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Network Measures of Social Capital

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INTRODUCTION

As Burt (1998) notes, "social capital is fast becoming a core concept in sociology and political science". But it has mostly been used in a theoretical context; only a few researchers have had to confront the issue of measurement. Those that have (e.g., Burt 1992; Gulati 1999) have almost universally chosen or constructed a single measure of social capital. The focus has been substantive rather than methodological, so none have systematically considered the range of possible measures. In this short paper, we would like to consider which existing network measures might be used to formalize the notion of social capital.

DIFFERENT CONCEPTIONS OF SOCIAL CAPITAL

Barry Wellman and Sherry Bartram (email message to SOCNET listserv, 10 January 1997; reprinted in Borgatti, 1998) have suggested that there seem to be at least two fundamentally different usages of the term social capital. One usage – exemplified by Putnam (1995) – conceives of social capital as a quality of groups (usually whole societies). It is partly cultural, partly socio-structural. It includes such things as rule of law, social integration, and trust. Other writers in this vein include Fukuyama (1995) and Loury (1987), as well as the apparent originators of the term, Hanifan (1920) and Jacobs (1961).

Another usage – exemplified by Burt (1992) – conceives of social capital as the value of an individual's social relationships. It has been axiomatic in the social support literature since the 1970s (e.g., Cassel, 1974) that one's relationships with others are a source of material, information and emotional aid. A more formal statement of this view – renamed social resource theory – is provided by Lin (1986). Similarly, in the organizational literature, one's relationships have been seen as a source of power (Brass, 1992). In a somewhat different vein, Burt (1992) suggests that certain configurations of relationships with others confer significant information and control benefits. This view is rooted in a long sociological tradition of viewing an actor's position in a social network as determinant of its opportunities and constraints (Wellman, 1988).

Wellman and Bartram argue that these two usages primarily reflect two different levels of analysis: the individual and the group (or social system). But Putnam (email message to SOCNET, 12 January 1997; reprinted in Borgatti, 1998) suggests a different distinction. He notes his own usage of social capital might be thought of as emphasizing "the collective-good facet of social capital -- I can benefit from broader social networks and the associated norms of reciprocity and trust, even when I did not help produce and do not own those assets", while Burt's usage could be seen as emphasizing "the private-good facet -- how my connections can help me".

Our own view is that both distinctions need to be made, although we shall prefer somewhat different language. Wellman and Bartram are right: some writers focus on the individual, while others focus on the group. But let us consider the group level for a moment. In general, the group has been implicitly conceived of as a universe: relationships, norms and systems within the group are discussed, but nothing outside the group is considered. For example, Putnam (1995) takes the United States as his object of analysis, and he documents the decline of participation in volunteer groups within the US. He does not examine the structure of American relationships with individuals in other countries. Yet, most groups we study are not universes: they are embedded in their own social environments. Let us consider the case of teams or departments within an organization. Specifically, let us examine the social capital of an academic department within a university. With the department as our unit of analysis, we can take either of the approaches to social capital described above. Taking Putnam's approach, we would look at such things as the working relationships among the members of the department (e.g. are their many pairs that like each other?), the structure of ties (e.g., are their mutually exclusive factions?) the working procedures of the team (e.g., Do they utilize secret ballot voting? Run meetings according to Roberts' Rules of Order?), the department norms (e.g., is it ok to criticize someone's work?), and so on.

Or we can take Burt's approach, but applied to the department, not the individuals within it. For example, we look at the relationships that the department (or its members) have with the individuals and groups outside of it. Are some of the faculty well-connected with the dean and with chairs of other departments? Does the department itself have relations, as a department, with other departments through joint degrees, research centers, etc.? What is the reputation of the department in the eyes of the other departments?

In other words, we consider the substance of Putnam's and Burt's approaches to be separable from the unit of analysis. When applied to collective actors within a larger system, the essence of Putnam's approach is to look within the collectivity, while the essence of Burt's approach is to look to look outside the collectivity. Thinking in purely network terms, Putnam would look at the structure of relationships within the group, while Burt would look at the structure of the group's relationships to outsiders. Combining the individual vs. group dimension with the inside vs outside dimension generates a two 4-fold classification, as shown in Table 1.

Table 1. Different Conceptions/Forms of Social Capital

	Type of Focus:	
Type of Actor:	**Internal**	**External**
Individual	A)	B) Burt (1992); Lin (1986); Brass (1992);
Group	C) Putnam (1995); Fukuyama (1995);	D) Ancona (1990); Cohen & Levinthal (1990); Everett & Borgatti (1999);

The top left cell ("Box A") is presumably empty since the individual is normally seen as the indivisible atom of the sociological world. On the other hand, since physicists have now split the atom and connectionist theories of mind currently dominate cognitive science, one is tempted to write "human capital" in that cell and rename the table "different forms of non-financial capital". Nevertheless, we choose not to pursue that line of thinking any further in this paper.

The top right cell ("Box B") corresponds to the conception of social capital that Wellman and Bartram regard as 'individualist' and Putnam describes as the private-good facet of social capital. This basic approach is found in Burt (1992), DiMaggio (1992), Gulati (1999), and in all of classical social resource theory (e.g., Lin, 1986) and structuralist position theory (Wellman, 1988).

The bottom left cell ("Box C") corresponds to what Wellman and Bartram regard as 'groupist' and Putnam describes as the collective-good facet. This is the underlying conception found in Putnam (1995), Bourdieu (1986), and most of Coleman (1990). It is rooted in a tradition that includes such classical writers such as Adam Smith and de Tocqueville, who did not use the term *social capital* but probably would today.

The bottom right box ("Box D") is just beginning to receive attention. In the context of teams within business organizations, Ancona (1990) has suggested that teams whose members have

strong ties with the rest of the organization are more successful in getting things done. However, she does not apply the term social capital. Similarly, Cohen and Levinthal (1990) suggest that ties to outsiders help organizational teams to innovate. Everett and Borgatti (1999) present measures of centrality defined for cohesive subsets and explicitly identify this centrality as measuring the social capital of groups, but this paper is not yet in print.

Now we consider specific measures for each of the three non-empty boxes in Table 1. We shall confine ourselves to purely network measures: that is, we ignore norms, procedures and other cultural aspects of social capital. We shall also want to ignore relational contents (e.g., friendship versus acquaintance), but will not be completely successful in this. In all cases we must be careful about the underlying social relation on which the measures are computed — which relation is appropriate will vary according to the setting. In general, however, it is assumed that we want to measure "neutral" or "positive" relations, such as *knows* or *likes* rather than "negative" relations such as *hates* or *is not speaking to*.

BOX B: EXTERNAL MEASURES FOR INDIVIDUAL ACTORS

The first set of measures, closest to the verbal description of social capital, consists of the standard ego-network measures that are well known in the network literature (see Table 1). Note that in the table uses "ego" to mean the person whose social capital we are measuring, and "alter" to mean the persons that the ego is directly connected to. The column labeled "relation to social capital" gives the conventional wisdom on how the network variable is related to social capital. The last two rows present measures that require additional data on the alters beyond who is connected to whom.

Table 2. Standard Ego-Network Measures for "Box B Social Capital"

Name:	Description:	Relation to Social Capital:
Size / degree (Burt, 1983)	The number of alters that an ego is directly connected to, possibly weighted by strength of tie.	Positive. The more people you have relationships with, the greater the chance that one of them has the resource you need.
Density (Burt, 1983)	The proportion of pairs of alters that are connected.	Negative. If all your alters are tied to each other, they are redundant. Given limits on relational energy, need to put eggs in more than one basket.
Heterogeneity* (Burt, 1983)	The variety of alters with respect to relevant dimensions (e.g., sex, age, race, occupation, talents).	Positive (except when it conflicts with compositional quality)
Compositional Quality*	The number of alters with high levels of needed characteristics (e.g., total wealth or power or expertise or generosity of alters)	Positive. The more connected to useful others, the more social capital.

*Requires attribute data on all nodes in addition to relational data.

The next set of measures are the structural hole measures proposed by Burt (1992). He proposes two basic measures – *effective size* and *constraint* – along with variants of each. Table 3 shows only the basic categories.

Table 3. Structural Hole Measures for "Box B Social Capital"

Name:	Description:	Relation to Social Capital:
Effective Size (Burt 1992)	The number of alters, weighted by strength of tie, that an ego is directly connected to, minus a "redundancy" factor.	Positive. The more different regions of the network an actor has ties with, the greater the potential information and control benefits.
Constraint (Burt 1992)	The extent to which all of ego's relational investments directly or indirectly involve a single alter	Negative. The more constrained the actor, the fewer opportunities for action.

The third set of obvious measures includes all the standard centrality measures. These differ from the ego-network measures in that they require that the entire network be measured in order to be computed. Thus, they are richer measures of a node's position in the network, but require much more complicated data as input. Table 4 presents just a few of the more well-known measures (new ones are developed every year).

Table 4. Standard Centrality Measures for "Box B" Social Capital

Name:	Description:	Relation to Social Capital:
Closeness (Freeman 1979)	The total graph theoretic distance from ego to all others in network.	Negative. The greater the distance to other nodes, the less the chance of receiving information in a timely way.
Betweenness (Freeman 1979)	The number of times that ego falls along the shortest path between two other actors.	Positive. Actors with high betweenness link together actors who are otherwise unconnected, creating opportunities for exploitation of information & control benefits.
Eigenvector (Bonacich 1972)	The extent to which ego is connected to nodes who are themselves high in eigenvector centrality.	Positive. An actor has high eigenvector scores when they are connected to well-connected others.

BOX C: INTERNAL MEASURES FOR COLLECTIVE ACTORS

This is the version of social capital implicit in the writings of Putnam, Bourdieu and others. Ignoring cultural and cognitive aspects of this conception, we have the measures shown in Table 5. They are all standard measures of network cohesion.

Table 5. Standard Cohesion Measures for "Box C" Social Capital

Name:	Description:	Relation to Social Capital:
Density (Harary 1969)	The proportion of group members who are tied (with a "positive" relation, such as friendship, respect, acquaintance, past collaboration, etc.).	Positive; Curvilinear for intellectual conflict relations; Negative for personal conflict relations
Average or maximum Distance (Harary 1969)	The average (or maximum) graph-theoretic distance between all pairs of members	Negative. Smaller distances mean faster communication among members, which is an asset
Centralization/Core-Periphery Structure *(Freeman 1979; Borgatti & Everett 1996)*	*The extent to which the network is NOT divided into cliques that have few connections between groups*	*Positive. Controlling for density, core-periphery structures are easier to coordinate than fractionated networks*
*Homophily** *(Marsden 1988)*	*The extent to which members of the group have their closest ties to members who are similar to themselves*	*Negative. Less homophily should mean greater exposure to a wider range of ideas*

**Requires attribute data on all nodes in addition to relational data.*

Note that the measures in Table 5 duplicate many of the measures in Table 2, although they are applied differently. One measure that is missing is size. Although crude, this would not be a bad measure to include. One reason the United States does well in the Olympics is probably that in such a large country, there are bound to be a few individuals who are exceptionally gifted in ways that can be molded into champions of some Olympic sports. In many team settings, however, the relationship of size to performance is probably curvilinear, as greater numbers create coordination problems.

Another measure that is missing is *compositional quality*. Translated to the within-group context, this would refer to measures like the number of group members with certain qualities, such as high intelligence. But most researchers would probably prefer to think of such measures as an aggregate form of human capital, hence we leave it off the list.

BOX D: EXTERNAL MEASURES FOR COLLECTIVE ACTORS

There are really two kinds of external measures for collective actors. One type is about the relationships that the group -- as an entity separate from its constituent members -- has with other entities. For example organizations are legal entities that have relationships with other organizations (e.g., sells to, has joint venture with, etc.). In this case, the group is seen as a single entity, and the relations this entity has with others are its own, not some aggregating of the relationships of its members. The fact that the group is made up of separable individuals is immaterial, and so this situation is identical to that of "Box B" social capital: no further development is needed.

The other type of external group social capital occurs when all the relations being studied belong to individuals, but we are interested in the position of a group of individuals in this network of individuals. For example, in the case of teams within an organization, we might look at the assets that a given team has with respect to the friendship network of the organization. In other words, by virtue of the relationships of its members, who can the team call on for help?

Measures appropriate for measuring this kind of social capital have appeared in the social network literature as measures of *group centrality*. Table 6 summarizes some of these measures.

Table 6. Group Centrality Measures for "Box D" Social Capital

Name:	Description:	Relation to Social Capital:
Group Degree (Everett & Borgatti, 1999)	Number of outsiders tied to at least one group member.	Positive. As noted by Ancona (1990), members' positive relationships with the rest of the network is an asset to the team.
Group Closeness (Everett & Borgatti, 1999)	Total distance of the group to all non-members. Distance from group to outsider usually defined as minimum distance from outsider to any insider.	Negative. The greater the distance to outsiders, the less timely information available to the team.
Group Betweenness (Everett & Borgatti, 1999)	The number of times that the shortest path between any two outsiders passes through a group member.	Positive. Teams scoring high on group betweenness have few redundant ties with outsiders, generating exploitable structural holes.

Another set of measures that can serve, in some cases, as measures of "Box D" social capital are the measures proposed for 2-mode networks (Bonacich 1991; Faust 1997; Borgatti and Everett 1997). In these measures, neither relations among groups nor among individuals are directly available: there is only the relation of membership of individuals in groups. If individuals may be members of several groups simultaneously, and if the ties that a group's members have with other groups are useful, then these measures can also act as measures of social capital. These are summarized in Table 7.

Table 7. 2-Mode Centrality Measures for "Box D" Social Capital

Name:	Description:	Relation to Social Capital:
2-mode Closeness (Faust 1997; Borgatti & Everett 1997)	Total distance of the group to all other groups and non-member individuals.	Negative. The greater the distance to outside entities, the less timely information available to the team.
2-mode Betweenness (Faust 1997; Borgatti & Everett 1997)	The number of times that the shortest path between any two entities (groups or individuals) passes through the group.	Positive. Teams scoring high on 2-mode betweenness have members who belong to groups that share few members. This lack of redundancy generates exploitable structural holes.
2-mode Eigenvector (Bonacich 1991; Faust 1997; Borgatti & Everett 1997)	A group is central to the extent it is has many members who belong to groups who have many members who ... (recursive definition)	Positive. Groups high on this measure well-connected in terms of working together in multiple settings.

CONCLUSION

In order to find measures of the structural aspects of social capital, we have had to grapple with the apparent diversity of usages of the term. One important source of variation, as Wellman and Bartram have pointed out, is the unit of analysis – individual or group. Differences in level of analysis have masked another difference: an outward focus versus an inward focus. This second dimension has remained hidden because researchers focusing on individuals have (naturally) looked to ties outside the individual, while researchers focusing on groups have (by coincidence) been concerned only with all-encompassing groups and therefore looked only at ties within the group. But when we try to measure the social capital of groups embedded within larger structures, such as teams in organizations, we immediately recognize the possibility of looking at either ties within the group, or ties to outsiders.

Cross-classifying interest in social capital by these two dimensions yields a four-fold table in which one cell (internal measures for individual actors) is ignored. This leaves a need for three basic kinds of social capital measures: external measures for individuals ("Box B"), internal measures for groups ("Box C"), and external measures for groups ("Box D"). Looking in the standard network analytic toolkit, we find several measures available "off-the-shelf" for each kind of social capital.

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