic model approximates Goertz and Diehl's observed 43-year rivalry duration. If an additional fifteen years after the final dispute in each rivalry are rendered ineligible, then between 35 and 58 years for each predicted rivalry must be removed from the simulation because of their ineligibility for further rivalry onset. It is possible to reestimate the predicted number of rivalries by adjusting the number of eligible dyad-years in the equation and solving for the number, using the following equation:

$$N = (11{,}001 - (I*N)) * .004$$

In this simple equation, N is the number of rivalries predicted by the model, 11,001 is the original number of eligible years in Gartzke and Simon's Table 2, I is the number of years that must be

[9] Regardless of what happens to the number of "eligible" dyad-years, Gartzke and Simon's stated probabilities of militarized dispute or rivalry occurrence in any given year will not change, because these are based on the overall number of militarized disputes and dyad-years between 1816-1976. Any decrease in the number of eligible dyad-years, then, will produce a corresponding decrease in the number of stochastically predicted rivalries.

removed as ineligible for each predicted rivalry (the actual number is used in solving this equation rather than the symbol X), and .004 is the Poisson probability of a rivalry beginning in any eligible dyad-year (taken from Gartzke and Simon's Table 2, although the full value is used in calculation rather than the truncated three-decimal-point version reported in that table).[10]

If the minimum rivalry duration of twenty years is used, along with the requirement of fifteen additional years after the final dispute in a rivalry, then the above equation with the value of I=35 produces an estimate of 39.7 rivalries from the stochastic process with no relationship among disputes. If Goertz and Diehl's average duration of forty-three years is added to the fifteen years to produce a value of I=58, the stochastic model predicts 36.6 rivalries. The actual value is likely to be somewhere in the middle of these two predictions, because while the average rivalry duration is likely to be somewhat greater than the definitional minimum of twenty years, some of these extra years during or after rivalries have already been censored by the 1976 end of data analysis or by Gartzke and Simon's exclusion of the last twenty years in each dyad.

While an estimate of 36-40 rivalries is still reasonably close to Goertz and Diehl's observation of 45 rivalries using their definition in the same time period, we must remember that this adjustment to the original stochastic model is based exclusively on cases that must be removed from the simulation because of *enduring* rivalries. Each episode of militarized conflict that occurs outside of an enduring rivalry -- which Goertz and Diehl (1995: 32) note to be the case for 55 percent of all disputes -- also produces ineligible cases that must be removed from the simulation. Goertz and Diehl (1995) identify a total of 96 proto-rivalries, each of which includes three to five militarized disputes within a fifteen-year period, and hundreds of episodes of "isolated conflict" with one or two disputes. Each of these shorter isolated conflict or proto-rivalry series also produces fifteen ineligible years in its aftermath, as well as any years between the disputes in the series itself. While it is not clear exactly how many years would be involved if Gartzke and Simon's simulation were to exclude these ineligible years, it does appear likely that as many several thousand cases would be affected beyond the cases that were already excluded because of enduring rivalries, reducing the predicted number of rivalries to thirty or less (a substantial difference from the 45 rivalries that were observed empirically based on this definition).

Adjusting Goertz and Diehl's Observations

Another way to illustrate the shortcomings of Gartzke and Simon's simulation is to consider the different methodologies used in determining how many rivalry-like dispute sequences might be expected from a stochastic process, and in determining how many such sequences have been observed empirically. The key difference in this regard is related to the problem discussed above, where every single dyad-year in the simulation is considered eligible for a new enduring rivalry.

[Table 1 about here]

Take, for instance, the observed rivalry between Israel and Syria, which is depicted in

[10] The author is grateful to Erik Gartzke for suggesting this equation as a way to estimate the impact of including ineligible years on the stochastic model's predictions.

Table 1 (using the 1816-1976 MID data used by Gartzke and Simon and by the Goertz and Diehl studies against which they measure their stochastic simulation). A militarized dispute in the year 1948 marks the beginning of this rivalry, which eventually goes on to include a total of sixteen militarized disputes before the end of the data set in 1976. This Israel-Syria dispute sequence forms one of the 45 rivalries appearing in Goertz and Diehl's data set.

Under Gartzke and Simon's coding rules, though, each year in their population of cases -- corresponding to each dyad-year in the Israel-Syria relationship, as well as in every other dyad from 1816-1976 that is referenced in their study -- is considered a potential candidate for a new rivalry sequence that includes at least six MIDs and lasts for twenty years. Their simulation thus allows for the possibility of an Israel-Syria rivalry sequence beginning in 1948, another in 1949, and so on, up to the time twenty years before the end of the data set (when a new twenty-year dispute sequence is logically impossible). Applying these coding rules to the single Goertz and Diehl rivalry in Table 1, Israel and Syria begin a qualifying sequence of militarized disputes in the year 1948, since they experience ten militarized disputes over a twenty-year period. Additional Israel-Syria rivalry sequences begin in 1951, 1954, 1955, and 1957 -- meaning that what Goertz and Diehl count as one of 45 enduring rivalries actually accounts for five separate rivalry sequences under Gartzke and Simon's simulation methodology! While not all of Goertz and Diehl's rivalries will produce multiple qualifying rivalry sequences like this case does, this observation is enough to indicate that the stochastic prediction of 45.4 rivalry sequences is probably a dramatic underprediction of six-disputes-in-twenty-years sequences in the observable data.

[Table 2 about here]

Table 2 presents an estimate of the revised total of observed rivalry-like sequences in the MID data set under Gartzke and Simon's operationalization, in order to allow a fair comparison of the same type of "enduring rivalries" predicted by the stochastic simulation. These rivalry-like sequences are identified as in the Israel-Syria example provided in Table 1, and each qualifying sequence is listed. As Table 2 reveals, many of Goertz and Diehl's single-case enduring rivalries account for multiple Gartzke and Simon rivalry sequences, with two producing ten distinct rivalry sequences and one producing twelve.[11] In all, Gartzke and Simon's operationalization produces a total of 123 observed enduring rivalry sequences in the MID data that they employed, which is certainly far higher than the 45.4 enduring rivalries that their simulation suggests should be expected from a stochastic process.

Summary

[11] Not all of Goertz and Diehl's 45 rivalries appear on this table. The absence of several cases can be traced to the need for consistency with Gartzke and Simon's methodology. Most important is the elimination of multiple militarized disputes after the first between two adversaries in a given year. Because Gartzke and Simon's methodology only allows for a single militarized dispute to occur in a given year, it would be unfair to compare their prediction to observable data where some rival dyads produce two or three disputes in a given year. This change eliminates approximately fifty militarized disputes from the original total of 1529, meaning that some dyads that were coded as enduring rivalries by Goertz and Diehl no longer qualify because two or more of the necessary six disputes occurred in the same year.

Even with the most favorable (and most widely used) definition of rivalry, then, the stochastic model model seriously underestimates the rivalry-like dispute series once appropriate corrections are taken into account. Either adjustment reported in the past few pages produces a major departure from the near-perfect prediction reported by Gartzke and Simon, and errs in the direction that is most consistent with a meaningful connection between militarized disputes. Based on Gartzke and Simon's (1999: 794) own decision criteria, "To reject the hypothesis that disputes are independent events, definitions of enduring rivalry need to report a significantly higher number of disputes than is generated by the null statistical model." While the authors explicitly reject the use of statistical significance tests in making this determination of "significantly higher" (Gartzke and Simon 1999: 794), their results after incorporating this study's modifications do not appear to offer much support for the stochastic model. It does not appear that this stochastic simulation can reject the claim of a linkage between militarized disputes, as substantially more rivalries have been observed empirically than would be expected from a truly stochastic process.

Empirical Analyses

Up to this point, I have examined Gartzke and Simon's theoretical critique of the so-called enduring rivalry approach, and I have examined the methodology behind their stochastic simulation. While their simulation has been shown to be much less successful than had initially been claimed, a more valuable exercise would involve using their stochastic critique to reevaluate an existing approach to rivalry. Indeed, Gartzke and Simon (1999: 794) seem to suggest that they would prefer their most important contribution to involve stimulate additional thought and scrutiny by rivalry scholars. As a result, I now attempt to evaluate the evolutionary approach to rivalry in light of two of Gartzke and Simon's alternative explanations. The evolutionary approach appears to be the most appropriate model for this comparison, as it is built around the expectation that past interactions can help to generate future conflict, or the notion of "dispute-to-dispute linkages" that Gartzke and Simon mention so frequently.

Expectations about Dispute-to-Dispute Processes

Hensel's evolutionary model of rivalry (Hensel 1996, 1999) grows out of research on recurrent interstate conflict (e.g., Hensel 1994; Maoz 1984), which focuses on relationships between militarized disputes between the same adversaries. This evolutionary explanation for the origins of rivalry begins with two states contending over one or more conflicts of interest, or contentious issues (e.g., Hensel 1996: 84ff). These states may employ militarized conflict to pursue their goals over the issues, or they may attempt to pursue them through non-militarized means. Once militarized force has been threatened or used, the history of past conflict is seen as an important influence on subsequent decisions and interactions. The evolutionary approach includes two separate effects of past interactions between two countries, involving both the general

impact of past relations and the impact of specific details of past interactions between them.[12]

The general impact of past relations involves the expectation that "conflict begets conflict," or that -- all else being equal -- a longer history of past militarized conflict should increase the probability that military means will be employed again in the future. The theoretical logic involves both the accumulation of grievances and hostility from past confrontations and changing expectations about the adversary's likely actions or intentions (e.g., Hensel 1996: 65-66). Specific characteristics of past confrontations are also seen as relevant, particularly involving the outcome of past disputes. Renewed militarized conflict is thought to be more likely after confrontations that end with stalemated outcomes than after decisive outcomes or negotiated compromises, because neither side was able to achieve its goals through force or through a mutually acceptable settlement (e.g., Hensel 1996: 87-88). Beyond past dispute outcomes, the evolutionary approach suggests that other details may plan an important role, such as the severity level of past disputes and the issues that were involved in recent conflict (e.g., Hensel 1996: 88-91).[13]

In short, the evolutionary approach suggests that after the first militarized dispute has occurred (for reasons related to the specific issue(s) under contention between the adversaries), both the general history of past conflict and specific details of the most recent dispute should affect future relations. This leads to the following two basic hypotheses:

Evolutionary H1: The probability of militarized conflict is increased by the history of conflict between two adversaries; adversaries with more past conflict are more likely to engage in subsequent conflict.

Evolutionary H2: The probability of militarized conflict varies depending on the outcome of the most recent dispute between two adversaries; subsequent conflict is more likely after a stalemated outcome than after a decisive or compromise outcome.

It is worth noting that Gartzke and Simon argue that the evolutionary approach, and particularly its empirical finding of increasing dispute probability, is actually the result of selection on the dependent variable. For example, they suggest (1999: 783) that dyads that engage in at least one dispute have crossed some minimal threshold of opportunity and willingness to engage in militarized conflict. After the initial confrontation, these same dyads should thus be expected to be more likely to engage in subsequent conflict than non-conflictual dyads that have never crossed

[12] Hensel (2001b) develops a more generalized version of this evolutionary model that explicitly incorporates the impact of non-militarized forms of past interaction and that explicitly allows for non-militarized methods of pursuing issue-related goals. Beyond militarized means, states may attempt to pursue their goals through bilateral negotiations with the adversary or with the (binding or non-binding) assistance of third parties. Additionally, beyond the number and characteristics of past militarized conflict, adversaries' decisions are influenced by the number and effectiveness of past attempts to resolve their issues peacefully through any of these means.

[13] A similar evolutionary approach is developed by Maoz and Mor (1996, 1998a, 1998b). Under Maoz and Mor's evolutionary approach, the outcomes of past interactions between states (such as militarized confrontations) can produce changes in each adversary's satisfaction with the status quo and perceived ability to change this status quo if desired, as well as in each side's perceptions of the other's satisfaction and capability. These resulting changes can then increase or decrease the probability of reaching enduring rivalry.

such a threshold. In other words, by focusing on cases that have already engaged in one militarized dispute, evolutionary research on rivalries appears to select on the dependent variable of conflict, and the evolutionary finding that conflict propensities increase with histories of past conflict is dismissed as "encouraging, but not surprising" (Gartzke and Simon 1999: 783). Yet the evolutionary argument -- with its emphasis on past conflict behavior as a predictor of subsequent conflict propensity -- is not intended to compare the conflict propensities of conflictual dyads to that of non-conflictual dyads, which by definition have no observable conflict. Rather, the emphasis is on comparisons within the category of dyads that have engaged in conflict at least once (thus overcoming Gartzke and Simon's criticism, because all of these dyads have already passed whatever minimal opportunity/willingness threshold is required for conflict involvement). Indeed, this research emphasis is exactly what Gartzke and Simon repeatedly call for, because it is necessary to establish whether or not the history of past conflict affects future conflict propensities.

The Stochastic Model

Gartzke and Simon offer two alternative models to account for the observed temporal and spatial clusters of militarized conflict that other scholars have termed "rivalries." The first model, which appears to be their preferred alternative (and which is the only model to be addressed by their empirical analyses), suggests that conflict clusters or series are produced by a stochastic process in which episodes of conflict are not causally related to each other in any way. Gartzke and Simon (1999: 789) attempt to model the frequency of apparent rivalries in "a world in which there is a certain probability of dyadic conflict every year, year after year." In such a world, all dyads have an equal probability of engaging in militarized conflict or rivalries in any given year, and the occurrence of one militarized dispute has no causal impact on the occurrence or nonoccurrence of subsequent conflict. In other words, the model argues that there should be nothing that distinguishes one dyad (or type of dyad) from another; every dyad-year across the entire history of the interstate system should have exactly the same probability of seeing militarized conflict.[14] As a result, past conflict behavior should have no impact on the future, and any series of events that appear to be "enduring rivalries" would only be manifestations of underlying random processes.

This stochastic model differs substantially from past explanations for rivalry. Each of the theoretical approaches discussed above -- whether the punctuated equilibrium model, evolutionary, or issues approaches -- assumes that the context of rivalry is very different from other types of international contexts. This is most obvious in the evolutionary approach, which is explicitly based on the existence of specific causal relationships between conflict; both the general history of conflict and specific details of recent conflicts are hypothesized to affect future conflict propensities in systematic ways. Research using the punctuated equilibrium or issues approaches also assumes that the context of rivalry differs from non-rivalry contexts, although most research on these approaches has addressed questions besides the recurrence of militarized conflict.

[14] Of course, as Gartzke and Simon note, having an identical probability does not imply an identical distribution of observed conflict behavior.

Stochastic H1: The probability of militarized conflict is not affected by past relations between two adversaries; conflict probabilities are constant across time and space.

The Exogenous Model

Gartzke and Simon's second alternative model involves the possibility that some common exogenous factor accounts for each individual confrontation in a series of militarized disputes. Specifically, the simple observation that militarized disputes cluster together in time does not demonstrate a causal connection between individual disputes. Instead, some other factor is thought to account for each individual dispute in a "rivalry" series, meaning that the disputes in the series have no independent causal impact on each other because they each result from a common cause (Gartzke and Simon 1999: 783-784).

Unfortunately, the exogenous model is stated in vague terms, with the authors being hesitant to suggest specific exogenous factors that might account for each dispute in a rivalry-like series. Gartzke and Simon (1999: 784) highlight contiguity, which is thought to be associated with both rivalries and isolated disputes, but with little or no causal impact on the linkages between disputes. Whatever the exogenous factor, though, this argument is incompatible with the stochastic model that is addressed by Gartzke and Simon's empirical analyses, because it suggests that certain dyads have some characteristic that makes them more conflict-prone than other dyads -- and that we can not assume that the probability of militarized conflict or rivalry remains constant across time and space.

Exogenous H1: The probability of militarized conflict is not affected by past relations between two adversaries. Certain types of adversaries are simply more likely to engage in conflict, regardless of their past conflict history; any apparent effect of past relations should disappear after controlling for the influence of exogenous factors such as contiguity.

Research Design

These three models' expectations must be tested with a somewhat different spatial-temporal domain from that used by Gartzke and Simon's stochastic simulation, in order to render the results of the tests more meaningful. Gartzke and Simon began with the population of all dyads that had engaged in at least one militarized dispute sometime between 1816-1976, according to the old version of the COW militarized dispute data (Gochman and Maoz 1984). The present study uses the revised version 2.10 of the militarized dispute data (Jones et al. 1996), which covers the 1816-1992 period. This revised data set has been the basis for almost all research on rivalry since 1994 or 1995, and includes additional data on dispute outcomes that enable appropriate tests of the evolutionary model. Because of Gartzke and Simon's reliance on the previous version of the data -- which lacked data on outcomes -- they found the evolutionary model "difficult to adapt to our test" (781), rendering their simulation inappropriate for the only approach to rivalry that has even

attempted to test a possible relationship among individual militarized disputes.

It is also worth noting that Gartzke and Simon used portions of each conflictual dyad running from twenty years before the outbreak of the first militarized dispute in the dyad to twenty years after the end of their final dispute. Yet if the goal of the model were to account for the outbreak of the initial militarized dispute between two countries, then this twenty year period before the dispute unfairly excludes a potentially long period of time when the adversaries were able to become involved in militarized conflict but are known to have avoided it. Similarly, the twenty year extension beyond the end of the last dispute includes a time period when the adversaries did not become involved in future conflict, and indeed, any new conflict that would have occurred would have been considered to represent a new rivalry. For these reasons,the present study begins with the year immediately following the initial dispute in a sequence (thus preventing the initial dispute from biasing the results) and includes all dyad-years in which a new dispute would have prolonged the existing dispute sequence (i.e., a period of up to fifteen years after the conclusion of the previous dispute, following a standard length employed in past research by Goertz and Diehl, Hensel, and others).[15] While this approach does not allow us to predict the outbreak of the initial dispute in a sequence, the focus of the evolutionary approach is on the connections between disputes, which this approach does allow us to study. As Gartzke and Simon (1999: 786) point out, the existence of a direct relationship between disputes in a sequence is "a claim that is both empirical and testable," although they themselves are unable to test it directly; the present study is meant to do so.

Three variables are used in this analysis. The first, the general conflict history, reflects the number of militarized disputes that have occurred in a given conflict series up to the dyad-year being studied. A conflict series begins with a militarized dispute between two states, and continues through the end of the first fifteen year gap without any subsequent disputes. The second variable, most recent dispute outcome, is based on the outcome data in the MID 2.10 data set, following the procedure described by Hensel (1996, 1999). Dispute outcomes are divided into "decisive" outcomes (originally coded as "victory" or "yield"), stalemates, or compromises; "unclear" or "released" outcomes are coded as missing and excluded from analysis. This outcome variable is based on the outcome of the most recently concluded militarized dispute between two adversaries prior to the dyad-year being studied. Finally, contiguity is coded for the disputants based on the

[15] As with Gartzke and Simon, this analysis is limited to dyad-years in which both states are members of the COW system, and to years covered by the available data (1816-1992 here because of the use of the revised MID data). I reject their use of contiguity as a criterion for inclusion in the analysis. Although it is unclear from Gartzke and Simon's description (pp. 789-790), they appear to exclude most noncontiguous dyad-years, while failing to exclude any militarized disputes based on the contiguity of the participants; their calculations in Table 2 are explicitly based on all 1529 militarized disputes in the original data set, without any determination of the participants' contiguity status. Additionally, they exclude all dyad-years in which formerly contiguous adversaries lose their contiguity status because of changes to the states' opportunity and willingness for conflict, *unless* they become involved in subsequent conflict; this appears to be an inconsistent and post hoc coding rule. Finally, it is unclear how they measure contiguity, particularly in terms of colonial borders and contiguity across open seas; their example (p. 790) of Spanish contiguity to Mexico changing after the Spanish-American War suggests that their "contiguous" category includes contiguity both by colonial border and by distance across water, although this is never explicitly stated.

COW contiguity data set, with contiguity reflecting a shared land or river border.

The Stochastic Challenge

[Table 3 about here]

The first analysis involves the impact of past conflict on the probability of militarized dispute recurrence, or in other words, the question of whether or not conflict begets conflict. According to the stochastic model proposed by Gartzke and Simon, there should be an identical probability of dispute recurrence across time and space, regardless of the history of past conflict between any two adversaries at any given point in time. According to the evolutionary model of rivalry, though, the probability of conflict at any given point in time should be increased by the amount of past conflict between the same adversaries *(ceteris paribus)*.

Table 3 indicates that the probability of conflict recurrence increases significantly with the length of the history of conflict between two adversaries, and is meant to address the evolutionary and stochastic hypotheses on past conflict. This table focuses on the first nine militarized disputes in a given series (the time during which a budding rivalry is becoming established), combining the tenth and subsequent disputes into a single category to reflect subsequent conflict patterns once rivalry is clearly established. Each row of the table lists the number of eligible years (or the number of years that began with the specified history of past conflict), the number of these years in which a stochastic model would predict the outbreak of militarized conflict (based on the overall dispute probability in the entire table listed in the final row), and the number of years in which a militarized dispute was observed (and the percentage of eligible years). The final column presents a Z-test to evaluate whether this observed proportion of years with militarized conflict is significantly different from what would be expected from a stochastic process in which dispute probability is identical across time, space, and past conflict history (based on the "total" row at the bottom of the table).

A recurrent militarized dispute breaks out in 4.40 percent of all eligible dyad-years between adversaries that have engaged in one recent dispute, for a total of 427 disputes in 9694 eligible years, when a constant probability of dispute involvement would lead us to expect 704 disputes (nearly twice as many as were observed); this result is highly significant ($Z = -13.96$, $p < .01$). A constant-probability model such as that proposed by Gartzke and Simon is fairly accurate for adversaries with either two or three recent disputes. After this point, though, the constant-probability model underpredicts conflict quite dramatically, predicting no more than half of the observed total of disputes for adversaries with six or more recent disputes (by which time many definitions would consider the adversaries to be enduring rivals). Every comparison after the third dispute results in a highly significant underprediction of dispute behavior, which mirrors the significant overprediction of dispute behavior for adversaries with little history of past conflict. The constant-probability model thus performs quite poorly overall, indicating that there appear to be important differences in dispute probabilities based on the history of past conflict between two adversaries -- and offering strong support for the evolutionary approach's hypothesis over that

based on the stochastic model.

The lower half of Table 1 examines the other central element of the evolutionary approach to rivalry, which focuses on details of the most recent confrontation between two states. As with the first analysis, the stochastic model's expectation of constant probabilities of dispute recurrence does not appear to be borne out. For relations following a stalemated outcome, the constant-probability model underpredicts by 226 cases, indicating that adversaries in such circumstances are much more conflict-prone than we would expect ($Z = 8.74$, $p < .001$). This model then overpredicts substantially for both decisive outcomes ($Z = - 9.45$, $p < .001$) and compromise outcomes ($Z = - 3.21$, $p < .01$), which is consistent with the evolutionary model's expectation that such outcomes should reduce the adversaries' propensities for future conflict. These results offer additional evidence in support of the evolutionary model's expectations about dispute outcomes, and further evidence against the stochastic proposition the dispute probabilities remain constant regardless of the amount or details of past conflict.

The Exogenous Challenge

[Tables 4 and 5 about here]

Tables 4 and 5 break down the results from Table 1 by the contiguity status of the adversaries, calculating base rates for dispute probabilities separately for contiguous and noncontiguous dyads in order to determine whether similar evolutionary dynamics hold for both groups. The exogenous model would suggest that there should be no systematic difference in conflict behavior over time within each group, because the nature of the groups -- contiguity in this case -- explains the groups show such different behavior. The results continue to support the hypothesis based on the evolutionary model, as both contiguous and noncontiguous adversaries show dramatic changes in conflict behavior based on the history of past conflict. A constant-probability model dramatically overpredicts the probability of militarized conflict between adversaries with little history of conflict, and underpredicts conflict between adversaries with lengthy history of past conflict. Thus, while there are substantial differences in the raw probabilities of conflict between contiguous and noncontiguous adversaries, both groups show the same general pattern of increasing dispute propensity with a longer history of past conflict.

The results presented in Tables 4 and 5 again generally support the expectations of the evolutionary approach with regard to past dispute outcomes, with five of the six tested relationships producing highly significant ($p < .001$) differences from what would be expected based on the overall dispute probability. The one exception is the impact of compromise outcomes for noncontiguous adversaries, which overpredict the number of disputes by one-fourth, a difference that narrowly misses conventional levels of statistical significance ($Z = - 1.41$, $p < .08$)

Summary

This brief analysis has attempted to compare basic expectations about dispute-to-dispute processes from the evolutionary, stochastic, and exogenous models of rivalry. Using both the

general expectation regarding the number of past disputes and expectations about specific dispute characteristics, the evolutionary model appears to outperform both the stochastic and exogenous models in each table. Both these general and specific effects receive strong support relative to the stochastic model's expectations of constant probabilities of conflict across time and space. Additionally, both effects apply when the analysis is split by the contiguity of the participants, casting doubt on the exogenous model's expectation that observed patterns of conflict recurrence or rivalry can be explained by some outside factor such as contiguity.

Conclusions and Implications

In concluding their article, Gartzke and Simon (1999: 794) warn that readers should not "treat as too serious the overall implication of the test," and that "it would be precipitous to claim that enduring rivalries do not exist." This paper's analysis has suggested that these caveats are appropriate, and that scholars should be wary of claims that observed rivalry processes are best accounted for -- theoretically or empirically -- by stochastic processes.

The Gartzke and Simon critique has played a useful role in the study of rivalry by raising a fundamental question that must be addressed by rivalry-related research. Portions of the rivalry literature have accepted a causal linkage between disputes without any empirical testing or theoretical consideration, which is an unacceptable simplification when this linkage forms the central basis for the entire line of research. Yet much of the rivalry literature has advanced and tested specific theoretical models that account for the origins of rivalry, which are generally ignored in Gartzke and Simon's criticism of a single theoretical "enduring rivalries approach."

For a variety of both theoretical and empirical reasons, Gartzke and Simon's simulation has been of only limited value. Research design problems mean that the stochastic model appears to predict a very accurate number of rivalries, wrongly suggesting that we do not need a more complicated theoretical explanation for the apparent phenomenon of "enduring rivalry." Yet when the application of stochastic processes of militarized conflict recurrence is brought into line with the actual definitions of enduring rivalry that have been used in rivalry-related research, the stochastic model's predictions appear to lose much of their accuracy. Even beyond this research design problem, Gartzke and Simon's application of the stochastic model is unable to rule out any of the more established theoretical approaches as explanations for the observed empirical results. In short, this simulation has been unable to address their central question of whether or not there is any systematic relationship between militarized disputes within the same rivalry-like series.

Several brief analyses further suggest that Gartzke and Simon's stochastic and exogenous critiques of rivalry -- while they raise important questions that should be considered -- do not offer strong explanations for militarized conflict behavior. Indeed, in head-to-head tests of important expectations of each model, both of these models are outperformed by the evolutionary model, offering evidence that is more consistent with a systematic relationship between militarized disputes than with a stochastic process or with a process dominated by exogenous factors such as contiguity.

Because of the weaknesses of Gartzke and Simon's simulation, the main contribution of their article lies in its raising of a potentially important issue rather than in its answer to that issue. Thus, it is valuable that Gartzke and Simon have proposed the stochastic and exogenous models as an explanation for rivalry -- but for the study of rivalry to advance theoretically, these models must be compared head to head with their existing competitors, in order to determine which model (or models) best accounts for the origins of rivalry. I now consider several ways in which such advances can be made, focusing on testable implications of different model.

This study's brief analyses have identified important differences between the evolutionary model and the stochastic and exogenous alternatives. Much more sophisticated analyses could be run to evaluate the differences between these models, though; the purpose in this paper was simply to undertake an exploratory study highlighting a basic difference between each model. Similarly, the punctuated equilibrium model can be compared more directly with the stochastic and exogenous models by considering the number of rivalries that begin in periods following hypothesized types of shocks, as well as by modifying Gartzke and Simon's Poisson simulation to consider the number of dyad-years following various types of shocks in which enduring rivalries could begin. If rivalries are substantially more likely to begin after shocks than in other historical periods, then we could gain confidence in the punctuated equilibrium model as an explanation of rivalry origins; evidence that shocks have little impact on rivalry origins would be more consistent with the stochastic model.

Moving beyond the stochastic model, it would be desirable to flesh out the exogenous model in much greater detail. Gartzke and Simon have been quite vague about the type of exogenous factors that might account for conflict behavior and eventually rivalry, specifically mentioning only contiguity. If specific exogenous factors could be identified, then Gartzke and Simon's simulations could be modified to consider the differential probability of militarized conflict (and rivalry) in the presence and absence of the exogenous factors in question; their current simulations have been unable to address the exogenous critique. Additionally, identifying such factors would allow head-to-head comparisons of the exogenous model with other alternatives; this would be a valuable way to evaluate what might best be described as Gartzke and Simon's (1999: 784) assumption that exogenous factors are more likely to account for dispute processes than are evolutionary dispute-to-dispute relationships. Without such direct comparisons of competing models, the study of rivalry will be unable to advance meaningfully, with or without critiques such as those introduced by Gartzke and Simon.

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Table 1: Israeli-Syrian Militarized Disputes and "Enduring Rivalry Sequences"

Year of MID	New Gartzke & Simon "Enduring Rivalry Sequence"?
1948	Yes (began a sequence of ten MIDs in twenty years)
1951	Yes (began a sequence of nine MIDs in twenty years)
1954	Yes (began a sequence of ten* MIDs in twenty years)
1955	Yes (began a sequence of ten* MIDs in twenty years)
1957	Yes (began a sequence of ten* MIDs in twenty years)
1962	No (less than 20 years of rivalry behavior before data ends)
1964	No (less than 20 years of rivalry behavior before data ends)
1966	No (less than 20 years of rivalry behavior before data ends)
1967	No (less than 20 years of rivalry behavior before data ends)
1968	No (less than 20 years of rivalry behavior before data ends)
1972	No (less than 20 years of rivalry behavior before data ends)
	No (less than 20 years of rivalry behavior before data ends)
1973	No (less than 20 years of rivalry behavior before data ends)
	No (less than 20 years of rivalry behavior before data ends)
1974	No (less than 20 years of rivalry behavior before data ends)
1976	No (less than 20 years of rivalry behavior before data ends)

* As described in the text, multiple MIDs in the same dyad-year are excluded for consistency with Gartzke and Simon's operationalization, so these figures are lower in this table than in the original observed data.

Notes

• This table is based on version 1 of the COW militarized interstate dispute data set (Gochman and Maoz 1984), which covers the years 1816-1976.

• A new "rivalry" is considered to begin in any year when a militarized dispute begins that starts a sequence of at least six disputes within at least twenty years, with no greater than a fifteen year gap between any two disputes in the sequence; sequences with less than six disputes, less than twenty years total duration, or one or more gaps of greater than fifteen years do not qualify.

Table 2: Frequency of Gartzke and Simon "Enduring Rivalry Sequences" (1816-1976)

Rival States	Years	MIDs	"Rivalries"
USA - Haiti	1869-1891	6	1
USA - Mexico	1836-1893	16	10
USA - Ecuador	1952-1972	7	1
USA - UK	1837-1861	9	2
USA - Spain	1850-1875	11	3
USA - USSR	1946-1973	12	3
USA - China	1949-1974	11	2
Ecuador - Peru	1893-1955	14	9
Peru - Chile	1871-1921	7	2
Brazil - UK	1826-1863	6	1
Bolivia - Paraguay	1906-1938	10	2
Bolivia - Chile	1857-1884	7	2
Chile - Argentina	1873-1902	7	2
UK - Italy	1911-1943	7	1
UK - Russia	1877-1923	12	5
UK - Turkey	1876-1923	11	6
Belgium - Germany	1912-1940	8	2
France - Germany	1905-1945	9	4
France - Italy	1912-1943	7	1
France - Turkey	1880-1923	7	2
France - China	1860-1915	8	3
Italy - Yugoslavia	1923-1953	6	1
Italy - Turkey	1880-1926	15	5
Greece - Turkey	1853-1922	15	10
Russia - Turkey	1876-1921	9	4
Russia - China	1898-1929	9	2
Russia - Japan	1895-1976	17	12
Iraq - Israel	1948-1973	6	1
Egypt - Israel	1948-1974	12	3
Syria - Israel	1948-1976	16	5
Jordan - Israel	1948-1970	8	1
Afghanistan - Pakistan	1949-1974	6	1
China - Japan	1874-1943	13	7
China - India	1950-1975	10	1
India - Pakistan	1947-1971	18	4
India - Nepal	1950-1969	6	1
Thailand - Cambodia	1954-1976	11	1
TOTAL			N=123

Notes

• "Years" and "MIDs" indicate the years that a militarized relationship endured and the number of militarized interstate disputes that occurred during that period. These columns are included for informational purposes only, to indicate the extent to which Gartzke and Simon's simulation methodology distorts the number of rivalry-like sequences by counting a single Goertz and Diehl rivalry as multiple qualifying sequences. See notes from Table 1 for other details on data sources and measurement.

Table 3: Past Conflict and Militarized Dispute Recurrence

A. General Conflict History

Past Disputes in Series	Eligible Years	Expected MID Years	Obs. MID Years (% Eligible)	Z
1	9,694	704	427 (4.40%)	- 13.96***
2	3,271	238	255 (7.80)	- 1.08
3	1,963	143	172 (8.76)	0.71
4	949	69	121 (12.75)	4.94***
5	670	49	87 (12.99)	4.37***
6	422	31	62 (14.69)	4.74***
7	274	20	57 (20.80)	7.48***
8	282	20	44 (15.60)	4.43***
9	158	11	37 (23.42)	6.87***
10+	1116	11	302 (22.30)	22.67***
Total	18,799		1564 (8.32)	

* p < .10; ** p < .05; *** p < .01

B. Most Recent Dispute Outcome

Dispute Outcome	Eligible Years	Expected MID Years	Obs. MID Years (% Eligible)	Z
Decisive	5,080	443	253 (4.98%)	- 9.45***
Stalemate	8,377	730	956 (11.41)	8.74***
Compromise	1,544	135	99 (6.41)	- 3.21***
Total	15,001		1308 (8.72)	

* p < .10; ** p < .05; *** p < .01

Table 4: Past Conflict and Dispute Recurrence in Contiguous Dyads

A. General Conflict History

Past Disputes in Series	Eligible Years	Expected MID Years	Obs. MID Years (% Eligible)	Z
1	1942	221	157 (8.08%)	- 6.48***
2	1102	126	115 (10.44)	- 2.57***
3	794	90	89 (11.21)	- 1.53*
4	485	55	62 (12.78)	- 0.17
5	349	40	50 (14.33)	0.71
6	216	25	35 (16.20)	1.38*
7	122	14	33 (27.05)	4.60***
8	145	17	26 (17.93)	1.75**
9	94	11	23 (24.47)	3.29***
10+	96	11	19 (19.79)	11.00***
Total	5345		609 (11.39)	

* p < .10; ** p < .05; *** p < .01

B. Most Recent Dispute Outcome

Dispute Outcome	Eligible Years	Expected MID Years	Obs. MID Years (% Eligible)	Z
Decisive	1180	157	96 (8.14%)	- 5.25***
Stalemate	3225	430	533 (16.53)	5.35***
Compromise	757	101	59 (7.79)	- 4.48***
Total	5162		688 (13.33)	

* p < .10; ** p < .05; *** p < .01

Table 5: Past Conflict and Dispute Recurrence in Noncontiguous Dyads

A. General Conflict History

Past Disputes in Series	Eligible Years	Expected MID Years	Obs. MID Years (% Eligible)	Z
1	7,752	426	270 (3.48%)	- 9.81***
2	2,169	119	140 (6.45)	0.57
3	1,169	64	83 (7.10)	1.33*
4	464	25	59 (12.70)	5.87***
5	321	18	37 (11.53)	4.00***
6	206	11	27 (13.11)	4.14***
7	152	8	24 (15.79)	4.94***
8	137	8	18 (13.14)	3.40***
9	64	4	14 (21.88)	5.23***
10+	52	3	14 (26.92)	18.13***
Total	12,486		686 (5.49)	

* p < .10; ** p < .05; *** p < .01

B. Most Recent Dispute Outcome

Dispute Outcome	Eligible Years	Expected MID Years	Obs. MID Years (% Eligible)	Z
Decisive	3900	246	157 (4.03%)	- 5.85***
Stalemate	5152	325	423 (8.21)	5.64***
Compromise	787	50	40 (5.08)	- 1.41*
Total	9839		620 (6.30)	

* p < .10; ** p < .05; *** p < .01