Production Networks and the Organization of the Global Manufacturing Economy

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Abstract

In this article, I explicate an organizational theory that links global models of networked organization to cross-national variation in manufacturing specialization. To subject the theory to empirical scrutiny, I derive cross-nationally comparable measurements of the average network position of resident firms in two industries with ideal-typical forms of network governance—garments and transportation equipment. Analytical results suggest that manufacturing specialization varies by network position in both industries, even when controlling for time-invariant country-specific organizational unobservables and conventional thinking on international specialization. Moreover, these networks matter only during the period after which the two types of governance are alleged to have become the predominant organizational logic of the two industries, and are more important for manufacturing specialization in the transport-equipment industry. The article concludes by implicating these findings in discussions of the distribution of the gains from networked forms of economic organization.

Keywords

economic sociology, globalization, production networks, commodity chains, development

Introduction

Explanations for cross-national variation in industrial structure are central to macro-comparative social science (Alderson 1999; Biggart and Guillen 1999; Harrigan 1995; Kollmeyer 2009; Ricardo [1817] 1919; Wood 1994). Sociological accounts contend that the structure of industry "in a society may not be independent of [that] in others" (Bollen and Appold 1993:297). The current period of economic globalization only increases the *prima facie* validity that intersocietal relations matter for the structure of industry. Indeed, bridging two core sociological projects—network forms of economic organization and global/transnational sociology—a growing literature on global production networks contends that cross-national variation in economic organization are a function of emergent transnational production networks (Bair 2005, 2009; Feenstra and Hamilton 2006; Gereffi 1994, 1999; Schrank 2004; Thun 2008).

In this article, I formalize and test the global production network explanation for cross-national variation in manufacturing specialization. I begin by reviewing two distinct global network

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types—buyer- and producer-driven networks. Both form when leading firms shrink the scope of activities contained within their formal boundaries. However, they vary by the kind of positional power leading firms exercise, the scope of activities that remain internal to lead firms, and the terms under which other firms gain access to the network. The diffusion of these network forms among lead firms multiplies production networks over time, creating entirely new "markets" for both intermediate and finished goods. Because other firms must integrate into these networks to gain access to these markets and firms are spatially embedded within countries, the type of economic activity occurring within national borders is increasingly a function of the network position of firms located therein.

The dearth of macro-comparative analyses of these questions is explicable in part by the absence of cross-nationally and temporally comparable firm-level data, which makes it difficult to measure how "a firm's insertion into a particular [production network] maps on to a country's incorporation" in the larger world economy (Bair 2005:166). As a point of departure, I detail the implications of qualitative case-study findings regarding the behavior and location of powerful firms for observed patterns of bilateral trade. I then derive cross-nationally comparable measurements of the average network position of resident firms in two archetypically buyer- and producer-driven industries. I estimate the impact of these network positions on manufacturing specialization net of a baseline model that controls for persistent country-specific organizational variation, industry-specific factor abundance, export promotion, skill levels, trade openness, economic development, world-system position, and market size. The analysis suggests positional power matters for patterns of specialization during the period when these network forms became the predominant organizational logic in these industries, but the salience of network position varies between industries. The concluding section implicates these forms of network governance in the distribution of the returns in global production networks.

Positional Power and the Organization of Global Production Networks

The global production network paradigm documents the way in which the temporal rise in cross-border flows of manufactured goods is driven by the embedding of production in networks of formally independent firms (Feenstra 1998;Gereffi 1996; Mahutga 2012). Despite the lack of formal ownership ties among network participants, a subset of these firms exercises varying degrees of authority over other network participants. Unlike the bureaucratic authority that governs vertically integrated firms, the power of this subset—identified in the production network literature as "lead firms"—stems from their ability to decide who gains access to the network and under what conditions (Bair 2008). That is, deverticalization involves a selection process concerning both which parts of the production process to externalize and to whom to externalize them—a process in which both the exercise and maintenance of power by lead firms figure prominently.

There are at least two sources of power available to lead firms. First, "resource power" is the ability of lead firms to "control access to major resources" necessary for the viability of other firms (Gereffi 2002:4). Second, lead firms can have one of two types of bargaining power. "Supplier power" accrues to firms who supply critical inputs or outputs for which there are few substitutes. "Buyer power" accrues to firms who buy in large volumes, who themselves have few competitors, and who can easily switch between suppliers (Porter 2008). However, not all lead firms possess the same kinds of power, and different power constellations generate *at least* two types of organizational structures—"buyer-driven" and "producer-driven" networks.[1] The former occur in nondurable consumer industries like garments; the latter occur in durable consumer

Table 1. Stylized Description of Lead-Firm Resource and Bargaining Power in Buyer- and Producer-Driven Networks.

	Buyer-driven networks	Producer-driven networks
Resource power	Design, retail, and marketing	Design, R&D, capital-, technology-, and scale-intensive production
Bargaining power	Buying power	Supplying power
Archetypical industries	Apparel	Transportation equipment

industries like transportation equipment (Bair and Gereffi 2001; Gereffi and Memedovic 2003; Kaplinsky 2005; Kimura 2007; Rothstein 2005).

Resource power plays two important roles in production networks, but varies in content by network type. First, and consistent with resource dependency theory, resource power incentivizes other firms to join production networks because lead-firm resources are critical to their viability (e.g., Cook 1977). Through the establishment of global brands, lead firms control access to the consumer markets where sales are realized in both network types. In buyer-driven networks, for example, the retail price of clothing depends heavily on the brands attached to it, and the leading firms often own the retail outlets in which sales are realized (Gereffi 2002; Heintz 2006; Kaplinsky 2005). In producer-driven networks, lead firms not only control the established brands in industries such as autos and airplanes but also pools of proprietary knowledge, technology, and organizational resources that set them apart from other firms (Kaplinsky 2005). Beyond the capabilities that subordinate firms stand to gain by forming ties with leading firms, the increased legitimacy that comes from associating with lead firms might also allow subordinate firms to expand into the networks of other firms (Crook and Combs 2007; Dimaggio and Powell 1983).

The scarcity of critical resources also directly impacts the profitability of lead firms. In the parlance of global commodity chains, lead firms build production networks to specialize in "industry segments where the barriers to entry for new competition are greatest" and profits are therefore high and/or stable (Gereffi 1996:434). However, while brand-name recognition is an important resource for all lead firms, buyer- and producer-driven networks differ in that entry barriers *to manufacturing* are considerably lower in the former, on average (Gibbon and Ponte 2005; Uzzi 1996). Both highly capitalized and technologically advanced production facilities, and knowledge- and technology-intensive research and development operations increase barriers to new firm entry in producer-driven networks, thereby reducing competition in manufacturing for both the leading and many of the supplier firms that own them. Contrarily, manufacturing functions in buyer-driven networks have extremely low entry barriers. Here, the entry barriers protecting lead firms in buyer-driven networks consist of "intangible" functions, such as "the lavish advertising budgets and promotional campaigns required to create and sustain global brands" (Gereffi 2002:4; Gibbon and Ponte 2005).

The differences between buyer- and producer-driven networks are summarized in Table 1. Each network type is more likely to occur in certain industries, where apparel is archetypically buyer-driven and transportation equipment is archetypically producer-driven (e.g., Bair 2005; Gereffi 1994; Mahutga 2012). Lead firms in both networks have a high degree of resource power, but the resource *content* varies between them. The salient role of entry barriers to manufacturing is evinced by the industries in which the two networks reside, as well as differences in the types of resource power available to lead firms. However, differences in the height of entry barriers to manufacturing also impact the number of capable suppliers available to leading firms in the two network types, which has implications for differences in lead-firm bargaining power across the two network types (Mahutga 2014). Here, firms have more power when many alternative exchange partners are available to them (Cook 1977:66; Porter 2008). In buyer-driven networks, low entry barriers to manufacturing increase the pool of capable suppliers available to the leading firms (Gereffi 1999; Kaplinsky 2005; Mahutga 2012). Conversely, higher entry barriers to manufacturing in producer-driven networks reduce the pool of capable suppliers from which lead firms can choose. Thus, the "drivenness" of production networks is closely associated with the type of relational bargaining power among its leading firms, which has implications both for the content of the ties linking lead firms and suppliers, as well as the geographic distribution of manufacturing activity worldwide.

For example, the division of labor among network participants varies across the two network types. Outsourcing increases flexibility for the lead firm by allowing for the reallocation of resource bundles "cheaply and quickly to meet changing environmental demands" (Jones, Hesterly, and Borgatti 1997:918–19). To the extent that outsourcing is limited to manufacturing functions, this also shifts some of the risks associated with fixed investment from leading to subordinate firms. However, outsourcing also increases transaction costs for leading firms and risks the transmission of the lead firm's key sources of competitive advantage, thereby creating a competitor from its supplier pool (Dunning 1980; Williamson 1981). Thus, network relations tend to produce conflict over the division of labor, as lead firms attempt to protect their core competencies and exercise power to reduce the cost of necessary inputs, and suppliers attempt to upgrade their position in the network (Herrigel and Wittke 2007; Kaplinsky 2005)

In buyer-driven networks, the linkages between suppliers and lead firms are relatively shallow. Lead firms use offshore buying offices to match orders with local manufacturers, or place them with overseas intermediaries who, in turn, coordinate production with their own dispersed networks of garment manufacturers (Gereffi 1999). The information exchange between lead firms and their suppliers can be limited to the transmission of highly codified electronic design specs and the designation of quality, timing, and price (Gereffi and Memedovic 2003; Hoffman and Rush 1988). Moreover, the large pool of capable suppliers allows lead firms to offset higher transaction costs with lower unit-input costs because the "scope for subcontractors to raise production costs without triggering a substantial loss of [orders]" is low (Heintz 2006:509). Finally, leading firms in buyer-driven networks are "intolerant of competition in the highly profitable design, marketing and distribution sectors," so that relegation to "manufacturing activity may therefore constitute the inherent price of participation in the apparel commodity chain" for producers (Schrank 2004:138).

Alternatively, lead firms in producer-driven networks try to keep in house both "intangible" aspects of product engineering, design, and marketing and "particular aspects of the manufacturing process in which they hold a competitive advantage or have valuable, difficult to replicate expertise," and thus limit outsourcing to inputs that do not infringe on these core competencies (Herrigel and Wittke 2007:313). The sourcing relations that lead firms forge in these industries, however, vary by the location of a given supplier in a tiered supplier pool. Here, "first-tier" suppliers possess capabilities that go beyond manufacturing to include engineering and design functions, while lower-tier suppliers provide more standardized and less integral manufacturing inputs. Indeed, lower-tier suppliers are often one step removed from the lead firms because first-tier suppliers typically coordinate the lower-tier suppliers directly (Humphrey and Memedovic 2003; Sturgeon, Van Biesebroeck, and Gereffi 2008). Thus, the higher entry barriers to manufacturing in producer-driven networks not only limit the ability of lead firms to exercise buying power against their primary first-tier suppliers, but also protect the profitability of all but the most standardized manufacturing functions (Gereffi et al. 2005; Herrigel and Wittke 2007; Kimura 2007; Sturgeon et al. 2008). In contrast to the division of labor that prevails in buyer-driven networks, then, lead firms in producer-driven networks resist the encroachment of suppliers into both intangible and a significant subset of the manufacturing functions. They also forge relatively interdependent relations with first-tier suppliers, who, in turn, forge more shallow ties with lower-tier suppliers.

Networked Models of Economic Organization and International Specialization

The forgoing discusses how leading firms coordinate networks by exercising various forms of organizational power to shore up their competitive position and determine the inter-firm division of labor in the network. Yet, much of the substantive impetus for studies of the organizational anatomy of these networks eminates from a desire to understand how network relations among *firms* impact the *countries* in which they reside (Bair 2009; Gereffi and Memedovic 2003; Humphrey 2000; Humphrey and Memedovic 2003; Schrank 2004). While production network analysts claim that the formation and diffusion of these networks impact a host of national-level outcomes, the focus of the present discussion is the dramatic changes in the geography of manufacturing that occurred over the course of economic globalization (Bair 2005, 2008; Bair and Gereffi 2007; Gereffi 1999; Sturgeon et al. 2008).

In particular, production network analysts suggest that observed shifts in national patterns of manufacturing specialization are a function of the way in which leading firms create both entirely new markets for finished and intermediate goods and a growing pool of capable suppliers to feed these markets. For example, Hamilton and Gereffi argue that the success of the export projects of East Asian developmental miracles stemmed from the strategic agency of "U.S,[*sic*] European and Japanese buyers [who] played a fundamental role in creating supplier markets," which "were a large enough component of the respective economies that they shaped the organization of the entire economy" (2009:153; see also Feenstra and Hamilton 2006). That is, leading firms played a key role in the development of the manufacturing sectors in East Asia that included both market making—engaging in offshoring behavior—and building up supplier capability to meet the demands of these new markets.

However, production network analysts argue explicitly that the causal link between network formation and changes to the international division of labor is historically specific—it depends on the extent to which manufacturing processes become embedded in global production networks. In the case of Hamilton and Gereffi's discussion of East Asia, the link depends critically on the proportion of manufactures that fell under the organizational purview of leading big box retailers and branded marketers. Thus, the transformation of South Korea and Taiwan into "demand responsive economies" was most evident by the early 1980s because this was the period when these actors controlled the sale and distribution of the majority of consumer goods (Hamilton and Gereffi 2009:149–59). Put differently, production network analysts argue that inter-firm networks become the most important explanation for "the organization of economic activity" in national economies *as production networks become the predominant organizational logic in manufacturing industries over time* (Bair 2008:351).

At the same time, production network analysts also argue that both the mechanisms by which network formation changes the geography of manufacturing and the precise divisions of labor that follow vary by the governance of the production network in question. In the buyer-driven garment industry, leading firms offset the transaction costs associated with complete outsourcing by exercising buying power over suppliers. This effectively reduces the unit price for manufactured inputs, increases the returns to intangibles, and should, therefore, induce a shift out of manufacturing in countries where the leading firms are located. Concretely, this new model of economic organization includes both a geographically diverse set of contractors capable of supplying finished garments for big buyers as well as a host of "middle men" who managed the interface between buyers and suppliers (Gereffi 1999).

However, historical case studies of the garment industry suggest that buyer-driven governance became the *predominant* organizational logic in the latter part of the twentieth century (e.g., Bair 2006; Frobel, Heinrichs, and Kreye 1980). In particular, many garment firms experimented with various forms of offshoring throughout the 1960s and 1970s, but it was not until later that the buyer-driven model of network governance became the predominant organizational logic. Part of this was made possible by the widespread adoption of export processing zones in many developing countries through the 1970s and 1980s (Frobel et al. 1980). However, even this "maquiladora" model, in which big buyers engaged in limited amounts of manufacturing and used suppliers for simple assembly, represented an intermediate stage in the development of the buyer-driven model. Eventually, the modal organizational strategy crystalized into a "full-package" model where buyers design and retail garments that are manufactured entirely by independent suppliers (Bair and Gereffi 2001; Schrank 2004).

The diffusion of the buyer-driven model was also facilitated by the declination of developed country protectionism over the same period. The Multi-fiber Arrangement was gradually phased out beginning with the Agreement on Textiles and Clothing (ATC) in 1994, and culminated in January of 2005 with the abolition of protections in the garment industry (Bair 2006; Gereffi 1999). Thus, while there was a significant and growing amount of offshoring throughout the 1970s, it was not until after then 1980s that "the 'denationalization' of apparel production was well underway in many higher wage economies," which, in turn, was driven by the exercise of power by "retailers and branded clothing companies vis-à-vis other firms in the chain" (Bair 2006:2235). A historically grounded hypothesis is thus,

Hypothesis 1: Countries in which firms occupy leading positions in buyer-driven networks should exit garment manufacturing more extensively after the 1980s.

The reverse is true in the case of producer-driven industries, where the viability of a country's transportation-equipment-manufacturing sector depends on the network position of its firms in the industry. However, there is some reason to suspect temporal variation in the association between network position and transport-equipment-manufacturing specialization. The industry was not very networked prior to the latter two decades of the twentieth century. Instead, production was highly concentrated among the wealthier countries of Europe, North America, and Japan, and was organized via a handful of vertically integrated firms. Much of the transition to networked organization was in response to the innovations of leading Japanese firms, who spearheaded the trend toward deverticalization by constructing production networks crisscrossing the whole East Asian region. These networks allowed Japanese firms to capture a growing share of North American and Western European markets (Cummings 1984; Womack, Jones, and Roos 1990). By the early 1980s, "it became clear that the Fordist mass producers faced systematic rather than cyclical difficulties" so that American and European lead firms had no option but to imitate (Massey and Meegan 1982; Maxton and Wormwald 2004; Piore and Sable 1984; Whitford 2005:15). In short, the producer-driven model originated among Japanese auto manufacturers during the 1960s and 1970s, and gradually diffused to other lead firms worldwide. While it is difficult to identify a specific year by which some version of the ideal-typical model was adopted by the majority of leading firms, many industry observers argue that these industries made a full transition "from a series of discrete national industries to more integrated global industrie[s]" during the 1980s (Sturgeon et al. 2008:302).

Hypothesis 2: Countries in which firms occupy leading positions in transportation-equipment industries should specialize more extensively in transport-equipment manufacturing after the 1980s.

Alternative Accounts of Manufacturing Specialization

As the above discussion prefigures, the production network explanation for economic organization often stakes its theoretical space in juxtaposition with alternative accounts that suggest countries specialize in economic activity for which they possess a natural comparative advantage, or that state policy plays the decisive role (Hamilton and Gereffi 2009; Sturgeon 2008). Factor-based explanations of comparative advantage argue that countries tend to specialize in economic activities that are most appropriate to the skills available in local labor markets, the relative abundance of labor and capital, the technological capability of domestic firms, and so on, because domestic firms producing goods making use of abundant factors will fare better than those that do not. Statist explanations suggest instead that states create incentive structures to which domestic firms respond so that, *ceteris paribus*, cross-national specialization tends to reflect the strategic intervention of states (Evans 1995; Plümper and Graff 2001). Rather than inter-firm relations, then, alternative accounts argue that specialization derives from the attributes of nation-states. Thus, I outline an important set of alternative explanations that could account for cross-national variation in garment- and transportation-manufacturing specialization.

Trade Openness

Theories linking international specialization to comparative advantage begin with international trade. Exposure to world markets through trade causes domestic capital to shift into the most efficient productive activity. While there is some disagreement about whether cross-national differences in technology and labor productivity (e.g., Ricardian models) or factor abundance (e.g., Heckscher-Ohlin models) account for this dynamic, the link between trade openness and specialization works through both import and export channels. Countries that expose their manufacturing sector to international competition through trade will experience higher international demand for the more internationally competitive goods and lower domestic demand for the less internationally competitive. Both exports and imports increase, and capital flows to internationally competitive sectors (Bowen et al. 1987; Ricardo [1817] 1919).

Sector-Specific Export Specialization

Contending schools of thought argue that export specialization and manufacturing specialization are correlated across countries. Consistent with the discussion of trade openness above, both Heckscher–Ohlin (H-O) and Ricardian trade theory suggest that, in the absence of barriers to trade, countries tend to manufacture and export goods for which they have a comparative advantage and import those for which they do not (Bowen, Leamer, and Sveikauskas 1987; Harrigan 1995). As differences between the Ricardian and H-O variants of comparative advantage imply, the sources of such advantages “appear to be the outcome of a number of factors,” many of which are difficult to pin down a priori (Balassa 1965:116). Thus, practitioners of comparative advantage often turn to measures of observed export specialization as a point of departure, with the intuition that cross-country differences in sector-specific export specialization reflect unobservable differences in comparative advantage for those sectors.

On the other hand, government industrial policy can also play a role in the variation of manufacturing specialization cross-nationally. States that provide export-sector-specific incentives may increase the returns to subsidized sectors relative to sectors that do not receive subsidies. While this kind of industrial policy constitutes a price distortion that would reduce the long-term returns to trade according to modern trade theory, it would nevertheless predict a positive association between sector-specific export specialization and manufacturing specialization in the short term. Indeed, empirical studies show that countries do tend to produce and export "goods for which strategic interventions, say export subsidies, are comparatively larger, while they import goods for which government interventions are relatively lower" (Plümper and Graff 2001:664–5).

Skills and Secondary Education

Another factor that influences cross-national specialization patterns is skills. Factor-based theories of specialization suggest countries that continually mobilize an educated populace produce the requisite skill base to specialize in skill-intensive goods. Indeed, some suggest that a combination of falling barriers to trade and persistent North/South skill differentials as measured in various kinds of educational outcomes drive the rise in labor-intensive manufacturing from the South to the North over the course of globalization (Wood 1994). Because garment manufacturing requires fewer skills than transport-equipment manufacturing, secondary school enrollment—a measure of the extent to which a country provides a basic secondary education—should have a negative association with garment-manufacturing specialization and a positive association with transport-equipment-manufacturing specialization.

Economic Development

A compelling argument regarding cross-national variation in types of specialization is economic development, in which countries experience sequential stages of specialization that progress from agricultural products to low- and medium-skill-/capital-intensive industries and finally to high-skill-/capital-, technology-, and knowledge-intensive industries (Gereffi 1999; Porter 1990). This developmental model suggests an inverted U-shaped association between development and specialization in the garment industry because it is often "the first rung on the latter" of industrialization, a rung on which "virtually every poor country that has developed successfully has gone through" (Sachs 2005:11–12). Transportation-equipment specialization should also increase with development, but it is not clear whether it would stabilize or decline at the highest levels of development. It is among the more skill and capital-intensive manufacturing industries, which suggests a positive linear association with development. But it is not the only such industry and a highly developed country might shift additional resources into comparable industries. Thus, I control for both linear and curvilinear development effects in both industries.

Alternative Conceptions of National Power

I also consider two alternative conceptualizations of national power. First, some argue that garment manufacturing has undergone a secular process of "peripheralization" in a way that transportation-equipment manufacturing has not (Korzeniewicz and Martin 1994; Schrank 2004; Silver 2003). Thus, manufacturing specialization across these two industries might be a function of world-system position, where core countries specialize in the manufacture of transport equipment rather than garments. Second, to the extent that firms in countries with large internal markets can reduce unit-manufacturing costs via economies of scale, manufacturing intensities in the countries where they reside can depart from those predicted by the allocation of production factors (Firebaugh 1983). Moreover, countries with large internal markets possess a degree of leverage in negotiating the terms under which foreign firms gain access, as exemplified in the 1985 plaza accord when, in the face of U.S. government pressure, Japanese auto firms agreed to "voluntary" export restraints and built transplant firms in the United States (Brenner 2002:60). Thus, I also control for a time-varying measure of world-system position and economic size (gross domestic product [GDP]).

Data and Method

Networked Models of Economic Organization and the Positional Power of Nations

While the implications of production network formation for cross-national variation in manufacturing specialization are straightforward, the firm-level orientation of the production network paradigm "poses a unit of analysis dilemma" in terms of evaluating how firm-level dynamics impact "the larger units that are traditionally regarded as the spaces or containers" of economic performance and behavior (Bair 2005:166). Thus, while network analysts argue that the dynamics of network formation are the primary cause of manufacturing specialization, none have tested this hypothesis directly (cf. Feenstra and Hamilton 2006). The primary reason for this hole in the literature is that it is difficult to measure the network position of a country's firms when "publicly available and detailed information at the level of firms is generally lacking" (Gereffi 2005:169).

Production network analysts commonly evoke country-level, industry-specific trade statistics to demonstrate the network position of resident firms. The logic underlying the analysis of national trade statistics is that they increasingly reflect the way "lead firms go about setting up and maintaining production and trade networks" as the industry in question becomes organized via production networks over time (Gibbon and Ponte 2005:93). However, these analyses rarely include more than one or two cases and, therefore, preclude the kind of model-based evidence that undergirds alternative accounts of economic organization (e.g., Bair 2006; Gereffi 2009; Hamilton and Gereffi 2009). Alternatively, other sociological traditions do operationalize notions of positional power at the country level with international trade networks among a large number of countries but do not account for variation in the way these industries organize (e.g., Clark 2010; Jorgenson and Clark 2009; Smith and White 1992; Snyder and Kick 1979). I synthesize these two approaches by using international trade data in two archetypically buyer- and producer-driven industries to measure the average positional power of resident firms for a large sample of countries in a way that is both cross-nationally and temporally comparable.

The key task is to identify which countries engage in trade relations that are consistent with hosting lead firms in buyer- and producer-driven networks. The first major distinction is between importing and exporting behavior. In the language of social networks, the powerful actors in buyer-driven networks reside on the major *receiving* (i.e., in-degree) nodes because bargaining power accrues to buyers rather than manufacturers. Alternatively, the powerful actors in producer-driven networks reside in the major *sending* (i.e., out-degree) nodes because bargaining power is highest on the supply side.

The second major distinction regards the determinants of bargaining power in the two networks. For example, the bargaining power of leading firms in buyer-driven networks increases with the number of alternative suppliers available to them, and then with the relative dependency of their suppliers. Leading firms often choose to source some part of their product lines from firms located in countries far from final markets to realize lower unit costs. At the same time, they may also source other parts from firms located close to the final market to ensure speedy delivery (Gereffi 1999; Hamilton and Gereffi 2009). Maintaining sourcing channels in multiple countries also allows leading firms to benefit from volatile "trade policies, productivity improvements, or the entry of new low-wage producers or exchange rate depreciation[s]" (Heintz 2006:513). Finally, countries with multiple lead firms should import from many alternative partners precisely because their import profiles will reflect the sourcing decisions of many firms, which are additive at the country level. In short, countries containing leading firms in buyer-driven industries should import a large share of the garment exports from many import partners.

Conversely, a focal country that contains a preponderance of leading firms in producer-driven industries should export to many countries that depend on it for imports. Indeed, it is important to distinguish between countries that host foreign factories and those that contain the home base of leading firms. In the auto industry, for example, countries whose domestic production primarily reflects the presence of foreign transplant factories typically have less geographical reach than do those in which the leading firms are headquartered. Mexico's auto industry consists primarily of transplants owned by leading firms from Germany, Japan, and the United States, who built factories in Mexico to supply the North American market. Thus, Mexico's export profile is concentrated on a single market. In contrast, the countries in which leading firms headquarter export to a wider array of import partners. First, leading firms use domestic production to "supplement offshore production through exports" (Sturgeon et al. 2008:309). Second, lead firms tend to produce the higher end models or core components in the home country and export them (Humphrey and Memedovic 2003; Klier 2008; van Tulder and Ruigrok 1998). Still other lead firms, such as Italy's Fiat or South Korea's Hyundai, serviced the world market extensively or even primarily through exports from the home country during the period observed below (Veloso 2000). In short, countries containing firms in prominent positions in producer-driven networks should not only engage in exporting behavior but also export to a wide range of countries and capture significant share of their import markets.

The generalizability of the relationship between a country's trade relations and the positional power of its firms is limited by the extent to which the underlying trade networks represent either buyer- or producer-driven industries. While the buyer-/producer-driven dichotomy cannot stand in for the full spectrum of organizational types and not all global industries fit neatly within it (Gereffi et al. 2005; cf. Gibbon and Ponte 2005), the garment and transport-equipment industries discussed above exemplify archetypical buyer- and producer-driven governance (Gereffi 1994, 1999; Gibbon and Ponte 2005; Thun 2008). Not only are these two industries ubiquitously regarded as archetypical of the buyer-/producer-driven dichotomy, but they are also the two most heavily researched industries in the production networks literature.[2] Thus, I estimate the average network position of resident firms in both the garment and transportation-equipment industries by modifying Wallace, Griffin, and Rubin's (1989) "logarithmic method" to operationalize the two distinct forms of bargaining power in each network type.[3]

In the case of buyer-driven networks, I measure the positional power of a country's resident firms in the garment industry with *Buyer-Driven Power* (P_j^B ,) which is defined in equation (1).

$$P_j^B = \sum_{i=1}^{n} \log(Y_{ij} / X_i . +1) \tag{1}$$

In equation (1), Y_{ij} is the import received by country *j* from country *i* in the garment industry, $X_i \cdot$ is the total garment exports of the sending country *i* and *log* is the base 10 logarithm. This measure takes the value in every cell on the import columns of receiving country *j*, divides it by the total exports of each sending country, adds one to define empty cells, and then transforms these ratios with the base 10 logarithm. These transformed values are then summed down the import vector to create the *Buyer-Driven Power* of country *j* in the global garment industry. Countries rank high when they have many dependent import partners—that is, when they have many partners from which they import a large proportion of their total garment exports—and low when they have few. Scores increase with the absolute dependency of each import partner thereafter.

In producer-driven networks, I measure country *j*'s *Producer-Driven Power* (P_j^P) with

$$P_j^P = \sum_{i=1}^{n} \log(X_{ji} / Y_i \cdot +1), \tag{2}$$

where X_{ji} is the exports from country *j* to country *i* in a producer-driven industry, $Y_i \cdot$ is the total imports of receiving country *i* and *log* is the base 10 logarithm. This measure operates across the rows (export vector) rather than down the columns and normalizes by the total imports of the receiving country rather than the sending one. Countries rank high when they have many dependent export partners—that is, when the focal country has many partners to which they export a large proportion of their partner's total transport-equipment imports—and increase with the absolute dependency of each export partner thereafter.

Network Data

The trade networks underlying buyer- and producer-driven power come from UNCOMTRADE and are categorized according to Rev. 1 of the Standard Industrial Trade Classification (United Nations 1963, 2006). I employ trade in category 84 (Clothing) and 71 (Transportation Equipment) for buyer- and producer-driven industries, respectively. In both cases, I build the network with reported imports collected at five points in time over a 35-year period (1965, 1970, 1980, 1990, and 2000).[4] The networks track the same countries in each period to preclude biases owing to partner attrition/addition. The year-on-year variation in which countries report restricted the networks to the 96 countries listed in the footnote of Table 2, which nevertheless account for between 95.5 and 98.6 percent of world trade and from 92.5 to 96.8 percent of world GDP over the period.[5]

Dependent and Baseline Control Variables

The dependent variables in the analyses that follow are manufacturing specialization in the garment and transport-equipment industries, respectively. I observed all of the independent variables in 1965, 1970, 1980, 1990, and 2000. To establish the time order, I observed the dependent variables one year later (1966, 1971, 1981, 1991, and 2001). Unreported tests for reciprocal causality suggest it does not operate here. Further descriptions of these and the baseline control variables are displayed in Table 2. Bivariate associations and descriptive statistics appear in Table A1 of the appendix.

Panel Models

Hypotheses 1 and 2 require separate models of garment- and transportation-manufacturing specialization. Due to missing data on the dependent and independent variables, fewer than the 96 countries in the garment and transport-equipment trade networks also appear in the regression models. In the models of garment-manufacturing specialization, 83 countries and 354 country–year observations appear. In the models of transport-equipment specialization, 80 countries and 345 country–year observations appear (Table 2 identifies which countries appear in each industry model). These panels are therefore unbalanced (countries yield a different number of observations through time), "large N, small T" panels (the number of countries greatly outnumbers the time-series observations), and unequally spaced (the gap between 1965 and 1970 is smaller than the others). However, the number of country observations appearing in each year does not systematically vary with time and remains relatively constant, ranging from 66 to 76 and 65 to 71 in the models of garment and transportation-equipment specialization, respectively. The ratio of developed to developing countries also remains roughly constant over time. Models that exclude the 1965 period were substantively identical to those reported.

These panel data call for analytical techniques to address unmeasured country-specific heterogeneity bias. The most common approaches include random (REM) and fixed (FEM) effects models. The models that follow utilize fixed-effects regression for several reasons. First, hypotheses 1 and 2 require an analysis of the temporal variation because they suggest that impact of buyer- and producer-driven power should change over time. Second, while the FEM model has been criticized for ignoring between-case variation, the option of analyzing within-case variation

Table 2. Variable Descriptions.

Variable names	Description	Source
Garment and transport-equipment-manufacturing specialization[a]	Manufacturing specialization is the proportion of manufacturing value added accounted for by either the garment or transportation-equipment industries. Models of the log of value added in each industry with value added for the manufacturing sector as a whole as an additional control are virtually identical (Firebaugh and Gibbs 1985).	Manufacturing value added comes from United Nations Industrial Development Organization (2006). Value added in the garment industry is category 322, "Manufacturers of Wearing Apparel Except Footwear." Value added in the transport-equipment industry is category 384, "Manufactures of Transportation Equipment." Value added counts only the manufacturing activity conducted within a country, excluding that embodied in imported components
Garment and transport-equipment-export specialization[a]	Export specialization is the ratio of either garment or transportation-equipment exports to total exports.	Garment and transportation-equipment exports come from commodity categories 84 and 71, respectively, of the UNCOMTRADE database (United Nations 1963, 2006), while total exports come from the IMF's Direction of Trade Statistics (IMF 2006)
Secondary education[a]	Students enrolled in secondary education/school-aged population.	EDSTAT database (World Bank 2002)
Trade openness[a]	Exports + imports/GDP	The aggregate trade data come from the IMF's Direction of Trade Statistics (IMF 2006), and GDP comes from the World Bank (2006)
Economic development[a]	GDP per capita converted to achieve purchasing power parity (PPP). I include both GDP per capita and its squared term.[b]	PENN World Tables (Heston, Summers, and Aten 2002)
World-system position	A *time-varying* network-based ordinal measure of core, semiperipheral, and peripheral status in the world	Mahutga and Smith (2011)
Market size[a]	Gross domestic product (GDP)	World Bank (2006)

Note. Countries included in each set of trade networks were Algeria*#, Angola, Argentina*#, Australia*#, Austria*#, Bahrain, Barbados*#, Belgium, Benin*, Bolivia*#, Brazil*#, Brunei Darussalam, Burkina Faso, Cameroon*#, Canada*#, Central African Republic#, Chad, Chile*#, China*#, Colombia*#, Congo#, Costa Rica*#, Côte d'Ivoire*#, Cyprus*#, Czechoslovakia*#, Denmark*#, Ecuador*#, Egypt*#, El Salvador*#, Ethiopia*#, Finland*#, France*#, Gabon*#, Gambia, Germany*#, Ghana*#, Greece*#, Guatemala*#, Honduras*#, Hong Kong*#, Hungary*#, Iceland*#, India*#, Indonesia*#, Iran*#, Ireland*#, Israel*#, Italy*#, Jamaica*#, Japan*#, Jordan*#, Kuwait*#, Libya*, Madagascar*#, Malawi*#, Malaysia*#, Mali, Malta*#, Mauritius*#, Mexico*#, Morocco*#, Netherlands*#, New Zealand*#, Nicaragua*#, Niger, Nigeria*#, Norway*#, Pakistan*#, Panama*#, Paraguay*#, Peru*#, Philippines*#, Poland*#, Portugal*#, Qatar*, Romania*#, Samoa, Saudi Arabia*#, Senegal*#, Singapore*#, South Korea*#, Spain*#, Sri Lanka*#, Sweden*#, Switzerland*, Thailand*#, Togo*, Trinidad/Tobago*#, Tunisia*#, Turkey*#, UK*#, Uruguay*#, USA*#, Venezuela*#, Yugoslavia, Zambia*#. *appears in garment industry models; #appears in transport-equipment industry models. IMF = International Monetary Fund.

[a]Base 10 logarithm.

[b]I use an orthogonal second-order polynomial to mitigate collinearity (Wong 1935).

is the very strength of panel data because it better approximates the experimental logic that regression emulates and thereby "buys protection against biased and inconsistent parameter estimates" (Halaby 2004:523). Finally, the FEM allows me to control for substantively relevant unmeasured factors that are time invariant and correlated with specialization, such as geography and persistent variation in institutionally determined economic organization at the national level (Berger and Dore 1996).[6]

Panel data also allow one to control for period-specific but country-invariant heterogeneity. I include a post-1980-period dummy variable to control for period-specific heterogeneity because it allows me to test hypotheses 1 and 2 by way of an interaction term between network position and the post-1980 period (1990 and 2000). One particularly astute review questioned the periodization incorporated here on substantive grounds insofar as there was a significant amount of offshoring prior to 1980. To be sure, 1980 is a convenient cutoff because industry analysts argue the two models did not become globally predominant until sometime during the 1980s. This reviewer also raised statistical issues in that the results might depend on this particular operationalization of the temporal dynamics and the omission of the time dummies *within* the two periods. Indeed, these models assume that differences between the coefficients on buyer- and producer-driven power are not significant within the two broad periods ($\beta_{1960} = \beta_{1970} = \beta_{1980} \neq \beta_{1990} = \beta_{2000}$) and that the coefficients on the other covariates do not change in meaningful ways when T-1 dummies are controlled. Thus, I estimated unreported models that include interactions between buyer- and producer-driven power and T-1 dummy variables along with the T-1 constituent terms (Friedrich 1982). I observed significant differences in the point estimates for buyer- and producer-driven power only *between* the two broad periods, and the coefficients on the remaining covariates were substantively identical (see also note 9 below). In short, given the 10-year intervals at which I observe these countries, only after the 1980s is it safe to assume that the two industries were organized in this way worldwide, and the analytical results below are robust to alternative operationalizations of the temporal dynamics.

The FEM assumes a homoscedastic error term, which is rarely the case in cross-national data. I therefore report standard errors that are robust to heteroskedasticity. I also estimate and adjust for a panel size weighted first-order autocorrelation process because diagnostic tests rejected the hypothesis of zero first-order correlation in the residuals. Unreported results that adjust for serial autocorrelation via either a lagged dependent variable or various types variance/covariance estimators that are robust to serial and/or spatially contemporaneous autocorrelation were substantively identical. The AR(1) adjusted FEM models reported below are quite conservative considering the large N, small T structure identified above. Regressions were carried out in Stata.

Results

Buyer- and Producer-Driven Power

Buyer- and producer-driven power measures the positional power of countries over time, where power is a function of the network position of firms therein. While the trade relations discussed above are logically consistent with the literature on bargaining power in the two network types, they should also coincide with the location of firms identified in the case-study literature as lead firms. Thus, I obtained a sample of the country-level presence of lead-firm functions in the garment and transportation-equipment industries for the most recent period to further assess the face validity of buyer- and producer-driven power.[7] Figure 1A shows the relationship between buyer-driven power and the number of lead-firm retail outlets in each country. The correlation is fairly high at .675, and larger than the correlation between firm location and GDP per capita (.508). Figure 1B shows the relationship between producer-driven power and the number of lead-firm manufacturing operations located in each country in the same period. The association is also fairly high at .783, particularly compared with the association with GDP per capita (.432). Buyer- and producer-driven power measure the network position of a country's firms above and beyond conventional measures of economic development.

One possible limitation of producer-driven power is that trade statistics do not explicitly differentiate between countries in terms of whether or not exporting firms are domestically owned. In practice, however, producer-driven power does discriminate between countries in which lead

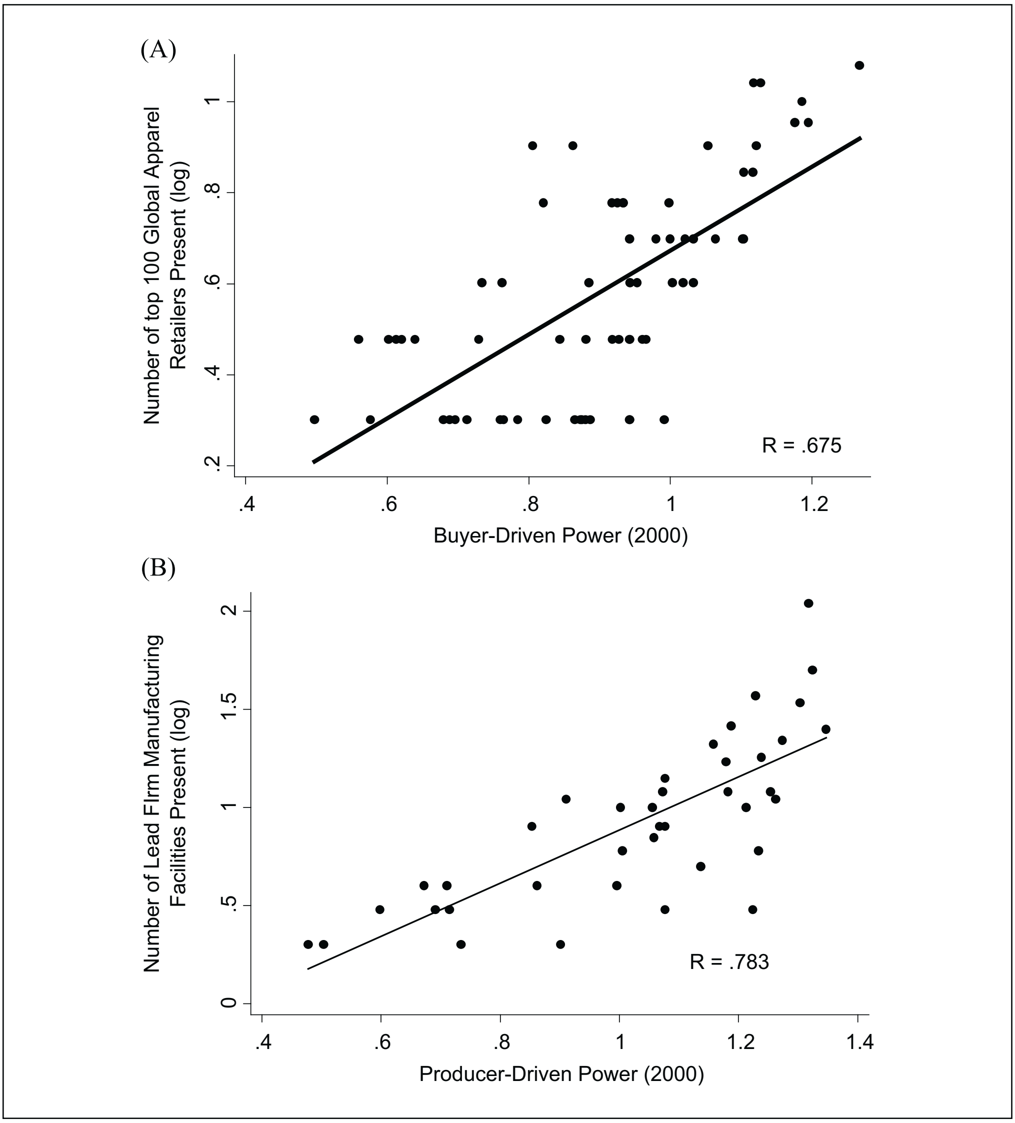

Figure 1. Association between buyer-/producer-driven power and the presence of lead-firm operations in the garment and transportation-equipment industries.
Note. Figure 1A includes *N* = 66 countries. Figure 1B includes *N* = 39 countries. Smoother fit with least squares. Log is the base 10 logarithm.

firms are headquartered and those that play host to transplants because the former have more geographically expansive trade ties than the latter. For example, Mexico hosts transplants from Japan, the United States, and Germany, but primarily services the North American market. Mexico's measured level of producer-driven power varies in rank from 32 to 21 over time and, therefore, remains in the "second tier." By comparison, the United States' rank is third throughout, Japan moves from sixth to first, and Germany varies between first and second. South Korea provides an even better comparison because it upgraded from simple manufacturing to the development of two of the largest auto firms in the world (Hyundai and Kia). South Korea ascends from the 65th position in 1965 to the 6th in 2000.

Table 3. Bivariate Association between Network Power and Manufacturing Specialization in Two Industries.

	r	
Level	BDP, GMS	PDP, TMS
Pooled	−.009	.595***
Pre-network Period	.163*	.597***
Network Period	−.236**	.716***

Note. GMS = garment-manufacturing specialization; TMS = transportation-manufacturing specialization.
*p < .05. **p < .01. ***p < .001 (two-tailed tests).

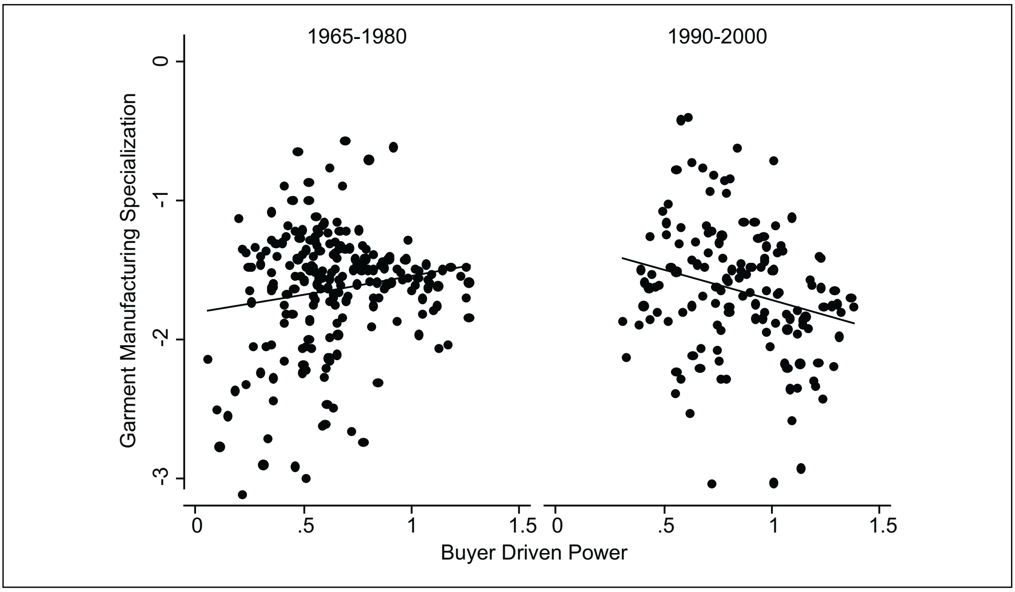

Figure 2. Association between buyer-driven power and garment-manufacturing specialization by time period.
Note. *N* = 354 observations on 83 countries. Smoother fit with least squares.

Positional Power and Manufacturing Specialization

Table 3, and Figures 2 and 3 display the bivariate correlations between buyer- and producer-driven power, and manufacturing specialization in the two industries. Table 3 reports these correlations at the pooled level, as well as before and after the period during which the two models of network governance became globally predominant. Both Table 3, and Figures 2 and 3 support the first and second hypotheses. The association between buyer-driven power and garment-manufacturing specialization becomes negative during the period when the buyer-driven model became predominant organizational logic in the industry. Similarly, the association between producer-driven power and transportation-manufacturing specialization becomes increasingly positive after the 1980s. Do these associations hold net of unmeasured time-invariant country-specific variation and the baseline model?

Table 4 reports unstandardized coefficients from a fixed-effects regression of garment-manufacturing specialization. Model 1 regresses garment-manufacturing specialization on

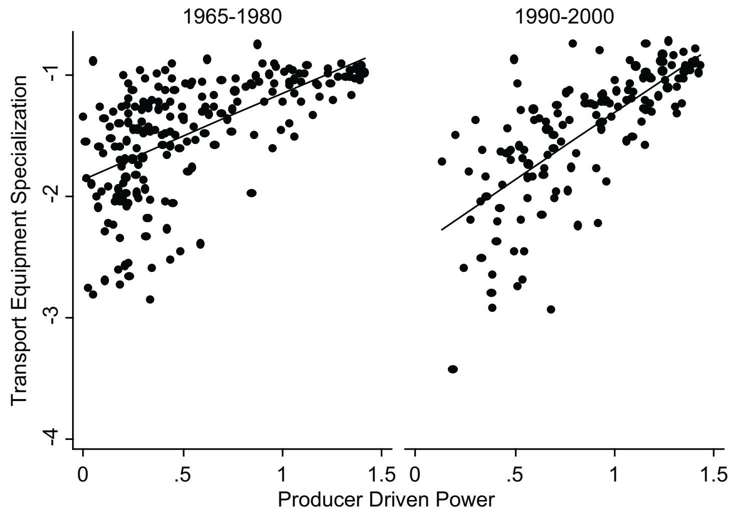

Figure 3. Association between producer-driven power and transportation-manufacturing specialization by time period.
Note. N = 345 observations on 80 countries. Smoother fit with least squares.

buyer-driven power and the fixed unit and period effects. As might be expected given the pattern of bivariate associations documented in Table 3, there is no time-invariant effect of buyer-driven power. Model 2 introduces buyer-driven power and its interaction with the post-1980 period. The interaction term is consistent with hypothesis 1—the effect of buyer-driven power tends negatively after 1980.

Model 3 includes three variables that capture cross-national variation in factor endowments that could favor garment manufacturing—garment export specialization, secondary education enrollment, and trade openness. Export specialization and trade openness are significant and in the expected direction: as countries specialize in garment exports and increase their exposure to global markets, the share of garment manufacturing in total manufacturing increases. While the sign on secondary education enrollment is in the expected direction, the effect is not significant. Controlling for these three covariates from the baseline model, the interaction of buyer-driven power with the network period remains significant.

Models 4 and 5 include GDP per capita and its square. GDP per capita is non-significant in model 4, but the coefficients on both GDP per capita and its square are significant in model 5, which suggests that garment manufacturing first rises and then declines over the course of development. Over and above the development quadratic, however, the negative interaction term on buyer-driven power remains significant. Model 6 includes world-system position and market size. Consistent with world-systems expectations regarding systemic cycles of innovation and peripheralization, garment manufacturing became peripheralized over the period, while market size is non-significant. Still, the persisting significance of the negative interaction of buyer-driven power with the network period suggests that patterns of specialization in the garment industry are not reducible to alternative accounts of specialization or national power.

Table 5 reports coefficients for transport-equipment-manufacturing specialization. The significantly positive effect of producer-driven power in model 1, net of unit and period fixed effects, suggests that countries with producer-driven power specialize in transport-equipment

Table 4. Unstandardized Coefficients from AR(1) Corrected Fixed-effects Regression of Manufacturing Specialization in the Garment Industry on Buyer-Driven Power and the Baseline Model.

	(1)	(2)	(3)	(4)	(5)	(6)
Positional power						
Buyer-driven power	−.062	.341*	.030	−.054	−.112	−.060
	(.128)	(.137)	(.143)	(.159)	(.148)	(.149)
Buyer-driven power × Network period		−.856***	−.674***	−.699***	−.343**	−.334**
		(.111)	(.112)	(.112)	(.108)	(.108)
Endowments, industrial policy, and skills						
Garment-export specialization			.858***	.862***	.779***	.779***
			(.183)	(.179)	(.160)	(.159)
Secondary education			−.024	−.063	−.115	−.082
			(.133)	(.137)	(.143)	(.149)
World-economic exposure						
Trade openness			.481***	.458***	.348**	.360**
			(.132)	(.132)	(.131)	(.129)
Economic development						
GDP per capita				.209	.488***	.525***
				(.135)	(.143)	(.139)
GDP per capita squared					−.202***	−.194***
					(.030)	(.030)
Alternative national power						
GDP						−.053
						(.065)
World-system position						−.183*
						(.089)
Network period	.0167	.668***	.450***	.463***	.224*	.222*
	(.0399)	(.103)	(.106)	(.105)	(.101)	(.100)
Constant	−1.459***	−1.685***	−2.298***	−2.912***	−3.814***	−3.480***
	(.323)	(.301)	(.338)	(.501)	(.501)	(.543)
R^2	.613	.664	.731	.735	.761	.765
ρ	.143	.036	−.041	−.048	−.026	−.017

Note. 83 countries appear, for a total of 354 country–year observations in each model. Robust standard errors in parentheses. Panel size weighted AR(1) term denoted by ρ.
*$p < .05$. **$p < .01$. ***$p < .001$ (two-tailed tests).

manufacturing across the sample's temporal range. However, the highly significant interaction term in model 2 suggests that the association between transportation-manufacturing specialization and producer-driven power becomes increasingly positive as manufacturing becomes embedded in producer-driven networks.

Model 3 includes transport-equipment-export specialization, secondary education, and trade openness, and shows that countries with high rates of secondary education enrollment possess the requisite skill levels for a viable transportation-manufacturing sector. The interaction between producer-driven power and the post-1980 network period attenuates slightly but remains significant net of the controls in model 3. Models 4 and 5 include GDP per capita and its quadratic. The significantly negative squared term on GDP per capita in model 5 indicates the improved fit of the quadratic model (Friedrich 1982). While this finding seems to contradict the reasoning that capital-/skill-intensive manufacturing should increase with development, the significant development quadratic could indicate that countries with relatively high labor productivity engage in

Table 5. Unstandardized Coefficients from AR(1) Corrected Fixed-Effects Regression of Manufacturing Specialization in the Transportation Industry on Producer-driven Power and the Baseline Model.

	(1)	(2)	(3)	(4)	(5)	(6)
Positional power						
Producer-driven power	.320**	.311**	.190	.273	.110	.028
	(.101)	(.097)	(.138)	(.162)	(.147)	(.154)
Producer-driven power × Network period		.274***	.285***	.325***	.427***	.413***
		(.077)	(.080)	(.085)	(.088)	(.085)
Endowments, industrial policy, and skills						
Transport-equipment-export specialization			−.019	−.020	−.016	−.017
			(.018)	(.018)	(.017)	(.017)
Secondary education			.312*	.345*	.294	.163
			(.150)	(.155)	(.155)	(.156)
World-economic exposure						
Trade openness			.114	.108	.086	.078
			(.127)	(.127)	(.126)	(.127)
Economic development						
GDP per capita				−.164	.042	−.080
				(.162)	(.169)	(.179)
GDP per capita squared					−.120***	−.129***
					(.030)	(.032)
Alternative national power						
GDP						.141*
						(.074)
World-system position						−.089
						(.068)
Network period	−.131***	−.362***	−.417***	−.445***	−.476***	−.497***
	(.035)	(.093)	(.098)	(.098)	(.094)	(.095)
Constant	−1.878***	−1.870***	−2.489***	−1.969**	−2.634***	−2.903***
	(.315)	(.306)	(.363)	(.604)	(.599)	(.622)
R^2	.788	.805	.812	.814	.822	.824
ρ	−.032	−.073	−.075	−.081	−.067	−.064

Note. 80 countries appear, for a total of 345 country–year observations in each model. Robust standard errors in parentheses. Panel size weighted AR(1) term denoted by ρ.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$ (two-tailed tests).

manufacturing specialization across a number of capital-/skill-intensive industries in addition to the transportation-equipment industry.

Finally, model 6 includes world-system position and market size. *Ceteris paribus*, world-system position is not related to transport-equipment manufacturing. However, countries with large internal markets do devote a larger share of their manufacturing activity to transport equipment (Brenner 2002).[8] Similar to Table 4, the persistent significance of the positive interaction between producer-driven power and the network period dummy suggests that variation in transport-equipment specialization is not reducible to that in economic development, market size, or world-system position.

The forgoing analysis provides rather clear empirical evidence that as buyer- and producer-driven networks become the predominant organizational logic in these two industries, the trade relations forged by leading firms play a growing role in patterns of manufacturing specialization cross-nationally. The analysis also raises two important questions with respect to the explanatory power of the production network paradigm. First, do buyer- and producer-driven

Table 6. Coefficients on Positional Power Conditional on Predominant Global Organizational Model.

	1	2	3	4
	(From model 2)	(From model 3)	(From model 5)	(From model 6)
Buyer-driven power				
Pre-network period	.341*	.030	−.112	−.060
	(.137)	(.143)	(.148)	(.149)
Network period	−.515***	−.645***	−.455**	−.394**
	(.137)	(.140)	(.153)	(.153)
Producer-driven power				
Pre-network period	.311***	.190	.110	.028
	(.097)	(.138)	(.147)	(.154)
Network period	.585***	.475**	.537**	.441*
	(.141)	(.170)	(.186)	(.188)

Note. The coefficients for the early period are drawn from the first rows of Tables 2 and 3. The conditional effect in the networked period is obtained with $\frac{\beta_1+\beta_3}{\sqrt{\text{var}(\beta_1)+\text{var}(\beta_3)+2\text{cov}(\beta_1\beta_3)}}$, where β_1 is the uninteracted coefficient on positional power and β_3 is the interaction between positional power and the network period (Friedrich 1982). Model 2 controls for fixed country and period effects, model 3 adds garment/transport-equipment-export specialization, education and trade openness, model 5 adds the development quadratic, and model 6 adds market size and world-system position.
*p < .05. **p < .01. ***p < .001 (two-tailed tests).

power have a significant effect on specialization when controlling for the cross-national distribution of latent production factors, state policy, and national power? To address this question, Table 6 reports coefficients for buyer- and producer-driven power conditional on the periods before and after these two network forms of economic organization became the predominant organizational logics in their respective industries. These test the hypothesis that the association between buyer-/producer-driven power and specialization are significantly different from zero in each period.

Column 1 shows the conditional effect of buyer- and producer-driven power when the coefficients on alternative accounts are constrained to zero. The first two rows provide a rather surprising result for the earlier period—firms in countries with the highest levels of buyer-driven power were nevertheless major garment producers. On the contrary, the results for the second two rows suggest that firms in countries with the highest degree of producer-driven power were major transport-equipment producers even before this global network model came to dominate the industry. However, the coefficients in columns 2 to 4 obtain when controlling for the alternative accounts and imply an entirely different causal narrative in two ways. First, the association between network position and manufacturing specialization during the early period drops out entirely when controlling for baseline covariates in models 3 to 6. Second, the association between positional power and manufacturing specialization during the later period attenuates upon the inclusion of the baseline covariates but remains significant. Substantively, columns 2 to 4 suggest that buyer- and producer-driven power has a significant impact on specialization that is *independent* from alternative accounts, *but only during the historical period during which these networks are alleged to have become the predominant organizational logics in the industry*.[9] Accounts of specialization based on cross-national variation in the attributes of nation-states were all that mattered for specialization prior to the emergence of global production networks, after which network dynamics play a significant and growing role.

The second major question left unanswered concerns the *relative* explanatory power of the production network explanation of international specialization *vis-à-vis* alternative accounts. Indeed, the attenuation of buyer- and producer-driven power observed during the network period when other factors are controlled suggest that *both* the baseline model *and* network position matter for cross-national variation in patterns of specialization, even during the network period. Of the significant effects in the full model of the garment industry, for example, the GDP per capita quadratic yields a standardized coefficient (.474, −.389) that is larger than buyer-driven power (−.241), as does world-system position (−.281). Clearly, the large standardized coefficients on GDP per capita and world-system position call attention to the motivation underlying the construction of far-flung subcontracting networks in the garment industry—labor costs are a clear production factor that determines where garments are produced. At the same time, the significant if slightly smaller effect of buyer-driven power captures the *additional* savings to be gained from exercising buyer power to extract costs from diffuse supplier networks. Thus, the standardized coefficients for GDP per capita, world-system position, and buyer-driven power simply reflect different mechanisms by which leading firms gain from offshoring production in buyer-driven networks, even if the prevailing wage rate across countries is the more important of the two (e.g., Heintz 2006; Kaplinsky 2005).

On the contrary, the standardized coefficient for producer-driven power in the full model of transport-equipment manufacturing (.362) is larger than any of the other covariates, with market size (GDP) coming in as the second largest (.280). The relatively large impact of GDP is in keeping with known determinants to transport-equipment specialization, where governments are so keen to expand domestic auto production that lead firms "have to adjust their sourcing and production strategies to include a measure of local and regional production that firms in other industries do not" (Sturgeon et al. 2008:312; cf. Hamilton and Gereffi 2009). As the U.S. government's ability to impose "voluntary" import quotas on Japanese auto exports in the 1980s attests, the power of governments to persuade lead firms to adjust their production strategies is proportional to the value (size) of their domestic markets to lead firms, and one would therefore expect GDP exert a powerful influence on where transport-equipment production takes place (e.g., Brenner 2002; Sturgeon and Florida 2004).

Conclusion

A key hypothesis guiding research on network forms of economic organization is that differential network positions across "organizations influence a range of their behaviors" (Bandelj and Purg 2006:590). Likewise, sociological accounts of country-level economic behavior recognize that the structure of productive activity is "partially determined by the global environment" (Bollen and Appold 1993:283). Bridging these traditions, others argue that *globally* networked forms of economic organization play a causal role in restructuring the "geography and organization of economic activity" over time (Bair and Gereffi 2007). While there are a few country-level case studies supporting versions of this claim (e.g., Feenstra and Hamilton 2006; Gereffi 1999; Hamilton and Gereffi 2009; Rothstein 2005), they have yet to congeal into a general theory or an empirical test thereof.

The forgoing thus explicates a theory of the link between globally networked forms of economic organization and cross-national variation in manufacturing specialization in two archetypically networked industries and subjects the theory to empirical scrutiny. The empirical evidence is largely consistent with the network approach. Holding constant time-invariant variation in economic organization at the national level and alternative accounts of specialization, network-specific forms of bargaining power become increasingly powerful predictors of manufacturing specialization after 1980 in two industries that developed unique forms of network governance. The independent effects of network power underscore the link between patterns of international specialization and the bounded agency of lead firms, who build and coordinate production networks to maximize their own competitive position. That is, just as the division of labor among firms in globalizing production networks is a function of the positional power of lead firms, so too is the division of labor among countries a function of the network position of firms within them. Transnational production networks are important girders in the architecture of the evolving world economy; they are, in fact, instituting the global economy.

These results also have implications for the relationship of network power to the distribution of the gains from network forms of economic organization. Indeed, an important strand of research on the network form has “dealt with the consequence of firm’s network position for their economic performance,” with the belief that networked organization leads to long-term gains to all participating actors (Bandelj and Purg 2006:590; Uzzi 1996). Similarly, much of the motivation for studies of global production networks is a desire to identify how the network integration of Southern firms might lead to industrial upgrading at the firm level and economic development at the national level (Bair 2005; Bair and Gereffi 2001; Humphrey 2000; Humphrey and Memedovic 2003; Kaplinsky 2005; cf. Schrank 2004).

Production networks can foster development in the South by diffusing knowledge on a range of issues including quality standards, market characteristics, manufacturing processes, design, engineering, and research and development capabilities from lead to subordinate firms, which potentially leads to “learning by doing” among the latter (Gereffi 1999). Moreover, absent the linkages between lead and subordinate firms, the latter would have no way of gaining access to the “markets” for either the finished goods or intermediate components. Thus, just as embedded networks are thought to shift actor’s motivations “toward the enrichment of relationships through trust and reciprocity” on smaller geographical scales, lead firms in globally organized networks appear willing to help suppliers engage in industrial upgrading because it provides them with greater certainty that the finished goods will meet the quality standards that final consumers demand (Uzzi 1996: 677). Both lead and subordinate firms can gain from network participation.

Yet, the power asymmetries that characterize global production networks challenge this conventional understanding of economic networks as necessarily “embedded” in the Granovetterian sense (Mahutga 2014). Indeed, power asymmetries may, in fact, create inequalities in the returns to network participation (Schrank 2004). For example, if lead-firm strategy revolves partially around the externalization of activities with low and/or declining returns, then the distribution of returns to network participation might be skewed toward the leading firms (e.g., Bair 2005; Schrank 2004). Thus, while production network analysts do contend that production networks can lead to “long-term cooperative relationships that have both individual and collective level benefits,” they also imply that power differentials—and by extension the magnitude of cooperation and collective benefits—vary by the governance of the production network in question (Uzzi 1996:693). Not all network forms are created equal.

These are theoretical possibilities, however, and the nature of the link between network power and the distribution of the gains in production networks is ultimately an empirical question; one that may in turn answer the call for network researchers to “pay closer attention to the possible dysfunctionalities of networks forms” (Bandelj and Purg 2006:591; Heintz 2006; Schrank 2004). In addition to comparing economic performance across actors occupying different positions within the same network, future work might extend the logic here to the unique governance patterns observed in industries like electronics to understand whether the mode of network governance matters for the distribution of the returns to network participation. Buyer- and producer-driven governance in no way exhaust the full range of governance mechanisms observed empirically, and the extent to which power operates on all global networks is an empirical question (Gereffi et al. 2005). Addressing these questions would extend analyses of the returns to network participation to the global level, expand our theoretical understanding of the distribution of those returns across participating actors, and illuminate the contingencies that lead to growth and stagnation in an increasingly networked global economy.

Appendix

Table A1. Zero Order Correlation Coefficients and Descriptive Statistics.

	1	2	3	4	5	6	7	8	9	10	11
1. Garment specialization											
2. Transportation-equip. specialization	−0.038										
3. GDP per capita	0.162	0.411									
4. Buyer-driven power	0.005	0.380	0.763								
5. Producer-driven power	−0.039	0.598	0.645	0.777							
6. Garment-export specialization	0.427	−0.160	−0.055	−0.047	0.004						
7. Transportation-export specialization	0.108	0.414	0.552	0.650	0.810	0.110					
8. Secondary school enrollment	0.181	0.386	0.778	0.620	0.648	0.113	0.592				
9. Trade openness	0.347	−0.168	0.241	0.193	−0.066	0.208	0.076	0.251			
10. World-system position	−0.137	0.596	0.528	0.604	0.812	−0.106	0.619	0.475	−0.227		
11. GDP	−0.202	0.563	0.534	0.677	0.869	−0.015	0.602	0.563	−0.240	0.711	
12. Global period	0.020	0.000	0.266	0.386	0.352	0.262	0.284	0.413	0.232	0.030	0.453
Mean	−1.650	−1.480	3.662	0.723	0.600	0.052	−5.908	1.566	1.734	1.653	7.040
SD	0.460	0.500	0.450	0.278	0.412	0.144	2.007	0.427	0.279	0.695	0.994
Min	−3.270	−3.420	2.660	0.059	0.000	0.000	−10.151	−0.222	0.556	1.000	4.508
Max	−0.400	−0.730	4.530	1.383	1.430	0.800	−0.614	0.000	1.912	3.000	9.990

Notes

1. The literature on global commodity and value chains contains two distinct types of governance schemes. The original commodity chain distinction between buyer- and producer-driven chains most closely approximates the industry-level discussion here. The more recent fivefold "value chain" governance scheme focuses not on the governance of a whole industry but rather on the dyadic link between the leading firm and its first-tier supplier (Bair 2009; Gereffi et al. 2005). The literature appears headed toward a synthetic governance scheme where the fivefold coordination mechanisms are "nested" within the dichotomy (Gibbon and Ponte 2005; Mahutga 2012).
2. For example, Duke University's Global Value Chains Initiative lists a total of 470 publications spanning 72 industrial categories. Publications on transportation and garments account for a full 44.69 percent of all, even though these two industries only account for 9.72 percent of those listed on the website. http://www.globalvaluechains.org/
3. Buyer- and producer-driven power are modifications of Wallace, Griffin, and Rubin's (1989) logarithmic method because they employ different normalizing procedures. Buyer-driven power is analogous to Wallace et al.'s "upstream power," except that each entry in country *j*'s receiving vector is divided by the total exports of the sending country *i* rather than an attribute of country *j*. Similarly, producer-driven power is analogous to Wallace et al.'s "downstream power," except that each entry in country *j*'s export vector is divided by the total imports of the receiving country *i* rather than an attribute of country *j*. In both cases, this reflects the power-dependency principle that the power of actor *j* over *i* is a function of the dependency of *i* on *j* (e.g., Cook 1977; Thompson 1967).
4. Given an ***N*** by ***N*** matrix where cell *ij* represents the export from actor *i* to *j*, one can use either actor ***i***'s reported exports, or actor *j*'s reported imports to measure the flow. Reported imports tend to be slightly more accurate because of the care taken by state agencies to record imports for the purpose of tariffs (Durand 1953). Matrices were logged for skewness.
5. Countries appear in the network if they report trade flows in at least three of the five time periods, and mirror flows (reported exports to missing countries from nonmissing countries) and temporally proximate flows between missing countries were available in the other two periods.
6. If it can be shown that the unit error terms estimated via a random effects model (REM) are uncorrelated with the regressors, then the REM is justified on consistency grounds (Wooldridge 2002). Hausman tests show this assumption to be invalid.
7. I selected all the garment retailers among the top 100 largest global retailers reported by the National Retail Federation, which also reports the countries in which retail outlets are located. The firms in this sample are Wal-Mart, Seven & Holdings Co., Aeon Co., Sears, ITM Development, Migros-Genossenschafts Bund, El Corte Ingles, SA, The TJX Companies, Coop Group, Inditex SA, The Gap, Tengelmann, H&M Hennes & Mauritz AB, Isetan Mitsukoshi Holdings, S Group, Otto (GmbH & Co. KG), Kesko Corp, UNY Co., Dansk, The Daiel, C&A Europe, Limited. The country-level presence of lead firms in the garment industry is measured as the sum of all retail outlets in the country.

   I selected the auto and aeronautic firms that were among the top 120 global *Fortune 500* companies and then used their corporate Web sites and other sources to identify the location of the manufacturing operations they own worldwide. The firms included in the sample are Airbus, BMW, Boeing, Daimler, Fiat, Ford, General Motors, Honda, Hyundai, Nissan, Peugeot, Toyota, and Volkswagen. The country-level presence of lead firms in the transportation-equipment industry is measured as the total number of manufacturing facilities in a country as reported by each firm.

8. All coefficients displayed in Tables 3 and 4 behaved identically in intermediate models between 2 and 6 where each additional covariate was added individually (available upon request).
9. I conducted unreported robustness checks in which buyer- and producer-driven power were interacted with (a) the ratio of world trade to world GDP and (b) the ratio of world garment/transport-equipment trade to world garment/transport-equipment value added because each of these variables measure the extent to which manufacturing has become organized via global production networks at the global level. The results were substantively identical—buyer- and producer-driven power become significant predictors of manufacturing specialization as the two models of network organization become predominant. Moreover, above and beyond the endogeneity tests mentioned above, the temporal variation in the significance of the coefficients boosts our confidence that the causal arrow runs from network position to specialization. That is, we know that transport-equipment manufacturing was concentrated in Germany, the United States, and Japan (and a handful of other developed countries) in the immediate postwar period (i.e., before auto manufacturing became embedded in global production networks). These countries also have the highest measured levels of producer-driven power in that period. Thus, if network position were a function of specialization, one would expect a robust partial association even in the early period.

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