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Investor commitment to serial entrepreneurs: A multilayer network analysis

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ABSTRACT

Social networks are complex systems composed of interdependent organizations and people with diverse network structures. Understanding network dynamics, such as exchange commitment, requires a methodological toolkit that does not assume away complexity. In this study, we extend a technique for analyzing longitudinal, multilayer network data called network alignment. We introduce a novel metric – intersect proportions – for analyzing similarity between divergent graphs. We demonstrate the application of network alignment and intersect proportions to the context of investor commitment to startups and entrepreneurs. Using this technique, we are able to disentangle exchange commitment across complex networks.

1. Introduction

In the world of inter-organizational exchange commitment, startup investment in PayPal is exemplary. PayPal was the result of a merger between online payment startups Confinity and X.com in 2000. As expected, many investors in PayPal's pre-merger days continued to invest in later fundraising rounds. From another angle, however, PayPal elucidates the complexity of inter-organizational exchange commitment. PayPal was founded by Elon Musk, Max Levchin, Peter Thiel, Luke Nosek, and Ken Howery. Each of these cofounders left PayPal to start new companies. Elon Musk, for example, founded SpaceX in 2002 and Tesla Motors in 2003. Notably, as many as five investors in PayPal separately committed to Musk, consistently funding his subsequent ventures.

Why is this interesting? We know that actors dealing with a high degree of uncertainty, such as startup investors, will prefer to exchange with those in their network than those outside of their network. Networks generate social constraints against malfeasance, are perceived as signals of quality, and deliver new information that improves the appeal of networked exchange partners. Much of the literature on investor commitment, however, only evaluates commitment within a single network layer, such as repeat investment in the same company. Yet, the *founder* is one of the primary criteria under which investment decisions are made. Given such a pivotal role of the entrepreneur, and the investor's tendency to become embedded in its investment relations, investors should not only commit to a single company, but to the founders of those companies who go on to found subsequent ventures. A thorough analysis of investor and other exchange commitment requires inclusion of multiple units of analysis and multiple types of relationships.

Social networks are complex systems composed of interdependent organizations and people with diverse network structures. Understanding network dynamics, such as exchange commitment, requires a methodological toolkit that does not assume away complexity. Studying relationships across networks entails tracking movements of distinct units of analysis and distinguishing exchange in one layer from exchange in another. In this study, we extend a technique for analyzing longitudinal, multilayer network data called network alignment. We introduce a novel metric – intersect proportions – for analyzing similarity between graphs based on temporal precedence of exchange in each layer. We demonstrate the application of network alignment and intersect proportions to the context of investor commitment to startups and entrepreneurs. Using this technique, we are able to disentangle exchange commitment across complex networks.

2. Exchange commitment in complex networks

Organizations face competing pressures to both exit and persist in exchange relations. Prior exchange should predict future

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exchange. However, organizational networks are dynamic and complex. Power and dependence can lock organizations into an inefficient relationship. Yet, exchange commitment occurs in the absence of dependence. To understand the mechanisms of commitment, we must be able to examine interactions across the layers of complex social networks.

In an artificial social vacuum, network ties would not decay. Structural balance theory asserts that networks will seek an equilibrium where positive relations continue and negative relations cease (Heider, 1958; Davis, 1967; Granovetter, 1973). Open triads are "forbidden" in social networks because friends of friends become friends and friends of enemies become enemies (Granovetter, 1973). These closed, Simmelian triads are "super strong and sticky" (Krackhardt, 1998). In this way, cohesion and tie persistence become a path of least resistance (Gulati, 1995; McKelvey, 1997; Contractor et al., 2006).

There is no such thing as an artificial social vacuum, however. The organizational ecosystem is neither closed nor static (Scott and Davis, 2007). As new organizations enter the ecosystem, power shifts. The more powerful have less incentive to retain old ties when potential ties become more valuable (Cook, 1977). In economic systems, moreover, opportunity lies in the uneven distribution of uncertainty (Knight, 1921) and information (Burt, 1995). As a result of this tension between power and uncertainty, organizations oscillate between opportunism and commitment.

Social exchange theorists use structural balance theory to explain how social exchanges persist. In this view, the distribution of power and dependence across an exchange network influences who exchanges with whom (Emerson, 1972; Cook, 1977; Cook and Emerson, 1978; Markovsky et al., 1988). Cook et al. state that "the higher the average mutual dependence, the higher the relational cohesion" (2006: 197). Thus, as long as power is structurally balanced, the steady state of the graph should be the persistence of ties. Social exchange theorists called this exchange "immobility," implying an inability to sever a tie due to dependence on the tie (Cook and Emerson, 1978). Cook (1977) argues that commitment becomes a competitive disadvantage, which "serves to prolong the exchange and tends to limit the mobility of the exchange partners by preventing the exploration of alternatives in order to take advantage of opportunities which would increase their reward levels and improve their positions in an exchange network" (Cook, 1977: 68).

However, commitment occurs without dependence (Cook and Emerson, 1978). Despite incentives for opportunism in an imbalanced network, social scientists recognize that actors are likely to prefer familiar to unfamiliar exchange partners (see Monge and Contractor, 2001 for a review of relevant social network mechanisms). "Loyalty" occurs despite apparent market pressures for exit from an exchange relationship (Hirschman, 1970). This can be the result of uncertainty and trust (Kollock, 1994; Cook and Emerson, 1984; Markovsky et al., 1988; Podolny 1994; Rice, 2002; Yamagishi et al., 1998; Molm et al., 2009), positive affect (Lawler and Yoon, 1996; Molm et al., 1999, 2000), transaction costs (Burt, 1999, 2002; Williamson, 1981, 1985), or structural embeddedness (Granovetter, 1985; Podolny, 1994, 2001; Uzzi, 1996, 1997; Powell et al., 2005). For example, familiarity from prior exchange might increase the actor's trust that the exchange partner will perform as expected, thus reducing the actor's uncertainty in the outcome of the exchange (Sorenson and Stuart, 2001).

Organizational exchange commitment involves relationships across diverse units of analysis. Relational "endowments" (Burt, 2002) such as embeddedness, affect, and trust occur among individuals as well as organizations. Seabright et al. recognized the role of individual employees in the dissolution of inter-organizational ties in 1992. They found that clients are more committed to the individual CFO than the overall auditing firm. If the CFO leaves the firm, the client will also switch to a new auditor. The authors acknowledged that "attachments in an exchange relationship may emerge as the result of individual- or organization-level ties" (Seabright et al., 1992: 126). More than two decades later, Sorenson and Rogan (2014) again called for distinguishing individual from organizational social capital. While individuals connect organizations, it is often the organization that benefits from the relationship. The authors describe conditions under which an employee might claim ownership of inter-organizational social capital: valued resources rest predominantly with the individual, the exchange partner feels more indebted to the individual than the organization, and there is a high emotional attachment between the individual exchange partners.

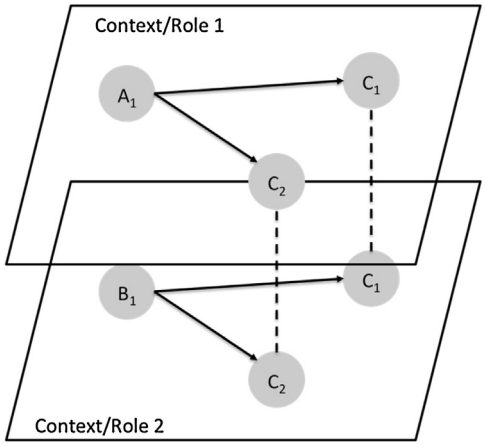

Fig. 1. Abstract Depiction of a Multilayer Network. Each context or role comprises a different network layer. Nodes of type C are common to each layer and connect the layers into a single multilayer network. If any of the nodes interact in more than one layer (including via common affiliation), then this network is also multiplex. If there is a hierarchy inherent in any of the edges (including within or across the network layers), then this network is also multilevel.

To understand mechanisms of commitment in social exchange relations, we must move beyond single-network analyses (Becker, 1960; Lazega et al., 2008; Lomi et al., 2016). We must be able to analyze interactions across network layers. When we ignore the intersecting networks that influence exchange commitment, we risk underestimating the depth of the relationship that might not be confined to a single network layer. In the next section, we introduce a novel method for disentangling organizational commitment from interpersonal commitment in network analysis.

3. Measuring exchange commitment across multilayer networks

Networks can be defined according to their edge or node types. In complex systems, multiple types of networks are connected through common edges, nodes, or other social groupings. To analyze these complex network systems, researchers traditionally depict each network as a single two-dimensional layer. Incorporating a third dimension – i.e. multiple layers – permits researchers to analyze how these network layers are interrelated. "Multilayer networks" is a broad term that includes any set of networks that are interrelated (see Fig. 1). Kivela et al. (2014) define multilayer networks as occurring when one network (layer A) is connected to another network (layer B) via a uniting set of nodes in common. Multilayer networks include multiplex, multilevel, hierarchical, and hypernetworks, among others (see Kivela et al., 2014 for an extensive review of multilayer network analysis).

In this article, we will discuss two types of multilayer networks: multilevel and multiplex networks. In this section, we define these two types of multilayer networks and explain how "network alignment" can be used to capture the dynamics of both.