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Measure for Measure: Concept Operationalization and the Trade Interdependence–Conflict Debate*

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While most quantitative studies find a negative relationship between economic interdependence and interstate disputes, research by Barbieri finds that interdependence precipitates conflict. Participants in the debate suggest several causes, but we show that alternative variable constructions are sufficient to account for the discrepant findings. A simple formal equivalence unites respective operationalizations of dyadic interdependence used by Oneal & Russett (*trade dependence*, $\text{trade}_{ij}/\text{GDP}_i$) and Barbieri (*trade share*, $\text{trade}_i/\text{trade}_j$) with the consensus construction of monadic trade *openness* ($\text{trade}_i/\text{GDP}_i$). We also show that Barbieri's *trade share* is negatively correlated with *openness*. Arguments in the article are verified through large-sample quantitative regression analyses of the two competing dyadic variable constructions and trade *openness* on MID onset. The results of these dyadic regression analyses show that *trade share* increases the probability of MID onset, *trade dependence* decreases the probability of MID onset and, correspondingly, that trade *openness* is negatively correlated with MID onset.

Introduction

Recent dyad-level quantitative studies of the consequences of trade for international conflict behavior report what appear to be incompatible results. Barbieri (1995, 1996, 1998b) finds that bilateral trade increases the probability of militarized interstate disputes (MIDs). Other research makes the opposite assertion, offering evidence that bilateral trade *reduces* the likelihood of MIDs in economically liberal dyads (Bennett & Stam, 2000; Gartzke, Li & Boehmer, 2001; Oneal et al., 1996; Oneal & Ray, 1997; Oneal & Russett, 1997, 1999a,b; Russett, Oneal & Davis, 1998). The source of contradictory findings is a subject of considerable debate, and has been identified variously as disparities in data collection, econometrics, model specification, control variables, and the choice of temporal and spatial domain (Barbieri & Schneider, 1999). We argue that the disparity in findings can be at least partly explained by features inherent to the variable constructions used by the competing approaches. How researchers construct measures of dyadic interdependence can help to determine what they find in empirical

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analyses of the relationship between trade and conflict.

Interdependence really *is* complex. Economic linkages involve interactions at the systemic, dyadic, and national levels that are by themselves intricate. The political permutations of economic linkages further amplify complexity (Mansfield & Pollins, 2003). How economics matters to political processes is ultimately an empirical question, but it is a question with significant analytical prerequisites.[1] Since researchers cannot actually see the value politicians place on the economic relationships that span borders, we must guess at the impact these relationships have on political decisionmaking.[2] Dyadic analysis of trade–conflict relationships requires an explicit interpretation of the nature of this political impact. One approach to the question is to ask whether a given linkage is valuable, relative to other trade relationships (Barbieri). Another approach is to assess whether a given trade relationship matters, relative to a state's overall economic performance (Oneal & Russett). These two operationalizations of trade interdependence tap into different dimensions of the underlying multidimensional concept. Yet, if each measure relates to the same fundamental process, then the measures must also be related to each other. The relationship between measures of dyadic interdependence is an underexplored and potentially important element in how conflict interacts with economics.

We examine the relationship between the two major competing dyadic measures of interdependence in this article. After reviewing the two competing measures offered by Barbieri and Oneal & Russett, we show how each is compatible with the other and constitutive of the same core concept. We also show that the effect of one measure (*trade share*) is inversely related to the consensus measure of *openness* (monadic trade interdependence), capturing the disconnectedness from the world economy or dependency aspects of trading relations. The debate in the literature about the consequences of economic interdependence may be due in part to differences in variable construction. Explicating issues in the debate, and evaluating competing claims, depends on understanding the underlying identity uniting formulations of dyadic trade interdependence. We then employ our conceptual reasoning to compare empirical results based on these measures. Statistical results substantiate our theoretical claims. Finally, we offer a summary and some conclusions from our results.[3]

Debating Multiple Measures of One Concept

Several indicators have appeared in the literature to measure trade interdependence and its consequences for dyadic conflict (Polachek, 1980; Gasiorowski, 1986). Two of the most discrepant ongoing research programs, in terms of their findings about the effect of trade interdependence on the same dependent conflict variable (militarized interstate disputes, MIDs), are based on the different variable constructions offered by Barbieri (1995, 1996, 1998b) and Oneal & Russett (cf. 1997, 1999a,b; there are other disparities between these two research programs including different data). Table I illustrates the steps for constructing each dyadic measure. Barbieri's composite variable uses the proportion of bilateral trade to each

[1] Mansfield & Pollins (2003) and McMillan (1997) offer reviews of the literature.

[2] One approach to better approximating the value of trade linkages is to examine price elasticities. See Crescenzi (2003), Polachek (1997), Polachek & McDonald (1992), and Polachek, Robst & Chang (1999).

[3] Oneal (2003) also explores aspects of the mathematical identity among the three measures, such as the inverse relationship between *trade share* and *openness*. The two studies developed independently.

state's total trade (*trade share*) in row (1). Treating interdependence as the proportion of bilateral trade to a state's total trade is argued to be consistent with Hirschman (1977) and forms the basis of an empirical measure by Gasiorowski (1986). The concentration of *trade share* in a single partner is argued to represent vulnerability and might be indicative of political manipulation. *Trade share* seeks to measure the political importance of a given trading relationship, relative to trade with a state's other partners. Dyadic *trade salience* in row (2) equals the square root of the product of *trade share* measures for both states in a dyad. *Symmetry* in row (3) assesses the 'balance' of the two *trade share* measures, and *trade interdependence* in row (4) is meant to summarize the interaction of *salience* and *symmetry*. Thus, Barbieri's several dyadic measures are all derivative from, and monotonic with, *trade share*.

Oneal & Russett, by contrast, base their measure on the ratio of bilateral trade to a state's gross domestic product (GDP), summarized in rows (5) and (6) in Table I. The measure captures the share of a state's economy that is devoted to a particular dyadic trade relationship, suggesting the state's *trade dependence* on the bilateral economic relationship. Oneal & Russett apply the 'weak link' assumption, using the lower of the two *dependence* measures to assess the level of dyadic *trade interdependence*, as denoted by row (7). *Trade dependence* seeks to capture interdependence using the economic importance of a given bilateral trade relationship within the national economy, without considering the role of the trade relationships with third-party states. Asymmetry in dyadic interdependence is then evaluated by including the higher economic *dependence* measure as a separate variable in the regression (*trade asymmetry*), as denoted by row (8).

Table I shows that the difference between Barbieri's and Oneal & Russett's approaches to concept operationalization centers on the difference between the importance of a particular bilateral trade relationship to a country's overall trade and the importance of the bilateral trade relationship to a country's

Table I. Components of Two Measures of Bilateral Trade Interdependence

Studies	*Measure*
Barbieri (1995, 1996, 1998b)	(1) $\text{trade share}_i = \frac{(\text{imports}_{ij} + \text{exports}_{ij})}{(\text{imports}_i + \text{exports}_i)} = \frac{\text{trade}_{ij}}{\text{trade}_i}$
	(2) $\text{trade salience}_{ij} = \sqrt{\text{trade share}_i * \text{trade share}_j}$
	(3) $\text{trade symmetry}_{ij} = 1 - \lvert\text{trade share}_i - \text{trade share}_j\rvert$
	(4) $\text{trade interdependence}_{ij} = \text{trade salience}_{ij} * \text{trade symmetry}_{ij}$
Oneal & Russett (cf. 1997, 1999a,b)	(5) $\text{trade dependence}_{ij} = \frac{(\text{imports}_{ij} + \text{exports}_{ij})}{\text{GDP}_i} = \frac{\text{trade}_{ij}}{\text{GDP}_i}$
	(6) $\text{trade dependence}_{ji} = \frac{(\text{imports}_{ji} + \text{exports}_{ji})}{\text{GDP}_j} = \frac{\text{trade}_{ji}}{\text{GDP}_j}$
	(7) $\text{trade interdependence}_{ij}$ = lower of (dependence_{ij} and dependence_{ji})
	(8) $\text{trade asymmetry}_{ij}$ = higher of (dependence_{ij} and dependence_{ji})

Where subscript *ij* denotes a dyadic variable, subscripts *i* and *j* denote states *i* or *j*, such that $i \neq j$.

total economy. The stories embedded in these two approaches, however, are richer. First, the two measures – *trade share* and *trade dependence* – are related mathematically. Second, Barbieri's *trade share* measure partly captures the degree to which a state is *dis*connected from world trade. Third, as constructed, Oneal & Russett's measure reflects aspects of both trade concentration and dyadic economic *openness*. We discuss each of these points below.

A Mathematical Relationship Between Two Dyadic Measures

Explanations for the effect of trade interdependence on international conflict differ (Morrow, 1999; Gartzke, Li & Boehmer, 2001), but researchers seem to agree that interdependence influences dyadic conflict because of the (subjective) value of the bilateral relationship to states in a dyad.[4] The more costly disruptions to the bilateral trade relationship, the greater the opportunity costs (or, alternatively, the signal of resolve) of such disruptions, and the less likely that the two states will engage in costly military violence. Alternatively, the more valuable the bilateral trade relationship, the larger the basis for tension between interdependent states. At a minimum, the value of a bilateral trade relationship is contingent on both the structure of a country's foreign trade and the structure of the state's national economy. The measures being examined here are related. We show below how a state's *openness* to trade, *trade share*, and *trade dependence* are mathematically identified.

Let $\left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right)$ denote the share of bilateral trade between states i and j within state i's total trade, or state i's *trade share* with state j. Let $\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right)$ represent state i's *trade dependence* on state j. Finally, let $\left(\frac{\text{trade}_i}{\text{GDP}_i}\right)$ denote the *openness* of state i's economy. The identity (listed below as Equation 1) then follows:

$$\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right) = \left[\left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right) * \left(\frac{\text{trade}_i}{\text{GDP}_i}\right)\right] \quad (1)$$

State i's *trade dependence* on its linkages with state j (from which Oneal & Russett's interdependence measure is derived) is equivalent to the product of the bilateral *trade share* for state i (from which Barbieri derives her measure of interdependence) and state i's *openness* (the consensus monadic measure of interdependence).

When *trade share* is equal to one, *trade dependence* perfectly represents *openness*. For *trade share* to equal one, of course, a state must have only one trade partner (the state must have autarkic relationships with all other partners). To the degree that *trade share* departs from this extreme (i.e. if a state trades with more than one partner), *trade dependence* departs from measuring the same thing as does *openness*. It also follows that *trade*

[4] The claim in most versions of trade–conflict arguments is that conflict disrupts trade. Barbieri & Levy (1999) cite examples where trade continues between states at war. Morrow (1999) suggests that the anticipated effects of conflict deter trade, negating some or all of the observable trade–conflict relationship. Trade occurs where there are profits to be had from the exchange of goods and services. The level of profits may be lower in one relationship than another (owing to possible conflict), but this is only economically relevant if goods are in limited supply or if costs or risks make trade unprofitable (not just less profitable). A second concern with the Morrow argument is that it assumes that firms can anticipate conflict. According to the bargaining logic of contests, states themselves must be unable to anticipate contests for the contests to occur. Third, even if firms can anticipate conflict, contests are themselves intermittent events. In the interim, if there are profits to be made, firms trade, stopping only when fighting begins. Finally, the idea that traders anticipate conflict and stop trading pre-emptively ignores the consequences of supply shocks on prices. If firms leave a given market because of risk, the profits to be had by remaining in that market increase. Indeed, firms trade with the enemy (as Barbieri & Levy point out) precisely because war profiteering is so profitable. See Li & Sacko (2002) for detailed theoretical and empirical analyses of the effects of conflict on trade.

dependence is a function of the interaction between bilateral *trade share* and trade *openness*.

As *trade share* reflects the structure of trade and *openness* the structure of the national economy, Table II shows how bilateral *trade share* and *openness* interact to determine the value of the *trade dependence* measure. A high level of bilateral *trade share* denotes either asymmetric trade partner concentration or relatively few trade partners (or both), while a low level of *trade share* indicates either an asymmetric trade partner concentration or a trade portfolio with many partners. Of course, a high level of *openness* represents a relatively open economy, and low *openness* suggests a closed economy. In Table II, Cell (1) implies that bilateral trade relations matter to both total trade and to the domestic national economy, while Cell (4) indicates relative unimportance to trade and economy. Cell (2) suggests that a particular bilateral trade relationship is important to a nation's economy, though not necessarily constituting a large portion of the state's overall trade, while Cell (3) suggests a trade relationship that is important in terms of overall trade but not in terms of the total national economy.

Trade share and *openness* are likely to have comparable effects on dyadic disputes in Cells (1) and (4), since both measures have similar values in the two cells (along the cross diagonal). These are scenarios where a country has many trade partners but trades very little in general (closed economy), or very few trade partners but a very large total trade (open economy to a few partners). The bilateral trade is important (or unimportant) to both the structure of trade and the national economy. Differences in the effects of the two measures should occur in Cells (2) and (3) (along the main diagonal). These two scenarios are where a country has concentrated trade partners and a very small total trade (closed economy) or a large number of trade partners and a very large total trade (open economy to a lot of countries). The values of *trade share* and trade *openness* correlate negatively for these two cells. Which of the scenarios in Cells (2) and (3) is likely to have a greater suppressive effect on interstate

Table II. The Conceptual Relationship Between Openness and Trade Share

Structure of trade	*Structure of national economy* *Openness*$_i$ (trade$_i$/GDP$_i$)	
Trade share$_{ij}$ (trade$_{ij}$/trade$_i$)	*More autarkic*	*More integrated*
Concentrated	(3) Relatively closed economy, asymmetric distribution of trade among few partners. trade$_{ij}$ High importance to total trade, but low importance to national economy.	(1) Relatively open economy, asymmetric distribution of trade among more partners. trade$_{ij}$ High importance to both total trade and national economy.
Dispersed	(4) Relatively closed economy, symmetric distribution of trade among few partners. trade$_{ij}$ Low importance to both total trade and national economy.	(2) Relatively open economy, symmetric distribution of trade among more partners. trade$_{ij}$ Low importance to total trade, but high importance to national economy.

disputes? One may look to theory for insights (using dependency, opportunity cost, or signaling arguments), but the relative impact of the two mixed scenarios is not clearly addressed by existing explanations. Nevertheless, it is at least plausible that the scenario in Cell (2) is the more valuable to a country as a whole and implies greater integration into the global trading system than the scenario in Cell (3). Hence, a measure of interdependence that captures more of the components of national trade *openness* is likely to be superior as an indicator of interdependence to a measure that captures concentration but ignores *openness*. Equation (1) and the above discussion provide some basic conceptual tools for illustrating implications of the measures used by Barbieri and Oneal & Russett. One can think of measures of interdependence in terms of their representation of these two axes (integrated vs. autarkic, concentrated vs. dispersed). We next discuss implications of each measure using this approach.

Barbieri's Measure of Trade Interdependence

From Equation (1), we can derive an identity for Barbieri's bilateral *trade share* measure. The *trade share* measure is then used to construct Barbieri's measures of *trade salience*, *trade symmetry*, and *trade interdependence*.

$$\left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right) = \left[\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right) / \left(\frac{\text{trade}_i}{\text{GDP}_i}\right)\right] \qquad (2)$$

Again in simple terms, the bilateral *trade share* for state i equates to the quotient of state i's *trade dependence* on its economic linkages with state j and state i's trade *openness* (*trade share* = [*trade dependence*/*openness*]). This form of the identity has two important implications. First, *trade share* is positively related to *trade dependence*. Holding everything else constant, increasing Oneal & Russett's measure must increase Barbieri's indicator. Yet, all else *cannot* be kept constant. *Openness* is related to *trade dependence* (Equation (1)). Changes in the value of *trade dependence* must alter the value of *openness*. This leads to our second implication. *Trade share* is inversely related to *openness*. States that have large values of *openness* will tend to exhibit small values for *trade share*.

$$\left(\frac{\text{trade}_i}{\text{GDP}_i}\right) = \left[\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right) / \left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right)\right] \qquad (3)$$

Equation (3) emphasizes this critical point. *Openness* is now shown as a quotient of *trade dependence* and *trade share*. For *openness* to increase, *trade dependence* can increase or *trade share* must decrease. Put differently, *ceteris paribus*, increases in the general economic interdependence of a state cannot be reflected equally in the two measures. If we hold *trade share* constant and increase *openness*, *trade dependence* must increase. If, however, we again increase *openness* but this time hold *trade dependence* constant, the value of *trade share* must *decrease*.

Neither dyadic measure can fully capture all aspects of the conception of interdependence embodied in trade *openness*. Indeed, *trade share*, from which Barbieri's composite measures of economic interdependence are derived, reflects to a large degree the *dis*connectedness of a state from world trade. To see why this is so, imagine a state i with some quantity of total trade (x) and some arbitrary number of trade partners (n). For simplicity, assume that an exogenous process determines the distribution of global trade, so that trade with each partner can be represented as $\left(\frac{x_i}{f(n_i)}\right)$. *Trade share* then equals $\frac{\left(\frac{x_i}{f(n_i)}\right)}{x_i} = \left(\frac{x_i}{f(n_i)}\right) \cdot \frac{1}{x_i} = \frac{1}{f(n_i)}$. If we simplify the function by assuming that trade is equally distributed among partners (this is not necessary but simplifies the illustration), *trade share* becomes equivalent to $\frac{1}{n}$. Broadly speaking, *trade share* is inversely related to the number of a state's trade partners. Thus, *ceteris paribus*, the greater the number of partners a state has, the less interdependent the state will appear according to the construction of the measure.

The empirical implications of the relationship between *openness* and the monadic variables can be stated more explicitly by performing the following simple mathematical operations:

$$\log\left(\frac{\text{trade}_i}{\text{GDP}_i}\right) = \log\left[\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right) / \left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right)\right] \quad (4)$$

We can log both sides of Equation (3) and then redistribute the terms as in Equation (5).

$$\log\left(\frac{\text{trade}_i}{\text{GDP}_i}\right) = \log\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right) - \log\left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right) \quad (5)$$

Measuring interdependence as conceived by liberal theory implies that the two dyadic variables discussed here must be negatively related. Thus, the monadic concept, as defined by *openness*, can be written as follows:

$$\beta_1 * \log\left(\frac{\text{trade}_i}{\text{GDP}_i}\right) = \beta_2 * \log\left(\frac{\text{trade}_{ij}}{\text{GDP}_i}\right) + \beta_3 * \log\left(\frac{\text{trade}_{ij}}{\text{trade}_i}\right) \quad (6)$$

where β_2 and β_3 must have opposite signs. Note further that, because *openness* is expected to negatively affect the onset of Militarized Interstate Disputes (MIDs), the signs on β_2 and β_3 on MID onset should be reversed from that shown here. The coefficient for *trade share* should be negative (increasing the chances of a dispute).

If one acknowledges that Barbieri's measure of interdependence is derivative of the bilateral *trade share* variable, then it seems clear mathematically that *trade share* is inversely related to a state's trade *openness* as well as the state's number of trade partners. Do empirical assessments bear out this conceptual relationship? Based on the trade data from Barbieri (1998a) for all dyads from 1950 to 1992, we can say that the conceptual relationship appears to be reflected in our quantitative analysis. Barbieri's *trade interdependence* measure, which we construct as in row 4 of Table I, correlates with *trade share* at (0.48), while *trade share* correlates with the number of a state's trading partners at (–0.16). *Trade share* in turn correlates with a state's *openness* at (–0.03). All correlation coefficients are statistically different from zero at the 1% significance level.

As *trade share* increases, Barbieri's *trade interdependence* measure also increases while the number of a state's trading partners appears to decrease. This correlates with a decline in a state's *openness*, posing for us some concern about the ability of *trade share* to reflect trade interdependence. It is possible that these results are the product of confounding factors. For a robustness check, we conduct two multivariate analyses: one for the relationship between the number of a state's trade partners and its monadic *openness*, and the other for the relationship between *trade share* and *openness*. Tables III and IV report the results of the multivariate analyses.

The monadic analysis in Table III regresses a state's *openness* on the number of its trading partners (*partners$_t$*) in a given year, its GDP, and the country dummies. *Openness* is a state's total trade divided by its GDP. Trade data used for the regressions are from Barbieri (1998a). GDP data are in current

Table III. Effect of Number of Partners on Trade Openness

Dep. var.: openness (monad years)	*Coefficient*	*t-score*
Number of trade partners	0.0011***	5.59
GDP (log)$_{t-1}$	0.0147***	3.12
Constant	0.1393***	4.16
N	4,307	
Adjusted R^2	0.82	

Results for 142 country dummy variables not reported.
T statistics based on robust standard errors.
Two-tailed test: *** significant at 1% level.

international dollar amounts, using purchase power parities (PPP) from Oneal & Russett (1999a). Oneal & Russett obtain these data from the Penn World Tables (Summers & Heston, 1991). The GDP variable, measuring a state's market size, should correlate negatively with *openness*. We lag the variable to avoid simultaneity bias. We also log transform the variable because of the skewed distribution common in national income statistics.

We include the country dummies to control for country-specific heterogeneity and other unmeasured variables. As King (2001: 504) notes, 'Fixed effects regressions do control for all dyad-specific heterogeneity, including otherwise unmeasured variables. The intended result is that with the omitted variable effectively in the analysis, the bias would vanish.' As we have a continuous dependent variable and a large sample, the weaknesses of the fixed effects estimator are not problematic, but advantages are important for the simple model we use. We also estimate White robust standard errors to control for heteroskedastic variance.

The results in Table III show clearly that a country's *openness* is positively related to the number of its trading partners. The relationship is statistically significant at 1% level, and the results are robust even after we control for other confounding variables. The more trading partners a state has, the more open is its economy. Conversely, the fewer trading partners a state has, the less open is that state's economy.

The analysis in Table IV regresses a state's *trade share* with each partner on its *openness* in a given year and the dyad dummies, following the rationale for the use of fixed effects estimators discussed above. *Trade share* is the ratio of bilateral trade to a country's total trade. Trade data used for the regressions are again from Barbieri (1998a). We use the same data for *openness* as in the model in Table III. We lag the *openness*

Table IV. Effect of Openness on Trade Share

Dep. var.: trade share (dyad years)	*Coefficient*	*t-score*
Openness$_{t-1}$	–0.0011***	–5.74
Constant	0.0152***	196.58
N	254,173	
Adjusted R^2	0.80	

Results for 11,966 dyad dummy variables not reported.
T statistics based on robust standard errors.
Two-tailed test: *** significant at 1% level.

variable to avoid simultaneity bias. We also estimate robust standard errors to control for heteroskedastic variance.

Table IV shows that *openness* is statistically significant and negative at the 1% level, after controlling for dyadic heterogeneity. Countries with greater trade *openness* tend to have smaller trade shares, which is consistent with the finding that countries of greater trade *openness* tend to have more trade partners. Hence, the *trade share* measure, which is inversely related to the number of a state's trading partners, appears to tend to represent a state's overall economic isolation – the opposite of trade *openness*. The appropriateness of *trade share* as an indicator of interdependence depends on one's conception of interdependence. If one favors the notion that dyadic trade interdependence should correlate positively with the broad connectedness both states in a dyad have with the world market, then the *trade-share*-based measure appears inappropriate. More specifically, if *openness* affects conflict negatively, *trade share*, which negatively correlates with *openness*, can be expected to affect conflict positively. *Trade share* appears much more effective at capturing the dependency aspects of trading relations. States with large trade shares tend to have intense economic relationships with a few states. Thus, studies of dependency may benefit from continuing to use the *trade share* measure while studies interested in measuring a broader conception of interdependence may prefer to look elsewhere.

Oneal & Russett's Measure of Trade Interdependence

Oneal & Russett's interdependence measure captures the common-denominator-level importance of the bilateral trade relationship in a dyad. Table V illustrates how the Oneal & Russett dyadic measure of interdependence can be generated as a consequence of its two constitutive elements (bilateral *trade share* and national trade *openness*). For each state in a dyad, that state's trade *dependence* (i.e. its bilateral trade over its GDP) equals the product of its *trade share* (its bilateral trade over its total trade) and *openness* (its total trade over its GDP). Following the weak link assumption, Oneal & Russett choose the lower of the two trade *dependence* ratios in a dyad as their preferred measure of dyadic interdependence.

Table V shows that for each of the two states in a dyad (State *i* and State *j*), the level of the value of *trade dependence* corresponds with similar levels of values of *trade share* and *openness*. For example, a high (low) value of *trade dependence* corresponds to high (low) values of *trade share* and *openness* for each of the two states. Oneal & Russett select the lower of the two *trade dependence* ratios to represent the effect of dyadic trade.

Referring to Table II, we can now conclude that Oneal & Russett's measure reflects the scenario in Cell 4 at the common denominator level within a dyad. That is, the lower of *trade dependence* measures tends to relate to relatively closed national economies (few partners) rather than relatively open economies (more partners). Thus, the measure reflects the joint significance or insignificance of a particular bilateral trade relationship to both total trade and to the national economy. Recall that Barbieri's interdependence measure, based on *trade share*, is more likely to correlate with trade-partner concentration and lower levels of *openness*. Given these differences, it is hardly surprising that the analyses by Barbieri and Oneal & Russett should find different, and often contradictory, results. These discrepancies need not derive from differences in data, sample, or model specification, but can result directly from variable construction.

Is Oneal & Russett's measure, then, the appropriate construction for studying the

Table V. Relationships Between *trade dependence* and *openness* and *trade share*

State i			State j		
trade dependence $\left(\frac{trade_{ij}}{GDP_i}\right)$	*openness* $\left(\frac{trade_i}{GDP_i}\right)$	*trade share* $\left(\frac{trade_{ij}}{trade_i}\right)$	*trade dependence* $\left(\frac{trade_{ij}}{GDP_j}\right)$	*openness* $\left(\frac{trade_j}{GDP_j}\right)$	*trade share* $\left(\frac{trade_{ij}}{trade_j}\right)$
$High_i$	$High_i$	$High_i$	$High_j$	$High_j$	$High_j$
$Medium_i$	$High_i$ Low_i	Low_i $High_i$	$Medium_j$ Low_j	$High_j$ $High_j$	Low_j
Low_i	Low_i	Low_i	Low_j	Low_j	Low_j
If $\left(\frac{trade_{ij}}{GDP_i}\right)Low_i < \left(\frac{trade_{ij}}{GDP_j}\right)Low_j$, then			If $\left(\frac{trade_{ij}}{GDP_i}\right)Low_i > \left(\frac{trade_{ij}}{GDP_j}\right)Low_j$, then		
dyadic *trade dependence* = $\left(\frac{trade_{ij}}{GDP_i}\right)Low_i$			dyadic *trade dependence* = $\left(\frac{trade_{ij}}{GDP_j}\right)Low_j$		

effects of bilateral trade interdependence on conflict? This again depends on one's conception of economic interdependence. At a minimum, Oneal & Russett's measure represents the joint importance of a particular bilateral trade relationship to both total trade and the national economy. However, because the measure results from the two constitutive components – each of which pertains to a particular dimension of trade interdependence – the variable tends to reflect the *net* effect of trade on disputes if the constitutive elements have contrasting effects. Mathematically, according to Equation (1), bilateral *trade dependence* equals the product of *trade share* and *openness*. Following the weak link assumption, Equation (1) may be transformed into the following:

$$\left(\frac{trade_{ij}}{GDP_{i\ or\ j}}\right)_{Low} = \left[\left(\frac{trade_{ij}}{trade_{i\ or\ j}}\right)_{Low} * \left(\frac{trade_i}{GDP_{i\ or\ j}}\right)_{Low}\right] \quad (7)$$

or

$$\beta_4 * \log\left(\frac{trade_{ij}}{GDP_{i\ or\ j}}\right)_{Low} = \beta_5 * \log\left(\frac{trade_{ij}}{trade_{i\ or\ j}}\right)_{Low} + \beta_6 * \log\left(\frac{trade_i}{GDP_{i\ or\ j}}\right)_{Low} \quad (8)^5$$

The mathematical relationship reconciles some previous empirical findings and suggests why the negative effect of *trade dependence* on conflict is not always robust in analyses (see, for example, Beck, Katz & Tucker, 1998). Barbieri (1995, 1996, 1998b) finds that the *trade share*-based measure of interdependence correlates positively with

[5] Empirically, the weak link assumption means that different states may contribute the lower of dyadic *openness* and *trade share* variables. In our empirical analysis below, we use the *openness* and *trade share* values from the same state that has the lower of the two *trade dependence* values in a dyad. Hence, the three measures are based on the same state in a dyad. However, it is worth noting that we also conduct a sensitivity analysis where each of the three variables simply takes on the lower value in a dyad, resulting in observations where *openness*, *trade share*, and *trade dependence* come from different states in a dyad. Statistical results are robust and consistent with our arguments.

militarized disputes. Oneal & Russett (1997) find that trade *openness* correlates negatively with MID incidents. These findings accord with the fact that *trade share* and trade *openness* are negatively correlated. In measuring interdependence using *trade dependence* (constitutive of *trade share* and trade *openness*), the countervailing effects of *openness* and *trade share* on MIDs probably weaken the apparent impact of *trade dependence*. Where the effect of *trade dependence* is positive or insignificant, it appears that the effect of *trade share* exceeds that of *openness*. Where the effect of *trade dependence* is negative, it appears that the converse is true, that the effects of trade *openness* matter more than the impact of *trade share*.

Empirical Comparisons

In the section below, we examine empirically the relationships among the three measures of interdependence by evaluating their effects on MID onset. According to Equations (3) and (6), if *openness* is negatively related to disputes, then *trade share* should take a positive sign (as it correlates negatively with *openness*), while *dependence* should take a negative sign (as it correlates positively with *openness*). We log transform values on both sides of Equation (3) to linearize the product term and derive Equation (6).[6] By logging the equation, we linearize the right-hand side of Equation (3), and we are able to use the two terms as an equivalent of *openness* in one statistical model. This allows us to test our expectations of the relationships among the three measures in an additive model. Before we begin, we should note that log transforming the variables reduces the variance available to the estimator and thus weakens the apparent causal impact of the variables. A lack of statistical significance for any of the variables should not be treated as evidence that the variables fail to influence dispute behavior. Our intent here is only to evaluate hypotheses in this article about the relationship between different measures. Statistically significant results then indicate robustness in our arguments.

We examine two logit model specifications. The dependent variable is MID onset, coded 1 for any dyad year in which a threat, display, use of force, or war begins, and 0 otherwise (including subsequent years in a multi-year dispute). We use the dyadic MID data (DYMID 1.1) produced by Zeev Maoz (1999). The first model specification includes *openness*, the left-hand side of Equation (6), where we expect a negative sign. The second model includes *trade share* and *dependence*, the right-hand side of Equation (6), expecting that *trade share* is positive and *dependence* is negative. The empirical results will bear on our theoretical predictions of the relationships among the three measures and their effects of MID onset.

All three variables take on the values from the country of lower trade *dependence*, following the weak link assumption. We use trade data from both Barbieri (1998a)[7] and Oneal & Russett (1999a) to ensure that our findings are not an artifact of one or other of the two competing data sources.[8 9] We

[6] Zero values are transformed into ($1/e^{21}$) to avoid missing values.

[7] Barbieri also reports results using the bilateral trade-to-GDP ratio. These are positive but not significant (Barbieri, 1998b: Tables 5, 6). We focus on the trade concentration and *trade share* variables because they are published, statistically significant, and are distinct from Oneal & Russett's *trade dependence*.

[8] We compute the *trade share* variable following Equation (2), using data on *dependence* and *openness* from Oneal & Russett (1999a). The computed *trade share* variables for the two states in a dyad have some unreasonable values. For example, some observations have values of roughly 2 or 3, implying that a country's trade with a given partner is 2 or 3 times larger than its total trade. These values are excluded from our analysis.

[9] We control for data disparities between studies. Barbieri's trade data 1870–1992 are available on the Peace Science Society (international) website (http://pss.la.psu.edu/TRD_DATA.htm). Oneal & Russett's data were provided by the authors. Both datasets are widely used and referenced.

estimate the two model specifications both for all dyads and for 'politically relevant dyads', as sample selection appears to be a point of debate (cf. Barbieri, 1998b; Oneal & Russett, 1999a). Model specification for all dyads or for 'politically relevant dyads' includes variables recognized as essential by both parties to the debate.[10] One issue concerns how to treat missing values. Many values may be missing from trade data. Further, it is not likely that listwise deletion of these data through missing values is randomly distributed. While it is reasonable to assume that many missing values in bilateral trade data equal zero, we present statistical results with missing values set to zero and with missing values omitted to ensure an even-handed comparison.[11]

To maintain comparability, we use data on other control variables from Oneal & Russett (1999a). These data contain observations for much of the post-World War II era (1950–92), for all pairings of states for each year (dyad years) or for 'politically relevant dyads'.[12] DEMLOW is the lower of the two monadic democracy values – the difference between reported values for democracy (DEMOC) and autocracy (AUTOC) in the Polity III data (values range from 10 [democratic] to –10 [autocratic] for each variable). DEMHIGH equals the higher monadic democracy value in a given dyad year. DEMLOW codes the dyadic threshold of democracy (the weak link assumption), while DEMHIGH measures asymmetry in regime type. CONTIGUITY is a dichotomous variable for geographic distance, equal to 1 when states in a dyad are contiguous (or within 150 miles by water), and 0 otherwise. DISTANCE equals the natural logarithm of the great-circle distance between two states' capitals, or sometimes of major ports for the largest states. MAJOR POWER is a dummy variable coded 1 if at least one state in a dyad is a major power as defined by the Correlates of War project (COW), and 0 otherwise (major powers: China, France, United Kingdom, United States, USSR). Oneal & Russett (1999a) argue that DISTANCE and MAJOR POWER variables should be included in statistical models using 'politically relevant dyads' as the sample, and we adopt this approach. ALLIES equals 1 when dyadic members share in common a military alliance, and 0 otherwise. CAPABILITY RATIO is the natural logarithm of the composite national capabilities (CINC) score of the more capable state in the dyad divided by the CINC score of the less capable state. Following Beck, Katz & Tucker (1998), _SPLINES represent a vector of three spline variables plus a linear term, constructed to control for duration dependence in dyads (duration dependence results from temporal correlation in the dependent variable).

The statistical results are reported in Tables VI, VII, and VIII. Table VI is based on the Barbieri (1998a) trade data, Table VII is based on the Oneal & Russett (1999a) trade data with the missing bilateral trade values set to zero, and Table VIII is also based

[10] The issue of 'politically relevant dyads' is controversial. Some argue that politically relevant dyads are the only legitimate sample for analyzing international conflict. It is not clear to us why this should be so. The smaller sample is not scientifically superior to the whole sample of dyads. Further, the use of non-random sampling is not supportable on methodological grounds. We analyze both samples as a robustness check.

[11] See Oneal & Russett (1999a) for discussion of the rationale and criteria of coding the missing bilateral trade values as zeroes. Although this practice by Oneal & Russett is plausible, it is not one adopted by the IMF in the Direction of Trade database. Barbieri and others contest substitution of zero for missing values. We present results for a sample with missing data as a robustness check. As shown later in Tables VII and VIII, coding missing values as zero or missing appears to have little impact on the statistical results. One possible solution to the missing data problem is the interpolation of missing values. Yet, interpolation is only as valid as the inferences used in estimating missing values. In the absence of decent data for many observations for the many poor and underdeveloped countries, interpolation constitutes an educated guess.

[12] 'Politically relevant dyads' include major powers in the post-World War II period (China, France, Soviet Union, United Kingdom, United States) and states that are contiguous by land or within 150 miles by water.

Table VI. Logit Estimates of MID Onset Based on Barbieri (1998a) Trade Data, 1950–92

Dep. var.: MID onset	(1) *All dyads*	(2) *All dyads*	(3) *Relevant dyads*	(4) *Relevant dyads*
trade *openness* (log)$_{t-1}$	–0.4364**		–0.4278**	
	[3.756]		[3.912]	
trade share (log)$_{t-1}$		0.4084**		0.3948**
		[3.664]		[3.790]
trade dependence (log)$_{t-1}$		–0.4158**		–0.4120**
		[3.317]		[3.548]
DEMLOW$_{t-1}$	–0.0599**	–0.0602**	–0.0596**	–0.0591**
	[5.016]	[4.837]	[5.261]	[5.010]
DEMHIGH$_{t-1}$	0.0196*	0.0193*	0.0318**	0.0321**
	[2.119]	[2.031]	[3.257]	[3.209]
CONTIGUITY$_{t-1}$	2.4801**	2.4734**	1.0299**	1.0504**
	[10.702]	[10.544]	[4.452]	[4.590]
DISTANCE$_{t-1}$	–0.3577**	–0.3530**	–0.1804**	–0.1807**
	[4.769]	[4.563]	[3.175]	[3.125]
MAJOR POWER$_{t-1}$	1.1799**	1.1772**	0.1229	0.1374
	[5.567]	[5.804]	[0.577]	[0.664]
ALLIES$_{t-1}$	–0.0571	–0.0540	–0.1427	–0.1411
	[0.301]	[0.285]	[0.847]	[0.835]
CAPABILITY RATIO$_{t-1}$	–0.1313**	–0.1354**	–0.2219**	–0.2304**
	[2.601]	[2.613]	[4.170]	[4.173]
PEACE YEAR	–0.3610**	–0.3634**	–0.3460**	–0.3472**
	[8.439]	[8.510]	[8.309]	[8.322]
_SPLINE1	–0.0017*	–0.0017*	–0.0014*	–0.0014*
	[2.332]	[2.338]	[2.029]	[2.027]
_SPLINE2	0.0003	0.0003	0.0002	0.0002
	[0.701]	[0.692]	[0.441]	[0.430]
_SPLINE3	0.0002*	0.0002*	0.0003*	0.0003**
	[2.432]	[2.464]	[2.575]	[2.604]
Constant	–2.4268**	–2.4154**	–1.7081**	–1.7566**
	[3.938]	[3.931]	[3.761]	[3.830]
N	104,270	104,270	19,444	19,444
Wald test	1,818	1,871	744	746

Robust z statistics in brackets, adjusted for clustering over dyads.
Two-tailed test: *significant at 5%; **significant at 1%.

on the Oneal & Russett (1999a) trade data but with missing bilateral trade values kept as missing. We start our discussion with Table VI. In columns (1) and (3) of Table VI, *openness* is a negative and significant predictor of the dispute onset for both all dyads and for 'politically relevant dyads'. These results are consistent with the findings of many others (see, for example, Oneal & Russett, 1997).

In columns (2) and (4) of Table VI, *trade share* is statistically significant and positive, while *dependence* is statistically significant and negative, for both all dyads and politically relevant dyads. The results about *trade share* are consistent with Barbieri's (1996) finding that a measure based on bilateral trade concentration contributes to disputes. These results substantiate our expectation that the construction of *trade share* leads to a

Table VII. Logit Estimates of MID Onset Based on Oneal & Russett (1999a) Trade Data (Missing Trade Values Set as Zero), 1950–92

Dep. var.: MID onset	*(1)* *All dyads*	*(2)* *All dyads*	*(3)* *Relevant dyads*	*(4)* *Relevant dyads*
trade *openness* (log)$_{t-1}$	–0.1966*		–0.2019*	
	[2.119]		[2.355]	
trade share (log)$_{t-1}$		0.4109**		0.3321**
		[3.780]		[3.775]
trade dependence (log)$_{t-1}$		–0.4451**		–0.3715**
		[3.773]		[3.889]
DEMLOW$_{t-1}$	–0.0713**	–0.0657**	–0.0599**	–0.0540**
	[5.708]	[5.237]	[5.622]	[5.017]
DEMHIGH$_{t-1}$	0.0237**	0.0215*	0.0301**	0.0285**
	[2.657]	[2.445]	[3.442]	[3.381]
CONTIGUITY$_{t-1}$	2.8193**	2.7548**	1.0678**	1.0586**
	[12.015]	[11.795]	[5.219]	[5.247]
DISTANCE$_{t-1}$	–0.4915**	–0.5005**	–0.2154**	–0.2126**
	[6.515]	[6.484]	[4.090]	[4.039]
MAJOR POWER$_{t-1}$	1.5356**	1.4916**	0.2033	0.2320
	[6.536]	[6.523]	[1.003]	[1.177]
ALLIES$_{t-1}$	–0.2614	–0.2716	–0.3231*	–0.3075*
	[1.535]	[1.622]	[2.083]	[2.012]
CAPABILITY RATIO$_{t-1}$	–0.1736**	–0.1953**	–0.2539**	–0.2759**
	[3.467]	[3.988]	[5.510]	[6.076]
PEACE YEAR	–0.3354**	–0.3362**	–0.3184**	–0.3173**
	[9.318]	[9.286]	[8.934]	[8.879]
_SPLINE1	–0.0018**	–0.0019**	–0.0012	–0.0013*
	[3.053]	[3.155]	[1.940]	[2.055]
_SPLINE2	0.0006	0.0006	0.0001	0.0002
	[1.404]	[1.505]	[0.265]	[0.406]
_SPLINE3	0.0001	0.0001	0.0002**	0.0002**
	[1.722]	[1.640]	[2.805]	[2.629]
Constant	–1.4757*	–1.8349**	–1.9288*	–1.4274**
	[2.322]	[2.797]	[2.048]	[3.172]
N	225,653	225,653	25,960	25,960
Wald test	2,146	2,152	895	895

Robust z statistics in brackets, adjusted for clustering over dyads.
Two-tailed test: *significant at 5%; **significant at 1%.

positive coefficient. The results on *dependence* are consistent with the various studies of Oneal & Russett. The findings are also consistent with our argument that *trade share* measures a state's isolation or 'disconnectedness' from world trade while *dependence* measures a state's integration or 'connectedness'.

The results in Tables VII and VIII are also consistent with our expectations. Openness is negative and significant in the models in columns (1) and (3) of both tables. *Trade share* is positive and significant while *trade dependence* is negative and significant, in columns (2) and (4) of both tables. Differences in data sources and coding of missing bilateral trade values do not alter these results.

The results in Tables VI, VII, and VIII evaluate the patterns among the three different measures that are suggested by

Equations (3) and (6).[13] These analyses appear quite adequate (and indeed informative) for the purpose of illustrating the relationships among the three measures that we identify conceptually in the above theoretical portions of the article. They also support our claims about the relationship between the monadic *openness* variable and the two dyadic measures, *trade share* and *trade dependence*.[14] Our arguments are robust against data differences.

[13] Between *openness* (log) and *trade share* (log), for all dyads, correlation is –0.081 (Barbieri data), –0.038 (Oneal & Russett data, missing trade as missing), and 0.037 (Oneal & Russett data, missing trade as 0). Correlation between *openness* (log) and *trade dependence* (log) is 0.112, 0.103, and 0.088 for the three data sources, respectively. In addition, correlation between *trade share* (log) and *trade dependence* (log) is 0.979, 0.988, and 0.997 for the three sources, respectively. *Trade share* (log) and *trade dependence* (log) are collinear, a subject of significant potential concern. Multicollinearity is indicated when one has a good model fit, but insignificant variables. This occurs when an estimator is unable mathematically to determine coefficients using the unencumbered variance for each independent variable. The fact that both variables are consistently statistically significant in the expected directions in all three tables shows that sufficient unencumbered variance exists for the estimator to fashion statistically significant estimates. Given that we have specific theoretical expectations, since there is no ready econometric remedy for multicollinearity (standard solutions involve collecting more data or using a different model specification), and since the collinear variables remain statistically significant, we adopt Kennedy's advice that researchers 'do nothing' about multicollinearity (1992: 181; see also Johnston, 1984: 250–259).

[14] One reviewer requests the estimation of a full model of all three variables included to assess whether either *openness* or both *trade share* and *dependence* could be statistically significant (but not both), because *openness* is equivalent to the difference between *dependence* and *trade share*. The results based on Barbieri (1998a) data, for all dyads and politically relevant dyads, show that *openness* is statistically insignificant and negative, while both *trade share* and *trade dependence* are insignificant but with the expected signs. In contrast, the results based on Oneal & Russett (1999a) data, with missing trade values set at zero, show *openness* is statistically insignificant, while *trade share* is positive and significant, and *trade dependence* is negative and significant. Results using Oneal & Russett (1999a) data, with missing trade values left missing, show that all variables are in the expected directions, though none is statistically significant. These models can be expected to be unidentified. Our interest is to show that this is the case, and that the three variables still function as anticipated. Future research may explore how these measures represent different dimensions of interstate trade relations.

Conclusion

Our findings suggest that discrepant results about interdependence and conflict can be explained by variable construction, even without data inconsistencies. More important, we develop a rigorous theoretical account of the relationships among the monadic and dyadic measures of interdependence that we test in a manner consistent with our theoretical claims. We find empirical support for the relationship in dissimilar datasets and different samples. We provide a rigorous and empirically substantiated argument that explains and demonstrates the relationship among the monadic and dyadic measures of interdependence, which may help to resolve the controversy and allow researchers to use these measures with greater perspective.

We hope our efforts contribute to the resolution of a salient controversy in the international conflict community. Studies continue to cite Barbieri (1996) and the works of Oneal & Russett as evidence of the contradictory impact of trade interdependence on dyadic military disputes. According to our discussion and empirical assessment, *trade share* is inversely related to a state's *openness* to trade. *Trade share* tends to measure a country's *lack* of integration into the world economy and is more effective at capturing the dependency aspects of trading relations. Hence, the positive effect of *trade share* and the negative effect of *openness* do not necessarily indicate any inconsistencies in theory, data, or other sources. Instead, it is possible to attribute the discrepancy to variable construction alone. The relationship between the measures and the inverse relationship between *trade share* and *openness* should help to resolve the puzzle of why Barbieri and Oneal & Russett and others achieve discrepant findings. There need be no theoretical contradiction between the positive correlation of the *trade share* measure

Table VIII. Logit Estimates of MID Onset Based on Oneal & Russett (1999a) Trade Data (Missing Trade Values Set as Missing), 1950–92

Dep. var.: MID onset	*(1) All dyads*	*(2) All dyads*	*(3) Relevant dyads*	*(4) Relevant dyads*
trade *openness* (log)$_{t-1}$	–0.3437**		–0.3155**	
	[3.232]		[3.291]	
trade share (log)$_{t-1}$		0.3625**		0.3166**
		[3.396]		[3.374]
trade dependence (log)$_{t-1}$		–0.3774**		–0.3454**
		[3.173]		[3.297]
DEMLOW$_{t-1}$	–0.0644**	–0.0633**	–0.0637**	–0.0612**
	[4.999]	[4.705]	[5.318]	[4.887]
DEMHIGH$_{t-1}$	0.0127	0.0111	0.0323**	0.0325**
	[1.184]	[1.018]	[3.212]	[3.153]
CONTIGUITY$_{t-1}$	2.4181**	2.4003**	0.9847**	1.0021**
	[10.559]	[10.403]	[4.631]	[4.773]
DISTANCE$_{t-1}$	–0.3696**	–0.3658**	–0.1615**	–0.1674**
	[4.712]	[4.467]	[2.749]	[2.792]
MAJOR POWER$_{t-1}$	1.3138**	1.3136**	0.0826	0.1125
	[5.441]	[5.753]	[0.365]	[0.510]
ALLIES$_{t-1}$	–0.1735	–0.1708	–0.2115	–0.2060
	[0.799]	[0.795]	[1.135]	[1.109]
CAPABILITY RATIO$_{t-1}$	–0.1479**	–0.1574**	–0.2422**	–0.2573**
	[2.797]	[3.040]	[4.624]	[4.856]
PEACE YEAR	–0.3440**	–0.3494**	–0.3273**	–0.3293**
	[7.742]	[7.858]	[7.675]	[7.709]
_SPLINE1	–0.0013	–0.0014	–0.0010	–0.0011
	[1.810]	[1.867]	[1.452]	[1.500]
_SPLINE2	0.0001	0.0001	–0.0001	–0.0000
	[0.227]	[0.270]	[0.135]	[0.083]
_SPLINE3	0.0003**	0.0003**	0.0003**	0.0003**
	[2.835]	[2.819]	[3.150]	[3.091]
Constant	–2.0466**	–2.1259**	–1.4460**	–1.6056**
	[3.131]	[3.322]	[2.856]	[3.293]
N	116,351	116,351	21,588	21,588
Wald test	1,643	1,680	700	712

Robust z statistics in brackets, adjusted for clustering over dyads.
Two-tailed test: *significant at 5%; **significant at 1%.

and the negative correlation of the *trade dependence* measure with dyadic militarized interstate disputes. More economic linkages correlate with fewer disputes.

From the measurement perspective, our analysis also helps explain why Oneal & Russett's dyadic variable may be less robust than the monadic indicator of *openness*. As *trade dependence* is 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 to conflict positively, *trade dependence* reflects the net effect of two measures of interdependence that work in opposite directions.

While this article examines relationships between existing measures of interdependence, there are several other issues that appear worthy of future investigation. First, in Barbieri's measure of *trade share*, the dyadic trade in the numerator is always part of the total trade in the denominator. By having $trade_{ij}$ in the numerator and in the denominator, greater trade with *j* increases *i*'s *trade share* but at a diminishing rate (since the increase in the numerator is discounted by the increase in the denominator). Thus, *trade share* potentially biases the impact of trade on conflict. Second, existing constructions make estimation of the independent effect of trade difficult. Using several variables to measure interdependence (*trade share*, *salience*, *trade symmetry*, and *trade interdependence*) makes interpreting Barbieri's coefficients problematic because each component contains trade. The components are collinear (as indicated in Table I), and no one component actually measures the full effect of trade. Taking a derivative with respect to trade is complex, indirect, and unlikely to clearly identify trade's impact. Similarly, if GDP has an independent effect on conflict, then *trade dependence* conflates the effect of trade and the effect of GDP. Third, neither Barbieri's variables nor Oneal & Russett's measure separates imports and exports. Fourth, neither measure gets at the variation in commodity losses, as do Reuveny & Kang (1998). Similarly, existing measures do not directly assess the political impact of interdependence. Crescenzi (2003), Polachek (1997), and Polachek, Robst & Chang (1999) attempt to measure trade elasticities. States that suffer from conflict-induced trade losses do so to the extent that they are unable to substitute other goods and services for those that are missing. To get at the impact of interdependence, one must ultimately measure what is lost, and not just assume that all trade is equal.

Finally, this article identifies some other intriguing new puzzles. Additional research may address in greater detail why the monadic measure of *openness* is statistically significant and extremely robust. This finding begs the question of whether different theoretical logics underlie the dyadic and monadic variables or whether the same logic is represented by different empirical constructs (we hint at this here). Our results pose new questions as to how dyadic economic relations affect dyadic conflict, and whether interdependence at the dyadic level acts in the same way as the broader process of economic integration into the world economy. Gartzke & Li (forthcoming) show that bilateral trade and broader economic integration are not identical, that the effect of economic integration on dispute behavior follows a somewhat different causal logic than that generally acknowledged in existing studies of interdependence and peace. Fundamentally, is the difference between monadic and dyadic measures a theoretical problem or an empirical measurement issue? Future research may focus on developing a new dyadic indicator or on identifying a set of variables that better capture the dual components of *trade share* and *trade dependence* at the level of the dyad.

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