

Measure for Mis-measure: A Response to Gartzke & Li*

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Barbieri & Peters (B&P) question Gartzke & Li's (G&L's) conclusion that the contradictory findings between Barbieri and Oneal & Russett on the trade–conflict question can be explained by their use of alternative measures. There are problems with G&L's analysis. First, G&L's findings are based on analyses with measures incompatible with Barbieri's. Second, G&L adopt measures that are not truly dyadic. Third, G&L draw erroneous conclusions from their mathematics. B&P explain these problems and present empirical analyses that show that even when controlling for economic openness, as G&L propose, dyadic interdependence is still positively associated with conflict. B&P find support for G&L's conclusion that openness promotes peace.

Introduction

Within trade–conflict research, there are two main schools of thought. One school, commonly associated with John Oneal & Bruce Russett (O&R), argues that trade promotes peace; the other, often associated with Katherine Barbieri, suggests that trade is associated with conflict.¹ O&R (Oneal et al., 1996; Oneal & Russett, 1997, 1999a,b;

Russett & Oneal, 2001) and Barbieri (1995, 1996a,b, 2002) each provide empirical support for their positions. Gartzke & Li (2003) (G&L) argue that the discrepant findings can be explained by the use of alternative measures. G&L also argue that economic openness promotes peace and that Barbieri's measure is inversely proportional to *openness*, whereas O&R's measure is directly proportional to it. G&L believe Barbieri's finding that interdependence is positively associated with conflict can be explained by her use of a measure that captures disconnectedness from the global economy, rather than interdependence. While G&L raise some important points, we believe their argument has problems.

We agree with G&L that differences in measures can produce different results and

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¹ For summaries of the trade–conflict literature, see Barbieri & Schneider (1999), Mansfield & Pollins (2001), and Schneider, Barbieri & Gleditsch (2003).

that openness may be useful to consider when examining interdependence and conflict. However, G&L's analysis contains several flaws. First, their analyses use measures incompatible with Barbieri's. Second, G&L present their work as a dyadic analysis, but adopt measures that are not truly dyadic. Third, they draw erroneous conclusions from their mathematics. We explain these problems, present new empirical analyses, and draw conclusions.

Comparing Trade Measures

G&L (2003) attribute their measures, *trade share* and *trade dependence*, to Barbieri and O&R, respectively. Their analysis also includes a measure of economic openness (2003: 5). Although *trade share* and *trade dependence* are a function of the trade between two countries, these are not fully dyadic measures, since they estimate dependence with respect to only one state in the dyad – the state with the lower dependence score. Barbieri (1995, 2002) uses both G&L's *trade share* and *trade dependence* measures (which she terms *partner dependence* and *economy dependence*, respectively) to create what are truly *dyadic* measures. She argues that dyadic interdependence emerges when two states depend heavily upon each other and when that dependence is mutual. Thus, she measures the *salience* and *symmetry* of dependence, calculated as follows:²

$$\text{salience } (A, B) = \frac{\text{partner dependence } (A, B)}{\sqrt{\text{partner dependence } (A, B) \times \text{partner dependence } (B, A)}} \quad (1)$$

$$\text{symmetry } (A, B) = 1 - \frac{|\text{partner dependence } (A, B) - \text{partner dependence } (B, A)|}{\text{partner dependence } (A, B) + \text{partner dependence } (B, A)} \quad (2)$$

These measures are dyadic and preserve all the information in the respective partner dependencies since

² The *economy dependence* measures are calculated analogously.

$$\begin{aligned} \text{partner dependence } (A, B) &= \sqrt{L^2 + \frac{1}{4}(1 - M)^2} - \frac{1}{2}(1 - M) \\ \text{partner dependence } (B, A) &= \sqrt{L^2 + \frac{1}{4}(1 - M)^2} + \frac{1}{2}(1 - M) \end{aligned} \quad (3)$$

where $L = \text{salience } (A, B)$, $M = \text{symmetry } (A, B)$, and $\text{partner dependence } (A, B) \leq \text{partner dependence } (B, A)$. That is, there is an invertible mapping between the set of all *partner dependence* dyads and the set of all (*salience, symmetry*) dyads. This implies that any analyses performed using the dyad (*salience* (A, B), *symmetry* (A, B)) lose no information about the dyad (*partner dependence* (A, B), *partner dependence* (B, A)). Barbieri also employs measures of *salience* and *symmetry* based on her *economy dependence* measures (G&L's *trade dependence*) and she defines a scalar interdependence measure as the product of *salience* and *symmetry*.³

$$\text{interdependence } (A, B) = \text{salience } (A, B) \times \text{symmetry } (A, B) \quad (4)$$

Barbieri used the vector of values,

$$[\text{salience } (A, B), \text{symmetry } (A, B), \text{interdependence } (A, B)] \quad (5)$$

that shows a positive correlation between interdependence and conflict.

Mischaracterizations and Mis-measures

The first significant problem with G&L's analysis is that they mischaracterize Barbieri's measures and then draw conclusions about her findings based on measures unrepresentative of hers. G&L's primary argument is that the *trade share* of country A with

³ Barbieri's (2002) recent work includes a measure of interdependence that is the product of the normalized scores of *salience* and *symmetry*.

country *B* correlates negatively with the openness of country *A*. Openness, they claim, is positively associated with number of trading partners. Therefore, *high trade share*, which they believe is associated with a *low* number of trading partners, means the country is isolated. Thus, they state, if isolation were positively associated with conflict, *trade share* would be positively associated with conflict. G&L believe that Barbieri's finding of a positive relationship between interdependence and conflict is simply the result of her measure capturing isolation, not interdependence. Even if one assumes that monadic *trade share* and isolation are positively correlated, dyads consisting of states with high *trade shares* could still have high dyadic interdependence. Dyadic interdependence could be high even if both states were isolated from the global economy. G&L's measures do not tell us about dyadic interdependence.

G&L imply that they are conducting a dyadic analysis of the interdependence–conflict relationship. Yet, they rely on what are essentially monadic indicators of *trade share*, *trade dependence*, and *openness*. They use the 'weakest link' approach (Dixon, 1993, 1994) that presumes the lesser of the two states' dependence scores is sufficient to describe the dyad. Dixon & Goertz (2003) argue that the 'weakest link' is dyadic in that it relies on information about both states to derive the minimum value. However, once this value is derived, specific information about the maximum is discarded. A truly dyadic measure should include information about two states, rather than one. The weakest link measure neglects disparities in dependence or the presence of high dependence. This is problematic. Imagine: state *A* and state *B* each depend on the other for 10% of their respective trade, while state *A* depends on state *C* for 10% of its trade and state *C* depends on *A* for 90% of its trade. Most would agree that *A*'s relationships with states *B* and *C* are different.

Yet, G&L assign identical values to these two relationships. Barbieri does not.

While people disagree about whether symmetrical or asymmetrical relations are more peaceful, few would view them as identical. The weakest link approach assumes the less constrained (less dependent) state defines the conflict propensity of the dyad. It ignores the motivation or power of the more dependent state to influence the relationship. This seems inconsistent with many theories, including Liberalism.

Liberals assume the cost of conflict increases as the gains from trade increase (Polachek, 1980). States that depend heavily upon a given relationship should face greater costs from conflict. This should create greater incentives to prevent or resolve conflicts. Dyadic conflict should be viewed as a function of the behavior of two states. A dyad that contains a state with great incentives to maintain peace (a highly dependent state) should be different from one that contains no such state. Similarly, a dyad with two states highly motivated to maintain peace should differ from one that contains only one such state or none.

G&L suggest that a major difference in O&R's and Barbieri's conclusions results from O&R using a GDP-based measure of dependence, while Barbieri uses a total trade-based measure. These assumptions are critical to G&L's arguments, but they are at least partly incorrect. Barbieri's work does not rely exclusively on total trade-based measures.⁴ Barbieri (1995, 2002) employs two-dimensional vector measures constructed from *partner dependence* and *economy dependence*, where the latter is GDP-based. She argues that both measures are important for understanding *interdependence*, but it is not always possible or desirable to employ both. For example, most states did not systematically

⁴ G&L acknowledge in a footnote that Barbieri also employs a GDP-based measure, but their characterization of her measure throughout their study neglects that fact.

collect information required to compute GDP prior to WWII, while most collected total trade figures for a long period. This makes total trade measures more reliable and generalizable for some historical periods.⁵ There are also differences in GDP-based measures beyond the manner in which national scores are transformed into dyadic measures. G&L employ a ratio measure where the numerator (trade) is reported in current dollars, while the denominator (GDP) is reported in PPP-adjusted dollars. Barbieri consistently uses current dollars in both her numerator and denominator.⁶

Barbieri (2002) found no substantive differences in the results derived from her different measures, which leads her to doubt that GDP versus total trade is the issue. The more important explanation is whether one uses information about two states, rather than one, to describe a dyad.

Implications of the Equations

Another problem with G&L's analysis is that they misinterpret their equations. Three equations, (1), (2), and (3), capture the relationships between *trade share*, *trade dependence*, and *openness*. They perform a statistical analysis that leads to results consistent with the equations. But they claim that the equations imply *only* those results. After Equation (3) they state, '*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' (Gartzke & Li, 2003: 558).

The previous statement is, strictly speaking, untrue. *Openness* may or may not change if *trade dependence* or *trade share*

change. If trade between countries *A* and *B* changes without an effect on *A*'s total trade, then there is no change in *openness*. This could happen if the change in trade between *A* and *B* is offset by changes with *A*'s other partners. Moreover, *openness* could increase while both *trade dependence* and *trade share* increase. That would happen if GDP(*A*) shrinks while both *trade dependence* and *trade share* increase, with *trade share* increasing at a faster rate.

In addition, consider the strength of the relationships that G&L point to in drawing their general conclusions. The negative correlation between *trade share* and *openness* is -0.03 . The relationship may be statistically significant, but the substantive connection is weak at best. Similarly, *trade share* has only a small inverse correlation with the number of a state's trading partners (-0.16). Moreover, there exists no reliable source of data on the number of trading partners states possess.⁷

The Trade–Conflict Relationship Revealed

Despite problems with G&L's analysis, their argument about considering states' openness to the global economy is important. The question remains whether Barbieri's findings, that trade is positively associated with conflict, would differ if she were to consider dyadic openness. We conducted an empirical analysis to answer this question. While G&L measure openness monadically,⁸ we created a dyadic measure that included information about both states in the dyad. We employed Barbieri's *salience* measures to capture dyadic interdependence. We performed separate analyses for the *partner dependence* and *economy dependence* measures of *salience*, since the two variables were highly correlated

⁵ See Barbieri (2002, 2003) for an elaboration of measurement issues.

⁶ Alan Heston, in personal communications (1996), whose Penn World Tables are G&L's source for GDP, argued strongly that it was completely inappropriate to construct a ratio variable that combined trade figures measured in current dollars with GDP figures that were PPP-adjusted values.

⁷ For a discussion of problems with trade statistics, see Barbieri (2002: Appendix A).

⁸ Whether G&L have the best measure of openness is an issue that is itself subject to debate, but beyond the scope of this article (see Schneider, Barbieri & Gleditsch, 2003: 26–27).

Table I. Interdependence and Conflict, 1949–92

<i>Independent variables</i>	<i>Dispute occurrence_t</i>	
	<i>Partner dependence</i>	<i>Economy dependence</i>
<i>Salience</i> _{<i>t</i>-1}	2.919*** (0.835)	14.720*** (2.510)
<i>Openness</i> _{<i>t</i>-1}	-2.070*** (0.264)	-2.370*** (0.266)
<i>Contiguity</i> _{<i>t</i>-1}	2.013** (0.091)	1.985*** (0.090)
<i>Joint democracy</i> _{<i>t</i>-1}	-0.011*** (0.001)	-0.010*** (0.001)
<i>Alliance</i> _{<i>t</i>-1}	0.124 (0.095)	0.129 (0.094)
<i>Relative capabilities</i> _{<i>t</i>-1}	-0.053* (0.027)	-0.047 (0.025)
<i>Peace</i>	-0.374*** (0.024)	-0.377*** (0.024)
<i>Spline 1</i>	-0.002*** (0.000)	-0.002*** (0.000)
<i>Spline 2</i>	0.001*** (0.000)	0.001*** (0.000)
<i>Spline 3</i>	-0.000 (0.000)	-0.000 (0.000)
<i>Constant</i>	-2.273*** (0.153)	-2.171*** (0.152)
χ^2	2,627.83***	2,637.27***
Log-likelihood	3,301.41	3,282.79
Pseudo <i>R</i> ²	0.27	0.28
N	118,815	118,353

Robust standard errors appear in parentheses.

Significance levels refer to two-tailed tests.

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

(0.75).⁹ Our dyadic measure of *openness* was calculated similarly to the *salience* measure; it is the geometric mean of each state's *openness* score (total trade/GDP). Our analyses employed the data and control variables used in Barbieri (2002) and used logit regression analysis to estimate our models.

The results reveal that even after controlling for dyadic *openness*, the relationship between interdependence and conflict remains statistically significant and positive.

⁹ The high correlation between a dyad's lower *trade share* and lower *trade dependence* measures (0.71) raises further questions about G&L's analysis.

This is true for both the *partner* and *economy dependence* measures. We find that dyadic *openness* has a negative and statistically significant relationship to conflict. Thus, while G&L's monadic measure of *openness* may be wrong, their conclusion about openness appears correct. Dyads of states more dependent upon the global economy appear to be more peaceful than those not dependent. However, the favorable effect of openness does not compensate for the higher incidence of conflict present in interdependent relationships. The findings suggest that the differences between G&L's and Barbieri's

conclusions result neither from their inclusion of openness nor from using GDP versus total trade-based measures. The differences result, in part, from G&L's decision to use monadic measures to capture dyadic interdependence.

Conclusions

Gartzke & Li's (2003: 567) claim to have 'develop[ed] a rigorous theoretical account of the relationships among the monadic and dyadic measures of interdependence' rings hollow. Not only have they used inappropriate measures, they have assumed that a subset of possible solutions of an equation is the complete set. The statement: *data with a set of properties, P, are consistent with equation T* does not imply the statement: *data that are consistent with T must have properties P*. The weak correlations that they show, such as the -0.03 coefficient between *trade share* and *openness*, are consistent with the equations. But nothing precludes *openness* from increasing as *trade share* increases; all it requires is a sufficient simultaneous drop in the GDP.

Finally, even if we overlook the problems in G&L's analysis, scholars should still question their conclusion that interdependence promotes *dyadic* peace. Assume state *A* is heavily dependent upon the global economy and also engages in military conflict. G&L's dyadic level prediction would be that *A* would be more likely to fight the trade partner upon whom it depends heavily. Moreover, G&L suggest that open states are more peaceful, because they have many partners and, therefore, do not depend heavily on any one state. This implies that it is low *dyadic* interdependence that is positively associated with peace and high *dyadic* interdependence that is associated with conflict.

Although we have taken issue with many of G&L's claims, we applaud their effort. We

hope these few pages, like G&L's article, further increase understanding of how best to measure important and complicated concepts, especially as we work towards solving the puzzle of trade's influence on international conflict.

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