NETWORKS, CLUSTERS, AND SMALL WORLDS

ARE THEY RELATED?

LUCA GIUSTINIANO • CHIARA D'ALISE

Abstract: In recent years, many industries have seen the rise of new inter-organizational forms. Among those new forms, organizational networks, clusters, and small worlds are attracting increasing interest, both in academic research and management practice. While economic theory considers such forms to be market failures, organization theory highlights their potential positive effects on the participating organizations. The organizational literature often uses the terms "networks", "clusters", and "small worlds" as synonymous even though there are differences between them. Moreover, given the sometimes-spontaneous emergence of these organizational forms, the extent to which they can be designed is not always clear. This article discusses the characteristics of networks, clusters, and small worlds; their operational parameters; and how these organizational forms are related. Further, we identify the role of design in these types of organizations.

Keywords: Networks, clusters, small worlds, organization design, new organizational forms

In recent years, many industries have seen a rise in business networks and other inter-organizational and cooperative arrangements. Organizational *networks* and other inter-organizational forms, such as *clusters* and *small worlds*, are gaining momentum, both in academic debate and management practice (Molina-Morales et al., 2015). Economic theories view inter-organizational forms as alternatives to markets and hierarchies or as market failures (e.g., transaction cost economics, agency theory, and the property rights approach). By contrast, the resource-based view of the firm (Wernerfelt, 1984) has explicated the win-win properties of networks. Although the resource-based theoretical perspective has a more positive view of business networks, its focus on the characteristics of the individual firm – its resources and capabilities – limits its analytical and explanatory power.

We believe that resource dependence theory (Pfeffer & Salancik, 1978) can provide further insights into business networks because of its greater explanatory power regarding cooperation between or among organizations. The resource dependence view characterizes the organization as an open system, dependent on resources and contingencies in the environment. In this view, the focus on resources switches from the intra-firm level to the inter-organizational level, as well as from resource availability to the acquisition of resources via negotiation. According to Pfeffer (1987: 26-27):

> *Organizations are not autonomous, but rather are constrained by a network of interdependencies with other organizations… [so] organizations take actions to manage external interdependencies, although such actions are inevitably never completely successful and produce new patterns of dependence and interdependence.*

Thus, resource dependence theory posits that many of the resources that every organization needs originate from the environment. Organizational networks allow resource sharing across organizations, and a network of complementary firms may be a solution for overcoming a competence gap. Further, we maintain that forming a network organization does not merely mean negotiating the acquisition of existing resources. Rather, new jointly determined resources can be generated through cooperation. The stock of knowledge available to a focal

JOD, 4(2): 48-53 (2015)
DOI: 10.7146/jod.20478

node in a network results from the combination of two elements: the knowledge owned by the nodes linked to the focal node and the new knowledge created through relationships with those nodes. By shifting the focus from the single firm (node) to the relations and interactions between firms, we recognize the existence of exchange processes involving products and services, information, and knowledge. By focusing on the value of the interactions, the benefits of networks, clusters, and small worlds can be interpreted more fully.

RELEVANCE OF NETWORKS AND OTHER COOPERATIVE FORMS TO ORGANIZATION DESIGN

In addition to competition, cooperation has emerged as a model for efficient resource allocation, shifting the focus to the exchange relationship and the inter-firm alignment of complementary assets, resources, and activities (Dyer & Singh, 1998). In this vein, the analysis of networks may answer the call for juxtaposing resource dependence theory (RDT) with other theoretical lenses to examine organizational interdependencies not included in its original formulation (Hillman, Withers, & Collins, 2009). Although RDT is able to explain networks, new cooperative inter-organizational forms have emerged. Networks, clusters, and small worlds are sometimes discussed as synonymous, without any clear demarcation. A better understanding of these forms can aid research on both organizational boundaries (Burton, 2013; Lomi, 1997) and inter-organizational exchanges found in newer organizational forms such as collaborative communities (Fjeldstad et al., 2012; Miles et al., 2009). Do clusters or small worlds have different characteristics and yield different benefits from traditional networks? Can resource dependence theory usefully interpret the dynamics of clusters and small worlds?

Responding to these questions is timely and consistent with the growing levels of complexity and interdependence of organizations and their environments under the pressures of globalization, technological development, and the faster pace of economic life. Within this setting, as Burton (2013: 42) has pointed out, "Organization design theory and practice must keep pace with increased complexity and interdependence." We believe that networks, clusters, and small worlds have different features that affect the relations between them. Networks obtain performance benefits due to their flexibility, the variety of capabilities that can be assembled, and their economies of scope and experience (Miles & Snow, 1994). Clusters, defined as spatial networks, yield superior benefits due to two characteristics: geographic localization and the vertical heterogeneity of the nodes (Porter, 1998, 2000). Furthermore, the more integrated the cluster is in a small-world network structure, the higher the cluster's performance (Watts, 1999). Organization design can focus on the inter-firm relations, and through a multi-level perspective and micro–macro bridges, combine different levels of analysis. We therefore aim to pave the way for the study of "clusters of clusters" and the combination of intra-cluster and inter-cluster dynamics.

The reconsideration of resource dependence theory for the understanding of networks, clusters, and small worlds fits with many contributions in the *Journal of Organization Design*. For example, RDT is consistent with boundary-crossing organizational strategy as defined by Burton (2013: 43): "In the end, organizations must have a strategy which links the outside and inside, and that strategy must be continually adjusted to fit the changing environment." Similarly, in discussing "supra-firm" designs, Mathews (2012: 42) notes:

> *...the scope of organization design has expanded steadily from work-flow issues and job specifications to firm-level considerations and now to supra-firm industrial structures, where such issues as modularity and clustering loom large. The impetus for this development lies partly in the fact that some supra-firm designs clearly work better than others.*

The investigation of networked forms is consistent with the concept of *consilience* (Puranam, 2012), aimed at explaining phenomena occurring at one level of aggregation based on knowledge about lower-order phenomena. Therefore, we can infer that changing the unit of analysis and assuming a multi-level perspective could be important in understanding organizational phenomena. We advocate a shift in analysis from the whole network to single clusters and vice versa.

A focus on cooperation allows for the explanation of inter-firm variation in performance (innovation rates, financial results, etc.) in line with traditional economic explanations. The added value lies in the incorporation of sociological factors and the consideration of networks as informational structures, conduits for knowledge spillovers, and sources of knowledge generation. The main contributions can be summarized as the focus on (a) relations among actors, (b) multi-level analysis, and (c) micro–macro bridging. Regarding the focus on relations among actors, we argue that organizations are not atomistic entities but rather are actors whose economic actions and performance are influenced by their context – by the network of inter-organizational relations in which they are embedded. Consequently, there is a need to understand the interaction of each unit of analysis within its wider context. We argue that inter-organizational ties have an important role in shaping firm behavior and outcomes. Regarding multi-level analysis, we maintain that it is important to analyze the structure of a networked system at different levels: single actor, ties, groups of actors (nodes' attributes and structure), and the overall network. The analysis of networks, clusters, and small worlds has to be conducted at different levels of aggregation. This approach also allows for micro–macro bridging: small-scale interactions are translated into large-scale patterns, and these in turn feed back into small groups. This allows researchers to capture the interactions of any individual unit within its larger domain.

NETWORKS, CLUSTERS, AND SMALL WORLDS: A POTENTIAL INTEGRATION

In the past few decades, there has been an upsurge of interest in the role of networks, variously considered as metaphors, methods, or objects of new theory. Economic sociologists define a network as a form of organized economic activity that involves a set of nodes (e.g., individuals or organizations) linked by a set of relationships (Granovetter, 1973) that can be extended to customer–supplier relationships, interlocking directorates, relationships among individual employees, strategic alliances, and other types of relationships (Snow & Fjeldstad, 2015).

The advantage a node can derive from a network (the node's payoff) is a function of its position in the network or of the structure of the network (structural capital) rather than of individual relationships (Borgatti & Foster, 2003). Therefore, the study of different potential network structures, including the small-world structure, is an attempt to identify which type of network can maximize benefits for the nodes. The network structure is a channel between firms for resource sharing (the combination of knowledge, skills, and physical assets among firms) and for knowledge flows (e.g., information conduits through which news of technical breakthroughs, new insights into problems, and tacit information acquired through learning by doing travel from one firm to another) (Uzzi, 1997). Networks allow access (a broader information screen), timing (early receipt of relevant information), and referral (legitimization of the node through information) (Burt, 1992). Even though some studies have demonstrated the positive effects of inter-firm alliances on patenting (e.g., Ahuja, 2000; Uzzi, 1997), the effects of specific elements of the network structure (sparse vs. dense structure, or structural holes) on innovation remain ambiguous.

The use of a contingency approach can shed some light on this issue. We posit that clusters favor the application of a contingency approach in networks through consideration of specific characteristics of the nodes, while the small world is a specification of the structure of the network. Therefore, both concepts can provide insights into explaining the innovation effects of networks.

The concept of a network is more general than that of a cluster; the latter can be simplified as an aggregation of different actors in a localized network, implying two distinctive characteristics: vertical node heterogeneity and geographic localization. Clusters might well result in greater benefits in terms of innovation, such as for innovative research in biomedicine originating in regional clusters in the United States and in Europe. With respect to vertical nodal heterogeneity, clusters comprise various actors occupying different positions in the supply chain, from downstream to upstream: firms, universities, research institutes, and other institutions. The success of regions like Silicon Valley comes from specialized

complementarities arising between neighboring firms, something that cannot be accounted for in simple capital and labor terms in a production function (Mathews, 2012). Clusters allow the integration of agents characterized by different skills, competencies, and assets, enabling the generation of new ideas. With regard to geographic localization, innovation is spurred by several elements, such as local externalities, proximity to cross-fertilization and the sharing of know-how, access to human capital, and the availability of infrastructures (e.g., facilities and transportation).

Despite the vast literature on clusters, scholars seem to converge on other substantive elements, such as the existence of formal and/or informal inter-organizational relationships and a common aim to be reached collectively within a specific domain (e.g., fields of knowledge, competencies, and technologies). Yet, there are critical questions that remain: Do all clusters have a positive impact on innovation? Is there any single characteristic of clusters that is the ultimate driver of innovation? We suggest that answers can be obtained by adopting the small-world perspective in analyzing the outcomes of clusters.

The small-world network structure is made up of a local structure with high density integrated into a wider random network, and the coexistence of short-range and long-range connections (Watts & Strogatz, 1998). The main characteristics of a small-world network are: the network is sparse in the sense that each node is connected to an average of only k other nodes n; it is decentralized in that there is no dominant central point to which most other networks are directly connected; and it is highly clustered (Watts, 1999). So far, researchers studying small-world networks have focused on a single "organization", suggesting that it can be broken into subgroups or semiautonomous subunits. We instead advocate introducing a new application of small worlds in which the subgroups are "single clusters" and the organization constitutes "all the clusters considered together." The small-world structure is characterized by dense clusters, or hubs, randomly connected to other clusters by weak ties in a sparse structure. Consequently, we suggest expanding the focus to inter-cluster dynamics and not just intra-cluster dynamics, thereby enriching cluster concepts with a network perspective.

It is not only important to consider descriptions of the cluster itself (e.g., through social network analysis), but also how the cluster is connected to a wider network. Here, the question is: Are the characteristics of the specific cluster suitable for spurring innovation, considering both the intra-cluster and inter-cluster levels? The answer requires a picture of the comprehensive network "structure", considering both intra-cluster and inter-cluster ties. Previous research has suggested that the more integrated the cluster is in a small-world network structure, the higher the cluster's innovation performance (D'Alise, Giustiniano, & Peruffo, 2014). In fact, the small-world network structure could provide an intermediate solution between sparse structures (e.g., open networks) and dense structures (e.g., closed networks), resulting in complementarity, with firms benefitting from inter-firm resource pooling and cooperation.

Within this framework, small-world networks represent intermediate configurations able to solve the trade-off problem between open and closed networks. The bridging ties with other clusters allow outside exploration with access to heterogeneous and novel ideas, while the high density of clusters allows the effective exploitation of ideas and intra-cluster exploration. A small-world network can be decomposed in terms of each cluster's density (actual number of direct ties between nodes as a ratio of the maximum possible number of ties), and the presence of structural holes (Burt, 1992) between one cluster and other clusters. Dense and sparse configurations coexist at different scales and levels of the network in a multi-scaled cluster. Closure allows the value buried in a structural hole to be realized, effectively implementing new ideas captured from outside the cluster.

IMPLICATIONS FOR ORGANIZATION DESIGN

We posit that a flourishing stream of research can be developed by integrating concepts derived from the literature on networks, clusters, and small-world structures. Their integration can be effective in focusing on inter-firm relations and adopting a multi-level perspective. We suggest that networks that have both clustering and some amount of linkage between them –

cluster-spanning bridges – spur each cluster's innovation. We also suggest analyzing clusters using a network perspective, in particular a small-world network perspective, to detect the impact on innovation. It would be useful to study small-world networks, identify their connection with a cluster's innovation output, and complete the model with contingencies related to the nodes' characteristics.

As resource dependence theory and contingency theory share a number of fundamental assumptions related to the effects of environmental uncertainty and demand dependencies (Hillman, Whiter, & Collins, 2009), we believe that the investigation of new inter-organizational forms would contribute to their concomitant explanatory power. In the same vein, organization design can contribute to the definition of the best mix in business partnerships based on networks.

REFERENCES

Ahuja G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly* 45(3): 425-455.

Borgatti SP, Foster PC. 2003. The network paradigm in organizational research: A review and typology. *Journal of Management* 29(6): 991-1013.

Burt RS. 1992. *Structural Holes*. Harvard University Press, Cambridge, MA.

Burton R. 2013. The future of organization design: An interpretative synthesis in three themes. *Journal of Organization Design* 2(1): 42-44. DOI: http://dx.doi.org/10.7146/jod.7363

D'Alise C, Giustiniano L, Peruffo E. 2014. Innovating through clusters. *International Journal of Engineering Business Management* 6(28): 1-14.

Dyer JH, Singh H. 1998. The relational view: Cooperative strategy and resources of interorganizational competitive advantage. *Academy of Management Review* 23: 660-679.

Fjeldstad ØD, Snow CC, Miles RE, Lettl C. 2012. The architecture of collaboration. *Strategic Management Journal* 33(6): 734-750.

Granovetter MS. 1973. The strength of weak ties. *American Journal of Sociology* 78(6): 1360-1380.

Hillman AJ, Withers MC, Collins BJ. 2009. Resource dependence theory: A review. *Journal of Management* 35(6): 1404-1427.

Lomi A. 1997. Markets with hierarchies and the network structure of organizational communities. *Journal of Management and Governance* 1: 49-66.

Mathews JA. 2012. Design of industrial and supra-firm architectures: Growth and sustainability. *Journal of Organization Design* 1(2): 42-63.

Miles RE, Miles G, Snow CC, Blomqvist K, Rocha H. 2009. The I-form organization. *California Management Review* 51(4): 61-76.

Miles RE, Snow CC. 1994. *Fit, Failure, and the Hall of Fame: How Companies Succeed or Fail*. Free Press, New York, NY.

Molina-Morales FX, Belso-Martínez JA, Más-Verdú F, Martínez-Cháfer L. 2015. Formation and dissolution of inter-firm linkages in lengthy and stable networks in clusters. *Journal of Business Research* 68(7): 1557–1562. DOI: 10.1016/j.jbusres.2015.01.051

Pfeffer J. 1987. A resource dependence perspective on interorganizational relations. In M.S. Mizruchi and M. Schwartz (eds.), *Intercorporate Relations: The Structural Analysis of Business*: 22-55. Cambridge University Press, Cambridge, UK.

Pfeffer J, Salancik GR. 1978. *The External Control of Organizations: A Resource Dependence Approach*. Harper & Row, New York, NY.

Porter ME. 1998. Clusters and the new economics of competition. *Harvard Business Review* (Nov/Dec): 77-90.

Porter ME. 2000. Location, competition, and economic development: Local clusters in a global economy. *Economic Development Quarterly* 14(1): 15-34.

Puranam P. 2012. A future for the science of organization design. *Journal of Organization Design* 1(1): 18-19.

Snow CC, Fjeldstad ØD. 2015. Network paradigm: Applications in organizational science. In J.D. Wright (ed.), *International Encyclopedia of the Social & Behavioral Sciences*, 2nd ed., Vol. 16: 546-550. Elsevier, Oxford, UK.

Uzzi B. 1997. Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly* 42(1): 35-67.
Watts DJ. 1999. Small Worlds: *The Dynamics of Networks Between Order and Randomness*. Princeton University Press, Princeton, NJ.
Watts DJ, Strogatz SH. 1998. Collective dynamics of "small-world" networks. *Nature* 393(6684): 440-442.
Wernerfelt B. 1984. A resource-based view of the firm. *Strategic Management Journal* 5(2): 171-180.

LUCA GIUSTINIANO

Department of Business and Management
LUISS Guido Carli University
E-mail: lgiusti@luiss.it

CHIARA D'ALISE

Department of Business and Management
LUISS Guido Carli University
E-mail: cdalise@luiss.it