Knowledge and networks: An experimental test of how network knowledge affects coordination

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ABSTRACT

Scholars in the social sciences use network theory to study a range of collective action problems. Often the goal is to identify how the structure of the network affects efforts to coordinate or cooperate, and research suggests that adding connections to a network can improve the performance of groups faced with such tasks. On the other hand, theory and empirics also suggest that additional connections can degrade the performance of a network. If connections can have negative effects then it is important to consider if there are alternatives to adding connections to a network that can also improve network performance. Because a primary function of connections in a network is to disseminate information, providing individuals with more information about the network may act as a substitute for adding connections to a network. We test experimentally whether providing subjects with more information about the structure of networks can improve coordination. We find that a more complete view of the network leads to faster coordination, but the magnitude of this effect depends on network structure. These results suggest that changing what actors know about a network can improve outcomes without having to add connections that may impede overall performance.

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1. Introduction

Large-scale coordination is a central challenge in politics. Examples include choosing political leaders (Calvert, 1992), organizing collective action (Chong, 1991; Weingast, 1997), developing international technological standards (Morrow, 1994), and abandoning harmful cultural practices (Mackie, 1996). As Niou and Ordeshook (1994) put it, the challenge of coordination is "omnipresent," playing a role in literally every major social process. Recently, social scientists have begun to study how the shape of social and institutional networks affects our ability to solve coordination problems such as political participation and protests (McClurg, 2003; Chwe, 2000), natural resource management (Scholz et al., 2008), international trade and diplomacy (Hafner-Burton and Montgomery, 2008), and public goods provision (Bramoullé and Kranton, 2007).

Some scholars have argued that either adding connections to a network or changing the structure of the existing connections can promote successful coordination (Gould, 1993; Cassar, 2007; Watts and Strogatz, 1998) but changing the structure of connections can create new dependencies and therefore more obstacles to collective performance (Chwe, 2000; Enemark et al., 2011; Siegel, 2009; Lazer and Friedman, 2007; Jackson et al., 2012). Watts (2003) considered identifying the likely effects of adding connections or changing network structure a particularly vexing problem. Given that changes in network structure can have negative effects, it behooves us to search for an alternative to adding connections when faced with networked coordination problems.

This paper investigates a method for facilitating networked coordination that may pose less risk than modifying the structure of the network—namely increasing actors' view of the network (or in other words, to invest technologies that allow individuals to observe those to whom they are not directly connected). In some circumstances, a more complete view of the network may facilitate coordination that takes place over networks. We present experimental evidence that individuals are able to coordinate more quickly over networks when they can observe not only their neighbors, but their neighbors' neighbors or even the full network, but this effect depends on network structure and more information does not always lead to faster coordination.

2. Networks in Congress and international relations

Theoretical models and empirical studies of networks have examined how the structure of a network affects outcomes for a variety of tasks. Examples of scholars using network theories and analogies are too numerous to review in any detail, but to give a

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sense of how common and diverse the applications are, we discuss two prominent examples—networks in Congress and networks in international relations.

2.1. Congressional networks

Scholars studying Congress have used a network approach to study the organization of congressional committees and delegation both to committees and bureaucratic agents. The general idea in this literature is that congressional actors intentionally design networks to facilitate their political goals. For instance, Aberbach (1990) studies the information networks that congressional committees use to monitor the actions of various agencies. Although there is heterogeneity in the types and qualities of network developed by different congressional committees, Aberbach claims that overall the "well-developed information networks" aid Congress's attempts to learn about the various agents under their control. One of the most well-developed mechanisms for learning about others is via a network of fire alarms (McCubbins and Schwartz, 1984) that Congress intentionally designs and modifies depending on its political goals and constraints.

Congress also develops networks that are used for internal purposes. For instance, Bradbury et al. (2008) describe how whip organizations serve as networks for transmitting information that helps congressional leaders draft and pass legislation. Overall, then it is clear that scholars have used network analogies to help understand the various relations between members of congress, committees, agencies and interest groups. In the congressional setting scholars typically assume that adding links to the network will make the network more functional.

2.2. International trade and diplomacy networks

Network theory and analysis have also been applied to the study of global settings—often looking at networks created by the interaction of countries with each other (see Kahler, 2009; Hafner-Burton et al., 2009 for recent reviews). Scholars of international relations have long argued that countries are not independent of each other and that networks provide a way to model and study the dependencies between countries. Bradley and Kelly (2008) write: "Most nations today participate in a dense network of international cooperation that requires them to grant authority to international actors." Kahler (2009) provides an overview of different applications of network studies in international relations. In general, scholars have used the network approach to capture the relational nature of international politics and the way that structure and agency interact to produce outcomes.

Scholars studying the diffusion of public policy (Simmons and Elkins, 2005; Gleditsch and Ward, 2006, 2008) theorize about and model the effect of connections between countries on the likelihood that one country's policy choices affect another's. In this same vein, Cowhey and Mueller (2009) writes, "scholars have used the concept of networks to examine how informal systems of information exchange and coordination can organize actors globally." Network models allow scholars to relax the assumption that policy choices are independent across jurisdictions and account for the ways that ties between countries (and the topology of these ties) affect the choice of public policy.

Others studying networks in international relations have examined how the ties between countries either engender or mitigate conflict. Scholars using this approach make direct use of various concepts from network theory and connect traditional concepts in international relations to measures derived from network theory (Hafner-Burton and Montgomery, 2006; Maoz, 2006; Maoz et al., 2007). Scholars studying conflict have argued that more connections between countries can either prevent or encourage conflict.

The idea that connections could lead to inferior outcomes is crucial and it suggests that if we can control the structure of the network we will want to understand if an additional connection will help or hurt performance.

Of course, network theory has been used to model relational settings in other areas of political science (for a review, see Ward et al., 2011). We focus on these two subtopics simply to provide a sense of how widespread are the uses of network models and analogies in political science. In addition, in both of these settings the networks are largely *designed* by political actors to achieve goals. For instance, in the examples of congressional committees and delegation, the networks are designed by congressional actors and agencies to help achieve political goals such as information gathering and oversight. Likewise, in the international relations examples the networks are created by intentional interaction between countries and international institutions. In both cases, political actors make choices about network design that influence how effective the network is at helping them achieve some goal. The widespread use of network models in political science should make it clear that understanding how networks affect political outcomes is a central concern to scholars.

3. The network design problem

In studies of networks one of the key goals is to identify how the structure of a network affects outcomes. In many political settings (such as the ones we discussed in the prior section) the network structure does not arise randomly, but rather is at least in part a result of conscious design. Scholars have tended to argue that connecting previously unconnected actors is a good idea when designing or modifying a network, and experimental and observational research has implied that adding connections to a network can improve coordination (Kearns et al., 2006; McCubbins et al., 2009; Gould, 1993; Grannovetter, 1974). In particular, network structure can facilitate coordination even when subjects face considerable asymmetry in their payoffs such as in a Battle of the Sexes (McCubbins et al., 2009). The idea that more connections in a network are good underlies the business of social media companies such as Facebook, LinkedIn, MySpace, and Google+, which seek to make it easier for people to connect with each other and thereby share information.

Adding links to a network, however, may not improve performance. Scholars noted years ago in studying road networks that adding a new road to the existing network of roads could actually degrade overall performance (Braess, 1969). This is not just a theoretical curiosity, either. In 1990, New York City closed 42nd street in preparation for Earth Day festivities and many expected traffic to get much worse (Kolata, 1990). However, traffic actually improved with the removal of the street from the traffic network. Recently, computer scientists have turned to studying the phenomenon called Braess's Paradox across a host of network structures and they find that it is likely to occur quite commonly (Chung and Young, 2010).

Political scientists have also noted that adding connections to a network may either improve or worsen outcomes:

> "connectedness may impose constraints on autonomy as well as offer opportunities for influence. . . . States that are part of an alliance network may find themselves in conflicts they would rather avoid; trade ties can be used for economic sanctions; normative bonds are deployed to force compliance through naming and shaming; and telephone and email records can be used to destroy a terrorist network." Hafner-Burton et al. (2009)

The possibility that a new connection could impair activity in a network is also identified by Fowler (2005) and Siegel (2009) in