Social Network Analysis and Critical Realism

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ABSTRACT

Social network analysis (SNA) is an increasingly popular approach that provides researchers with highly developed tools to map and analyze complexes of social relations. Although a number of network scholars have explicated the assumptions that underpin SNA, the approach has yet to be discussed in relation to established philosophies of science. This article argues that there is a tension between applied and methods-oriented SNA studies, on the one hand, and those addressing the social-theoretical nature and implications of networks, on the other. The former, in many cases, exhibits positivist tendencies, whereas the latter incorporate a number of assumptions that are directly compatible with core critical realist views on the nature of social reality and knowledge. This article suggests that SNA may be detached from positivist social science and come to constitute a valuable instrument in the critical realist toolbox.

Keywords: critical realism, positivism, social network analysis, social relations, causal mechanisms

INTRODUCTION

A Google Scholar search on "social network analysis" yields 3,740 results for the years 1980 to 2000, but no fewer than 34,800 results for 2001 to 2012.[1] Although these figures should be taken with a grain of salt (as should all such figures), they confirm what numerous scholars have previously noted, i.e., that the most recent decade has witnessed an explosion in the number of academic publications analyzing social networks. Originating primarily in sociology, social psychology, and social anthropology, network analysis has increasingly gained ground in social science disciplines, including political science, political economy, economics, and history. Notably, it has also been the subject of studies in psychology, mathematics, computer science, physics, biology, and medicine (on the origins and development of network analysis, see, e.g., Freeman, 2004 and Prell, 2012: 19–58). In addition, there is little agreement on the exact status of social network analysis

(SNA). Some scholars describe it as a theory, others describe it as a strategy or an approach, and still others describe it as a set of techniques. Some scholars even consider it to be a paradigm in its own right (see, e.g., Kadushin, 2012; Prell, 2012; Scott, 2011). In this article, SNA is understood as an approach that consists of two main layers. First, there is a "foundation" that consists of a set of rather homogenous methods for mapping and analyzing complexes of social relations (and applications of these methods). Second, there is a more heterogeneous "superstructure" consisting of academic studies and research that addresses the social-theoretical nature and implications of social networks.

Although often compatible with different philosophies of science, methods incorporate specific ontological and epistemological assumptions that tend to make them resonate better with some philosophies of science than with others. Critical realism is a philosophy of science that has gradually gained popularity throughout the social sciences. Indeed, readers of this journal are likely to be familiar with this philosophical perspective because it has been discussed and utilized in several articles over the years. Initially developed by Roy Bhaskar in the 1970s, critical realism was later refined by Bhaskar himself and by scholars such as Margaret Archer, Andrew Sayer, Andrew Collier, and Tony Lawson. Critical realism ascribes considerable importance to social structures and relations in the explanation of events and other phenomena in the social world. As SNA aims to map and analyze complexes of social relations, it is natural to consider to what extent the two schools of thought resonate and, therefore, to what extent SNA can be naturally integrated in social scientific analyses that are informed by critical realism.[2]

The literature does not offer much help in clarifying these matters. Although a number of network scholars have discussed the assumptions that underpin SNA, such scholars have not discussed SNA in relation to critical realism or other established philosophies of science. In a similar vein, the literature on critical realism, including the more methods-oriented parts of it, is silent on SNA.[3] For instance, Sayer's seminal *Method in Social Science* and *Realism and Social Science* (Sayer, 1992; 2000) do not mention network analysis methods. The same applies to Danermark et al. (2002), Buch-Hansen and Nielsen (2005), Manicas (2006) and Hartwig (2007). In Jose Lopez and Garry Potter's introduction to critical realism, John Scott—who has authored a widely read textbook on network analysis—briefly mentions SNA but without linking it to critical realism (Scott, 2005: 83). Finally, a small number of political economists who draw inspiration from critical realism have employed SNA methods (see Carroll, 2010; 2013; de Graaff & Van Apeldoorn, 2011) but (again) without reflecting on the extent to which the two are compatible. In sum, SNA has gone largely unnoticed among critical realists, and the SNA literature does not in any way draw on critical realist terminology or scholarship.

With a view to establish the extent to which a "match" between SNA and critical realism is possible and meaningful, this article aims to explicate the ontological and epistemological views incorporated in the SNA approach. To this

end, the article draws on contributions by major scholars in the SNA tradition, including Jacob L. Moreno, Ronald S. Burt, John Scott, Barry Wellman, Mark Granovetter, David Knoke, Mustafa Emirbayer, Linton Freeman, Stephen P. Borgatti, and Robert A. Hanneman, in addition to recent SNA textbooks. Social network analysts tend to present SNA as a homogenous school of thought. For instance, Freeman (2004: 6) suggests that "Social network analysis is one of the few social science endeavors in which people influence one another in such a way that they all work together to build a cumulative body of knowledge". In reality, however, there are—unsurprisingly—disagreements and tensions within SNA (Knox et al., 2006). This article argues that a significant, yet unrecognized, tension relates to the foundation and superstructure of SNA discussed above: whereas many of the studies that focus mainly on the social-theoretical nature and implications of networks embody views that resonate well with critical realism, much of the methods-oriented and applied SNA research is implicitly more in tune with—for lack of a better word—positivism. Furthermore, this article suggests that it is possible to "detach" SNA methods from positivist social science and make it a valuable part of a social science informed by the key tenets of critical realism. Indeed, a combination of SNA and critical realism can potentially enrich both perspectives considerably.

The argument proceeds in four steps. First, SNA is briefly introduced, and the diverse ways in which it has been applied in empirical research are illustrated.[4] The following section identifies certain problematic positivist tendencies in applied and methods-oriented SNA scholarship but suggests that social network methods can be—and have been—applied in a non-positivist fashion. The third section identifies six respects in which there are important similarities between critical realism and views expressed by leading social network analysts. The section prior to the conclusion then discusses how SNA can be used in social scientific research underpinned by critical realism.

1. SOCIAL NETWORK ANALYSIS

SNA scholars understand networks as sets of objects called "nodes" that are connected by one or more relationships called "ties". In the social science context, nodes can be a wide range of social units, such as individuals, groups, organizations, companies, governments, and countries. Likewise, a large variety of relationships can be studied, relating, for instance, to club membership, family, information flows, ownership, competition, and employment. In brief, SNA is "based on an assumption of the importance of relationships among interacting units" (Wasserman & Faust, 1994: 4). Since the pioneering work of Moreno in the 1930s (e.g., Moreno, 1934), the visualization of networks by means of so-called sociograms has been an important element in much empirical research about networks. In sociograms, nodes are depicted as points, and the ties connecting

them are visualized as lines. If the relationship between two nodes is asymmetrical—when one node is initiating or sending the relation and the other is receiving it (e.g., when person A identifies person B as her best friend, but B does not identify A as her best friend)—lines can be directional (with arrowheads). Moreover, line thickness is often used to describe the weight or strength of relationships between nodes. Whereas Moreno drew his sociograms by hand to graphically represent relatively small networks (often of school children), contemporary network analysts use specialized software such as UCINET, Pajek, or Gephi to visualize networks of sometimes enormous proportions. Such software applications have also facilitated the development of sophisticated ways of measuring and analyzing networks. This is possible because "network analysis has consistently drawn on various branches of mathematics both to clarify its concepts and to spell out their consequences" (Freeman, 2004: 25). More specifically, SNA draws on the mathematical approach called graph theory, which provides theorems for analyzing the formal properties of sociograms (Scott, 2011: 22).

A number of SNA scholars focus on structural positions. This strand of research emerged in the 1970s when Harrison White and various co-authors began using matrices and matrix algebra to make sense of the hierarchical features of networks (Prell, 2012: 44). This approach is sometimes called block modeling because it restructures matrices by grouping actors that share a similar structural position into one block. Such similarity in structural position is described in the concept of "structural equivalence" (Lorraine & White, 1971; see also Hanneman & Riddle, 2005: 199–200). By uncovering shared positions across different types of relations, White aimed to develop knowledge of individual roles and of the entire role-structure of networks (Prell, 2012: 44). More generally, SNA scholars use notions such as "cliques", "clusters", "blocks", and "bridges" to divide actors in networks into sub-groups based on the patterns of their relations with one another (Hanneman & Riddle, 2005: 195).

One key SNA measure is "network density", which denotes the proportion of potential connections that actually exist among the nodes in a network. Density concerns the cohesiveness of a network: if the density is high, the transmission of, say, ideas, knowledge, or diseases through a network is more likely than if the density is low. Another important measure is that of "degree centrality", which relates to the number of ties each node in a network has. Degree centrality thus relates to each node's involvement in the network. In networks with directed ties, indegree centrality is the number of relations a node receives, whereas outdegree centrality is the number of relations each node sends. The larger the indegree centrality of a node—particularly from nodes that themselves have a high indegree centrality—the more popular or powerful a node will be. A large number of centrality measures have been devised to allow for analyses of the structural divisions within social networks (Scott, 2011).

Network density and degree centrality are important measures in studies of corporate power and connections, which is an area that has attracted much

attention from social network analysts. Such research, for instance, has focused on interlocking directorates—that is, when directors sit on the board of more than one company. Sociograms are frequently constructed to visualize interlocks in the form of nodes (companies) connected by ties (e.g., Fennema, 1982). Degree centrality is used in such studies to measure the number of ties connecting a particular firm to other firms in the network, whereas density is used to measure the ratio of the number of interlocks to the maximum possible that might exist in a given network (van Veen & Kratzer, 2011). One important finding in such scholarship is that interlocks increasingly exist at the transnational level between corporations headquartered in different countries. Several scholars see this as evidence of the rise of a transnational business community or of a transnational capitalist class. In the words of Carroll et al. (2010: 814), "[t]he large corporations and corporate directors that are drawn together through interlocking director-ships form a corporate community—a more or less cohesive elite with common goals and shared understandings on how to reach these goals".

Another strand of research explores ownership relations. One particularly impressive study looks at all 43,060 transnational corporations (TNCs) in the world and the vast web of ownership relations that exist among them. The authors produce a map of the most strongly connected companies—a group of 1,318 TNCs—and reach the mindboggling conclusion that "nearly 4/10 of the control over the economic value of TNCs in the world is held, via a complicated web of ownership relations, by a group of 147 TNCs in the core, which has almost full control over itself" (Vitali, Glattfelder & Battiston, 2011: 6). Among the members of this economic "super-entity" are well-known financial TNCs such as Barclays PLC, Goldman Sachs, Morgan Stanley, Citigroup, Credit Suisse, and Deutsche Bank.

Another network measure is "geodesic distance", which concerns the number of relations in the shortest possible path from one node to another. This is an important measure in SNA scholarship that addresses the "small world" issue of how long a chain of acquaintanceships is, on average, required to link two persons who are randomly selected from a given population. A fundamental insight of SNA research is that such distances tend to be surprisingly short. A popular notion is the idea that the distance between two random persons on earth is six, meaning that everyone is linked through a chain of acquaintances that has no more than five intermediaries. This idea was first tested in the 1960s by Stanley Milgram, who found some support for it (Milgram, 1967). Notably, this "six degrees of separation" hypothesis also finds support in research on Facebook, which is the largest network ever studied by means of SNA methods. Johan Ugander and his colleagues find that this network comprises approximately 721 million users (nodes) connected by 68.7 billion friendship ties. The network is almost fully connected, with 99.1 of the nodes belonging to one component. 92% of all pairs of Facebook users were found to be within five degrees of separation, and 99.7% were within six degrees. The average path length between pairs of users is 4.7

(Ugander et al., 2011). These findings clearly resonate well with the "small world" insight of SNA. More generally, the emergence of social networking sites on the Internet since the turn of the century has attracted considerable attention from SNA scholars—and indeed the wider momentum of SNA should be understood as (at least partly) related to the rise of such new forms of networks.

2. POSITIVIST TENDENCIES

Freeman (2004) begins his account of the pre-history of SNA with Auguste Comte, the father of positivism, noting that "he had a large, albeit indirect, influence on the development of the field" (2004: 11). Moreno (1934) drew inspiration from Comte, which indicates that there has indeed been a link between positivism and SNA scholarship from the outset. Because the key features of positivism are well established, a comprehensive account of this philosophy of science will not be outlined here (see, instead, Bhaskar, 1986; Moses and Knutsen 2012; Steinmetz, 2005). Suffice it to say that positivism, inter alia, entails a reductionist worldview according to which (social) reality is characterized by consistent event regularities (closed systems). This ontology underpins the notion that scientific knowledge should be generalizing and that the ultimate goal is to make predictions of future events. In the positivist tradition, theory generally takes the form of rigorous models from which hypotheses can be derived and tested empirically.

The positivist tendencies of SNA manifest themselves in various ways. One manifestation relates to the use of theory and models. Some scholars have combined SNA with rational choice theory (see Knoke, 1990: 18-27; Emirbayer & Goodwin, 1994: 1416), which qua being reductionist resonates well with the positivist worldview (for a critique of this type of theory, see, e.g., Archer & Tritter, 2000). Moreover, many contemporary scholars use SNA methods in a deductivist manner to test hypotheses derived from theory (Marin & Wellman, 2011: 16; Prell, 2012: 61–64). Finally, several social network analysts use formal mathematical models to describe the features of social networks. Although formalism is not positivist as such, it has—with direct reference to SNA—been associated with "attempts to *reduce* the ontological (and therefore empirical) content of the [sociology] discipline to a minimum by outlawing or radically limiting reference to any sort of intrapsychic and/or intra-organismic motivational factor" (Lizardo, 2009: 42). Such reductionism would appear compatible with the positivist philosophy of science and problematic in relation to critical realism, which is strongly anti-reductionist, as we will return to in the next section.

Another way in which the positivist link manifests itself is through the aspirations of certain network analysts to predict future interactions between social units in networks (Kadushin, 2012: 202). For instance, a study by David Liben-Nowell and Jon Kleinberg (2007: 1019) explores whether "the evolution of a social

network [can] be modelled using features intrinsic to the network itself"—that is, whether it is possible, based on a snapshot of a network at t_0, to predict how it will subsequently evolve. The study finds that, in fact, "information about future interactions can be extracted from network topology alone" (2007: 1019). Although the extent to which such predictions can be made is far from settled in the network literature, the aspiration to predict is consistent with the positivist view that there is a fundamental symmetry between explanation and prediction due to the widespread occurrence of consistent event regularities. Conversely, critical realists argue that the openness of the systems of the social world means that it is generally impossible to make precise predictions of the future; thus, social scientists should focus on providing explanations of past and existing phenomena (Bhaskar, 1979: 27, 1986: 107; for some qualifications of this view, see Næss, 2004 and Sayer, 1992).

A third manifestation of positivism relates to generalizations. Some scholars use descriptive statistics to summarize distributions of actors and relations in networks and also use inferential statistics to estimate the extent to which samples are typical of a larger population. Indeed, a difference between mathematical approaches and statistics is that the former generally do not assume that a network is a sample of a larger population, whereas the latter do (Hanneman & Riddle, 2005: 15). Network analysts who apply statistical methods often seek to make generalizations; in many cases, these generalizations are based on the notion of (structural) equivalence discussed above, i.e., that individuals occupying similar positions can be treated as categories and grouped together as such. Thus, according to Hanneman and Riddle (2005: 196), "[b]eing able to define, theorize about, and analyze data in terms of equivalence is important because we want to be able to make generalizations about social behavior and social structure. That is, we want to be able to state principles that hold for all groups, all organizations, all societies". Generalizations of this type are typically associated with positivism and resonate poorly with critical realism. Sayer lists several reasons why generalizations can be problematic, one of them being that generalizations give "a transhistorical, pancultural character to phenomena which are actually historically specific or culture-bound" (Sayer, 1992: 100; see also Collier, 1994: 67–68). Indeed, the notion of (structural) equivalence would seem to entail precisely this.

In summary, much of the applied and methods-oriented SNA scholarship implicitly embodies positivist features—features that are rightly considered problematic from a critical realist point of view.[5] This raises two important questions. First, to what extent is it possible to "detach" SNA methods from positivist social science? Second, to what extent can SNA be part of ("attached" to) a social science informed by the tenets of critical realism? The first question can be answered right away. It *is* perfectly possible to apply SNA techniques without using them deductively, without combining them with rational choice theory, without making predictions and generalizations, and without relying on crudely reductionist formal models. Research on interlocking directorates, which was

cited in the previous section, is a prime example of social network analyses that—for the most part—avoid positivist pitfalls. Such studies empirically identify existing corporate interlocks and then employ SNA methods to analyze and visualize them (usually) without resorting to generalizations, predictions, and reductionism. Another case in point is arguably studies that combine network analyses with rich historical narratives, such as Padgett and Ansell's by now classic study of the various networks constituting the Medicean political party which played a key role in the emergence of the Florentine Renaissance state (Padgett & Ansell, 1993; on historical SNA more generally, see Wetherell, 1998). Such historical research is generally idiographic rather than nomothetic, and at least in this respect breaks with positivism.

To answer the second question, the next section sets out to establish in which respects SNA and critical realism resonate with one another. To this end, the focus is shifted from the foundation of applied and methods-oriented research to the social-theoretical superstructure of SNA, which is where social network analysts have explicated the assumptions underpinning the approach.

3. DIMENSIONS OF RESONANCE

This section establishes six important ways in which the SNA superstructure incorporates views on the nature of social reality and knowledge that are directly compatible with critical realism. This resonance relates to realist ontology, the agency-structure relationship, emergence, the openness of the social world, the nature of knowledge, and social science. The account presented below draws substantially on fragmented, and in many cases rather superficial, reflections on these matters contained in articles by leading social network scholars. The inevitable downside is that the full picture painted below may not reflect the position of any one—let alone all—of these scholars. Although this reservation should be kept in mind, the account remains relevant because it documents how views that resonate strongly with critical realism have been expressed in SNA scholarship. As such, it lends support to the idea that a "match" between SNA and critical realism makes intellectual sense.

3.1 Depth Realism

A number of SNA scholars lean toward a rather idealist position according to which the "social structure rests on the underlying pattern of perceptions in people's minds" (Krackhardt & Kilduff, 1999: 770). Generally, however, "social network analysts adopt a realist ontology, viewing social structures as real entities", which indicates that "while social structures are cognitively interpreted and imaged by agents, they cannot be reduced to social constructions" (Tindall

& Wellman, 2001: 272). In this view, social relations "must be understood as independent of the actors' wills, beliefs, and values" (Emirbayer & Goodwin, 1994: 1417). This view resonates perfectly with the realist ontology of critical realism, according to which an independent reality exists. Nevertheless, as noted by Bhaskar, "[t]he crucial questions in philosophy are not whether to be a realist or anti-realist, but *what sort* of realist to be" (Bhaskar, 1991: 25). He famously contrasts his own depth realism, which acknowledges the existence of unobservable structures and mechanisms, with an "empirical realist" position, in which only the observable can be said to exist. What type of realists, then, are social network analysts? In a classic text, Moreno stresses the importance of "invisible structures" and processes and "the powerful effect they have upon human conduct" (Moreno, 1934: 35). There are also many examples of more recent SNA studies that refer to the unobservable nature of structures. For instance, one scholar notes that the interactions of individuals "produce extended structures that they had not imagined and in fact cannot see" and further notes that SNA "reveals what is hidden in plain sight" (Kadushin, 2012: 11, 6). It seems reasonable to conclude that—at least for the most part—social network analysts are not empirical realists and that they, like critical realists, acknowledge the existence of unobservable structures.

3.2 Agency and Structure

The second dimension of resonance concerns the conceptualization of the agency-structure relationship. Social network analysts generally insist that social behaviors and processes "must be explained with reference to networks of social relations that link actors or 'nodes' " (Emirbayer & Goodwin, 1994: 1417). SNA thus entails a focus on both agents and structure—and the latter is understood in relational terms as "a network of networks" (Wellman, 1988: 20). This understanding is compatible with the critical-realist view, according to which social structures are "relations of various kinds: between people and each other, their products, their activities, nature and themselves" (Bhaskar, 1989: 81). The relationship between agency and structure is not, as such, specified in the foundation of the SNA approach. As a result, various positions may be incorporated, and both more structuralist and more individualist approaches have been articulated in the social-theoretical part of the network literature (see Haines, 1988). This being said, most of these studies emphasize the need to account for the importance of both agents and structures. In this view:

> "Actors do not behave or decide as atoms outside a social context, nor do they adhere slavishly to a script written for them by the particular intersection of social categories that they happen to occupy. Their attempts at purposive action are instead embedded in concrete, ongoing systems of social relations." (Granovetter, 1985: 485)

According to the critical realist social ontology, pre-existing structures constrain and facilitate agency and are subsequently reproduced or transformed through social interactions (Archer, 1995: 196; Bhaskar, 1979: 35). In the network literature, one finds expressions of a similar view. Burt explains that "actions taken under social structural constraint can modify social structure itself and these modifications have the potential to create new constraints to be faced by actors within the structure" (Burt, 1982: 9), whereas Emirbayer and Goodwin note that "the network approach investigates the *constraining* and *enabling* dimensions of patterned relationships among social actors within a system" (Emirbayer & Goodwin, 1994: 1418; see also Haines, 1988: 176 and Wetherell, 1998: 126).

To link agency and structure, Bhaskar has introduced the concept of *position-practice systems*. The idea is that agents occupy particular structural positions (such as a job or the role as a family man) that are associated with particular resources, constraints, predicaments, and powers and that these positions motivate their "occupiers" to engage in particular practices (Bhaskar, 1979: 51; see also Porpora, 1989: 200). It is not only critical realists who have a longstanding interest in structural positions. As discussed above, SNA research has focused on such positions since the pioneering work of Harrison White and his colleagues in the 1970s. Social network analysts emphasize that structural positions impact the powers and inclinations of their inhabitants (e.g., Burt, 1978: 199; Kadushin, 2012: 204; Knoke, 1990: 9-10). Burt has devised the notion of "structural holes" to denote "the empty spaces in social structure" (Burt, 2005: 16) that exist when nodes in a network are not connected. One reason that structural holes can be important is that they place nodes connecting disconnected nodes into a privileged "broker position". An example is the gatekeeper who controls access to the leader of an organization. As Wellman (1988: 45) notes, this broker position often brings "wealth, flattery, influence, use of the organizational resources, and pleasure from exercising control". Not only are such insights into structural positions compatible with the critical realist notion of position-practice systems; they also have the potential to further advance it.

3.3 Emergence

The recognition of emergence is the third feature that critical realism has in common with a number of studies in the SNA literature. For critical realists, emergence denotes "situations in which the conjunction of two or more features or aspects gives rise to new phenomena, which have properties which are irreducible to those of their constituents, even though the latter are necessary for their existence" (Sayer, 2000: 12; see also Bhaskar, 1986: 104; Collier, 1994: 107–115). A number of social network theorists note that the SNA approach has developed in opposition to what they call "attribute analyses"—that is, studies analyzing social phenomena solely in terms of the aggregated attributes (weight, age, sex, race,

income group etc.) of individuals (e.g., Emirbayer, 1997; Wellman, 1988). Such analyses—which have also been criticized in the critical realist literature (see Sayer, 1992: 177–78)—treat agents as independent units and see social behavior as the result of individuals possessing common attributes. In other words, they "neglect social properties that are more than the sum of individual acts" (Wellman, 1988: 38). Conversely, social network analysts emphasize that social relations cannot be reduced to the attributes of the units they connect: "A relation is not an intrinsic characteristic of either party taken in isolation, but is an emergent property of the connection or linkage between units of observation" (Knoke & Kuklinski, 1991: 174). Borgatti et al. (2009: 894) describe emergence as the idea "that social ties can bind nodes together in such a way as to construct a new entity whose properties can be different from those of its constituent elements". This notion of emergent properties is similar to that advanced by critical realists.

3.4 Open Systems

A core feature of the critical realist social ontology is the assertion that the social world consists of open systems, which means that consistent regularities in the form of constant conjunctions of events generally do not occur (unlike in closed systems). Social network analysts *do* contrast open and closed system networks, but they use the concepts in a manner that diverges from their critical realist usage. Closed-system networks are networks "in a box"; they are networks with clear boundaries, such as the connections between students in a class, or between the members of a family. Open-system networks, by contrast, are networks without clear boundaries (Kadushin, 2012: 17), such as networks on social media sites, friendship networks, or connections between companies. Thus, for SNA scholars, the distinction between closed and open systems does not concern the question of whether consistent event regularities occur.

  Whether such regularities exist is not, to my knowledge, a theme anywhere in the SNA literature. However, because aspirations to generalize and make predictions are premised on the existence of closed systems, it may be argued that an implicit closed-system ontology underlies at least some strands of applied and method-oriented SNA scholarship. Tony Lawson explains that the notion of such closed systems presupposes that objects, including individuals, in the social world are like atoms, i.e., "items which exercise their own separate, independent and invariable (and so predictable) effects" (Lawson, 2003: 14). This is not, however, the way most social network analysts—certainly not those preoccupied with social theory—see the world, which again confirms the presence of a tension at the heart of the SNA approach. Among the network scholars oriented toward social theory, the consensus is that individuals are related and, consequently, cannot be understood as isolated units (e.g., Emirbayer, 1997; Granovetter, 1985). In this context, it is also worth mentioning Patrick Doreian's observation that, although some

classic network studies were based on data that were collected in experimental settings, "[i]n general, experiments where variables are controlled and/or randomization is used are not very relevant in this discussion" because "most empirical studies of social networks are done in uncontrolled situations. For this realm of empirical work, experimental evidence provides, at most, suggestive insights" (Doreian, 2001: 100). Thus, because the social world is open, data that are collected in closed settings are generally of limited use.

3.5 Fallible and Social Knowledge

Fifth, one can detect a common understanding about the nature of social-scientific knowledge in critical realist and SNA scholarship. Critical realists insist that the production of knowledge is a human activity situated within a social context. New knowledge builds upon and transforms existing knowledge and is in this sense a social product. As Bhaskar observes, "the already known is the indispensable means for the production of the unknown; models, analogies and so forth provide the only type of craft a science can set sail in as it embarks on its voyages of discovery, the only kind of resource it can bend and shape as it labours on its work of transformation" (Bhaskar, 1986: 55). Social network analysts have made similar observations about the development of SNA. For instance, Burt likens the approach to a jungle of terminology in which any newcomer may plant a tree and notes that network analysis is a "loose federation of approaches, progressing on many fronts as a result of the efforts of many persons" (Burt, 1980: 79). Freeman's book on the origins and development of SNA confirms that the approach is indeed the outcome of a (continuing) process that has witnessed the contributions of many scholars (Freeman, 2004). Critical realists also insist that knowledge is fallible—knowledge is never certain, let alone definitive (e.g., Bhaskar, 1986: 60; Sayer, 2000: 40). In a similar vein, Tindall and Wellman (2001: 272) write that "social network analysts view knowledge as provisional, and measurement as being subject to error".

3.6 Social Science

Bhaskar argues that the essence of (social) scientific knowledge production consists in the movement from knowledge of manifest events and phenomena to generation of knowledge of the mechanisms and structures that have caused and sustained such events and phenomena (Bhaskar, 1989: 20). Thus, identifying and producing in-depth knowledge of underlying social structures and causal mechanisms is an important task of social scientists, according to critical realists. It is clear that this view does not resonate with network scholarship, which believes its primary task is to generalize and make predictions. However, this does not mean that critical realism and SNA are incompatible in all respects regarding what the essence of

social science is. Indeed, Moreno considered it as a critical goal of his work to uncover "the invisible dynamic organization which actually exists below the official one" (Moreno, 1934: 223)—an observation that is in clear harmony with critical realism. More generally, social network analysts have an ambition to get beneath the surface of social reality. In their study of elite networks and the emergence of the Renaissance state in Florence, Padgett and Ansell (1993: 1310) argue that "to understand state building . . . one needs to penetrate beneath the veneer of formal institutions . . . down to the relational substratum of people's actual lives". In a similar vein, Wellman notes that "[w]e want to tease out the structural patterns that underlie the surface noise of social systems and use our knowledge of these patterns to understand social interaction" (Wellman, 1994: 28).

As SNA scholars understand it, individuals are embedded in networks—often large networks—through which ideas, information, diseases, and influence travel. The greater the geodesic distance between actors A and B in a network, the less transparent their respective positions and relationships tend to become for one another. To illustrate, although a person will know who his or her closest friends are and have a generally good idea who they in turn are friends with, knowledge of the friends of these friends of friends—let alone of the friends of friends of friends of friends—will generally be much more limited. This is true of friendship networks but also of professional, corporate, and political networks. By mapping an entire network—or selected parts of it—webs of relations that were not visible from the perspective of individual network members, let alone outsiders, are brought into view. A sociogram showing thousands of companies as well as direct and indirect relationships between them allows us to see otherwise invisible patterns. Although network distance is generally not what critical realists have in mind when they talk about structures not being observable, the ambition of SNA scholars to disclose structural patterns resonates well with critical realism.

To recapitulate, whereas the previous section noted that SNA *can* be detached from positivist social science, this section has demonstrated that there is considerable resonance between critical realism and the assumptions underpinning SNA—at least as these are explicated in the social-theoretical part of the network literature. These are clearly two important preconditions for taking the next step, which is to consider the extent to which SNA methods may be fruitfully applied in research that is informed by the tenets of critical realism. This step is taken in the next section.

4. SNA AND CRITICAL REALIST SOCIAL SCIENCE

"Intensive research" is a label used by Sayer (2000: 20) to refer to research that begins with individuals and aims to "trace the main causal (including discursive) relationships into which they enter and study their qualitative nature as well as their number". Sayer discusses studies of agents in their causal contexts,

interviews, ethnography, and qualitative analysis as typical methods scholars can use in this primary type of critical realist research. SNA techniques can safely be added to this list because they constitute a method to map and analyze relationships. However, it is no coincidence that Sayer talks about *causal* relationships: as accounted for above, for critical realism a key task of social scientists is to produce knowledge of causal mechanisms. Can SNA be used to identify such mechanisms?

The answer to this question is "no" if one looks solely at statistically and mathematically oriented SNA scholarship. Although there is some disagreement among critical realists as to the fruitfulness of statistics in social-scientific research (compare Olsen & Morgan, 2005 with Lawson, 1997 and Sayer, 1992), the consensus seems to be that statistics are of very limited use in causal explanations. In the words of Danermark et al. (2002: 54), statistical investigations of co-variance and frequency "cannot at all inform about causes, they cannot produce explanations . . . A cause is something totally different to statistical co-variance". A similar point has been made in relation to SNA by Doreian, who writes that it is "extremely difficult to establish causality through the use of statistical tools when network data are analysed" (Doreian 2001: 102). As for mathematical models, Sayer (1992: 179) notes that they are of little assistance in causal analyses because their language "is acausal and astructural", lacking "the categories of 'producing', 'generating' or 'forcing' which we take to indicate causality". Although these observations put much statistically based SNA scholarship into perspective, they obviously do not rule out the possibility that network causality can be studied in other ways.

As discussed above, SNA offers researchers the tools to produce sociograms that depict networks. Although directed sociograms, in particular, may seem to visualize causal relationships, caution is necessary. To use the example of a friendship network again, let us say we have two persons, A and B. A identifies B as a good friend, whereas B does not identify A as a good friend. In a sociogram, this asymmetrical relationship can be visualized with an arrow-headed line running from A to B. Whereas such a visualization, perhaps correctly, gives the impression that A has more influence on B than vice versa, it does not explain what has caused this relationship, i.e., why does B not consider A to be a good friend? In a similar vein, sociograms that visualize groups of companies connected by interlocking directorates do not explain what caused the interlocks to exist, let alone what effects the interlocks have on, say, competition or the development of class consciousness. This limitation suggests that the value of sociograms is found in their ability to visualize the existence (and sometimes the direction and strength) of ties in a network but not in disclosing causal mechanisms. From a critical realist perspective, another problem with sociograms and social network analyses is that they tend to focus on only one or a few types of relationships at a time. This is problematic if critical realists are correct in asserting that social phenomena are generally caused by complex combinations of different types of mechanisms that work in open systems.

A number of studies use findings that are generated by SNA methods and combined with other forms of data to explain still other phenomena—phenomena that could not be explained by using SNA techniques alone. For example, a study that set out to explain why a particular conception of markets and competition ("post-*dirigisme*") prevails in France (Clift, 2012) posited that the explanation is, inter alia, found in a "social context of elitist, oligarchic networks, the 'financial network economy', which interlink the public and private spheres and around which French capitalism coheres" (Ibid.: 3). The existence and nature of these networks are validated by referring to findings in SNA studies on, for instance, interlocking directorates, whereas the importance of the networks in relation to post-*dirigisme* are established by drawing on a variety of other sources.

This example indicates that perhaps the most promising way in which SNA might become a valuable instrument in research based on the tenets of critical realism is as a supplement to other methods. SNA provides techniques that can be used to generate overviews of complexes of social relations and to analyze these complexes. However, these techniques cannot by themselves show that specific sets of relations were mechanisms that caused the occurrence a given phenomenon outside the network in question. To establish causation, different methods and data will generally be required. Although SNA methods alone cannot establish the causes of a specific phenomenon or event, they place the process of identifying causal mechanisms on firmer ground by helping researchers produce in-depth knowledge of the nature of various structures and relationships. Indeed, because it is the most rigorous method that exists for mapping and analyzing social relations, SNA can render structures more tangible objects of study. As such, the contribution it can make to (a critical realist) social science should not be underestimated. Nevertheless, SNA neither can nor should replace other methods that critical realists employ to identify underlying structures and mechanisms, including the use of abstraction and substantive theories.

Integrating SNA methods into social scientific analyses informed by critical realism will undoubtedly entail abstaining from using SNA in some of the ways that it is currently applied. In particular, many of the mathematical and statistical "advances" of SNA will most likely not constitute natural elements in social scientific analyses informed by critical realism. The reason is not that there is necessarily anything inherently wrong with these advances; to the contrary, their level of sophistication is in many cases impressive and certainly intellectually stimulating. However, their relevance declines in a social science that is not oriented toward generalizations and predictions. Moreover, as Sayer (1992: 176) stated, "the discovery that a model is free from mathematical errors says nothing about whether it is applicable to the world". What matters to critical realists when using SNA methods—or any other method—is the extent to which those models can help us make sense of the part of social reality we are trying to explain. In this context, it is difficult to imagine that critical realist researchers would be attracted to, say, block modeling or to the "exponential random graph models" that are

being developed by statisticians to compensate for missing data (see Prell, 2012). Thus, the more "basic" features of SNA, including many of those introduced in the first section above, are likely to be the most relevant features in relation to social scientific research informed by critical realism.

For critical realists, "it is the nature of objects that determines their cognitive possibilities for us" (Bhaskar, 1979: 31; see also Sayer, 2000: 19). Thus, it is the object under investigation and our research questions that determine which method is appropriate to use and why. Undoubtedly, SNA techniques are more suitable for explaining certain structures than others. For instance, SNA methods can be and have been used to produce extremely valuable knowledge about certain structural features of capitalism—as with the aforementioned research on corporate control and company interlocks. However, the SNA approach is most likely unsuitable for analyzing all structural aspects of capitalism, such as the exploitative nature of capital-labor relations. SNA performs at its best when there are measurable connections, but it is not useful in the absence of data that can meaningfully be plotted into a matrix or a spreadsheet.

5. CONCLUSION

Within the SNA literature, a tension currently exists between applied and methods-oriented research, on the one hand, and work that is oriented toward social theory, on the other. The former in many cases exhibits positivist tendencies, as is manifest in the deductive use of theory, reliance on reductionist formal models, a combination of SNA with rational choice theory, and aspirations to predict and generalize. The latter incorporates views that are directly compatible with core critical realist ideas about the nature of social reality and of knowledge. This compatibility involves the following: (1) a commitment to a realist position that acknowledges the existence of unobservable structures; (2) shared ideas about the conceptualization of the agency-structure relationship; (3) a notion of emergence; and, (4) at least to some extent, an acknowledgement of the openness of the social world. Moreover, this compatibility involves (5) the recognition that knowledge is a social and fallible product and (6) an agreement that a key purpose of social science is to get beneath surface appearances and identify underlying social structures.

In addition to arguing that SNA may be applied in a non-positivist way and showing that its superstructure embodies elements that are compatible with critical realism, this article discussed how SNA can be used in social-scientific analyses informed by critical realism. It suggested that although SNA is not in and of itself able to identify causal mechanisms, it can help researchers produce in-depth knowledge about the nature of various structures. Only by using other methods and data, as well as abstraction and substantive theories, can it be determined whether those structures are likely to have constituted causal mechanisms in relation to the phenomenon that is to be explained.

In one sense, SNA and critical realism are strange bedfellows; the two positions have developed independently of one another, and much SNA scholarship embodies positivist tendencies. However, in another sense, it may be "a match made in heaven" as the two schools of thought have considerable potential to enrich one another: SNA techniques have the potential to be a valuable instrument that is currently missing from the critical realist toolbox. Conversely, an engagement with critical realism could place SNA on ontological and epistemological grounds that are more solid than the positivist ground on which it partly rests at the moment and it might as such help overcome the tension at the heart of SNA.

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NOTES

[1] This work has benefited greatly from comments made by Tim Celik, David Kempel, Duncan Wigan, Raphaël Wolff and the anonymous reviewers. Any remaining errors or dubious arguments are my own.

[2] Although it is not possible to do so in the present article, it would be interesting to discuss SNA in relation to a number of philosophies of science/philosophical positions. For instance, one of the anonymous reviewers suggested that the analytical philosophy position advocated by Bertrand Russell is in fundamental respects compatible with SNA.

[3] The SNA approach discussed in the present article should not be confused with the type of postmodernist network theory criticized by Joseph 2010 or with "actor-network theory", which has been considered in relation to critical realism by Elder-Vass 2008.

[4] For more comprehensive overviews of SNA findings and concepts, cf. Kadushin 2012; Scott & Carrington 2011.

[5] The positivist connection can also be shown in a more indirect way. SNA scholars do not, to my knowledge, explicitly attempt to uncover and criticize unfair social structures with the goal of emancipating individuals and groups in the social world. This stance is at least arguably compatible with the objectivist positivist position that normative views do not belong in social scientific studies.

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