

EXPLAINING THE TRADE-GROWTH LINK:

ASSESSING DIFFUSION-BASED AND STRUCTURE-BASED MODELS OF EXCHANGE*

Rob Clark
University of Oklahoma
robclark@ou.edu

Matthew Mahutga
University of California-Riverside
Matthew.mahutga@ucr.edu

ABSTRACT

International development scholars advance contrasting theoretical explanations for the hypothesized link between trade and growth. Diffusion-based models suggest that trade with integrated partners provides states with greater access to technical knowledge. Structure-based models propose that trading with isolated partners produces a bargaining advantage. In this study, we adjudicate between these competing visions by applying Bonacich's (1987) measure of power centrality to the international trade network. We manipulate the procedure's "attenuation factor" (β) such that a state's trade centrality can be enhanced when a state is connected to either central or isolated partners. Drawing from a sample of 101 states during the 1980 – 2000 period, we use difference-of-logs models to assess the impact of trade centrality on economic growth net of controls. We find that the positive relationship between trade centrality and growth peaks when states trade with isolated partners in the periphery.

*Both authors contributed equally to this paper

INTRODUCTION

International development scholars propose that trade can serve as a catalyst for economic growth. Studies routinely show a positive relationship between economic development and trade centrality (Clark 2010; Clark and Beckfield 2009), trade flows (Barro 2001; Frankel and Romer 1999), and trade liberalization (Greenaway, Morgan, and Wright 1998; Sachs and Warner 1995). However, opinions vary as to the purported mechanism linking exchange to growth. Early theoretical work encouraged states to import goods that the domestic economy is ill-suited to produce, as well as export goods that provide them with a comparative advantage. More recently, diffusion-based models have proposed that trade relations form “information bridges” through which technical knowledge and innovation spread (Edwards 1992; Grossman and Helpman 1990; Romer 1990). From this perspective, developing nations may have much to gain by trading with advanced, integrated countries because the latter group provides access to the highest level of technical information available. By contrast, structure-based models highlight the relational mechanisms that condition the returns to trade (Kick and Davis 2001; Nemeth and Smith 1985; Snyder and Kick 1979). According to this perspective, countries that are highly integrated in the world trade network enjoy leverage during exchange, whereas isolated economies lack alternatives when sending and/or receiving goods. Therefore, when central and peripheral states exchange goods with one another, differences in bargaining power result in superior terms of trade for the former.

In sum, while both diffusion-based and structure-based models specify mechanisms that link trade to a country’s economic performance, they offer contrasting recommendations. If, on the one hand, international trade functions as an information network, then states should form trade relations with central partners because these nations possess the greatest stock of advanced

knowledge. Conversely, if trade functions as a bargaining network, then states should establish ties with isolated partners in order to secure the most favorable terms of trade.

To address this matter empirically for the first time, we apply Bonacich's (1987) measure of power centrality to the international trade network. By manipulating the procedure's "attenuation factor" (β), we enhance each state's trade centrality by the extent to which states are connected to either central or isolated trade partners. Accordingly, we create multiple versions of β to assess whether the link between trade and growth is strongest when states are allocated greater power for trading with the center or the periphery. In doing so, we adjudicate between two of the leading explanations for the trade-growth link, juxtaposing their distinct literatures and operationalizing their ideas within a network context. Estimates from difference-of-logs models on a sample of 101 countries during the 1980 – 2000 period reveal that the trade-growth link tends to peak when states are rewarded for trading with isolated partners. Moreover, we find that the bonus accrued from isolated trade is statistically significant in most specifications that consider the direction of flow (export vs. import) and the type of matrix (dichotomized vs. valued) used to measure trade centrality. Additional analyses that account for influential observations, trade composition, regional effects, and lagged values produce similar results, and our findings hold when using a more recent time period and an expanded sample. In sum, our findings provide greater support for the structure-based model of exchange. We conclude by applying this model to the case of East Asia and speculate that isolated trade may have contributed to the "economic miracles" witnessed in this region during the sample period.

INTERNATIONAL TRADE AND ECONOMIC GROWTH

In this section, we organize existing theory and research around a series of trade-growth models that specify relationships at progressively complex levels. Classic trade models promote

(a) “first-order” effects, whereby trade openness stimulates growth via comparative advantage and technology spillovers, and (b) “second-order” effects, whereby trade centrality stimulates growth via bargaining power. Building on these ideas, we then review “third-order” effects, whereby states are rewarded for trading with either central partners (to enhance technology spillovers) or isolated partners (to enhance bargaining power).

FIRST-ORDER EFFECTS. Trade models that articulate the relationship between openness and growth consider both (a) the principles of comparative advantage, in which a one-time increase in the level of output produces a short-term gain in the transitional growth rate, and (b) technology spillovers, which can produce more dynamic, long-term gains in the steady-state growth rate (Dowrick and Golley 2004; Wacziarg 2001). Given that transitional and steady-state growth both imply an elevation in output, and that the two forms of growth are often indistinguishable empirically (Winters 2004), both comparative advantage and technology spillovers are considered important mechanisms for linking trade to economic growth.

A major part of existing theory and research on the trade-growth link owes to the classic Ricardian model of comparative advantage, which has been applied to a range of industries and countries (Dornbusch, Fischer, and Samuelson 1977; Jones 1961). According to this model, countries are encouraged to participate in the world economy in order to produce goods for which they are naturally endowed and receive imports they would otherwise be ill-suited to produce domestically. Consequently, trade is thought to benefit all participants, relative to autarky, because each country sends and receives goods produced in optimal conditions (Ricardo [1817] 2004). The related Heckscher-Ohlin theorem suggests that countries export goods for which they have abundant factors and import those for which domestic factors are scarce (Leamer 1995). In this way, trade can benefit all partners because it stimulates demand for the

abundant factor in the focal country. Taken together, the Ricardian and Heckscher-Ohlin frameworks yield a basic understanding that remains foundational to modern trade theory, namely, that trade benefits all partners because open economies will tend to import and export goods with optimum efficiency.

While these classic models specify one-time gains from international trade, more recent work proposes that trade also features a dynamic component that allows countries to learn from one another and upgrade domestic production (Romer 1990). Countries that are integrated in the world economy have a greater capacity to absorb new ideas and technological innovations that are generated elsewhere (Edwards 1992; Parente and Prescott 2000). Economic integration also reduces duplication in research and development because integrated states are exposed to the global stock of technical knowledge, thereby enhancing efficiency (Grossman and Helpman 1991). Other dynamic gains attributed to openness include capital accumulation and improved macro-economic policy (Wacziarg 2001), as well as the introduction of competition from the world market, which can inspire innovation (Grossman and Helpman 1994). Thus, international trade diffuses technology, provides access to the marketplace of ideas, and boosts efficiency, all of which stimulate productivity and lead to greater output growth. Collectively, the above ideas motivate empirical tests of the trade-growth link, operationalized either as actual trade flows (Barro 2001; Frankel and Romer 1999) or liberalization policies (Greenaway, Morgan, and Wright 1998; Sachs and Warner 1995).¹

SECOND-ORDER EFFECTS. Another classic model linking international trade to economic growth emphasizes a state's structural position in exchange relations, highlighting the effect of

¹ To be sure, a number of detractors recommend some (often limited) types of protectionism, including the protection of infant industries. Critics of openness contend that a country's comparative advantage might lie in a sector where learning potential is rather limited or technological innovation is constrained (Chang 2003; Young 1991). Nevertheless, protectionism has drawn its share of critics (e.g., Krueger 1998), and the belief that trade openness produces long-term economic benefits remains quite influential.

occupying either a core or peripheral position in the world economy. Early work focused on the role of unequal exchange (Amin 1976; Emmanuel 1972). Here, the wage gap between the core and periphery is greater than the same gap in productivity, which means that commodities produced in the periphery are cheaper than comparable goods made in the core. The greater relative mobility of capital vis-à-vis labor allows multinational firms to exploit these wage differentials by producing in the periphery, which results in an unequal exchange whereby the “extra” surplus value created by peripheral workers is consumed in the core rather than the periphery.

More recently, scholars have used network analysis to formalize the structure of world trade in order to operationalize a unique set of relational mechanisms by which a state’s network position may influence various outcomes (Clark 2010; Clark and Beckfield 2009; Kick, McKinney, McDonald, and Jorgenson 2011; Lloyd, Mahutga, and De Leeuw 2009; Mahutga 2006; Nemeth and Smith 1985; Smith and White 1992; Snyder and Kick 1979; Van Rossem 1996). Much of the current structural thinking on the growth consequences of trade was influenced by Galtung (1971), who noted that patterns of trade between developed and underdeveloped countries created a “feudal interaction structure,” comprised of two positions: center and periphery. Core nations in the center feature dense trade links, spreading their ties among both central and peripheral partners. By contrast, peripheral nations are only connected to states occupying the center and are, therefore, isolated from one another. Thus, core nations feature diverse trade profiles, while peripheral nations concentrate their exchange with a smaller number of partners. As a result, core states occupy favorable bargaining positions in trade. For example, while import prices in the center are affected by competition among a relatively large number of import partners for core markets, commodity prices in peripheral countries are not

subject to such downward pressure. Likewise, peripheral nations are vulnerable to whatever demand fluctuations and trade policies exist from its few export partners in the center (Dahi and Demir 2008; Greenaway and Milner 1990).

World-system analysts noticed that trade patterns conform to a core/periphery structure, but relaxed the dichotomy to allow for an intermediate “semiperiphery” that occupies a somewhat advantageous bargaining position *vis-à-vis* the periphery, but a disadvantageous one *vis-à-vis* the core (Wallerstein 1974). Despite this added category, many of the trade-based mechanisms explaining the core’s bargaining power over the periphery were extended to this tripartite structure. Table 1 shows block densities for a trichotomized network in international trade during the 1980s (Clark and Beckfield 2009), indicating the proportion of possible ties in each block that are actually observed. Note that countries in the core occupy favorable bargaining positions based on their relatively dense in-group links. Almost all core states trade with one another (.979), in contrast to the semiperiphery (.379) and periphery (.049), the latter of which is almost completely isolated from itself. Moreover, core economies are more likely to send exports to, and receive imports from, the semiperiphery (.851 and .837, respectively) than the periphery (.522 and .427, respectively), while semiperipheral and peripheral nations are even less likely to trade with one another (.168 and .136, respectively). Studies motivated by these ideas generally find that network-based measures of “coreness” (i.e., the extent to which a country occupies a core-like position in the world economy) are positively associated with economic growth (Clark 2010; Clark and Beckfield 2009; Kick and Davis 2001; Nemeth and Smith 1985; Snyder and Kick 1979). Similarly, several studies have also examined the impact of trade partner concentration, which is the conceptual inverse of “coreness,” but report mixed results (Kentor and Boswell 2003; Ragin and Bradshaw 1992; Van Rossem 1996). In sum,

countries occupying structural positions that yield many trade partners are thought to enjoy faster economic growth than those states situated in more isolated positions.

[Table 1 here]

THIRD-ORDER EFFECTS. Building on these classic theories, we can now review “third-order” effects, whose models are derivative of those outlined above. The underlying logic of third-order models is that the returns to trade tend to vary by the structural position of one’s *partners*. The application of first-order principles to this level implies a diffusion-based model whereby trade with central partners enhances technology spillovers. Conversely, the application of second-order principles to this level implies a structure-based model, whereby trade with isolated partners enhances bargaining power. We review each model below.

Structure-based accounts of third-order exchange span multiple levels of analysis. For example, in organizational research, exchange theory suggests that organizations are disadvantaged when their survival or success is contingent on gaining access to resources that are controlled by an exchange partner. Conversely, “to the extent that alternative sources are available to an organization in an exchange network, dependence is less and the organization has more bargaining power in terms of influencing the exchange ratio” (Cook 1977: 66). In other words, the ability for a focal seller in a given dyad to set prices depends not only on whether it can sell to alternative buyers, but also on the extent to which the buyer can procure the good from alternative sellers. If the focal buyer has few or no alternatives, then the seller has more leverage to determine the conditions of exchange.

Early sociological accounts of trade developed similar arguments at the national level, noting that many central countries also chose trade partners whose alternatives were limited. This was thought to increase the probability of favorable trade terms, decrease the likelihood of

trade disruption in times of war, and/or create political allies with geographically proximate countries (Hirschman 1980 [1945]). Thus, states with many partners are not only advantaged by their ability to bargain those partners against one another, but this bargaining power becomes enhanced when those partners themselves have relatively few options. More recently, Sacks, Ventresca, and Uzzi (2001: 1580) develop a structure-based account of trade, arguing that “states are stratified in complex social, economic, and political arrangements, and the impacts of [trade] may well be contingent on where a country is positioned in this system of stratification.” In particular, states that trade with isolated partners have a “great advantage in gathering information and negotiating the terms of exchange for trade” because their partners cannot share information or in any way collude against them (Sacks, Ventresca, and Uzzi 2001: 1583).

This argument may be applied specifically to developing countries, who may achieve greater returns by establishing trade relations with other isolated nations than by intensifying exchange with wealthier, core partners. As Galtung’s center-periphery model suggests, wealthy countries may capture the bulk of the gains from trade with poorer countries “because of greater bargaining power” (Greenaway and Milner 1990: 49). Thus, exchange with similarly isolated partners removes a critical source of imbalance for developing nations. As an added benefit for pursuing South-South trade, exchange among developing nations tends to be more skill-intensive, where learning effects are greatest (relative to capital-intensive or labor-intensive trade) (Amsden 1986; Dahi and Demir 2008). In sum, it is not only the relational pattern of the focal country that matters, but also the relational pattern of the focal country’s partners.

In contrast to the structure-based model, a diffusion-based model suggests that the greatest economic gains accrue to actors trading with central partners. The transfer of technology and innovation through exchange is crucial to the diffusion-based model, where

many of the mechanisms linking trade to growth hinge on the spread of advanced knowledge through trade. Thus, because central nations possess the largest stocks of accumulated knowledge, establishing trade relations with central partners should accelerate technology spillovers and enhance the positive effect of trade in stimulating growth.

Consequently, less developed countries may have the most to gain from diffusion-based trade because their primary access to innovation is through exchange with lead economies or their integrated partners. Trade provides access to new products and inputs, as well as intermediate goods that are crucial for development among poorer nations (Yanikkaya 2003). “We may well argue that developing countries can receive more benefit from trade with developed countries, which are technologically innovative countries, than from trade with developing countries, which are non-innovating countries” (Yanikkaya 2003: 61). Similarly, “one advantage of backwardness is that ideas can be borrowed (i.e., imported) from richer countries...Hence, the ability to import ideas is of particular advantage to countries that lag behind the technological frontier” (Rodrik 1999: 25). The absorption of production technology by poorer countries not only increases the stock of available knowledge in the poorer country, but may also promote growth further by increasing competition and triggering further innovation in rich countries. That is, trade between central and isolated countries may initiate a virtuous cycle of innovation-imitation-innovation and thereby increase the returns to trade for all participants (Grossman and Helpman 1990; Aghion and Howitt 1998). Finally, developing nations are thought to benefit from North-South trade through a “disparity of attention,” whereby the attention of advanced nations is spread thin across their dense trade links relative to poorer states that invest more heavily in their smaller number of exchange relations (Hirschman 1978).

Consequently, some find that the positive effect of trade persists (Edwards 1992; Harrison 1996), and may even be stronger (Barro 2001), among developing countries.

To recapitulate, the above discussion reveals the contours of two very different conceptualizations of the returns to trade. The structure-based model suggests that growth is significantly enhanced by trading with isolated partners, while the diffusion-based model suggests that trade with integrated partners is advantageous. In the following section, we formalize these hypotheses.

BONACICH'S MEASURE OF POWER CENTRALITY

In order to assess the empirical credibility of these competing images of trade, we introduce Bonacich's (1987) measure of "power centrality", in which the relational mechanism through which power is attained varies across different types of networks. For example, in some networks, establishing ties with densely integrated partners is advantageous because it enhances an actor's access to information. In other networks, by contrast, establishing ties with isolated partners is preferable when the partner's relational dependence gives the actor an exploitive advantage. Bonacich's measure considers these alternatives by taking into account the centrality of network partners through an "attenuation factor" (β) that can either positively or negatively weight the centrality of an actor's neighborhood. As equation 1 illustrates, i 's centrality is a function of the centrality of the actors to which it is connected. When $\beta = 0$, Bonacich's measure simply considers the number of other actors with whom one is connected, and the centrality of i 's neighborhood is canceled out. However, as β departs from zero (in either direction), an actor's power centrality increasingly becomes a function of both its direct and indirect ties, such that the centrality of the actor's partners is also taken into account. As β drops below zero, actors

are allocated more power for being connected to isolated partners. As β rises above zero, actors are allocated more power for being connected to central partners.

$$(1) \quad c_i = \sum_{j=1} A_{ij} (\alpha + \beta c_j)$$

We can illustrate Bonacich's notion of power centrality through a hypothetical example in which we show how the relative power of actors with equal degree centrality can fluctuate depending on the value of β . Figure 1 displays our hypothetical network, featuring one central actor with ties to four partners (node A), three intermediate actors with ties to two partners each (nodes B, C, and D), and two isolated actors with ties to only one partner each (nodes E and F). [Figure 1 here]

We can illustrate the consequences of occupying certain locations in our hypothetical network that are consistent with diffusion-based and structure-based models of trade by manipulating the attenuation factor (β) in equation 1 and comparing the resulting centralities across nodes with equal degree. Table 2 shows each node's power centrality (according to Bonacich's measure) with different versions of β (we set β to range from -.010 to .010 to be consistent with our subsequent analyses). When $\beta = 0$, each node's degree centrality is reproduced, with node A featuring the greatest power centrality (4.000), followed by nodes B, C, and D (2.000), and nodes E and F (1.000). Thus, when $\beta = 0$, the centrality of each node's partners is ignored.

As we manipulate β to take on positive and negative values, however, we see that the power centrality for each actor begins to shift accordingly. When $\beta = -.010$, those nodes connected to isolated partners are rewarded more than nodes connected to integrated partners, which is consistent with the structure-based model of trade. Thus, even though nodes B, C, and D all possess the same number of ties, node D has a greater power centrality score (1.951) than

nodes B and C (1.941) when β is set to $-.010$. All three nodes are connected to the center (node A). However, nodes B and C are also connected to intermediate partners (via their connections to one another), while node D gains a slight bargaining advantage by being connected to an isolated partner (node E). Notice, by contrast, that when we set β to $.010$, actors are rewarded for being connected to central partners, and the relative positions of these intermediate nodes flip, which is consistent with assumptions generated by the diffusion-based model of trade. Thus, we see that nodes B and C achieve greater power centrality scores (2.061) than node D (2.051). Likewise, the two isolated nodes (E and F) undergo a similar switch in their relative centralities when we manipulate β . When $\beta = -.010$, node E has greater power centrality (0.980) than node F (0.961) because node F is more exploited by its connection to the center (node A) than E is by its connection to an intermediate partner (node D). Conversely, when $\beta = .010$, node F achieves greater power centrality (1.041) than node E (1.021) due to F's connection to the network center.

[Table 2 here]

As the above example demonstrates, Bonacich's notion of "power centrality" allows us to operationalize the positional power of countries in a manner consistent with both diffusion-based and structure-based models of trade. When β is set at a positive value, the relative centralities of each node are consistent with a diffusion-based model, in which countries benefit from having integrated partners that provide them with access to advanced knowledge. To the extent that this is an accurate rendering of the trade-growth link, world trade functions as a sort of communication network in which, as Bonacich (1987: 1170 – 1171) explains, "a positive value of β is appropriate because the amount of information available to a unit in the network is positively related to the amount of information available to those with which it has contact."

*Hypothesis 1: The positive relationship between trade centrality and economic growth will be strongest when β is set at a large **positive** value.*

In contrast, setting β at a negative value is consistent with the structure-based model of trade, in which favorable positions are obtained by maximizing one's own trade links, while minimizing those of one's partners (Galtung 1971). That is, placing a negative weight on β tends to penalize actors who trade with central others, and reward those who trade with isolated others. In this rendition, world trade consists of a series of bargaining situations in which, as Bonacich (1987: 1171) notes, "it is advantageous to be connected to those who have few options; power comes from being connected to those who are powerless. Being connected to powerful others who have many potential trading partners reduces one's bargaining power. In these types of situations, a negative value for β is appropriate."

*Hypothesis 2: The positive relationship between trade centrality and economic growth will be strongest when β is set at a large **negative** value.*

METHODS

SAMPLE. Our sample consists of 101 countries, comprising 85% of the world's population, for which we have complete data on all variables. As we discuss below, we perform several robustness checks to ensure that sample composition is not driving our results, replicating our models after (a) identifying and removing outliers, and (b) including additional cases by dropping several control variables.²

² Our sample includes the following 101 countries: Albania, Algeria, Angola, Argentina, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium, Benin, Bolivia, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo-DR, Congo-R, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Finland, France, Gambia, Ghana, Greece, Guatemala, Guinea-Bissau, Guyana, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Kuwait, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Saudi Arabia, Senegal, Sierra Leone, South

DEPENDENT VARIABLE. *GDP PC (PPP)*. We measure economic growth with each country's gross domestic product per capita (GDP PC) based on purchasing power parity (PPP). Data are in 1995 international dollars. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. Data come from the *World Development Indicators* (International Bank for Reconstruction and Development 2004).

INDEPENDENT VARIABLE. *Trade Centrality*. We use data on all commodities in international trade to construct a network of trade relations among 144 states during the 1980 – 1990 period (T_1) and 161 states during the 1990 – 2000 period (T_2), with 138 common states appearing in both decades. Data come from the *Direction of Trade Statistics* (International Monetary Fund 2004). When constructing network data on trade, analysts can rely on either export data (trade flows *from* the reporting country to its partner) or import data (trade flows *to* the reporting country from its partner). Because both reports consider trade flows to and from each country pair, only one is necessary to fill the entire network. We use the import version because it is considered to be more accurate (see Kim and Shin 2002). Thus, trade ties reflect the average value of all imports from country $_i$ to country $_j$ for the 1980 – 1990 and 1990 – 2000 periods. The time period is strategic insofar as the growth rate of world trade from 1980 to 2000 was among the highest in recorded history and thereby provides a good context in which the returns to trade should be most acute.

In order to assess the robustness of our findings, we consider both the direction of trade flows (exports vs. imports), as well as the type of matrix structuring these relations (dichotomized vs. valued). That is, our analyses consider both the centrality of a country's export partners, as well as the centrality of its import partners. Moreover, we consider whether

Korea, Spain, Sri Lanka, Sudan, Sweden, Syria, Thailand, Togo, Trinidad-Tobago, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Zambia, and Zimbabwe.

or not a country trades with specific partners (using dichotomized data), as well as a country's volume of trade to specific partners (using valued data). The dichotomized version of our network reflects our conversion of the raw data into binary form with a cut-off of \$1 million (U.S.), so that a tie between country i and j is present if the two countries exchange goods totaling \$1 million or more. In the valued version of our network, we use the base-10 logarithm of the raw data to measure ties.

In order to adjudicate empirically between structure-based and diffusion-based models of exchange, we construct multiple versions of a country's trade centrality by manipulating the attenuation factor (β) in Bonacich's measure of power centrality (Borgatti, Everett, and Freeman 2002). For the dichotomized version of our trade network, UCINET provides a default recommendation of setting β to absolute values less than .014 (1980s) and .012 (1990s). For the valued version, UCINET recommends setting β to absolute values less than .008 (1980s) and .007 (1990s). UCINET's recommendation is based on the reciprocal value of the largest eigenvalue of the trade network.

Using these recommendations as a guide, we set β at 21 interval values (ranging from -.010 to .010) for our dichotomized network and 13 interval values (ranging from -.006 to .006) for our valued network. While the second-order effect of trade is realized when we set β to zero, the third-order effect of trade is realized when we set β to positive or negative values. As we note above, large positive values of β reward states for trading with central partners (consistent with the diffusion-based model), while large negative values of β reward states for trading with isolated partners (consistent with the structure-based model).³

³ We note that these manipulations produce trade centrality scores that are substantially different from one another. To be sure, the association between (a) trade centrality growth when β is set to its largest negative value, and (b) trade centrality growth when β is set to its largest positive value, tends to be high. However, the correlations are far from perfect across all four versions of trade centrality growth, including the export-based (dichotomized) version (r

CONTROL VARIABLES. We estimate the effect of trade centrality growth on economic growth net of the following controls.⁴ *Gross Capital Formation.* Gross capital formation indicates each state's level of domestic investment, calculated as a share of GDP. Gross capital formation considers additions to the fixed assets of the economy, including land improvements (e.g., fences, ditches, drains), plant, machinery, and equipment purchases, as well as the construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. *Secondary School Enrollment.* Secondary school enrollment captures each state's level of human capital and refers to the proportion of people in the age group that officially corresponds to the secondary level who are currently enrolled. *Labor Force Participation.* We measure each state's crude labor force participation as total labor force divided by total population. Total labor force refers to a country's "economically active" population, which consists of all people who supply labor for the production of goods and services. *Industrialization.* Industrialization refers to the amount of value added to industry, measured as a share of GDP. Industry corresponds to ISIC (International Standard Industrial Classification) divisions 10 – 45 and includes manufacturing (ISIC divisions 15 – 37), as well as mining, construction, electricity, water, and gas. *Trade Concentration.* In addition to the potentially harmful effects of trading with relatively few partners, countries that export a relatively small number of goods are also thought to be disadvantaged. A lack of diversity in export commodities makes countries more dependent upon foreign markets for receiving goods that they cannot produce for themselves and more vulnerable to market fluctuations in the prices of the few goods they specialize in (Chase-Dunn 1975: 723). Accordingly, previous studies have

= .789), the import-based (dichotomized) version ($r = .837$), the export-based (valued) version ($r = .619$), and the import-based (valued) version ($r = .739$). In sum, the decision to reward states for trading with isolated or central partners produces scores that noticeably depart from one another.

⁴ Data for the following measures come from the *World Development Indicators* (International Bank for Reconstruction and Development 2004), unless otherwise noted.

found that trade commodity concentration negatively affects economic growth (Bradshaw 1987; Glasberg and Ward 1993; Kentor and Boswell 2003). Thus, we isolate the impact of *partner* concentration from *commodity* concentration by controlling for the latter using the Herfindahl-Hirschman Index (HHI), an indicator of commodity concentration based on each country's number of exports at the three-digit Standard International Trade Classification (SITC) (revision 3) level. Data come from the United Nations Conference on Trade and Development's (2009) online *Handbook of Statistics. Trade Openness*. Prior studies typically measure the first-order effect of trade (i.e., openness) via trade flows or policy indicators. We employ the flow measure, which is the version "most often used in empirical studies" (Dowrick and Golley 2004: 40), calculated as the sum of exports and imports of goods and services measured as a share of GDP.

ANALYSES. The panel structure of our data requires that we take steps to mitigate country-specific heterogeneity bias, which occurs when time-invariant variables that are correlated with both the right-hand and left-hand variables do not enter the model. Thus, we test our hypotheses through a series of first-difference models. In first-difference models, the dependent variable and all predictors are calculated as change scores ($T_2 - T_1$), which mitigates the confounding effect of unmeasured time-invariant variables by removing them from the model. These models are unbiased and consistent in the presence of country-specific heterogeneity under the same assumptions as the "within" or "fixed-effects" models. Indeed, the two approaches are identical when only two time periods exist (Wooldridge 2002; Halaby 2004). In particular, we employ difference-of-logs models, where all measures are logged prior to differencing so that the coefficients reflect the partial association between the growth rates of both the independent and dependent variables (Firebaugh and Beck 1994). We use period averages for all variables in order to reduce volatility in the data, where T_1 refers to the 1980 –

1985 period, and T_2 refers to the 1995 – 2000 period (except for trade centrality, as noted above).⁵ Collinearity is not a problem in our models, as the mean and maximum variance inflation factor (VIF) scores range from 1.17 to 1.23 (mean) and 1.36 to 1.39 (maximum). Following our main analyses, we also estimate a series of additional models to determine the extent to which (a) third-order trade effects are significantly different from second-order effects, and (b) whether or not our main results are robust to a number of additional factors. We discuss these additional analyses below.

In all models, we implement Huber and White’s “sandwich” HCCME (heteroskedasticity-consistent covariance matrix estimator) to estimate standard errors. However, our network data violates the assumption of independent observations, so we supplement our standard hypothesis tests with permutation tests. Permutation tests do not rely on the assumption that the observations are independent or randomly sampled, and are therefore used widely by network analysts to test hypotheses with network data (Alderson and Beckfield 2004; Hubert and Schultz 1976; Wasserman and Faust 1994). In the context of linear regression, permutation tests simulate a sampling distribution under the null hypothesis by randomly permuting the dependent variable k times and comparing the observed parameter estimates to those that result from each of these permutations. Thus, “significance” in this context is based on the proportion of randomly permuted samples that yield a coefficient as extreme as the one we observe, using standard cutoffs as our criteria (i.e., $p < .05$, $p < .01$, and $p < .001$). Permutation “ p -values” are equal to p/k , where p refers to the number of permuted samples yielding a coefficient as extreme as the one observed, and k refers to the number of permutations performed ($k = 1,000$ for each permutation test).

⁵ UNCTAD’s online *Handbook of Statistics* does not provide trade concentration data prior to 1990. Therefore, T_1 for trade concentration covers the 1990 – 1995 period.

RESULTS

We begin by presenting results from bivariate analyses. Figure 2 reports correlation coefficients between trade centrality growth and economic growth across the entire range of values of β for both the dichotomized network (indicated by hollow markers; β ranges from -.010 to .010) and valued network (indicated by solid markers; β ranges from -.006 to .006). Circles refer to the export-based versions of trade centrality growth, while triangles refer to the import-based versions. All four versions of trade centrality feature positive correlations with economic growth. More importantly, in three versions (export-dichotomized, import-dichotomized, and import-valued), the strongest positive correlation occurs when β is set to its largest negative value. In the fourth version (export-valued), the strongest correlation occurs when β is set to zero. Thus, in only one scenario does the second-order effect of trade centrality (i.e., when β equals zero) optimally specify the trade-growth link. In the other three versions, a consideration of the centrality of one's trade partners appears to further enhance the link between trade and growth. Specifically, increasing trade with isolated partners is associated with greater economic growth than increasing trade with central partners. However, does this pattern persist when holding constant other predictors of growth?

[Figure 2 here]

In order to address this question, we present results from our fully specified models that include all the control measures outlined above. For ease of presentation, we report *t*-Ratios (Figure 3) and standardized coefficients (Figure 4) as they vary across the full range of positive and negative values of β , thereby indicating the likelihood and magnitude of association between trade centrality and economic growth as β varies. The primary conclusion we derive from Figure 3 is that the likelihood of association between trade centrality growth and economic growth tends

to be highest when states are rewarded for trading with isolated partners, as evidenced by the t -Ratios diminishing in size as we move from negative β values to positive β values. For our two import-based measures, the trade-growth association peaks when β is set at its largest negative value (-.010 and -.006). For our two export-based measures, the trade-growth association peaks when β is set at -.010 (dichotomized version) and -.002 (valued version). In short, the likelihood of a positive relationship between trade centrality growth and economic growth is strongest when we set β at a negative value, and is uniformly weakest when we set β at the largest positive value possible. Note also that the decision of where to set β affects whether or not the two import-based versions of trade centrality achieve statistical significance.

[Figure 3 here]

The pattern for standardized coefficients, depicted in Figure 4, is fairly similar. The magnitude of trade centrality's effect on economic growth tends to be strongest when we set β at negative values. For our two import-based measures, growth in trade centrality produces the strongest effect when we set β at the largest negative value possible (-.010 and -.006). Our two export-based measures, by contrast, show divergent patterns, with the strength of trade centrality's effect peaking when β is set at the largest negative value (-.010) for the dichotomized network and zero for the valued network. In sum, the regression results suggest that third-order effects are operative in three of the four measures of trade centrality growth. In particular, our results suggest that the returns to trade tend to peak when states export to, and import from, isolated nations.

[Figure 4 here]

In order to make sure that our results are not a function of an incorrect application of standard hypothesis tests, we also estimated the models summarized in Figures 3 and 4 with the

permutation tests described above. The results from our permutation tests are consistent with those presented above in that the smallest permutation p -values tend to occur when β is set to a negative value. In the export-dichotomized models, the minimum p -value (i.e., .0000) occurs when β equals -.010 and -.008. In the import-dichotomized models, the minimum p -value (i.e., .0150) occurs when β equals -.010. In the import-valued models, the minimum p -value (i.e., .0000) occurs when β equals -.005 and -.004. Meanwhile, the export-valued models prove an exception to the general pattern (consistent with the results illustrated in Figures 3 and 4), where the minimum p -value (i.e., .0000) occurs across all values of β . Thus, in three of the four replications, the permutation tests show greater support for a structure-based account of trade, while in the fourth replication (the export-valued models), the permutation tests are inconclusive.

SECOND-ORDER VS. THIRD-ORDER EFFECTS. The results thus far are most consistent with a structure-based model of exchange insofar as the t -Ratios and standardized coefficients tend to peak when β is negative rather than positive. However, we do not know whether third-order trade effects (i.e., the peak effect of trade centrality as β varies from zero) are *significantly* different from second-order trade effects (i.e., the effect of trade centrality when β is set to zero). Thus, we take the additional step of testing this hypothesis in the fully specified models. To do this, we conduct a two-stage procedure in which we first regress (a) trade centrality growth when β yields the highest t -Ratio, on (b) trade centrality growth when β is set to zero, and save the residuals. We then estimate the fully specified growth models outlined above, but include both the residual from the first stage (i.e., the portion of third-order centrality that is uncorrelated with second-order trade centrality) and second order trade centrality growth (i.e., trade centrality when β equals zero). Thus, if there is a significant and independent effect of third-order trade centrality, this would be indicated by the t -Ratio for the residualized measure. We replicate this

procedure across all four versions of trade centrality growth: export-based (dichotomized), import-based (dichotomized), export-based (valued), and import-based (valued).

Table 3 presents the results.⁶ Each cell reports the t -Ratio, with the standardized coefficient in bold. Note that we flag significance using standard hypothesis tests (*), as well as our permutation tests (+). There are four panels representing each version of trade centrality, and each panel features three models: (1) the effect of second-order trade centrality growth (when β equals zero) on economic growth net of the controls, (2) the effect of third-order trade centrality growth (when β is set to the value that corresponds to the peak t -Ratio in Figure 3) on economic growth net of the controls, and (3) the effect of second-order trade centrality growth and the residualized third-order measure on economic growth net of the controls. The first two models of each panel replicate what is shown in Figure 3, while the third model introduces the residualized term. In three of the four panels, the residualized measure in model 3 is positively signed and statistically significant (according to either test), indicating that, net of second-order effects, the bonus accrued from third-order effects is substantial. By contrast, the residualized measure in the export-valued replication is non-significant (bottom left panel), which is not surprising given that the peak t -Ratio (-.002) very closely mimics a second-order effect. Overall, though, the results show that the trade-growth link is optimally specified as a third-order effect in three of our four replications (and a second-order effect in the fourth replication), such that countries tend to receive a *significant* bonus when trading with isolated partners over and above second-order effects.⁷

⁶ We do not report results for the control measures in order to preserve space, but they are available upon request.

⁷ York (2012) questions the validity of orthogonalized covariates in multivariate regression because the procedure biases the unstandardized coefficient and standard error of the residualizer, but has no effect on either the unstandardized coefficient or standard error of the residualized variable. However, our purpose here is to (1) test the hypothesis that third-order trade centrality is significantly different from zero when holding second-order trade centrality constant, and (2) compare the *standardized* coefficient of each measure. Neither collinearity, nor residualization have any impact on the first goal. Indeed, unreported models that estimate the correlated version of

[Table 3 here]

ROBUSTNESS CHECKS. Figures 5 and 6 present results from a series of robustness checks, where we introduce alternative specifications to our fully specified models by (a) excluding outliers, (b) controlling for the content of trade, (c) controlling for world region, (d) including lagged values for the dependent and independent variables, (e) expanding our sample by dropping several controls ($N = 110$), and (f) using an alternative time period (1980 – 2005).

First, we investigated the presence of influential cases using the Hadi procedure available in *Stata 11* (Stata Corporation 2009). The procedure identifies multiple outliers in multivariate data (we use the $p < .05$ significance level as our outlier cutoff). We found that Ghana, Mozambique, and Sierra Leone were consistent outliers in our models and exclude these cases in the replications reported below.⁸

Second, we consider the possibility that the effects of trade centrality growth across the values of β are proxying for differences in the content of trade across actors occupying different levels of centrality. In other words, it is possible that trade with isolated partners offers greater benefits than trade with central partners simply because of differences in what is being traded across these two forms of exchange. Exports and imports embody different levels of skill and/or

third-order centrality with second-order centrality provide identical t -Ratios for third-order centrality to those reported here and, consistent with York (2012), smaller t -Ratios for second-order centrality. Therefore, the hypothesis tests in Table 3 are conservative with respect to our theory. Of course, collinearity can impact the size of the standardized coefficient on correlated covariates. In our unreported models featuring the correlated versions of third-order centrality, the absolute size of the standardized coefficient for third-order centrality was always at least 50% larger than those reported here. By comparison, the sign of the standardized coefficient for second-order centrality was *negative* in three and smaller in absolute size in two of these four unreported models. Thus, our comparison of standardized coefficients in Table 3 is also conservative with respect to our theory.

⁸ In separate analyses, we also replicated our models with robust regression, whereby outliers are dropped or down-weighted. The procedure begins by fitting a regression, calculating Cook's D , and excluding any observation for which $D > 1$. Next, the procedure calculates weights for each remaining case based on the absolute value of the residuals. Weights range from 0 to 1, with larger residual values getting down-weighted more, and dropped cases receiving a weight of 0. When re-running our models with robust regression, a large majority of our cases were given a weight of .8 or higher (about 85% – 90%) or .9 or higher (about 65% – 80%). Ultimately, we rely on the Hadi procedure, but both methods of outlier detection led to similar results in that the association between trade centrality growth and economic growth continues to peak at negative values of β .

productivity, and these differences may map on to differences in a partner's level of trade centrality. Thus, holding constant each country's trade composition may impact the third-order effects reported above. On the export side, high-skill (sophisticated) exports are associated with both higher productivity and higher learning potential, thereby encouraging higher growth from trade (Amsden 1986; Hausmann, Hwang, and Rodrik 2007: 4). On the import side, countries that import skill-intensive goods (especially less developed countries) have greater learning potential from trade because the tacit knowledge attached to such goods is higher than that found in low-skill intensive goods (Amsden 1983; Romer 1993). A practical example of this is the kind of "reverse engineering" of imported skill-intensive production technology that took place across much of East Asia between the 1960s and 1980s (Smith 1997). Moreover, a major explanation for the purportedly greater returns to intra-developing country trade is that it has a higher skill content than North-South trade (Amsden 1983, 1986; Dahi and Demir 2008).

Thus, we isolate third-order effects from the effects of trade composition by controlling for the ratio of skilled/unskilled goods for each country. Data come from the United Nations Commodity Trade Statistics database (<http://comtrade.un.org>) using the SITC (revision 1) system. We constructed both export-based and import-based versions of this measure. For skilled exports and imports, we use data from category 7 (Machinery and Transportation Equipment) (see Romer 1993) for the years 1980 and 2000. For unskilled exports and imports, we use data from categories 83 (Travel Goods, Handbags and Similar Articles), 84 (Clothing), and 85 (Footwear) (see Amsden 1983) for the years 1980 and 2000. We include each country's export-based scores in those models where we estimate export-based versions of trade centrality. Likewise, we include each country's import-based scores in those models where we estimate

import-based versions of trade centrality. However, doing so reduces the sample in our export-based models to 94, while reducing the sample in our import-based models to 100.

In our third replication, we include four regional dummy variables (representing Latin America and the Caribbean, Central and Sub-Saharan Africa, North Africa and the Middle East, and East Asia and the Pacific), with Europe and the West serving as the excluded reference category. Given the possibility that Western nations expanded trade relations during the sample period by primarily adding isolated Southern partners, and that African nations may have primarily expanded trade relations by adding integrated Northern partners, it is possible that the third-order effects reported above are simply the product of giving Western nations greater centrality than African nations when β is negative, and vice-versa when β is positive. Thus, although our difference models should remove any unobserved time-invariant differences associated with regions, we replicate our models when including regional controls to serve as a robustness check.

Fourth, we include lagged values for all variables (both dependent and independent), which represents each measure's initial score (T_1). Including the lagged values for each variable isolates any impact that initial values may have on growth, thereby preventing ceiling/floor effects from distorting the results.⁹ Fifth, we expand our sample to 110 countries by dropping several control variables (industrialization, trade concentration, and trade openness) to examine whether our findings are sensitive to sample composition. The expanded sample includes Cyprus, Haiti, Israel, Laos, Malta, Oman, Singapore, Switzerland, and United Arab Emirates.¹⁰

⁹ See Firebaugh and Beck (1994), who similarly use difference models that include lagged values.

¹⁰ In separate analyses, we also added a control for inward stock of foreign direct investment (as a percent of GDP). The results are quite similar to those reported above in that the relationship between economic growth and trade centrality remains strongest (as measured by both the t -Ratio and the standardized coefficient) when β is set to its largest negative value in the export-dichotomized, import-dichotomized, and import-valued networks, while the t -Ratio peaks when β equals $-.003$ and the standardized coefficient peaks when β equals zero in the export-valued network. We thank one anonymous reviewer for recommending these additional analyses.

Finally, we use an alternative time period (1980 – 2005) for our dependent variable to examine whether our findings are sensitive to the period chosen for analysis. Thus, we replicate our models by measuring our dependent variable as follows: GDP PC (PPP) ($T_2_{[2000-2005]} - T_1_{[1980-1985]}$). Here we use the World Bank’s revised estimates of GDP PC (PPP), expressed in constant 2005 international dollars, found in their *World Development Indicators* database (International Bank for Reconstruction and Development 2010).

Figures 5 and 6 present the results of these six sets of replications. Figure 5 reports the peak t -Ratio for each type of replication, while Figure 6 reports the peak standardized coefficient, across the different values of β . Circles refer to the export-dichotomized version of trade centrality, triangles refer to the import-dichotomized version, squares refer to the export-valued version, and diamonds refer to the import-valued version. As these figures illustrate, the positive relationship between economic growth and trade centrality growth remains strongest when states are rewarded for trading with peripheral partners. In all 24 replications, the peak t -Ratio occurs when β is negative. Similarly, in 21 of the 24 replications, the peak standardized coefficient occurs when β is negative, with the three remaining replications peaking when β equals zero (all involving the export-valued measure). Finally, the peak t -Ratio is statistically significant at the .05 level in 23 of 24 replications (and marginally significant at the .10 level in the one other replication). In sum, our main findings are largely robust to these alternative specifications.

[Figure 5 here]

[Figure 6 here]

In addition, we performed permutation tests for these alternative specifications. The minimum permutation p -values for the six export-dichotomized replications all occurred when β

was set to a negative value, as were the six import-dichotomized and six import-valued replications. By contrast, the six export-valued replications produced inconclusive results, whereby the minimum p -value in these models occurred when β was negative on two occasions, while the remainder of the replications featured a minimum p -value of .0000 that repeated across both negative and positive values of β . Overall, among these 24 sets of replications, the minimum p -value was significant at the .05 level (or greater) on 19 occasions, while marginally significant at the .10 level on three occasions, and non-significant twice. In sum, these results are largely consistent with the results presented in Figures 5 and 6.¹¹

THE CASE OF EAST ASIA. In recent years, considerable attention has been paid to the “economic miracles” of East Asia. During the final decades of the twentieth century, East Asia economically outgrew the rest of the world, and by wide margins in some cases (Firebaugh 2003; Firebaugh and Goesling 2004; Milanovic 2005). Identifying the source of these miracles has produced a number of lively debates that typically focus on (a) the relative contributions of capital accumulation (e.g., investment, human capital) versus productivity growth (stemming from technological improvements) in explaining output growth (e.g., Collins and Bosworth 1996), or (b) the role of the state in protecting local industries and investing heavily to produce national leaders versus liberalizing trade and investment flows and relying heavily on spillovers (e.g., Amsden 2001). Surprisingly, these debates have produced little consensus. Thus, in this

¹¹ We also considered the possibility that third-order trade centrality is endogenous to growth. Thus, we replicated our fully specified models performing instrumental variables regression using a two-step generalized method of moments estimator with robust standard errors. We used two instruments for our export-based models (lagged industrialization and trade concentration) and import-based models (lagged migration and trade concentration). Diagnostics reveal that the export-based and import-based instruments are both strong (i.e., correlated with trade centrality growth) and valid (i.e., uncorrelated with the error term). The results from these models are consistent with a structure-based model of exchange in that the peak statistical significance for all four trade centrality measures ($p < .01$ or greater) is achieved when β is set to the largest negative value possible. In sum, these results should ameliorate any concerns about potential endogeneity in our models.

section, we consider whether third-order effects can help account for the recent success of East Asian economies.

Table 4 reports trade centrality growth ratios between East Asia and four other world regions during the sample period (states are classified according to the five-category world region variable discussed above). We use all 138 states common to both time periods in our trade network to calculate growth ratios across all four versions of trade centrality as they vary according to β . The peak ratios for all 16 comparisons are in bold. In total, 12 of the 16 comparisons feature peak ratios when β is set to a negative value (five export ratios and seven import ratios), with three other ratios peaking when β is set to zero, and one when β is set to a small positive value (.002). Thus, as a whole, East Asia appears to have expanded trade relations with isolated countries more so than other regions, especially when considering imports.

Moreover, the peak β values (i.e., the value of β when the trade centrality growth ratio is at its peak) are highly and negatively correlated with the economic growth ratios shown in parentheses along the top row. Across all four versions of trade centrality, the level of correspondence is quite high, including the export-dichotomized version ($r = -.961$), the export-valued version ($r = -.859$), the import-dichotomized version ($r = -.867$), and the import-valued version ($r = -.705$). That is, the greater the economic growth ratio between East Asia and the other world region, the more negative β is when the corresponding trade centrality growth ratios peak. Consequently, while much work has been done to explain East Asia's recent economic success, these regional comparisons suggest that East Asia's development of isolated trade may warrant greater attention in future research.

We can also describe, anecdotally, the experience of several countries in East Asia during this time period. Between the 1980s and 1990s, South Korea began exporting to 16 new

countries, 11 of whom (69%) were ranked outside the top 100 in import-based degree centrality during the 1990s (out of the 138 countries in our common sample). Moreover, approximately half of India's (54%) and China's (46%) new export partners were ranked 101st or below in import-based degree centrality, as were almost one-third of Thailand's (32%) and Indonesia's (29%) new export partners. Overall, these percentages are relatively large when compared to those in several Latin American countries during this period. Although 70% of Brazil's new export partners were ranked outside the top 100 in import-based degree centrality, other major economies in this region featured much lower percentages, including Venezuela (24%), Chile (20%), Argentina (15%), and Mexico (5%). And if we change the direction of flow, we find a similar contrast. Exactly 50% of China's (10 out of 20) and India's (nine out of 18) new import partners were ranked below the top 100 in export-based degree centrality during the 1990s, while South Korea (38%), Thailand (35%), and Indonesia (30%) also featured relatively high percentages. By contrast, only Venezuela (43%) and Brazil (37%) featured comparable percentages, while other countries in Latin America lagged further behind, including Chile (21%), Mexico (13%), and Argentina (5%). In sum, when comparing major economies in both regions, East Asia's propensity to establish new export and import partnerships with peripheral nations was generally greater than that of Latin America during the sample period.

[Table 4 here]

DISCUSSION

In this study, we assess the empirical credibility of contrasting images of the trade-growth link. First-order models based on notions of comparative advantage and information diffusion emphasize trade liberalization, while second-order models emphasize network centrality in trade. While there is an extensive literature documenting both first-order and second-order trade

effects, we provide the first empirical test of two contrasting views of third-order models of trade. Third-order effects depend on the centrality of a given country's trade partners, where either trade with central nations (where knowledge is most heavily accumulated) maximizes a county's exposure to innovation via information diffusion, or trade with isolated nations (where partner dependency is greatest) produces the greatest benefits via bargaining power.

In order to bring evidence to bear on these contrasting images, we employ several network measures of trade centrality and estimate their impact on economic growth across 101 countries during the 1980 – 2000 period. Specifically, we enhanced each state's trade centrality by the extent to which states are connected to either central or isolated trade partners by adjusting an "attenuation factor" (β) in Bonacich's power centrality routine. In doing so, we consider both the direction of flow (export vs. import) and the type of matrix (dichotomized vs. valued) used to measure trade centrality. Overall, we find that the growth returns to international trade are positive. However, we find that the trade-growth link tends to peak when we reward states for trading with isolated partners, and that third-order effects are *significantly* greater than second-order effects in three out of four replications. Our results are robust to alternative specifications that account for influential observations, trade composition, regional effects, and lagged values, and our findings hold when using a more recent time period and an expanded sample. In short, the findings from this study imply that the structure-based image of trade is a better approximation of reality than are models premised on the diffusion of advanced knowledge.

The exception to this general pattern occurs with our export-valued measure of trade centrality, in which third-order centrality (i.e., trading with either isolated or central partners) appears to provide little in the way of a developmental bonus over and above second-order effects (i.e., occupying a central position in trade). The theoretical implications of this exception

are not entirely clear. On one hand, the different results across our export-valued and export-dichotomized measures might suggest that increasing the number of isolated partners enhances the returns to trade, while increasing the *strength* of ties to existing isolated partners does not. On the other hand, the greater consistency in results across our import measures may also suggest that bargaining power is more effective for securing cheaper imported goods than it is for securing higher export prices. Both possibilities suggest directions for future research.

Moreover, our regional case study reveals a relatively new conjecture regarding the rapid economic growth experienced by East Asia during the late 20th century. While East Asia's development is widely regarded as "miraculous" when compared to the historical experience of other countries, extant debates regarding the origins of the miracle have in common an intensive focus upon domestic determinants. That is, while scholars differ over whether or not the miracle is explicable in terms of domestic economic processes (i.e., capital accumulation or productivity growth), or domestic political processes (i.e., the developmental or liberal state), very few consider the role of external trade linkages. One of the few exceptions focuses upon inter-firm linkages between Western and Asian firms, implying that East Asian trade with central countries made all the difference (Feenstra and Hamilton 2006). By contrast, our regional comparisons suggest that the East Asian miracle may instead be driven by trade with isolated others.

Overall, the policy implications we draw from our results suggest that developing countries should proceed with caution when considering globalization as a growth strategy. We suggest that trade globalization may help trigger growth, but that much is contingent on *how* developing countries integrate themselves into the world economy. Rather than globalization per se, we suggest that the economic trajectories of less developed countries may be better explained

by differences in the extent to which they inculcate relatively dependent trade partners.¹² Indeed, even the inconclusive results for our export-valued measure cast doubt on the diffusion-based model insofar as none of our replications suggest that the highest returns to trade accrue to nations that trade more intensively with central partners.

Accordingly, our findings imply that countries may gain more from trade by adopting trading partners who are isolated from others. National governments might therefore identify isolated potential trading partners and sign bilateral trade agreements with them, which could foster isolated trade by removing tariff and non-tariff barriers to exchange at the dyadic level. Or, governments could encourage domestic firms to forge foreign investment or sub-contracting relations with firms in isolated countries in order to develop cross-border production networks. Indeed, these kinds of relations would replicate those that led to the literature on power and dependency in inter-organizational exchange networks (e.g., Cook and Emerson 1978). Still, other structural factors may limit the ability of less developed countries to influence their trade profile by inculcating ties with isolated others remains much in question. For example, countries in isolated network positions are also likely to suffer from export *commodity* concentration, with relatively few commodities to send abroad.¹³ This may limit their attractiveness for developing nations seeking new isolated partners, as well as limit the marketability of developing nations seeking such partnerships in the first place, as they may be likewise constrained in what *they* have to offer. Moreover, identifying isolated potential trade partners and negotiating bilateral investment treaties with them presupposes a state that is both relatively stable and materially

¹² In separate analyses, we also examined whether our results varied for countries at different levels of development by introducing an interaction term between trade centrality growth and initial GDP PC (PPP). The interactions were non-significant across negative and positive values of β for all four measures of trade centrality growth, suggesting that isolated trade tends to be optimal for both developed and developing countries alike.

¹³ The zero-order correlation between the change scores of export commodity concentration and third-order centrality with maximally negative β weights varies from -.060 to -.018 in our sample.

interested in changing the position its country occupies in trade networks, and previous research suggested that isolated states are less likely to possess these attributes than central states (Chase-Dunn 1998; O'Hearn 1994; Rubinson 1976). Connecting our findings to concrete policy *outcomes* is thus beyond the scope of the present analysis.

In closing, sociological accounts of exchange networks have long held that the returns to exchange vary by an actor's position and that of its partners. The analyses presented above largely verify this across a new context: countries participating in the network of international trade. We hope this paper will re-focus the sociological imagination on developing an understanding of the role that relational dynamics play in shaping economic development (cf. Jorgenson 2012; Jorgenson and Clark 2009; Rice 2007). At the very least, we call for greater emphasis on the network structure of exchange in future studies investigating the link between trade and growth. Rather than examining the impact of trade in terms of raw participation, we propose that second-order and third-order effects are important to capture. In particular, future research should examine mediating factors (e.g., terms of trade) that may further help to explain the key mechanisms linking exchange and growth.

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Table 1. Block Densities of Trichotomized Network in International Trade (1980 – 1990)

	Core	Semiperiphery	Periphery
Core	.979	.851	.522
Semiperiphery	.837	.379	.168
Periphery	.427	.136	.049

Note: Reproduced from Clark and Beckfield (2009: 13 – 14).

Figure 1. Hypothetical Network

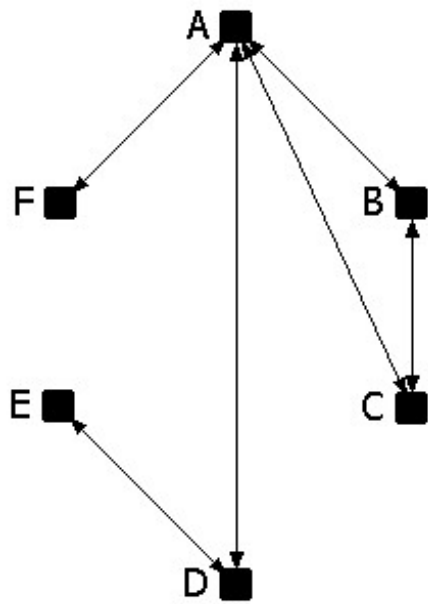


Table 2. Centrality in Hypothetical Network

Node	$\beta = -0.010$	$\beta = 0.000$	$\beta = 0.010$
A	3.932	4.000	4.072
B	1.941	2.000	2.061
C	1.941	2.000	2.061
D	1.951	2.000	2.051
E	0.980	1.000	1.021
F	0.961	1.000	1.041

Figure 2. Correlation Between Trade Centrality Growth and Economic Growth, by Attenuation Factor (β), N = 101

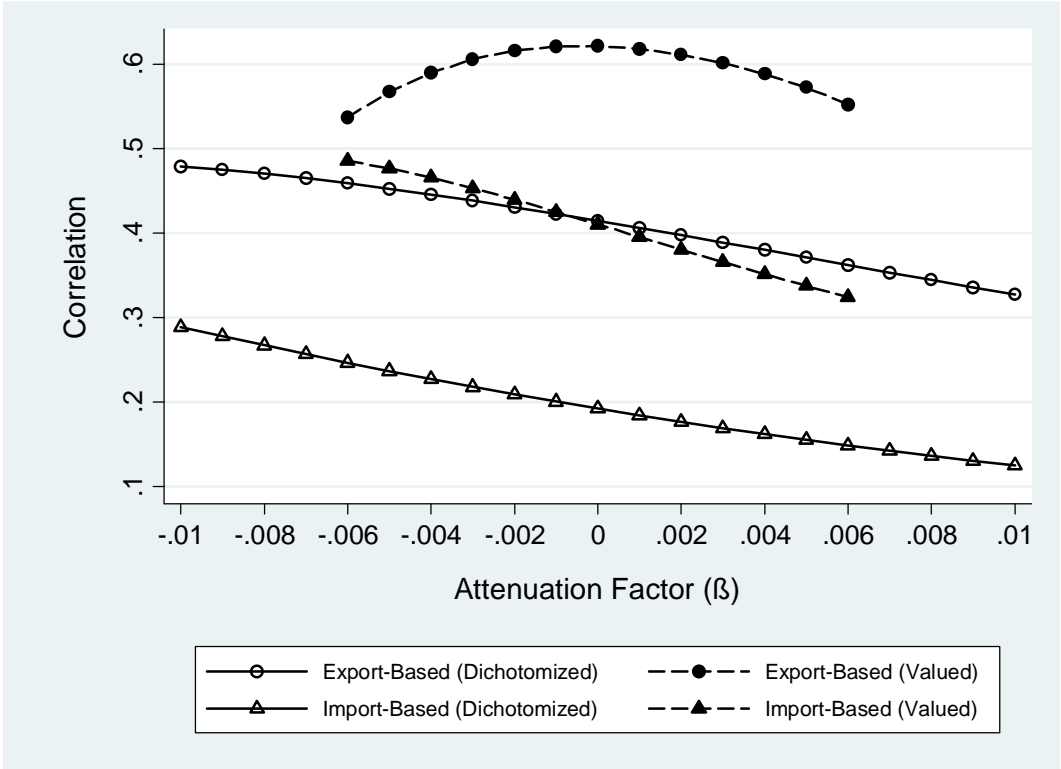
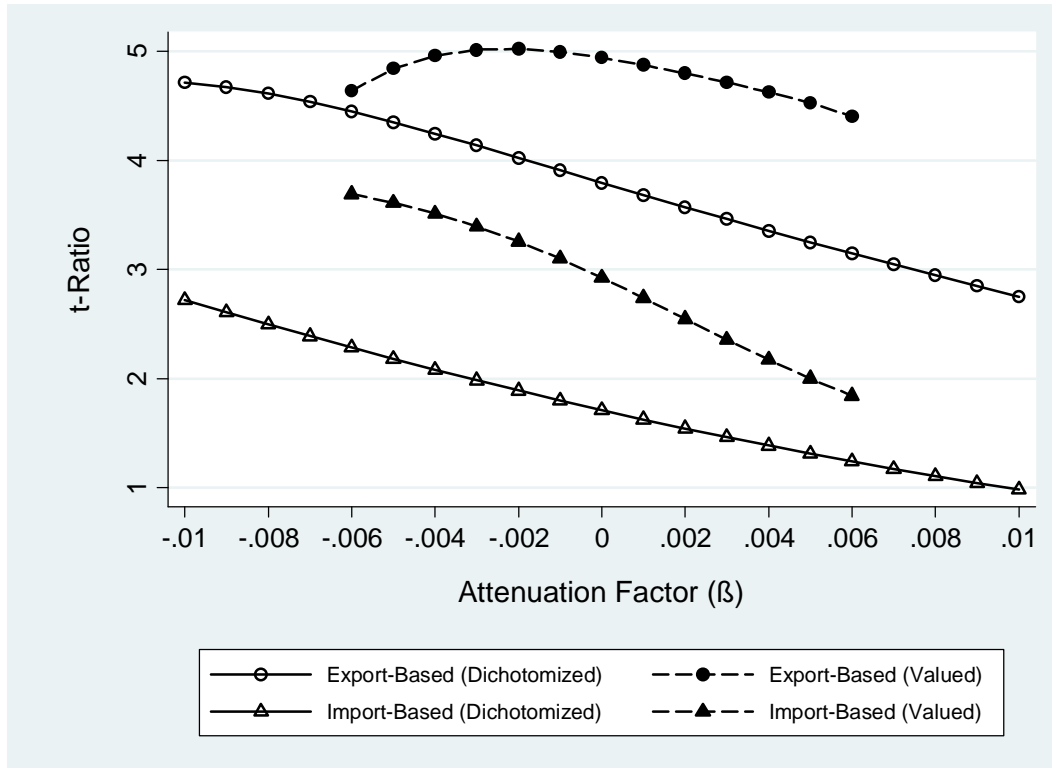
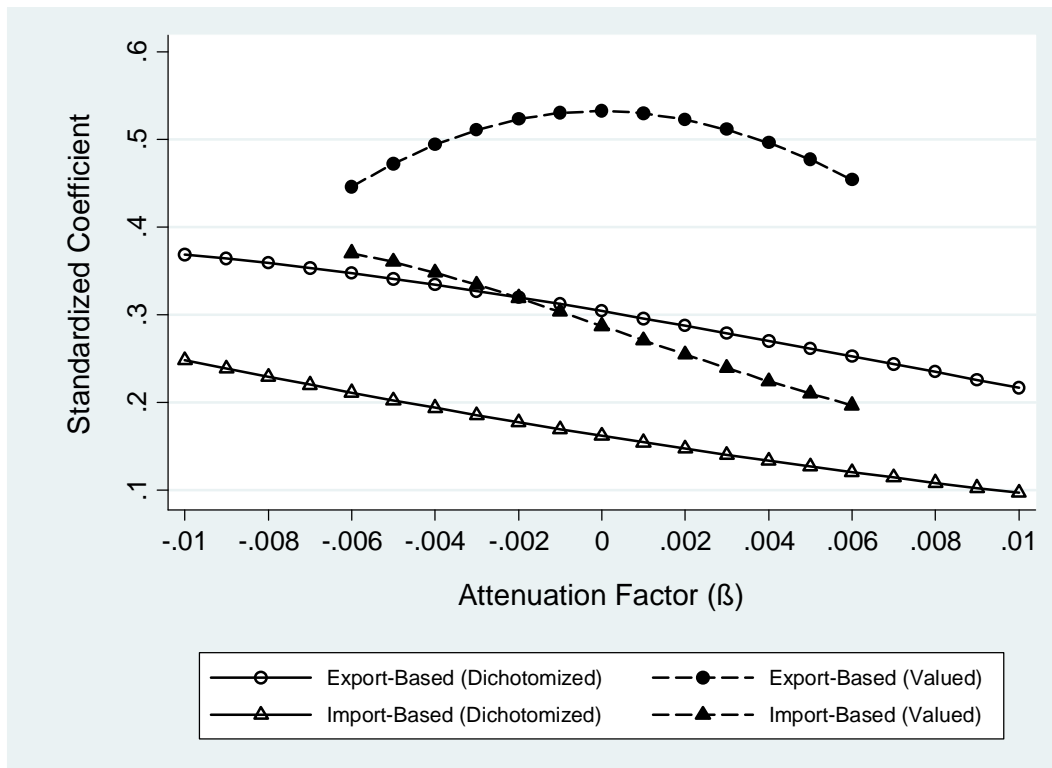


Figure 3. The Effect of Trade Centrality Growth on Economic Growth (t-Ratios), by Attenuation Factor (β), N = 101



Note: Estimates are generated in the fully specified model.

Figure 4. The Effect of Trade Centrality Growth on Economic Growth (Standardized Coefficients), by Attenuation Factor (β), N = 101



Note: Estimates are generated in the fully specified model.

Table 3. The Net Effect of Third-Order Trade Centrality Growth, N = 101

	<u>Export-Based (Dichotomized)</u>			<u>Import-Based (Dichotomized)</u>		
	(1)	(2)	(3)	(1)	(2)	(3)
(A) Trade Centrality Growth ($\beta = .000$)	3.797*** .304++		3.795*** .301++	(A) Trade Centrality Growth ($\beta = .000$)	1.711 .162	1.519 .152
(B) Trade Centrality Growth ($\beta = -.010$)		4.712*** .369+++		(B) Trade Centrality Growth ($\beta = -.010$)	2.722** .248+	
B residualized from A			2.718** .245+	B residualized from A		3.484** .291++
R ²	.335	.373	.387	R ²	.277	.311
	<u>Export-Based (Valued)</u>			<u>Import-Based (Valued)</u>		
	(1)	(2)	(3)	(1)	(2)	(3)
(A) Trade Centrality Growth ($\beta = .000$)	4.944*** .533+++		4.938*** .530+++	(A) Trade Centrality Growth ($\beta = .000$)	2.926** .287+	2.844** .281+
(B) Trade Centrality Growth ($\beta = -.002$)		5.024*** .524+++		(B) Trade Centrality Growth ($\beta = -.006$)	3.692*** .370+++	
B residualized from A			0.453 .034	B residualized from A		2.789** .249+
R ²	.480	.479	.481	R ²	.318	.366

Notes: Each cell reports the *t*-Ratio, with the standardized coefficient in bold; estimates are generated in the fully specified model.

* $p < .05$ ** $p < .01$ *** $p < .001$ (standard two-tailed tests).

+ $p > .05$ ++ $p < .01$ +++ $p < .001$ (permutation tests).

Figure 5. Peak *t*-Ratios, by Type of Replication

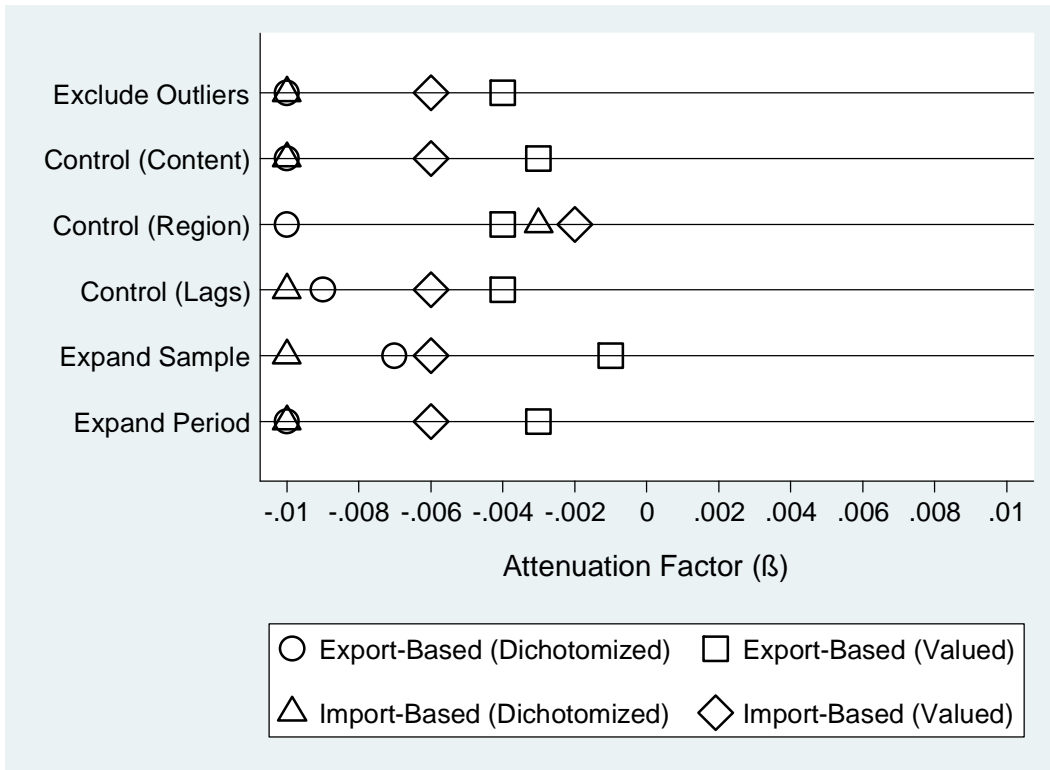


Figure 6. Peak Standardized Coefficients, by Type of Replication

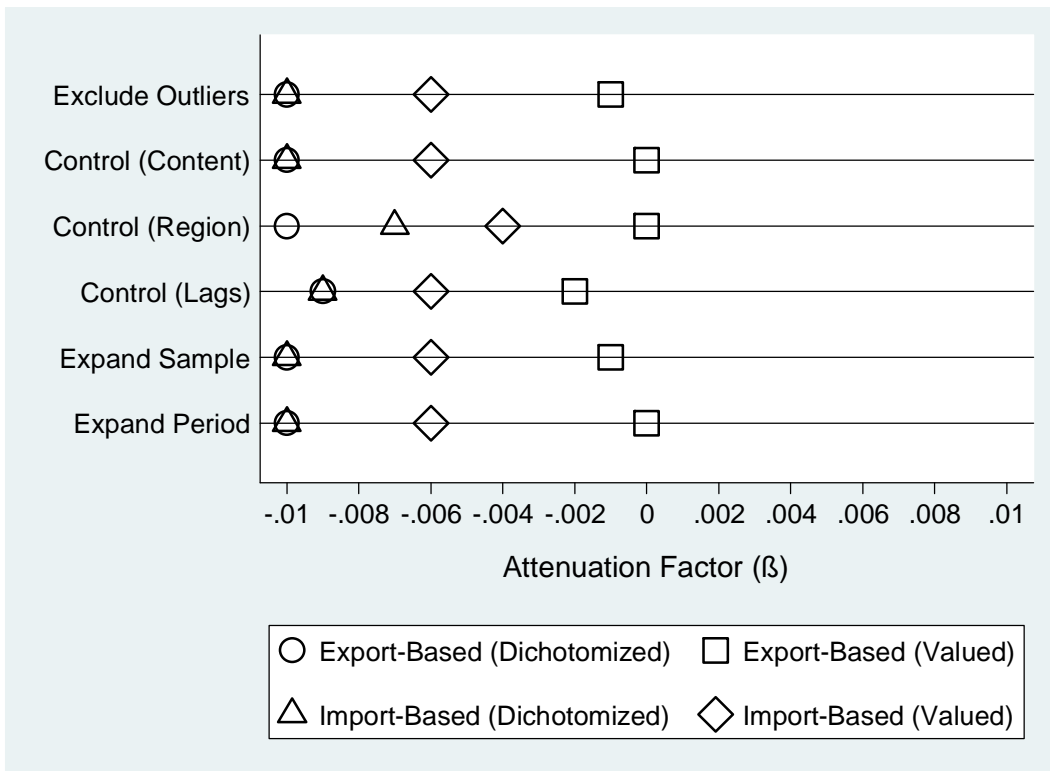


Table 4. Trade Centrality Growth Ratios (1980 – 2000): East Asia vs. Other World Regions, N = 138

	<u>East Asia / West</u>		<u>East Asia / Latin America</u>		<u>East Asia / Africa</u>		<u>East Asia / Middle East</u>	
	(Economic Growth Ratio: 1.482)		(Economic Growth Ratio: 5.910)		(Economic Growth Ratio: 18.440)		(Economic Growth Ratio: 4.610)	
	Export-Di	Export-Val	Export-Di	Export-Val	Export-Di	Export-Val	Export-Di	Export-Val
$\beta = -.010$.936		1.494		9.809		1.176	
$\beta = -.008$	1.143		1.596		3.892		1.335	
$\beta = -.006$	1.297	.947	1.647	2.010	2.868	15.973	1.435	2.599
$\beta = -.004$	1.409	1.423	1.665	2.236	2.421	3.916	1.495	2.795
$\beta = -.002$	1.482	1.670	1.659	2.256	2.153	3.069	1.526	2.726
$\beta = .000$	1.522	1.774	1.635	2.178	1.962	2.640	1.534	2.539
$\beta = .002$	1.530	1.761	1.593	2.014	1.806	2.275	1.518	2.262
$\beta = .004$	1.506	1.622	1.534	1.755	1.667	1.884	1.481	1.891
$\beta = .006$	1.449	1.318	1.456	1.358	1.534	1.399	1.421	1.399
$\beta = .008$	1.361		1.356		1.396		1.336	
$\beta = .010$	1.237		1.230		1.246		1.221	
	Import-Di	Import-Val	Import-Di	Import-Val	Import-Di	Import-Val	Import-Di	Import-Val
$\beta = -.010$	1.448		1.137		1.548		1.383	
$\beta = -.008$	1.540		1.141		1.437		1.430	
$\beta = -.006$	1.594	1.551	1.139	1.224	1.366	2.051	1.455	1.876
$\beta = -.004$	1.616	1.662	1.132	1.251	1.315	1.862	1.463	1.921
$\beta = -.002$	1.610	1.700	1.124	1.263	1.275	1.762	1.456	1.897
$\beta = .000$	1.579	1.677	1.113	1.263	1.240	1.674	1.436	1.819
$\beta = .002$	1.530	1.597	1.101	1.248	1.209	1.569	1.403	1.689
$\beta = .004$	1.462	1.451	1.087	1.207	1.178	1.423	1.358	1.500
$\beta = .006$	1.380	1.215	1.071	1.114	1.146	1.202	1.300	1.229
$\beta = .008$	1.283		1.054		1.111		1.230	
$\beta = .010$	1.173		1.034		1.070		1.144	

Notes: Largest ratio in bold; **East Asia & the Pacific** (N = 23): Bangladesh, Brunei, Cambodia, China, Fiji, India, Indonesia, Japan, Laos, Malaysia, Maldives, Mongolia, Myanmar, Nepal, North Korea, Papua New Guinea, Philippines, Singapore, Solomon Islands, South Korea, Sri Lanka, Thailand, Vietnam; **Europe & the West** (N = 28): Albania, Australia, Austria, Belgium, Bulgaria, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, United Kingdom, United States; **Latin America & the Caribbean** (N = 26): Argentina, Bahamas, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad-Tobago, Uruguay, Venezuela; **Central & Sub-Saharan Africa** (N = 41): Angola, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (DR), Congo (R), Djibouti, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe; **North Africa & the Middle East** (N = 20): Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, United Arab Emirates.