Reconsidering Economic Leverage and Vulnerability: Trade Ties, Sanction Threats, and the Success of Economic Coercion*

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Abstract

I contend that a state's position in the global trade network affects the initiation and outcome of sanction threats. A state is vulnerable, and thus more likely to acquiesce, when its trade has low value to trade partners that are well-connected to the global trade network. Conversely, a state has leverage that could motivate the use of sanction threats when its trade has high value to trade partners that are otherwise not well-connected. Capturing leverage/vulnerability with an interaction between two network centrality measures, results indicate that vulnerability is associated with acquiescence to sanctions, while leverage is associated with threat initiation.

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1 Introduction

The link between economic ties—particularly trade—and attempts by states to exercise power over other states is one of the oldest topics of academic study, dating back to the work of Thucydides (431 BCE [1903]). Sanctions are perhaps the most salient contemporary exercise of economic power, conceptualized in a classic study by Hirschman (1945, 17) as the *influence effect of trade*. In its ideal manifestation, a sanction (or threat thereof) compels the target state to choose between changing some proscribed policy or losing access to beneficial interactions—often trade—with the sanctioning state (the sender). It is an opportune time to examine how leverage (the ability to harm others) and vulnerability (susceptibility to harm) following from the structure of trade ties affect the use and outcome of economic coercion; emerging powers such as China increasingly employ their commercial strength towards ends of foreign policy. Indeed, inquiry in this area could have implications for the large literature considering how economic ties affect a wide range of cooperative and conflictual relations between states (e.g., Crescenzi 2003, see also Barbieri and Schneider 1999; Mansfield and Pollins 2001).

Sanctions research finds that target costs influence the outcome of sanctions episodes (Dashti-Gibson, Davis and Radcliff 1997; Drury 1998; Hufbauer et al. 2007; Allen 2008), with a common emphasis on how the availability of third-party markets influences target resistance (Early 2009, 2015; McLean and Whang 2010; Peksen and Peterson 2016). We know less about how the structure of the global trade network could render some states particularly susceptible to economic coercion, while enabling coercive behavior by other states. I argue that a state's tendency to threaten sanctions, as well as its propensity to acquiesce when threatened with sanctions, depend on its own costs *and* the costs that its trade partners would face, if trade were interrupted; and I contend that the state's position in the global trade network provides information on both of these costs. First,

a state's value to trade partners is proportional to the number of trade partners and the extent to which these trade partners rely on trade with the state for income—a perspective distinct from most studies that examine trade with respect to the state's own GDP. A state has relatively little leverage to coerce if its value to trade partners is low, but this position is associated with vulnerability only if, simultaneously, its trade partners are highly connected to the global trade network such that they could replace lost trade more easily. The opposite scenario—high value to trade partners that are not well-integrated within the broader global trade network—suggests leverage that motivates a state to consider economic coercion as a more efficacious foreign policy tool.

I demonstrate that two measures of centrality within the global trade network *in conjunction* capture the two crucial elements of leverage and vulnerability. Specifically, generalized out-degree centrality (Opsahl, Agneessens and Skvoretz 2010) captures a state's value to trade partners, while Google's PageRank algorithm (Page et al. 1999) can be used to measure the extent to which a state's trade partners are connected to the broader global trade network. Results of statistical analyses examining target acquiescence and sender initiation of sanction threats spanning 1950 to 2005 support my theoretical expectations that vulnerable states more often acquiesce to sender demands, while states with leverage are more likely to initiate sanction threats.

By extending important advances in network analysis, this article contributes to the larger understanding of how complex patterns of international trade affect political interactions between states (see, e.g., Maoz 2009; Dorussen and Ward 2010; Hafner-Burton and Montgomery 2008, 2012; Kinne 2012, 2014). I demonstrate that two measures of network centrality jointly provide useful information on leverage and vulnerability that could not be obtained with any single measure. Accordingly, my work invites researchers to reconsider how their theoretical concepts translate to empirical measures. My results also hold important implications for policy-makers. For states such as the US that commonly

use sanctions, my findings could help policy-makers to identify potential targets that would face unilaterally high costs from interruption of US trade, and thus could be most open to influence. Similarly, my approach facilitates identification of prospective sanction targets whose stronger position in the global trade network implies that unilateral sanction threats might be ineffective.

2 Trade Ties, Leverage, and Vulnerability

In the late twentieth century, scholars commonly examined how leverage and vulnerability associated with trade relationships affected political interactions. First, a large literature explored the effect of trade on armed conflict (for reviews of this literature, see Mansfield and Pollins 2001 and Barbieri and Levy 1999). Second, a generally separate body of research considered how power relationships influence the use and success of sanctions (see, e.g., Baldwin 1985; Drury 1998; Drezner 1999; Hufbauer et al. 2007).

Trade-conflict scholars allocate less attention to leverage and vulnerability in recent years. Most notably, formal work in this area suggests that differential costs associated with terminating trade ties should be subsumed into bargaining (Morrow 1999; Gartzke, Li and Boehmer 2001; Reed 2003). As such, to the extent that all parties are informed of their relative power, the state with greater leverage will demand more, while the more vulnerable state will offer more to avoid armed conflict. Instead, this perspective views the impact of trade on conflict as a function of information; larger trade volumes facilitate costly signaling and promote bargaining clarity.[1]

Yet, if informational theories of trade and conflict are correct, it becomes more important to understand the role of leverage and vulnerability in the onset and outcome of

[1] However, several studies suggest that asymmetric trade dependence is associated with higher propensity for armed conflict (Barbieri 1996; Peterson 2014*a*)–or at least a reduction in the pacifying impact of trade (Gartzke and Westerwinter 2016).

economic coercion. Indeed, sanction threats are a natural manifestation of bargaining (e.g., Wagner 1988; Krustev 2010). However, leverage and vulnerability are inherently difficult to conceptualize and more challenging still to operationalize and measure. Attempts to do so often require simultaneous attention to dyadic and higher-order phenomena. For example, research examining the link between trade and either cooperation or conflict between two trade partners often examines bilateral trade ties in conjunction with each state's economic ties to third-party states (e.g., Barbieri 1996; Aydin 2008; Peterson 2011, 2015; Kleinberg, Robinson and French 2012; Chatagnier and Kavakli 2017). Similarly, research suggests that we must consider the sender's and target's ties to third parties in order to understand the manner in which trade influences the onset of sanctions (Crescenzi 2003; Peksen and Peterson 2016) and the success thereof (Crescenzi 2003; McLean and Whang 2010; Early 2009, 2015).

Though work on dyadic and multilateral phenomena underlying economic coercion is a positive development, this work does not consider a state's position in the broader global trade environment, which has consequences widely for its ability to endure restricted commerce, as well as its ability to use economic coercion as a foreign policy tool. However, network analysis provides a foundation to create such measures. Network analysis allows for the incorporation of information beyond the dyad level; for example, network measures can incorporate information on a state's trade ties, their trade partners' trade ties, and *those* trade partners' trade ties, while retaining the state as unit of analysis. However, prior research generally has not examined how trade ties could influence vulnerability and leverage throughout the global trade network.[2]

[2]Exceptions include Maoz (2009), though this study operationalizes vulneability primarily using dyadic and monadic measures. Other studies apply a network approach to power relationships within trade agreements, finding that higher degree centrality within a preferential trade agreement network leads states to initiate sanctions more often (Hafner-Burton and Montgomery 2008), while power disparity potentially promotes conflict among agreement members (Hafner-Burton and Montgomery 2012). Related, research has examined sanctions themselves as network flows (Cranmer, Heinrich and Desmarais 2014).

3 Trade Network Position and Sanctioning Behavior

Sanctions–and threats thereof–occur when one state (the sender) attempts to extract policy concessions from another, backing its demand with the threat of costs associated with restrictions on commerce if the target fails to comply. As such, for sanctions to occur requires only that one state prefers another state to change some policy and that this state has the ability to restrict existing bilateral ties (Most and Starr 1989).[3] In many cases, sanctions are threatened when targets engage in behavior broadly proscribed by the international community–e.g., military aggression, human rights abuse, sponsorship of terrorism, or nuclear proliferation. Regardless of the specific issue, I assume that, from the target's perspective, initial policies reflect preferences of leaders who wish to remain in power (Bueno de Mesquita et al. 2004). The threat of a sanction requires target leaders to judge whether the sender's threat is sincere, and assuming it is, to consider the tradeoff between maintaining current policy and enduring consequential economic restrictions, or else adopting the sender's preferred policy.

In this model, the costs of sanctions to targets, along with the target's belief that the sender is not bluffing, are important determinants of sanction threat outcomes, while opportunity for one state to inflict costs on another is the critical determinant of sanction threat initiation. I contend that the structural position of states in the global trade network provides information on these factors. My main argument is that a state's position in the global trade network can either render it vulnerable to sanctions–i.e., sanctions would inflict sufficient costs on the state and minimal costs on its trade partners–that make it more likely to acquiesce to sanction threats; or else bestow leverage–i.e., the ability to impose

[3]Notably, senders also use sanctions (including threats thereof) for broader symbolic purposes (e.g., Galtung 1967; Nossal 1989; Morgan and Schwebach 1996; Whang 2011; Peterson 2013, 2014*b*). However, some ability to restrict commerce with a specific target state is necessary nonetheless. Even when sanctions busters replace lost trade between the sender and target (Early 2009, 2015), the target is still likely to suffer costs associated with establishing new trade flows. These costs could render sanctions worthwhile to the sender for their reputation effects (Peterson 2013, 2014*b*; Miller 2014).

high costs on others while suffering little costs itself–that incentivizes sanction threats as a potentially effective foreign policy tool when political disputes arise.

Specifically, I contend that there are two elements of a state's position in the global trade network that jointly determine its vulnerability, or conversely, its leverage. First, a state's *value* to trade partners is a function of the number and extent of its trade ties in terms of the income of its trade partners. A state that has many trade partners, and whose trade composes a larger proportion of its trade partners' income, has more value than a state that maintains few, because the state has many markets for trade (implying that the loss of any one is less important) and because its existing trade partners rely more its trade for income (suggesting the state can impose higher costs on its trade partners if economic exit were to occur). Having low value implies a lack of leverage to coerce trade partners because trade partners would face low costs in the event of trade interruption, while these parters also would be aware that the state has relatively fewer established markets to which it could redirect lost trade. However, the lack of value is not necessarily the same thing as vulnerability to trade partners; similarly, the presence of value does not, in isolation, confer leverage.

To understand vulnerability and leverage, we must consider a state's value in conjunction with a second element of its structural position: the *connectedness of its trade partners* to global trade network. This assumption follows naturally from the literature on interdependence that considers vulnerability in terms of the *relative* ease with which a state can adjust to the loss of a given trade tie (Hirschman 1945; Keohane and Nye 1977). However, partner connectedness is not simply a function of a state's trade partners' third-party trade. Rather, partner connectedness represents the degree to which a state's trade partners that are embedded in a dense, overlapping, and often reciprocal global trade network. All else equal, a well-embedded trade partner would be less afflicted by the loss of trade with the state, as this condition suggests that a more robust

infrastructure facilitating redirection to alternate markets is available.

A state with low value to trade partners, under the condition that its partners are also poorly-connected to the broader global trade network, will not be vulnerable because neither it nor its trade partners are in a position to harm one another greatly via trade restrictions, nor to redirect lost trade easily. Conversely, when a state's value to trade partners is low but its trade partners are very well-connected to the broader global trade network, it is more likely to face asymmetrically high opportunity costs in the event that trade is terminated because its trade partners could more easily replace lost trade.

I contend that states whose position in the global trade network suggests higher vulnerability (i.e., those that have lower value to trade partners under the condition of high trade partner connectedness) are more likely to acquiescence to sender demands when targeted with a sanction threat. As noted above, targets must judge whether the sender's threat is sincere, and consider the costs of sanctions against the cost of changing policy to the sender's satisfaction. Holding constant the cost of compliance, I contend that higher vulnerability suggests a higher likelihood of acquiescence to sanction threats because 1) targets will face higher costs associated with economic restrictions and 2) targets will be aware that sender costs from economic restrictions would be relatively low, and thus the sender is likely to follow through with its threat.

Mirroring the argument above, a state with high value to trade partners—that is, one maintaining many trade partners that depend on its trade for a substantial portion of their income—nonetheless might not be in a position to exercise leverage. If its trade partners simultaneously are highly connected to the global trade network, leverage could be minimal given that the state is less certain of asymmetric costs advantaging itself. In fact, the potential for mutually high costs associated with trade interruption could spur recognition of common interests in maintaining cooperation. Yet when a state has high value to trade partners that are weakly connected to the global trade network, these trade part-

ners could face a major loss of income (and thus welfare) if commerce is restricted, while the state itself is more likely to be insulated from these costs given its large number of trade partners who rely on its trade for a lager proportion of their income, suggesting that the loss of any one is less important. As such, when political disputes arise, the ability of states with leverage to inflict economic costs on targets while enduring relatively light costs themselves renders sanction threats a relatively attractive foreign policy tool amid the alternatives–whether carrots such as foreign aid or sticks such as militarized conflict (Palmer and Morgan 2010).

The discussion above focuses on state-level trade network position, and thus my arguments apply foremost in cases of unilateral sanctions. However, a state's power relationships stemming from its position in the global trade network have implications for multilateral sanctions as well. All else equal, the less vulnerable a state is, the more senders would be needed to impose sufficient costs to render sanction threats effective. Similarly, while senders with greater leverage should be in a better position to issue unilateral sanction threats, lower leverage for any one sender might necessitate international cooperation on multilateral sanctions for economic coercion to be successful.[4] This logic holds implications for previous research on the effectiveness of multilateral and institutional sanctions (e.g., Martin 1993; Drezner 2000; Bapat and Morgan 2009). When considering whether multilateral (including institutional) sanctions are more or less effective than unilateral sanctions, it is critical to consider the degree to which cooperation is required following from the target's position in the global trade network.

The argument above leads to the following hypotheses:

[4]Notably, credible commitments to cooperate on sanctions could be difficult to achieve. As such, higher individual state leverage should render sanction threat initiation more likely, as I argue above.

Hypothesis 1 *Under the condition that its value to trade partners is low, a state is more likely to acquiesce to sanction threats when the connectedness of its trade partners is higher. As its value to trade partners increases, the positive association between partner connectedness and acquiescence diminishes towards zero.*

Hypothesis 2 *Under the condition that the connectedness of its trade partners is low, a state is more likely to initiate sanction threats when its value to trade partners is higher. As its partner connectedness increases, the positive association between a state's value to trade partners and its propensity to initiate sanctions diminishes towards zero.*

4 Research Design

I test my hypotheses with a dataset of sanction threats spanning 1950 to 2005 to examine acquiescence, and with a dataset of all state-years over the same period to examine the initiation of sanction threats by senders. This time span is delimited by the availability of data; sufficient coverage of cross-national GDP data used to calculate leverage and vulnerability is unavailable prior to 1950, while sanction threat initiation data is unavailable for the period after 2005. I focus on sanction episodes that begin with *threats* because research suggests that successful coercion is most likely to occur during the threat stage (Nooruddin 2002; Drezner 2003; Lacy and Niou 2004).

My first set of models examines acquiescence to economic coercion, testing hypothesis 1. Using a dataset of all sanction threats between 1950 and 2005 from the Threat and Imposition of Economic Sanctions (TIES) data version 4.0 (Morgan, Bapat and Kobayashi 2014),[5] I code two variants of *acquiescence*, the first of which is equal to 1 if TIES records the outcome of the sanction threat as complete acquiescence to the sender's demand (that is, where the TIES *final outcome* variable is equal to 1 or 6), and otherwise equal to 0. The second measure of *acquiescence* is broader, coded as equal to one when the

[5] I include all sanction types, despite the fact that some sanctions do not target trade specifically. This decision is driven by the fact that trade correlates with other economic ties such as foreign aid (Berthelemy and Tichit 2004). Appendix models demonstrate that results look similar if I include only sanction types involving restrictions on trade.

target acquiesces *fully or partially* to the sender's demand (that is, where the *final outcome* variable is equal to 1, 2, 6, or 7).[6] Given the construction of these binary DVs, I use logit models to assess support for hypothesis 1.[7] In order to increase confidence that my results are not an artifact of omitted variable bias, the supplemental appendix presents alternate, generalized linear mixed effects models with a logit link function and random intercepts for the primary sanction issue and for target state.

Turning to hypothesis 2, I use data on all state-years to code my second dependent variable, *sender initiation* of a sanction threat. Using the TIES data to identify threat onset, I code two variants of this dependent variable. The first is equal to 1 when a state initiates at least one sanction threat over any issue in a given year,[8] and is equal to 0 otherwise. The second variant is equal to 1 if a state initiates a sanction over an issue other than trade, the environment, and economic reform, and is equal to 0 otherwise.[9] The exclusion of these three issues allows me to determine whether support for hypothesis 2 extends beyond less important, "low politics" issues (Drezner 2003). Because both of these variables are dichotomous, I estimate all models using logistic regression. Furthermore, given that high-income states tend to use sanctions more often than developing states, I present models both for all states and specifically for high-income states, using the World Bank definition of high-income as GDP per capita above $12,735 in (inflation-adjusted) 2014 dollars. To account for duration dependence, all sender initiation models include a variable counting the years since the previous sanction initiation, as well as a squared and

[6] These variables examine acquiescence in either the threat or imposition stage of the sanction episode. In models presented in the supplemental appendix, I demonstrate that results look essentially identical if I code the dependent variable as equal to one only in cases when the target acquiesces during the threat stage.

[7] Additional models, presented in the supplemental appendix, show that results hold in ordered logit regressions in which I specify an ordinal dependent variable, where 0 = no acquiescence, 1 = partial acquiescence, and 2 = complete acquiescence.

[8] This variable is coded for year t+1 to mitigate simultaneity bias.

[9] In both cases, I exclude cases where the primary sender is an international organization in order to capture state behavior specifically.

cubed term thereof (Carter and Signorino 2010). The supplemental appendix presents a variety of additional models examining sender initiation, including models specified with random intercepts for the state.

4.1 Primary Explanatory Variables

As discussed above, one must consider a state's value to its trade partners as well as the connectedness of its trade partners to the global trade network in order to capture the state's leverage or vulnerability following from its position in the global trade network. Two measures of trade network centrality—generalized out-degree centrality and Google's PageRank algorithm, both applied to the global trade network—accomplish this task.[10]

For the purposes of this study, I conceive of a global trade network that is *directed*, where flows from *state i* to *state j* represent the value of *ij* trade in terms of *j*'s GDP. Specifically, in the *ij* directed network, edge weights (i.e., the magnitude of a given network tie) are equal to $\frac{imports_{ij}+exports_{ij}}{GDP_j}$. Accordingly, a given *ij* flow represents *state i*'s trade value with respect to *j*. Deflating exports by GDP is particularly useful because it suggests that a given value of trade is less important to a state's trade partners as the income of these states increases.[11]

4.1.1 A Network Measure of a State's Value to Trade Partners

One of the simplest measures of network centrality, *degree centrality*, typically is operationalized as the count of connections between states. However, given that many states

[10] Somewhat related, Dorussen and Ward (2010) calculate a *maximum flow* network measure that accounts for bottlenecks, though their application considers the idea that some states act as gatekeepers who exercise influence against other states maintaining fewer trade ties.

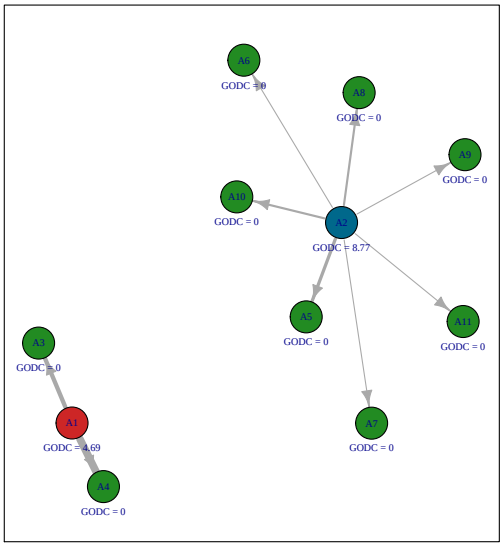
[11] It also accounts for the fact that trade volumes have increased over time, which might otherwise produce spurious correlation when associated centrality measures are used in statistical models.

trade with most other states in the contemporary international system, simplified trade networks that dichotomize the absence or presence of a trade flow between two states are limited in explanatory power. An alternative is to sum the weights of trade ties. This measure, called *strength*, also is limited for my purposes because it would produce a country-level measure of trade as a function of partner GDP, an (abstract) indicator that ignores the number of trade partners the state maintains. To overcome this dilemma, I turn to a study by Opsahl, Agneessens and Skvoretz (2010), which creates a new measure that incorporates both the number and extent of network ties, using the tuning parameter α to capture the relative importance of tie count vs. weight. $\alpha = 0$ ignores edge weights, counting ties between nodes and thus producing traditional degree centrality, while $\alpha = 1$ sums weights, ignoring the count of ties and producing an indicator of strength. However, levels of α between these extremes incorporate both tie counts and weights into an indicator of generalized degree centrality. To illustrate, generalized out-degree centrality (GODC) is equal to:

$$C_D^{w\alpha}(i) = p_i^{1-\alpha} \sum_j^N w_{ij}^{\alpha}$$

In this measure, w represents the edge weight ($\frac{trade_{ij}}{GDP_j}$). I code generalized out-degree centrality for *state i* with respect to all of *i*'s trade partners *j* $\neq$ *i*, using $\alpha = 0.5$ in order to give explanatory power in equal measure to the number of trade ties and the extent of these ties. The left hand illustration in Figure 1 presents hypothetical variation in generalized out-degree centrality. In this figure, state A1 maintains fewer ties than state A2 (2 vs. 7), but total edge weights—represented by the thickness of lines—are equal (at 11). With α equal to 0.5, generalized out-degree centrality is equal to 4.69 for state A1 and 8.77 for state A2, a useful compromise that accounts both for tie count and tie extent.

A. Illustration of Value to Trade Partners



B. Illustration of Partner Connectedness

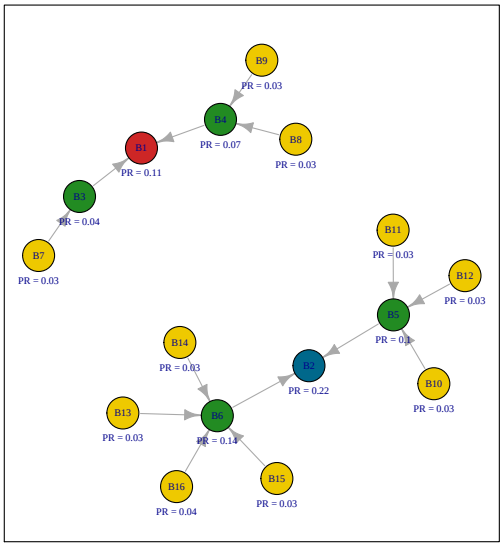


Figure 1: Illustration of centrality (GODC = generalized out-degree centrality; PR = PageRank)

4.1.2 A Network Measure of a State's Trade Partner Connectedness

Google's PageRank algorithm (Page et al. 1999) is a variant of weighted eigenvector centrality,[12] which can be viewed as an "extended form" of degree centrality (Newman 2004); a state's position in the network is measured as a function of how well-embedded in the network are the states to which it is connected. PageRank for *state i* can be understood as a measure that accounts for the weighted degree centrality for all states *j* to which *state i* is joined—as well as the states *k* to which each state *j* is joined, recursively throughout the global network.[13] PageRank (PR) is calculated in steps. First, each of *N* nodes (states) is assigned a PR equal to $\frac{1}{N}$. Then, for each subsequent step, PR for state *i* is recalculated as:

$$PR_i = \frac{1-d}{N} + d \sum_{j \in T(i)}^{N} \frac{PR_{j,t-1}}{T_j}$$

Where *d* is the damping parameter (set to the default of 0.85),[14] $j \in T(i)$ represents all states *j* that trade with *i*, $PR_{j,t-1}$ represents *j*'s PageRank score from the previous step, and T_j represents the value of *j*'s network ties. The above calculation is then repeated until final values converge.

The right-hand illustration in Figure 1 presents a highly stylized illustration of how two states could have identically low direct ties and yet vary considerably in their PageRank

[12] Mathematically, an eigenvector associated with a given square matrix A satisfies the eigenvector equation: $Av = \lambda v$. Specifically, the eigenvector v is a vector which, when multiplied by the matrix A, produces a result equal to the same vector multiplied by a constant λ (an *eigenvalue* of matrix A). As such, the eigenvector is considered a latent vector associated with a matrix, which allows one to compute complex calculations with a matrix much more simply than would otherwise be possible. The equation for eigenvector centrality, $x_i = \frac{1}{\lambda} \sum_j v_j$, simplifies to the eigenvector equation. See Bonacich (1987) and Hafner-Burton and Montgomery (2012) for details.

[13] Indeed, PageRank is a natural complement to GODC as, given the same network flow, $\frac{trade_{ij}}{GDP_j}$, GODC measures *direct, outward* ties, while PageRank measures *indirect, inward* ties.

[14] In the PageRank algorithm, the damping parameter represents the complement of the probability that one might stumble upon a webpage (or state) randomly if choosing among all options. The inclusion of the damping parameter is useful to preclude problems calculating eigenvector centrality in the presence of relatively isolated nodes.

Score. State B1 (in red) and state B2 (in blue) both maintain two, identically-sized trade connections. Yet state B2's trade partners are themselves more connected to third party trade partners. Accordingly, state B2's PageRank score is higher than that for state B1. The figure also illustrates that indirect ties are particularly important in the calculation of PageRank scores. State B5 has more direct ties than B1 and B2, and yet has a lower PageRank score than either.

One might expect that, on average, states with high value to trade partners also have highly connected trade partners. However, there is considerable variation in this relationship. The correlation between generalized out-degree centrality and PageRank by year is usually positive, but low, varying between -0.05 and 0.16, with a mean equal to 0.04 over the 56 years spanning 1950-2005. The top graph in Figure 2 presents these two values in a scatterplot for the year 1950. The upper-left area of the plot illustrates that several states have low trade power but high partner connectedness. I contend that these states will be more likely to acquiesce to sanctions/threats thereof. I also suspect that states on the lower-right of the plot are most likely to initiate sanction threats as senders; they have leverage associated with the fact that their value to trade partners is high while the connectedness of their trade partners is low (relative to their own GDP).

The bottom half of Figure 2 replicates the same scatterplot for the year 2005. The basic distribution of points is similar to that in 1950. However, the plot shows that there has been change in the makeup of states that are likely to be vulnerable or hold leverage. For example, India has increased its value to trade partners (GODC) slightly while its partner connectedness (PageRank) has fallen somewhat. The United Kingdom's value to trade partners has fallen somewhat but its partner connectedness has diminished considerably, which could suggest an overall more favorable position. China has seen both values increase between 1950 and 2005, though its value to trade partners has increased by a large margin while its partner connectedness is only slightly higher in 2005.

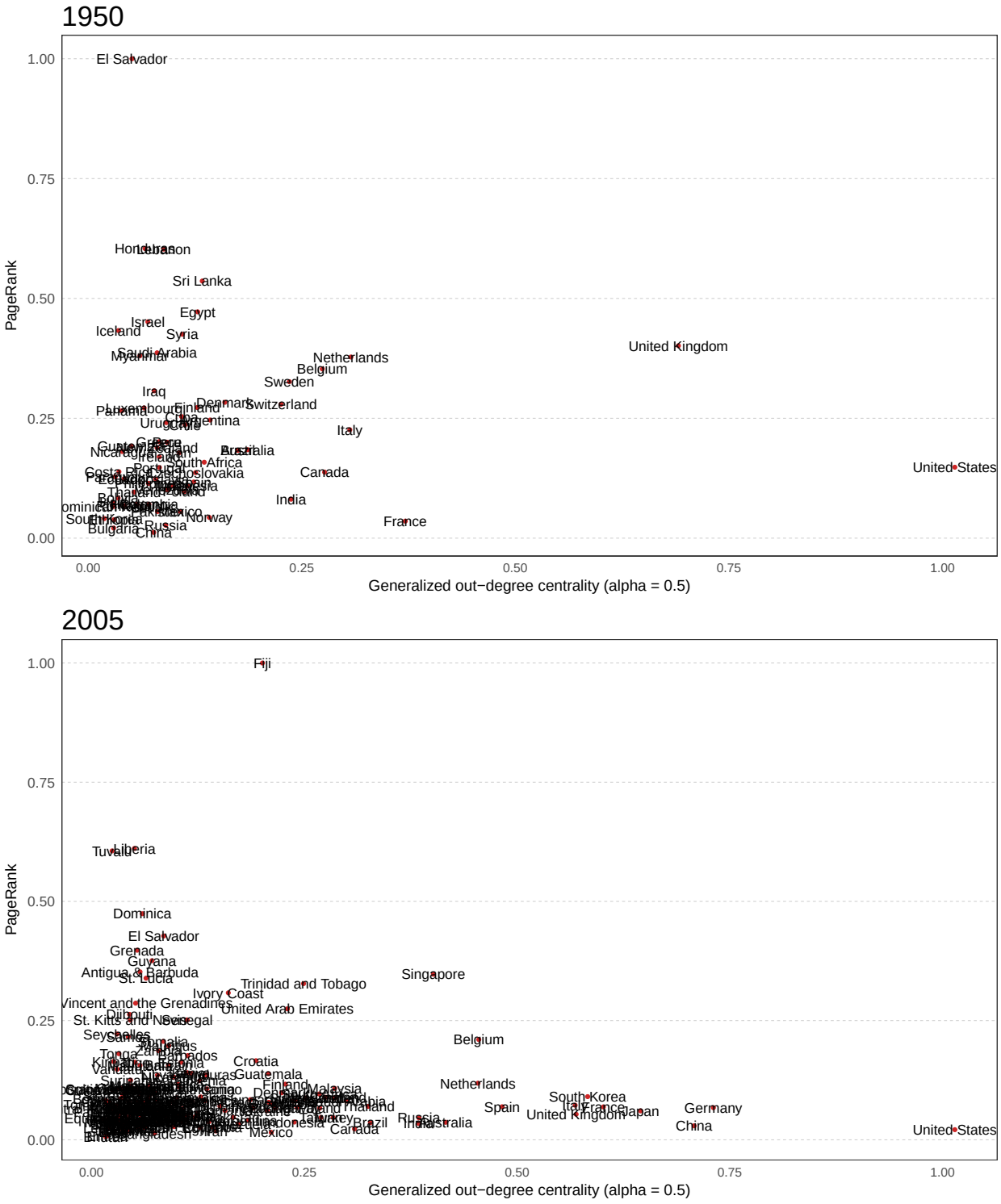


Figure 2: Comparison of centrality measures, 1950 and 2005

4.1.3 Final Centrality Measures

In all models, the primary explanatory variables are composed of an interaction between a state's GODC (Opsahl, Agneessens and Skvoretz 2010) and its PageRank score (Page et al. 1999), calculated yearly between 1950 and 2005. An interaction is necessary because my theory requires attention to a state's value to trade partners *conditional* on the connectedness of its trade partners, and vice versa. Trade data are taken from the Correlate of War Bilateral Trade Dataset version 4.0 (Barbieri and Keshk 2016), while GDP data are taken from the Expanded GDP data version 6.0 beta made available by Gleditsch (2002). As discussed above, Opsahl, Agneessens and Skvoretz's generalized degree centrality incorporates both the number and extent of trade ties, thereby providing a useful measure of the value of a state's trade to its trade partners, as well as the number of partners (and thus alternate markets) available to the state. I calculate this measure using R's tnet package, setting the tuning parameter α to 0.5. Furthermore, I normalize the measure by dividing raw scores each year by the highest yearly value, resulting in a measure that varies between 0 and 1 (with higher values representing greater trade power). As noted above, PageRank captures the extent to which a state's trade partners are connected to the global trade network. Again, the raw measure is deflated by the largest value each year, resulting in a normalized measure that varies between 0 and 1 (again, with higher values representing greater partner connectedness).[15] I calculate this measure using the igraph package in R (Csardi and Nepusz 2006).

4.2 Additional Explanatory Variables

I include additional explanatory variables best suited to reduce the potential for spurious correlation. In the case-level models examining target acquiescence, I include several

[15] Absent this transformation, PageRank scores for each year would sum to 1 and would be quite small given the presence of many states in the system.

variables regarding the nature of the threat that could covary with the target's position in the global trade network and with its predisposition to resist attempts at economic coercion—all of which are taken from the TIES data. First, I include a dichotomous variable equal to one for multilateral sanctions—that is, when TIES records more than one sender. From the target's perspective, the origin of the sanction threat matters less than its own ability to endure sanction costs. However, one might expect that a greater number of senders suggests higher target costs for interrupted trade, on average. I identify the United States as a sender with another dichotomous variable. I also include a dichotomous variable indicating whether a case involved the eventual imposition of sanctions. Given that the range of issues over which TIES records sanctions varies from armed aggression and support for terrorism, to unfair trade practices and destruction of the environment, all models include a dummy variable identifying "low-politics issues" (trade, the environment, and economic reform) (Drezner 2003).[16] Considering issues further, I also code a variable accounting for the context under which sanctions episodes might occur. Specifically, I code a dichotomous variable equal to one when the target has engaged in proscribed–defined as initiating a revisionist militarized interstate dispute (Palmer et al. 2015), engaging in pursuit of nuclear weapons (using data from Miller 2014), engaging in severe human rights abuses (coded as falling below the 25^{th} percentile on the measure by Fariss 2014), or sponsoring terrorism (coded using the official list of US state sponsors of terror).[17] This indicator could identify "pariah" states that are both poorly tied to the global trade network and (potentially) unresponsive to sanction threats.

I also include indicators of target characteristics that could covary with trade network position and response to sanction threats. Specifically, I include a measure of the target's

[16] Appendix models exclude these "low politics" cases entirely, finding equivalent results.

[17] The official US state sponsors of terror list admittedly is, at least in part, politically-motivated. However, it is a useful indicator because it isolates states that violate norms and are *not* political allies of the United States purposely kept off the list–which might also be insulated from pressures to initiate sanction threats.

trade openness, defined as total trade (imports plus exports) divided by GDP. This variable is included primarily to demonstrate that the influence of trade network positions are not simply a consequence of overall trade importance.[18] I include a variable recording the target's GDP per capita, taken from the Expanded GDP dataset version 6.0 beta (Gleditsch 2002), given that more developed states could trade more and can more easily resist coercion. These models also include a variable identifying whether the target has features associated with liberal democracy, defined as scoring at least a 7 on the 21-point Polity combined score (Marshall and Jaggers 2014). This measure identifies political participation and competition, as well as constraints on executive action, which could increase leader responsiveness to domestic pressure for favorable outcomes, potentially including generally higher trade levels and the appearance of strength when negotiating with foreign states.[19]

The sender initiation models also include the variables for trade/GDP, Polity score, and logged GDP per capita–for reasons largely equivalent to their inclusion in target acquiescence models. Specifically, including the trade/GDP of the prospective sender accounts for overall reliance on the state for income, while GDP per capita accounts for development–both of which might covary with sender costs from sanctioning. The Polity measure accounts for the fact that leaders in liberal democracies could face pressure to respond to proscribed behavior by other states. Related, the sender initiation models also include a variable to complement the proscribed target behavior variable discussed above, which serves as a proxy for awareness of or exposure to pariah states. Specifically, this variable counts the number of states located within 200 miles that are coded as engaging in proscribed behavior.[20] Finally, the sender initiation models include a dichoto-

[18] Importantly, there is low correlation between trade openness and each of the centrality measures: -0.03 for GODC and 0.46 for PageRank.

[19] In the supplemental appendix, I present additional models examining target acquiescence that include more variables (e.g., institution-backed sanctions).

[20] In the supplemental appendix, I present models using a more complex indicator of a state's proximity to

mous variable indicating the United States, a unique state that stands out with respect to high leverage and that uses sanctions often.

5 Analysis

Table 1: Coefficients and 95 percent confidence bounds examining acquiescence to sanction threats, 1950-2005

	Complete Acquiescence		Complete or Partial Acquiescence	
	Model 1	Model 2	Model 3	Model 4
Generalized out-degree centrality	−0.71	0.70	−0.17	1.00
	(−1.78, 0.36)	(−0.58, 1.98)	(−0.99, 0.64)	(−0.02, 2.03)
PageRank	5.44***	4.56***	4.82***	4.05***
	(3.35, 7.52)	(2.25, 6.87)	(2.88, 6.77)	(1.90, 6.20)
GODC X PageRank	−9.81*	−10.67**	−9.19**	−9.85**
	(−17.28, −2.34)	(−18.67, −2.67)	(−15.29, −3.10)	(−16.37, −3.33)
Trade/GDP	0.05	0.48	−0.14	0.05
	(−0.87, 0.96)	(−0.66, 1.62)	(−0.96, 0.67)	(−0.98, 1.07)
log GDP per capita		−0.30*		−0.13
		(−0.56, −0.04)		(−0.36, 0.11)
Democracy		0.94***		1.10***
		(0.46, 1.42)		(0.67, 1.53)
Proscribed Behavior		−0.05		−0.35
		(−0.52, 0.43)		(−0.77, 0.06)
US sender		−0.50*		−0.35
		(−0.93, −0.06)		(−0.73, 0.04)
Multilateral sanction		0.47*		0.62***
		(0.04, 0.89)		(0.26, 0.99)
Imposed sanction		−0.80***		−0.77***
		(−1.19, −0.40)		(−1.11, −0.43)
Trade/Environment/Reform issue	−0.26	−0.01	−0.35*	−0.11
	(−0.64, 0.12)	(−0.44, 0.42)	(−0.68, −0.02)	(−0.47, 0.26)
Constant	−1.49***	0.79	−0.93***	−0.12
	(−1.89, −1.10)	(−1.36, 2.94)	(−1.28, −0.58)	(−2.05, 1.81)
Observations	916	848	916	848
Log Likelihood	−411.20	−352.60	−513.55	−445.80

*** p less than 0.001, ** p less than 0.01, * p less than 0.05

Results of statistical models demonstrate support for my expectations that network position is associated with a sanction target's likelihood of acquiescing to the sender's demand, and with the likelihood that a state initiates a sanction threat as a sender. Table 1 presents coefficients and 95% confidence bounds for four models examining target acquiescence to sender demands when threatened with sanctions, covering episodes that begin between 1950 and 2005. Models 1 and 2 examine *complete acquiescence*

badly-behaving states.

as the dependent variable, while Models 3 and 4 examine *complete* or *partial* acquiescence. Models 1 and 3 include my primary explanatory variables and controls for target trade/GDP, as well as an indicator of a "low politics" issue, while Models 2 and 4 add controls for additional target and sanction threat characteristics. Results from all four models support hypothesis 1. Keeping in mind that constituent coefficients from an interaction provide limited information in logit models, I find that the coefficient for *PageRank* is positive and statistically significant ($p \leq 0.001$ in all four models). The interaction term is negative and statistically significant ($p \leq 0.05$ in Model 1; $p \leq 0.01$ in Models 2-4). However, little can be inferred from interaction terms in nonlinear models (Ai and Norton 2003). Accordingly, I turn to Figure 3, which presents four related plots that explore predicted probabilities and marginal effects associated with the interaction of GODC and PR, from Model 1.

In the upper-left plot of Figure 3, the solid line indicates the probability of acquiescence for states with low (10^{th} percentile) PageRank (i.e., partner connectedness) scores over the range spanning the 10^{th} to 90^{th} percentile of GODC (i.e., value to trade partners). The dashed line indicates the probability of acquiescence for states with high (90^{th} percentile) values of PageRank over the same range of GODC. Both lines are accompanied by shaded 95% confidence bounds. The upper-right plot complements these predictions with an illustration of the marginal effect of PR conditional on the value of GODC. The upper-left plot shows that, when target value to trade partners is low (i.e., when GODC is held at its 10^{th} percentile), an increase in partner connectedness (PageRank) from its 10^{th} to 90^{th} percentile is associated with an increase in the probability of acquiescence, from under 0.2 to nearly 0.4. However, when the target has high value to trade partners (i.e., when GODC is at its 90^{th} percentile), this same increase in PageRank has no statistically effect on the probability of acquiescence, which remains low (under 0.1). The top-right graph shows the same pattern: at lower levels of target value to trade partners, partner

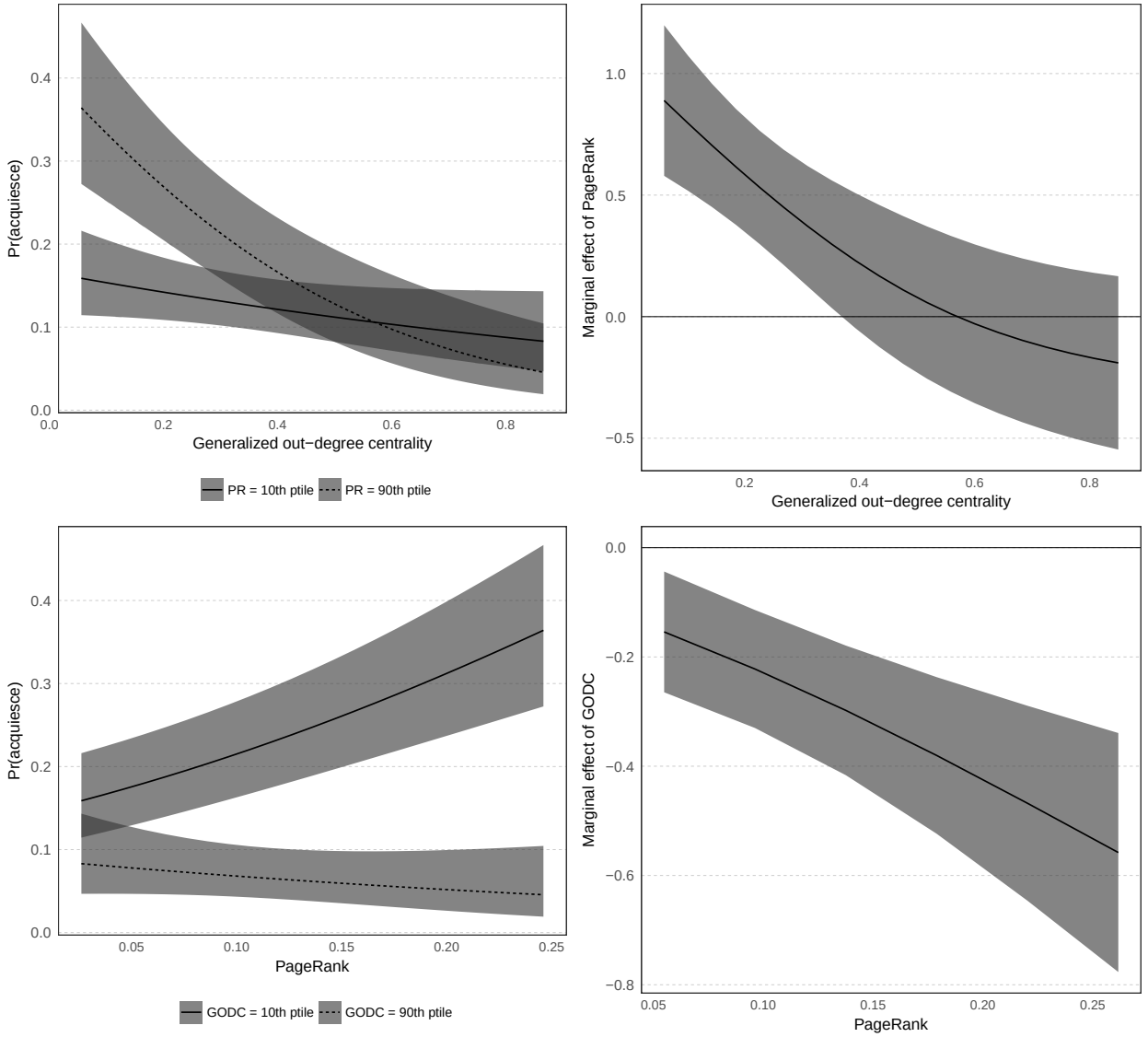


Figure 3: Visualization of the interaction of GODC X PageRank (from Model 1). Left-hand plots illustrate predicted probabilities of target acquiescence for low (10^{th} percentile) and high (90^{th} percentile) of each constituent term over the same range of the other constituent term. Right-hand plots illustrate conditional marginal effects of each constituent term on target acquiescence over the 10^{th}-90^{th} percentile of the other constituent term.

connectedness to the global trade network has a positive and significant marginal effect on the probability of acquiescence. However, this marginal effect diminishes as target value to trade partners increases, eventually losing statistical significance. These findings provide support hypothesis 1.

The lower plots in Figure 3 illustrate the "other side" of the interaction (Berry, Golder and Milton 2012). Specifically, the lower-left plot illustrates the probability of acquiescence for the 10^{th} (solid line) to 90^{th} (dashed line) percentile of value to trade partners (GODC), over the range of low (10^{th} percentile) to high (90^{th} percentile) values of partner connectedness (PageRank) on the x-axis. The lower-right plot illustrates the conditional marginal effect of GODC over the same range of PageRank. As expected, these plots show that states with higher value to trade partners are less likely to give in to sender demands; high levels of trade value (GODC) are associated with a lower probability of acquiescence regardless of partner connectedness (PR), and that this association (and marginal effect) becomes stronger (increasingly negative) as partner connectedness increases. Notably, however, the lower left-hand plot shows that the increasingly negative marginal effect results from the fact that, when target trade value is high, the probability of acquiescence remains low and relatively flat as partner connectedness increases; whereas, when target trade value is low, the probability of acquiescence increases over the range of partner connectedness (PR). Again, these results support hypothesis 1.

Turning to tests of hypothesis 2, Table 2 presents coefficients and 95% confidence bounds for four models examining initiation of sanction threats by senders. Models 5 and 6 examine the initiation of any threat, while Models 7 and 8 examine the initiation of non-economic threats. Models 5 and 7 examine all states as possible senders, while Models 6 and 8 include only high-income states, which generally are far more likely to initiate sanctions. Results from these four models provide support for hypothesis 2. Considering coefficients (which, again, provide limited information), I find that GODC is positive and

Table 2: Coefficients and 95 percent confidence bounds examining sanction threat initiation as a sender, 1950-2005

	Initiation of any threat		Initiation of non-economic threat	
	Model 5	Model 6	Model 7	Model 8
Generalized out-degree centrality	5.47***	4.05***	5.12***	4.02***
	(4.31, 6.63)	(2.50, 5.61)	(3.90, 6.34)	(2.37, 5.68)
PageRank	−0.60	−3.82	−0.30	−5.77*
	(−2.17, 0.97)	(−7.91, 0.27)	(−1.96, 1.35)	(−10.98, −0.57)
GODC X PageRank	−6.98**	1.19	−5.79*	3.75
	(−11.96, −2.00)	(−6.73, 9.10)	(−10.96, −0.62)	(−5.16, 12.66)
Trade/GDP	−0.21	0.39	−0.22	−0.13
	(−0.89, 0.48)	(−0.65, 1.43)	(−1.03, 0.58)	(−1.44, 1.18)
log GDP per capita	0.29***	0.47**	0.30***	0.51**
	(0.16, 0.43)	(0.11, 0.82)	(0.15, 0.46)	(0.12, 0.89)
Democracy	−0.17	0.23	−0.43*	−0.10
	(−0.47, 0.13)	(−0.28, 0.74)	(−0.79, −0.06)	(−0.67, 0.47)
US dummy	−0.42	0.05	0.36	0.56
	(−1.48, 0.65)	(−1.10, 1.20)	(−0.68, 1.40)	(−0.56, 1.68)
Proscribed behavior proximity	−0.05	−0.43**	0.13	−0.10
	(−0.24, 0.15)	(−0.75, −0.10)	(−0.08, 0.34)	(−0.45, 0.24)
Years since initiated	−0.18***	−0.19**	−0.10**	−0.04
	(−0.25, −0.12)	(−0.31, −0.08)	(−0.18, −0.03)	(−0.17, 0.08)
Years since initiated^2	0.01**	0.01	0.00	−0.00
	(0.00, 0.01)	(−0.00, 0.01)	(−0.00, 0.01)	(−0.01, 0.01)
Years since initiated^3	−0.00*	−0.00	−0.00	−0.00
	(−0.00, −0.00)	(−0.00, 0.00)	(−0.00, 0.00)	(−0.00, 0.00)
Constant	−5.13***	−6.75***	−5.69***	−7.47***
	(−6.29, −3.97)	(−10.57, −2.93)	(−7.02, −4.37)	(−11.70, −3.24)
Observations	7,364	1,640	7,364	1,640
Log Likelihood	−1,090.73	−424.88	−877.49	−351.83

Models 5 and 7 include all states; Models 6 and 8 include only high-income states

*** p less than 0.001, ** p less than 0.01, * p less than 0.05

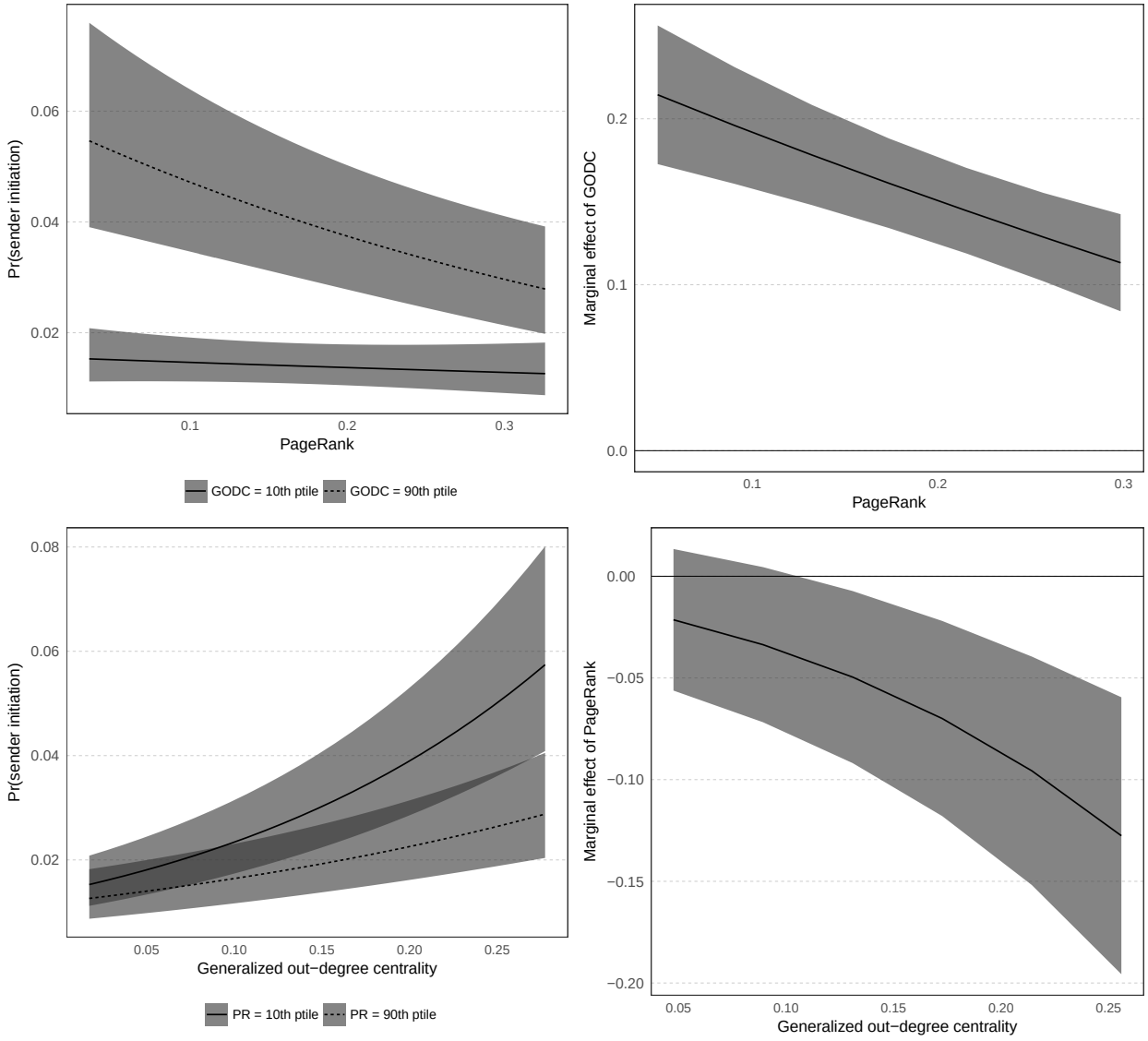


Figure 4: Visualization of the interaction of GODC X PageRank (from Model 5). Left-hand plots illustrate predicted probabilities of sender initiation for low (10^{th} percentile) and high (90^{th} percentile) of each constituent term over the same range of the other constituent term. Right-hand plots illustrate conditional marginal effects of each constituent term on sender initiation over the 10^{th}-90^{th} percentile of the other constituent term.

significant in all four models. As such, when partner connectedness is at its lowest, I find preliminary evidence that more value to trade partners suggests a higher likelihood that a state initiates a new sanction threat. The interaction term is negative and significant only in Models 5 and 7 (those examining all states). As above, I use visualizations to provide a complete explanation of probabilities and marginal effects associated with the interaction of GODC and PR.

Specifically, Figure 4 illustrates the interaction as estimated in Model 5. The figure is set up like Figure 3, distinct only in terms of the dependent variable and ordering of sub-plots. Two conclusions are evident from the figure. First, states with more (moving from the 10^{th} to 90^{th} percentile) value to trade partners (GODC) are more likely to initiate sanctions at all levels of partner connectedness, though the magnitude of the marginal effect declines as partner connectedness (PR) increases. Second, partner connectedness has no association with initiation of sanction threats when value to trade partners is low (at its 10^{th} percentile). However, as a state's value to trade partners increases (above approximately 0.1), the marginal effect of partner connectedness becomes increasingly negative. One explanation for PageRank having a non-statistically significant marginal effect at low levels of GODC is that states with low value to trade partners generally are unlikely to initiate sanction threats in any event. Higher trade value provides opportunity to inflict costs on others, but in this case, greater partner connectedness suggests that the sender itself would *also* face relatively greater costs, while its targets would face a relatively easier prospect of redirecting trade.

Importantly, these results for sender initiation can be explained even if sanctioning is not a purely policy-focused behavior by sender leaders, but rather the function of lobbying by domestic interest groups (import competitors and ordinary citizens). Because I examine state years, looking at threat initiation against any target rather than against specific targets, my models capture the overall ability of states to use sanctions as a foreign policy

tool, as opposed to a focus on the particularities of specific bilateral relationships. States with more leverage can use sanctions more easily *in general*; and my models suggest that those who can, do.

Additional important conclusions are evident from my statistical results. First, while I find support for my expectations, I also find that acquiescence to sanction threats typically is a rare event. Figure 3 shows that even highly-vulnerable targets give in to sender demands less than half the time. Similarly, despite overall support for my expectation that leverage incentivizes economic coercion, the baseline probability of sanction threat initiation is quite low, around 0.05 for high-leverage states according to Figure 4. This result makes sense given that states with leverage hold opportunity to coerce effectively, but also require motivation–e.g., a political dispute with a trade partner–to initiate sanction threats (Most and Starr 1989).

6 Conclusion

I find evidence that a state's position in the global trade network influences its vulnerability to, or conversely, leverage over, its trade partners. A state with little value to trade partners that are highly-connected to the broader global trade network is more likely to acquiesce to sanction threats. Mirroring these circumstances, a state with high value to trade partners that are weakly-connected to the global trade network is more likely to initiate economic coercion with a sanction threat. Furthermore, I demonstrate that two measures of network centrality—generalized out-degree and Google's PageRank—together capture the two elements of vulnerability and leverage inherent in the global trade network. This study contributes to the literature linking trade dependence and vulnerability to a wide variety of international political interactions, highlighting the importance of state position in the global trading environment as an indicator of its likely behavior, and utilizing network

analysis to develop a measure of leverage and vulnerability that incorporates complex, multilateral ties while retaining the state as the unit of analysis.

My findings hold implications for scholars and policy-makers. First, future research can take this study a step further by examining whether states that are more vulnerable to interrupted trade behave strategically, avoiding proscribed behavior such as human rights abuse or nuclear proliferation proactively—at least in cases where leaders see sanctions as realistic possible consequences of these behaviors. By synthesizing my argument with recent studies on the reputation effect of sanctions (Peterson 2014*b*; Miller 2014), future researchers can better isolate the context under which sanctions would be most successful and thus potentially motivate proactive policy change by likely future targets.

Second, future work can consider the implications of my findings for multilateral and institutional sanctions. My conceptualization suggests that a vulnerable state, all else equal, has relatively few trade partners and that these partners do not much value its trade. These few states therefore could collaborate to impose unilaterally high sanction costs on this vulnerable state without suffering themselves. As such, multilateral sanction threats from this relatively small group could be feasible and highly costly to the target. Conversely, when a potential sanction target maintains many trade ties that are of high value to its trade partners, it might be more difficult to secure multilateral cooperation because trade partners acting as senders would incur higher costs on average, while the target could more easily withstand the loss of a few trade relationships. As such, cooperation, to be successful, would require credible commitments from many senders (Martin 1993), and possibly could require institutional involvement (Bapat and Morgan 2009).

Related, policy-makers in common sender states such as the US could apply my model of leverage and vulnerability to identify potential targets that would face high costs if sanctions were to be imposed, and thus could be most open to influence. Similarly, my

approach facilitates identification of prospective sanction targets whose stronger position in the global trade network implies that unilateral sanction threats might be ineffective. These cases would require greater cooperation by a larger number of senders in order to inflict sufficient costs on targets. Indeed, policy-makers could use my model to identify specific trade partners of the target with which to seek cooperation on multilateral sanctions (McLean and Whang 2010).

All else equal, senders prefer effective foreign policy—keeping in mind that their goals could include acquiescence to sanctions, or simply the knowledge that resistance will entail high costs for the target (Galtung 1967). As such, future work could synthesize my arguments with previous work examining sanctions busting (e.g., Early 2009, 2015) and strategic behavior by senders to avoid imposing sanctions that targets could easily mitigate (Peksen and Peterson 2016). All else equal, a state that is vulnerable–i.e., with low value to trade partners who are highly connected to the global trade network–would have higher costs associated with seeking sanctions-busters. However, there is likely to be measurable variation here. Future scholars might benefit from adapting a measure of (weighted) betweenness centrality–a measure that considers shortest paths between trade partners accounting for trade volume–as a measure of opportunity for sanctions busting.

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