

Four concepts of network: From connectedness to object-oriented collaboration

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Abstract

The proliferation of network research has confused the meaning of the concept of network. To enhance conceptual clarity, this paper distinguishes between four concepts of network: economic, social, socio-economic, and objectual. Each of these has a different understanding of the fundamental character of networks. They also differ in relation to methodological choices, understanding of the historicity of networks as well as trust and sociality within networks. Each of the concepts also regards different things as essential: in the economic concept, this is oscillation between market and hierarchy; in social, embeddedness of economic activity in non-economic sociality; in socio-economic, sociality and trust within economic activity; and in objectual, joint creation of use values by network partners. The article argues that the objectual concept of network is stronger than the others to make sense of the contents of network exchange, motives of the participants and foundations of trust in network collaboration.

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1. Introduction

After decades of peripheral use (Scott 2000), the term “network” emerged at the turn of the millennium as one of the most fashionable buzzwords in social and business research and policymaking. Networks of innovators were introduced as a key issue in innovation studies (Freeman 1991) and, later on, the science and technology policy of the Organisation for Economic Co-operation and Development (OECD 1998). Further, the idea of the intentional planning of networks became a part of business management research (Håkansson and Snehota 1989), whereas the World Bank employed the notion of social capital, a close relative of network, with social scientists and economists becoming engaged in its measurement and promotion (Woolcock 1998). Actor network theory, in turn, gained popularity with its original network ontology (Latour 1993), and sociologist Manuel Castells (2000) renamed our era “the network society”. And, economic and organizational sociologists studied networks in relation to two traditional forms of economic activity, i.e., markets and hierarchies (Granovetter 1985; Powell 1990). Finally, social network analysis (Wasserman and Faust 1994), following the sociometric tradition, gathered momentum.

Network research therefore has grown into a multi-disciplinary field of numerous established approaches. These have different origins, underline different aspects of networks, rely on different research methods and data and lead to different guidelines for networking. In so doing, they also use and develop different concepts of network. We will make a distinction between four such concepts: the economic, social, socio-economic and activity-based objectual concept of network. These concepts are ideal types that in practice exist as hybrids. They cross disciplinary boundaries but have stronger ties to some research approaches than others.

On the most abstract level, networks are understood as formal structures of nodes,

links, and network positions (Nohria 1992: 4; Castells 2000: 501). In the form of social network analysis, this conception has been applied to a wide range of organizational topics from group problem solving to world political and economic systems (Wasserman and Faust 1994: 5–6). It holds that actors are not autonomous units but nodes in a larger constellation of links. The lasting patterns of these links are represented as quantifiable variables, such as centrality, betweenness, and cohesion, that provide “opportunities for or constraints on individual action” (Wasserman and Faust 1994: 3–4). Two kinds of criticisms have been presented against this view. First, when the activity of nodes is being explained by the node-link structure, little attention is paid to “what flows across the links” (Stinchcombe 1990: 381), i.e., to “the content of what it is that is being exchanged” in networks (Powell and Brantley 1992: 389). Second, the structural explanation of action lacks an adequate concept of agency. The critics thus point out that to make sense of networks we need to know the “values, preferences and projects” of their members (DiMaggio 1994: 39).

Departing from this ontological stance this article discusses four other ideas about networks. The first, *the economic concept of network*, is exemplified by transaction costs economics (Williamson 1985; 1996). According to it, a network, such as a long-term contract between companies, is an outcome of economic calculation. In the optimization of a firm’s transaction costs, the network is a compromise between the flexibility of a market and the managerial control of a hierarchy. The new economic sociology (Granovetter 1985) has developed the social concept of network wherein economic relationships acquire network character through their embeddedness in trust-based social relationships that are a condition for efficient economic collaboration. The socio-economic concept of network has emerged as a critique of the economic one and finds networks to be an emergent form

of organization that are needed in innovative activity and in the production of complex products. Finally, the activity-based, objectual concept of network has its roots in science and technology studies (Miettinen 1999) and in cultural-historical activity theory (Engeström and al. 1999). It claims that an object of collaboration (technology, product) is the key motive of interaction and determines what kind of complementary expertise is needed in the work of creating an innovation.

In what follows we will clarify the central methodological challenges of each concept and highlight important disagreements between them. Three such challenges become evident through the comparison: the historicity of networks, the origins and foundations of trust and sociality in network interaction and the relationship between the structure and content of interaction in networks. We will discuss each of the network concepts separately, analyzing their position in relation to the methodological challenges taken up above.

2. The economic concept of network: network as a hybrid of market and hierarchy

In neoclassical economics, a market is a borderline case of cooperative activity. It is about rational, self-interested behavior that is only minimally affected by social relations. “Under perfect competition there is no room for bargaining, negotiation, remonstrations or mutual adjustment, and the various operators that contract together need not enter into recurrent or continuing relationships as a result of which they would get to know each other well” (Hirschman 1992: 123). Real markets are more or less saturated by social relations. From the neoclassical viewpoint these relations, however, are irrational albeit transitory departures from the ideal competitive model.

More recently, transaction cost economics (TCE; Williamson 1985), a descendant of neoclassical theory, has pushed the asocial nature

of homo economicus a step further. In neoclassical theory self-interest-seeking actors are rule followers who adhere to contracts and disclose all pertinent information on inquiry. TCE deprives them of these social virtues and analyzes economic activity in terms of “opportunism.” According to Williamson (1985: 47), opportunism “refers to the incomplete or distorted disclosure of information, especially to calculated efforts to mislead, distort, disguise, or otherwise confuse”. It is “self-interested seeking with guile” which “includes but is scarcely limited to more blatant forms, such as lying, stealing, and cheating” (Williamson 1985: 47).

The homo economicus of TCE is also impaired by “bounded rationality” (Simon 1957), which refers to the limited capacity of economic actors to deal with complex problems and thus to make fully rational choices. Obviously, opportunism and bounded rationality are problematic bases for contracts. They render contracts unavoidably incomplete and complex contracts unfeasible. Some theories (e.g., Macaulay 1963) may take this as a reason for replacing formal contracts with handshakes and trust. In its opportunistic world this kind of behavior would be non-rational for TCE. Instead, it makes breaches of contract expensive by building cost-effective contractual safeguards.

In TCE, the existence and dynamics of economic institutions, such as markets (contracts between firms) and hierarchies (internal authority structures of firms) is explained by opportunism and bounded rationality. Institutions exist to “organize transactions so as to economize on bounded rationality while simultaneously safeguarding them against the hazards of opportunism” (Williamson 1993: 59). When calculating transaction costs, firms oscillate between “make” and “buy”, i.e., internalizing transactions into their hierarchy and externalizing them on the markets. In general, transactions that are uncertain, repetitive and require specialized resources will most likely

take place within hierarchies. More straightforward and non-repetitive transactions are dealt with on the markets.

As well as TCE, several other theories also emphasize firms as independent entities vis-à-vis markets. Organizational identity theory (OIT), for instance, emphasizes the central, distinctive, and enduring characteristics of an organization (Albert and Whetten 1985) and pays attention to the ways in which organizations create boundaries by socially defining themselves, i.e., answering questions like “Who are we?” and “Who do we want to become?” (He and Brown 2013). The resource-based (RBV) view, on the other hand, focuses on an internal analysis of a company’s valuable, rare, inimitable, and non-substitutable resources and the use of these to achieve sustained competitive advantage (Barney 1991). Finally, resource dependence theory (RDT), developed by Jeffrey Pfeffer and Gerald Salancik, conceptualizes firms as open systems that try to minimize their critical resource dependencies on external actors with the help of diverse managerial strategies, such as vertical integration, inter-organizational alliances, political action, executive succession, and revision of board composition (Hillman and al. 2009, cf. Håkansson and Snehota 2006). Because the focus of analysis in OIT and RBV is predominantly internal to an organization, we shall continue to address the economic concept of network by referring to TCE and RDT.

Although the sources of environmental uncertainties are understood differently in TCE and RDT, both theories emphasize the focal firm’s perspective in managing these. In RDT, resources, activities, and behaviors that lie outside the focal firm’s control are regarded as environmental factors. If these are critical to the firm’s performance, i.e., if the firm is dependent on them, it will seek to minimize its dependencies either by internalizing the resources in its own organization (mergers, acquisitions) or absorbing them by using

inter-organizational alliances. When oscillating between these alternatives, the firm considers their short-term coordination costs as well as prospects for its long-term survival and growth (Malatesta and Smith 2014). As noted by Malatesta and Smith (2014), the inter-organizational alliances discussed in RDT are thus similar to what Williamson (1996) calls networks, or “hybrids”: various modes of the governance of “bilateral resource dependency” between firms, such as long-term contracting, reciprocal trading, and franchising. In TCE, markets, hierarchy, and networks are commensurable as efficient forms of transactions and as the objects of rational calculation. In dealing with the risk related to asset specificity, hierarchy is not the only possibility, but, along with RDT, another option is a contractually safeguarded network, given that the added investments in its governance are cost-effective.

Both theories thus see the inter-organizational alliances as issues of coordination and control. They also share the idea that such relations are “founded on opportunism and bounded rationality, and that organizations seek to control the critical aspects of their business network interactions in order to pursue their goals” (Rossignoli and Ricciardi 2015: 7). The theories, however, differ in their views on networks. RDT regards an entire industry as a network of interdependent companies, each of which seeks to acquire positional advantage in relation to others by means of exercising power (Rossignoli and Ricciardi 2015). TCE, in turn, considers that network is not a unique, qualitatively different form of organization but rather an intermediate fusion between market and hierarchy. Network lags behind market in economic incentives and individual adaptation but is well ahead of hierarchy. In control and coordinated adaptation network beats market but loses to hierarchy, in which administrative orders replace time-consuming and expensive contracts. According to Williamson (1996), a network

is a hybrid of a market and hierarchy, not *with* them. Without a distinctive social quality of its own, it tends to be a transitory phase in the oscillation of firms between the two dominant forms of transaction.

In an opportunistic economy, the natural mindset is calculative. Williamson (1993) takes pains to prove that calculativeness makes a social tie strong enough to explain economic cooperation and that there is no need to refer to trust. According to him, this applies also to what is conventionally taken as an exemplary case of trust: diamond dealers in New York City. They seal deals with a handshake and without such institutional market elements as formal contracts and legal sanctions as back-ups. However, Williamson (1993: 471-472) argues that what is replacing these institutions is not trust but other institutions like private law, reputation bonds and the arbitration system of a close-knit Jewish community that enable the community to provide “cost-effective sanctions” for individual actors. For TCE, trust in economic relations is thus a misnomer of what, under closer examination, turns out to be a farsighted calculation of the benefits, risks and safeguards of transactions. Instead of trust, calculation implies a predictability of institutions achieved by sanctions hard enough to make the breaking of their rules economically irrational. Calculation and trust are mutually exclusive. Trust is non-calculative and therefore belongs to “very special relations between family, friends and lovers (Williamson 1993: 484). In a similar vein, RDT represents an economic explanation of inter-organizational alliances (Barringer and Harrison 2000) and largely omits discussion on trust: resource dependencies are the primary motivators for forming alliances by the use of which firms seek to increase their power over others in their operating environments.

3. The social concept of network: social embeddedness of the economy

What economics throws out, sociology brings back in. Sociology has traditionally taken social relations as the necessary underpinning of markets and hierarchies. An approach known as new economic sociology (Granovetter 1985) posits that networks obtain social content that separates them from markets and hierarchies. Networks, defined as personal relationships, are the real basis of an economy in which well-functioning markets and hierarchies are embedded. Granovetter (1985: 488-490) argues that the contribution of TCE suffers from a dualistic position. It is “undersocialized” and “oversocialized” at the same time. It is undersocialized by its notion of opportunistic economic action and oversocialized in resorting to institutions as a resolution of the problems caused by opportunism. What is missing is the middle ground between individuals and institutions; the sociality consisting of ongoing personal interaction and social networks formed in this interaction. It is well known that “business relations are mixed up with social ones” (Granovetter 1985: 495), and that “[f]riendships and longstanding personal connections affect business connections everywhere” (Lohr 1982, cit. Granovetter 1985: 497). Refined into a methodological principle, this fact is called the “social embeddedness” of the economy.

New economic sociology views the real working of markets and hierarchies as an accomplishment of social networks wherein both are embedded. Look at a longstanding market relation and you will find a strong social network. An example is a long-term, fixed-price contract between contractors and subcontractors in the building industry (Granovetter 1985: 497-498). Economic rationality would suggest that these contracts are an incentive for subcontractors to shirk their performance requirements. This leads a contractor to either submit problematic

transactions to market competition or internalize them into the firm's hierarchy. Yet this does not happen, because the contractor-sub-contractor relations are embedded in the professional community of the building industry. This community is a much more effective way than a hierarchy to control the interaction. In addition, the economically rational reaction of the contractor would prove harmful by destroying the long-term social relations and the pleasure of the interaction accompanying them. Hierarchies are embedded in the same way. The best explanation of the efficiency of internalized transactions is not hierarchy as such but the fact that social networks within hierarchies can be denser than is possible between firms in markets (Granovetter 1985: 502).

Social networks are created and maintained in various places. For instance, in Uzzi's (1999) study on the banking business these include "wedding invitations, parties, dining, sports competitions, shows, and other social events" (Uzzi 1999: 484) that is, a social world beyond factories and offices. Granovetter (1985: 486, 498) adds to these kinds of venues of pure sociability work-related ones, such as professional communities and social interactions in workplaces. Social relations that develop in these contexts are saturated by familiarity, friendship and trust. Trust is here defined as the opposite of institutional arrangements which are its "functional substitutes" (Granovetter 1985: 489).

Apart from its economic-behaviorist formulations (Zafirovski 2005), social exchange theory can be regarded as an early variant of the social concept of network. Emerging from the seminal work of Bronisław Malinowski, George Homans and Peter Blau (Cropanzano and Mitchell 2005), the theory provides a general "frame of reference" (Emerson 1976: 359) to understanding human behavior in terms of exchange relations between actors. According to it, social relationships are composed of purposive actions by interdependent actors

who sustain reciprocity of long-term social relations by "giving others something more valuable to them than is costly to the giver" (Cropanzano and Mitchell 2005: 3). By means of establishing such mutually advantageous relations, actors thus engage in exchanges where they not only seek their own benefit but also gradually build trust and commitment, and thereby establish explicit or tacit norms that further strengthen ongoing reciprocal relations (Lambe and al. 2001).

In recent decades, social exchange theory has been used to analyze exchange relationships that take place in a variety of institutional contexts, including business-to-business relations (Lambe and al. 2001). Moreover, it has been acknowledged as compatible with literature on social capital (Adler and Kwon 2002), and has also figured in relation to the formal characteristics of network as a factor which is supposed to explain why some people, organizations, regions, and nations do better than others. According to Burt (1992; 2001), for instance, brokers bridge networks with "structural holes" between otherwise unconnected and non-redundant sources of information. They have a more social capital and competitive advantage compared with actors in "closed" networks with redundant ties between unconnected sources of information. Granovetter's (1973) thesis about the "strength of the weak ties", was a forerunner of this idea. Thereafter many others have come in on the debate on impacts of these two types of network structures and, respectively, the "bridging" and "bonding" social capital (Putnam 2000, 22-24).

Along with the research cited above, the social concept of network fills the network with a distinctive social content. In contrast to neoclassical and neoinstitutional economics, it brings these socialized networks into the economy. Economics is based on the duality of nonsocial, "rational" economic behavior and "nonrational" social behavior excluded from the economy. The social concept of network

reunites these two by embedding markets and hierarchies in social networks. However, the duality is bridged in a way that keeps it fundamentally unchanged. Embeddedness implies nonsocial markets and hierarchies that need to be embedded in extra-economic social networks (cf. Krippner 2001: 778). According to Uzzi (1996: 674), it “refers to the process by which social relations shape economic action [...]”. The main causal arrow goes from social networks to economic relations. Social determinism is accentuated by cementing embeddedness as a transhistorical constant: all economies are embedded in social networks in basically the same way (Granovetter 1985: 482–483).

As embedded in social networks, economic relations get their share of the network sociality. Then, a “behavior that is culturally associated with familiar and non-commercial transactions is enacted as a part of the commercial exchange” (Uzzi 1999, 484). According to Uzzi (1999: 484), embeddedness provides “an essential *primary mechanism* that promotes initial offers of trust and reciprocity that, if accepted and returned, solidify through reciprocal investments and self-enforcement”. Having been successfully embedded, economic cooperation can realize the social capital of networks, for instance, as better information and privileged access to resources (Granovetter 1985: 490).

The emphasis on social networks may turn out to be problematic in accounting for the emergence of new economic networks. These have disintegrating effects on traditional work and residential communities, and as short-lived projects are not ideal in bringing about stable social relations. The result is an aggravation of “problem of trust” (Seligman 1997), a paradoxical situation where emerging institutions desperately need trust while themselves undermining its social basis. Signs of this self-destructive tendency of the economy and society include the “corrosion” of the committed and trustworthy employee char-

acter (Sennett 1998) and a lack of “adequate stocks of social capital” upon which “our economy, our democracy and even our health and happiness depend” (Putnam 2000: 28).

Although these analyses may not say much about new forms of network sociality, their message about the decline of the old social bases of the economy is compelling. Characteristic of current economic networks is their disembeddedness from traditional work and residential communities. In order to take seriously the social potential of the network cooperation, the dualistic frame of the non-social economy and the extra-economic sociality must be expanded to the non-dualistic social economy.

Since early capitalism there have been theorists who find that the market nourishes social virtues like honesty, civility and trustworthiness, as opposed to others who see it as a source of alienation and moral corrosion. As Hirschman (1992: 139) points out, along with the economic and social concepts of network there is a third alternative, which acknowledges that both opposite theses could hold true simultaneously: economic relations can be seen as a combination of self-interested individualism and social cooperation (Gintis and al. 2005) and the economy as a “moral economy” (Sayer 2000) with a much wider spectrum of rationalities than monetary calculation only.

4. The socio-economic concept of network: networks as organizations of innovation

The specific character of the socio-economic concept of network can be summarized in three major claims. First, networks are historically new, emerging phenomenon characteristic of the knowledge economy of the late 20th century. Second, their emergence stems from the growing necessity to combine specialized complementary resources especially in high-technology industries. Third, they exhibit a specific social character if compared to

markets and hierarchies. The socio-economic concept of network thus enables the reunion of two features of networks that were once regarded as exclusive: their specific sociality compared with markets and hierarchies, and their economic character.

A growing body of research on networks treats networks as an economic form parallel to markets and hierarchies (e.g., Powell 1990; Adler 2001; Thompson 2003; Benkler 2006). Views on the relation between these three forms vary. We find Powell's (1990) two-way definition as a standard. On the one hand, in contrast to the economic concept of network, a network is "neither market nor hierarchy" (Powell 1990: 277-279) but differentiated from these by its specific social character. The difference is crystallized in their respective coordination mechanisms: in markets, it is the price, in hierarchies, authority, and in networks, trust. On the other hand, in contrast to the notion of embeddedness, the sociality is not exogenous but endogenous to networks as a form of economic exchange (Powell 1990: 300).

In contrast to TCE, evolutionary economics argues that many networks are built to reduce the uncertainty of technological and market development and to bring about successful innovations with the extra profits these entail (DeBresson and Amesse 1991). The significance of these reasons emerges, for instance, from research on inter-firm alliances (Freeman 1991). The specificity of the network may become visible in the context of innovation, which often requires combination of specialized, complementary knowledge, technologies and know-how. In innovation studies, Powell and others (Powell and al. 1999) have explained the growth of biotechnology firms in terms of their "network centrality", measured by the number and diversity of links between organizations operating in the biotechnology field. The firms with the most relations are also the swiftest to increase them and, thereby, to open new avenues to

innovative activities. Also supplier networks (Saxenian 2000) and user networks (von Hippel 2005) are increasingly geared towards innovation.

In contrast to the economic and social concepts of network, the socio-economic concept connects networks to socio-economic evolution. On the one hand, it can be assumed that network cooperation is coeval with market and hierarchy (cf. von Hippel 2005: 77-80). On the other, market, hierarchy and network can be seen as historically successive forms. Broadly speaking, competition between market-oriented firms dominated until the end of the 19th century and large hierarchical corporations until the end of the 20th century. The rise of networks took place towards the turn of the millennium: an "extremely rapid growth" (Freeman 1991: 504) of innovation networks was observed due to the emergence of the "information-technological paradigm" (Freeman and Louçã 2001). Network can thus be regarded as a new organizational form characteristic to the current knowledge economy (Powell and al. 1996; Adler 2001).

In the socio-economic concept of network, the link between network and innovation is related to the production and distribution of knowledge (Powell and Grodal 2005). The increasing complexity of products requires new combinations of knowledge, technologies, actors and skills as well as various settings of production and use (Hobday and al. 2000). The scope of innovation expands beyond production and marketing as a result of intensified customization and user involvement (von Hippel 2005) known as continuous "reconfiguration" (Castells 2004: 10) or "co-configuration" (Victor and Boynton 1998). Products are also expanding to include services: in the US software industry two-thirds of revenues come from services (Benkler 2006: 45). Furthermore, services are developed quickly, as innovation-based economic competition is characterized by a "winner takes all" attitude. This is why keeping pace with the develop-

ment of knowledge and reducing the time between invention and marketable product becomes essential (Powell 1990).

There can be seen a “match” between these new dimensions of competition and the specific social character of networks (Freeman and Louçã 2001). As organizational structures for mobilizing distributed actors and resources, networks are characterized by comprehensiveness and precision (Benkler 2006). To combine complementary resources, networks cross the organizational boundaries of markets and hierarchies vertically, between producers, suppliers and users, and horizontally, between different technologies, disciplines and expertise. These new social relationships are also supposed to change the content of collaboration and communication.

To be transferable in the market, knowledge must be explicated, packed and priced. And when a transaction takes place, it flows mainly one way, from seller to buyer. The same applies to hierarchies where standardized knowledge moves predominantly top-down from supervisors to subordinates and from planning departments to production units. Networks, in contrast, enable exchange that is more informal, intensive and comprehensive (Powell 1990; Ebers 1999; Adler 2001; Håkansson and Snehota 2006). As Powell (1990: 304) claims, networks are especially useful for the exchange of commodities whose value is not easily measured. Such qualitative matters as technological capability, a particular style of production, a spirit of innovation or a philosophy of zero defects are very hard to put a price tag on.

When consolidated, network relations also foster transformation of tacit knowledge into explicit one, thus accelerating knowledge production and transfer (Powell and Grodal 2005: 75). This double capacity of a network to connect diverse actors having complementary capabilities with channels for complex communication makes it “the locus of innovation” of complex knowledge-intensive products

and services. By combining dispersed knowledge, networks open up opportunities for their novel synthesis that is a typical mechanism of innovation (Smith-Doerr and Powell 2005: 385–386).

Because of the built-in uncertainty of their outcomes and means, emerging innovations are not specified enough to be coordinated by contracts or managerial control based on monetary calculation. Thus, differing from the economic and social concepts of network, the socio-economic concept views trust as a mode of economic rationality that is needed when neither calculation nor social networks are enough. For instance, Cohen and Fields (1999) found that networks in Silicon Valley are kept together by a “performance-based” trust, which is learned and reinforced through successful economic cooperation (also Meyerson and al. 1996; Sabel 1993; Adler 2001). Calculation, contracts, prices and monitoring are turned into its tools, as in the case of the common profit-sharing plan of the assembler and supplier in a car manufacturing network (Womack and al. 1990: 146–153). Another example of how formal contracts and profit sharing schemes complement more subtle, social methods of trust formation is provided by Tuunainen and Miettinen (2012) in their study on trust formation in the biotechnology sector. Together with analysis by Tuunainen (2011), this study lends support to the conclusion according to which “formal written contracts and trust are complementary mechanisms for governing inter-firm relations, both of which are needed to successfully manage joint product development work” (Tuunainen and Miettinen 2012).

5. The activity-based objectual concept of network: collaborative construction of use values

The fourth, activity-based, objectual concept of network tries to make visible the joint creation of a shared object (i.e., product, service) by the network members and, at the

same time, the network itself. To allow this, knowledge and data of the content of the network interaction needs to be provided. The data need to cover the process of product development from the emergence of the idea to the market introduction. In this sense, the object-oriented approach converges with empirical studies of innovation process and uses observations, interviews, documents and developmental interventions as data (Van de Ven and al. 1999; Miettinen and Hasu 2002).

Two theoretical traditions, actor network theory (ANT) and cultural-historical activity theory (CHAT), have contributed to the development of the objectual concept of network (Miettinen 1999; Spinuzzi 2008). ANT defines itself as relational materialism (Law 1994) or distributed monism (Latour 1993). Its methodological maxim is: "Follow the actors, both as they attempt to transform society and as they seek to build scientific knowledge or technological systems" (Callon and al. 1986: 4). CHAT, on the other hand, analyses human activity as object-oriented and mediated by artifacts. Although the two traditions have methodological affinities, namely antidualism and recognition of the key significance of material artifacts, they conceptualise the object and the network differently. ANT focuses on power and rhetoric, while CHAT concentrates on human agency, complementary cultural contributions by the network partners in object construction, as well as learning (Engeström and Escalante 1995; Miettinen 1998; 2014).

The early form and a forerunner of actor network theory, the sociology of translations, introduced the concepts of power and politics to characterise network relations. The concept of translation, adopted from the French philosopher Michel Serres, was defined in terms of "negotiations, (...) acts of persuasion and violence thanks to which an actor or force takes (...) authority to speak or act on behalf of another actor or force" (Callon and Latour 1981: 279). In this perspective, a spokesman, an

entrepreneur or an innovator, enrol other actors into a network. He or she also transforms their interests and makes the participation in the network an obligatory point of passage for them. The actor-network theorists thus compare the spokesman of new technologies to Machiavelli's Prince "who is skillful of managing variable and unexpected social forces" (Callon and al. 1986: 7).

According to Latour (1992: 282) the new generalised principle of symmetry is "the most important philosophical discovery" of ANT. According to this principle, the same kind of treatment should be given to both human and non-human elements of the networks that are called actants (Callon 1986). Correspondingly, actor networks are characterised as heterogeneous networks of different kinds of actants, i.e., "techno-economic networks" (Callon 1991), "collectives of humans and non-humans", (Latour 1991) or "hybrid collectifs" (Callon and Law 1995).

From the viewpoint of activity theory, the symmetrical analysis of networks has three serious problems (Miettinen 1999). First, it does not provide any criteria for defining the nature and scope of actors in advance. A complete description of actants is needed for an explanation (Callon 1991: 155). However, in any innovation network the number of potential elements is almost unlimited. A sympathetic user of ANT expressed this problem by saying: "I found myself constantly overwhelmed by the number of actants that could be construed (...). In short, I was paralyzed by the choice of actants to follow (...)" (Rachel 1994: 810). Second, in empirical accounts of innovations, those speaking most loudly, typically innovators, managers and politicians, tend to be selected as the most important actants. Star (1991) called this a managerial or an entrepreneurial model of innovation and networks. Engineers, workers and users as well as technological elements tend to remain without voice and agency (Czarniawska 1997: 19). The third problem of ANT is its "complete

indifference in providing a model of human competence” (Latour 1997: 4). ANT does, however, implicitly provide a theory of human competence, the competence of the prince in negotiating and exercising power. Although power and politics are important aspects of networking, this approach largely ignores the agency and motives of partners in networking, development of expertise, learning as well as the complementarity of resources and know-how in network construction.

Cultural-historical activity theory is based on the work of psychologist Lev Vygotsky (Vygotsky 1978; Engeström and al. 1999) who introduced the concept of cultural mediation which refers to the interaction between a human agent and the world mediated by tools and signs. The internalisation of cultural means (e.g., language, tool use) in joint activities constitutes the foundation of human thought and action. On the other hand, human actions, intentions and cognitive norms are objectified into cultural artifacts, namely concepts, instruments, methods and rules. The follower of Vygotsky, Aleksei N. Leont’ev (1978), argued further that individual actions are always formed in joint, collective activities, such as work organizations, characterised by division of labour and rules. Accordingly, the unit of analysis in studying human activity should be an activity system, a community of actors (or an organization) who has a joint object for its activity (Engeström 2014). Correspondingly, a network is analysed in terms of a network of human activity systems (e.g., work communities or organizations).

An object of activity understood as a motive, purpose or focus of engagement, is a driving force behind an activity.¹ It is the “why” of an activity and is realised through construc-

tion of products and services that satisfy human needs. The object constructed together thus constitutes a central motive for collaborative activity. It drives the collaboration and supplies the stakeholders with a horizon for their future actions. Because objects are increasingly complex systems, different kinds of complementary expertise and resources need to be mobilised through network collaboration. In an activity theoretical perspective, the composition of the network changes during the object construction process, depending on what kind expertise is needed in different phases of problem solving (Miettinen 2000).

The intentionality and agency in collaborative object construction in networks is explained on two levels. First, a vision of a new object or use value, that is, technology or service, is projected to serve as a means of solving a functional problem or a contradiction of a societal or productive activity (Miettinen 2014). A classic example of this is the steam engine. It was originally developed at the turn of the 16th and 17th centuries as a pumping device to solve the aggravating problem of water concentration in coal mines (Seidel 1976). A more recent example of an object is an immunodiagnostic method based on fluorescence that was developed to solve various problems caused by the use of radioactive labels in diagnostic work (Miettinen 2000).

Second, the commitment of partners to a joint project needs to be explained. The reasons for different partners to collaborate are related to their emerging needs to expand their expertise, find new products, raw material or market, or resolve specific problems evolving in their activities (Miettinen 1998). In providing an explanation of the emergence of collaborative agency, Miettinen (2014) has

¹ Both Russian and German languages have separate words for an object (‘objekt’ in both languages) that is an existing material thing and an object of activity (predmet, Gegenstand), that is an object of conscious transformation by humans able of resisting the projections of the humans. In the English language, the term object is used for both meanings, which is a cause for confusion.

developed the concept of creative encounter, which is an event or a process in which two or more persons representing different organisations meet face-to-face and recognise the complementarity of their expertise and resources for the creation of a new artifact that can solve a problem in a human activity. A creative encounter thus leads to the emergence of a collaborative agency, which assumes the form of a joint project.

Activity-theoretical studies on object-oriented product development networks have uncovered two dimensions that have not been in focus of the other approaches. First, instead of seeing networks as structures with homogenic ties, activity theory analyses networks in terms of historically formed layers of relations that evolve during object-related collaboration (Miettinen and al. 2008). The nature of interaction within these layers varies from joint object construction in product development to contract-based routine collaboration and to non-active, latent relationships that can be re-activated whenever ideas about new projects emerge (Starkey and al. 2000; Tuunainen and Miettinen 2012).

Second, activity-theoretical analyses have shown that different forms of collaboration coexist and change during product development processes. As product development turns into commercialisation and marketing phases, the early use-value-oriented trust and expertise-based networks tend to be replaced by exchange-value-oriented market and hierarchical relations. An example of this is the development of the Phusion enzyme analysed by Tuunainen and Miettinen (2012). The case of Delfia technology, on the other hand, shows that this qualitative transformation of network relations is not always straightforward. In this case, the owner prohibited a biotechnology firm from producing novel diagnostic kits as they did not fit into the owner's main lines of products and because it, therefore, did not have marketing channels to distrib-

ute them (Miettinen 2000). In the same case example, an early trust-based professional collaboration between key partners ended up in a bitter dispute about the recognition of inventive novelty and of the share of returns generated by selling the new product, an issue which destroyed the successful collaboration network.

An important analytical capacity of the objectual concept of network is that it facilitates understanding of emerging forms of networks, such as Internet-mediated open source communities and transnational networks of civil society organizations. Linux and Wikipedia are paradigmatic examples of the former. Research that analyses open source software development (e.g., Weber 2004; Benkler 2006) has shown that the commitment of contributors in these projects can best be explained by the use-value qualities of the object: the contributors in networks are constructing better tools for themselves and other users. Also von Hippel (2005) provides examples of product development processes by user communities in multiple areas such as software, medical innovation, library systems, and sports. Recently, user-run Internet forums, such as those related to energy-related heat pumps, have shown that people come together in networks for the purpose of exchanging information, providing peer support, comparing use experiences, and suggesting improvements to the devices in use (Hyysalo and al. 2013). Thus, these kinds of networks are not based on close social ties or contracts but are driven by shared objects and problems of their use.

Another recent phenomenon is the transnational networking among civil society organizations (Evans 2008). An example of these kinds of networks is the co-operation between Rainforest Action Network (California), Environmental Paper Network Europe, Siemenpuu Foundation (Finland), and the Jikalahari rainforest protection network in

the Riau region in Indonesia.² These organizations collaborate and coordinate their actions in campaigns with several specific objects, such as resisting the conversion of rainforests into oil palm plantations for the pulp and paper industry. The campaign works against climate change and defends the rights of local communities and the distraction of wildlife habitats. The aforementioned and other organizations (WWF, Greenpeace, Bankwatch) participate in the network to provide their expertise and connections to advance the objectives of the campaign. It is evident that these kinds of networks differ from business networks since the use values being pursued—social and ecological sustainability—are ethical, ideological and political in nature. The “networks for alternative globalization” (Evans 2008) thus constitute an interesting, emergent type of activity, in the analysis of which the other network concepts can hardly play significant role.

Conclusion

The four concepts of network discussed in this paper attempt to reveal the specificity of networks as a part of economic and social activities. The concepts discern the essential features of networks in different ways and prepare the way for the study of networks with dissimilar methods and data. They also provide contradictory accounts of some of the key dimensions in network collaboration, such as the historicity of networks and the nature of sociality and trust in network interaction. The following Table sums up the key features, similarities, and differences between the network concepts.

When it comes to the basic understanding of the network, different concepts provide alternative theoretical lenses: the economic con-

cept defines the network as an organizational form designed to economize on transaction costs, social as an extra-economic relation embedded in trust and reciprocity, socio-economic as a combination of complementary resources in innovation and activity-based objectual concept as historically evolving object-oriented collaboration. The typical units of analysis correspond with these theoretical perspectives and range from economic calculations to social connections, innovation processes, and interconnections among innovators, users, and civil society organizations. As far as the historicity is concerned, the first two concepts suggest that networks embody an unchanging, transhistorical content, while the latter two regard networks as historically emerging forms of organizing production and political action. Finally, trust and sociality play a different role in each of the network concepts. In the economic concept, trust and sociality are subsumed into the calculativeness of the economic actors and consolidated by formal contracts and legal sanctions. The social concept finds trust to be a foundational phenomenon and suggests that it develops through extra-economic social relations. The socio-economic concept takes trust as a basic “coordination mechanism” of networks and sees it as a “performance-based” phenomenon, which emerges within economic activity. Finally, the objectual concept agrees with this and finds the shared use-value-oriented motives of collaboration and the complementary expertise of the partners as important foundations of trust. In transnational networks of civil society organizations, moral and political values also provide a strong foundation for trust.

The different concepts of network are partly an outcome of the methodology used

²⁾ Rainforest action network (RAN) was established in 1985 as a nonprofit public benefit corporation to conduct research and educate the public about environmental issues. Its mission is to “campaign for the forests, their inhabitants and the natural systems” (Rainforest Action Network 2016).

Table. Key features of the four concepts of network.

CONCEPT OF NETWORK	BASIC UNDERSTANDING OF NETWORK	TYPICAL UNIT OF ANALYSIS IN EMPIRICAL RESEARCH	HISTORICITY	NATURE OF SOCIALITY AND SOURCES OF TRUST
ECONOMIC	A form of organization selected on the basis of economizing on transaction costs	Calculations in forming a contract	Transhistorical: opportunism and bounded rationality are characteristic of all economic behavior	Excluded from economic behavior
SOCIAL	Embeddedness in trust-based unofficial social relationships	Personal networks as a source of knowledge and resources	Transhistorical: embeddedness is characteristic of all human societies	Trust between partners emerges from personal interaction in social activities outside the economy
SOCIO-ECONOMIC	Historically new form of sociality within economic collaboration characteristic to innovation and new technologies	Evolution of network structures in new fields of technology	Specific organizational form of information technological revolution/ knowledge society	Performance-based trust within economy
ACTIVITY-BASED OBJECTUAL	Historically evolving object-oriented collaboration in product development and use, and in political activity	Innovation process and trajectory of product-development collaboration, user communities, and transnational networks of civil society organizations	Organizational form of high-technology / cognitive capitalism and alternative global governance	Object and competence-based trust, shared motive as well as ideological and moral commitment

in the empirical studies on networks. These methodologies entail the ways in which networks are analytically delimited, the kinds of empirical data used, how that data is analyzed as well as how the results are presented. Economic and social concepts of network are often based on case examples. The community of New York diamond dealers, for instance, is a case which was used both to support (Granovetter 1985) and refute (Williamson 1993) the thesis of social embeddedness.

The socio-economic concept, in turn, regards networks as trust-based organizational forms that are alternative to markets and hierarchies. They enable the transfer of knowledge between partners and foster the combination of complementary capabilities. However, in using data of firms' contracts and analyzing the frequency of contractual relations to uncover changes in network structures, it shares the abstractness of social network analysis by

presenting the network structures in graphical form, based on the number of ties between the nodes (e.g., Powell and al. 1999). This methodology does not allow for a detailed analysis of the specificity of the networks, content of interaction between the partners or learning and formation of trust between them.

Finally, the activity-based objectual concept of network directs attention to the development of a product, the historical trajectory of innovation or a project, and particular histories of the collaborative relationships. In line with these units of analysis, the approach combines documents with interviews in addition to ethnographical observations of actual situations of collaboration (Miettinen and Hasu 2002). Its methodological approach is oriented towards overcoming the structural bias embodied in social network analysis. It is also capable of revealing collaborative rela-

tions that are not based on formal contracts (Tuunainen and Miettinen 2012), analyzing contributions by the main actors in different phases of joint work as well as addressing the qualitative changes in the network collaboration (Miettinen and al. 2008).

Although the four concepts of network are based on different presumptions and units of analyses, on the methodological level they could provide complementary research approaches. Already now, some representatives of the socio-economic concept have applied the methods of social network analysis to understand the development of high-tech industries in different regions. In future, the regional mapping of industrial networks could be combined with case-based analytical approaches of the objectual concept of network, too. This research approach could proceed in two phases: First, regional interfirm linkages based on contractual data could be mapped by using social network analysis. Second, the most important network clusters identified could be subjected to case-based qualitative and historical analysis with the help of the objectual concept of network. An example of research along these lines of development is provided by Cambrosio and others (2004).

On the basis of the present paper, three challenges for future research can be formulated. First, as suggested above, integrated research on networking is needed to overcome the theoretical and methodological limitations of individual approaches. This kind of research could combine structural analysis of networks with historical understanding of their formation and change as well as pursue an ongoing ethnographical analysis of key collaborative relations present in them. Second, there is a need for a deeper understanding about the nature of Internet-based technology or product-related forums so as to discern their specific characteristics in relation to more traditional types of networks. The research focusing on these might provide a fruitful basis for analyzing their charac-

teristics; for instance, in terms of objectual networks or, perhaps, communities and platforms of technology-based activities. Third, the emergence of new transnational networks of civil society organizations that seek to strengthen global democracy against neoliberal governance is an interesting opportunity for network research. Challenging the established corporate activities, these kinds of networks put pressure on firms to become engaged in what has been termed as corporate social responsibility and might thus open up an avenue to form linkages between distinct literatures, such as those of business economics, management studies, and moral and political theories.

Finally, the managerial implications emerging from the study are threefold. First, the paper suggests that a differentiated understanding of the historical layers of firm networks may contribute to strategic management of a company. To put it briefly, managers should regard the firm's previous partnerships as latent layers of network that can be re-activated in relevant future situations to address emerging contextual contingencies or opportunities. Second, the studies based on the objectual concept of network have identified typical challenges firms may encounter in different phases of product development collaboration. On that basis, actions to nurture and maintain trust-based collaborative relations can be defined. Third, the objectual concept of network underlines the managerial need to optimize the conditions for creative encounters. In practice, this requires deliberate actions by the use of which key employees of a firm expose themselves to representatives of other organisations and professional communities so as to open up a possibility for the recognition of complementary expertise and resources the firms in question may possess—for instance, to create new products. Based on such encounters, new collaborative product development projects may emerge.

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