Network Capital and the Self-organizing Provision of Public Goods

John T. Scholz (Florida State University)

Meredith Whiteman (Florida State University)

Ramiro Berardo (CONICET-Argentina)

Abstract

Decentralized governance activities outside formal government institutions are expanding throughout the Western democracies, and informal relationships in these policy arenas become critical to government performance. We analyze relationships among stakeholders that provide political, technical, financial, and regulatory resources to water projects in one such governance arena. The risk hypothesis argues that bridging network capital increases productivity for low-risk coordination problems whereas bonding capital increases productivity for higher-risk cooperation dilemmas. We find that stakeholders who establish more relationships in networks of political support and financial assistance improve the performance of projects they support. In addition, greater bridging capital leads to greater productivity among participants in the financial assistance network, but productivity in the political support network is facilitated by bonding capital. Furthermore, self-interested organizations appear to seek the more productive type of relationship in each network, since bridging relationships are more prevalent among financial providers and bonding relationships among political providers.

To the extent that policymaking decisions migrate from formal institutions to informal policy networks (Heclo 1978, Bardach 1998, Agranoff and McGuire 2003), from governmental actors to a broad range of public and private organizations (Kettl 2002, Klijn, Koppenjam and Termeer 1995, Milward and Provan 2000), and from centralized to decentralized actors (Laumann and Pappi 1976, Feiock and Scholz 2010), understanding this evolving framework of governance requires models that explain how relationships among relevant governmental and nongovernmental stakeholders develop and how they influence the production of public goods.

The governance literature has progressed from documenting the impact of informal networks on the performance of formal institutions (e.g. Meier and O'Toole 2001, Schneider et al 2003, Scholz and Wang 2006) to considering the relative capacity of alternative network structures for resolving different types of collective action dilemmas at the systems (Bodin and Crona 2009) and individual level (Scholz, Berardo and Kyle 2008). The relative advantages of bridging and bonding relationships for different types of dilemmas provides one major focus of current research (Bodin and Crona 2009), with particular emphasis on linking the theoretical arguments about the advantages and disadvantages of bridging and bonding capital to the appropriate set of network measures that best represent these concepts (Burt 2005, Scholz Berardo and Kyle 2008, Geys and Murdock 2008). Berardo and Scholz (2010), for example, identify specific network measures for analyzing their risk hypothesis: bridging capital enhances performance in policy networks dealing with low risk coordination games that involve less uncertainty, while bonding capital enhances performance when dealing with high risk prisoners dilemma games involving more uncertainty. Since their analysis does not compare networks dealing with different levels of risk, however, they do not actually test their hypothesis.

We clarify and test the role of bridging and bonding capital in the Cooperative Funding Initiative (CFI) in Tampa Bay, one of the many new "self-organizing" policy arenas (Feiock and Scholz 2010) that encourage collaboration of public and private organizations in the development, planning, and implementation of public goods projects. Unlike centralized policy processes in which elected officials determine which projects to support, public goods projects in self-organizing systems succeed only if stakeholders are willing to supply them with the needed political, financial, technical, and regulatory resources. To the extent that political and financial resources impose greater risks and uncertainties generally associated with the political process, the risk hypothesis suggests that bonding capital will be more effective among organizations providing political and financial resources, while bridging capital will be more effective in the supply of technical and regulatory resources.

The empirical analysis tests this speculation using all organizations that provide at least one of these resources to all projects competing in one annual CFI funding cycle. We construct the political, funding, technical and regulatory networks in which links between organizations reflect their joint participation in providing the specified resource to a common project. Each organization's bridging and bonding capital is measured independently in each of these resource networks with a broad set of alternative structural measures, and regression analysis tests the impact of these measures on the performance of projects supported by the organization. Specifically, we test whether bonding relationships enhance performance for riskier exchanges in the "policymaking networks" providing political and financial resources, while bridging relationships enhance performance in the lower-risk "implementation networks" providing technical and regulatory resources. Since the structure of relationships emerge from the choices of collaborative partners rather than from any statutory design, our inquiry considers both the incentives of stakeholders to develop bridging and bonding relationships and the impact of the resultant bridging and bonding capital on the performance of public goods projects.

Bridging, Bonding, and Performance in Policy and Implementation Networks

The structure of governmental institutions has long been a central theme of political science. Classical public administration theory argues that the structure of government agencies should minimize communication costs necessary to overcome task and technological uncertainties based on the agency's statutory mission (e.g., Gulick 1937). In modern network terminology, simple bridging communication structures (hierarchies) perform best for technologies imposing less uncertainty, while bonding capital (interacting teams of task-oriented specialists enhance performance as interdependencies across specialties increase uncertainties at the task performance level (Thompson 1967) .

Contemporary theories analyze organizational structures that minimize transaction costs associated with exchange uncertainty (Coase 1937, Williamson 1981, Greif 1994) rather than communication costs associated with task uncertainty, but bridging and bonding relationships still play a comparable role. Complex exchanges imposing the greatest uncertainty require either a formal governance structure (Williamson 1981) or informal relationships involving intensive strong ties, reciprocity, and clustered transitive relationships that can provide trust, credible commitments, and continuous communication between buyer and seller (Granovetter 1985). But when exchanges are less uncertain and carry lower transaction costs, unified governance and strong tie relationships impose unnecessary costs and constraints. In this case, bridging capital and "weak ties" that link otherwise unconnected groups can enhance the outreach necessary to locate desired exchange partners (Granovetter 1973, Krackhardt 1992) and can provide brokerage opportunities to explore new ideas and innovate through exposure to information and resources not available within the group (Burt 1992, 2005).

Berardo and Scholz (2010) and Scholz, Berardo and Kile (2008) extend this logic to partner selection by individual actors in policy networks, based on the assumption that stakeholders seek communication and collaboration partners that maximize their individual gains in the estuary's ecology of games (Lubell, Henry and McCoy 2010). As in classical public administration and contemporary institutional design, they elaborate the argument that bridging relationships provide the highest expected payoffs to individual actors when risk and uncertainty are low, while bonding relationships perform better as risk and uncertainty rise. Scholz, Berardo and Kile (2009) find that actors with more bridging relationships achieve higher levels of collaborative activity, while Berardo and Scholz (2010) report that partners providing bridging relationships appear more attractive than those providing bonding relationships. In both cases, bonding relationships are also active, but had less impact and were less sought than bridging relationships. And in both cases, the level of risk in the network is inferred from the prevalence of bridging capital and no comparison of low and high risk networks is provided.

The CFI context provides a test of the hypothesis based on the comparison across different networks, and also creates an opportunity to expand the set of network measures in order to consider different dimensions of bridging and bonding capital. Although there is considerable consensus about the general classes of network structures that represent bridging and bonding capital (Burt 2005, Scholz, Berardo and Kile 2008, Bodin and Crona 2009, Carpenter, Esterling and Lazer 2004), there is less clarity about which of the large array of available network measures is most appropriate to represent bridging and bonding in any given circumstance. The next section clarifies different theoretical dimensions of bridging and bonding that are represented by different network measures and suggests their relevance to a given context.

Network Measures of Bridging and Bonding Capital

Network analysis has developed arguably the richest vocabulary to provide a precise structural categorization of bridging and bonding relationships. Network analysis represents a policy arena as a graph, with each organization represented as a node and all relationships between organizations as links between nodes (Wasserman and Faust 1994). The full richness of relationships could potentially be represented by links that vary in strength, with multiple relationships represented by different links. We simplify the following discussion to the dichotomous symmetric relationships used in most empirical studies, and consider extensions to richer representations in later discussion. Thus relationships are represented by the presence or absence of a relationship between nodes *i* and *j*. A walk from node *i* to node *j* refers to any set of links that connect *i* to *j*, a path is a walk that does not repeat any node, and a geodesic is the shortest path between the nodes. *Ego* refers to any designated node *i* being analyzed, and any node *j* linked to ego is referred to as an *alter* and a member of the ego network. The measures discussed here characterize the bridging and bonding capital of a given node based on the full graph, and are used to estimate each measure's impact on the performance of projects supported by each node.

Bridging as Outreach

If a link represents an exchange of information or other resources, bridging as outreach involves relationships that enhance ego's ability to receive and utilize resources from other nodes in the network, and thus reflect ego's connectedness within the network. Consider, for example, the time required for ego to receive information from any randomly-selected node in a connected network. In an implementation network, for example, this might represent a discovery by some organization of a simple technique to solve a common problem. If each node transmits this information accurately through all alters and each transmission step takes about the same time, then the time required for ego to receive this information will be proportional to the shortest path length between ego and the innovating organization (Borgatti 2005). The average geodesic for each node thus represents the expected time of arrival of information at that node from any randomly-located discovery; in this case, nodes with the shortest average geodesic have the greatest bridging capital, and should outperform other nodes whenever timely information is critical to performance. Closeness measures the average inverse of geodesics to all other nodes, so higher-scoring nodes are closer than low-scoring nodes, and disconnected nodes have a closeness of zero.

Of course, the appropriate structural measure of bridging capital will depend on the nature of resources involved. Borgatti (2005) provides a useful catalog of network measures that represent alternative hypotheses about the characteristic flow of a resource through links in the network. In particular, more complex information or more fragile resources may lose value quickly through multiple transmissions, increasing uncertainty and decreasing value as the length of the transmission path increases. In the extreme case only direct links with the innovator may be useful in the hypothetical example, in which case bridging capital is proportional to ego's number of alters or ***degree***[1]. With less fragile resources or more generalizable information, the number of organizations reachable in two-paths (ego to alter to the alter's alter), three-paths, etc. or some geometrically-weighted summation across all k-paths would provide the better measure.

[1] Of course, measures can represent multiple phenomena. Degree, for example, also represents the frequency of visits for any resource that continues to spread randomly throughout the network. For example, if conflict continues to spreads like an infection from a node to a single alter, degree will predict the expected frequency of conflict experienced by a given node.

Thompson's (1967) serial technology hypothesis, for example, calls for similar subunits requiring greater amounts of common information to be linked by a common supervisory node (2-path), and supervisors of similar processes themselves to be linked by a common supervisor throughout the k-level hierarchy (k-paths).

Bridging as Brokerage

Bridging capital includes not just the connectivity of the node that reflects the ability to obtain resources, but also its brokerage role in connecting other nodes. Burt (1992) argues that network brokers who bridge *structural holes* between others have distinct advantages in their ability to gain unique information and control information flows between groups; subjects with higher brokerage scores tend to perform better on multiple measures, particularly in studies of careers in research and development industries (Burt 2000, 2005).

Borgatti and Everett (2006) point out that brokerage measures of bridging are *medial* measures that count the number of walks or paths between other pairs of nodes in which ego is involved, whereas outreach measures of bridging discussed above are *radial* measures of connectivity based on the number or length of paths radiating from ego to all other nodes. Medial measures reflect the number of times a node is needed for a given actor to reach any other actor. On the global level of medial measures, Freeman's (1977) *betweenness centrality* for ego is based on the total number of geodesic paths between any two nodes that include ego.[2] When brokerage is only effective over paths of k steps or less, *k-betweenness centrality* would be the preferred measure of bridging capital.

[2] The implicit assumption in this measure is that only resource flows along the shortest path matters, as with the innovation diffusion. Borgatti and Everett (2006) note that gossip flows randomly along any walk, so the appropriate betweenness measure for gossip-type flows would count the number of walks rather than geodesics. When brokerage reflects the ability to withhold the flow of resources through any walk rather than just through the shortest paths, *flow-betweenness centrality* would measure this ability.

Burt's (1992) analysis of structural holes assumes that brokerage is most effective among direct relationships, so his brokerage measure of the *effective size* of an ego network counts the number of alters minus the average number of ties between alters. Brokerage is greatest when no alters are linked to each other, in which case the effective size equals the number of alters, or ego's degree. Brokerage is least when all alters are interconnected, giving an effective size of 1. To separate the effect of brokerage from the effect of degree, brokerage *efficiency* divides effective size by degree, thus reflecting the proportion of alters that are dependent on ego for mediation.

Bonding

Bonding is associated with redundant, overlapping, clustered links that in turn are associated with the development of trust, common norms, credibility of commitments, and maintenance of cooperative relationships (Coleman 1988, Putnam 1993, Burt 2005). Bonding relationships are those creating paths that begin and end with ego, primarily including reciprocal directed links between two nodes and transitive links connecting three nodes to each other, but potentially including higher order cycles relating to larger clusters of interrelated nodes. Bonding is measured by the density of relationships among ego's alters, or clustering coefficient, which equals the observed ties divided by the potential ties between alters or the proportion of potential ties that are observed. As noted earlier, bonding represents costly redundancies in relationships, reflecting the tendency of two alters to form direct links even though they are already connected through ego. The direct link thus eliminates ego's potential brokerage role between directly-connected alters, so an increase in bonding decreases the egonet-based measure of brokerage.

Self-Organizing Governance through Resource Networks

The Cooperative Funding Initiative (CFI) of the Southwest Florida Water Management District (SWFWMD, or "the district") provides a strategic research site for studying the impact of bridging and bonding on performance. The CFI relies on and encourages self-organizing relationships among concerned organizations to develop and implement public goods projects in the greater Tampa Bay area. Like many new programs, the CFI reflects the assumption that decentralized local initiative and participation in local projects is likely to incorporate local knowledge that is frequently ignored in more centralized, bureaucratic systems for the provision of public goods (Ostrom 1990). In addition, those expected to benefit from the project will generally have greater motivation than central bureaucratic experts (Ostrom 1990) to overcome the inevitable difficulties encountered in the planning and implementation of a project and see it through to a successful conclusion.

The CFI encourages local provision of public goods not through the type of collaborative local institution analyzed by Ostrom, but rather through an annual competition for 50% matching funds provided by the regional water management district (Berardo 2009). Our research analyzes the 97 applications presented in December of 2006 that range from multi-million dollar water supply projects to neighborhood flood control and trail projects, with a median budget of $784,000 and mean budget of over $3 million. The median budget for the 76% of applications that were funded was $920,000, accounting for a total budget exceeding $300 million, a substantial part of the total investment in water projects within SWFWMD jurisdiction.

We are interested in the organizations responsible for the initiation, development, and implementation of these public goods projects. Project managers identified 178 organizations that provided needed resources to their projects. This organizational set included federal (5% of total), state (7%), regional (7%), and local government agencies (40%) as well as research organizations (13%) and environmental (10%), business (10%), and homeowner groups (8%).

Organizations decide for themselves which projects are worth supporting and which collaborating organizations are worth partnering with in the production of public goods. Once the project has been chosen, organizations investing in the same project have strong incentives to establish close working relationships. Berardo (2009) uses this joint participation to define links in the interorganizational collaboration network. He finds that a larger number of organizations providing resources to a project increases the project's likelihood of funding, but that projects with fewer organizational supporters can compensate by attracting support from organizations with higher brokerage scores. However, when Whiteman (2010) limits the data to organizations providing political resources to projects, she finds that only brokerage organizations increases the likelihood of funding for controversial projects, and that brokers may actually have negative impacts for less controversial projects. The difference between the first study based on relationships aggregated over all support organizations and the second study limited to organizations supplying only political resources suggests the potential advantage of independently analyzing networks supplying different resources.

Resource Networks

Organizations supplying the same resource to a given project have the greatest need to collaborate closely to ensure an adequate supply of that resource, and hence we use this relationship to define a link in the network for the specified resource. A study advisory panel of local experts in our project identified four types of resources critical to project success in the CFI program, including *political* ("developing adequate political support and public buy-in", *technical* ("obtaining technical information and knowledge"), *financial* ("securing adequate funding”), and *regulatory* resources (“acquiring needed permits and regulatory clearances”). When asked how important each resource was for the success of their project, managers reported that all resources were important; on average the *Importance of Resource* measure was highest for financial resources (6.6 on a 7-point scale), followed closely by technical (6.3), political (5.7) and regulatory resources (5.2).

As noted earlier, each resource corresponds to different governing functions associated with the classic policymaking cycle (Easton 1965). The political function of articulation and aggregation of demand for the public good is traditionally associated with interest groups, parties, and the electoral system. The technical planning function of designing a project to meet the articulated needs generally falls on experts in specialized government agencies. The financial function of selecting specific alternatives and determining funding levels for projects is associated with the decisions adopted by elected legislative and executive officials, and the regulatory function of implementing the project within statutory constraints again falls on the specialized government bureaucracies.

In network terms, the two policymaking networks provide the necessary political and financial resources that arguably impose greater uncertainties and hence are hypothesized to favor bonding capital,, and the two implementation networks provide the technical and regulatory resources that arguably impose relatively less uncertainties and hence are hypothesized to favor bridging capital. .

To map out the resource networks, each project manager identified the organizations that provided each resource to the project. The technical resource suppliers made up the largest network with 114 organizations, followed by the political (91), financial (73) and regulatory (53) networks. On average, each organization providing a given resource did so to two projects, with slightly higher averages for technical (2.6) and financial (2.3) and lower for political (2.0) and regulatory (1.8) resources. However, the ten largest providers in each network supplied a substantial proportion of projects needing the resource, ranging from 58% for technical and 52% for financial resources to 41% for political and 38% for regulatory resources. The resultant average number of links between organizations varied from a high of 3.5 in the technical network to 2.5 in the political network, 1.7 in the financial network, and 1.3 in the regulatory network.

Little pattern of specialization by organizational type is evident in Figure 1, in which circles represent the organizations, lines indicate that the organization provides the linked resource (squares), and different colors represent the different organizational types indicated in the legend. Thus multiple types of organization supply each resource and many organizations supply multiple types of resources.[3] When compared on a link by link basis for networks that include the full set of organizations, correlations of links across networks varied from .39 to .45 among all networks other than regulatory, which is correlated with others at .32 and less.[4] In short, there are sufficient theoretical and empirical differences across resource networks to justify separate analyses of network capital and performance.

Research Design

Our focal research question about structure and performance is the extent to which an organization's bridging and bonding capital within each resource network affects the performance of the projects supported by the organization. The secondary question addresses the concern of whether the self-organizing nature of these networks can generate efficient governing

[3] However, an ongoing effort to study these networks as two-mode structures has found that organizations of the same type are more likely to participate in common projects in political and technical networks than in the remaining two (Berardo 2010).

[4] Matrix correlations were calculated in UCINET using the QAP procedure. All correlations were highly significant.

structures: do the uncoordinated, self-interested decisions of organizations actually increase the frequency of the most effective form of bridging or bonding capital in each network?

To test the risk hypothesis we would ideally predict whether bridging or bonding capital would most enhance performance based on the uncertainty involved in the supply of each resource, and would select the appropriate network measure to test the hypothesis based on the nature of the resource flow. Since the current knowledge about self-organizing governance is insufficient to provide a consensus on appropriate measures and hypotheses, we base our tests on the rebuttable assertion that the political and financial networks most closely associated with policymaking impose greater uncertainties on providing organizations, so bonding capital is expected to be most productive and most prevalent; technical and regulatory networks most closely associated with implementation, on the other hand, impose fewer uncertainties and hence bridging capital should be more productive and more prevalent. Since the appropriate measure of bridging capital is also not clear, we utilize the full range of measures discussed earlier. In short, we use statistical models and the risk hypothesis primarily as exploratory devices to probe the relationship between structure and function in self-organizing policy arenas.

The CFI research site offers the following useful features for addressing the research questions:

- an important, self-organizing, geographically-bounded network governance system in which organizations individually determine which projects to support, and hence which organizational partners to collaborate with,
- a potential for mapping each organization’s position in each resource network as determined by links reflecting common provision to the same project,

- a governance system in which successful provision of public goods is reflected in project success, which in turn requires the integration of multiple policymaking and implementation resources at the project level, and hence
- potential measures of project performance that can be related to the organizational position of the project's resource providers.

Performance Measures: All data for the analysis were collected from archival data provided by the CFI program and from telephone interviews with 97 project managers in the summer of 2007.[5] Performance measures included both types of data. *CFI-Funded* is a dichotomous variable with value of 1 for projects that succeeded in obtaining CFI funding, as determined from budgetary documents. Funding decisions are based on a staff review of technical merits as well as on the priority funding areas outlined prior to the process, so this performance measure tests the extent to which network capital affects technical and regulatory competence as well as political and financial abilities to establish the project's priority. Success in obtaining funding is a necessary condition for success in other performance measures, since projects seldom go forward without CFI matching funds.

Funding does not guarantee success, so managers were asked to rate project performance on other dimensions of performance using a seven-point response scale. We expect managers to rate their own projects higher than others might, but this bias is not necessarily a problem for analyzing the ratings relative to other projects. *Evaluation* averages responses to three statements that the project will fully satisfy the expectations of the manager's organization, the project initiators, and the community (Alpha =.83). The responses reflect the manager's current expectations based on the first year of a development and implementation process that in most

[5] The selection of these managers, response rates, and other details are provided in (----).

cases will last for several more years. This preliminary estimation provides the most general assessment of how well this project will provide the expected public good.

Since the ability of self-organizing systems to deliver public goods is dependent on the ability and willingness of organizations to collaborate, two additional performance measures focus on the potential for current and future collaboration that evolves as organizations work together on the project. *Collaboration* asks for agreement with the statement that "all partners on this project have fully collaborated to their greatest capacity." *Future collaboration* asks for agreement with the statement that "participation in this project will increase my organization's future collaborative efforts with other agencies on water policy and water projects."

Project Control Measures: We include several project characteristics likely to influence performance to control for potential spurious effects on the network measures. *Participating Organizations* counts the total number of organizations providing any resource to the project, which can control for and test Berardo's (2009) finding that it is primarily the total number of participating organizations that enhance performance and can substitute for other network characteristics. *Number of Projects* counts the total number of projects sponsored by the project's designated lead organization, *Number of Venues* indicates the number of water policy venues that the project's lead organization is active in, and *Policy Activity* reflects the manager's perception of the level of activity of the lead organization in the policy environment. All serve as proxies for the size and amount of resources available to the lead organization, and represent the claim that lead organizations with more resources enhance project perform. The number of projects is squared to emphasize the impact of larger numbers, which also tests for the possibility that undertaking too many projects can negatively affect project performance, controlling for the other two indicators of size. The project director's manager's commitment to protecting the *environment* and *trust in government* serve as two common orientations potentially aiding the project's performance. Finally, *Water Supply* is a dummy variable representing water supply projects, which tend to be more popular among local officials. Although few of these controls turn out to be significant, they remain in the model to ensure that these issues are all controlled for in the final estimation process.

Bridging and Bonding Capital Measures: The measures discussed earlier to represent bridging (activity, outreach and brokerage) and bonding relationships are calculated in UCINET for each organization in each resource network.[6] The measures in each network are based only organizations supplying the given resource, where a link between two organizations means that they supply the given resource to at least one common project. In network analysis terms, our focus on organizational relationships is uses a unimodal approach to two-mode data linking projects and organizations (Borgatti 2009).

To match the organizational measures of structure with the project measures of performance, we averaged the organizational measure across all organizations supplying the given resource to the project. This procedure assumes that the contribution from each organization's network position has a cumulative impact on the project's ability to obtain wider resources from the wider network; initial tests using the minimum and maximum rather than average of the involved organization did not in any case indicate major differences in significant relationships with performance measures.

[6] The network measures calculated in UCINET for each network used in the initial comparisons include average geodesic distance, number of weak component in ego network, density of ego network, 2-step reach, reach efficiency, brokerage in ego network, efficient brokerage in ego network, betweenness in ego network, flow betweenness, Bonacich power centrality, closeness centrality, betweenness centrality, eigenvector centrality, reach centrality, and degree. Since density of egonetwork is interpreted in terms of avoiding potential conflicts it is set to 1 for organizations with only one link, indicating no conflict, to avoid the loss of these observations in regression analyses.

Since we cannot claim a defensible theoretical argument to select the appropriate bridging measures corresponding to outreach and brokerage, we selected the measure most consistently correlated with our full set of performance measures across the four resource networks. This procedure eliminated the more global measure of brokerage (betweenness centrality) and the intermediate measure of outreach (two-step reach); any potential effects of brokerage appear limited to an organization's immediate partners (efficient brokerage in ego network), while potential effects of outreach appear to require the ability to gain information either from partners (degree) or from the full resource network (closeness).

As suggested in Whiteman (2010) we assume that network resources will have the greatest impact on projects most in need of the resource. We therefore interact the *Importance of Resource* rating by project managers discussed earlier with the bridging and bonding measures for the same resource. The median response category of 6 (out of 7) in the political network was recoded to zero in all networks, so the interaction term will have no impact on this category. In other words, the coefficient for the network measure indicates its impact on performance for projects in this category. A significant positive coefficient for the interaction term therefore measures the increase in impact of the network measure for projects most needing the resource compared with projects in the median category (or, stated inversely, the decrease in impact on projects needing less of the resource).

The Impact of Bridging and Bonding Capital on Performance

To test the impact of network measures from each resource network on performance, we estimate the same model independently for each of the four resource networks and each of the four performance measures, for a total of 16 regression models.[7] Probit estimation is used for funded, the dichotomous variable, and ordered probit for the remaining ordered category variables. Only the political and financial network measures have significant impacts on performance, with each network affecting two different performance measures.

The four estimations that found significant network effects are presented in thee columns of Table 3. The resource network is indicated above the relevant columns, and the performance measure that provides the dependent variable in each estimation is indicated above each individual column. The cells report coefficients for each row variable included in the model, with standard errors reported in italics below each coefficient. In the reported models, all network measures are retained to demonstrate their insignificance, but interaction terms are dropped if the network measure and interaction term are always insignificant in alternative model specifications and the interaction term appears to cause collinearity problems.

Each measure of performance is significantly affected by at least one network measure, although the chi squared tests reported in the last line indicate a relatively marginal model fit for three of the models. We note in passing that the project-based control variables have surprisingly little impact on performance. The number of projects developed by the lead agency affects both evaluations and funding, with the negative effect on evaluations being consistent with the expected overcommitment effect that reduces the effectiveness of the leading organization. The positive coefficient for funding, on the other hand, suggests that size and effort of the lead agency do help projects successfully navigate the funding process. The negative coefficients for environment and trust in government may suggest the value of skepticism for project leaders, or at least that positive attitude toward government and the

[7] Given the potential for collinearity among measures for the different networks and the relatively small number of observations (85-89) with complete data, models that included network measures from all four resource networks in the same equation generally performed poorly.

environment are not prerequisites for successful environmental projects in the realm of self-organizing governance. Somewhat surprisingly, the number of participating organizations that significantly increased the probability of funding when calculate for the combined resource networks (Berardo 2009) is not significant for the specialized political or financial networks analyzed here, where the degree of the organizations providing support is more important than the number of supporting organizations. We are most concerned with the network measures, so we first discuss the two networks with significant impacts on performance, and then consider each term in order.

1. Financial and Political Networks Enhance Performance, but Technical and Regulatory Networks Do Not

Table 1 indicates that network capital in both political and financial networks significantly impact performance. Network capital has no significant effects in technical and regulatory networks, so the regressions are not reported in the table.[8] Furthermore the results suggest a more complex relationship between network capital and performance than hypothesized, since each performance measure responds to different forms of network capital in different networks of resources. In addition, the response to bridging and bonding capital tends to vary with the relative importance of the resource to the project. We note each significant network effect in turn, and discuss the implications in a later section.

2. Political Bonding Improves Project Evaluations, but Financial Bonding Reduces Future Collaboration

[8] Brokerage (the measure of how much ego connects otherwise unconnected organizations) in the network of provision of technical information), affects collaboration at a significance level of .1. With interactions, brokerage enhances collaboration in the funding arena for projects that report funding to be a critical resource, but actually has a negative effect when funding is not a critical resource. Thus organizations with the ability to broker funding agreements apparently help smooth relationships among partners when funding is critical, but tend to increase friction when funding is not as critical. However, the large number of models we tested would caution against putting much emphasis on results using this generous cutoff for significance.

The evaluation model in the first column indicates that organizations with greater bonding capital in the political network enhance the evaluation of projects that most need political support. The coefficient for density is not significant, so bonding capital does not have a significant impact for projects in the median category (=0) of importance of political resources, which is coded as zero. However, for the 32 projects needing the most political resources (= 1), the significant positive interaction term indicates that greater bonding capital among supporting organizations significantly improves evaluations. Conversely, projects needing fewer political resources (<= -1) are worse off when supporting organizations have higher bonding capital, since negative values for the importance of the political resource ensure that the interaction effect in this category is negative.

Contrary to the risk hypothesis for policymaking networks, the positive effect of bonding capital for political suppliers is reversed for financial suppliers, where the interaction term in the future collaboration model is significant but negative. Future collaboration is less likely among the projects that report the highest importance for financial resources if their financial supporters have higher levels of bonding capital. Conversely, higher levels of bonding capital will enhance future collaboration among projects where financial resources are less important.

3a. Bridging Capital: Activity Enhances Funding and Collaboration for All Projects

All measures of bridging capital in Table 1 have at least one significant effect, but the simplest measure of the organization’s degree or number of partners has the most consistent and straightforward effect. A higher degree significantly increases the likelihood of obtaining CFI funds (column 2) for the organization’s projects, while (somewhat ironically) higher degree in the financial network increases collaboration (column 4). In all equations, the interaction term is insignificant when included but is omitted from the final estimation because of potential multicollinearity problems.

3b. Bridging Capital: Financial Brokerage Enhances Collaboration when Funding is Important

Brokerage within the financial ego network has a marginally significant (.1) impact on collaboration for the 73 projects that indicate the highest importance of funding (=1). The insignificant coefficient for brokerage indicates that effects are negligible on the remaining projects, since very few projects have negative scores for the importance of funding.

3c. Bridging Capital: Political Closeness Enhances Evaluations Only for Noncontroversial Projects

Finally, the insignificant main effect of closeness combined with the significant negative interaction term in the first column indicates that only projects with below-average need for political support improve their evaluations when associated with organizations with higher closeness scores. Since all networks are disconnected, the closeness measure primarily reflects the size of the component containing the organization. Organizations that are members of the largest component in the political network improve evaluations for noncontroversial projects, but harm evaluations for those projects needing the most support.

Analyzing the Impact of Performance on Bridging and Bonding Relationships

Given that performance is enhanced by bridging relationships in financial networks and bonding relationships in political relationships, we next analyze the extent to which the most effective relationships are more prevalent in each network before discussing both findings together . Comparing average measures from Table 1 across networks suggests that political and financial networks each reflect the more effective form of network capital, The average bonding measure (egonet clustering coefficient) is higher in the political (70) than in the financial network (59). The average bridging measure of brokerage is slightly higher in the financial (0.5) than in the political network (0.4), although the bridging measure of outreach (closeness) is the same (0.8) in both networks. The bridging measure of average organizational degree is considerably higher in the political (3.5) than in the financial network (1.7), but since degree increases performance in both networks, there is no reason to test these differences for significance to test whether more effective network capital is more prominent in the political and financial networks.

Exponential Random Graph Models (ERGM) can provide an appropriate statistical test for whether these observed differences in bridging and bonding are significant. An ERGM model tests the extent to which the observed frequency of structures included in the model differ significantly from the frequency expected in a randomly-generated graph containing the same number of nodes and links. Coefficients provide the maximum likelihood of generating the observed frequency of all structures included in the model, with significant positive (negative) coefficients indicate a greater (lower) frequency in the observed data. More importantly for our purposes, the standard errors of the coefficients provide a test of whether the expected frequency of bridging and bonding structures differ significantly in political and financial networks.

ERGM models represent bridging and bonding with slightly different measures than those in the regression analysis. The three structural measures included in these models were recently developed to represent classes of relationships with a single measure as a means to avoid degeneracy problems and a proliferation of structural coefficients commonly encountered when using multiple individual measures (Snijders et al. 2006, Robins et al. 2007). Bonding capital is represented by the "alt-k-triangle" structure that estimates the frequency of transitive relationships in which nodes *i* and *j* are linked and both have links to one or more common nodes. Within this structure any alter to *i* is also an alter to *j*, thus representing the kind of clustered relationships associated with bonding capital. The brokerage aspect of bridging capital is represented by alt-k star, which estimates the frequency of brokerage relationships in which nodes *i* and *j* both have links to one or more common nodes, just as in the bonding measure. In this measure, however, *i* and *j* themselves are not linked, so resource transfers between *i* and *j* must flow through one or more of their common alters who serves as a broker. The outreach aspect of bridging capital is represented by alternating independent two-paths, which measures "trees" of non-redundant (independent) two-step connections that increase the connectivity of the network.

Table 2 presents estimates of the ERGM model applied to each resource network using SIENA (Stocnet version 3.17, Snijders et al. 2008).[9] The results fully support the conclusion

---

[9] The analysis followed the recommended procedure of analyzing the structure of each resource network initially with models containing only the simplest structures, testing for differences between simulated and observed counts on more complex structures not included in the model, and adding structures to the model that are not well-accounted for in the next cycle of tests. Initial models based on simple representations of stars, triangles and two-paths did not converge, as is common in graphs with considerable transitivity (Snijders et al. 2006, Robins et al. 2007), so the improved measures were used with default setting of 2-- higher parameter settings did not improve model performance. Simulation tests revealed other structures (particularly 4- and 5-star) poorly predicted by the model for each network, but these structures were either not significant or produced models that did not converge in subsequent tests. Dummy variables representing the two outlier nodes with unusually high degrees also proved to

that bonding capital is more prevalent in the political than in the financial network, while bridging capital is more prevalent in the financial than in the political network. First, the coefficient for bonding in the political network exceeds the bonding coefficient in the financial network by many multiples of the standard error.[10] Thus a connected pair is significantly more likely to share common alters in the political network compared with the financial network.

Second, both bridging coefficients are significantly higher (less negative) in the financial than in the political network. Unconnected pairs are significantly more likely to share alters who can broker relationships in the financial than in the political network. Similarly, organizations are significantly more likely to have multiple independent 2-paths to enhance outreach in financial than in political networks.

In short, Table 2 confirms that the political and financial networks differ significantly in all measures of bridging and bonding capital. Organizations supplying political resources appear to prefer bonding capital by joining projects that produce overlapping, clustered relationships

---

be insignificant. Even with the improved "alt-k" measures and repeated estimations, convergence for the reported models was only marginally satisfactory (<.2) for all but the poorest performing political network model (=.4). Note that relationships in our data are defined by affiliation with a project, and affiliation relationships in general create higher frequencies of transitive structures (alt-k-triangles) and hence lower frequencies of brokerage (alt-k-stars) than expected in random graphs (Opful 2009?). This accounts for the higher bonding coefficients and the otherwise surprising negative coefficients for brokerage in all networks.

[10] The magnitude of difference in terms of standard errors is large enough to compensate for the complication in comparisons caused by the difference in the number of nodes (91 to 73) and links (228 to 124) between the networks.

with other political suppliers. Organizations supplying financial resources, on the other hand, prefer maximizing their bridging capital by seeking projects with organizational partners that offer both brokerage and outreach to a broader set of financial suppliers. As an aside, the technical network most closely resembles the political network, while the regulatory network falls between the political and financial networks in bridging and brokerage, but exceeds both (though not significantly for the financial network) in outreach.

Implications for Self-organizing Governance

The two general conclusions from these analyses of a self-organizing policy arena are that network relationships significantly impact the provision of public goods and that the most effective form of network capital emerges as the most dominant form of relationship simply an outcome of the individual choices of organizations. Understanding which relationships impact which dimensions of performance and whether organizations can improve these relationships is therefore critical for understanding the potential role of self-organizing governance within our political system.

The sociograms of political and financial networks in Figures 2 and 3 summarize and visually elaborate the two analyses.[11] The nodes in both figures represent organizations, and the connecting lines represent links between organizations sharing at least one common project. Node color represents the type of organization, node height is proportionate to the organization's brokerage measure, and node width is proportionate to the clustering score. Nodes with higher degree are located nearer the center of the diagram, and the concentric circles extending outward from the center are distance measures labeled with the percentage of total network links accounted for by each organization (organization's degree divided by total number of links in the

[11] The figures were created with Visone (Brandes andWagner 2004).

network) located that distance from the center of the circle. Based on Table 1 estimates, central nodes impact performance in both networks, while wide nodes in the political network and tall nodes in the financial network also impact performance.

The results demonstrate the limited validity of our working hypothesis and suggest important refinements to our overly-simple assumptions about resource networks in self-organizing governance structures. First, bridging relationships in technical and regulatory networks did not significantly impact project performance despite the potential gain from sharing technical and legal know-how across similar projects. Perhaps technical and regulatory knowledge relevant for CFI projects may be sufficiently widespread or sufficiently specialized by project that each organization controls sufficient resources without the need for bridging relationships. If so, measures reflecting the supply organizations' individual capabilities would best predict project performance. Alternatively, network structures based on a different pattern of relationships might more closely reflect the nature of technical and regulatory exchanges, or models that better account for heterogeneity among organizations and projects may be needed to observe effects undetected in our study.

Second, all significant measures except closeness are based on direct contacts, and the negative effect of closeness further indicates that indirect connections do not help impacts, at least for controversial projects. Effective political and financial resources appear to be shared through direct relationships growing out of work on shared projects rather than through indirect relationships that could provide more global access to the network's resources. Indeed, all projects improve performance when assisted by organizations with the highest number of direct contacts in both Figures 2 and 3; SWFWMD followed by a University of Florida program dominate both networks, counties and the Florida Legislature are more influential in the political network, while a greater diversity of government agencies from the City of Tampa and the Florida Department of Environmental Protection to the Tampa Bay Estuary Program are most influential in the financial network.[12]

Third, contrary to their assumed symmetry, the two policymaking resource networks differ both in the dimensions of performance affected and in the preferred type of network capital that influences them. Political network capital has significant impacts on the external performance criteria related to project funding and evaluation, so adequate political resources are required not just to obtain CFI funding but also to make continuing progress toward the goals of all partners. Financial network capital affects internal performance criteria relating to current and future collaboration, presumably by reducing fiscal strains that otherwise complicate collaborative efforts. In addition, financial bridging relationships improve an organization's range of contacts and ability to keep up with the latest innovations in project development, both of which can improve the organizations ability to find and attract the most competent partners for future collaboration.

The difference in preferred network capital is affected by the tradeoff between bridging and bonding capital that is illustrated in Figures 2 and 3. The higher degree nodes toward the center are generally tall and thin, indicating a close relationship between high degree, high brokerage and low bonding. The opposite is true of peripheral low degree nodes that are generally short and wide, indicating low degree, low brokerage and high bonding. An organization's first project *A* creates a fully-connected set of partners. An added project *B* that

[12] Degree could be a proxy for the organizations level of resources, which is not controlled for in the reported equation. However, project-level controls include several proxies for the level of resources of the lead agency that were not significant. Only the lead organization's number of projects was significant, and this had negative impacts on evaluations associated with over-commitment. The positive impact on CFI-funding may be related to organization's resources, suggesting that bigger, more active organizations in the political networks are more effective in securing funding. A dummy variable for SWFWMD was not significant (Meredith, please check), so the effect of degree is not due simply to the most central actor.

involves the same partners maintains the highest bonding capital but adds nothing to degree. An added project *C* that involves a different set of partners adds bridging relationships between the two sets of alters that increases both degree and brokerage, but at the same time reduces bonding because the new alters are not connected to the previous alters. Project B would be the more prevalent choice in political networks where it enhances evaluations among controversial projects, while project C would be the more prevalent choice in financial networks where it enhances collaboration among partners that are most in need of funding.

As expected, bonding capital appears to mitigate the higher levels of uncertainty expected in political relationships, where multiple overlapping bonding relationships from common projects can enhance credibility and shared norms while reducing the incentive to defect (e.g., Coleman 1988) if controversial projects run into strong opposition. The significant negative coefficient for closeness adds additional support to the importance of clustered relationships, suggesting that more isolated but strongly interconnected peripheral groups (like those in the southwest quarter of Figure 2) can focus more narrowly on the specific requirements of common projects For less controversial projects, the advantages from bonding appear to be outweighed by the added expense of redundant relationships; that is, the value of redundancy diminishes when risk and uncertainty are low. The cost of redundancy poses a difficult tradeoff for political suppliers, since adding new alters by selecting project *C* in the previous example would increase degree and hence the likelihood of obtaining CFI funding, but at the cost of decreasing bonding and hence decreasing evaluations.

Contrary to initial assumptions, the advantage of brokerage rather than bonding in financial networks suggests that credibility is not the main concern here in terms of the impact on collaboration. The negative interaction term of ego network density for future collaboration and the positive interaction term of brokerage for collaboration are both consistent with a risk portfolio perspective (Shrestha 2010).[13] The brokerage strategy ensures that the failure of a single partner to meet financial obligation in project *A* will not threaten project *C*. The bonding strategy, on the other hand, exposes project *B* to the failure of the same partner, and the redundancy of relationships increases the likelihood of failure by restricting access to a single set of organizations. Since failure is more likely with projects most in need of funding resources, brokerage relationships provide the most assurance against financial strains for these demanding projects, but are less important for less demanding projects. This refinement demonstrates how network analysis based on existing but inadequate working assumptions can contribute to a better understanding of the unique risks and uncertainties associated with each resource and the effective network strategies used to cope with them.

The striking difference between bridging and bonding impacts on performance parallel differences in project selection strategies that tend to favor project *B* for political networks and project *C* for financial networks. The political tasks of interest articulation and aggregation to gain support for a common set of projects appears more reliant on developing trust, common interests, and coordinated strategies among collaborating organizations, as expected in the working hypothesis. Financial tasks of finding and committing adequate resources to specific projects, on the other hand, appear to be more concerned with risk portfolio management. Perhaps available contractual arrangements provide sufficient credibility for financial commitments, so the failure of even credible partners is the main source of uncertainty. Understanding the differences between these resources will provide a better understanding of the nature of uncertainties mitigated by bridging and bonding relationships, an important next step in

[13] We thank Carter Butts for this observation.

the development of a comprehensive theory of structure and performance in the provision of public goods.

The CFI provides an example of self-organizing governance in which the more effective network capital for the production of public goods emerges even without the aid of a central authority. The competition for funds apparently provides incentives for organizations to carefully select projects and partners that can enhance success, thereby aligning private and social benefits in the process of selecting partners. Our focus has been on the success of projects emerging from the CFI program rather than on their public value, so our claim is limited to the ability of participating organizations to select wisely for the success of the projects they sponsor. Furthermore, not all relationships correspond to the favored pattern; at least two dense clusters appear directly east and west of the center even in the financial network in Figure 3, for example. Even when no central intervention is required to encourage productive relationships, a more complete theory of structure and performance and a better understanding of its application in specific programs can enhance performance for interested stakeholders in the policy arena.

The results of our study demonstrate the potential gain from expanding the use of network analysis in policy studies. Recent advances in the study of affiliation relationships provide a strong foundation to extend and verify our findings with increasingly sophisticated techniques. Weighted rather than dichotomous measures can account for differences in the number of shared projects, although the added complexity and controversies involved in using such weighted measures are currently under discussion (e.g., Opsahl and Panzarasa 2009, Opsahl, Agneessens and Skvoretz 2010). The two-mode ERGM models currently under development (Wang et al 2009, Lubell, Robins and Wang 2010) are building the capacity to simultaneously analyze network structures in both dimensions (projects and organizations in our study), while existing one-mode models focus on analyzing the interactions of multiple networks (Snijders *et al*. 2006, Robins *et al.* 2007). Although these developments fall short of capturing the full richness of relationships involved in the policy process, their application to policy analysis hold promise for improving our theoretical and analytic ability to understand how the structure of relationships affects governance.

Conclusion

We have applied a network theory of risk and uncertainty to study how relationships among supporting organizations impact the performance of public goods projects in self-organizing policy arenas. By separately analyzing political, financial, technical, and regulatory networks of organizations providing resources to these projects, we provide evidence that the most active organizations in political and financial networks enhance the likelihood of funding and of future collaboration, respectively. Of greater theoretical interest, bridging capital in the financial networks enhances collaboration among partners in the projects, while bonding capital in the political network enhances project evaluations. Thus the nature of the resource being provided changes the effectiveness of network capital, although in a more complex manner than expected in the risk hypothesis. Furthermore, network capital involving direct links representing shared participation in the same project are much more important than indirect links to organizations not sharing the same projects, at least in the CFI context. Finally, we find that organizations tend to select partners with the most effective network capital in both networks, preferring organizations with higher bonding capital in political networks and higher bridging capital in financial networks.

The practical implication of these findings is that project managers and their organizational counterparts can enhance project performance by seeking support from more organizations among those that provide political and financial support, particularly by seeking organizations rich in bonding capital for political support and bridging capital for financial support. In other words, seek political support from homogeneous organizations all sharing similar projects, but seek financial support from heterogeneous organizations with projects involving different sets of organizations. The observed prevalence of bonding capital in political networks and bridging capital in financial networks suggests that at least some managers already understand and act upon this advice, although we cannot say whether they already do so at some optimal level.

We view this demonstration as an early contributing step in the development of theory and analytic tools required to understand informal policy processes both within and beyond the formally-defined governance institutions (O'Toole 1997). Although this study focused on self-organizing governance, we seek a unified theory of structure and performance in the provision of public goods that applies to both policymaking and implementation functions in formal and informal governance structures alike. A more nuanced understanding of the risks and uncertainties involved in the exchange of the relevant resources combined with network concepts appropriate to each category of risk and uncertainty may provide an adequate foundation for such a theory.

A complete structural theory of informal governance would need to know what attributes of a policy arena make it likely that measures of direct relationships will be more important than those involving indirect relationship, as we found in our study. When will each dimension of bridging and bonding relationships play critical roles, and when can these informal relationships safely be ignored in analyzing formal governance institutions? Answering these questions will require both theoretical explorations linking critical assumptions about relationships to specific network measures (e.g. Borgatti 2005) and empirical analyses applying appropriate regression and ERGM-like analyses to a broader spectrum of policy arenas.

References

Agranoff, Robert, and Michael McGuire 2003. *Collaborative Public Management: New Strategies for Local Governments.* Washington D.C.: Georgetown University Press.

Bardach, Eugene. 1998. *Getting Agencies to Work Together. The Practice and Theory of Managerial Craftsmanship*. Washington, D.C.: Brookings Institution Press.

Berardo, Ramiro. 2009. "Processing Complexity in Networks: A Study of Informal Collaboration and its Effect on Organizational Success." *Policy Studies Journal* 37(3):521-539.

Berardo, Ramiro. 2010. "The 'Invincible' Hand: Exploring the Role of Government as a Catalyzer for Interorganizational Collaboration in Competitive Systems." Working paper.

Berardo, Ramiro, and John T. Scholz. 2010. "Self-Organizing Policy Networks: Risk, Partner Selection and Cooperation in Estuaries." *American Journal of Political Science* 54(3):632-649.

Bodin, Orjan and Beatrice I. Crona. 2009. "The role of social networks in natural resource governance: What relational patterns make a difference?" *Global Environmental Change* 19:366-374

Borgatti, Steve P. 2005. "Centrality and network flow." Social Networks 27(1): 55-71.

Borgatti, Steve P. 2009. "2-Mode Concepts in Social Network Analysis,"in Robert A. Meyers (ed) *Encyclopedia of complexity and systems science* New York : Springer.

Borgatti, Steve P., and Martin G. Everett. 2006. "A graph-theoretic framework for classifying centrality measures." *Social Networks* 28(4): 466-484.

Brandes, Ulrik, and Dorothea Wagner. 2004. "Visone. Analysis and Visualization of Social Networks." In *Graph Drawing Software*, eds. Michael J¨unger and Petra Mutzel. Berlin: Springer-Verlag, 321–40.

Buchanan, James M., and Gordon Tullock. 1962. *The Calculus of Consent*. Ann Arbor, MI: The University of Michigan Press.

Burt, Ronald. 1992. *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.

Burt, Ronald. 2000. "The Network Structure of Social Capital." In Staw, B. M. and R. I. Sutton (eds.) *Research in Organizational Behavior.* Amsterdam; London and New York: Elsevier Science JAI, 2000, pp. 345-423.

Burt, Ronald. 2005. *Brokerage and Closure. An Introduction to Social Capital*. Oxford: Oxford University Press.

Carpenter, Daniel P., Kevin M. Esterling, and David M. J. Lazer. 2004. "Friends, Brokers, and Transitivity: Who Informs Whom in Washington Politics?" *The Journal of Politics* 66: 224-246.

Coase, Ronald. 1937. "The Nature of the Firm." *Economica*, 4(16): 386-405.

Coleman, James S. 1988. Social capital in the creation of human capital. *American Journal of Sociology* 94 (Supplement): 95–120.

Easton, David. 1965. *A Systems Analysis of Political Life*. New York: Wiley.

Feiock, Richard, and John T. Scholz (eds.). 2010. *Self-Organizing Federalism: Collaborative Mechanisms to Mitigate Institutional Collective Action.* New York: Cambridge University Press.

Freeman, Linton. 1977. "A Set of Measures of Centrality Based on Betweenness." *Sociometry* 40(1): 35-41.

Geys, Benny and Zuzana Murdock. 2008. "How to make Head or Tail of Bridging and Bonding?: Addressing the Methodological Ambiguity." *British Journal of Sociology* 59(3): 435-454.

Granovetter, Mark. 1973. "The Strength of Weak Ties." *American Journal of Sociology,* 78: 1360-1380.

Granovetter, Mark. 1985. ''Economic Action and Social Structure: The Problem of Embeddedness.'' *The American Journal of Sociology* 91 (3): 481–510.

Greif Avner, Paul Milgrom and Barry R. Weingast. 1994. "Coordination, Commitment, and Enforcement: The Case of the Merchant Guild". *The Journal of Political Economy*, 102(4) 745-776.

Gulick, Luther. 1937. "Notes on the Theory of Organization" in Luther Gulick and Lyndall Urwick (eds.). *Papers on the Science of Administration*. New York: Institute of Public Administration, Columbia University. 1-45.

Heclo, Hugh. 1978. "Issue Networks and the Executive Establishment." In *The New American Political System,* ed. Anthony King. Washington, D.C.: American Enterprise Institute. 87-124.

Kettl, Donald. 2002. *The Transformation of Governance*. Baltimore and London: The John Hopkins University Press.

Klijn, Erik-Hans, Joop F. M. Koppenjan, and Katrien Termeer. 1995. Managing networks in the public sector: A theoretical study of management strategies in policy networks. Public Administration 73:437–54.

Krackhardt, David. 1992. "The Strength of Strong Ties: The Importance of Philos in Organizations." In N. Nohria & R. Eccles (eds.), *Networks and Organizations: Structure, Form, and Action.* Boston, MA: Harvard Business School Press: 216-239.

Laumann, Edward O., and Franz Urban Pappi. 1976. *Networks of Collective Action: A Perspective on Community Influence Systems*. New York, NY: Academic Press.

Lubell, Mark, Adam Douglas Henry, and Mike McCoy. 2010. "Collaborative Institutions in an Ecology of Games." American Journal of Political Science 54(2): 287-300.

Lubell, Mark, Garry Robins and Peng Wang. 2010. "Policy Coordination in an Ecology of Water Management Games." Presented at the 2010 Annual Meeting of the Midwest Political Science Association, Chicago, IL.

Meier, Kenneth J., and Laurence J. O'Toole. 2001. Managerial strategies and behavior in networks: A model with evidence from U.S. public education. *Journal of Public Administration Research and Theory* 11:271–93.

Milward, H. Brinton, and Keith Provan. 2000. Governing the hollow state. *Journal of Public Administration Research and Theory* 10:359–79.

Opsahl, Tore, Filip Agneessens and John Skvoretz. 2010. "Node centrality in weighted networks: Generalizing degree and shortest paths". Social Networks 32, 245-251.

Opsahl, Tore and Pietro Panzarasa. 2009. "Clustering in weighted networks". *Social Networks* 31(2): 155-163

Ostrom, Elinor. 1990. *Governing the Commons.* Cambridge, MA: Cambridge University Press.

O'Toole, Laurence J. 1997. Treating networks seriously: Practical and research-based agendas in public administration. *Public Administration Review* 57:45–52.

Pfeffer, Jeffrey, and Gerald R. Salancik. 2003 [1978]. *The External Control of Organizations. A Resource Dependence Perspective*. Stanford, CA: Stanford University Press.

Pressman, Jeffrey, and Aaron Wildavsky. 1973. *Implementation*. Berkeley, CA: University of California Press

Provan, Keith G., and H. Brinton Milward. 1995. A preliminary theory of interorganizational network effectiveness: A comparison study of four community mental health systems. *Administrative Science Quarterly* 40:1–33.

Putnam, Robert D. 1993. Making democracy work: Civic traditions in modern Italy. Princeton, NJ: Princeton Univ. Press.

Rethemeyer, R. Karl and Deneen M. Hatmaker. 2008. "Network Management Reconsidered: An Inquiry into Management of Network Structures in Public Sector Service Provision." *Journal of Public Administration Research and Theory* 18:617–646.

Robins, Garry L., Tom A.B. Snijders, Peng Wang, Mark S. Handcock, and Philippa E. Pattison. 2007. "Recent developments in exponential random graph (p*) models for social networks." *Social Networks*: 192-215

Scholz, John, Ramiro Berardo, and Brad Kile. 2008. "Do Networks Enhance Cooperation? Credibility, Search, and Collaboration." *Journal of Politics* 70(2): 393-406.

Scholz, John, and Cheng-Lung Wang. 2006. "Cooptation or Transformation? Local Policy Networks and Federal Regulatory Enforcement." *American Journal of Political Science* 50(1): 81-97.

Schneider, Mark, Mark Lubell, John Scholz, Denisa Midruta, Matt Edwards. 2003. "Building Consensual Institutions: Networks and the National Estuary Program." *American Journal of Political Science*, 47:143-158

Shrestha, Manoj. 2010. "Do Risk Profiles of Services Alter Contractual Patterns? A Comparison across Multiple Metropolitan Services." In Feiock, Richard, and John T. Scholz (eds.) *Self-*

Organizing Federalism: Collaborative Mechanisms to Mitigate Institutional Collective Action. New York: Cambridge University Press. Pp. 114-141.

Snijders, Tom A.B., Philippa E. Pattison, Garry L. Robins, and Mark S. Handcock. 2006. "New specifications for exponential random graph models." *Sociological Methodology:* 99-153.

Snijders, Tom A.B., Christian E.G. Steglich, Michael Schweinberger, and Mark Huisman. 2008. Manual for SIENA version 3.2. Groningen: University of Groningen, ICS. Oxford: University of Oxford, Department of Statistics. http://www.stats.ox.ac.uk/siena/

Thompson, James D. 1967. *Organizations in Action*. New York, NY: McGraw-Hill.

Wang, Peng, Ken Sharpe, Garry L. Robins, Philippa E. Pattison. 2009. "Exponential random graph (p∗) models for affiliation networks," *Social Networks* 31: 12–25.

Wasserman, Stanley, and Katherine Faust. 1994. *Social Network Analysis: Methods and Applications*. Cambridge: Cambridge University Press.

Whiteman, Meredith. 2010. "Structuring Public Support Networks for Project Success"

Williamson, Oliver E. 1981. "The economics of organization: The transaction cost approach." *American Journal of Sociology* 87:548–77.

Table 1

The Impact of Organizational Network Measures on Project Performance

Resource Network	*Political Network*		*Financial Network*	
Project Performance (dependent variable) *Organizational Measures*	**Evaluation**	**CFI-Funded**	**Future Collaboration**	**Collaboration**
Bonding				
Egonet Density	-0.01	0.00	0.01	0.01
	0.07	*0.01*	*0.01*	*0.01*
Density*Importance	0.01**		-0.03**	
	0.00		*0.01*	
Bridging				
Degree	-0.01	0.15**	-0.01	0.06**
	0.03	*0.06*	*0.03*	*0.03*
Brokerage	-0.77	-1.20	1.44	.26
	1.54	*2.23*	*2.72*	*2.56*
Brokerage*Importance		1.18		4.47*
		1.54		*2.41*
Closeness	.63	-3.00	48.58	61.66
	2.058	*2.69*	*36.98*	*74.21*
Closeness*Importance	-5.05**		-47.60	-67.63
	2.03		*36.99*	*74.37*
Importance of Resource	4.32**	-0.63	41.76	56.12
	1.83	*0.83*	*31.86*	*63.73*
Project Controls				
Participating Organizations	-0.05	0.13	0.04	-0.03
	0.05	*0.08*	*0.06*	*0.06*
Number of Projects (sq)	-0.02**	0.03**	-0.01	-0.01
	0.01	*0.01*	*0.11*	*0.11*
Number of Venues	-0.17	0.03	0.36	0.09
	0.11	*0.16*	*0.19*	*0.10*
Policy Activity	0.12	0.09	-0.08	-0.07
	0.09	*0.13*	*0.11*	*0.10*
Environment	0.00	0.02	-0.01*	0.16
	0.18	*0.28*	*0.01*	*0.19*
Trust in Government	-0.04	-0.36**	0.11	0.00
	0.10	*0.16*	*0.13*	*0.01*
Water Supply	-0.02	-0.06	0.05	0.10
	0.09	*0.13*	*0.10*	*0.13*
Constant (probit only)		6.45		
		5.73		
Number of Observations	*88*	*86*	*85*	*85*
Prob > Chi^2	*.04*	*.10*	*.10*	*.11*

Notes: For ease of interpretation, the interaction terms were centered on category 6 (the median category in public support), calculated by subtracting 6 from the importance of resource variable. Measures from UCINET: Density and Closeness are from Centrality>Multiple measures(old). Brokerage from structural hole efficiency… * p>.1, **p>.05. Number of projects.

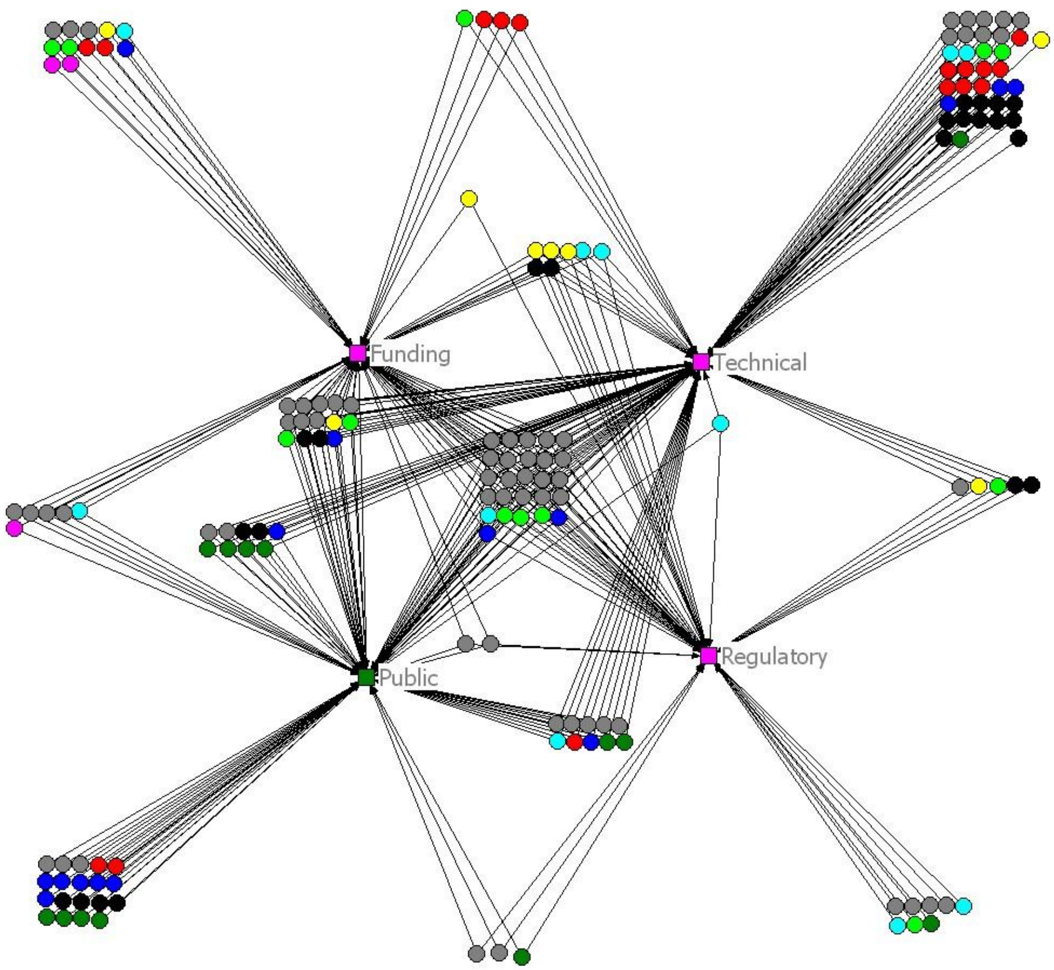
Table 2

ERGM Models Comparing Bonding, Brokerage and Outreach for each Network

Structural Measures	**Political Network**	**Technical Network**	**Regulatory Network**	**Financial Network**
Bonding (alt-k-triangle)	3.90 (0.21)	3.80 (0.18)	3.32 (0.31)	2.54 (0.27)
Bridging: Brokerage (alt-k-star)	-1.00 (0.10)	-1.03 (0.07)	-0.66 (0.17)	-0.23 (0.19)
Bridging: Outreach (alt-ind-2-path)	0.023 (0.004)	0.015 (0.002)	0.051 (0.008)	0.045 (0.006)

Cells report coefficients and (standard errors) from ERGM estimates for the resource network indicated in the column, estimated by the conditional maximum likelihood procedure for undirected graphs default model in SIENA (3.17) run through Stocnet.

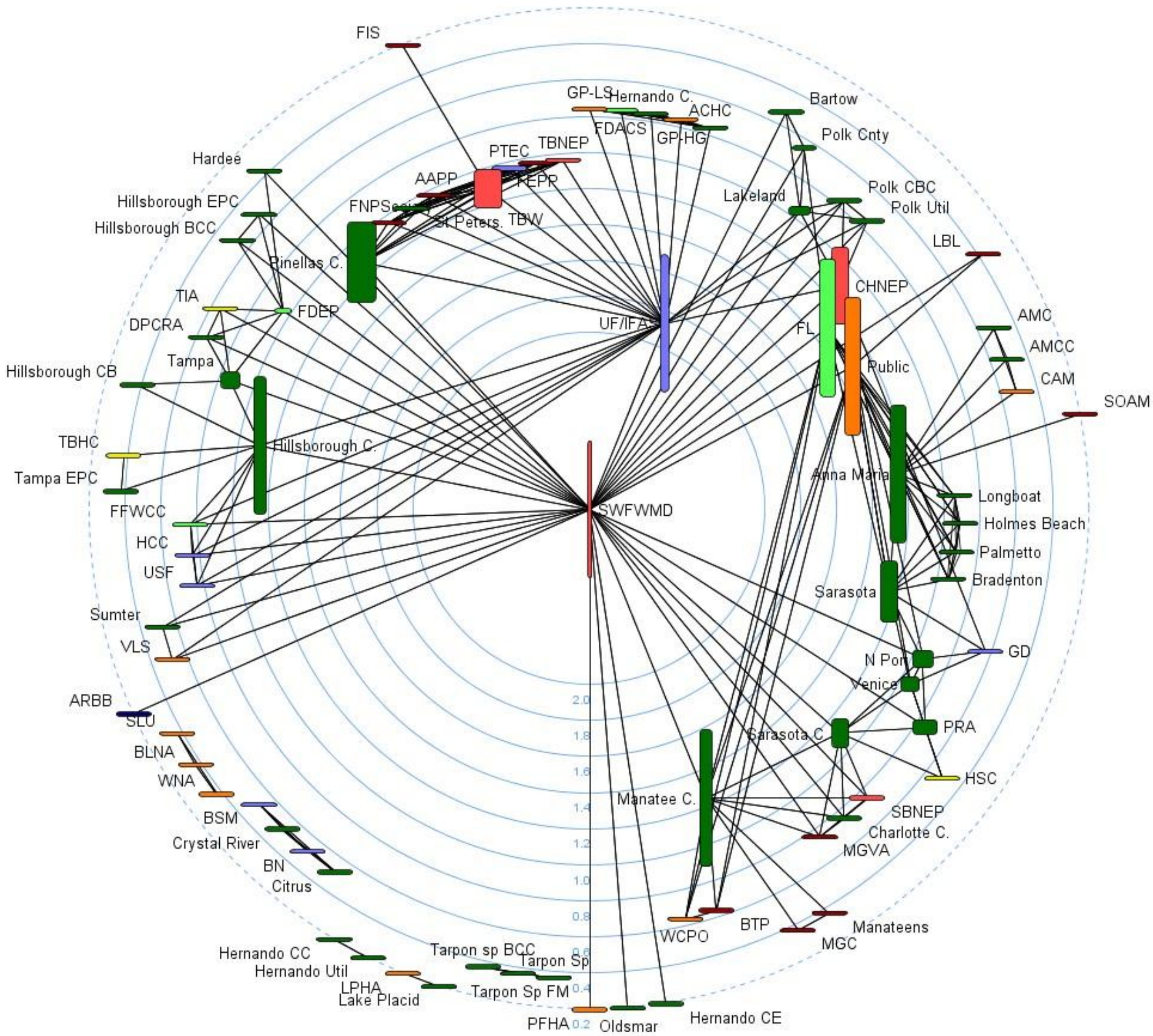
Figure 1
Resources Provided by Organizations



Organizational type Color Key:
grey= local government
yellow= federal government
turquoise = state government
green = regional government
red = business
blue = environmental group
black = research institute
Dark Green = homeowners association
Created with Netdraw.

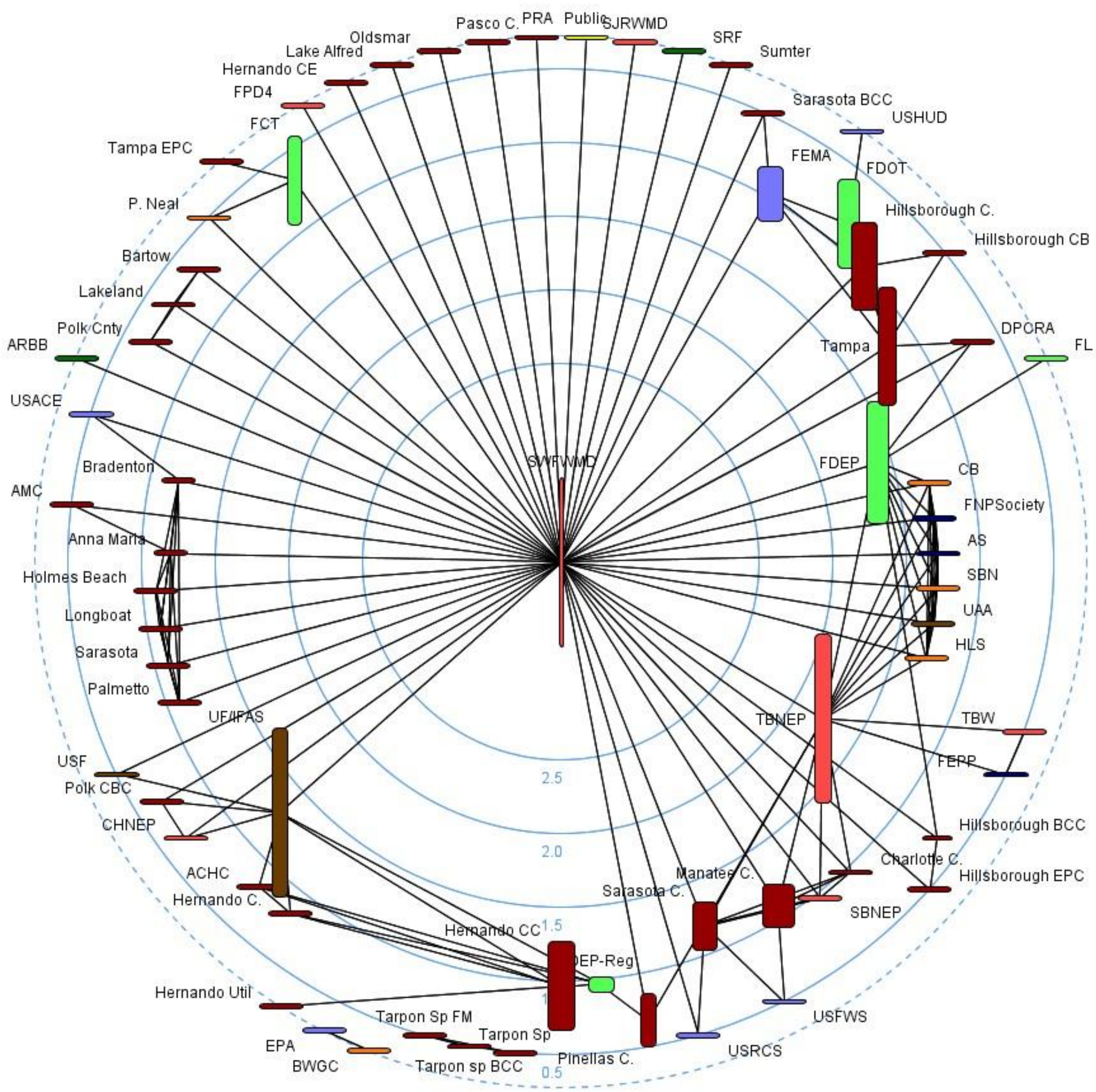
NOTE: Each circle represents one organization, with the colors indicating the type of organization for categories listed in the figure's legend. Lines linking each circle with the squares labeled political, technical, funding, and regulatory indicate that the organization supplies that resource to at least one project. Note that the 76 specialized organizations in the corners of the figure supply a single resource, the 25 multipurpose organizations in the center supply all four resources, and the remaining organizations supply two or three types of resources.

Figure 2
Political Network of Organizations
Linked through Common Projects



Note: Created in Visone (Brandes andWagner 2004). Node color represents the type of organization, node height is proportionate to the organization's brokerage measure, and node width is proportionate to the clustering score. Nodes with higher degree are located nearer the center of the diagram, and the concentric circles extending outward from the center are distance measures labeled with the percentage of total network links accounted for by each organization (organization's degree divided by total number of links in the network) located that distance from the center of the circle.

Figure 3
Financial Network of Organizations
Linked through Common Projects



Note: Created in Visone (Brandes andWagner 2004). Node color represents the type of organization, node height is proportionate to the organization's brokerage measure, and node width is proportionate to the clustering score. Nodes with higher degree are located nearer the center of the diagram, and the concentric circles extending outward from the center are distance measures labeled with the percentage of total network links accounted for by each organization (organization's degree divided by total number of links in the network) located that distance from the center of the circle.