Just part of the game? Arms races, rivalry, and war

Toby J Rider, Michael G Findley and Paul F Diehl

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Toby J Rider

Department of Political Science, Texas Tech University

Michael G Findley

Department of Political Science, Brigham Young University

Paul F Diehl

Department of Political Science, University of Illinois at Urbana-Champaign

Abstract

In this study, we look at the relationship of arms races to war, with appropriate consideration of rivalries. Are arms races more common in rivalries than in lesser competitions? Are they merely a consequence of rivalry competitions? How do the patterns of arms races map with those of war in rivalries? We explore these concerns with an empirical examination of rivalry and non-rivalry populations in the 1816–2000 period. In brief, we find that: arms races occur most frequently in the context of enduring rivalries; arms races are more likely in the middle and later stages of rivalry; the frequency of arms races is higher in rivalries with war than rivalries that do not experience war; and only when arms races occur in the later phases of rivalries is there an increased chance of war. Our study narrows the scope of the arms race–war relationship relative to past studies, demonstrating that the arms race–war relationship is conditional on rivalry processes.

Keywords

arms races, conflict, Heckman selection model, rivalry

Introduction

Arms races are deemed by scholars and policymakers alike to be critical phenomena in the process of war. Significant scholarly attention has been devoted to whether arms races lead to war or not, with the debate extending over decades (Huntington, 1958; Wallace, 1979; Diehl, 1983; Morrow, 1989; Werner & Kugler, 1996; Sample, 1997, 2002; Gibler, Rider & Hutchison, 2005). Despite claims otherwise (Werner & Kugler, 1996; Sample, 1997), the issue is not fully resolved, although the grounds for debate have shifted. Previous concerns focused on data issues and methodology. More recently, scholars agree that a modest positive relationship between arms races and war exists (Sample, 1998; Gibler, Rider & Hutchison, 2005; Senese & Vasquez, 2008), but there is some dispute over what this association represents. It could be that arms races exercise a causal effect on dispute escalation; yet, they also might be epiphenomenal and therefore only have a spurious association with war. Diehl & Crescenzi (1998) argue that arms races are related to war only indirectly: both are products of enduring rivalry competition (a similar point is made by Kennedy, 1983). That is, arms races occur primarily in enduring rivalries, and enduring rivalries are the context under which a disproportionate number of wars occur (Diehl & Goertz, 2000). At best, however, those authors provide only preliminary and suggestive evidence that this is the case.

In this study, we examine the relationship of arms races to war, with appropriate consideration of rivalries.

Corresponding author:
toby.rider@ttu.edu

Are arms races more common in rivalries than in lesser competitions? Are they merely a consequence of rivalry competitions? How do the patterns of arms races map with those of war in rivalries? We explore these concerns with an empirical examination of rivalry and non-rivalry populations in the 1816–2000 period.

Such an examination makes a number of contributions to different research milieus in the study of international conflict. First, this analysis provides a more explicit test of Diehl & Crescenzi's (1998) claim that enduring rivalries are the phenomena driving both arms races and war. This has obvious implications for the substantive importance, or lack thereof, of the arms race–war association. Second, the analysis provides insights into the dynamics of rivalries; indeed, most if not all major theoretical approaches to rivalries share expectations about the occurrence and timing of arms races in rivalries. Finally, we also add to the knowledge about the causes of arms races; heretofore, most analyses have focused on Richardsonian reaction processes, which have not been especially successful empirically and beg the question of how arms competitions begin (an exception is Rider, 2009).

The arms race–war debate and its parameters

The empirical literature on the 'arms races to war' relationship was, for many years, dominated by methodological debates. In response to Wallace's (1979) finding that arms races have a strong relationship with the escalation of disputes to war, a number of studies appeared critiquing Wallace on research design grounds (for a summary, see Siverson & Diehl, 1989). Sample (1997, 2002) helped resolve much of the controversy by conducting a variety of tests, holding the measure of military buildups constant while employing different conflict datasets. Her findings have led even critics to acknowledge that 'arms races have a modest, positive, and significant association with dispute escalation' (Diehl & Crescenzi, 1998: 111). Because of the protracted methodological debate, theoretical explanations tying arms races to war developed only in some research areas, such as the steps-to-war thesis (Senese & Vasquez, 2008). Yet many unanswered theoretical concerns accumulated, none of which is more important than what this emerging consensus about the empirical relationship really means.

Diehl & Crescenzi (1998) raise the fundamental question of whether the arms race–war connection is substantively meaningful or spurious. Answers to this question largely begin with theory, but this literature has been plagued by overly inductive approaches devoid of theoretical specification (Siverson & Diehl, 1989). Diehl & Crescenzi (1998) offer three possible answers to the question. First is a direct and causal connection between arms races and war. Those who argue that arms races 'cause' war cite a host of connections between the two. These include the claims that arms races increase the influence of the military in decisionmaking (Noel-Baker, 1958), lower trust (Sample, 1996), exacerbate the urge for pre-emption (Lambelet, 1975; Morrow, 1989; Weede, 1980), and encourage the use of shortcuts that result in misperception (Jervis, 1976). Yet such explanations are largely *post-hoc* claims that are not directly subject to testing. Somewhat implicitly, Sample (2000) argues that prevailing international norms affect the arms race–war relationship, a point echoed by Senese & Vasquez (2008). This is consistent with the finding that the arms race–war relationship was stronger prior to World War II and the development of nuclear weapons. Yet this is better at explaining why the arms race–war relationship changed with the advent of nuclear weapons than in accounting for why it occurred in prior periods.

A second posited connection between arms race and war is indirect, reflected most notably in deterrence theory (Weede, 1980; Glaser, 2000). Three significant problems arise, however. First, at best, arms races are connected to deterrence only in how they affect capability distributions. Yet, many arms races will not necessarily enhance the relative capabilities of the status quo state, and capabilities are only one component of successful deterrence anyway. Second, most of the research on arms races has connected them to dispute escalation. That a militarized dispute has already occurred indicates a failure of general deterrence, however, and arms races would seem to be less relevant to immediate deterrence. Third, there is little empirical evidence that arms races promote peace; the scholars most skeptical of the original Wallace studies find that arms races have *no* relationship with war rather than a pacifying effect. Thus, the indirect connection between arms races and war through deterrence is theoretically weak and empirically unverified.

The third possibility is that arms races and war are the joint products of some other process. Diehl & Crescenzi (1998) suggest that it is enduring rivalries that produce the other two phenomena. In their preliminary investigation into Sample's (1997) arms race cases, Diehl & Crescenzi (1998) find that the arms race–war connection is strongest in the context of enduring rivalries. They also note that all but one of the arms race–war cases among non-enduring rivalries were so-called contagion cases, in which the states joined an ongoing war between two or more major powers, rather than choosing to go to war with each other exclusively and directly. Although these findings are suggestive,

they are far from determinative. On the one hand, the authors never test whether arms races are more common in enduring rivalry contexts than in lesser rivalries. In addition, they did not provide any theoretical explanation for the rivalry connection to arms races and wars, providing only some inductive evidence about the latter.

Valeriano (2003) explores the rivalry–arms race connection through a 'power-politics' theoretical framework. His theoretical approach builds on an earlier version of the Senese & Vasquez (2008) Steps-to-War model, and posits that *realpolitik* practices (including military buildups) increase the probability that two states will become rivals. Valeriano hypothesizes that arms races should occur early in the life of the rivalry (the opposite of what we expect below), and finds little empirical support for this. Valeriano (2003: 207) states, 'It is clear from this analysis that .... mutual military buildups occur late in the life of enduring rivalries.' He concludes (2003: 321) 'The main negative finding ... remains that mutual military buildups are not necessary conditions of rivalry, and furthermore, they do not occur early in the life of a rivalry. It is likely that mutual military buildups are sometimes symptoms of rivalry, rather than factors that promote the development of rivalry.'

Gibler, Rider & Hutchison (2005) attempt to sort out the rivalry, arms race, and war connection, but focus only on whether a rivalry process was responsible for the war, rather than the arms race. They use rivalries as a case selection device rather than as a primary explanatory factor, hoping to test deterrence theory more effectively. By using a list of strategic rivals (Colaresi, Rasler & Thompson, 2007), however, they cannot separate out the effects of various stages of rivalry on arms race and war involvement. Consequently, they also do not identify any theoretical explanation for why rivalries might encourage arms races and wars.

In summary, some progress has been made sorting out the empirical relationship between arms races and war. Yet much remains about understanding what that connection means. Most notable is Diehl & Crescenzi's (1998) unverified suggestion that rivalries drive arms races and the connection with war is therefore spurious. Some recent studies have begun to address rivalry concerns, but do not directly address the issues raised in their article. Our aim is to fill that gap and we appropriately begin with a theoretical specification of the relationship as a prelude to empirical testing.

Connecting arms races, rivalries, and war

In order to assess the connection between rivalries, arms races, and war, it is essential to begin with a theoretical framework, rather than inductively (and often blindly) searching for it. We begin with much of the work conducted on international rivalries. Several different theoretical formulations exist about rivalries, most prominently the punctuated equilibrium (Diehl & Goertz, 2000) and evolutionary (Hensel, 1999; Maoz & Mor, 2002) models, respectively. Although they diverge on a number of points, they share a series of assumptions about the processes of rivalry development, and therefore the function of arms races in the rivalry competition.

Most conceptualizations regard rivalry as a process that proceeds through a life-cycle made up of several stages: onset, maturation, stasis, and termination (Diehl & Goertz, 2000; Thompson, 2001). Key elements of rivalries are that they are not anonymous (i.e. actions are specifically directed at the other rival), and they include both the 'push of the past' and the 'pull of the future' (Klein, Goertz & Diehl, 2006). That is, previous interactions and expectations of future interactions respectively influence the dynamics of rivalries. The latter is especially relevant here, as rivals develop expectations that they will face security threats into the extended future from their rival. Given that rivalry termination is abrupt and often unforeseen (Diehl & Goertz, 2000), the shadow of the future for rivals is undefined.

What do non-anonymity and long-term strategies in rivalries suggest for the onset of arms races? Our first contention is that arms races are likely to be confined to long-term or mature rivalries. In order to increase weapons or manpower, states must explicitly make decisions and provide allocations to pay for them, processes that may take a significant period of time, especially when the approval of government legislative bodies is involved. Most importantly, weapons development and military recruitment take time to reach fruition. For example, acquiring more fighter planes or aircraft carriers takes many years from the initial decision through the manufacture, delivery, and actual deployment of the weapons. By definition, arms races are also not single-year events; rather, they signify competition over extended periods of time. In effect, states do not choose to build up their militaries to meet immediate threats. Instead, military buildups are a series of ongoing actions that respond to long-term military concerns. In contrast, alliances are also designed to address long-term security needs, but alliances are much easier to arrange quickly and therefore can have more immediate effects; weapons acquisition involves a significant lag time. This is consistent with Vasquez (2005) who finds that alliances formed early in the India–Pakistan rivalry, whereas arms races occurred later.

In general then, arms races make sense as a strategy only in the context of long-term military threats, evidenced by an enduring rivalry. Short-term military threats or single crises may prompt arms races, but only if a long-term threat is perceived. Moreover, any arms race may only be evident years after those events. Indeed, if no rivalry develops, short-term crises will fade away and any arms races will likely be aborted. Thus, our first hypothesis is that arms races will occur disproportionately in the context of mature rivalries. We argue that rivalries are the process, and arms races are a consequent strategy, rather than the reverse.

If arms races are strategies to address extended rivalries, at what point in rivalries would states adopt such a strategy? At the earliest stages of a rivalry, states may not recognize that a rivalry exists and that they must adopt long-term strategies. Virtually all theoretical and empirical work on rivalries suggests that arms races are very *unlikely* in the earliest stages of a rivalry. Indeed, we hypothesize that arms races are most likely to occur in the middle or later stages of a rivalry, after it has been firmly established. Furthermore, in a later stage of an extended rivalry, states will reach the limits (resources, defense burdens, and the like) of an arms race strategy and therefore abnormal military spending increases should cease. Thus, we posit a curvilinear relationship between the age of a rivalry and the propensity for arms races.

The evolutionary model of rivalries (Hensel, 1999) postulates that the early phase of competition determines whether the relationship develops into a mature rivalry. Some rivalries are resolved quickly because one side prevails or compromises are reached. Similarly, Maoz & Mor (2002) argue that states learn from their interactions early in a rivalry. Only when there are a series of deadlocks or stalemates in these confrontations do positions harden and mature rivalries develop. Most rivalries 'die' in their nascent stages and therefore states have little need to adopt long term strategies of arms races. Even among those rivalries that do mature, the rivals do not yet recognize themselves as being in a long-term competition and therefore have not yet adopted policies of enhancing their military capabilities. Thus, the evolutionary model is consistent with arms races occurring in later phases of rivalry.

Similarly, the punctuated equilibrium model of rivalries (Diehl & Goertz, 2000) assumes an organizational, policy model of decisionmaking. The punctuated equilibrium model expects repeated conflicts as governments 'lock into' rivalry policies that are difficult to change over the course of the rivalry. Indeed, this is why it takes a major 'political shock' to break such patterns and for the rivalry to terminate. In the punctuated equilibrium framework, rivalries enter a 'lock-in' phase early in their existence, as interactions between the rivals establish the patterns that will characterize the rivalry thereafter. In this phase, decisionmakers take lessons from their interactions and begin to plan for the future. In the punctuated equilibrium logic, arms races occur following the lock-in phase and would be reflected beginning in the middle stages of the rivalry. By this time, rivalry policies have been established and defense and other policy matters have been adjusted to reflect long-term security concerns. Providing some empirical confirmation to the punctuated equilibrium model is McGinnis & Williams (2001) explanation of the arms acquisition patterns in the USA–USSR rivalry. They contend that the rivals did not react to one another in some sort of Richardsonian process. Rather, a rivalry is sustained by an underlying process by which the rivalry becomes institutionalized. Bureaucracies and planning based on belief systems become ingrained and are hard to change as expectations harden. Arms acquisition then occurs as an ongoing policy in response to the perceived threat, not as the spiral model (Jervis, 1976) describes.

The preceding discussion argues that arms races are a consequence of rivalries, but this still leaves the question of where war fits into the equation. In the evolutionary model, militarized disputes increase in frequency as the rivalry progresses (Colaresi, Rasler & Thompson, 2007). Furthermore, those disputes have a higher likelihood of escalating to war than those taking place earlier in the rivalry (Hensel, 1999). This is because the outcomes of previous disputes, the issues at stake, and adversary characteristics all contribute to the changing context of rivalry, making the rivalry more conflictual and violent (Colaresi, Rasler & Thompson, 2007), not because of any arms races taking place at the same time. Accordingly, the arms race–war connection is a function of the coterminous presence of military buildups and more frequent as well as dangerous disputes later in the rivalry.

The punctuated equilibrium model tells a different story, although one with a similar punchline. War is not thought to be any more likely to occur at one stage of a rivalry rather than another; Diehl & Goertz (2000) report outbreaks of war at the beginning, middle, and ends of rivalries. Thus, within enduring rivalries, there should be no relationship between the occurrence of arms races and war. How does one explain the empirical findings to the contrary? Punctuated equilibrium theorists might argue that arms races are more likely in enduring rivalries and wars are more likely in enduring rivalries, but there is no causal connection. Previous

studies do not take into account rivalry context, including many lesser or isolated rivalries in the analysis; these are largely negative cases (no arms race, no war cases) that drive the statistical significance of the relationship (Diehl & Crescenzi, 1998). When those cases are sorted out or controlled for in the analysis, the arms race–war association should disappear. Indeed, using a different population of rivalries as well as a different theoretical model, Colaresi, Rasler & Thompson (2007) initially find that arms races have an effect on war escalation only after several crises and in a period 10–15 years after the onset of the rivalry. Yet when controlling for other factors, arms races end up with only a very weak effect on the likelihood of war. Senese & Vasquez (2008), in testing aspects of the Steps-to-War model, make a related argument that a curvilinear relationship might exist in which the likelihood of war is highest during the middle of rivalry and find results that support this proposition. These recent studies suggest the plausibility of the idea that because wars occur mid-to-late in rivalry and arms races occur mid-to-late in rivalry, that both could be driven by mature rivalry.

In summary, we derive three theoretically interrelated and testable propositions. The first proposition asserts that arms races are more frequent in rivalries than in other populations. The second concerns the timing of arms races: military build-ups are expected only after the two states realize they are in a rivalry competition, after it has 'locked-in'; the propensity for arms races, however, should diminish in the later part for the most extended rivalries. Third and finally, we expect that the arms race–war relationship is likely spurious to the rivalry process, with both arms races and the greater likelihood of dispute escalation occurring in the middle and later stages of the rivalry.

Identifying the key variables

Spatial-temporal domain and rivalries

Evaluation of the first proposition requires comparing arms race frequencies across several different populations. We first need to identify a general population in which there exists an opportunity for interaction, a necessary condition for an arms race. In the past, scholars have focused on 'politically relevant dyads' (PRD), those in which the two states are 'directly or indirectly contiguous and/or at least one of the states is a major power' (Lemke & Reed, 2001a: 127). Yet PRDs include pairs of states that are friendly toward one another and for whom mutual increases in military capability might be welcome rather than feared. Thus, we need a further qualification to ensure arms increases are viewed as potentially threatening, a situation consistent with the notion of an arms race. One way is to include only PRDs in which the two states have divergent foreign policy preferences. The similarity of foreign policy preferences is commonly measured according to the degree to which two states have similar alliance commitments; the tau-b statistic indicates the correlation of alliance portfolios (Bueno de Mesquita, 1975). Accordingly, we restrict our population of interest to PRDs with disparate foreign policy preferences, signified by those politically relevant dyads with a negative tau-b correlation (calculated using EUGene – Bennett & Stam, 2000). This selection process yields 1,992 unique dyads and 54,244 dyad-year observations over the period 1816–2000.[1]

For comparative purposes and in order to test our expectations, this general population is further divided into four mutually exclusive subpopulations. The first consists of dyads never having experienced a militarized dispute (Ghosn, Palmer & Bremer, 2004); there are 1,373 unique dyads never having experienced a militarized dispute, producing 29,695 dyad-year observations. This allows us to examine incidences of arms races outside of violent conflict, a set of cases absent from all previous analyses that focused exclusively on competitions surrounding militarized disputes or rivalries. Pairs of states experiencing isolated conflict make up the second subpopulation. Klein, Goertz & Diehl (2006) define two states as having experienced isolated conflict if those states engage in at least one and no more than two disputes, with each other, during the life of the dyad; this definition produces 403 unique dyads and 15,213 dyad-year observations. This second group (isolated conflict) allows us to detect arms races in the context of low-level conflict; the first group (no conflict history) captures instances in which arms competition might have produced general deterrence effects.

The last two subpopulations are interrelated – rivalry dyads and rivalry dyads during non-rivalry periods, respectively. In identifying rivalries, we rely on Klein, Goertz & Diehl (2006). For our purposes, the beginning and end of rivalries are marked by the dates of the first and last militarized disputes in the rivalry sequence. We identify 192 unique dyads having experienced rivalry

[1] Actually, this process yields 72,872 dyad-year observations but missing data on the military expenditures variable, most often during major power wars, used to identify arms races restricts the population to 54,244 dyad-year observations.

Table I. Arms race frequencies in PRD with negative tau-b scores: 1816–2000*

		Arms race onset		χ2	Probability	
	Dyad years	Realized	Expected	pr	P()	%Δ
All PR dyads with neg tau-b	54,244	554	n/a	n/a	0.0102	n/a
No MID history	29,695	238	303	0.000	0.0080	−21%
Isolated conflict	15,213	182	155	0.011	0.0119	+16%
Rivalry						
Non-rivalry years	6,144	71	63	0.266	0.0115	+12%
Rivalry years	3,192	63	33	0.000	0.0197	+93%

*PRD = politically relevant dyads.

at some point, resulting in 220 unique rivalries with negative tau-b scores, generating 3,192 rivalry-dyad year observations.[2] The fourth category is simply the non-rivalry years of the aforementioned rivalry dyads. All years before rivalry onset and after rivalry termination for the identified rivalries are coded as 'rivalry dyads during non-rivalry years'. There are 6,144 dyad-year observations for rivalry dyads during non-rivalry years. The last two categories provide almost a natural experiment in which we can compare arms race behavior during and outside rivalry, holding the states in question and many other associated elements constant (see Diehl & Goertz, 2000, on the rivalry approach).

Arms races

A lengthy debate has taken place in the literature regarding how best to measure an arms race. We do not wish to revisit this debate, but we need to identify an indicator that allows us to test our propositions and promote the integration of our results with prior findings. Wallace's (1979, 1982) index is not replicable and suffers from a number of other shortcomings (Weede, 1980; Diehl, 1983). Other approaches have more validity (Sample, 1997) but are tied to the occurrence of a dispute; this is inadequate for our purposes, as we must be able to detect military buildups independent of violent conflict.

We adopt Diehl's (1983) straightforward and replicable definition of an arms race as 8% or more increases in military expenditures or personnel over at least 3 years by both states. This measure, and its similarity in outcome to other measures, provides a greater opportunity to integrate past results; we want to minimize the possibility that differences in our results are attributable to differences in measurement vis-à-vis past studies. We would like to use Gibler, Rider & Hutchison's (2005) modification of Diehl's index to capture the interdependence of arming efforts, but their measure is tied exclusively to rivalry characteristics and again not suited to our need to test for buildups among non-rivals or during non-rivalry periods. Thus, we must be content with the mutual military build-up measure, which we will refer to as 'arms races' hereafter for purposes of consistent terminology.[3] In the population of PRDs with a negative tau-b score, 554 unique cases of arms race onset are identified.

War

Consistent with previous studies, we define war according to the Correlates of War standard (Sarkees, 2000) of 1,000 or more battle-related fatalities using dyadic data (Maoz, 2005). Within the population of rivalries (the only ones in which war incidence is examined), there were 94 dyadic wars spread across 220 rivalries.

Empirical findings

The context(s) for arms races

The first proposition deals with the propensity for military buildups to cluster in rivalries. In order to evaluate this proposition, we compare the probability of observing an arms race across the four different subpopulations and against a baseline probability for the general population. The results of these comparisons are reported in Table I.

The baseline probability of two states experiencing an arms race in any given year is 0.0102; thus, such

[2] The reason 192 unique dyads produce 220 unique rivalry dyads is because a number of dyads experience more than one episode of rivalry.

[3] We fully acknowledge that the measure used here does not account for interdependence and, therefore, represents what others have called a mutual military buildup, rather than an arms race (see Diehl, 1983, and Gibler, Rider & Hutchison, 2005). We use the term arms race, rather than mutual military buildup, in order to maintain consistency with the theoretical literature and continuity throughout the paper.

increases are relatively rare events. For states that have never experienced a militarized dispute (with each other), the probability of an arms race is 21% lower than for the general population. Among states with only isolated conflict, there is a 16% increase over the probability in the general population. The last two populations capture dyads during rivalry and non-rivalry years. The probability of arms races for rival states during non-rivalry years is 0.0115, or 12% higher than the general population. This might suggest that some characteristics of such dyads put them 'at risk' for conflict above the general populations, but the difference is not statistically significant ($p = 0.266$). Most illuminating are those same states during periods of rivalry. There is a dramatic increase in the probability of an arms race while two states are rivals: 93% greater than the general population and 81% greater than when the same pair of states was not in a rivalry.[4]

Arms races are more frequent on average in dyads that experience militarized disputes and in particular when recurring conflict in the form of rivalries occurs. These findings generally confirm our initial expectations. Yet even though arms increases are much more likely in rivalries, arms races still occur with some frequency in other contexts. Our intuition is that most of these instances are false positives – cases of coincidental arming. We took a random sample of alleged arms race cases from the first two populations, namely those dyads with no conflict history or limited militarized dispute interaction. The results generally produce cases that lack face validity. Purported arms races occur between major powers and a number of other states (e.g. UK–Benin, Ivory Coast–China, El Salvador–Soviet Union) with no history of hostility, few interactions with one another, and little to fear (at least for one side) from arms increases. Although we restricted our analysis to PRDs with different foreign policy preferences, this clearly was insufficient to exclude all absurd cases. Even among the sampling of dyads that have experienced isolated military conflict, the cases do not seem to meet conventional conceptions of arms races. Many are cases in which a state (e.g. Egypt) joined a war (World War II) against another party (e.g. Germany). The arms race preceded the isolated conflict and indeed an examination reveals little threat connection between arms races and the subsequent war diffusion. Other cases seem more plausible (e.g. Germany and Spain in the 1930s), but some of the arms increases may be as much internally directed (e.g. Spanish Civil War) rather than indicative of responses to external threats.

Arms races are more likely in rivalries, and most likely there are a limited number of true arms races that occur outside of these competitions. To be sure, however, we took a random sample of arms races in the context of rivalry. In contrast to those cases outside of rivalry, a random sample of arms races in rivalry yields cases with strong face validity. These include the United Kingdom–Japan in the early 1930s (following Japan's intervention in Manchuria), Syria–Israel in the mid-1960s (prior to the Six Day War), and India–Pakistan from 1957 to 1959. These all represent cases in which there was imminent threat and the two states were clearly reacting to the escalating competition.

The timing of arms races in rivalry

Having established that arms races occur disproportionately in rivalries, we move to the second proposition derived from our theoretical argument: arms races occur in middle or later phases of rivalry rather than randomly or at the outset, but the propensity for arms races tails off as rivalries mature. There are several ways to gauge the 'age' of a rivalry and, therefore, what stage it is in at a given point in time. Most prominent are by reference to the number of militarized disputes that a dyad has experienced (Hensel, 1999) or the number of years passed since rivalry inception (Goertz, Jones & Diehl, 2005). In both cases, the assumption is that states learn through repeated violent interactions or the passage of time that a competition is not fleeting and therefore a protracted rivalry is likely.

In order to evaluate the relationship between rivalry age and arms races, we conduct a probit analysis with rivalry dyad-year as the unit of analysis. Arms race onset is the dichotomous outcome variable and 'age' is the number of previous disputes. Both squared and cubed dispute history terms are included to capture a hypothesized curvilinear relationship, where the probability of an arms race is low during the initial years of rivalry, begins to rise after the rivalry is locked-in and then begins to decrease again over time. Consistent with Rider's (2009) model of arms race onset, we include four control variables: contiguity, joint alliances, joint democracy, and relative military capabilities. Dummy variables are used to measure contiguity (Stinnett et al., 2002), joint alliances (Gibler & Sarkees 2004), and joint democracy (Marshall & Jaggers, 2002). Parity is a continuous variable ranging from 0 to 1, measured as the ratio of the weaker to the stronger state's capabilities (Singer, Bremer & Stuckey,

[4] These results are robust when using Diehl & Goertz's (2000) former rivalry categories: isolated, proto, and enduring.

Table II. Effects of MID history on arms race onset

	Model 1		*Model 2*	
MID history variables	*Coefficients*	*Standard errors*	*Coefficients*	*Standard errors*
MID history	−0.016*	(0.008)	−0.100*	(0.041)
MID history squared			0.007*	(0.003)
MID history cubed			−0.000*	(0.000)
Control variables				
Contiguity	0.048	(0.120)	0.086	(0.114)
Joint alliance	n/a	n/a	n/a	n/a
Joint democracy	0.101	(0.302)	0.102	(0.305)
ln(Capability ratio)	0.114*	(0.046)	0.110*	(0.045)
Constant	−1.806*	(0.138)	−1.670*	(0.168)
Log-pseudolikelihood	−303.612		−301.380	
Chi-square	9.83*		14.92*	
Pseudo-R^2	0.019		0.026	
N	3,177		3,177	

Entries represent probit estimates, with robust standard errors (for clustering on the dyad) in parentheses. *p <= .05.

1972). We normalize parity in the statistical analysis by taking the natural log of the capability ratio.

We estimate two models, one using the dispute history variable and the other including the transformed dispute history measures.[5] Both models are reported in Table II and produce the basic pattern hypothesized. In Model 1, there appears to be a negative relationship between the number of disputes and the onset of an arms race. When the transformed terms are added in Model 2, however, the hypothesized curvilinear relationship becomes evident. In the nascent stage of rivalry, there is a negative relationship between 'age' and arms race onset. As the rivalry matures, however, the probability of an arms race begins to rise and tails off toward the end of the rivalry.

Although these findings seem to support the second proposition, one must take caution in interpreting the results. Transformed terms, such as the squared and cubed duration terms, act as interaction variables in the model and should not be interpreted based on coefficients and significance tests (Brambor, Clark & Golder, 2006). Instead, the meaningfulness of these relationships should be interpreted by examining the substantive impact of changes in values of the constituent variables on the probability of arms race. The results of graphing the marginal effects appear in Figure 1.

The probability of an arms race is relatively high right at the onset of rivalry but then immediately drops precipitously. The plot indicates that the probability of an arms race decreases until about the 9th or 10th militarized interstate dispute. Many rivalries never reach that stage, although a majority of the enduring rivalries do (Diehl & Goertz, 2000). Once that phase of the rivalry is reached, the probability of an arms race then increases until the rival states reach about the 25th or 26th dispute. Only a handful of rivalries are as severe and last longer; in these 'most enduring' of rivalries, the probability again decreases and finally increases, although after the 40th dispute the statistical effect appears to be marginal as the lower bound of the confidence interval goes to zero. These results support the punctuated equilibrium logic with arms races appearing in the middle and later stages of mature rivalries, although the evidence for a lessening of arms race manifestation at the end of rivalries is less clear.

Evaluating the relationship between rivalry, arms races, and war

Previous studies examined the arms race–dispute escalation relationship, but we need to broaden that approach in order to test our third proposition about the relationships between rivalries, arms races, and war. We first

[5] We re-estimated the models using an alternative measure of 'age', the duration of the rivalry in years, and a similar decreasing-then-increasing pattern emerges. The only difference is that the subsequent decreasing pattern found using the cubed dispute history variable does not manifest itself with the cubed duration variable. We also re-estimated the analyses using an alternative rivalry list (Colaresi, Rasler & Thompson, 2007), which includes not only a different set of rivalries, but also rivalry beginning and ending dates not tied to militarized dispute occurrence. Substantively, the model produces robust results, but none of the dispute history variables is significant.

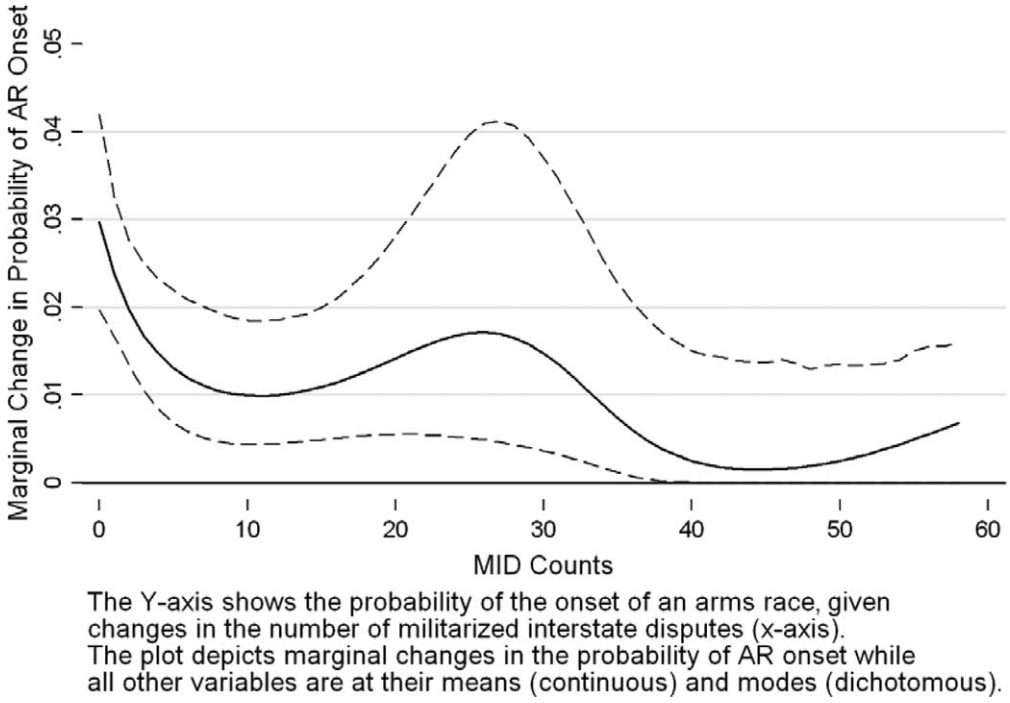

Figure 1. Marginal effect of MID counts on the probability of AR onset

Table III. Distribution of arms races and wars across rivalry dyads

	Rivalry dyads	*Percentage of rivals*	*Wars*	*Percentage of wars*	*Ratio wars/rivaly*
Totals	220	n/a	94	n/a	n/a
Rivalry dyads without AR*	167	75.90%	52	55.31%	31.14
Rivalry dyads with AR	53	24.09%	42	44.68%	79.25

*AR = arms race. There are 63 arms races in rivalry dyads with arms races.

divide the population of rivalries into rivalry dyads without arms races and rivalry dyads with at least one arms race. The number of cases in these categories and relative frequency of rivalries, wars, and arms races are given in Table III.

One hundred and sixty-seven rivalries never experience an arms race, or 75.90% of the entire population of rivals. Clearly, this indicates that the existence of rivalry does not automatically prompt an arms race. Arms increases may be unnecessary to address capability disparities or states may adopt alternative mechanisms, such as alliances, to address security threats from enemies. Fifty-two wars (55.31%) occur in this context, indicating that arms races are far from the necessary condition for conflict escalation that was implied in the original Wallace (1979) article. A greater number of wars occur in rivalry dyads without arms races (55.31%) than rivalry dyads with arms races (44.68%). Accounting for the relative size difference between these populations, the ratio of wars to rivalry dyads suggests that wars are much more likely in the context of rivalries with arms races; indeed, the ratio of wars to rivalry dyads with arms races is 79.25, compared to only 31.14 for those rival dyads without arms races. These numbers should be interpreted with caution, as it is difficult, based on the descriptive statistics alone, to determine causal ordering (i.e. whether the arms races temporally preceded the wars). Accordingly, we estimate a series of maximum likelihood models to determine systematically the relationship between arms races and war.

If the Diehl & Crescenzi (1998) story is correct, and the arms race to war relationship is actually spurious to the rivalry process, then controlling for the factors that influence participation in rivalry should eliminate the arms race to war finding. In order to test this proposition, we estimate a probit with selection, in which the first stage determines participation in rivalry and the second stage war onset. Lemke & Reed (2001b) propose that similar factors influence both rivalry participation

Table IV. Ongoing rivalry and war onset given an arms race in the last ten years

	Model 3	*Model 4*	*Model 5*
Y1: Rivalry			
Conflict controls			
Contiguity	0.643* (0.113)		0.643* (0.113)
Joint democracy	−0.446* (0.122)		−0.447* (0.121)
Joint satisfaction	−0.264 (0.371)		−0.265 (0.371)
ln (Capability ratio)	0.156* (0.035)		0.156* (0.035)
Shock variables			
Systemic shock	0.154* (0.049)		0.154* (0.048)
Domestic shock	0.127* (0.062)		0.126* (0.062)
Constant	−1.168* (0.320)		−0.543* (0.906)
Y2: War			
Arms race (10 years)		0.275* (0.117)	0.215* (0.102)
Conflict controls			
Contiguity		−0.070 (0.101)	−0.467* (0.175)
Joint democracy		0.059 (0.236)	−0.323 (0.221)
Joint satisfaction		0.330 (0.438)	0.399 (0.374)
ln (Capability ratio)		0.085* (0.046)	−0.042 (0.071)
Shock variables			
Systemic shock		n/a	n/a
Domestic shock		n/a	n/a
Constant		−2.170* (0.369)	−1.168* (0.321)
Rho	n/a	n/a	−0.716
Log-pseudolikelihood	−12173.479	−369.324	−12541.31
Chi-square	145.92*	16.05*	26.70*
Pseudo-R^2	0.145	0.017	n/a
N	62,438	3,773	Y1 =62,438 Y2=3,773

Entries for Models 3 and 4 are probit estimates; Model 5 entries represent estimates from a probit with selection. Robust standard errors are reported for clustering on the dyad. *p <= .05.

and escalation to war. Consequently, studies failing to account for the correlation between these two processes potentially produce misleading estimates regarding what factors prompt escalation to war.

Consistent with Lemke & Reed (2001b), we use a standard set of conflict control variables believed to affect both rivalry participation and escalation to war: contiguity, joint democracy, joint satisfaction with the system leader, and parity.[6] Contiguity and parity should be related to a higher probability of both rivalry and war. Joint democracy and satisfaction with the system leader should be negatively related to rivalry participation and escalation to war.

The second set of variables capture political shocks, using the measures and logic of Diehl & Goertz (2000), who found that major political shocks are related to rivalry onset and termination. They identify two primary types: systemic and domestic shocks. These major events can alter relations to bring about the end of an existing rivalry or lay the groundwork for the emergence of a new rivalry.[7] Both shock variables are dichotomous variables coded 1 if either state has experienced a shock in the last 10 years and 0 otherwise.

Estimation of the probit with selection requires the use of an extra variable in the selection equation, not included in the outcome equation (Sartori, 2003: 112). The 'exclusion restriction' helps the model differentiate between the effects of the independent variables on selection and the outcome. An appropriate exclusion restriction should be correlated with selection into the population (rivalry) but not with the outcome of interest (war). We use the shock variables as the exclusion

[6] Contiguity and parity are measured consistent with those in the previous section. Rather than a dichotomous variable, joint democracy and satisfaction are continuous variables ranging from 0 to 1, where 1 represents perfectly jointly democratic states and two states perfectly satisfied with the system leader (see Lemke & Reed, 2001b: 463).

[7] We also add the end of the Cold War as a systemic shock.

Table V. Ongoing rivalry and war onset given an arms race in the last ten years

	Model 6	*Model 7*	*Model 8*
Y1: Rivalry			
Conflict controls			
Contiguity	0.643* (0.113)		0.643* (0.113)
Joint democracy	−0.446* (0.122)		−0.446* (0.122)
Joint satisfaction	−0.264 (0.371)		−0.265 (0.371)
ln (Capability ratio)	0.156* (0.035)		0.156* (0.035)
Shock variables			
Systemic shock	0.154* (0.049)		0.153* (0.049)
Domestic shock	0.127* (0.062)		0.126* (0.062)
Constant	−1.168* (0.320)		−1.168* (0.320)
Y2: War			
Arms race (10 Years)		−0.562 (0.335)	−0.392 (0.310)
Conflict controls		−0.100 (0.102)	−0.481* (0.175)
Contiguity		0.037 (0.250)	0.301 (0.236)
Joint democracy			
Joint satisfaction		0.501 (0.452)	0.524 (0.389)
ln (Capability ratio)		0.092* (0.036)	−0.034 (0.074)
Shock variables			
System shock		n/a	n/a
Domestic shock		n/a	n/a
Rivalry phase			
Adolescence		−0.155 (0.135)	−0.108 (0.098)
Mature		−0.120 (0.126)	−0.066 (0.087)
ARX Adolescence		0.939* (0.387)	0.689 (0.373)
ARX Mature		1.212* (0.381)	0.879* (0.426)
Constant		−2.182* (0.394)	−0.613* (0.958)
Rho	n/a	n/a	−0.700
Log-pseudolikelihood^{r}	−12173.479	363.022	−12535.19
Chi-square	145.92*	32.55*	46.30*
Pseudo-R^2	0.145	0.034	n/a
N	62,438	3,773	Y1=62,438Y2=3,773

Entries for Models 6 and 7 are probit estimates; Model 8 entries represent estimates from a probit with 1 selection. Robust standard errors are reported for clustering on the dyad. *p <= .05.

restriction, leaving them out of the war onset equation. Rivalry research and models (Diehl & Goertz, 2000) indicate that shocks are associated with the onset of rivalries, but not with the outbreak of war in that context. Finally, we include an arms race variable in the war equation in order to estimate the effects of arms races on war onset given that the two states are rivals. The arms race variable is measured dichotomously, where 1 indicates that the two states have experienced an arms race in the last ten years and 0 otherwise.[8]

Before estimating the probit with selection, we first estimate two separate probit models as baselines for comparison. The first, Model 3 in Table IV, estimates the effects of contiguity, joint democracy, joint satisfaction, parity, and the two political shock variables on participation in rivalry. Model 4 estimates a probit analysis predicting war onset using the same set of variables (minus the shock variables) but adding the arms race variable. The determinants of rivalry participation, reported in Model 3, are as expected. Contiguity and parity are positive and statistically significant in relation to rivalry participation; joint democracy and satisfaction are negatively related to rivalry, although satisfaction is not statistically significant. Both types of political shocks are, as expected, positive and statistically significant in relation to rivalry participation. Model 4 estimates war onset in the

[8] The analyses reported in Table IV are also estimated using a stricter five, rather than ten, year window on the arms race variable. Although not reported, the findings are similar to those found using the ten year window.

context of rivalry and is also reported in Table IV. Consistent with previous findings in the literature positing a modest relationship (Sample, 1998; Gibler, Rider & Hutchison, 2005; Senese & Vasquez, 2008), the presence of an arms race is positive and statistically significant with war onset in the context of rivalry. All control variables, except parity, are in the opposite direction as predicted, but only parity is statistically significant. As rival states approach parity, they are more likely to experience war onset.

Model 5 is a probit with selection, estimating escalation to war given rivalry participation. The results from Model 5 are reported in Table IV and, as one would expect, the results from the rivalry stage are very similar to those reported in Model 3. This is because the first stage of the selection model is the equivalent of the standard probit model estimated in Model 3. Somewhat surprisingly, the results from stage two, the war onset stage, are also very similar to those reported in Model 4. The only real change is that parity switches signs but only one of the controls, contiguity, reaches statistical significance; contiguity has a negative effect on war onset. The key variable, arms race in the last ten years, remains positive and statistically significant with war onset.[9] The results suggest that arms races, even when one accounts for the rivalry process, are still correlated with the outbreak of war.

Although the previous models are reasonable tests of the relationship between arms races and war, a better test lies in looking at the role of the rivalry process in the arms race–war relationship. According to the theory and evidence provided for our second hypothesis, arms races are more likely in the middle to late stages of rivalry; thus, arms races are most likely to occur in the most enduring of rivalries. We also know from previous research that these enduring rivalries are the most conflict prone. It is possible that the arms races most likely to go to war are those that occur during the middle to late stages of enduring rivalries. Consequently, we re-estimate the models presented in Table IV but with variables that identify the phase of the rivalry in which an arms race occurs. Rivalry phase is measured consistent with Hensel (1999) – infancy (one or two disputes), adolescence (three to five disputes), maturity (six or more disputes). In addition, we include interaction variables between rivalry phase and the presence of an arms race. The expectation is that arms races that occur in the mid (adolescence) to late (mature) stages of rivalry should be more war prone than those occurring early in rivalry. The findings are reported in Table V.

Model 6 is essentially the same as Model 3 and, thus, does not warrant discussion. As well, the control variables in Models 6–8 behave similarly to those in Models 3–5; consequently, our discussion will focus exclusively on the new variables. Model 7 re-estimates war onset (Model 4) except that we now include four new dummy variables: one each for the two later rivalry phases, as well as interactions between those phases and arms races. A variable for the first phase is excluded from the analysis, acting as the baseline.

As should be clear from the results reported in Model 7, the phase in which the arms race occurs matters when predicting war onset.[10] The arms race component term is negative, suggesting that arms races that occur early in the life of the rivalry are unlikely to be followed by war; but the relationship does not reach conventional levels of statistical significance. Yet, the probability of war is 78% *lower* for an infant rivalry that has experienced an arms race as compared to rivalry in the same phase without an arms race.[11] In addition, rivalry phase alone appears to be a poor predictor of war. The interactions between arms race and the latter two, however, are both positive and statistically significant.[12] Arms races that occur in those phases are much more likely to go to war than those occurring in the first phase. An adolescent rivalry that has experienced an arms race has a 68% greater probability of war onset over the baseline; a mature rivalry has a 222% increase in the probability of war over the baseline.[13] Furthermore, later phase

[9] One explanation for the similarity between stage two of the probit with selection and the standard probit estimating war onset (Model 4) is that the Rho coefficient fails to reach statistical significance. An insignificant Rho implies that the separate processes of selection into rivalry and war onset are not related in a way that would bias our estimates if these equations were estimated separately.

[10] Consistent with the recommendations of Brambor, Clark & Golder (2006), we include predicted probabilities to facilitate the interpretation of the interaction terms in Model 7. Additionally, we conduct an F test on the joint hypothesis for the interaction between arms race and rivalry phase. The test suggests that the null hypothesis, coefficients on each term equaling zero, can be rejected.

[11] Percent change in probability is in reference to the baseline condition: a rivalry in infancy that has not experienced an arms race, with all control variables set at the mean (continuous variables) or mode (dummy variables). The baseline probability of war is 0.0193.

[12] We also estimate the model with a single 'advanced' rivalry variable, defined as rivalries that are in either of the latter two rivalry phases. The results are similar to those using separate variables for the adolescent and mature phases.

[13] The probability of war in the second phase with an arms race is 0.0324; the probability of war in a mature phase with an arms race is 0.0621.

rivalries that have experienced an arms race have a greater risk of war than similar rivalries that have not experienced an arms race. The probability of war increases by 147% when moving from an adolescent stage rivalry without an arms race to one with an arms race; a similar change from a mature rivalry without an arms race to one with an arms race increases the probability of war by 331%.[14]

In Model 8, Table V we again estimate a selection model to determine whether these relationships hold after accounting for selection into rivalry. Stage 1 of Model 8 yields results similar to Model 6 (as well as Model 3 and stage 1 of Model 5). Stage 2 of Model 8 and Model 7 are very similar, except that the interaction between arms race and adolescent rivalry is no longer statistically significant. Notably, the arms race component term is not statistically significant, indicating it exercises no independent impact on dispute escalation to war. The only significant impact of arms races is confined to the third phase of rivalry. Once one controls for rivalry phase, the significant findings on the arms race component in Table V disappear and the sign of the coefficient is reversed. Thus, only arms races that occur in the last stage of rivalry, those most enduring rivalries, are more likely to be followed by war than arms races that occur in earlier stages; nevertheless, the overwhelming majority of cases are likely to remain below the war threshold.

Summary and conclusion

The arms race–war debate has been one of the longest running, but perhaps least enlightening, debates among international conflict scholars. In this article, we set out to provide a theoretical explanation for the arms race–war connection that includes a central role for interstate rivalries rather than a direct causal relationship. In doing so, we are able not only to shed some light on the arms race–war debate, but also to provide a more complete picture of how arms races fit into the rivalry process. First, we are able to justify the long relied-upon assumption that rivalry is the appropriate population for studying arms races by providing evidence that arms races are more likely in the context of rivalry, and that those military buildups that occur outside of rivalry are likely episodes of coincidental arming. Indeed, the probability of an arms race increases by over 80% when moving from non-rivalry to rivalry. Furthermore, those military buildups that do occur in the context of non-rivalry appear to be cases of coincidental arming, rather than actual interdependent arms races.

Second, the probability of arms race occurrence increases after rivalry lock-in. The probability of an arms race increases after lock-in (around the 9th or 10th dispute) and continues to rise until late in the life of the rivalry (25th or 26th dispute), before decreasing again. Rival states likely view arms races as one of many tools for addressing the threat and competition inherent in a rivalry. The arms race represents a long-term commitment to the rivalry competition and, thus, is most likely after the two states recognize that they are in a rivalry and that it is likely to be enduring. Most nascent competitions end before states have a chance to make these types of long-term foreign policy commitments.

Third, the arms race–war relationship is conditional on the rivalry process. Recall that we started by outlining three potential logics for the arms race–war relationship drawn from the extant literature. The first suggested that arms races have a positive correlation with war, the second suggests a negative relationship, and the third that the relationship is spurious to the rivalry process. There is little evidence in the empirical literature that arms races have a negative relationship with war; even those critical of the positive relationship generally find no relationship rather than a negative one. The most consistent empirical evidence suggests a positive relationship. The theory provided in this paper argues that arms races are spurious to the rivalry process. The empirical analyses provided here suggest some truth in both of these claims. Accounting for the rivalry process does not eliminate the modest, positive relationship between arms races and war. It does appear, however, that accounting for the rivalry process is necessary for fully understanding the arms race to war relationship. Arms races that occur early in the life of the rivalry do not increase the likelihood of war; those that occur later, in the context of mature rivalry, do. Indeed, the probability of war in mature rivalries with arms races is higher than in mature phase rivalries without arms races.

These findings fit well with existing literatures on rivalry, arms races, and war. First, Gibler, Rider & Hutchison (2005) provide some of the most compelling evidence for the arms race–war relationship in the context of rivalry.

[14] The probability of war for an adolescent rivalry moves from 0.0131 to 0.0324 when there has been an arms race in the last ten years. The probability of war for a mature rivalry moves from 0.0144 to 0.0621 when there has been an arms race in the last ten years.

Second, these findings are consistent with the evolutionary approach to rivalry (Hensel, 1999), which predicts that escalation to war is most likely later in rivalry after repeated disputes. Third, our findings are consistent with the Steps-to-War (Senese & Vasquez, 2008) propositions that view arms races as *realpolitik* behavior that we should expect to observe later in the rivalry process and to increase the probability of escalation to war. This project builds on these findings by emphasizing that the rivalry process must be explicitly modeled in order to understand fully the rivalry–arms race–war relationship.

In sum, arms races are a competitive behavior most likely found in rivalry, increase in likelihood after rivalry lock-in has occurred, and are associated with war during the mid-to-later stages of the most enduring of rivalries. Although our analysis provides answers to key questions in the conflict literature, there are still important puzzles yet to solve. In particular, more information is needed about the role arms races play in the rivalry process and the resolution of disagreements. Do arms races reveal information about relative power that might bring about quicker resolution (Kydd, 2000) or do arms races prolong competition and the duration of rivalry? Additionally, given the high costs of arms races, more understanding is needed regarding domestic processes in the decisions to engage in a military build-up, continue building as an arms race develops, and terminate an arms competition.

Replication data

The dataset and do-files for the empirical analysis in this article can be found at http://www.prio.no/jpr/datasets.

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TOBY J RIDER, b. 1976, PhD in Political Science (University of Illinois at Urbana-Champaign); Assistant Professor of Political Science, Texas Tech University (2009–). Research interests include rivalry, territorial conflict, and arms races; recent article on arms races in the *Journal of Politics*.

MICHAEL G FINDLEY, b. 1976, PhD in Political Science (University of Illinois, Urbana-Champaign); Assistant Professor of Political Science, Brigham Young University (2007–). Research interests include civil wars, terrorism, and international conflict. Recent articles in *Journal of Politics, Civil Wars, and International Studies Quarterly.*

PAUL F DIEHL, b. 1958, PhD in Political Science (University of Michigan, 1983); Henning Larsen Professor of Political Science, University of Illinois (1989–); most recent books *Peace Operations* (Polity, 2008), *The Dynamics of International Law* (Cambridge University Press, 2010), and *Evaluating Peace Operations* (Lynne Rienner, 2010).