Sectoral Differentiation and Network Structure Within Contemporary Worldwide Corporate Networks

Ronald Sean Wall
Rotterdam School of Urban Management (IHS)
Erasmus University Rotterdam
Burg. Oudlaan 50
Rotterdam
3062PA
The Netherlands
wall@ihs.nl

G. A. van der Knaap
Department of Applied Economics
Erasmus University Rotterdam
Burg. Oudlaan 50
3000 DR Rotterdam
The Netherlands
vanderknaap@ese.eur.nl

Key words:
world cities
multinationals
advanced producer services
networks
centrality
structure
hierarchy
heterarchy

abstract

This article contributes to the converging literatures on global production networks and new regionalism, which show that these two entities and their respective geographic scales are complexly interdependent. It explores two key conceptual differences between the leading world city network studies of Alderson and Beckfield and the work of the Global and World City (GaWC) Research Network. The first is the sectoral differentiation of the data, in which the former focuses on multinational corporations in all industrial sectors and the latter specifically targets only advanced producer services. The second involves methodological differences that lead to dissimilar network structures. Alderson and Beckfield made only a basic hierarchical differentiation of the firms, while the GaWC study used a more elaborate classification method. Combining these approaches, we explore firms' global and regional interdependencies (their centrality within their network and its structure). Using a single data set of the top 100 global multinationals (2005) and their ownership linkages with thousands of subsidiaries in 2,259 unique cities worldwide. The findings not only reveal the nodal centralities and linkage structures within the "all industrial sector" network and the "producer service sector" network but also show a strong correlation between these two networks, specifically toward the apex of the economic systems, and evidence of the coexistence of hierarchical and heterarchical city network structures.

87(3):267–308. © 2011 Clark University. www.economicgeography.org

In recent years, academics and policymakers have persistently focused on subnational regions as the essential unit of economic activity. Indeed, economic geography has for a long time cultivated a self-conception of being the science of the mesoscale (Grabher 2006), which has led to an "overterritorialized" view of regional development (Hess 2004). In this light, most studies have failed to conceptualize regional development in an era of globalization (Dicken and Malmberg 2001). Instead, a strategic coupling of global production networks and regional assets has been pursued, in which activities are mediated across different geographic and organizational scales (Coe et al. 2004; Dicken, Kelly, Olds, and Yeung 2001). Rather than the persistent focus on regions as locally embedded entities, regions must be seen as "new islands of an archipelago economy" (Hein 2000), in which a process of transnational network embedding exists, creating interpersonal relationships of trust at different, interrelated geographic scales (Henderson et al. 2002; Hess 2004). Similarly, Gereffi, Korzeniewicz, and Korzeniewicz (1994) defined global commodity chains as interorganizational networks of products that link enterprises and states to each other within the world economy. Earlier, within a city-related context, Friedmann and Wolff (1982) developed a conceptualization of world cities as "command centers" that regulate the "new international division of labor." Common to both approaches is the emphasis on the importance of multiscalar networks in regional development (Derudder and Witlox 2010).

These initial approaches have led to various studies on cities and globalization (e.g., Sassen 1991; Amin and Thrift 1992; Castells 1996; Cohen 1981; Meijer 1993; Abbott 1997; Godfrey and Zhou 1999), but the number of empirical studies on world city networks has been limited because of the scarcity of "relational" data (Smith and Timberlake 1995; P. J. Taylor, Catalano, and Walker 2002). The relational data incorporate interactions among cities, and to date only a handful of studies have used such data (e.g., on international banks by Meyer 1986; advanced producer firms by P. J. Taylor 2004; the governance of multinational corporations by Rozenblat and Pumain 2006; Alderson and Beckfield 2004; Wall 2009a, 2009b; and corporate directorates by Carroll 2007). In a similar vein, we seek to understand the significance of interscalar corporate networks for economic development in particular societies (Henderson et al. 2002) without privileging one particular geographic scale (Coe et al. 2004).

Nonetheless, even in these studies, conceptual differences are evident (Derudder 2006), as is clearly exemplified in the critical debate between P. J. Taylor (2006) and Alderson and Beckfield (2006). The first concerns differences in the economic sectors of primary focus. Alderson and Beckfield (2004), taking the lead from Hymer (1972), argued that the key relationship linking cities into a world system is the multinational enterprise, regardless of which industrial sector is observed. Alternatively, P. J. Taylor (2004), taking Sassen's lead (1991), focused on the advanced producer service sector, which is justified as representing cutting-edge global economic activity because producer service firms have become multinationals in their own right, creating an essential "interlocking" (Knoke and Kuklinski 1982; P. J. Taylor 2001) global network of offices. However, according to Alderson and Beckfield (2006, 902), "this is an important empirical question that should not be foreclosed" because although producer services may lead the way in integrating cities into a global network, it is likely that other industrial sectors also create important connections among cities. Therefore, Alderson and Beckfield recommended that future research should compare multinational and producer service networks using a single data set—a recommendation that we follow in this article.

The second important issue in this debate revolves around methodological differences and how they lead to *hierarchical* dissimilarities of the networks. As Alderson and Beckfield acknowledged, a key advantage of P. J. Taylor's (GaWC) method is its sensitivity to the relative importance of firms within cities. Alderson and Beckfield addressed this issue by pointing out that future research should more sensitively measure hierarchical differences within corporate organizations—another recommendation that we heeded.

On the basis of these recommendations, we pose the following central research question: what will the nodal centralities and linkage structures of cities be when different levels of corporate ownership are considered in terms of (1) ownership linkages generated by all industrial sectors, (2) ownership linkages derived from producer services, and (3) the degree of overlap between the all-industries and producer service networks? In our study, we empirically explored the three major dimensions of corporate networks: firms, sectors, and territories (Dicken and Malmberg 2001). Furthermore, we paid special attention to three properties because the network characteristics of hierarchy and heterarchy are fundamental to corporate organizations (e.g., Hymer 1972; Lin, Cook, and Burt 2001; Hedlund 1986; Grabher 1993; Dunning and Lundan 2008). We borrowed techniques from social network analysis (e.g., Granovetter 1985; Irwin and Hughes 1992), although doing so is generally not appreciated in mainstream economic geography, because of the austere and formalistic style of this type of analysis (Grabher 2006).

To examine our research question, we compiled a data set similar to that of Alderson and Beckfield. In their case, the data concerned the global *Fortune* 500 firms (in 1999) and in our study, the data concerned the global *Fortune* 100 headquarters (in 2005). The essential difference between our data set and the one used by Alderson and Beckfield is that the latter did not differentiate ownership levels, while our data were classified into five corporate sublevels. In addition, in our database, firms were coded by their standard industrial classification codes (SIC) and city locations, resulting in 9,243 intrafirm ownership linkages among 2,259 unique cities. We applied social network analysis and geographic information systems (GIS) techniques to explore these linkages. The data and techniques are explained in detail in the Methodology section, followed by the analysis, results, and conclusions. In the next section, we discuss several conceptual and methodological differences within the world city literature.

The Worlds of Hymer, Friedmann, and Sassen

Hymer (1972) predicted that the structure of the world system would mirror the international organization of multinational enterprises; that is, the division of labor among geographic regions would correspond to the hierarchical division of labor within the firm. He expected that there would be a diffusion of industrialization to developing countries, whereby production-related activities would be concentrated in middle- and low-range cities, while corporate decision-making activities would be most concentrated in a limited number of hub cities, such as New York, London, Paris, and Tokyo, that are close to capital, markets, media, and governmental activities. Similarly, Friedmann's world-city hypothesis (1986) includes several generalizations that are relevant to our research. First, the extent to which a city is functionally integrated into the world economy is decisive for its level of development. Second, core cities are used by global capital as hubs in the spatial organization of markets and production. Third, the resulting economic network allows for the arrangement of world cities into an intricate spatial hierarchy. On the basis of these generalizations, Friedmann (1995) argued that world cities can be hierarchically ranked according to the economic strength that they command. Hence, cities that rank the highest can be seen as the control centers of the global economy, followed, at a lower level, by cities that control supraregional economies and, at even lower levels, cities that articulate national and subnational economies.

Sassen (2001a, 3) discussed the contemporary transformation of the world economic system into a "complex duality" of "spatially dispersed, yet globally integrated organization of economic activity." In particular, she argued that the centralized functions that are found in hub cities are strongly represented by the advanced producer services, which enable the control of production worldwide. Unlike Hymer (1972), but similar to Friedmann (1986), Sassen stressed that the globalization of services would give rise to a world with a new class of service cities controlling an array of production-oriented cities, in which a "vast territory" would be increasingly excluded from the vital economic processes of the global economy (Sassen 1994, p. 4).

These theories have in common their emphasis on competitive market mechanisms and urban development within the wider context of globalization, by which a hierarchical division of world cities into core and peripheral regions is defined (Cerny 1991). Although these theories have existed for some time, most contemporary analyses of economic development have been bedeviled by analytical disjunction, resulting in separate studies at the macro-, meso-, and microlevels (Henderson et al. 2002). Instead, the focus should be on the complex interactions between territorialized relational networks and global production networks (Coe et al. 2004). To date, only a handful of studies have addressed the interdependence among different geographic scales (e.g., Amin 2002; Bair and Gereffi 2001, P. J. Taylor 2004; and Alderson and Beckfield 2004). In the next section, we discuss the differences between two leading studies.

Parallel Paths in Network Analysis

The 2006 debate between P. J. Taylor and Alderson and Beckfield revealed that the primary conceptual and methodological differences stemmed from their assumptions about the major forces that shape the international urban hierarchy. Taylor supported Sassen's focus on advanced producer services, while Alderson and Beckfield supported Hymer's (1972) emphasis on multinationals in all industrial sectors. Alderson and Beckfield (2004) maintained that multinationals have taken advantage of new communication technologies to create today's global economic system. In contrast, Taylor (2006) argued that advanced producer services are essential to the overall structure of the world

city network because these firms form a cutting-edge service network that interlocks with the networks of other industrial sectors, thereby facilitating global production.

Broadly following Godfrey and Zhou (1999), Alderson and Beckfield (2004) collected data on the global *Fortune* 500 firms (in 2000) and their direct shareholding of subsidiaries worldwide. From these data, they produced a city × city matrix of 3,692 cities worldwide. Alternatively, the GaWC method collected data on 100 advanced producer firms and their offices across 315 cities worldwide (P. J. Taylor 2004) and distinguished different levels of corporate connections among cities to derive a "service values matrix." Furthermore, the studies differed in how they measured the economic function (sectoral differentiation) and network structure of the world city network. Alderson and Beckfield, coming from a sociological background, used a social network analysis toolkit to obtain several measures of network centrality and hierarchical structure. Alternatively, the GaWC method of measuring centrality, called total interlock connectivity, involved summing the products of every firm's service value in a given city with the same firm's service value in all other cities. Using three levels of service values, Taylor derived three distinct levels of an interlocking city network. In our analysis, we applied a hierarchical classification similar to that of Taylor's, to data similar to that of Alderson and Beckfield's.

The differences in approach just discussed have also led to different results. In Alderson and Beckfield's (2004) results (see Table 1), Tokyo, New York, Paris, and London topped the list in terms of both outdegree (outgoing linkages) and indegree (incoming linkages). The fact that Singapore and Hong Kong are strong in incoming linkages supports Godfrey and Zhou's (1999) conclusion that these cities play a vital role in the world economy with a strong presence of subsidiaries. P. J. Taylor, Catalano, and Walker's (2002) interlocking model revealed three overlapping levels of network connectivity (see Table 1): global, dominant, and subordinate. Again, London and New York topped the list, and Hong Kong ranked higher than Tokyo. P. J. Taylor (2006, 889) found it perplexing that Alderson and Beckfield undervalued cities like Hong Kong and Singapore in terms of outdegree. In our analysis, we followed Alderson and Beckfield's recommendations (1) to analyze both the multinational and advanced producer service networks on the basis of a primary data set and (2) to use the existing hierarchical structure of corporate holdings, found in the LexisNexis *Directory of Corporate Affiliations,* as a means of more sensitively measuring the presence of various kinds of firms in cities.

The Hierarchical and Heterarchical Organization of Firms

By emphasizing the critical role of the position of actors in webs of affiliation, Georg Simmel (1890) laid the foundations for social network analysis. Because economic action is said to be fundamentally a social phenomenon, social network analysis is useful for understanding firms (Polanyi 1944; Grabher 2006). Therefore, the firm can be considered a constellation of network relationships governed by social actors (Yeung 2005), whereby rather than being perceived as a mechanistic production function, the firm is perceived as a contested site for discursive and material constructions at various organizational and spatial scales. According to De Filippis (2001), social networks encompass hierarchies of power; otherwise, they would not be networks in the first place. Furthermore, there would be no incentive for strong actors to remain in a network if they did not disproportionately gain from the benefits of participating in the network (Lin et al. 2001; Christopherson and Clark 2007). So the issue is the degree to which hierarchic organizational structures exist within corporate networks and whether alternative organizational forms can also be found. Hymer (1972) assumed that the static, top-down hierarchy of his day would be perpetuated at the start of the 21st century; however, we have not moved far beyond his

Table 1

Comparison of the Rankings of Alderson and Beckfield and Taylor et al.

	Social Network Analysis		Interlocking Network Model		
City Rank	Outdegree Centrality	Indegree Centrality	Global Network Connectivity	Dominant Network Connectivity	Subordinate Network Connectivity
1	Tokyo	New York	London	London	Beijing
2	New York	London	New York	New York	Moscow
3	Paris	Paris	Hong Kong	Hong Kong	Zurich
4	London	Tokyo	Paris	Paris	Caracas
5	Dusseldorf	Los Angeles	Tokyo	Tokyo	Sao Paulo
6	Amsterdam	Chicago	Singapore	Frankfurt	Seoul
7	Zurich	Brussels	Chicago	Chicago	Prague
8	Munich	Amsterdam	Milan	Amsterdam	Shanghai
9	Osaka	Singapore	Los Angeles	Los Angeles	Brussels
10	San Francisco	Hong Kong	Madrid	Singapore	Beunos Aires

Sources: Alderson and Beckfield (2004) and Taylor et al. (2002)

simplistic projection of the hierarchical-organizational structure of the large multinationals onto geographic space, when a firm's organizational architecture today has become far more complex (Dicken and Malmberg 2001). In the late 20th century, new organizational forms emerged, such as strategic alliances and interfirm networks, that are fundamentally distinctive from the hierarchical control of the firm's activities through vertical integration (Yeung 2005).

P. J. Taylor, Hoyler, and Verbruggen (2008) postulated "central flow theory," which allows one to link horizontal spatial structures with nonlocal interactions. This theory would complement Christaller's (1933) "central place theory," which links vertical spatial structures with local interactions. The nature of the internal relationships between headquarters and subsidiaries and among subsidiaries is changing (Birkinshaw 1996; Birkinshaw and Morrison 1995; Ivarsson 1996; Taggart 1997) and, as a result, intracorporate competition among various units of a firm serves as a vital mechanism to redefine spatial divisions of labor and time-space configurations (Schoenberger 1997; Phelps and Fuller 2000), encapsulating the complex interrelations between "flow economies" and "territorial economies" (Yeung 1998, 229). Thus, the previously dominant vertical form of corporate organization has changed considerably (Chandler 1962, 1990) and, in many ways, its disintegrating (P. J. Taylor and Asheim 2001) as new economic innovations lead to intertwining vertical and horizontal connections (Koestler 1978; van der Knaap 2007; Wall 2009a), creating a "heterarchical" system (Hedlund 1986) in which firms become enmeshed in loosely coupled networks of interdependence, reciprocity, and unequal power relations (Grabher 1993, 2006; M. Taylor 1995, 1996).

A heterarchy has three aspects that distinguish it from the hierarchical model of corporate organization. First, resources and managerial capabilities are dispersed throughout the organization, instead of being located only at the top. Second, lateral relationships exist among subsidiaries in terms of products, people, and flows of knowledge. Third, activities are coordinated along multiple dimensions, typically geographically, by products, and by functions (Hedlund 1993, 1994). Hence, the multinational corporation has evolved from a comparatively simple set of unidimensionally and vertically controlled processes into a complex system of vertical and lateral intra- and interfirm relationships (Maskell 2001; Dunning and Lundan 2008). However, an organizational transformation to a more integrated network may be taking place (Bartlett and Ghoshal 1986); thus, we should be careful not to neglect entirely the primacy of the vertical, hierarchical dimension (Hedlund 1986; Koestler 1978). In addition, mutually exclusive categories of network structure arguably do not exist but instead overlap and interpenetrate to various degrees. Networks form complex combinations of overlapping, juxtaposed, and nested governance mechanisms (Grabher and Powell 2004). If hierarchy and heterarchy coexist, then what are their features? As is indicated in Figure 1, the topology of a hierarchical, vertically organized network would resemble the star-shaped structure on the left (Hannemann and Riddle 2005). Alternatively, a heterarchical, horizontally organized structure would resemble the "universal" network structure on the right, in which all actors are mutually connected (Todeva 2006).

Methodology

As was the case in the studies by P. J. Taylor and Alderson and Beckfield, we pursued an intercity network produced by firms' locational decisions. The data we compiled concerned the *Fortune* Global 100 multinationals, which accounted for 27 percent of the OECD revenue in 2005, indicating the economic importance of these firms. Next, the subsidiaries of these headquarters were extracted from the LexisNexis *Directory of*

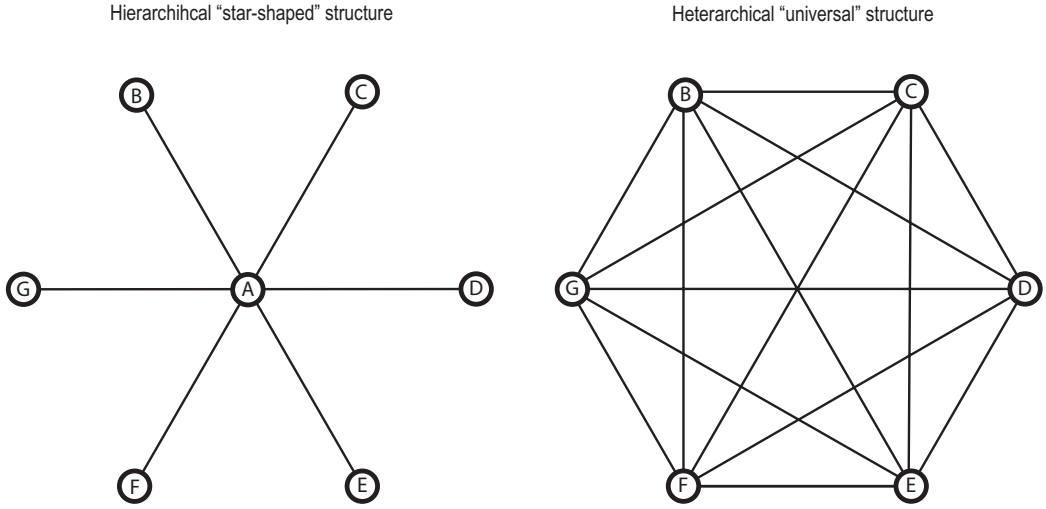
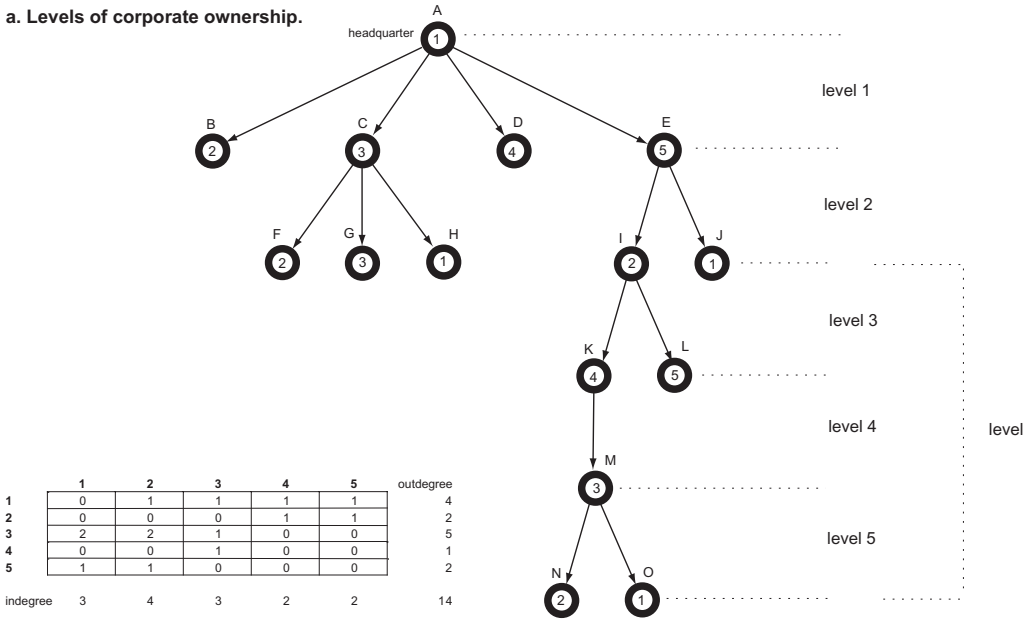


Figure 1. Simplified network diagrams to explain hierarchy and heterarchy.

Corporate Affiliations (2005). This database covers more than 180,000 of the most important headquarters in the world and their respective subsidiaries (see http://www.lexisnexis.com/dca) and also includes information on their industrial sectors and city locations. Another important aspect of these data is that they are classified into five levels of ownership (Figure 2a). At the first level, headquarter A owns shares in primary subsidiaries B, C, D, and E. At the second level, subsidiaries C and E, in turn, govern subsubsidiaries F–J. Firm I, at the third level, owns shares in firms K and L, and so forth. The lower the level, the more resource and production oriented these firms become. Firms at the top are generally more related to producer and consumer services or value-added manufacturing.

Next, the SIC code for each firm was identified to analyze both the entire network of all industrial sectors combined and the producer service network based on a single data set. Next, the location of each firm was identified at the city level, resulting in an adjacency matrix containing 9,243 corporate holdings in 2,245 unique cities. In Figure 2a, subsidiary levels 3, 4, and 5 were condensed into one level because these lower levels constitute a marginal proportion of the entire network. Figure 2b shows how the corporate organization in Figure 2a translates into a city $\times$ city network. Firms in Figure 2a are located in any of cities 1–5. For instance, firms B, F, I, and N are situated in city 2. The four centrality measures of outdegree, indegree, diagonal, and betweenness in the matrix (Figure 2d) are explained as follows. Outdegree relationships (corporate holdings) are a measure of ownership relationships that firms in a particular city have with firms in other cities and can be interpreted as the "power" of certain cities over others (Alderson and Beckfield 2004). For example, city 3 has the most influence over other cities because it ranks first in terms of outdegree centrality, with its strongest holdings in cities 1 and 2. Inversely, indegree relationships refer to the degree to which firms in particular cities are owned by firms in other cities. This is a measure of the "prestige" of a city (Alderson and Beckfield 2004); a city is prestigious because governing firms in other cities are dependent on a certain number of its firms. In Figure 2b, cities depend most on city 2, making it rank first in indegree centrality. Thus, the "directional" data we used to measure the direction of corporate ownership among cities clearly show that



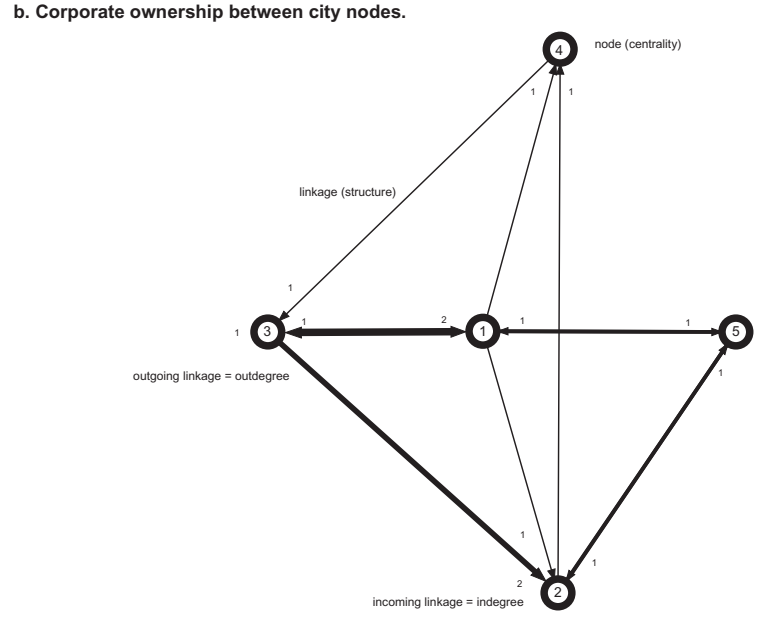


Figure 2. Corporate ownership.

hierarchical vertical relationships can exist (e.g., from city 3 to city 2) in addition to reciprocated horizontal relationships (e.g., between city 3 and 1).

Furthermore, a city can possess more than one ownership linkage to another city. For instance, city 3 has two ties to city 1. The diagonal relationships represent a measure of corporate "self-ties" within a city and show the extent to which a city is dependent on intercity and intracity ties. Finally, "betweenness" is unlike the other centrality measures because it measures the strategic position of a city in relation to other cities. The matrix

is "dichotomized" into unvalued relationships of either 0 or 1—the presence or absence of relationships, not the strength. In Figure 2b, cities 1 and 2 each have four unvalued ties to other cities and therefore rank highest in betweenness, followed by cities 3, 4, and 5. As Alderson and Beckfield (2006) discussed, betweenness measures the brokerage or strategic intermediacy of a city within a system of cities.[1] In addition, while the centrality measures are "nodal" measures of the network and concern aggregations of linkages, the structure of a network shows the strengths of the linkages between nodes. For instance, Figure 2b indicates that city 3 has the strongest ties. Conversely, city 4 is the most peripheral city of this network, with the weakest combined outdegree and indegree measures.

We used the network analysis software Ucinet/Netdraw (Borgatti, Everett, and Freeman 2002). The software revealed the essential nodes, linkages and core, and periphery zones of the data. Because this analysis disregarded geographic location, we used the GIS software MapInfo to map the spatial distribution of the network. Last, to measure how well the centrality and structure of the entire multinational network correspond to those just for producer services, we conducted a correlation analysis between the nodal and linkage strengths of these two networks.

Results

Centrality Within the Network of All Industrial Sectors

The results in Table 2(a–d) refer to the first part of the research question and cover ownership linkages of all industrial sectors combined. Table 2a shows the combined five levels of corporate holdings. The shaded columns include the purely intercity values of outdegree and indegree (ties between cities) and the intracity diagonal values (self-ties). Because it is debatable whether self-ties should be included in outdegree and indegree scores in measuring city connectivity, Table 2a also includes scores that do not include self-ties in the last two columns.

The outdegree column shows that New York has the largest number of corporate ownerships in firms that are located in other cities, followed by Paris, Tokyo, and London. Tokyo ranks similarly to P. J. Taylor, Catalano, and Walker's (2002) analysis. Of the 2,259 unique cities in our data set, only 17 percent of the cities have outdegree scores, and all are from developed countries, confirming Hymer's (1972) observation that corporate activity is concentrated in a limited number of cities that are close to capital markets. New York, Paris, London, and Tokyo together hold 25 percent of the corporate ownership of firms in other cities. In the lower-ranked cities—Zurich, Dusseldorf, Munich, and Amsterdam—
our analysis supports similar rankings as those found by Alderson and Beckfield (2004). The prominence of specialized cities like Palo Alto, California, and New Brunswick, New Jersey, also confirms Alderson and Beckfield's (2004) observation that headquarter functions are not necessarily concentrated in world cities and are instead often located in the city of the firm's origin.

Our top two cities, measured by indegree, exactly match Alderson and Beckfield's (2004) list, but we identified Singapore and Hong Kong as the third and fourth most

[1] Because of space constraints, we excluded the mathematical formulations of these measures. Those who are interested should see Alderson and Beckfield (2004, 288–25), Irwin and Hughes (1992), and Hannemann and Riddle (2005).

Table 2

Centrality Scores at Different Levels of Corporate Governance

a. All Industrial Sectors—Across All Five subsidiary Levels

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	New York	692	New York	165	New York	186	New York	878	New York	351
2	Paris	491	London	115	Tokyo	113	Paris	581	Tokyo	198
3	Tokyo	367	Singapore	101	Paris	90	Tokyo	480	Paris	182
4	London	326	Hong Kong	93	Dusseldorf	64	London	381	London	170
5	Zurich	293	Paris	92	Houston	63	Zurich	338	Houston	129
6	Dusseldorf	259	Tokyo	85	London	55	Dusseldorf	323	Brussels	123
7	Munich	253	Brussels	80	Zurich	45	Munich	278	Singapore	108
8	Palo Alto	218	Madrid	76	Brussels	43	Amsterdam	229	Hong Kong	102
9	Amsterdam	204	Milan	75	Atlanta	33	Palo Alto	219	Dusseldorf	94
10	Lausanne	191	Houston	66	Dearborn	28	Houston	197	Zurich	92
11	The Hague	165	Toronto	62	Amsterdam	25	Lausanne	197	Madrid	88
12	Irving	148	Mexico City	59	Munich	25	The Hague	170	Milan	82
13	New Brunswick	146	Buenos Aires	57	Omaha	18	New Brunswick	157	Amsterdam	74
14	Houston	134	Dublin	55	Turin	17	Brussels	152	Toronto	73
15	Ludwigshafen	131	Jakarta	50	Vienna	13	Irving	149	Mexico City	71
16	Frankfurt	116	Amsterdam	49	Stamford	13	Ludwigshafen	134	Atlanta	68
17	Brussels	109	Vienna	49	Madrid	12	Frankfurt	125	Vienna	62
18	Gerlingen	85	Bangkok	49	Mexico City	12	Stamford	92	Buenos Aires	62
19	Stamford	79	Frankfurt	48	Toronto	11	Gerlingen	85	Munich	59
20	Chicago	78	Zurich	47	Seoul	11	Detroit	84	Frankfurt	57
2,545		**7,783**		**7,783**		**1,460**		**9,243**		**9,243**

(Continued on next page)

Table 2

Centrality Scores at Different Levels of Corporate Governance (Continued)

b. All Industrial Sectors but Only Headquarter to First Subsidiary Level

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	New York	443	New York	53	New York	67	New York	510	New York	120
2	Zurich	205	Paris	42	Dusseldorf	56	Dusseldorf	238	London	72
3	Munich	202	Houston	41	London	35	Munich	215	Dusseldorf	70
4	Palo Alto	186	Tokyo	40	Brussels	33	Zurich	214	Brussels	66
5	Dusseldorf	182	Milan	40	Atlanta	27	Palo Alto	187	Houston	59
6	London	134	Frankfurt	38	Amsterdam	19	London	169	Milan	47
7	Paris	121	London	37	Dearborn	19	Paris	124	Amsterdam	46
8	The Hague	112	Madrid	36	Houston	18	New Brunswick	115	Paris	45
9	Irving	110	Singapore	34	Turin	14	The Hague	113	Frankfurt	40
10	New Brunswick	104	Mexico City	34	Munich	13	Irving	111	Tokyo	40
11	Amsterdam	91	Brussels	33	Vienna	11	Amsterdam	110	Vienna	40
12	Brussels	72	Toronto	29	Seoul	11	Brussels	105	Madrid	40
13	Frankfurt	67	Vienna	29	Omaha	11	Frankfurt	69	Singapore	38
14	Chicago	62	Zurich	28	New Brunswick	11	Chicago	64	Zurich	37
15	Lausanne	60	Amsterdam	27	Zurich	9	Houston	61	Atlanta	37
16	Gerlingen	51	Dublin	27	Wolfsburg	9	Lausanne	60	Toronto	36
17	Wolfsburg	50	Hong Kong	27	Detroit	8	Wolfsburg	59	Mexico City	34
18	Detroit	48	Hamburg	26	Milan	7	Detroit	56	Seoul	32
19	Calgary	44	Buenos Aires	26	Toronto	7	Atlanta	55	Munich	30
20	Houston	43	Bangkok	25	Schaumburg	7	Gerlingen	51	Bangkok	28
1,463		**3,412**		**3,412**		**564**		**3,976**		**3,976**

(Continued on next page)

Table 2

Centrality Scores at Different Levels of Corporate Governance (Continued)

c. All Industrial Sectors but Only First Subsidiary Level to Second Subsidiary Level

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	Paris	290	New York	65	New York	89	Paris	350	New York	154
2	Tokyo	177	Hong Kong	57	Paris	60	Tokyo	231	Paris	94
3	London	133	London	43	Tokyo	54	New York	217	Tokyo	78
4	New York	128	Singapore	40	Zurich	34	London	145	Hong Kong	57
5	Amsterdam	84	Paris	34	Houston	20	Zurich	106	London	55
6	Zurich	72	Brussels	30	London	12	Amsterdam	90	Zurich	48
7	Lausanne	59	Buenos Aires	26	Munich	11	Munich	60	Singapore	43
8	Dusseldorf	53	Tokyo	24	Brussels	10	Lausanne	59	Brussels	40
9	Ludwigshafen	52	Madrid	24	Stamford	10	Houston	58	Houston	33
10	Munich	49	Milan	24	Osaka	10	Dusseldorf	56	Buenos Aires	30
11	Edinburgh	40	Atlanta	20	Dearborn	9	Ludwigshafen	52	Madrid	29
12	Alpharetta	39	Dublin	18	Amsterdam	6	Edinburgh	45	Milan	24
13	Houston	38	Barcelona	17	Madrid	5	Brussels	42	Amsterdam	21
14	Frankfurt	38	Amsterdam	15	Auburn Hills	5	Frankfurt	42	Barcelona	21
15	Brussels	32	Toronto	15	Santiago	5	Dearborn	41	Munich	20
16	Dearborn	32	Melbourne	15	Edinburgh	5	Alpharetta	39	Atlanta	20
17	Southfield	27	Vienna	15	Richmond	5	Osaka	32	Dublin	18
18	Auburn Hills	26	Zurich	14	Utrecht	5	Auburn Hills	31	Melbourne	17
19	Detroit	25	Kawasaki	14	Buenos Aires	4	Stamford	29	Stamford	16
20	Osaka	22	Houston	13	Barcelona	4	Southfield	29	Toronto	16
1,166		**2,373**		**2,373**		**514**		**2,887**		**2,887**

(Continued on next page)

Table 2

Centrality Scores at Different Levels of Corporate Governance (Continued)

d. All Industrial Sectors but Only Second Subsidiary Level to Third Subsidiary Level

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	Tokyo	151	New York	47	Tokyo	59	Tokyo	210	Tokyo	80
2	New York	121	London	35	New York	30	New York	151	New York	77
3	Paris	80	Singapore	27	Paris	27	Paris	107	Paris	43
4	Lausanne	72	Tokyo	21	Houston	25	Houston	78	London	43
5	Stamford	60	Jakarta	20	Mexico City	12	Lausanne	78	Houston	37
6	London	59	Toronto	18	Hong Kong	9	London	67	Singapore	27
7	Cupertino	55	Brussels	17	Glendale	9	Stamford	63	Mexico City	24
8	Houston	53	Paris	16	London	8	Northfield	56	Toronto	21
9	Northfield	51	Madrid	16	Honolulu	8	Cupertino	56	Jakarta	21
10	New Brunswick	42	Bangkok	15	Culver City	8	Ludwigshafen	42	Madrid	19
11	Ludwigshafen	39	Shanghai	15	Hamburg	7	New Brunswick	42	Hong Kong	18
12	Irving	34	Chicago	14	Minneapolis	6	Portland	36	Brussels	17
13	Portland	33	Cleveland	14	Cincinnati	6	Irving	34	Sao Paulo	16
14	Osaka	32	Houston	12	Atlanta	6	Osaka	33	Bangkok	15
15	The Hague	32	Mexico city	12	Hartford	6	The Hague	33	Shanghai	15
16	Naperville	31	Sao Paulo	12	Lausanne	6	Omaha	31	Dusseldorf	14
17	Amsterdam	29	Los Angeles	11	Dusseldorf	5	Naperville	31	Chicago	14
18	Omaha	27	Markham	11	Wilmington	5	Dusseldorf	29	Cleveland	14
19	Irvine	26	Milan	11	Washington	5	Irvine	29	Hamburg	13
20	Palo Alto	25	Sydney	11	Northfield	5	Amsterdam	29	Los Angeles	12
1,070		**1,998**		**1,998**		**382**		**2,380**		**2,380**

ED = excluding the diagonal ID = including the diagonal

prestigious cities, similar to Godfrey and Zhou's (1999) and P. J. Taylor, Catalano and Walker's (2002) results, which showed that these two cities, along with capital cities in developing economies such as Mexico City, Buenos Aires, Jakarta, and Bangkok, have important subsidiary functions (see Table 2a). The indegree list includes a rich variety of cities from both developed and developing nations, supporting Hymer's (1972) prediction of a strong diffusion of industrialization to developing countries. It is also interesting that cities that Sassen (1994) once conceptualized as being "peripheral," such as Bangkok, Mexico City, and Buenos Aires have emerged as highly ranked world cities. Furthermore, our data support the view that important cities derive their status from what flows between them, rather than what remains fixed within them (Amin and Graham 1999; Allen 1999; Castells 1996). In terms of diagonal centrality, only 16 percent of the interactions proved to be intraurban (self-ties). Thus, the networks of firms are indeed capable of exercising control and power over firms at a distance (Yeung 2005, 316).

Tables 2b, 2c, and 2d are subnetworks of Table 2a. Table 2b shows linkages from corporate headquarters to first-order subsidiaries. Table 2c represents first subsidiary to second subsidiary holdings, and Table 2d represents the remaining linkages of the combined third-, fourth- and fifth levels. The first level accounts for 44 percent of all connections, followed by the second level with 30 percent and the remaining levels with 26 percent, suggesting that corporate governance is the strongest toward the top of the system, presumably because higher-end functions need a stronger degree of control than do the more production-oriented functions downstream. At the first level, the strongest outdegree cities are New York, Zurich, and Munich; London and Paris play weaker roles at the first level than in the aggregate. Tokyo's outdegree drops significantly from the 3rd to the 24th position; however, as Tables 2c and 2d show, Tokyo's outdegree rises to the top position at more production-oriented levels.

Unlike in P. J. Taylor, Catalano and Walker's (2002) results, and similar to Alderson and Beckfield's (2004), our analysis shows that Hong Kong and Singapore do not play strong roles in terms of outdegree at any corporate level. Even if we limited our analysis only to producer services, as did Taylor, we would find that these two cities do not play significant roles in terms of outdegree centrality. In terms of indegree scores, at the first level (Table 2b), both Singapore and Hong Kong drop significantly in the rankings, which indicates that their strengths as subsidiary cities are weaker at this level of corporate ownership.

As is shown in Table 2c, the positions of Hong Kong and Singapore rise significantly within lower subsidiary levels. New York, London, Paris, and Tokyo dominate the list of cities with strong self-ties, making these global cities equally strong in intracity as in intercity ties. Our analysis also shows a strong correlation between a city's global and local networks. Last, our measure of betweenness (Table 3, left) shows that New York, Paris, Tokyo, Dusseldorf, and London are the most strategic for corporate interactions among the majority of the world's cities, making these cities prime mediators or brokers of global corporate ownership relationships.

Structure Within the Network of All Industrial Sectors

In aggregating all levels (Figure 3a), we found that two patterns of network topology and geography emerge. Topologically, we observed a hybrid structure between hierarchical and heterarchical interdependence. The star-shaped structures, in which central cities (e.g., New York, Paris, and London) exercise corporate governance over others clearly exemplify Hymer's (1972) conceptualization of hierarchical, vertically organized interaction. The triangulated structures connecting cities (e.g., the London, Hong Kong, and

Table 3

Betweeness Centrality

	City	ALL sectors	City	APS sectors
1	New York	28,7	New York	12,0
2	Paris	13,4	Paris	12,0
3	Tokyo	11,7	London	5,6
4	Dusseldorf	9,4	Houston	2,6
5	London	7,3	Toronto	2,0
6	Munich	7,2	Dusseldorf	2,0
7	Houston	7,1	Tokyo	2,0
8	Palo Alto	6,4	Amsterdam	1,9
9	Zurich	5,1	Chicago	1,9
10	Irving	4,5	Omaha	1,7
11	Amsterdam	4,2	Zurich	1,7
12	Chicago	3,8	Munich	1,5
13	The Hague	3,6	Brussels	1,4
14	Lausanne	3,5	Auburn Hills	1,2
15	Brussels	3,2	Montreal	1,2
16	New Brunswick	3,0	Frankfurt	1,2
17	Calgary	2,8	The Hague	1,1
18	Detroit	2,8	Los Angeles	1,1
19	Cincinnati	2,7	Mississauga	1,1
20	Ludwigshafen	2,7	Atlanta	0,9
21	Gerlingen	2,6	Philadelphia	0,9
22	Philadelphia	2,4	Singapore	0,9
23	Northfield	2,3	Madrid	0,9
24	Greenwich	2,0	Minneapolis	0,9
25	Toronto	1,9	Edina	0,9
26	Portland	1,8	Louisville	0,9
27	Atlanta	1,8	Vienna	0,8
28	Auburn Hills	1,8	Calgary	0,8
29	Stamford	1,7	Palo Alto	0,7
30	Omaha	1,7	Richmond	0,7

Singapore triad) represent heterarchical interactions among cities (Hedlund 1986). Furthermore, Singapore and Hong Kong not only are part of London's network but also share positions in other networks. For instance, Singapore forms part of Tokyo's and Zurich's network. It is also interesting that New York and Tokyo are essentially connected to cities within their proximate regions.

In the subnetwork (Figure 3b) that represents corporate level 1, we see the primary linkage between New York and London, confirming P. J. Taylor et al.'s (2009) statement that this city pair is the "global cities dyad par excellence." Furthermore, unlike New York, London is essentially connected to other transnational cities. Notably, Paris plays a moderate role at this level of interaction. It is also evident in the outdegree and indegree scores that Singapore and Hong Kong do not play important roles at the top of the corporate network. Zurich, Munich, Dusseldorf, and Milan form important European centers, and Tokyo essentially connects to Taipei and Bangkok.

At level 2 (Figure 3c), Paris, Tokyo, London, and New York prove to be important central cities, revealing both hierarchical "hub-and-spoke" structures and heterarchical, triangulated structures. Whereas Paris was insignificant at level 1, it is the primary city at level 2, with its strongest links to Brussels, New York, and London. It is interesting that

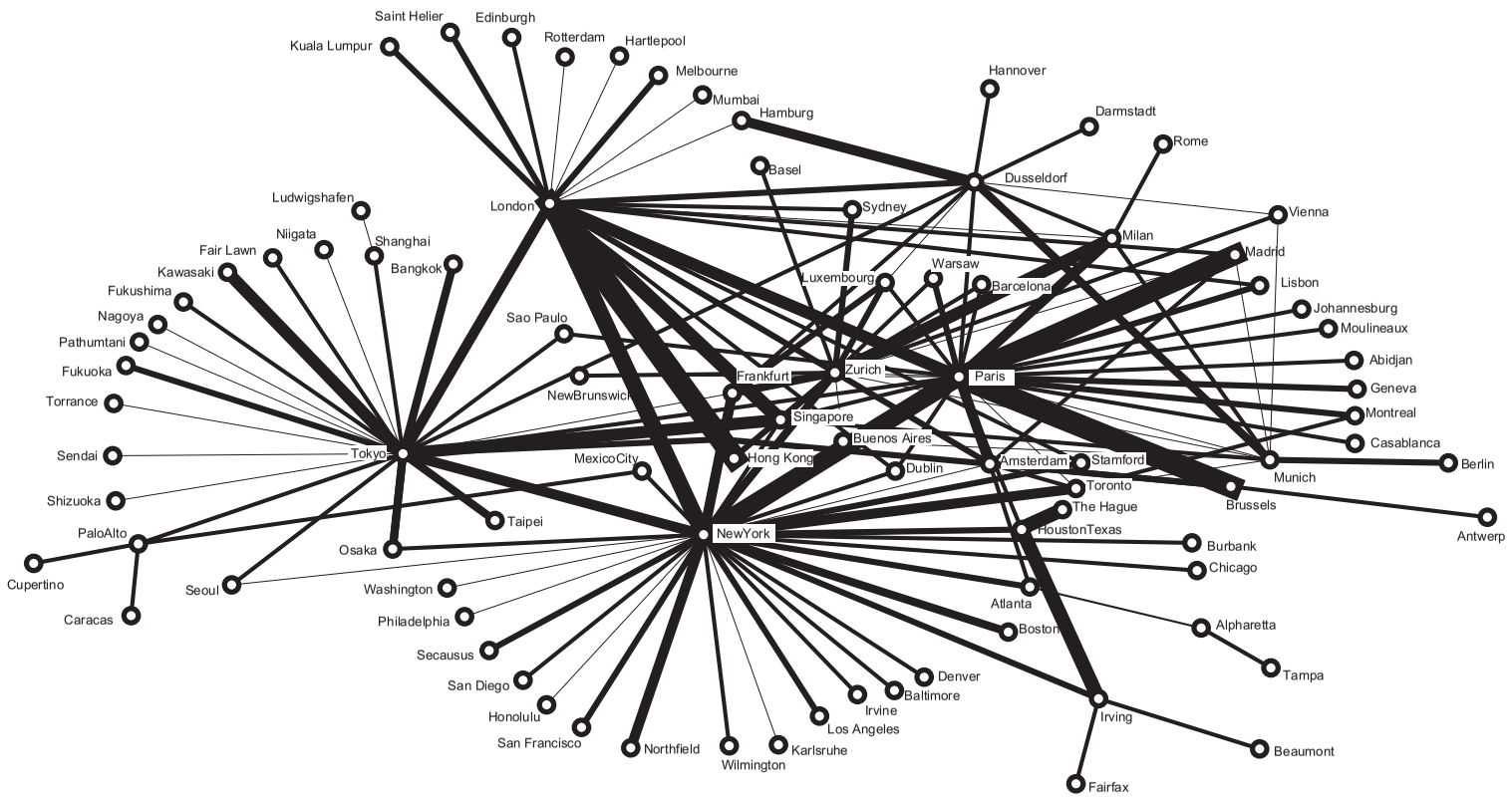


Figure 3a. All industries—all headquarter to subsidiaries (levels 1–5).

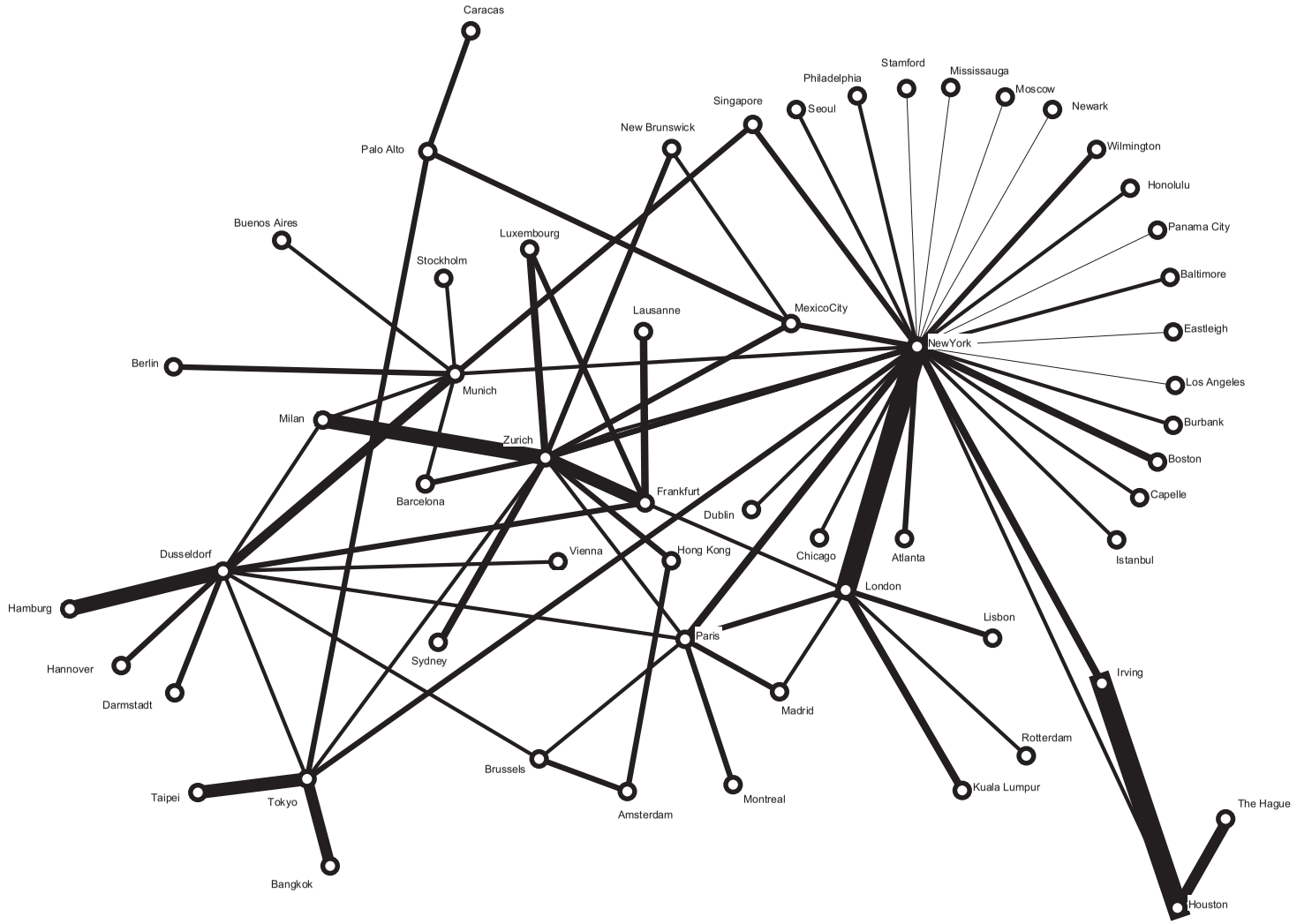


Figure 3b. All industries—headquarters to first subsidiaries (level 1).

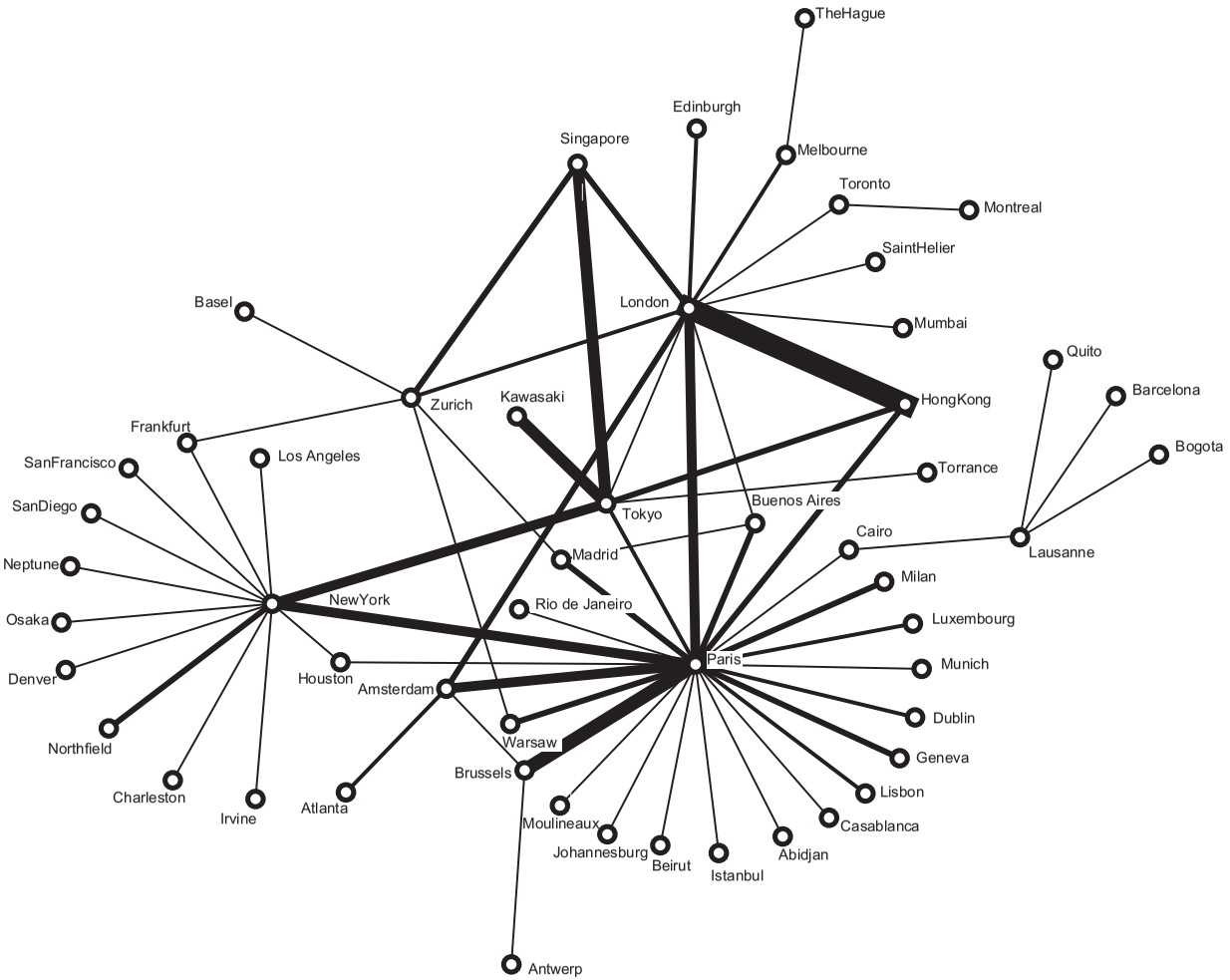


Figure 3c. All industries—first subsidiaries to second subsidiaries (level 2).

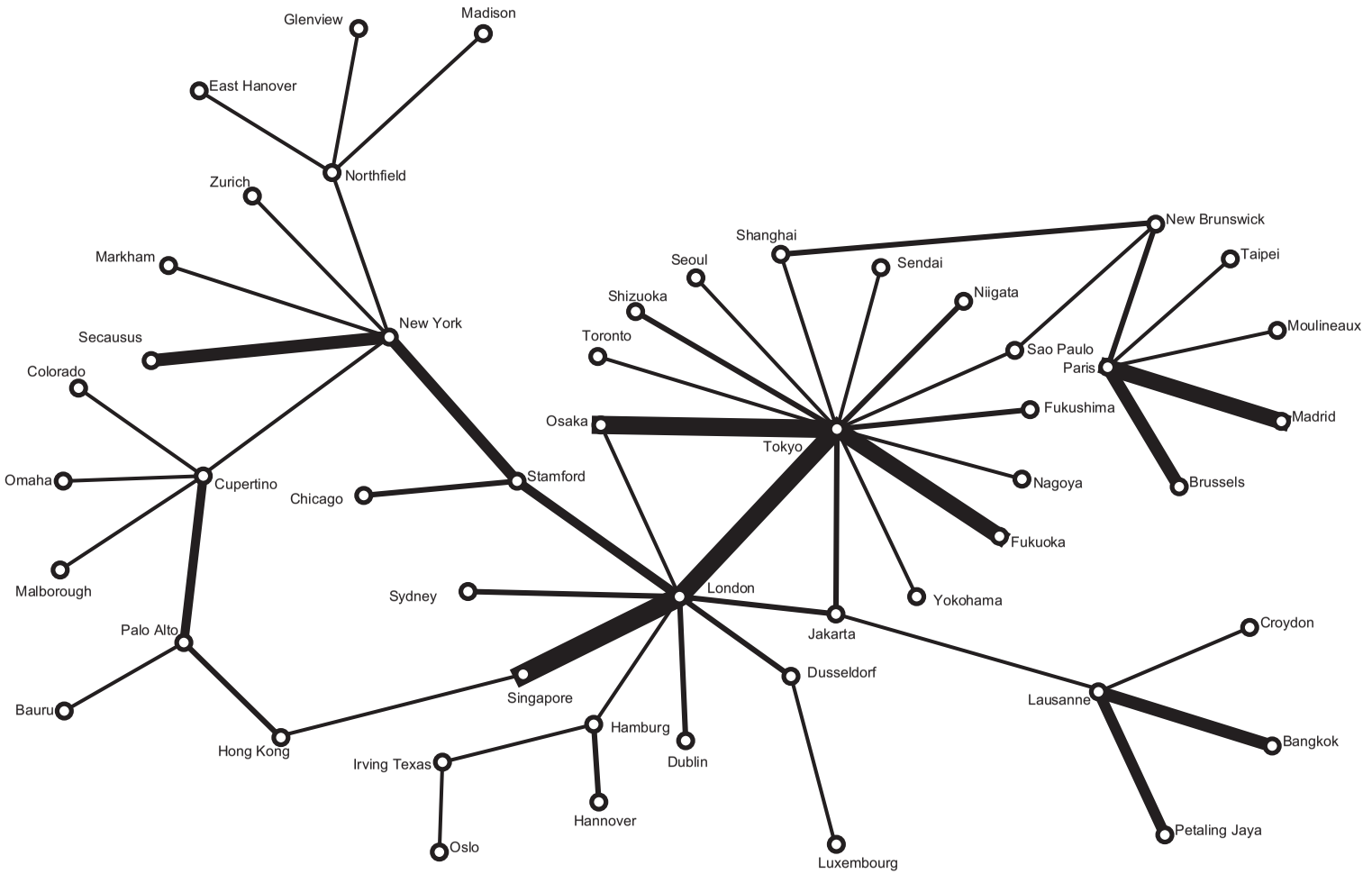


Figure 3d. All industries—second subsidiaries to remaining subsidiaries (level 3–5).

Hong Kong and Singapore play important roles at this level. At level 3, the last network of this series (Figure 3d), the importance of Tokyo, New York, London, and Paris is evident, but heterarchical characteristics are weak. Tokyo is strongly connected to London and an array of proximate Japanese and Asian cities. It is clear at this level that Tokyo performs a strong national and regional function within Southeast Asia. In this light, the role of the Japanese integrated trading companies, called "Sogo Shosha"[2] (Young 1979; Edgington and Haga 1998), is less transnational and more nationally oriented than expected (Hill and Kim 2001), which raises the question of whether Tokyo can be considered a world city (see also Friedmann 2001; Sassen 2001b; Hill and Kim 2000).

The corporate networks among cities were mapped using GIS (see Figure 4). The white dots depict the presence of firms within cities and are scaled according to the sum of each firm's indegree and outdegree. The black lines illustrate the aggregate corporate shareholdings among cities of at least five links, while the gray lines show ties with fewer than five links. The supraregional East-West triad (Friedmann 1986; Carroll 2007) among North America, Europe, and Pacific Asia is clearly evident. For instance, 70 percent of Europe's ownership ties are with the rest of the world, and only 30 percent take place within the European region. In the case of North America, 65 percent of its connections are global. These results verify that there is indeed a strong coupling of regions to global production networks (Coe et al. 2004). In addition, approximately 30 percent of the total connections are localized, presumably reflecting the interdependencies of geographic agglomeration achieved through territorial embeddedness (e.g. Storper and Salais 1997; Whitley 1999; Feldman 2000; Hall and Soskice 2001). Conversely, the fact that roughly 70 percent of the ties operate at a distance cautions against overemphasizing local and regional embeddedness (see Coe et al. 2004; Dicken et al. 2001; Henderson et al. 2002, Bathelt, Malmberg, and Maskell 2002). The southern hemisphere linkages are mainly to Commonwealth countries (see Alderson and Beckfield 2004, 835) and South America. Africa is primarily bound through Johannesburg, Abidjan, Lagos, and Cairo, but the relative share of connectivity to this continent is sparse (1 percent of the total). The gray lines indicate frequent but weak interregional activity. Also, the prominence of trans-Atlantic interaction is clear.

We also examined intra- versus international ties specifically for New York, Paris, London, and Tokyo (see Table 4). The top two tables show outdegree and indegree scores for all industrial sectors combined. New York is essentially connected to U.S. cities (59 percent outdegree and 74 percent indegree to U.S. cities), and its transnational ties are sparse, making New York's world "cityness" questionable. However, the immense scale of the United States should be taken into account, since the size of its regional network roughly equals that of all European countries combined (see Figure 4). Tokyo ranks second as the most intranational city (47 percent outdegree and 63 percent indegree to Japan), emphasizing again that Japanese Shogo Shoshas are more nationally oriented than expected (Hill and Kim 2001). Paris is ranked the third most nationally oriented city. However, it holds the highest share of ownership linkages to unique cities (87 percent), making it the most integrated city of the four. In terms of outdegree and indegree, London is the most "global" of the cities because it is primarily connected to other countries.

[2] Sogo Shosha refers to a specific type of Japanese firm: the general trading company, which is a complex agglomeration of diversified firms.

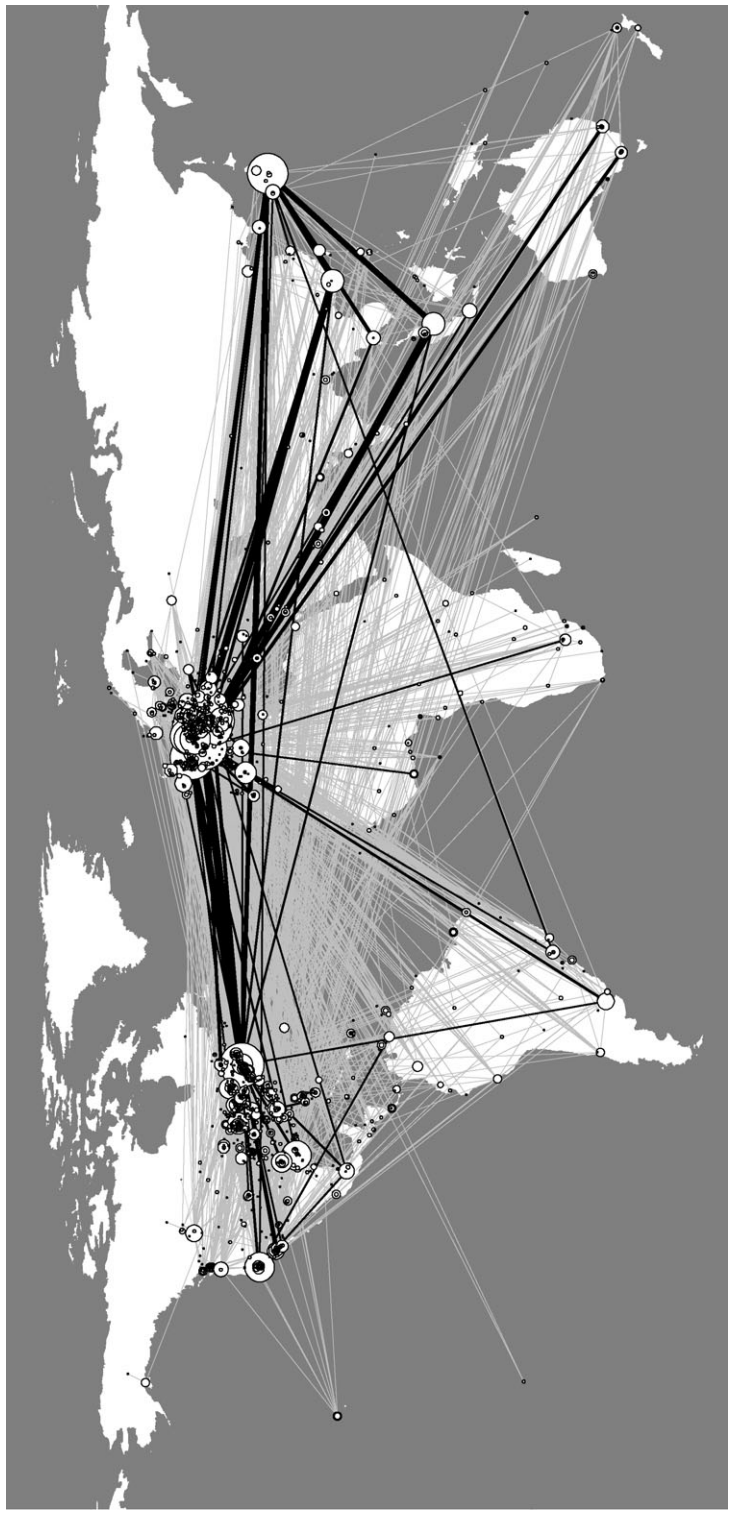


Figure 4. Geographic information system map of the all-industries multinational network.

Table 4

Share of Outdegree and Indegree of Four Core Cities to Various Nations

Top 5	City	Country	Links	%	City	Country	Links	%	City	Country	Links	%	City	Country	Links	%
							All industrial sectors outdegree									
1	New York	United States	406	59	Paris	France	122	21	London	Canada	64	17	Tokyo	Japan	224	47
2	New York	Canada	43	6	Paris	United States	69	12	London	United Kingdom	45	12	Tokyo	United States	71	15
3	New York	Germany	25	4	Paris	Spain	34	6	London	China	24	6	Tokyo	China	27	6
4	New York	United Kingdom	18	3	Paris	Canada	33	6	London	United States	22	6	Tokyo	Canada	21	4
5	New York	Switzerland	10	1	Paris	Belgium	27	5	London	Germany	19	5	Tokyo	Thailand	13	3
Total links			**692**				**581**				**381**				**480**	
Destinations			**82**				**87**				**66**				**36**	
							All industrial sectors indegree									
1	New York	United States	260	74	Paris	France	97	52	London	United Kingdom	61	36	Tokyo	Japan	124	63
2	New York	Germany	20	6	Paris	United States	28	15	London	United States	39	23	Tokyo	United States	26	13
3	New York	France	20	6	Paris	Germany	17	9	London	Japan	16	9	Tokyo	Germany	18	9
4	New York	Japan	16	5	Paris	The Netherlands	16	9	London	France	13	8	Tokyo	United Kingdom	11	6
5	New York	United Kingdom	12	3	Paris	United Kingdom	8	4	London	Germany	10	6	Tokyo	France	7	4
Total links			**351**				**187**				**170**				**198**	
Destinations			**13**				**12**				**15**				**9**	
							Advanced producer services outdegree									
1	New York	United States	293	65	Paris	France	35	14	London	Canada	44	18	Tokyo	Japan	47	47
2	New York	Canada	30	7	Paris	United States	34	14	London	United Kingdom	34	14	Tokyo	China	13	13
3	New York	Germany	19	4	Paris	Germany	15	6	London	China	21	9	Tokyo	Canada	6	6
4	New York	Switzerland	8	2	Paris	Canada	14	6	London	Singapore	16	7	Tokyo	Indonesia	5	5
5	New York	Japan	5	1	Paris	United Kingdom	12	5	London	United States	16	7	Tokyo	Singapore	4	4
Total links			**453**				**247**				**244**				**100**	
Destinations			**60**				**66**				**49**				**21**	
							Advanced producer services indegree									
1	New York	United States	112	71	Paris	France	35	58	London	United Kingdom	44	42	Tokyo	Japan	29	63
2	New York	Germany	12	8	Paris	United Kingdom	6	10	London	United States	25	24	Tokyo	Germany	6	13
3	New York	France	11	7	Paris	Belgium	5	8	London	Japan	6	6	Tokyo	United Kingdom	4	9
4	New York	United Kingdom	8	5	Paris	Switzerland	4	7	London	Germany	6	6	Tokyo	The Netherlands	3	7
5	New York	Switzerland	8	5	Paris	Germany	4	7	London	France	6	6	Tokyo	Switzerland	2	4
Total links			**157**				**60**				**106**				**46**	
Destinations			**11**				**9**				**12**				**7**	

Centrality Within the Network of the Advanced Producer Service Sector

Table 5a shows the combined five levels of producer service corporate holdings. In the outdegree column, New York, Paris, and London head the list, followed by a secondary set of cites: Zurich, Frankfurt, The Hague, and Amsterdam. Tokyo plays a more marginal role within producer services than in total industries, making Tokyo arguably a production-oriented city. The absence of Hong Kong and the insignificance of Singapore (30th) suggest that these cities do not have a strong presence of corporate headquarters. In terms of indegree (subsidiaries), however, these cities rank 3rd and 4th, respectively, and are governed by headquarters specifically in London (see Figure 5a). The highest-ranked cities in terms of outdegree are located in developed countries, whereas the highest-ranked cities in terms of indegree are located in both developing and developed nations. With respect to the diagonal (self-ties), 18 percent of the service links are self-ties.

With respect to sublevels of corporate holdings for advanced producer services (Table 5b–5d), level 1 (Table 5b) claims 45 percent of all connectivity, indicating that the majority of corporate governance exists at this top level. At lower levels, the connectivities weaken; level 2 (Table 5c) claims 34 percent of all service connectivity, and levels 3–5 (Table 5d) claim 21 percent. New York, London, The Hague, and Paris rank the highest for level 1 connectivity (Table 5b). New York is three times stronger than London and the other cities in terms of outdegree scores. This finding differs from P. J. Taylor, Catalano, and Walker's (2002) findings (see Table 1), in which London ranked above New York. Also striking is Tokyo's lack of prominence in outdegree scores at this level, again contradicting Taylor et al.'s findings, in which Tokyo is ranked fourth in connectivity. Furthermore, unlike in Taylor et al.'s findings, Hong Kong and Singapore are not prominent in our results. In terms of indegree scores (Table 5b), New York, London, Paris, and Toronto are the leading cities. Together with Singapore and Mexico City, Tokyo and Hong Kong are significant in terms of producer service subsidiaries.

At a lower level (Table 5c), Tokyo ranks high. Paris is the primary city and is at least 1.5 times stronger than London at this level. Hong Kong rises to first place of indegree scores, followed by London, Singapore, and New York. Furthermore, Paris and Tokyo are less prestigious at this level. A sub-Saharan African city (Johannesburg) plays a moderate role. At the lowest level (Table 5d), the same cities continue to top the outdegree list. On the indegree side, cities like Jakarta, Bangkok, and Shanghai rank high, holding subregional subsidiary offices in this sector. Betweenness centrality (Table 3, right) reveals that New York, Paris, London, Houston, and Toronto are the most strategic brokers within the total producer service system. Furthermore, compared to the results for all industrial sectors combined, Singapore holds an important strategic position for advanced producer services.

Structure Within the Network of the Advanced Producer Service Sector

The structural characteristics of the advanced producer service sector (Figure 5a–5d) that were revealed in our analysis suggest, for one, that hierarchical and heterarchical structures are evident at the aggregate level, in the star-shaped and triangulated structures of New York, Paris, London, and Zurich (see Figure 5a). Hong Kong and Singapore play central roles within this network. Whereas New York is strongly connected to London and Paris, Paris and London are weakly connected. At the first level of corporate ownerships (Figure 5b), New York claims the strongest position. The strongest dyad is between New York and London and is strongly connected to Frankfurt, Paris, and Boston. Heterarchical structures dissipate in the lower corporate levels (Figure 5c), and are instead dominated

Table 5

Centrality Scores at Different Levels of Corporate Governance

a. Advanced Producer Service Sector—Across All Five Subsidiary Levels

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	New York	368	New York	72	New York	85	New York	453	New York	157
2	Paris	218	London	66	London	40	Paris	247	London	106
3	London	204	Singapore	53	Paris	29	London	244	Paris	68
4	Zurich	116	Hong Kong	52	Atlanta	29	Zurich	143	Singapore	60
5	Frankfurt	89	Paris	39	Zurich	27	Amsterdam	102	Tokyo	57
6	The Hague	88	Tokyo	31	Tokyo	26	Tokyo	100	Hong Kong	57
7	Amsterdam	87	Milan	29	Brussels	26	Frankfurt	92	Zurich	52
8	Tokyo	74	Amsterdam	28	Dusseldorf	24	The Hague	89	Brussels	49
9	Brussels	58	Toronto	27	Amsterdam	15	Brussels	84	Amsterdam	43
10	Palo Alto	56	Zurich	25	Turin	10	Dusseldorf	75	Atlanta	43
11	Lausanne	54	Bangkok	25	Houston	9	Lausanne	59	Dusseldorf	34
12	Dusseldorf	51	Brussels	23	Wolfsburg	9	Palo Alto	57	Toronto	34
13	Munich	46	Madrid	23	Mexico City	8	Houston	50	Houston	31
14	Chicago	43	Houston	22	Seoul	8	Atlanta	48	Milan	31
15	Houston	41	Jakarta	21	Honolulu	8	Munich	48	Madrid	30
16	Omaha	35	Mexico City	20	Culver City	8	Chicago	46	Mexico City	28
17	Edinburgh	30	Frankfurt	19	Singapore	7	Omaha	42	Bangkok	26
18	Wolfsburg	26	Dublin	19	Toronto	7	Wolfsburg	35	Seoul	24
19	Dallas	24	Chicago	18	Madrid	7	Edinburgh	33	Jakarta	23
20	Northfield	23	Sao Paulo	17	Omaha	7	Osaka	30	Frankfurt	22
1,143		**2,708**		**2,708**		**604**		**3,312**		**3,312**

(Continued on next page)

Table 5

Centrality Scores at Different Levels of Corporate Governance (Continued)

b. Advanced Producer Service Sector but Only Headquarter to First Subsidiary Level

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	New York	267	New York	36	New York	28	New York	295	New York	64
2	London	84	London	25	Atlanta	25	London	107	London	48
3	The Hague	62	Paris	18	London	23	The Hague	62	Atlanta	29
4	Paris	59	Toronto	16	Brussels	19	Paris	61	Amsterdam	27
5	Palo Alto	55	Mexico City	16	Dusseldorf	17	Brussels	59	Brussels	24
6	Zurich	52	Singapore	15	Amsterdam	13	Amsterdam	56	Dusseldorf	24
7	Frankfurt	52	Houston	15	Wolfsburg	9	Palo Alto	56	Paris	20
8	Amsterdam	43	Tokyo	15	Seoul	8	Zurich	54	Toronto	20
9	Brussels	40	Zurich	14	Turin	7	Frankfurt	52	Singapore	19
10	Dusseldorf	34	Amsterdam	14	Vienna	6	Dusseldorf	51	Seoul	19
11	Chicago	32	Frankfurt	13	Luxembourg	5	Atlanta	43	Zurich	16
12	Munich	31	Milan	13	Saint Louis	5	Chicago	33	Houston	16
13	Wolfsburg	20	Bangkok	12	Toronto	4	Munich	32	Mexico City	16
14	Chesterbrook	20	Kuala Lumpur	12	Singapore	4	Wolfsburg	29	Milan	15
15	Philadelphia	20	Madrid	12	Aachen	4	Chesterbrook	22	Tokyo	15
16	Atlanta	18	Seoul	11	Dearborn	4	Philadelphia	20	Frankfurt	13
17	Calgary	14	Hong Kong	11	Calgary	3	Aachen	17	Bangkok	13
18	Toyota	14	Athens	10	Nicosia	3	Calgary	17	Kuala Lumpur	12
19	Aachen	13	Taipei	9	Santa Monica	3	Singapore	15	Madrid	12
20	Saint Paul	13	Budapest	9	Des Moines	3	Toyota	15	Luxembourg	11
663		**1,204**		**1,204**		**249**		**1,453**		**1,453**

(Continued on next page)

Table 5

Centrality Scores at Different Levels of Corporate Governance (Continued)

c. Advanced Producer Service Sector but Only First Subsidiary Level to Second Subsidiary Level

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	Paris	134	Hong Kong	41	New York	37	Paris	154	New York	54
2	London	84	London	23	Zurich	23	New York	100	Hong Kong	41
3	New York	63	Singapore	21	Paris	20	London	93	Paris	32
4	Zurich	52	New York	17	Tokyo	14	Zurich	75	London	32
5	Tokyo	38	Brussels	13	London	9	Tokyo	52	Zurich	31
6	Amsterdam	34	Paris	12	Brussels	7	Amsterdam	36	Tokyo	24
7	Frankfurt	30	Tokyo	10	Osaka	7	Edinburgh	33	Singapore	24
8	Edinburgh	30	Melbourne	10	Stamford	5	Frankfurt	30	Brussels	20
9	Brussels	16	Buenos Aires	10	Buenos Aires	4	Brussels	23	Buenos Aires	14
10	Ludwigshafen	16	Atlanta	10	Madrid	4	Osaka	17	Amsterdam	11
11	Munich	15	Amsterdam	9	Louisville	4	Dearborn	17	Madrid	11
12	Dearborn	14	Milan	9	Utrecht	4	Munich	16	Melbourne	10
13	Cincinnati	14	Zurich	8	Evansville	4	Ludwigshafen	16	Barcelona	10
14	Lausanne	14	Barcelona	8	Singapore	3	Cincinnati	14	Atlanta	10
15	Chicago	11	Toronto	7	Houston	3	Lausanne	14	Houston	9
16	Hamilton	11	Madrid	7	Johannesburg	3	Chicago	13	Johannesburg	9
17	Auburn Hills	11	Geneva	7	Los Angeles	3	Hamilton	13	Saint Helier	9
18	Osaka	10	Luxembourg	7	Edinburgh	3	Stamford	12	Milan	9
19	Dusseldorf	10	Saint Helier	7	Dearborn	3	Dusseldorf	12	Toronto	8
20	Omaha	10	Dublin	7	Dulles	3	Omaha	12	Osaka	7
546		**914**		**914**		**211**		**1,125**		**1,125**

(Continued on next page)

Table 5

Centrality Scores at Different Levels of Corporate Governance (Continued)

d. Advanced Producer Service Sector but Only Second Subsidiary Level to Third Subsidiary Level

	City	OutDegree (ED)	City	InDegree (ED)	City	Diagonal	City	OutDegree (ID)	City	InDegree (ID)
1	New York	38	New York	19	New York	20	New York	58	New York	39
2	London	36	London	18	Tokyo	12	Tokyo	45	London	26
3	Tokyo	33	Singapore	17	London	8	London	44	Tokyo	18
4	Lausanne	32	Paris	9	Mexico City	8	Lausanne	37	Singapore	17
5	Paris	25	Jakarta	9	Honolulu	8	Paris	32	Paris	16
6	Houston	25	Bangkok	9	Paris	7	Houston	30	Mexico City	10
7	Omaha	24	Milan	7	Culver City	7	Omaha	28	Jakarta	10
8	Dallas	24	Tokyo	6	Dusseldorf	5	Dallas	25	Bangkok	9
9	Northfield	20	Chicago	6	Wilmington	5	Northfield	21	Honolulu	8
10	The Hague	19	Shanghai	6	Houston	5	The Hague	20	Madrid	7
11	Providence	17	Amsterdam	5	Lausanne	5	Providence	20	Dusseldorf	7
12	Cupertino	15	Brussels	5	Hong Kong	5	Boston	16	Culver City	7
13	Boston	14	Boston	4	Omaha	4	Cupertino	15	Charlotte	7
14	Osaka	13	Madrid	4	Atlanta	4	Zurich	14	Wilmington	7
15	Zurich	12	Toronto	4	Madrid	3	Osaka	13	Sao Paulo	7
16	Madrid	10	Charlotte	4	Charlotte	3	Madrid	13	Milan	7
17	Amsterdam	10	Sao Paulo	4	Sao Paulo	3	Dusseldorf	12	Houston	6
18	Dearborn	8	Burlington	4	Providence	3	Hong Kong	11	Boston	6
19	Dusseldorf	7	Munich	4	Frankfurt	3	Amsterdam	10	Toronto	6
20	Toronto	7	San Diego	4	Bentonville	3	Frankfurt	10	Chicago	6
429		**590**		**590**		**144**		**734**		**734**

ED = excluding the diagonal; ID = including the diagonal

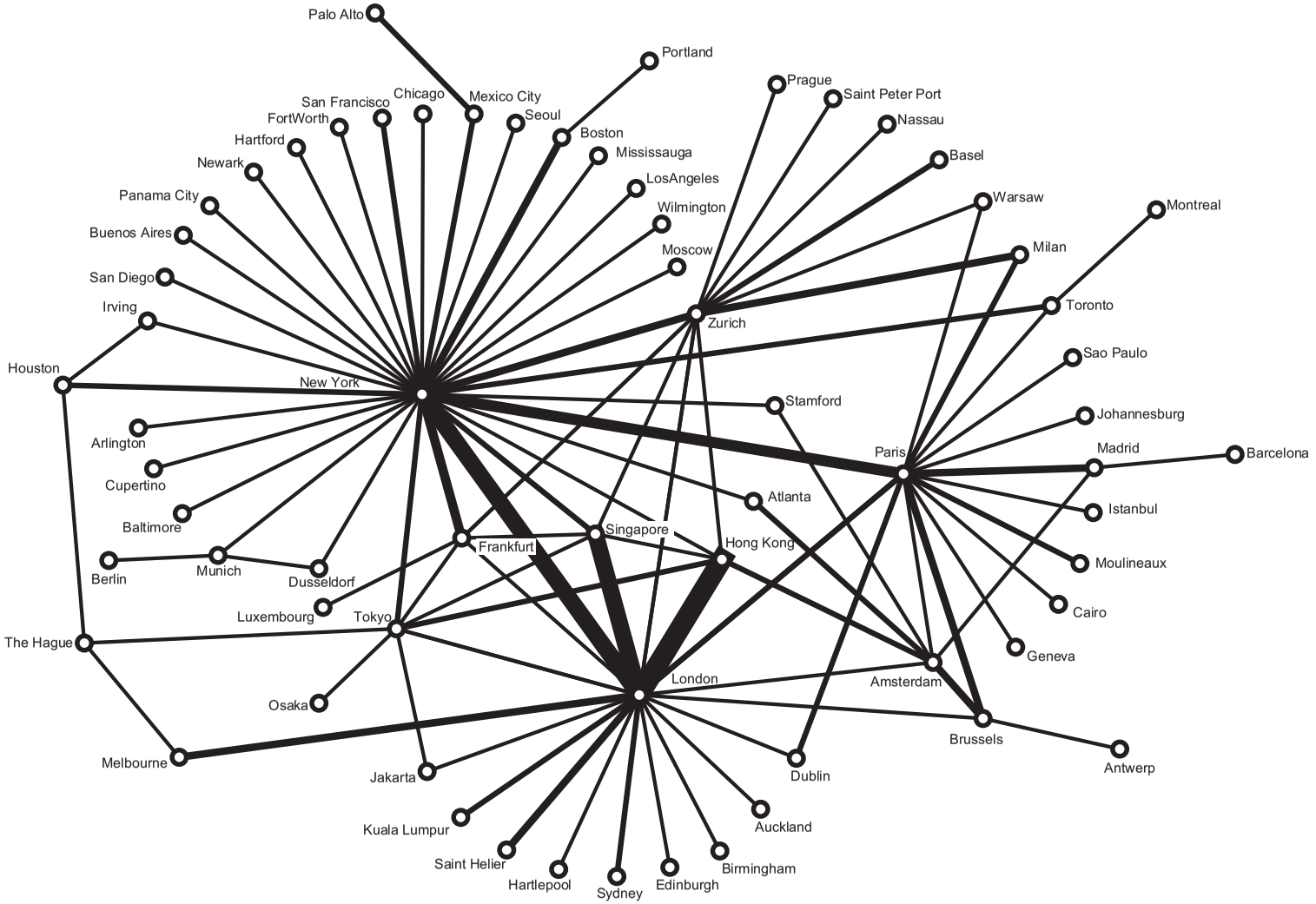


Figure 5a. Advanced producer services—all headquarters to subsidiaries (levels 1–5).

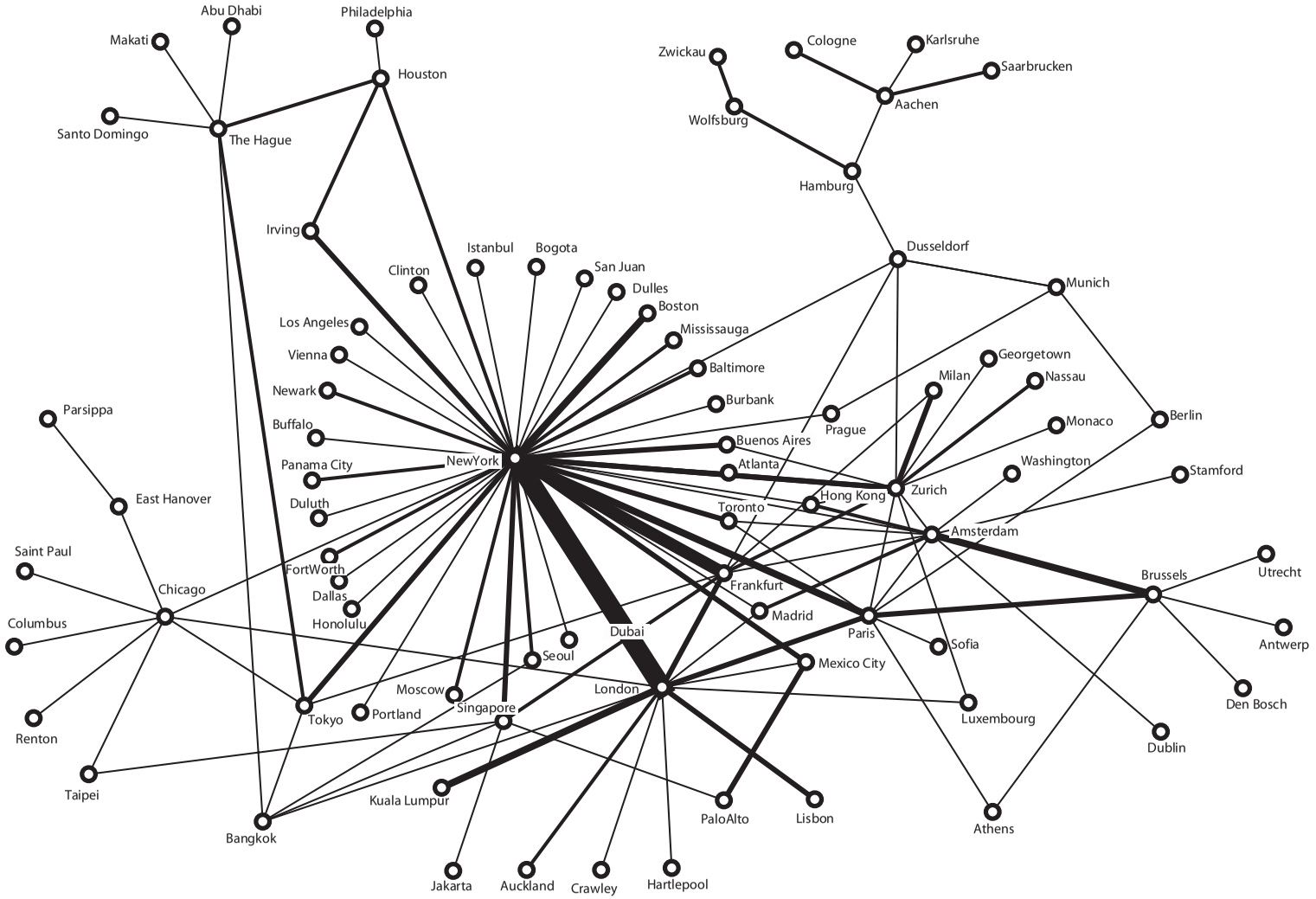


Figure 5b. Advanced producer services—headquarters to first subsidiaries (level 1).

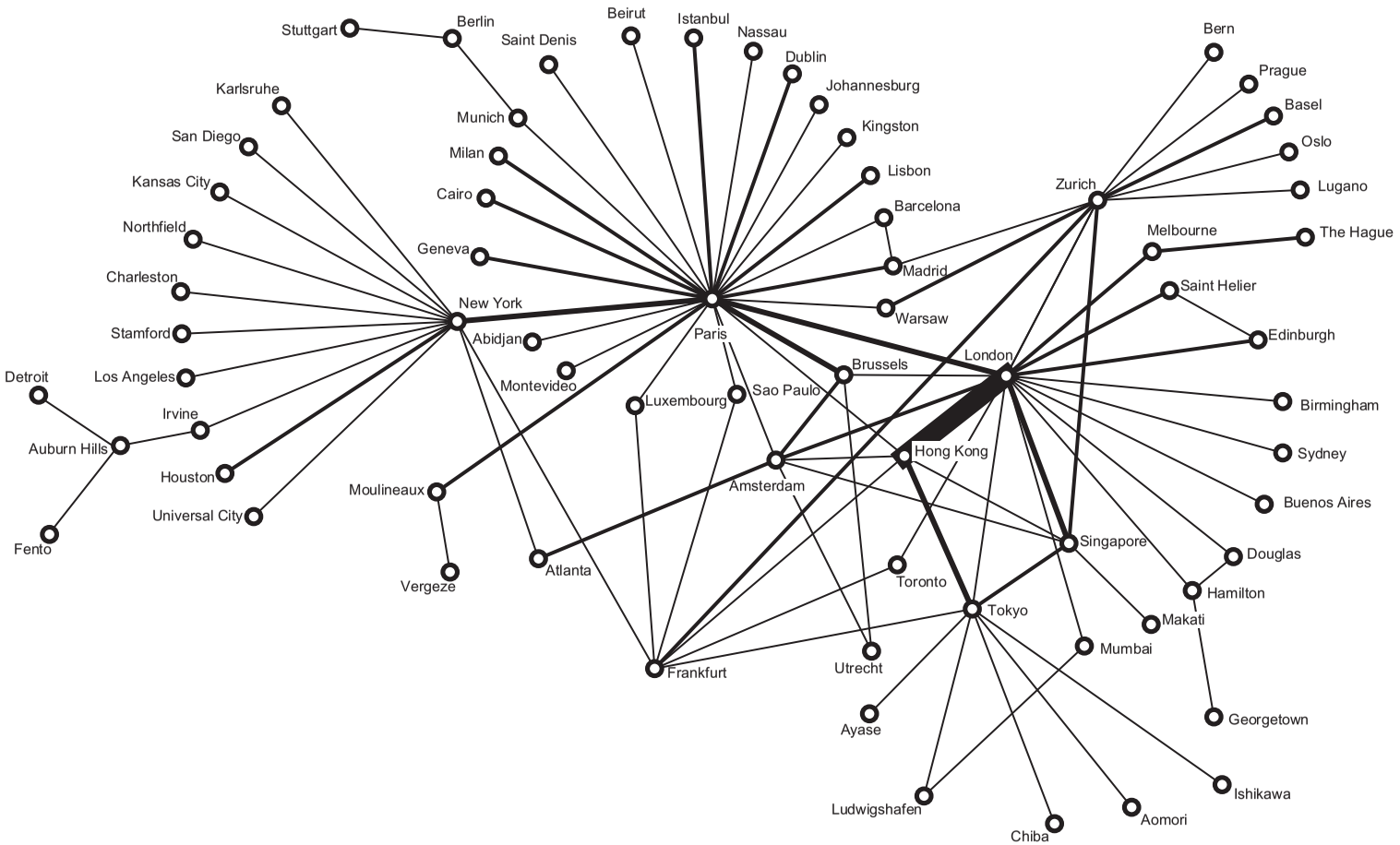


Figure 5c. Advanced producer services—first subsidiaries to second subsidiaries (level 2).

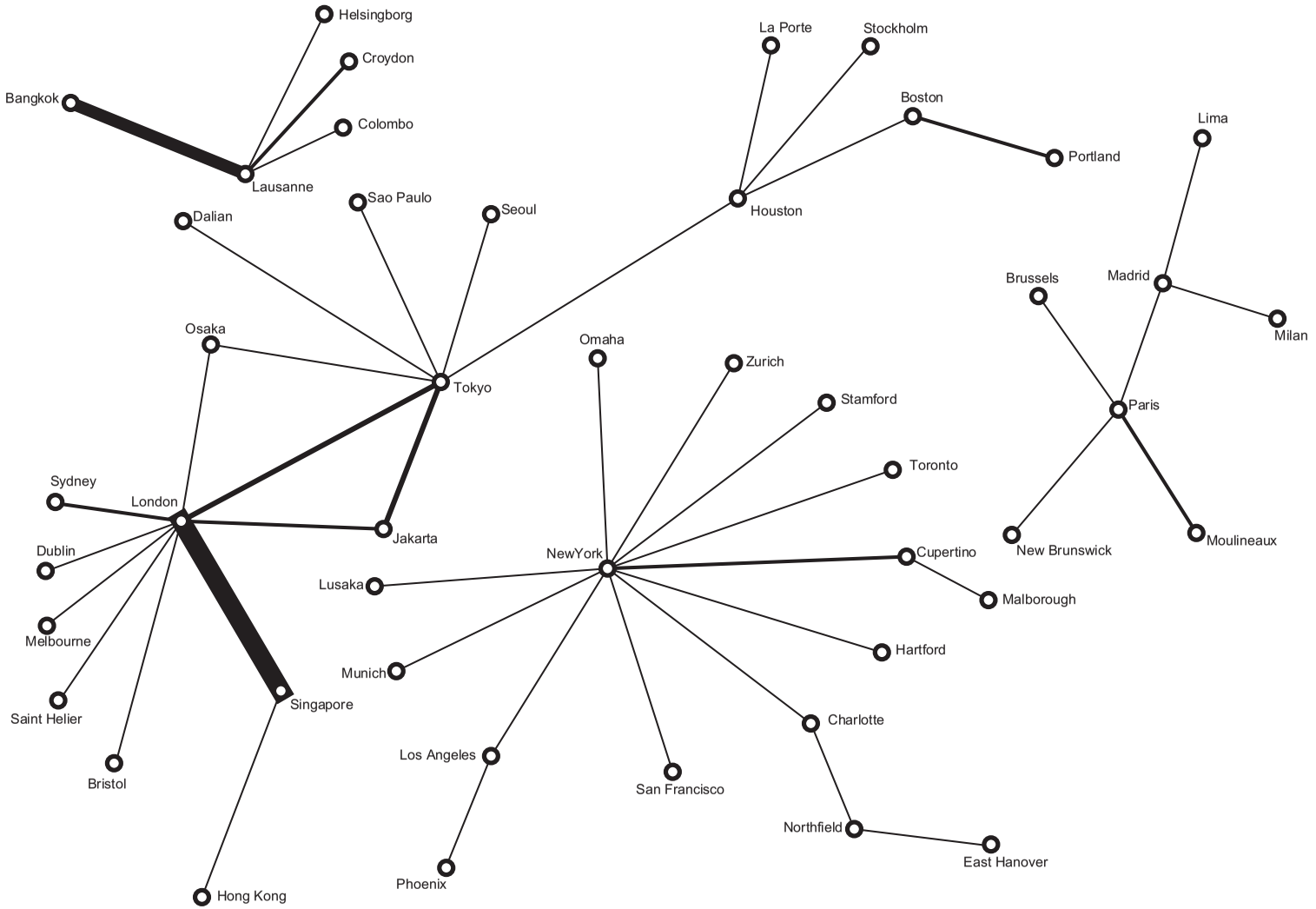


Figure 5d. Advanced producer services—second subsidiaries to remaining subsidiaries (level 3–5).

by the hierarchical star-shaped structures around Paris, New York, and London. At this level, the only exceptional link is between London and Hong Kong. In Figure 5d, all heterarchy has dissolved, and only fragmented hierarchies prevail. The only noteworthy link is that between London and Singapore. Hence, as in Taylor, Catalano, and Walker's (2002) results, London plays an essential role across all three levels, making it the most important city within the advanced producer services.

In the GIS map (Figure 6), we again observe the triad of North America-Europe-Pacific Asia. Three major "archipelago economies" (Hein 2000) are evident, connected almost entirely to each other, with a strong trans-Atlantic connectivity (Carroll 2007), combined with weak participations of cities in the Southern Hemisphere, confirming that "vast territory is increasingly excluded from the major economic processes that fuel economic growth in the new global economy" (Sassen 1994, 4). This exclusion stems from the distinct state-labor configurations of the three regions and their positions in the global production network. In Pacific Asia, Singapore and Hong Kong play prominent roles (Godfrey and Zhou 1999). Tokyo is not as strongly connected to Western cities but instead is strongly connected to Japanese and other Asian cities, as Hill and Kim (2001) observed. Hong Kong and Singapore thus function more as world cites than does Tokyo. As was observed in the combined industrial sectors, New York is primarily connected to producer services in the United States (65 percent). Again, Tokyo is the second most intranationally connected city, followed by London and Paris; however, Paris is primarily connected to other countries, making it the most transnational of the four in outdegree scores. Similar evidence can be found in the indegree scores.

Degree of Overlaps Between the All Sectors and Producer Service Networks

In Table 6, a strong correlation coefficient (0.84) is shown between the outdegree centrality scores for all industrial sectors and for advanced producer services. This finding indicates that cities that harbor headquarters for all industrial sectors also have high counts of advanced producer service headquarters. In terms of indegree (subsidiaries), the coefficient is modest (0.66) because of the higher variance of indegree cities within the networks. There is a high correlation in the diagonal centralities between the two groups (0.78), which indicates a strong coherence between advanced producer service firms and the other industrial sectors on which they depend. The coefficient of betweenness (0.69) indicates that cities that are strategically positioned within the all industries are equally likely to be strategically placed within the advanced producer services. In the linkage correlation (Table 7), the coefficients are separated into two parts. The top results, or "matching structure," indicate a correlation in which all sector city pairs are used only if they are also found within the advanced producer service networks. This analysis includes 2,196 unique pairs. The bottom results show a correlation across the entire network, involving 5,863 unique pairs. In the "matching structure" results, the coefficient is 0.73. This finding means that the strengths of the dyadic linkages in the two data sets are highly coherent, but when the rest of the network (the part excluding advanced producer services) is included in the calculation, the coefficient is weak (0.33). On the one hand, these results confirm P. J. Taylor's (2006) argument that producer services interlock strongly with the economic system. On the other hand, it is evident that this interlocking (P. J. Taylor 2006, 892) holds only for linkages at the top of the system. The low coefficient in the last result indicates that production ownership linkages at lower levels have little correspondence with those in the advanced producer services.

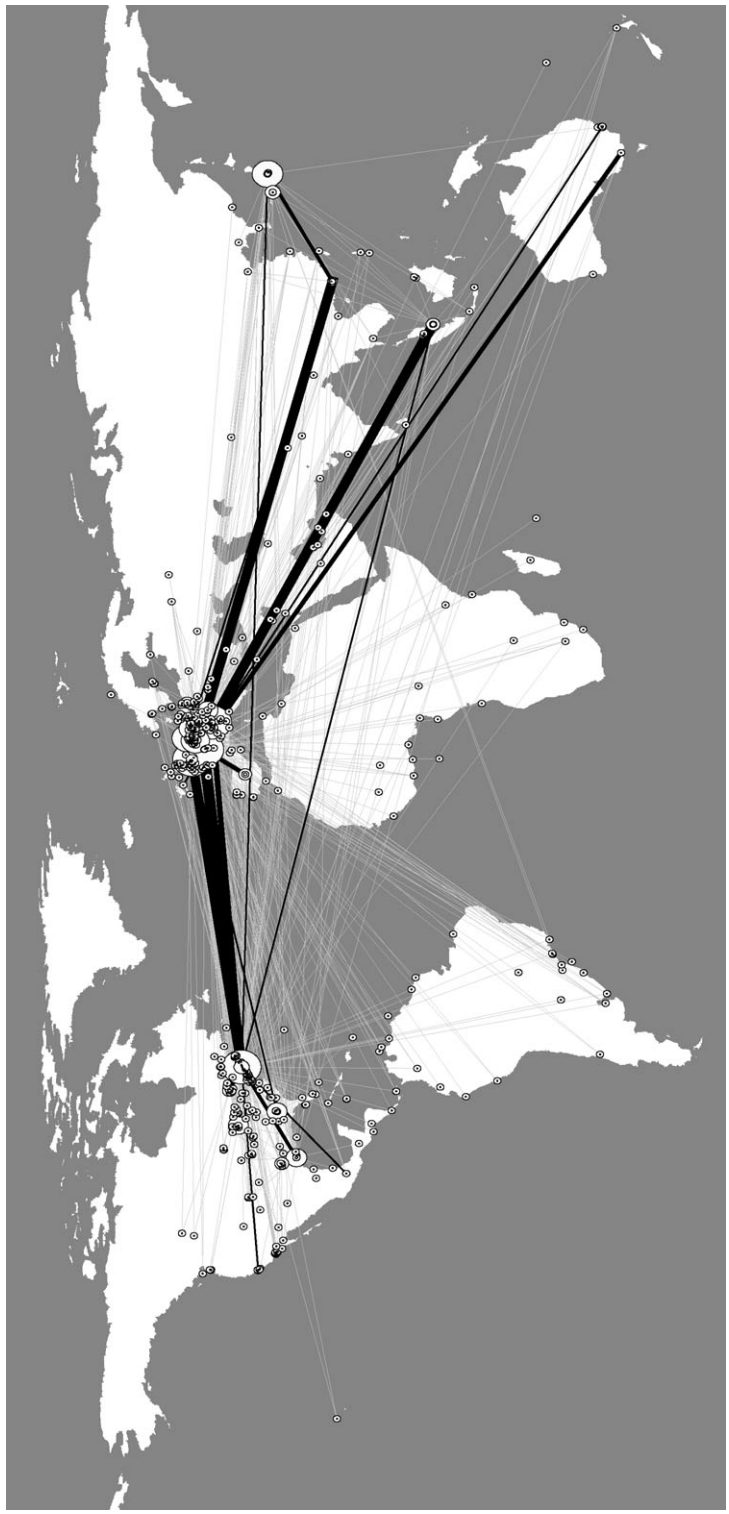


Figure 6. Geographic information system map of the producer service industries network.

Table 6

Multiple Correlations Among Outdegree, Indegree, Diagonal, and Betweeness (Both Networks)

	APS OutDegree (ED)	ALL OutDegree (ED)	APS InDegree (ED)	ALL InDegree (ED)	APS Diagonal	ALL Diagonal	APS nBetweeness	ALL nBetweeness
APS OutDegree (ED)	1.000	,847**	,076**	,256**	,526**	,590**	,665**	,637**
ALL OutDegree (ED)	,847**	1.000	,119**	,315**	,502**	,637**	,615**	,750**
APS InDegree (ED)	,076**	,119**	1.000	,669**	,278**	,304**	,567**	,345**
ALL InDegree (ED)	,256**	,315**	,669**	1.000	,323**	,361**	,522**	,644**
APS Diagonal	,526**	,502**	,278**	,323**	1.000	,785**	,487**	,435**
ALL Diagonal	,590**	,637**	,304**	,361**	,785**	1.000	,561**	,561**
APS nBetweeness	,665**	,615**	,567**	,522**	,487**	,561**	1.000	,695**
ALL nBetweeness	,637**	,750**	,345**	,644**	,435**	,561**	,695**	1.000

** Correlation is significant at the 0.01 level (two-tailed).

Table 7

Correlation Among Strengths of Linkages (Both Networks)

	APS Links (Matching Structure)	ALL Links (Matching Structure)	APS Links (Total Structure)	ALL links (Total Structure)
APS links (matching structure) $N = 2196$	1,000	,732		
ALL links (matching structure) $N = 2196$	,732	1,000		
APS links (total structure) $N = 5863$			1,000	,334
ALL links (total structure) $N = 5863$			,334	1,000

** Correlation is significant at the 0.01 level (two-tailed).

Conclusions

The findings of our study contribute to understanding the interdependencies among firms at the local, regional, and global territorial scales (Yeung 2005; Coe et al. 2004; Dicken and Malmberg 2001). By showing that 84 percent of the multinational network occurs among cities, not within them, and that approximately 70 percent of European and North American ties extend beyond their respective supraregions, we empirically support the claim that cities have become economically dissociated from their local geographies as their positions in worldwide corporate networks have grown (Friedmann 1986; Sassen 2001a). Furthermore, as Alderson and Beckfield (2004) showed, this study further substantiates Friedmann's (1995) postulation that world cities can be organized into a hierarchy according to the economic relations that they command. For example, although Hong Kong and Singapore are shown to be strong cities in terms of their number of subsidiaries, they are not strong in terms of corporate headquarters.

Because only 17 percent of cities hold outdegree centrality and New York, London, Tokyo, and Paris combined claim 25 percent of all outgoing connections, the premise that corporate decision-making functions are concentrated in a limited number of cities (e.g., Hymer 1972; Sassen 1991) is empirically confirmed. In addition, the GIS maps show that a "spatially dispersed, yet globally integrated organization of economic activity" exists in the modern world (Sassen 2001a, 3) and is clearly evident in the dense economic agglomerations within and among North America, Europe, and Pacific Asia. It is also evident that a vast territory exists that is excluded from the vital economic processes of the global economy. For example, although 10 percent of the world's population resides in sub-Saharan Africa, this region claims only 1 percent of multinational corporate connectivity. The unevenly distributed economic system of the world is clearly observable (Harvey 2006).

Our study has contributed specifically to research on world city networks, especially concerning the different approaches of P. J. Taylor (2006) and of Alderson and Beckfield (2006), by exploring their approaches on the basis of a single data set and by integrating several of their concepts and methods. We did so first, by consistently observing the networks of the combined industrial sectors in relation to that of the advanced producer sector and second, by including three separate levels of corporate ownership. We showed that the two sectorally different networks correlate strongly, meaning that, indeed, producer services interlock strongly with the overall economic system. Nonetheless, it has also been shown that this interlocking is strong only at the apex of the network. The weak correlation of producer services and all industrial sectors, when taking all five levels of corporate ownership into consideration supports Alderson and Beckfield's (2006)

assertion that although it may be true that the producer services sector leads the way in binding cities into a global network (P. J. Taylor 2006), it is equally likely that other economic sectors, such as trade and manufacturing, construct alternative forms of networks among cities (Alderson and Beckfield 2006).

One of the major similarities of the two types of networks is that New York, London, Tokyo, and Paris generally top the lists at all three corporate levels of analysis. This common position indicates an important trait of world cities: their ability to articulate among global, regional, and local networks, irrespective of the corporate level. This observation is distinct from Hymer's (1972) and Friedmann's (1986) strictly vertical conceptualizations, in which primary cities articulate at a global scale, secondary cities at the supraregional scale, and tertiary cities at the periphery. Today, ownership linkages among cities are not passed down in a clear-cut "treelike" hierarchy, but instead are reciprocated, with horizontal interactions existing among cities at all levels. However, as was shown in the network diagrams, the interaction among cities is neither purely hierarchical nor purely heterarchical. Instead, a hybrid form exists, confirming the coexistence of multiple organizational principles (Hedlund 1986; Koestler 1978; Grabher 2006; Grabher and Powell 2004).

The fact that New York, Paris, London, and Tokyo have hierarchical hub-and-spoke structures in most of the figures reveals the headquarters control functions of these cities over subsidiary cities. Although lateral relationships were found among different categories of cities, it is evident from our results that the strongest evidence of "horizontalization" (reciprocated ties) is found among the top-ranked cities and that this situation is most prevalent at the top level of corporate ownership, gradually declining in importance in the lower levels. Hence, heterarchy is most evident at the top level of corporate governance. This finding is not surprising because this level concerns high-end, complex activities between headquarters and first-order subsidiaries. Because the majority of individual ties are neither reciprocated nor triangulated, we can say that in terms of the "variety of connections," the corporate network is still essentially hierarchical. But these linkages are generally weaker in terms of numbers of connections than heterarchical ones. In the case of heterarchic linkages, although the number of reciprocated and triangulated ties is limited to only a handful of cities, these ties are disproportionately stronger. Hence, in terms of "strength of connections," the corporate ownership network is essentially heterarchical.

We also showed that cities with high outdegree are all located in developed countries. In contrast, in terms of subsidiaries, the highest-ranked cities are in both developed and developing nations. The latter clearly shows how shifts in competitive advantage in the global marketplace have increased the global reach of economic activity, driven by competitive market mechanisms, technological change, and space-time compression (Cerny 1991; Sassen 1991; Castells 1996).

Comparing our top 10 results to those of Alderson and Beckfield (2004), we found an 80 percent match; however, the rankings themselves differed slightly. Both studies identified New York, Paris, Tokyo, and London as the leading outdegree cities. In our study, we found that Tokyo's strength lies at the lower levels of corporate ownership and that it is primarily connected to Japanese and Pacific Asian cities, supporting the argument that Tokyo may not be a global city (Hill and Kim 2001). Furthermore, it has been shown that Tokyo is more production than service oriented.

We demonstrated that New York is more nationally than globally oriented and that London is the most globally connected city in the world. Similar to P. J. Taylor, Catalano and Walker (2002), Alderson and Beckfield's (2004), and Godfrey and Zhou's (1999) findings, we found that Hong Kong and Singapore emerged as important subsidiary-type

cities. These are therefore important cities that are "sought out by other cities" (Alderson and Beckfield 2004, 824); however, we discovered that Hong Kong and Singapore are far less important at the first level of the corporate hierarchy than at the lower two levels. In this light, the multilevel ownership approach has contributed to a more detailed specification of networks, demonstrating that different classes of corporate network lead to different city rankings and intercity network configurations.

One important finding in both our study and Alderson and Beckfield's (2004) is that important economic functions are not necessarily concentrated in world cities, but instead are often located in the city where the firms originated. Unlike P. J. Taylor, Catalano and Walker's (2002) study, which began with a predetermined set of cities, we included all cities that had headquarters or subsidiary ties, thereby providing a more complete view of intercity corporate relationships. However, it is worth mentioning that studies of corporate networks have included, by definition, only firms that connect to other firms and that these studies have not included the many small firms found in cities that do form corporate ownership linkages. We recommend that future studies incorporate these firms into their analyses. Thus, we suggest that future research focus on (1) developing measures of the spatiotemporal interdependence between global city network formation and local urban development and (2) fine-tuning measures to weigh different headquarters, subsidiaries, affiliates, and branch plants more accurately for more sophisticated analyses of centrality, structure, and hierarchy among cities.

References

Abbott, C. 1997. The international city hypothesis: An approach to the recent history of U.S. cities. *Journal of Urban History* 24:28–52.

Alderson, A. S., and Beckfield, J. 2004. Power and position in the world city system. *American Journal of Sociology* 109:811–51.

——. 2006. Whither the parallel paths? The future of scholarship on the world city system. *American Journal of Sociology* 112:895–904.

Allen, J. 1999. Cities of power and influence: Settled formations. In *Unsettling Cities*, ed. J. Allen, D. Massey, and M. Pryke, 181–281. New York: Routledge.

Amin, A. 2002. Spatialities of globalization. *Environment and Planning A* 34: 385–99.

Amin, A., and Graham, S. 1999. Cities of connection and disconnection. In *Unsettling Cities*, ed. J. Allen, D. Massey, and M. Pryke, 7–52. New York: Routledge.

Amin, A., and Thrift, N. 1992. Neo-Marshallian nodes in global networks. *International Journal of Urban & Regional Research* 16:571–87.

Bair, J., and Gereffi, G. 2001. Local clusters in global chains: The causes and consequences of export dynamism in Torreon's blue jeans industry. *World Development* 29:1885–1903.

Bartlett, C.A., and Ghoshal, S. 1986. Tap your subsidiaries for global reach. *Harvard Business Review*, November-December: 87–94.

Bathelt, H.; Malmberg, A.; and Maskell, P. 2002. *Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation*. Working paper 2002–12. Copenhagen: Danish Research Unit for Industrial Dynamics.

Birkinshaw, J. M. 1996. How multinational subsidiary mandates are gained and lost. *Journal of International Business Studies* 27:467–96.

Birkinshaw, J. M., and Morrison, A. J. 1995. Configurations of strategy and structure in subsidiaries of multinational corporations. *Journal of International Business Studies* 26:729–53.

Borgatti, S. P.; Everett, M. G.; and Freeman, L. C. 2002. UCINET 6 for Windows: Social network analysis software. Needham, MA: Analytic Technologies.

Carroll, W. K. 2007. Global cities in the global corporate network. *Environment and Planning A* 39:2297–323.

Castells, M. 1996. *The rise of the network society*. Oxford, U.K.: Blackwell.

Cerny, P. G. 1991. The limits of deregulation: Transnational interpenetrations and policy change. *European Journal of Political Research* 19:173–96.

Chandler, A. D. 1962. *Strategy and structure: Chapters in the history of American industrial enterprise*. Cambridge, Mass.: MIT Press.

——. 1990. *Scale and scope: The dynamics of industrial capitalism*. Cambridge, Mass.: Harvard/ Belknap.

Christaller, W. 1933. *Die Zentralen Orte in Suddeutschland [Central Place in Southern Germany]*. Jena, Germany: Gustav Fischer.

Christopherson, S., and Clark, J. 2007. Power in firm networks: What it means for regional innovation systems. *Regional Studies* 41:1223–36.

Coe, N. M.; Hess, M.; Yeung, H. W-C.; Dicken, P.; and Henderson, J. 2004. "Globalizing" regional development: A global production networks perspective. *Transactions Institute of British Geographers* 29:468–84.

Cohen, R. B. 1981. The new international division of labour, multinational corporations, and urban hierarchy. In *Urbanization and Urban Planning in Capitalist Society*, ed. M. Dear and A. Scott, 287–315. New York: Methuen.

De Filippis, J. 2001. The myth of social capital in community development. *Housing Policy Debate* 12:781–806.

Derudder, B. 2006. On conceptual confusion in empirical analyses of a transnational urban network. *Urban Studies* 43:2027–46.

Derudder, B., and Witlox, F. 2010. World cities and global commodity chains: An introduction. *Global Networks* 10:1–11.

Dicken, P.; Kelly, P. F.; Olds, K.; and Yeung, H. W-C. 2001. Chains and networks, territories and scales: Towards a relational framework for analysing the global economy. *Global Networks* 1:89–112.

Dicken, P., and Malmberg, A. 2001. Firms in territories: A relational perspective. *Economic Geography* 77:345–63.

Dunning, J. H., and Lundan, S. M. 2008. *Multinational enterprises and the global economy*. Cheltenham, U.K.: Edward Elgar.

Edgington, D. W., and Haga, H. 1998. Japanese service sector multinationals and the hierarchy of Pacific Rim cities. *Asia Pacific Viewpoint* 39:161–78.

Feldman, M. P. 2000. Location and innovation: The new economic geography of innovation, spillovers, and agglomeration. In *The Oxford handbook of economic geography*, ed. G. L. Clark, M. A. Feldman, and M. S. Gertler, 373–95. Oxford, U.K.: Oxford University Press.

Friedmann, J. 1986. The world city hypothesis. *Development and Change* 17:69–84.

——. 1995. Where we stand: A decade of world city research. In *World Cities in a World-System*. ed. P. L. Knox and P. J. Taylor, 21–47. Cambridge, U.K.: Cambridge University Press.

——. 2001. World cities revisited: A comment. *Urban Studies* 38:2535–36.

Friedmann, J., and Wolff, G. 1982. World city formation: An agenda for research and action. *International Journal of Urban and Regional Research* 6:309–44.

Gereffi, G.; Korzeniewicz, M.; and Korzeniewicz, R. P. 1994. Introduction: Global commodity chains. In *Commodity chains and global capitalism*, ed. G. Gereffi and M. Korzeniewicz, 1–14. Westport, Conn: Praeger.

Godfrey, B. J., and Zhou, Y. 1999. Ranking world cities: Multinational corporations and the global urban hierarchy. *Urban Geography* 20:268–81.

Grabher, G. 1993. The weakness of strong ties: The lock-in of regional development in the Ruhr area. In *The embedded firm: On the socioeconomics of interfirm relations*, ed. G. Grabher, 255–78. London: Routledge.

——. 2006. Trading routes, bypasses, and risky intersections: Mapping the travel "networks" between economic sociology and economic geography. *Progress in Human Geography* 30:163–89.

Grabher, G., and Powell, W. W. 2004. Exploring the webs of economic life. In *Networks*, ed. G. Grabher and W.W. Powell, 1–36. Cheltenham, U.K.: Edward Elgar.

Granovetter, M. 1985. Economic action and economic structure: the problem of embeddedness. *American Journal of Sociology* 91:481–510.

Hall, P., and Soskice, D. 2001. *Varieties of capitalism: The institutional foundations of comparative advantage*. Oxford, U.K.: Oxford University Press.

Hannemann, R., and Riddle, M. 2005. *Introduction to social network methods*. Riverside: University of California Press.

Harvey, D. 2006. *Spaces of global capitalism: A theory of uneven geographical development*. London: Verso Books.

Hedlund, G. 1986. The hypermodern MNC-A heterarchy. *Human Resource Management* 25: 9–35.

——. 1993. Assumptions on hierarchy: An application to the multinational corporation. In *Organization theory and the multinational corporation*, ed. S. Ghoshal and D. E. Westney, 198–221. London: Macmillan.

——. 1994. A model of knowledge management and the N-form corporation. *Strategic Management Journal* 15:73–90.

Hein, W. 2000. Die Ökonomie des Archipels und das versunkere Land. [The Economics of the Archipelago and the Submerged Land]. *E + Z* 41:304–7.

Henderson, J.; Dicken, P.; Hess, M.; Coe, N.; and Yeung, H.W-C. 2002. Global production networks and the analysis of economic development. *Review of International Political Economy* 9:436–64.

Hess, M. 2004. "Spatial" relationships? Towards a reconceptualization of embeddedness. *Progress in Human Geography* 28:165–86.

Hill, R. C., and Kim, J.W. 2000. Global cities and developmental states: New York, Tokyo and Seoul. *Urban Studies* 37:2167–95.

——. 2001. Reply to Friedman and Sassen. *Urban Studies*. 38:2541–42.

Hymer, S. 1972. The multinational corporation and the law of uneven development. In *Economics and World Order*, ed. J. N. Bhagwati, 113–40. New York: MacMillan.

Irwin, M. D., and Hughes, H. L. 1992. Centrality and the structure of urban interaction: measures, concepts, and applications. *Social Forces* 71:17–51.

Ivarsson, I. 1996. *Integrated international production: A study of foreign transnational corporations in Sweden*. Series B, No. 90. Department of Geography, University of Göteborg, Göteborg, Sweden.

Knoke, D., and Kuklinski, J. H. 1982. *Network analysis*. Beverly Hills, Calif.: Sage.

Koestler, A. 1978. *Janus—A summing up*. New York: Random House.

Lin, N.; Cook, K. S.; and Burt, R. S. 2001. *Social capital: Theory and research*. New York: Aldine de Gruyter.

Maskell, P. 2001. The firm in economic geography. *Economic Geography* 77:329–44.

Meijer, M. 1993. Growth and decline of European cities: Changing positions of cities in Europe. *Urban Studies* 30:981–90.

Meyer, D. R. 1986. The world system of cities: Relations between international financial metropolises and South American cities. *Social Forces* 64:553–81.

Phelps, N. A., and Fuller, C. 2000. Multinationals, intracorporate competition, and regional development. *Economic Geography* 76:224–43.

Polanyi, K. 1944. *The great transformation: The political and economic origins of our time*. Boston: Beacon Press.

Rozenblat, C., and Pumain, D. 2006. Firm linkages, innovation and the evolution of urban systems. In *Cities in globalization*. ed. P. J. Taylor, B. Derudder, P. Saey, and F. Witlox, 124–49. London: Routledge.

Sassen, S. 1991. *The global city: New York, London, Tokyo*. Princeton, N.J: Princeton University Press.

——. 1994. *Cities in a world economy*. Thousand Oaks, Calif.: Pine Forge Press.

——. 2001a. *The global city: New York, London, Tokyo*, 2d ed. Princeton, N.J.: Princeton University Press.

——. 2001b. Global cities and developmental states: How to derail what could be an interesting debate: A response to Hill and Kim. *Urban Studies* 38:2537–40.

Schoenberger, E. 1997. *The cultural crisis of the firm*. Oxford, U.K.: Blackwell.

Simmel, G. 1890. *Über soziale differenzierung. Soziologische und psychologische untersuchungen*. [About social differentiation. Sociological and psychological research]. Leipzig: Duncker and Humblot.

Smith, D. A., and Timberlake, M. 1995. World cities: A political economy/global network approach. *Research in Urban Sociology* 3:181–207.

Storper, M., and Salais, R. 1997. *Worlds of production: The action frameworks of the economy*. Cambridge, Mass.: Harvard University Press.

Taggart, J. H. 1997. Autonomy and procedural justice: A framework for evaluating subsidiary strategy. *Journal of International Business Studies* 28:51–76.

Taylor, M. 1995. The business enterprise, power and patterns of geographical industrialisation. In *The industrial enterprise and its environment: Spatial perspectives*, ed. S. Conti, E. Malecki, and P. Oinas, 99–122. Aldershot, U.K.: Avebury.

——. 1996. Industrialisation, enterprise power, and environmental change: An exploration of concepts. *Environment and Planning A* 28:1035–51.

Taylor, M., and Asheim, B. 2001. The concept of the firm in economic geography. *Economic Geography* 77:315–28.

Taylor, P. J. 2001. Specification of the world city network. *Geographical Analysis* 33:181–94.

——. 2004. *World city network: A global urban analysis*. London: Routledge.

——. 2006. Parallel paths to understanding global intercity relations. *American Journal of Sociology* 112:881–94.

Taylor, P. J.; Catalano, G.; and Walker, D. R. F. 2002. Measurement of the world city network. *Urban Studies* 39:2367–76.

Taylor, P. J.; Hoyler, M.; Verbruggen, R. 2008. External urban relational process: introducing central flow theory to complement central place theory. *GaWC Research Bulletin 261*. University of Loughborough, Loughborough, U.K.

Taylor, P. J.; Ni, P.; Derudder, B.; Hoyler, M.; Huang, J.; Fengyong, L.; Pain, K.; Witlox, F.; Yang, X.; Bassens, D.; and Shen, W. 2009. The way we were: Command-and-control centres in the global space economy on the eve of the 2008 geo-economic transition. *Environment and Planning A* 41:7–12.

Todeva, E. 2006. *Business networks: Strategy and structure*. New York: Routledge.

van der Knaap, G. A. 2007. Urban network development under conditions of uncertainty. In *Cities in globalization*, ed. P. J. Taylor, B. Derudder, P. Saey, and F. Witlox, 89–107. London: Routledge.

Wall, R. S. 2009a. *Netscape: Cities and global corporate networks*. Rotterdam: Haveka.

Wall, R. S. 2009b. The relative importance of Randstad cities within comparative worldwide corporate networks. *Journal of Economic and Social Geography* 100:250–58.

Whitley, R. 1999. *Divergent capitalisms: The social structuring and change of business systems*. Oxford, U.K.: Oxford University Press.

Yeung, H. W.-C. 1998. Capital, state and space: Contesting the borderless world. *Transactions of the Institute of British Geographers* 23:291–309.

——. 2005. The firm as social networks: An organizational perspective. *Growth and Change* 36:307–28.

Young, A. K. 1979. *The Sogo Shosha: Japan's multinational trading company*. Boulder, Colo.: Westview Press.