

## Article

# Mechanisms of Network Formation in the Public Sector: A Systematic Review of the Literature

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## Abstract

This article provides a systematic review of the network formation literature in the public sector. In particular, we code and categorize the theoretical mechanisms used in empirical network research to motivate collaboration and tie formation. Based on a review of the 107 articles on network formation found in 40 journals of public administration and policy from 1998 to 2019, we identify 15 distinct theoretical categories. For each category, we describe the theory, highlight its use in the literature, and identify limitations and concerns with current applications. Overall, we find that most studies rely on a similar set of general theories of network formation. More importantly, we find that most theoretical mechanisms are not well specified, and empirical tests are often unable to directly assess the specific underlying mechanism. The results of our review highlight the need for our field to embrace experimental designs, develop panel network datasets, and engage in more network-level research.

## Introduction

In 1997, O'Toole argued that our need to understand and manage networks will only grow along with the complexity of the challenges we face. His assertion remains valid today. At the core of the existing literature is the belief that networks are an important form of organization and a necessary tool to tackle a range of policy and collective action problems (Emerson and Nabatchi 2015; Klijn and Koppenjan 2015; Koliba, Meek, and Zia 2011; Weber and Khademian 2008).

Understanding the specific motivations that underlie decisions to collaborate are important for understanding network emergence. The growing literature on “network management” (Agranoff and McGuire 1999; Kickert, Klijn, and Koppenjan 1997; Klijn, Edelenbos, and Steijn 2010) focuses, in part, on how to develop and manage networks by shaping and altering the institutional contexts that incentivize and constrain actor decisions to cooperate and form ties with other actors (Lubell et al. 2012). However, to date, no systematic review has been conducted to analyze the

theoretical mechanisms that underlie the formation of networks in the public sector.

In the decades since O'Toole's seminal article, our field has produced papers examining and classifying the variety of work scholars pursue (Lecy, Mergel, and Schmitz 2014); an assessment of the state of the field (Isett et al. 2011); a review of the determinants of network effectiveness (Turrini et al. 2010), and an examination of the statistical use of network analysis (Kapucu, Hu, and Khosa 2017; Lubell et al. 2012). Related work has developed theoretical frameworks around collaborative governance processes (Ansell and Gash 2008; Emerson and Nabatchi 2015), summarized specifications of mandated networks (Segato and Raab 2019), and identified the practical implications of scholarly network research (Provan and Lemaire 2012).

While the prior articles noted above study networks and review relevant literature, they do not address the fundamental question of “where do these networks come from?”. In other words, what mechanisms

influence tie formation among the actors that comprise the network? It is important to make a distinction here. The term network is often a source of definitional confusion as it is used to capture two related but different concepts. First, networks are a form of organizing that can be contrasted with hierarchies and markets (Podolny and Page 1998; Powell 1990). Second, networks are a structural phenomenon comprised of a set of actors and the relationships or ties that exist among them. For instance, Segato and Raab (2019) study the formation stage of mandated networks, but they do not identify the specific ties or relationships that exist among the actors. Thus, they study networks as a form of organization rather than networks as an emergent structural phenomenon. In this paper, we refer to networks as the latter. Thus, while networks as a form of organization can arise voluntarily or via mandate,<sup>1</sup> in both instances, the actors involved maintain some agency over the types of and amount of relations they form with other actors. It is these tie-formation decisions that are the focus of our paper. We examine the underlying mechanisms that make ties more or less likely to exist and persist in a variety of settings (both voluntary and mandated) that involve public and nonprofit actors.

To address this research goal, we conduct a systematic review of the theoretical motivations posited in all empirical studies on network formation for the past 21 years (1998–2019) in 40 journals of public administration and policy. We include in our review policy networks, governance networks, and service delivery/implementation networks at both the individual and organizational levels. We include networks of different types and actors because as Brass et al. (2004) state, “Many of the variables that explain the formation of interpersonal and interunit networks explain the creation of interorganizational networks as well” (p. 802). Similarity in formation mechanisms is unsurprising as organizational networks are often established through relationships formed by individuals acting as representatives of their organization (Provan and Lemaire 2012, p. 643). In our effort to understand public sector network formation, we focus on empirical network studies that attempt to model or describe how networks form (i.e., those studies that collect network data; meaning data on the relationships and ties that exist among the relevant actors, and

therefore data suitable for network analysis methods). For the articles identified, we systematically code each hypothesis based on the theoretical mechanisms used by the authors to support tie formation. We identify 15 different categories of theories used by scholars studying public sector network formation. We then describe each theory, its use in the literature, and identify limitations and concerns with current applications. By systematically describing and evaluating network theories, this article can help researchers to better assess and use theory in their research and contribute to theoretical development in the field more generally.

Based on our review, we recognize several core challenges and limitations in the current literature on network formation. First, we find that the body of empirical research on network formation relies predominantly upon a core set of theories and mechanisms. Second, the structural configurations (e.g., reciprocal ties, transitivity) observed in the network are posited to arise through a variety of mechanisms. Existing research designs are unable to identify or isolate the particular mechanism at work, limiting our understanding of what drives network formation. Third, despite the use of common theories of network formation, observed networks vary drastically in their structural characteristics, highlighting the need to explore macro-level influences on micro motivations. To date, limited attention has been given to the environmental and institutional-level factors that make shape micro-level motivations. Overall, by taking stock of the existing literature, this article provides insight to network scholars and collaborative managers regarding the factors that influence network structures and offers a roadmap for future research to improve our knowledge base.

## METHODOLOGY FOR SYSTEMATIC REVIEW

Relevant published articles were identified through a systematic search process following a slightly modified version of the PRISMA protocol (Moher, Liberati, Tetzlaff, and Altman 2009). Rather than conducting a general database search for articles on a given topic, due to our specific interest in public sector network formation, we bounded our search to 39 journals previously identified as core public administration and policy journals. As noted by Kapucu et al. (2017), these journals were identified by scholars based on mission statements, perceptions of journal editors, and through bibliometrics (Bernick and Krueger 2010; Forrester and Watson 1994). To this list, we added one additional journal, *Public Management Review*, given that it has published a significant number of public-oriented network studies. A complete list of the 40 journals we review is available in the appendix. We

1 Note, mandates to form networks may define the actors that are needed to be members, but it cannot force them to establish relationships with each other. In other words, an external party, usually a government, can require certain actors to collaborate or come together to work on a policy issue. But such a mandate cannot force them to share advice, trust one another, or communicate outside of the designated meeting times. These ties form more organically and thus studying network formation in mandated networks is essential (Segato and Raab 2019).

focus on journals in public administration due to the differences in organizational values and mission, employee motivation, and the effects of network drivers between public and private settings (Perry and Wise 1990; Rainey and Bozeman 2000; Siciliano 2017).

We search articles beginning in January 1998, the year following O'Toole's (1997) seminal paper, through May of 2019. We chose to begin our systematic review in 1998 for three reasons. First, a series of articles published around that time developed models for network ties that overcame the limiting assumption of independence among the individuals in the networks (Anderson, Wasserman, and Crouch 1999; Robins, Pattison, and Wasserman 1999; Wasserman and Pattison 1996). The models these papers presented ( $p^*$  or exponential random graph models) are a primary analytic tool used to model network formation. Second, advances in software also occurred around this time as UCINET 5.0 was released in 2002 and the DOS version converted over to Windows 95. Finally, there is precedent for this starting point. A recent review article by Kapucu et al. (2017) began their assessment on the use of social network analysis in public administration in 1998 as well.

Given this timeframe, we follow PRISMA procedures for screening, eligibility, and inclusion to identify the relevant empirical network studies. First, all journals were searched for the terms "network" or "network analysis" or "collaboration" or "collaborative" in the title, keywords, and abstract (Kapucu et al. 2017). Terms were added individually and in combination. Results from the searches for each journal were combined and duplicates removed. This process yielded a total of 2,401 articles. Second, articles were screened by reading each abstract to make sure the paper was an empirical work concerning networks. Our use of the term empirical includes descriptive papers, comparative case studies, and inferential methods. Third, we assess the eligibility of the remaining articles by accessing the full text of each article and reading the methods section to ensure network analysis was used. We define network analysis as any descriptive (e.g., network density, nodal centrality) or inferential technique (e.g., quadratic assignment procedure, exponential random graph models) that focuses on the relationships and flows among a set of actors (people, organizations, or both). Again, we focus our review on empirical studies of networks because we are specifically interested in reviewing the theoretical basis used to support the formation of ties.

Finally, the context and setting for the remaining articles was reviewed. According to Frederickson et al. (2016), over the last 50 years the relevant research topics covered by the field of public administration are related to public organization behavior, public policy

implementation, and public management. Accordingly, we removed articles focused on private-sector networks and private organizations without any interaction with agencies from the public or nonprofit sector. This included, for example, studies examining networks in the biopharmaceutical and telecommunication industries. In total, we identified 195 articles that met our search criteria.

The articles were then separated into two categories, following Borgatti and Halgin (2011): (1) those that viewed the network as the dependent variable, such that tie formation or network structure was being explained ( $n = 107$ ), and (2) those that viewed the network as the independent variable, such that the network is used to explain some other phenomena of interest ( $n = 88$ ). Focusing on the former group, we extracted each hypothesis listed in the article and coded the (1) the theory used (as specified by the authors) and (2) the specific text used by authors to support the theory. In addition, we also coded each article based on a number of additional fields (not all of which are used in the current paper), these included: (1) type of network data (whole network, ego network, two-mode networks); (2) primary unit of analysis (whole network, actors/nodes, dyads); (3) type of nodes in the network (humans, organizations, both); (4) number of networks in the study; (5) number of types of ties or relationships studied; (6) method of data collection (survey or archival); (7) type of analysis (network as dependent variable, network as independent variable); (8) primary method of analysis (descriptive, traditional linear models, ERGM, SOAM, MRQAP, other), and (9) number of time points.

To begin the coding process, all three authors coded a pilot set of 20 articles to compare coding decisions, to make tweaks to the codebook, and to standardize classification for the fields listed above. The pilot articles functioned as a training set to make sure all authors were coding articles in the same way. The 107 articles on tie formation were then split among the authors and coded individually (though as noted below, each article was reviewed by a second coder to assess reliability). Once all articles were coded, the coding files were combined, and the hypotheses and theory fields were extracted. Because articles often use slightly different language to talk about the same theory, we reviewed all of the theories provided in the articles and developed higher-level categories. In total, 15 theoretical categories were identified. Once these categories were identified and defined, each hypothesis was re-coded into the appropriate category, and all articles were reviewed by a different coder. The coding decisions were then reviewed between the two coders for any potential inconsistencies or errors. Any such items were flagged and resolved by group consensus.

Intercoder reliability was high, with percent agreement at 97.5%.

## THEORIES OF NETWORK FORMATION

In this article, we are concerned with theories that scholars use to study networks. What are network theories? [Berry et al. \(2004\)](#) discussed three intellectual traditions of network research: sociological tradition (social network analysis), political science tradition, and public management tradition. Each tradition offers theories to explain network phenomenon, and some are grand theories that are influential in their disciplines. We use network theory to refer to any theory used to explain the mechanisms by which ties between actors are formed or dissolved. It is these mechanisms that lead to the formation or decay of certain network structures. A distinction between theory and framework is helpful here. A large number of frameworks related to network processes and governance have been proposed (e.g., ecology of games; institutional collective action; intuitional analysis and design; collaborative governance regimes; advocacy coalition framework). As [Ostrom \(2011\)](#) notes, these frameworks are compatible with a number of models and theories. Frameworks help us identify the relevant variables, but they do not help us to explain how the variables are connected and why they are connected in a certain way. We want to understand the theoretical mechanisms that operate and motivate organizations and individuals to interact or not to interact, and thus we focus our review on the theories and mechanisms used by the authors in empirical articles of network formation.

Due to the self-organizing properties of networks, we separate our 15 categories into two classes, an approach similar to [Contractor, Wasserman, and Faust \(2006\)](#). The first group consists of general theoretical mechanisms that identify actor incentives and behavior leading to tie formation. These mechanisms have been applied to non-network settings or are exogenous to the network itself. The second group consists of network-specific mechanisms that often concern the self-organizing properties of networks and are thus endogenous. Endogenous factors “refer to various relational properties of the focal network itself that influence the probability ties will be present or absent in the same network” [Contractor et al. \(2006, p. 686\)](#). For instance, triadic closure is an endogenous network mechanism that leads two actors to be more likely to form a tie if they are connected to a common third party. These mechanisms are considered self-organizing as the likelihood of a tie among two actors is dependent on the presence or absence of other ties in the network. [Table 1](#) lists the categories along with their definition.

A count of the use of each theory is provided in [figure 1](#) below. In the following sections, we will discuss each theory (in the order it appears in [table 1](#)) and how it operates in the empirical literature. Note, a large number of hypotheses were coded as “NA”, indicating that the hypothesis was motivated without reference to any specific mechanism or the authors provided multiple rival mechanisms for a single hypothesis. We will further discuss the “NA” category below.

### General/Exogenous Theories and Mechanisms of Network Formation

#### Collaboration Risk

The primary mechanism used to understand how risk and uncertainty shape actors’ collaborative actions is the risk hypothesis. The risk hypothesis argues “that actors seek bridging relationships (well-connected, popular partners that maximize their access to information) when cooperation involves low risks, but seek bonding relationships (transitive, reciprocal relationships that maximize credibility) when risks of defection increase” ([Berardo and Scholz 2010](#), abstract). The risk hypothesis is closely connected to the structural patterns of bridging and bonding as it is these structures that are the observable implications of the risk perceived by actors in a collective action dilemma. We found 17 different hypotheses across 11 papers that relied on collaboration risk and the risk hypothesis to explain patterns of tie formation.

Most scholars, such as [Angst and Hirschi \(2017\)](#) and [Feiock, Lee, and Park \(2012\)](#), view risk through the lens of collaboration problems and separate activities into two types: coordination and cooperation. Coordination problems are joint action dilemmas where all actors are better off when agreeing on a course of action (e.g., what technology to adopt or when to alert residents to evacuate), and thus premiums are placed on information access and exchange leading to greater levels of bridging social capital. In contrast, cooperation problems carry greater risk as actors become more dependent on one another to achieve their own interdependent goals. Because of this, opportunities to free-ride or shirk responsibilities arise, prompting actors to form cohesive groups with strong ties.

While the theory behind the risk hypothesis is well developed, current empirical tests are limited by the same tautology that scholars have previously criticized the social capital literature for ([Coleman 1994](#); [Lin 2001](#); [Portes 1998](#)). The articles relying on the risk hypothesis often posit how risk results in preferences for certain structural configurations but then rely on the presence or absence of those configurations to make a claim about the existing level of risk.



**Table 1.** Theoretical Mechanisms

Theoretical Category/Mechanism	Description
General/Exogenous	
Collaboration Risk/Risk Hypothesis	Risks associated with division, defection, and coordination.
Social Capital—Bridging	Interest in forming bridging ties and connecting to those with novel information or ideas.
Social Capital—Bonding	Interest in forming close, dense networks for additional support or ability to sanction those who defect.
Social Capital—Trust	Trust as a pre-condition for tie formation; or seeking ties to trusted actors.
Resource Dependency Theory	How resource needs or dependency on others for resources shapes one's networking behavior.
Transaction Costs	Associated with the search, bargaining, and policing costs to an agreement or relationship.
Rational Choice/Cost-Benefit Calculations	Actors operate rationally and weigh the benefits against costs when deciding to form a relationship.
Homophily—Attribute-Based	Connecting with others who share or are similar to you in terms of attributes.
Homophily—Geography-Based	Connecting with others who are close to you in terms of physical distance or space.
Heterophily/Heterogeneity	Interest or value in connecting to others who are unlike yourself.
Network-specific/Endogenous	
Transitivity/Triadic Closure	Tendency for actors with a common third partner to also be connected.
Reciprocity	Mutuality.
Preferential Attachment	Tendency to partner with already popular actors. Also known as the Matthew Effect or the “rich get richer”.
Multiplexity	Social relations tend to overlap. Ties in of one type are likely predictive or correlated with ties of another.
Other	Any other mechanism not listed above. This group includes hypotheses on power, bargaining, cognitive consistency theory, and social interdependence.

For example, one study<sup>2</sup> explored elected officials and appointed officials' networks in several counties to test their hypotheses. Due to data limitations, the authors were unable to assess the actual level of risk embedded in a given tie or network and thus relied on the resulting patterns of interaction to infer how actors may be responding to risk. They find tendencies toward transitivity and away from two paths in the networks studied and conclude that actors prefer to enhance trustworthiness (bonding) over efficiency (bridging). Similar empirical approaches were used, and conclusions reached, by five other studies. Other authors, rather than relying on the observed structural patterns to assess risk, rely on the meta properties of networks, such as their age or service area to determine the level of risk. In these cases as well, structural configurations or contexts are used to make inferences about how actors may be strategically responding to risk without having an empirical measure of that risk.

2 In instances where we rely on specific studies to highlight an issue or limitation, we elected not to provide specific author names. Our goal is not to criticize any particular work, but rather to reveal general concerns that are present across a number of studies.

#### Social Capital—Bridging and Bonding

Given the connection between bridging and bonding strategies, these two mechanisms will be discussed together. Most often, bridging and bonding are used to predict outcomes or benefits that accrue to individuals or groups based on their structural positions in a network (Bourdieu 1986; Burt 1992, 2005; Coleman 1988; Putnam 1995). In terms of tie formation, relevant mechanisms concern the rationale for why an actor would seek a given structural position or pattern. With regard to bridging, beyond its role in the risk hypothesis, existing theory suggests at least three motivations may be operative. First, actors may seek access to novel, non-redundant information and therefore look beyond their close contacts (Burt 1992; Granovetter 1973). Second, actors may wish to control the movement of information and resources and thus strategically place themselves between others. Third, an actor may hold a resource sought by two others and position themselves between the two competing actors in order to obtain a higher return for their resources (Monge and Contractor 2003). In other words, “structural holes provide entrepreneurs with investment opportunity” (Monge and Contractor

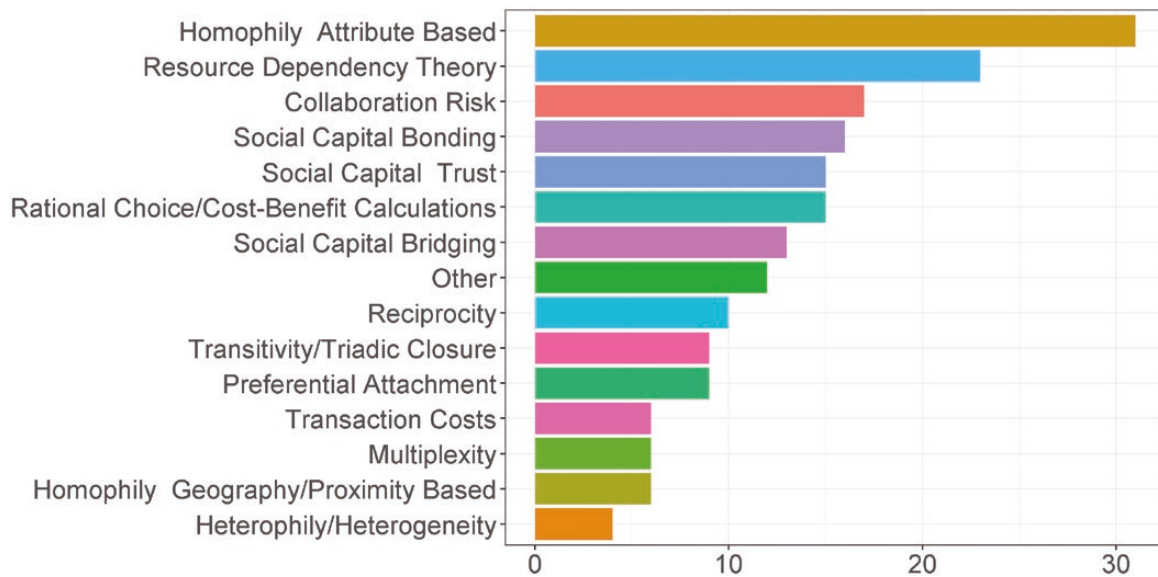


Figure 1. Frequency of Theory Use.

2003, p. 145). These discussions suggest some form of agency on part of the actor looking to benefit from bridging. However, without additional theory or information on part of the researcher, it is hard to differentiate among these motivations as well as differentiate them from motivations associated with perceptions of risk.

In the public administration and policy literature, nine articles produced 13 hypotheses regarding bridging behavior (not associated with the risk hypothesis). The primary mechanism hypothesized to motivate actors into establishing local bridges in the network is the efficient search for or movement of non-redundant information. Feiock et al. (2012), Feiock et al. (2010), Schrama (2019), Y. Lee, Lee, and Feiock (2012), and Shrestha (2019) all hypothesize that actors will form bridging patterns to ensure efficient information acquisition and transmission.

Several articles that rely on the information benefits of bridging as a driver of behavior tend to suffer from the same challenges as empirical tests of the risk hypothesis. For instance, one study states, “In this sense, a bridging structure provides a mechanism to transmit information about what others do and know. To the extent that information transmission through brokerage is critical, Hypothesis 2: Local government actors will link to bridging actors (two paths).” Here we see that the presence of a structure in the network (the dependent variable) is used as evidence of the presence of the mechanism (independent variable), in this case the need for simple and efficient information exchange. As another example, a study notes that the “presence of network bridging suggests that the

communities pursuing spinoff projects value learning from other communities more than they do building a closed group that limits access to new information.” However, whether communities do or do not value learning from others was not measured, rather the effect was inferred from the structural properties of the network.

Moving to bonding structures, we found 16 hypotheses across seven articles. The primary bonding structures in networks are strong ties, reciprocal ties, and transitive ties. Such bonding structures can emerge through a variety of mechanisms. For example, Henry, Lubell, and McCoy (2011), argue that policy entrepreneurs, who rather than capitalizing on their bridging role, help facilitate the development of ties between disconnected actors. One reason for this seemingly altruistic behavior is that policy entrepreneurs have interest in achieving network-level goals. Huang (2014) argues that tacit knowledge associated with service innovations is unlikely to be absorbed from single interactions, and thus strong ties often emerge to facilitate the transfer of complex information. This argument is notable as it potentially conflicts with prior work on bridging (which suggests open structures, like two paths, are best for information transmission) and the risk hypothesis (which suggest efficient exchange of information is likely to occur through bridging structures). The ideal structure may depend on whether the information needed is tacit or explicit (Siciliano 2017).

The primary role of bonding structures in the public administration and policy literature is not the mechanisms by which such structures emerge, but

rather the implications of strong ties in one network on relationships in another network. For instance, [Lambright, Mischen, and Laramée \(2010\)](#) look to bonding structures as predictors of dyadic trust and cooperation. They hypothesize that “network closure increases the probability that the trustor and trustee have successfully cooperated” (p. 68). [Hawkins, Qian, and Feiock \(2016\)](#) find that the strength of informal ties in an economic development network will positively affect the strength of ties in the formal network.

A few scholars examined the role of Simmelian ties ([Krackhardt 1998](#); [Simmel 1950](#)). [Krackhardt \(1998\)](#) defines a Simmelian tie as: “Two People are Simmelian tied to one another if they are reciprocally and strongly tied to each other and if they are reciprocally and strongly tied to at least one-third party in common” (p. 24). [Lemaire and Provan \(2018\)](#), in their study of a goal-directed network in Alberta for child and youth health and wellness, found support for their hypothesis that two organizations with Simmelian ties to the Network Administrative Organization (NAO) will have higher quality relationships and greater levels of collaboration. [Huang \(2014\)](#) argues the opposite in his study of an adult mental health network. He hypothesizes that “Two provider organizations that are Simmelian tied with the NAO have a reduced likelihood of sharing information about service innovations” (p. 590). Huang’s rationale is that NAOs who control resources in a network can create distrust among providers who compete for those resources. Huang found support for this hypothesis, as common third-party ties to the NAO significantly reduced the likelihood of information sharing between service providers (p. 594). The confirmation of these two conflicting hypotheses demonstrates the important role of context and the potential difficulty of translating findings from one network study to another.

Overall, the specific mechanisms leading to bonding structures are not well defined due to the nature of the empirical evidence used to test such theories. In most models, a transitivity term is used to examine whether the tendency toward triadic closure is greater in the observed network than one would expect by chance. However, transitivity and clustering are also self-organizing features in networks that have long been posited to derive from a variety of mechanisms, for instance: (1) trust—having a tie in common allows one to view a third party’s trustworthiness, (2) opportunity—friends of friends often become friends, and (3) incentives—policy entrepreneurs may be at work in facilitating unrealized collaborations. Thus, there are multiple mechanisms that may lead to the same structural configuration creating challenges for isolating the unique contribution for any one mechanism. A challenge we revisit in the discussion section.

#### Social Capital—Trust

We found 15 hypotheses on trust across 11 different articles. Trust is an important factor in forming both human and organizational relationships. While scholars have made distinctions among a number of types of trust ([Rousseau et al. 1998](#)), most scholars in public administration and policy focus on relational trust, which can be built through prior interactions. [Metz, Leifeld, and Ingold \(2019\)](#) examine actor preferences for certain policy instruments as two-mode networks. They argue that actors who interact with one another are likely to hold similar preferences. The mechanism for this similarity is the establishment of trust and social capital that emerges through interconnectedness.

[Bunger \(2013\)](#) explores the effects of competition and coordination among nonprofit agencies for children’s behavioral health. She offers two primary hypotheses related to trust, both of which were supported by the data. First, trust will have a direct impact on coordination. Trust implies one’s belief that a partner will not behave opportunistically, thus lowering the risks associated with coordination. Second, given that competition for the same scarce resources reduces the likelihood of coordination, trust can moderate the impact of competition on coordination. [Huang \(2014\)](#) also addresses how actors can overcome competition for resources that constrain collaboration. He argues that trust is an essential factor that increases one’s willingness to share knowledge and sensitive information with a competitor. He reasons that perceived trustworthiness of an actor increases the likelihood of sharing information. Similarly, [Parsons \(2020\)](#) contends that trust facilitates information and resource access, and therefore, social trust increases the likelihood of tie formation. [Scott and Thomas \(2015\)](#) offer an empirical test of the K. [Emerson, Nabatchi, and Balogh \(2012\)](#) framework and examine how principled engagement and capacity for joint action increase network tie formation. One mechanism offered for why principled engagement and capacity for joint action may increase tie formation is that actors are more likely to seek partners they are familiar with and trust.

An important distinction made in prior work is the direction of the trust-collaboration relationship. Whereas, [Metz et al. \(2019\)](#) contend that trust emerges through interactions, [Bunger \(2013\)](#), [Huang \(2014\)](#), [Parsons \(2020\)](#), and [Scott and Thomas \(2015\)](#) argue that trust leads to collaboration. Given the potential bi-directional relationship between trust and collaboration, cross-sectional research designs hinder our ability to understand the specific direction of causation between trust and tie formation. While [Lambright et al. \(2010\)](#) do not capture data at multiple time points, they do ask survey respondents about past and future interactions. Their work suggests that trust is both a predictor and consequence of collaboration and thus

longitudinal models examining how cooperation and trust coevolve are needed. However, of the 11 articles examining the effect of trust on tie formation, only one, [Isett and Provan \(2005\)](#) measured networks at more than one time point. [Isett and Provan \(2005\)](#) find that positive reputations, built through repeated interactions in a network, lead to the development of trust.

[Musso and Weare \(2015\)](#), rather than link collaboration to trust or vice versa, identify three individual motivations for network attachment: resource access, prestige, and trust. With regards to trust, [Musso and Weare \(2015\)](#) hypothesize that individuals who are motivated to build trust will form relationships that are reciprocal, transitive, and homophilous. Thus, trust in this study serves as a micro-level motivation for network activity rather than the result of collaboration or a necessary pre-condition.

#### Resource Dependence Theory

Building on R. M. [Emerson \(1962\)](#) power-dependence relations, resource dependence theory developed by [Pfeffer and Salancik \(2003\)](#) recognizes that organizations need to exchange resources with their environments, and imbalances in resource exchanges produce imbalances in power relations. Organizations thus need to actively manage their environments to maintain stable access to critical resources by using strategies such as building alliances, mergers, and acquisitions. From a network research perspective, this means that organizations strategically form ties with certain peers based on resource needs and power relations. Our review shows 23 hypotheses based on resource dependence theory across 15 articles.

Resource dependence theory has been used in network research at two different levels: the network level and the dyadic level. At the network level, resource exchanges and dependence is often viewed as the fundamental reason why networks exist. [Kapucu and Garayev \(2013\)](#) argue that “network relationships are characterized by specific asset interdependencies, which are the cornerstones of networks.” Focusing on the network level, [Provan and Huang \(2012\)](#) argue that the tangibility of resources being exchanged is likely to affect the degree of centralization in a network because tangible resources such as funding and facilities are usually controlled by a few organizations. On the other hand, resource exchanges have often been used to explain the emergence of dyadic relations. An organization in need of certain resources will try to access them by forming ties with the organizations that control those resources ([Feiock et al. 2012](#); [González and Verhoest 2020](#)). Based on this premise, [González and Verhoest \(2020\)](#) use the dynamics in resource exchanges between regulators and regulatees to explain the formation of ties between them.

While resource dependence theory provides a solid and straightforward theoretical foundation to explain tie formation and network structure, scholars often focus solely on resource criticality as the determinant of tie formation and fail to consider whether there are alternative suppliers ([Choi and Kim 2007](#); [González and Verhoest 2020](#)). If the critical resources are widely available, the organizations with the resources would not be highly sought after since there are many substitutes. With a few exceptions ([Provan and Huang 2012](#)), there is a lack of studies that give “resources” a more detailed examination and analyze how different types and sources of resources affect networks. Moreover, the strategic use of resources is also less studied. According to resource dependence theory, organizations actively manage their dependencies and resource exchanges to maximize their benefits, for example, they can limit the availability of certain resources to competitors, thus changing network structure.

#### Transaction Cost Theory

Transaction costs are the costs of “planning, adapting and monitoring task completion under alternative governance structures” ([Williamson 1981](#), p. 553). Social activities, including collaboration, involve transaction costs. In collaborative situations, transaction costs result from activities such as searching for partners, building trust, vetting partners, and monitoring collaborative activities. As an economics approach to the study of organizations, transaction cost theory emphasizes efficiency. One example can be found in [Feiock’s \(2013\)](#) discussion of the Institutional Collective Action Framework. He argues, “This framework can be applied to a wide range of policy dilemmas in which local governing units can potentially achieve better outcomes collectively than acting individually by reducing barriers to mutually advantageous collaborative action as represented by the transaction costs required for achieving joint projects” (p. 399). Our review found six hypotheses based on transaction costs across four articles.

A major barrier in interorganizational collaboration is the cost of searching for partners, negotiating contracts, and monitoring the enforcement of contracts. Sometimes the costs become prohibitive for collaborating. When using this theory as a mechanism to study tie formation, authors typically focus on how certain activities build familiarity and thus reduce transaction costs, which helps to overcome barriers in tie formation ([Herzog and Ingold 2019](#); [Scott 2016](#); [Scott and Greer 2019](#)). For example, [Hamilton and Lubell \(2018\)](#) based their hypothesis on how participation in the same policy forums help organizations to reduce transaction costs related to searching and monitoring partners and thus incentivize collaboration. This



theory assumes a careful calculation of self-interest by weighing transaction costs and benefits, but the empirical studies typically focus on the costs of collaboration while giving little consideration to the benefits. The application of this theory is thus often partial and does not capture the complete economic analysis of actors' benefits and costs of collaboration, as [Hamilton and Lubell \(2018\)](#) outlined.

#### Homophily

The most common mechanism used to explain tie formation is homophily. According to [Borgatti, Everett, and Johnson \(2013\)](#), homophily can be understood as the tendency to create ties with those who are similar and share attributes like gender, race, or ethnicity. In organizational networks, homophily may be based on sector, level of jurisdiction, client type or the demographics of citizens served. In our review, we examine attribute-based homophily as well as a second type of homophily based on geographic proximity.

Attribute-based homophily is a mechanism through which similarity on an individual or organizational attribute makes tie formation more likely. The increased likelihood of a relationship is due to the fact that similarity is often equated with trust and congruent expectations of behavior ([Brass 1995](#)). We found 31 hypotheses across 24 articles that consider attribute-based homophily as a driver of tie formation. Homophily can reside at a macro or organizational level, as well as at more micro levels, concerning beliefs and individual attributes. At the macro level, [Atouba and Shumate \(2015\)](#) use homophily to explain how international nongovernmental organizations interested in preventing and combating infectious diseases form collaborative ties based on shared attributes like mission, funding sources, and consultative status. [Chen, Ma, Feiock, and Suo \(2019\)](#) analyze the extent to which China's provincial governments have inter-provincial bilateral agreements in an environmental network proposing that provinces operating under the same political institution and with similar economic status engage in more bilateral agreements. A number of authors focus on similarity in organization type or organizational attributes as drivers of collaboration due to perceptions of similarity in policy agendas and preferences ([Jung, Song, and Park 2019](#); [I.-W. Lee, Feiock, and Lee 2012](#); [Lee et al. 2012](#)).

While attributes are often used as proxies for compatibility and preference alignment, some authors directly measure similarity in policy beliefs or problem exposure ([Herzog and Ingold 2019](#); [Matti and Sandström 2011](#)). [Elgin \(2015\)](#) proposes that network actors are more likely to connect with organizations that have similar policy beliefs around climate and energy policy. [Henry et al. \(2011\)](#) analyze a land-use

and transportation planning network in California and find evidence that shared policy beliefs positively influence tie formation.

At the individual level, [Rabovsky and Rutherford \(2016\)](#) study how political ideology plays a critical role in the decision-making process of public organizations. They argue that if a manager's ideology does not align with that of the political principals, networking efforts would be perceived as less useful or even a waste of time for gaining resources. [Song, Park, and Jung \(2018\)](#) also explore how political homophily increases local responders' ties with other agencies during disaster response and suggest that interlocal collaboration for timely response to a disaster is attributable to political similarities.

The other major form of homophily is "geography-based homophily." Generally, authors use this mechanism to predict tie formation on the basis of actors' location in a specific geographic area and social environment. We found six hypotheses across five articles positing that geography-based homophily induces collaboration. Akin to attribute-based homophily, the underlying rationale provided is often that organizations connected in physical space likely share common interests because they deal with similar issues and stakeholders. [Atouba and Shumate \(2010\)](#) explain how international nongovernmental organizations select collaborative partners that have their headquarters in the same region and in their same global hemisphere. [Feiock et al. \(2012\)](#), expect that actors who are geographically proximate will share similar economic development agendas and similar demographic and socioeconomic profiles, so they are more likely to create links to each other. While geographic homophily is often used as a proxy for similarity, other authors argue that it is actually proximity rather than similarity that drives collaboration. For example, [Chen et al. \(2019\)](#) propose that geographically contiguous provinces in China will engage in more bilateral agreements than noncontiguous provinces. The rationale being that actors who are physically proximate are more likely to interact, but also that geographic proximity can enhance trust and reduce the risks of collaboration (see also [Tulin, Volker, and Lancee 2019](#); [Zakour and Gillespie 1998](#)).

Overall, homophily is the most commonly used theoretical foundation for actor interaction in the articles we reviewed. The theoretical reasoning put forth for homophily is primarily instrumental: interacting with similar others is likely to lead to decreases in coordination, division, and enforcement costs ([Chen et al. 2019](#)), and increased likelihood of reciprocity ([McPherson, Smith-Lovin, and Cook 2001](#)). In general, attribute-based homophily and geography-based homophily are significant predictors of collaboration.

As with other mechanisms, one potential challenge with homophily is that multiple mechanisms are either consistent with finding homophilous ties in the network (e.g., social trust [Jung, Song, and Park 2019] or transaction costs [Lee, Lee and Feiock 2012; Song, Park and Jung 2018]) or multiple mechanism are provided by the authors for why we might find homophily (e.g., Rabovsky and Rutherford 2016). A challenge with the use of geographic homophily is it tends to confound two potential mechanisms: similarity (especially in citizen demographics or agenda) based on geographic distance and proximity that would lead to an increased likelihood of interaction.

#### Heterophily/Heterogeneity

As noted above, homophily is the tendency for ties to form among similar actors. Homophilous relations are said to increase the intensity of relationships, build trust, and aid in the mobilization of resources. However, one limitation of ties to similar others, is that the resources tend to be less diverse (Burt 1992, 2005; Granovetter 1973). Because of this, actors may be incentivized to develop ties to dissimilar others in order to gain access to more novel and perhaps more valuable resources. We identified four hypotheses across three articles related to heterophily.

The importance of access to unique resources is captured by Nohrstedt and Bodin (forthcoming). They state, “actors that seek to advance their position are unlikely to form ties with partners with similar resources and skills since adding similar partners does not broaden the skills for any given individual or the network as a whole. Actors seeking to maximize their own influence can, therefore, be expected to form social ties that add unique skills and resources” (p. 5). Thus, Nohrstedt and Bodin hypothesize that actors who do not share similar attributes are more likely to form ties. Similarly, Schrama (2019), in her article on monitoring networks for EU gender directives, posited two hypotheses regarding information exchange. She argues that information exchange is more likely when (1) actors have different organizational backgrounds and when (2) actors have different preferences related to implementation measures. The rationale being that information coming from different parts of the network is assumed to be more valuable and that “monitoring the implementation of external rules requires a network that includes different perspectives in order to gain full information on the process of implementation” (p. 7).

Thus, depending on actor needs in a network, different incentives may operate for connecting with similar or dissimilar others. When full information or diverse information is needed, then heterophilous ties may be prominent. When trust and risk reduction

are central concerns, then homophilous ties are more likely to emerge.

#### Rational Choice/Cost-Benefit Calculations

Rational choice theory considers actors as self-interested utility maximizers. Their motivations to cooperate with other actors is based on a desire to benefit themselves. Actor behavior can be understood based on the costs and benefits they associate with that action. We found 15 hypotheses related to rational choice theory across 10 articles. While rational action is also a component of transaction cost theory, the hypotheses identified below do not stress the major components of transaction costs and thus have been categorized as a rational choice.

Several authors rely on rational choice arguments to explain advice-seeking behavior in organizations and describe how individuals consider their personal costs before seeking information from others (Nisar and Maroulis 2017; Siciliano 2015, 2017; Siciliano, Moolenaar, Daly, and Liou 2017). Both Siciliano (2015) and Nisar and Maroulis (2017) predict that individuals tend to seek high-status peers like experts or senior members of the organization for advice to maximize their own benefit. Similarly, Siciliano (2017) predicts that teachers are more likely to seek advice from peers who they perceive as more accessible and with whom they feel more comfortable as these reduce the social costs of advice-seeking.

In the context of polycentric governance arrangements, Berardo and Lubell (2016) argue actors may strategically choose to participate in policy forums as a means to gather information about other actors' positions and to access knowledge needed to craft policy solutions. Similarly, Hileman and Bodin (2019) predict that through participation in policy forums, actors engage in a social learning process and increase their capacity to deal with a larger number of relationships until they maximize their utility by finding their optimal set of ties to actors and venues. Overall, the main purpose of this mechanism is to understand individual actor motivations as a driver of networking behavior.

#### Network-Specific/Endogenous Theories and Mechanisms of Network Formation

The preceding mechanisms are based on general social science theories that focus on actor attributes, needs for resources or information, or rational calculation as the drivers of tie formation. The following set of theories are substantially different as the mechanisms are predominately considered self-organizing, such that the tie between any two actors is dependent on the presence or absence of ties among the other actors in the network. Another important distinction between exogenous and endogenous theories is that

the exogenous theories often rely on structural configurations as proxy measures. For instance, transitivity may be used as an indicator of bonding social capital. For the network-specific mechanisms, it is the configuration that is being directly hypothesized about. As will be highlighted below and further in the discussion section, one of the major problems with this class of theory is despite the foundation in self-organization, authors often posit a number of other possible mechanisms that can lead to the same structural configuration. Rather than classify each reason separately, we decided to classify any hypothesis focused specifically on a network configuration or self-organizing process into its associated structural theory.

#### Transitivity/Triadic Closure

Networks have a tendency to form transitive structures leading to areas of high clustering and density. Transitivity is most appropriately viewed as a structural configuration in a network that can arise through a variety of means, the most common being the endogenous mechanism of triadic closure (e.g., a friend of a friend is a friend). However, it is common for authors to posit other mechanisms that produce closure in networks. Other processes leading to transitivity include homophily and physical proximity (Goodreau, Kitts, and Morris 2009), as well as means to reduce transaction costs and to resolve the commitment problem in collaboration (an extension of the risk hypothesis aimed at enforcing collaborative agreements). As noted above, authors may provide multiple rationales for justifying why transitive relations are likely to be observed in networks, and since these arguments are all in support of a single hypothesis focused on the expectation of finding transitive relations, we label them under this structural category. We take a similar approach to reciprocity and preferential attachment. Our review included nine hypotheses across nine articles focused on transitivity.

Nisar and Maroulis (2017, p. 831) argue that transitivity likely arises through two mechanisms. First, transitivity is driven by the potential benefits it brings when present. Thus, people seek transitive structures for enforcement and ability to sanction and reward certain actions. Second, transitivity and closure are driven by opportunity for interaction due to the presence of a common third party (triadic closure). Musso and Weare (2015) hypothesize that transitivity occurs in networks due to three potential mechanisms: access to existing partners, better social information about partners, and improved cooperation that comes with network closure. Similarly, Siciliano (2015, 2017) argues that transitivity in advice relations is due to tendencies toward hierarchy in human relations as well as preferences for cognitive consistency.

In each of these examples, the authors build support for their expectation to observe transitivity, but are unable to isolate or identify the specific mechanism responsible. Are actors consciously making decisions to form transitive ties because they are aware of the benefits that may arise when embedded in such structures or are these structures emerging because of opportunity, such that I am simply more likely to form ties to those with whom my partners are tied? Ultimately, this is a question about transitivity as a self-organizing, endogenous property of a network and transitivity as a result of strategic behavior on part of the actors. Without research designs capable of isolating a given mechanism, we are unable to discern what is primarily driving the observed tendency toward transitivity. Another issue, prevalent for articles that emphasize the enforcement mechanism, is that such strategic actions to partner with another's partner implicitly assumes that actors have an accurate perception of the broader network structure. In other words, they are aware of who a potential partner is already connected with and, therefore, can choose partners that provide network closure. However, this assumption has not received much support in prior research (Casciaro 1998; Krackhardt, 1987; Yenigün, Ertan, and Siciliano 2017) and therefore requires further empirical examination.

#### Reciprocity

Reciprocity, from a structural perspective, is simply the tendency for a relationship to be mutual. Reciprocity is seen as one of the most basic norms of social relationships and thus is a common structural feature in human and organizational networks. For instance, Nisar and Maroulis (2017, p. 831) state that reciprocity "refers to the expectation that if a resource (such as knowledge or information) travels from a person A to a person B, person B will be indebted to person A." Our review included 10 hypotheses based on this theory across nine articles.

In the literature, how reciprocity leads to tie formation has been discussed at two levels: human and organizational. The two levels highlight different mechanisms, though these mechanisms are not exclusive to one level. At the individual network level, Rivera, Soderstrom, and Uzzi (2010) identify three mechanisms through which reciprocity affects tie formation: (1) human beings tend to like those who like us; (2) individuals tend to reciprocate a tie because there is an implicit expectation of reciprocity (a utilitarian analysis); and (3) human beings tend to dissolve unreciprocated ties. At the organizational level, the emphasis has been on using reciprocity as an enforcement mechanism, especially in collective action settings (Feiock et al., 2012; Ulibarri and Scott 2016). Reciprocity is a key factor in the development of trust and social capital

(Putnam, Leonardi, and Nanetti 1993). Reciprocating a tie and engaging in repeated interactions, thus enhance the credibility of actors' commitment to one another to facilitate collaboration (Ulibarri and Scott 2016). Mutual exchange also provides a mechanism to deter defection because the defected party can be punished in future transactions (Feiock et al. 2012). Defection deterrence is why reciprocity is considered one of the bonding structures hypothesized through the risk hypothesis discussed above.

A challenge with understanding the origins of reciprocity in networks is that multiple mechanisms can be responsible for creating mutual ties. If we observe tendencies toward reciprocity, it is difficult, if not impossible, for the existing studies to separate the role of the enforcement mechanism from broader norms of reciprocation in relationships. Therefore, the influence of any given mechanisms behind reciprocity is left unresolved in the current literature.

#### Preferential Attachment

Actors within a network often seek out connections to others who are already well-connected and thus being popular can lead to further popularity (Barabási and Albert 1999). This self-organizing mechanism, also referred to as the Matthew Effect (Merton 1968), is more colloquially known as “the rich get richer.” When the mechanism of preferential attachment is present, networks develop positively skewed degree distributions that often follow a power law (Barabási and Albert 1999). These networks tend to be centralized and represent a “star network” where a central actor provides information to the rest of the members in the network (Y. Lee et al. 2012). In the context of interorganizational networks, preferences for popular actors tend to be driven by perceptions of their control of relevant resources and information (Y. Lee et al. 2012; Musso and Weare 2015; Stone 1980). In addition, this mechanism suggests that actors choose to collaborate with popular actors because they are more likely to be more productive, visible, and recognized (Zhang et al. 2018). We found nine hypotheses concerning preferential attachment across nine articles.

One of the primary motivations provided by authors for actor interest in connecting with popular nodes in the network is efficient access to information. Both Feiock et al. (2010) and Y. Lee et al. (2012) hypothesize that officials seek out central coordinators in order to access needed information and resources efficiently. However, neither found support for this hypothesis as actors maintained a strong tendency toward transitivity and reciprocity.

In addition to actor interest in efficient information exchange, preferential attachment has also been argued to be motivated by actor attributes such as

prestige. For instance, Musso and Weare (2015) argue that civic actors will seek out relationships with prominent actors defined by their education level and status. They argue that the prestige of certain members leads others to have a heightened interest in forming a relationship with them, thus promoting a self-reinforcing process where prestigious actors become more popular. In the area of emergency management, Nohrstedt and Bodin (forthcoming) found weak empirical support for popularity effects in terms of prior crisis management experience, level of professionalization, and capacity. Siciliano (2017) hypothesized that due to the uneven distribution of expertise within an organization, certain individuals will become central actors for advice provision. He suggests that employees who observe peers seeking a particular individual for advice may infer that individual is the best source of information, and thus popular individuals will become more popular.

Most often, measures of centrality have been used to test the role of prestige or popularity in generating additional ties (Musso and Weare 2015; Shrestha 2019; Siciliano 2017). One of the challenges in identifying the presence of preferential attachment through local structural configurations, such as in-degree or star configurations, is that such configurations can be driven by popularity itself or via actor attributes such as power, trust, resources, or expertise. Thus, proper model specification and identification of the salient attributes that drive popularity is critical for separating preferential attachment driven by popularity (i.e., a self-organizing process) from processes of preferential attachment based on attributes. If, for example, popular actors all share an attribute in common, and that attribute is not measured, then it will appear that actors are forming ties through a self-organizing “rich get richer” process rather than a strategic choice based on a relevant attribute. In addition, both attribute-based and popularity-based attachment processes may work together. If observed over time, actors may initially become popular targets for ties due to their expertise, but maintain and grow in popularity, not because of expertise, but due to the highly central position their expertise afforded them in the network at an earlier time point.

#### Multiplexity

Multiplexity is present when two or more ties of different types occur together among a set of actors; suggesting that actors' position in one set of relations is likely to predict or reinforce positions in another set of relations (LeRoux, Brandenburger, and Pandey 2010). Overlap in social relations may lead people to seek business relations to those with whom they have friendship or kinship ties (Uzzi 1996) or behave in



other ways not predicted by theories of rational choice. We found six hypotheses emphasizing multiplexity across three articles.

Huang (2014) analyzed the process of knowledge sharing for service innovation in health services provider networks governed by an NAO. He argues that multiple types of relationships among actors enable them to observe each other's behavior in various settings leading to strong ties (Huang 2014). Huang relies on the mechanism of multiplexity to predict that the greater the diversity of ties between two organizations, the greater the likelihood that they will share information about service innovations. Similarly, other authors explore the role of multiplex ties by considering how friendship relations affect professional ties. Siciliano (2015) explored advice network formation among teachers in 15 different schools. He proposed and found support for the hypothesis that individuals are more likely to seek advice from a coworker whom they consider to be a friend. Kapucu and Hu (2016) also analyze how friendship influences the formation of collaboration ties during disaster response within two counties in the state of Florida. The authors state that in emergency management networks, multiplex relationships are developed at the preparedness stage where agencies interact during emergency trainings, and such relations can influence patterns of collaboration during emergency response. As with other mechanisms, the causal direction may be questioned. While friendship ties and professional ties are indeed correlated in the studies we examined, it may be that professional ties led to the formation of friendship. The direction of the relationship was unable to be explored further due to the cross-sectional nature of the studies testing multiplexity.

#### "Other" Category

Twelve hypotheses across seven articles were categorized as "Other." This category included theories that only one or two hypotheses used. Choi and Kim (2007) use institutional theory to explain tie formation. According to institutional theory, the social pressure to justify their activities motivate organizations to form ties with organizations that are already perceived as having a high level of legitimacy, such as the Red Cross or the United Way. These ties serve the purpose of increasing an organization's power and legitimacy relative to other organizations operating in the same domain. Siciliano (2015) used the theory of social interdependence to predict tie formation in advice networks in public schools. He argues that negative interdependence, meaning "in order for one individual to succeed, another must fail" (p. 551), hinders teachers' willingness to seek advice from peers. Tulin, Volker, and Lancee (2019) use conflict theory to

explain why prejudice and discrimination may arise due to social groups' competition for scarce resources. In a study on how urbanism affects social relations, Wang, Lizardo, and Hachen (2018), based on the urbanism thesis, propose that urban residents "will have stronger nonlocal ties and weaker local ties in more urban areas" (p. 5). Using Williams' (1971) Lifestyle Model of Metropolitan Politics, LeRoux and Carr (2010) discuss how the network structures of interlocal agreements (ILAs) may differ for system maintenance functions and lifestyle services. System maintenance functions, such as roads and solid waste disposal, are less politically controversial, and thus high levels of networked cooperation and centralization are feasible. Overall, this category, though small in number, illustrates the wide spectrum of theories that researchers can use to study networks. Theories deriving from political science, sociology, psychology, and other disciplines also reveal the interdisciplinary nature of network research in public administration and policy.

#### NA Category

A total of 82 hypotheses across 32 papers were categorized as "NA," which means the authors did not present a clear theoretical mechanism to support their hypothesis. This does not necessarily mean that these papers lack theory or the hypotheses had weak justification. The primary scenario for placing a hypothesis into this category is that the hypothesis was justified more so on the research context rather than a theoretical mechanism. For example, Ackland and Halpin (2019) study the structure of interest group networks in the United Kingdom. While they situate their study within the broad framework of pluralism, they develop their hypotheses mainly based on changes in organized interest groups in UK policy-making. Similarly, Chen et al. (2019) examine participation in interprovincial agreements in China's Pan Pearl River Delta. They develop several hypotheses based on mechanisms such as homophily and heterophily (which we coded into those categories) but also develop two hypotheses mainly based on the unique features of the Chinese political system. One reason for the large number of hypotheses falling into the NA category may have to do with the field of public administration and policy. The field is both scientific and applied. The applied aspect of research on networks necessitates propositions and exploration of relationships that are context-specific rather than tied to broader theoretical mechanisms.

## DISCUSSION AND CONCLUSIONS

This study explored the theoretical mechanisms used in the public administration and policy literature to explain tie formation in public sector networks. Our

coding of the 107 articles across 40 journals and 21 years led to the identification of 15 theoretical categories. We found the body of research using network analysis to understand network formation in the public sector has centered on a consistent set of predominant theories. Of the hypotheses coded (i.e., those not categorized as NA), 54% fell into the categories of homophily (attribute and geography), social capital (bridging, bonding, and trust), and resource dependence. If we also include the risk hypothesis and rational choice, then over 70% of all hypotheses are covered. While the 'Other' category contained more diverse theoretical motivations, these were not the norm. We find there is great potential for network scholars to bring in additional theoretical foundations, which can offer innovative perspectives to investigate networks. Moreover, efforts should be made to diversify our theoretical approaches, which may deepen our understanding of network phenomena or open up windows for more inventive research designs.

By examining each category and identifying issues and challenges associated with its application, we also noted broader trends and themes in the literature on network formation. We will highlight three important themes and areas for future research: (1) mechanism isolation, (2) the lack research on network evolution and tie dissolution, and (3) network heterogeneity.

#### Mechanism Isolation

A number of mechanisms discussed above offer different rationales for the formation of the same sub-structures in the network. In other words, multiple theories and multiple hypotheses can lead to the same observed structural phenomena. As McElreath (2016, pp. 4–7) notes, the same statistical model can correspond to multiple hypotheses creating confusion about what to make of accepting or rejecting a given null hypothesis. For example, the risk hypothesis often views reciprocity as an indicator of bonding and thus the result of strategic action on a part of organizations or individuals to minimize risk of defection. Others see reciprocity as a basic norm that pervades all networks. Hence, at least two potential mechanisms can lead to the same statistical predictions. This creates uncertainty when researchers find a positive reciprocity parameter in their model as there are a number of competing hypotheses that would produce the same result. Because reciprocity is such a common social phenomena, any other mechanism that posits its presence is likely to reject the null hypothesis of no greater levels of reciprocity than we would expect by chance alone. Similar issues arise when authors hypothesize about the presence of a central actor, or skewed degree distribution. Such structural phenomena are hypothesized to result from (1) actor efforts to minimize search

costs, (2) actions to facilitate the efficient transfer of information, (3) strategic positioning on part of actors to play bridging roles, or (4) as a result of endogenous self-organization of networks via preferential attachment. However, research designs and empirical strategies often do not allow researchers to identify which if any of those mechanisms are the ones at work. Since each could lead to the same structural patterns in the network, our understanding of the mechanisms driving network formation remains limited. Current empirical tests are simply unable to directly assess or isolate the specific underlying mechanism. Inability to adequately isolate the operative mechanism was also prevalent for geography-based homophily, transitivity, and bridging and bonding social capital.

Consequently, we argue that the network literature must begin to embrace experimental design to better assess the mechanisms at work. Experiments in other fields offer potential insights into how public administration and policy scholars can design studies to examine tie formation and network design (e.g., Carrell, Sacerdote, and West 2013; Centola 2010; Hasan and Bagde 2015). For example, Boudreau et al. (2017) conducted a field experiment to assess how search costs affected scientific collaborations. By manipulating search costs through random assignment of individuals to information-sharing sessions, the authors found a 75% increase in the probability of a grant co-application. While the challenges associated with making causal claims are not unique to network research, we hope scholars can begin to look for or create sources of exogenous variation to better isolate the effect of interest and to estimate the causal impact of specific variables on network formation.

#### Network Evolution and Tie Dissolution

Studies that attempt to predict the structure of the network emphasize the factors that shape tie formation. Network evolution is inherently a dynamic process where actors form and dissolve ties. While cross-sectional methods such as ERGMs and MRQAP permit one to assess whether certain configurations or tendencies are more prevalent than would occur by chance, they are unable to explore patterns of network change over time. Overall, of the articles we examined, 79% were cross-sectional and only 8% measured networks at more than two points in time.

In addition, several of the posited relationships between variables and network structures may be endogenous, meaning that actor attributes may shape network structure, and in turn, network structures can shape actor attributes. For example, scholars employing the risk hypothesis suggest that actors who perceive or engage in high-risk forms of collaboration will tend to form bonding structures. However, over time as those

actors interact and demonstrate commitment and credibility to one another, trust increases and potentially reduces risk perceptions associated with future collaborations. Likewise, authors exploring trust assumed different causal directions for the role of trust. Some posited that trust led to collaboration while others suggested collaboration led to trust. Again, these are likely endogenous relationships requiring panel network data and suitable models to disentangle selection from influence (e.g., the coevolution models associated with RSiena).

Further, all of the studies examining network formation addressed in our review focus on factors that influence the formation of a tie. This is by default with cross-sectional data, as we only observe tie presence versus tie absence. But with longitudinal data, we can model whether tie formation is driven by a different set of processes (or whether those processes are more or less salient) when compared to tie dissolution. Prior research, implicitly or explicitly, assumes that factors explaining tie formation equally explain tie dissolution or decay. However, more recent research focusing on tie dissolution indicates that well-understood drivers of tie formation (e.g., homophily) are less salient predictors of decay (Dahlander and McFarland 2013; Jonczyk et al. 2016; Kleinbaum 2018). Suggesting that tie formation and tie dissolution are distinct processes (Dahlander and McFarland 2013). Scholars in public administration and policy need to emphasize the development of panel network datasets to address and explore the distinct factors leading to tie formation and tie decay.

### Network Heterogeneity

A majority of the empirical studies in our field rely on a core set of theoretical propositions for understanding the formation processes of networks. Given the similarity

in the use of governing mechanisms, one might expect similar network structures to emerge across a range of contexts and actors. However, this is not the case. Networks, even in similar geographic locations, can be structured quite differently, and wide variation has been found in different policy contexts. Given the use of common mechanisms, what is driving the variation in resulting structures? One likely answer is that there are contextual and meta-network level variables that moderate the influence of well-established micro-level mechanisms (McFarland et al. 2014). McFarland et al. (2014), attempted to answer the question of how the same micro-mechanisms can lead to wide variation in network structures by proposing “a network ecological theory that specifies the ways features of organizational environments moderate the expression of tie-formation processes, thereby generating variability in global network structures across settings” (abstract, p. 1088). A similar approach is needed in public administration and policy. However, because we tend to study only a single network at a single point in time, we have very little empirical examination of the contextual and institutional factors that shape networks.

Figure 2 provides a framework for tie formation in networks. It demonstrates the various levels at which factors associated with tie formation may exist. For instance, if the tie from actor  $i$  to actor  $j$  is being considered, the likelihood of its formation may be affected by factors at the macro and micro level and these factors may arise from the attributes of the actors or the endogenous properties of the network itself. Some of the theories and mechanisms identified in this article may operate at more than one level. For instance, the risk hypothesis can operate at the nodal, dyadic, network, and contextual levels.

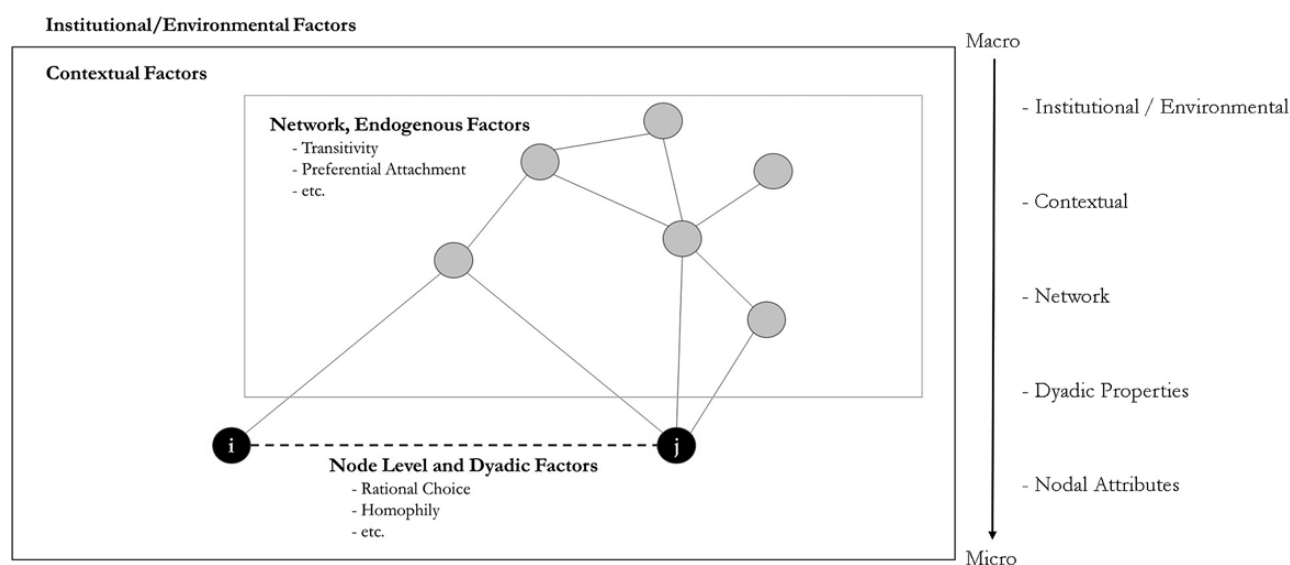


Figure 2. Macro and Micro Factors Influencing Tie Formation in Networks.

Despite the pursuit by management scholars to identify how institutional contexts incentivize or constrain cooperation and network formation, very few studies have attempted to model networks across different institutional settings and contexts. Studies that have attempted to understand how macro-level factors shape patterns of tie formation have tended to rely on only a small number of cases (Siciliano and Wukich 2017). Consequently, the most relevant practical question of what collaboratives or governments can do to foster the formation of particular structures is unknown. Overall, 73% of the studies we examined contained only a single network. Only four studies examined more than five different networks and no study contained more than 15.<sup>3</sup> Thus, any statistical analysis at the network or meta-network level is not possible among the current body of research as there are not enough observations at the macro-level.

In sum, this article provided a systematic review of the network formation literature in the public sector. By critically reviewing, coding, and summarizing the body of theoretical mechanisms used to motivate tie formation we identified 15 distinct theoretical categories employed by scholars. Overall, we find that most published work in our field relies on a core set of theories of network formation. More importantly, we find that most theoretical mechanisms are not well specified, and empirical tests are often unable to directly assess the specific underlying mechanism. The result of our review highlights the need for our field to embrace experimental designs, develop panel network datasets, and engage in more macro-level network research that connects institutional and contextual factors to micro-level behaviors.

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## Appendix. Search Results by Journal

Journal	First Step (Search Word Criteria)	Second Step (Abstract)	Third Step (Use SNA as Method)	Fourth Step (Public Organizations)
Administration and Society	109	35	8	7
The American Review of Public Administration	68	45	11	11
Australian Journal of Public Administration	57	29	2	2
Canadian Public Administration	44	11	0	0
Evaluation Review	7	1	1	1
Financial Accountability and Management	7	3	0	0
Human Relations	26	18	12	3
International Journal of Public Administration	68	29	4	4
International Review of Administrative Sciences	71	26	1	1
Journal of Accounting and Public Policy (JAPP)	37	0	0	0
Journal of Health Politics, Policy, and Law (JHPPL)	22	7	2	2
Journal of Management Studies	69	41	8	4
Journal of Policy Analysis & Management	38	21	19	3
Journal of Public Administration Research and Theory	114	70	30	30
Journal of Public Budgeting, Accounting & Financial Management	38	0	0	0
Journal of Public Policy (JPP)	74	20	8	8
Journal of Urban Affairs (UA)	53	27	11	8
Municipal Finance Journal	0	0	0	0
National Tax Journal	0	0	0	0
Nonprofit Management and Leadership	51	19	4	4
Nonprofit and Voluntary Sector Quarterly	127	63	13	12
Organization Studies	162	69	26	6
Policy Sciences	140	28	5	1
Policy Studies Journal	95	61	32	26
Political Psychology Journal	31	23	5	0
Political Science Quarterly	43	6	0	0
Public Administration & Development	54	16	1	1
Public Administration	201	89	9	8
Public Administration Quarterly	23	6	2	1
Public Administration Review	183	127	23	20
Public Budgeting and Finance	8	3	0	0
Public Finance Review	1	0	0	0
Public Performance and Management Review	119	24	7	4
Publius	22	7	2	1
Review of Policy Research	71	43	12	9
Review of Public Personnel Administration	10	5	1	0
State and Local Government Review	18	8	1	1
Social Science Quarterly	27	14	4	1
Urban Affairs Review	69	40	9	8
Public Management Review	44	27	8	8
Total	2,401	1,061	281	195