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All's Well That Ends Well: A Reply to Oneal, Barbieri & Peters*

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Oneal and Barbieri & Peters offer divergent critiques of Gartzke & Li, who present a mathematical identity between competing operationalizations of dyadic interdependence, and show that the relationship one finds between conflict and commerce depends on how one constructs one's dyadic indicator of trade. Oneal seems to accept the identity, but not some of its implications. Barbieri & Peters challenge the identity and offer contrasting results. Here, we show that Barbieri & Peters's results are due to their model specification, which Gartzke & Li argue involves omitted variable bias.

Oneal (2003) and Barbieri & Peters (2003) offer contrasting replies to our article on measuring interdependence in the September issue of this journal. Oneal (2003) agrees with the main arguments of Gartzke & Li (2003a), but disagrees with some implications. The response from Barbieri & Peters (2003) is more broadly critical, taking issue with almost all of the findings by Gartzke & Li (2003a), except that trade openness promotes peace. Given limited space, we focus on responding to the major points of each critique. We also offer quantitative evidence reconfirming our earlier claims.

Oneal (2003) agrees with Gartzke & Li (2003a) on several major issues. First, the study clarifies the mathematical relationships linking *trade dependence*, *openness*, and *trade share*. Second, *trade dependence* (the lower bilateral trade-to-GDP ratio in each dyad) and *openness* (the total trade-to-GDP ratio for the same state) negatively affect the likelihood of MID onset. Third, *trade share* (the lower ratio of bilateral to total trade in a dyad) is not a good measure of economic interdependence. However, Oneal (2003) rejects the explanation in Gartzke & Li (2003a) for why the bilateral trade-to-GDP measure may be less robust in dyadic studies of militarized disputes than is the measure of economic openness. He criticizes us for considering only the statistical significance of the two measures of interdependence, rather than their substantive effects on the probability of conflict.

We disagree with Oneal (2003) in three respects. First, in his reply, Oneal (2003) does not challenge the basic logic of our explanation for why *dependence* on conflict is not always robust in empirical analyses. Recall from Gartzke & Li (2003a) that *trade dependence* is

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the product of *trade share* and *openness*. The variable is positively correlated with both constituent variables. To the extent that *trade share* captures the effect of a state's disconnectedness from world trade and relates positively to conflict, *trade dependence* reflects the net effect of two measures of interdependence working in opposite directions. If Oneal (2003) accepts the math, then the implications that follow should also be accepted. Second, a number of studies have not found the negative effect of *dependence* to be robust. See, for example, Beck, Katz & Tucker (1998), Gartzke, Li & Boehmer (2001), and Gartzke & Li (2003b). Oneal (2003) does not address the lack of statistical robustness in these studies. Third, the size of the substantive effect should not be conflated with statistical significance for interdependence. Where *dependence* is statistically insignificant, the hypothesis that its coefficient equals zero fails to be rejected at the conventional level of Type I error. Focusing on the size of the coefficient alone ignores the sampling error and random noise in the data generation process.

In their reply, Barbieri & Peters (2003) delineate what they see as several serious problems in the analysis of Gartzke & Li (2003a). First, we adopt measures that are not truly dyadic. Second, we draw erroneous conclusions from our mathematics. Third, the findings of Gartzke & Li (2003a) are based on analyses with variables incompatible with Barbieri's measures. Finally, Barbieri & Peters (2003) show empirically that even when controlling for economic openness, dyadic interdependence based on Barbieri's salience measure is still positively associated with conflict. We address each of the criticisms in turn and show empirically that Barbieri & Peters's findings are an artifact of model mis-specification.

Barbieri & Peters (2003: 715) argue that we 'rely on what are essentially monadic indicators of *trade share*, *trade dependence*, and *openness*' by using the 'weakest link' approach. However, recall from Table V of Gartzke & Li (2003a) that the construction of trade dependence, for example, is equal to the lower ratio of the two bilateral trade-over-GDP statistics in a dyad. The variable can only be derived by comparing the two ratios of bilateral trade-over-GDP. Conceptually, the measure equals the *common* or *shared* level of bilateral trade in the dyad. The same logic applies to the similarly derived trade share and openness variables. It is factually incorrect to claim that our measures are monadic, in the same way that it is incorrect to characterize the median or mode of a variable as only a constituent value and not a summary statistic.

Barbieri & Peters (2003) also argue that a weak link measure ignores the effect of the more dependent state in asymmetrical relations. Noting that 'the cost of conflict increases as the gains from trade increase', they assert that the weak link measure is inconsistent with the opportunity cost argument (2003: 715).[1] Gartzke, Li &

[1] 'Gains from trade' constitute the difference between net welfare effects under free trade and under autarky. Neither the Oneal/Gleditsch/IMF dataset nor the Barbieri data measures gains from trade; instead, they capture only gross trade. This implies the need for some care in converting arguments about the gains from trade into empirical claims about conflict behavior. First, there is generally no information in existing studies about the opportunity or 'exit' cost for states of cutting off economic exchange (Polachek, Chang & Robst, 1999; Crescenzi, 2002, 2003). Second, we can at best infer crudely the welfare effects of changes in trade. One can probably comfortably claim that states and firms with a given trade pattern prefer that pattern to feasible alternatives, and that states that change their trade patterns abruptly (i.e. through war) have short-term incentives that contrast with their normal pattern. States that engage in trade asymmetry must prefer asymmetry to autarky. They may prefer symmetry, but this may not be possible. Third, it would be a logical fallacy to claim that states with asymmetric trade are necessarily differently dependent politically. How much a trading relationship is preferred to alternatives (such as autarky) depends on the profitability of trading relationships to firms and to states (these two actors are, of course, different with different preferences). Precisely because trade asymmetry presents important economic opportunities to limit the profits of dependent firms, additional political leverage for states resulting from economic asymmetry is limited (Wagner, 1988). Most of the additional leverage in asymmetric economic relationships will have already been extracted in terms of economic profits (better prices for firms), so that there remains little leverage for politicians.

Boehmer (2001) show formally that the opportunity cost argument does not hold in a bargaining model of military conflict. Trade or economic ties reduce violent conflict because of the signaling role of economic transactions. Further, Gartzke & Li (2003b) show that asymmetric trade interdependence or capital market integration has no statistically significant effect on MID onset.

Barbieri & Peters (2003) also claim that we draw erroneous conclusions from the mathematical identities in our study. We submit that it is Barbieri & Peters who misinterpret our equations. They claim that '*Openness* may or may not change if *trade dependence* or *trade share* change' (Barbieri & Peters, 2003: 716). We agree, but note that this does *not* redound on our argument. The confusion results from necessary versus sufficient conditions. Our study argues that changes in openness necessitate changes in trade share or dependence, not (necessarily) the converse. While variance in trade share, if combined with just the right changes in trade dependence, need not result in changes in openness, variance in openness *is necessarily* indicative of changes in one of the dyadic variables. Further, as the identity shows, these changes must occur in different directions, implying that variance in openness inversely correlates with variance in trade share.

Barbieri & Peters (2003: 716) point to the modest negative relationship between trade share and openness in our study (–0.03) and argue that the 'the substantive connection is weak at best'. If we were trying to predict openness, Barbieri & Peters would have a cogent point. Of course, we do not seek to predict openness, but instead argue that using trade share as a proxy for the concepts underlying the consensus monadic measure (openness) can lead to error. The fact that openness is poorly predicted by trade share does not help the case for using trade share, since trade share and openness are supposed to measure closely related phenomena. The negative relationship between openness and trade share contrasts with intuition about the relationship between monadic and dyadic indicators of interdependence, and supports our claim that dyads containing states with large trade shares generally tend to be less open.

Barbieri & Peters (2003) further argue that findings of Gartzke & Li (2003a) are based on analyses with measures incompatible with Barbieri's. While we employ the lower of two trade share values (bilateral trade over total trade) for two states in a dyad, Barbieri (1996, 2002) and Barbieri & Peters (2003) use the salience measure – the square root of the product of the constituent trade share values (called partner dependence) or trade-over-GDP values (called economy dependence). Hence, the empirical findings in Gartzke & Li (2003a) should not be trusted. Indeed, Barbieri & Peters (2003) show that the salience measure based on either trade share or GDP is positively associated with MID onset at a high significance level. Mathematically, the difference between the weak link measure and the salience measure is modest. For example, using trade share, the weak link measure equals bilateral trade divided by the total trade of the lower trade share country, while the salience measure is in fact the bilateral trade divided by the square root of the product of the total trade of both states. The difference exists in the denominators of both measures. Both denominators are positive, and one is a component of the other. Conceptually, however, the weak link measure is much easier to interpret and comprehend. By combining the lower and higher trade share scores together in a non-linear fashion, the salience measure confuses the effect of symmetric and asymmetric interdependence. The higher component score also captures the underlying asymmetric aspect of trade relations.

Nor is the non-linear nature of the salience measure based on any *a priori* theoretical expectations. The construction thus appears to us to be rather ad hoc.

A potentially serious problem with Barbieri & Peters's (2003) analysis, as well as Barbieri (2002), is the presence of significant model misspecification. While they use the all-dyads sample, important variables such as major power dyads and geographical distance in the dyad are not included in their models. Omitting variables can lead to biased estimates, if the omitted variables correlate with both the independent variables and the dependent variable in the models. As has been shown in many studies of interstate conflict, major power status and geographical distance appear to correlate both with MIDs and with bilateral trade. Major powers usually have large GDPs, while geographical distance correlates with transportation costs. Both GDP and distance are ubiquitous components of standard gravity models of bilateral trade flows and are always shown to be significant determinants of bilateral trade (see e.g. Anderson, 1979; Deardorff, 1998; Li & Sacko, 2002). By omitting major power status and distance, we believe that the

Table I. Effect of Salience Measures on MID Onset, 1949–92

	Partner dependence, all dyads			*Economy dependence, all dyads*		
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
Salience$_{t-1}$	2.919**	0.385	–0.872	14.720**	8.918**	2.351
	[0.835]	[0.952]	[1.044]	[2.510]	[2.793]	[3.435]
Openness$_{t-1}$	–2.070**	–1.329**	–1.466**	–2.370**	–1.474**	–1.489**
	[0.264]	[0.245]	[0.254]	[0.266]	[0.249]	[0.256]
Contiguity$_{t-1}$	2.013**	1.922**	1.531**	1.985**	1.889**	1.522**
	[0.090]	[0.092]	[0.103]	[0.090]	[0.094]	[0.104]
Joint democracy$_{t-1}$	–0.010**	–0.011**	–0.010**	–0.010**	–0.012**	–0.010**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Alliance$_{t-1}$	0.124	0.249**	–0.012	0.129	0.228*	–0.023
	[0.095]	[0.096]	[0.101]	[0.094]	[0.095]	[0.100]
Relative capabilities$_{t-1}$	–0.053*	–0.156**	–0.121**	–0.047+	–0.148**	–0.116**
	[0.025]	[0.026]	[0.027]	[0.025]	[0.026]	[0.027]
Peace year	–0.374**	–0.372**	–0.356**	–0.377**	–0.376**	–0.362**
	[0.024]	[0.024]	[0.025]	[0.024]	[0.024]	[0.025]
Spline 1	–0.002**	–0.002**	–0.002**	–0.002**	–0.002**	–0.002**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Spline 2	0.001**	0.001**	0.001**	0.001**	0.001**	0.001**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Spline 3	–0.000	–0.000	–0.000	–0.000	–0.000	–0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Major power		1.090**	1.273**		1.040**	1.221**
		[0.108]	[0.107]		[0.106]	[0.106]
Distance			–0.401**			–0.387**
			[0.042]			[0.043]
Constant	–2.274**	–2.495**	0.540	–2.169**	–2.434**	0.458
	[0.153]	[0.146]	[0.349]	[0.152]	[0.146]	[0.354]
Observations	118,815	118,815	118,517	118,353	118,353	118,055

Robust standard errors in brackets.
Two-tailed test: * significant at 5%; ** significant at 1%.

trade-related variables in Barbieri & Peters (2003), salience and openness, are biased.

In Table I, we estimate six models to assess the effect of omitted variable bias on Barbieri & Peters's analysis. Models 1 and 4 replicate the results in Table I of Barbieri & Peters (2003), based on partner dependence and economy dependence, respectively. Models 2 and 5 include a dummy variable for major power dyad, while Models 3 and 6 include both major power dyad dummy and the geographical distance variable. The results appear to us to be telling. First, Models 1 and 4 produce exactly the same results as those in Barbieri & Peters, where the salience measure based on partner dependence and economy dependence is significant and positive at a high significance level. Adding the major power dyadic dummy, however, the partner dependence-based salience measure is no longer significant in Model 2, while the GDP-based economy dependence remains significant in Model 5. Adding both major power dyad and the geographical distance variables, partner dependence-based trade salience remains insignificant in Model 3, while the GDP-based economy dependence is no longer significant. These results strongly suggest that the finding of a positive effect of salience, whether based on trade share or GDP, in Barbieri & Peters (2003) and Barbieri (2002), is an artifact of omitted variable bias.

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