COEVOLUTIONARY DYNAMICS OF STRATEGIC NETWORKS: WEAK TIES AND BOUNDARY SPANNING

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Abstract

Building on earlier research to explore organization-environment interaction via boundary spanning activity (Hazy & Tivnan, 2003; Hazy, Tivnan, & Schwandt, 2003; Richardson & Lissack, 2001), this study investigates such interactions via tests of analytical adequacy (McKelvey, 1999) to observe the emergence of strategic networks of organizations in a coevolutionary context of competition and collaboration. In so doing, this study intends to offer support for the application of complexity theory to organization science research (Anderson, 1999; Lissack, 1999).

This study describes the Coevolutionary model of Boundary-spanning Agents and Strategic Networks (C-BASN; pronounced like "SEA BASIN"), an extension of Hazy and Tivnan's (2004) Model of Organization, Structural Emergence, and Sustainability (MOSES). MOSES represents the boundary-spanning activity of a single organization (Hazy & Tivnan, 2003; Hazy & Tivnan, 2004; Hazy et al., 2003). Benefiting from other research on learning in adaptive networks (Allen, 2001; McKelvey, 2001), C-BASN extends MOSES to allow for the exploration of the collaborative efforts of organizations in a competitive, coevolutionary context; namely, the emergence of strategic networks.

The type of coevolution (McKelvey, 2002) that C-BASN will explore is the coevolution of mutation rate and the environment. All the more applicable in high-velocity environments (Eisenhardt, 1989) and hypercompetitive contexts (D'Aveni, 1994), what an organization has learned (Schwandt & Marquardt, 1999) and the rate at which it learns (McKelvey, 2002) offer the organization its best source for sustainable, competitive advantage (McKelvey, 2001). That is, an organization must learn faster and more effectively than its competitors to *establish* an initial competitive advantage, and then that same organization must continue to learn faster still if it is to *sustain* its competitive advantage. This dynamic is known as an "arms race" or the "Red Queen effect", adopted from Carroll's (1946) Red Queen when she says to Alice, "[i]t takes all the running you can do, to keep in the same place."

This study also addresses the concept of damping mechanisms (McKelvey, 2002). A damping mechanism provides a method for influencing the rate of coevolution. The practical implications of damping mechanisms lie in the realization that managers will likely desire to weaken damping mechanisms when coevolution is leading to effective adaptation or to strengthen them when coevolution leads to dysfunction.

Three of McKelvey's (2002) damping mechanisms have particular relevance to this study: (a) loss of agent heterogeneity, (b) loss of weak-ties, and (c) failing human capital. Fundamental to Ashby's (1956) Law of Requisite Variety, agent heterogeneity needs to constantly be increased so as to provide an organization with flexibility and responsiveness (i.e., Law of Excess Diversity (Allen, 2001)). Loss of weak-ties occurs when strong cliques emerge to diminish the innovation and entrepreneurship that results from information sharing and interaction among heterogeneous agents. Failing human capital occurs when agents decrease their absorptive capacity (Cohen & Levinthal, 1990) and thus diminish their ability to learn and adapt.

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Introduction

Today's literature, both popular and academic, contains countless references to the current environmental turbulence and change that organizations must routinely face (e.g., Meyer (2003)) due to globalization (e.g., Audretsch (2003)) and complex relationships both with other organizations (e.g., Davis (2003)) and entire markets (e.g., Sanchez (2004)). Possibly now more than ever, the external environment plays a vital role in the development of an organizational strategy – the mechanism by which an organization determines its unique market position, makes clear trade-offs between cost and quality, and tightens the fit between its whole system of activities (Porter, 1996). As indicated by its emergence as a new organizational form, strategic networks – the collaborative relationships of strategic intent between a cluster of organizations (Gulati, Nohria, & Zaheer, 2000) – represents an effective option for organizations to interact with their respective external environments.

Differing from other organizational ecology theories like the selection criteria of population ecology (Hannan & Freeman, 1984) and the social and cultural influences of institutional theory (DiMaggio & Powell, 1983; Scott, 1995), this study incorporates an ecological perspective consistent with Barney's (1986; 1991) resource-based theory of organizations. That is, an organization can enhance its competitive advantage – the sustainable performance difference over one's competitors that results from the totality of organizational activities (Porter, 1985) – via organizational resources that are: (a) valuable – the resources exploit an opportunity or neutralize a threat in the environment; (b) rare – the resources do not exist in the current or potential set of competing organizations; (c) imperfectly imitable – the resources result from either unique historical

conditions, causal ambiguity or social complexity; and (d) without strategically equivalent substitutes – the equivalent substitutes do not exist in the environment (Barney, 1991). An organization's strategic network of collaborative partners represents an emergent phenomenon reflecting these particular characteristics of just such a resource (Gulati et al., 2000).

Consider the following declaration from Mintzberg and colleagues in their discussion of strategic networks in their chapter on the Power School of thought on strategy formation. "Organizations do not operate in isolation, but in *complex webs of interactions* with other actors and organizations, including suppliers, competitors, and customers" (Mintzberg, Ahlstrand, & Lampel, 1998, p. 255, my italics). These comments allude to both the complexity of the environment in which many organizations find themselves and their respective attempts to improve their competitive advantage by interacting and collaborating with other organizations. These authors summarize their discussion of strategic networks and organizational attempts to improve their respective competitive advantage through collaboration by stating that "the boundaries of organizations are becoming increasingly blurred [because of networks]" and that strategic networks take an already complicated strategy-making process and "up its complexity several notches" (Mintzberg et al., 1998, p. 258).

Mintzberg et al. (1998) identify three concepts, each of principal importance to this study; namely, (a) the effects of cross-boundary activities between an organization and its external environment, (b) interorganizational collaboration via strategic networks, and (c) the complexity of organizational dynamics. For clarification, this study incorporates a collective cognition orientation to consider only the information and

learning aspects of cross-boundary activities and not the material and products aspects. Therefore, the intersection of Mintzberg's three concepts occurs at the organizational boundary - a social structure marked by various social signals (e.g., secure access to buildings, an uniform, contractual agreements etc. (Giddens, 1984; Hazy et al., 2003b)) that provides the perception of a demarcation between the organization and its external environment (Schwandt, 1997a).

Boundary Spanning Activity

In his model of organizational learning, Schwandt (1997a) emphasizes the informational significance of the organizational boundary. He describes the Environmental Interface as the actions associated with spanning the organizational boundary (i.e., boundary spanning) which provide the organization with an external focus. Via its Environmental Interface, an organization can perceive opportunities to enhance its competitive advantage through explorative and exploitative adaptation (March, 1991) as well as identify threats to its ability to produce economic rents – profits above the industry average (Besanko, Dranove, & Shanley, 1996).

To enact the functions of the Environmental Interface, an organization engages in the activity of boundary spanning to facilitate the transfer of information to and from the environment (Tushman & Scanlan, 1981). That is, boundary spanning encompasses any attempts, deliberate and otherwise, to enhance the embeddedness of the organization via its strategic network and the social networks of its members (e.g., memberships in trade associations, attending academic conferences, maintaining an active lobby, etc.) (Hazy et al., 2003b).

Considering the previous description of boundary spanning and Mintzberg's network quote, a conceptualization of an organization as independent of its environment lacks explanatory power. In stating that "organizations do not operate in isolation (p.254)," Mintzberg et al. (1998) imply support for Granovetter's (1985) argument for embeddedness. Granovetter argues that an organization tends to be embedded in multiple, complex social relationships with other organizations throughout its environment. Therefore, an organization is "so constrained by ongoing social relations that to construe them as independent is a grievous misunderstanding (Granovetter, 1985, p. 482)."

Strength of Weak Ties

Related to this notion of embeddedness, the strength of weak ties (Granovetter, 1973; Granovetter, 1983) has particular relevance to this research and the literature which supports it. Weak ties represent the complete set of social relationships of a focal person to his / her various *acquaintances* and *colleagues*; whereas, strong ties represent the complete set of social relationships of a focal person to his / her *close friends*.

Because one's close friends are far more likely to also be friends among themselves, strong ties lead to local cohesion and overall fragmentation of the larger social context (i.e., decreased embeddedness). Conversely, weak tie contacts who are far less likely to interact themselves provide a diverse and effective integration into the larger social context (i.e., increased embeddedness).

Generalized by Burt (1992; 1997), weak ties are defined as links between two otherwise disconnected clusters in a network which provide additive, informational benefit. Hence, the strength of weak ties lays in the exchange and flow of diverse

information and opportunities, thus creating ideal conditions for innovation and entrepreneurship (Burt, 1992).

Strategic Networks

Building on these concepts of embeddedness and the strength of weak ties, structural sociologists emphasize the primacy of an organization's social network of external contacts and the necessity for interorganizational collaboration (Gulati, 1998; Gulati & Gargiulo, 1999; Powell & Smith-Doerr, 1994). Since no single organization possesses all the necessary internal capabilities for sustainable competitive advantage in this age of rapid technological development and environmental turbulence (Powell, Koput, & Smith-Doerr, 1996), successful organizations participate both formally and informally in countless partnering relationships (i.e., interorganizational collaborations) (Powell et al., 1996).

To capture the social embeddedness of interorganizational collaboration, Gulati et al. (2000) draw on Laumann and colleagues' (1978, p. 458) definition of a social network as "a set of nodes (e.g., persons, organizations) linked by a set of social relationships (e.g., friendship, transfer of funds, overlapping membership) of a specified type." From this conceptualization of social networks, Gulati et al. (2000, p. 203) define strategic networks as "composed of interorganizational ties that are enduring, are of strategic significance for the organizations entering them, and include strategic alliances, joint ventures, long-term buyer-supplier partnerships, and a host of similar ties." Figure 1 provides a representative depiction of a strategic network.

INSERT FIGURE 1 HERE

Complexity of Organizational Dynamics

Consistent with Mintzberg's declaration that strategic networks complicate the strategy-making process, the complexity of organizational dynamics (Dooley & Van de Ven, 1999) has begun to attract a great deal of attention. Leading researchers in organization science (Anderson, 1999; Lewin & Volberda, 1999; McKelvey, 1997) are building on complexity theory research from physics (Gell-Mann, 1994), chemistry (Prigogine & Stengers, 1984), biology (Kauffman, 1993) and computer science (Holland, 1995). Much of this complexity research in organization science has given rise to the conceptualization of an organization as a complex adaptive system (Dooley, 1997). Essentially, a complex adaptive system (CAS) can be described as a system that (a) consists of many interacting components, (b) constitutes more than the sum of these interacting components (i.e., the interactions can lead to non-linear behavior), and (c) possesses some capacity to adapt to its external environment (Holland, 1995).

A representative sample of the research by the leading organization scientists exploring the non-linear adaptive capacity of organizations using the CAS framework includes the research of adaptive search on fitness landscapes (Kauffman, Lobo, & Macready, 2000; Levinthal, 1997; McKelvey, 1999a; Rivkin, 2000; Sorensen, 1997), emergent order (Holland, 1995; Kauffman, 1993; Mainzer, 1997; McKelvey, Forthcoming; Prigogine & Stengers, 1984), and coevolution (Lewin, Long, & Carroll, 1999; McKelvey, 1999a; McKelvey, 2002a). Crediting the groundbreaking research of Maruyama (1963) and Kauffman (1993), McKelvey (2002a) describes coevolution as an

inherently nonlinear and reactive adaptive process of an entity both with other entities and with a changing, abiotic environment.

I concur with the many scholars who are extending this research on CAS and organizational adaptive capacity, and now point to emergent order and coevolution as fundamental tenets for advancing organization science (Lewin et al., 1999; McKelvey, 1999a; McKelvey, 2002a). Indicative of emergent order, the largely-uncoordinated microstate activities of boundary spanning give rise to macrostate properties of enhancements to the adaptive capacity of the focal organization (Hazy et al., 2003b) and, in some instances, strategic networks between collaborating organizations (Gulati & Gargiulo, 1999). Indicative of coevolution, the emergence of strategic networks represents the adaptation activities of a focal organization and the subsequent adaptation activities undertaken by cooperating and competing organizations in the external environment of that focal organization.

To summarize, a focal organization will engage in boundary spanning activity in its attempt to scan its external environment for threats and opportunities to enhance its competitive advantage. This boundary spanning activity expands the social networks of the focal organization's members, thereby increasing the likelihood that the focal organization will participate in a strategic network. By participating in a strategic network, the focal organization attempts to adapt to while also altering aspects of its external environment, a prototypical example of coevolution (See Figure 2). In this study, I intend to manipulate levels of boundary spanning activity (i.e., the independent variable) to explore the emergence of strategic networks (i.e., the dependent variable) in a coevolutionary context (See Figure 3).

INSERT FIGURE 2 HERE

INSERT FIGURE 3 HERE

Problem Statement

To introduce the problem, an overview of the earlier research which this study aims to extend will likely benefit the reader. In the very recent past, three colleagues from the George Washington University - James Hazy, Brian Tivnan and David Schwandt (2003a; 2002) - collaborated to apply Schwandt's (1997a; 1997b) Organization Learning Systems Model (OLSM) to an extension of Krackhardt's and Carley's (1998) computational depiction of organizational networks, known as the PCANS framework.

In the course of their research, Hazy, Tivnan and Schwandt designed an agent-based model to examine the organizational dynamics and the resulting organizational outcomes (macro-level) of boundary spanning activity due to *random* agent behavior (micro-level). Consistent with the OLSM, their model simulated the following organizational dynamics: (a) the significant degrees of organizational interaction with the external environment via the boundary-spanning activity of agents (Hazy et al., 2002), (b) the dynamics of knowledge diffusion within an organization via agent interaction within the organization (Hazy et al., 2003a) and finally, (c) the resulting changes in social structure and increased organizational productivity resulting from the organizational learning and its subsequent diffusion due to agent interactions (Hazy et al., 2003a; Hazy et al., 2002).

Throughout this research stream, they delimited their research to and focused their attention on a single organization and its conceptualization of its external environment. Therefore, they did not explore the coevolutionary dynamics of competing or

collaborating organizations which is imperative with respect to understanding the essence of boundary spanning and the emergence of strategic networks. The reader will note that this study intends to address precisely this delimitation. Namely, this study will extend the previous research on the organizational learning merits of boundary spanning activity to explore the coevolutionary dynamics of strategic networks between organizations in their attempts to enhance their respective competitive advantage.

In an emergent phenomenon such as a strategic network, complex organizational dynamics (Dooley & Van de Ven, 1999) and environmental factors interact to create an extremely complex system. Such a system is best described as nonlinear; that is, small changes somewhere in the system can give rise to large changes that propagate throughout the system. This research intends to address the problem of linking the micro, local changes of boundary spanning activity to the emergent, macro-level phenomenon of a strategic network.

Purpose of the Study

Considering only organizations existing in this embedded, coevolutionary context; the purpose of this study clearly stems from addressing the problem of linking the micro-level phenomenon of boundary spanning to the emergent, macro-level phenomena of strategic networks. Subsequently, the purpose of this study is two-fold. By providing such a link, this study primarily aims to enhance managers' current efforts to make sense of the complexity and turbulence of their respective environments. With a deeper understanding of the complex dynamics of interorganizational collaborations and the implications for organizational learning, managers can possibly increase the competitive advantage of their respective organizations.

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The secondary and more theoretical purpose of the study is to further investigate the application of complexity theory to explore complex organizational dynamics and emergent phenomena in organization science. Citing the necessity for experiments to "separate science from witchcraft," McKelvey (1999b, p. 21) details the unstructured manner in which organization science researchers and practitioners have applied complexity theory.

Consequently, McKelvey proposes a resolution - adherence to the epistemology of the semantic conception for scientific inquiry. Fundamental to the semantic conception is a model-centered view of science which uses a model as an intermediary between theory and phenomenon to both represent theoretical relationships and predict fundamental, phenomenonological behavior. McKelvey (1999b; 2002b) argues convincingly that the model needs to be an agent-based model. As the primary tool of complexity theorists, agent-based models assume that agents behave in a stochastic, nonlinear manner and that agents possess a nonlinear capacity to adapt over time.

Research Questions

Focusing on this aspect of the purpose to advance a model-centered organization science, a synthesis between the purpose, the problem and the conceptual framework will elucidate the research questions. Both the scholarly literatures of organizational learning (March, 1991; Schwandt, 1997a; Schwandt & Marquardt, 1999) and strategy (Mintzberg et al., 1998; Porter, 1991; Porter, 1996; Porter, 1980) state that an organization must explore its external environment in order to exploit the opportunities found there and thus sustain its competitive advantage. In an attempt to build on the open systems perspective first put forward by organizational theorists (Katz & Kahn, 1978), structural sociologists

suggest that the social network of contacts represents the most important aspect of an organization's external environment (Gulati, 1998; Powell & Smith-Doerr, 1994).

Building on Carley's (1999; 1994; 2001; 1998) network representation of an individual organization, Hazy and Tivnan (2003a; 2003b) and Hazy, Tivnan and Schwandt (2003a; 2003b) have recently used agent-based models to explore the stochastic, nonlinear microstates of boundary spanning activity and the subsequent organizational adaptation. By considering only individual organizations independent from their embedded relationships (e.g., competitors, suppliers, customers etc.), this research not only reflects an under-socialized perspective of organization-environment interaction but also does not incorporate selectionist effects in a competitive context – a fundamental aspect of coevolution. To increase the verisimilitude (Popper, 1972) or accuracy of a representation of boundary spanning activity, such a model should include the interdependent relationships *between* organizations and their respective external environments as well as the coevolutionary dynamics at play.

The foundation having been laid by the discussion to this point, this research must integrate three salient points. First, an agent-based model provides an isolated, idealized system for conducting organization science experiments. Second, an organization is embedded within a larger, social context with competitors, collaborators, suppliers, distributors, and so forth. Third, boundary spanning activity encompasses a micro-level phenomenon that relates to the possible emergence of strategic networks, a macro-level phenomenon.

With increasing specificity, the following research questions extend the hypothesis to integrate these three salient points:

- "To what extent can the coevolutionary dynamics of the boundary spanning activities of several competing organizations and the resulting social networks be represented in an agent-based model?"
    - "If such a model can represent the boundary spanning activities of competing organizations, to what extent can the model depict organizational adaptation via collaborative activities such as strategic networks between organizations in their attempts to increase their respective competitive advantage?"
        - "What patterns of network structure emerge from the boundary spanning activities and how might these patterns inform practitioners?"

Significance of the Study

As reflected in the research questions, the significance of this research stems from three perspectives: (a) theory, (b) practice and (c) research. From the theoretical perspective, this research provides an extension to Carley's (1999; 1994; 2001; 1998) computational depiction of the PCANS organizational network. PCANS is an acronym representing the following: **P**recedence of organizational tasks, **C**ommitment of certain resources to tasks, **A**ssignment of personnel to particular tasks, social **N**etwork of personnel within an organization, and the **S**kills that each organizational member can apply to a task. Carley's framework is a deterministic, design model of a static network (i.e., organizational members (agents) do not possess the capacity to influence their respective social networks, thus the organizational network remains unchanged and independent of member interactions). However, this study builds on research that

highlights the influence of local, agent behavior and emergent, organizational outcomes (Hazy et al., 2003a; Hazy & Tivnan, 2003a; Hazy & Tivnan, 2003b; Hazy et al., 2003b).[1]

The second significance of this study stems from the practical value of its intended results. The model of coevolutionary dynamics of strategic networks will provide an engine for a multitude of computational experiments; experiments that would otherwise be extremely difficult and impractical to duplicate in the physical world. Additionally, these experiments should yield results that provide insight into highly complex relationships (e.g., the nonlinear impact of boundary spanning activity on organizational performance (Hazy et al., 2003b)); relationships that might normally exceed the bounded rationality of most practitioners (Simon, 1976).

The third and final significance of this study stems from the research contribution of its methodology. In an attempt to "separate science from witchcraft," this study aims to provide support for the applicability and validity of complexity theory in organization science research (Anderson, 1999; Lissack, 1999; McKelvey, 1999b; McKelvey, 2002a) with an agent-based, model-centered approach.

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[1] The reader will note that this fundamental extension (Hazy & Tivnan, 2003a) to Carley's (1999; 1994; 2001; 1998) PCANS framework was reviewed by the original theorists and received their respective endorsements (Carley, 2003; Prietula, 2003).

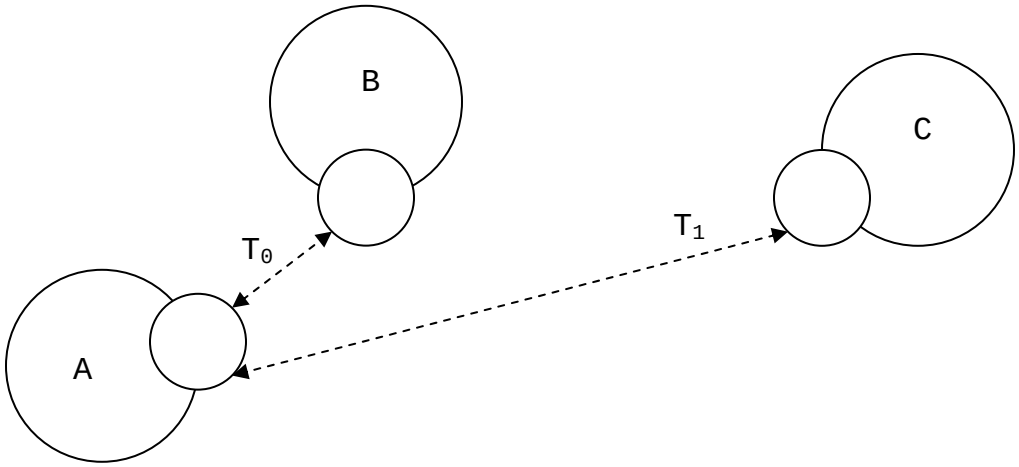

Figure 1. Simple Example of a Strategic Network

For the purposes of a simple example, assume that three organizations compete in the same market sector, reflected here as Organization A – Organization C. Each organization interacts with its external environment via boundary spanning activity, reflected here as the small circles on each organizational boundary. Suppose at some arbitrary time, T_0, that Organizations A and B form an interorganizational collaboration. At some other time, T_1, Organization C enters into a collaborative relationship with Organization A. Collectively, these three organizations have formed a simple strategic network.

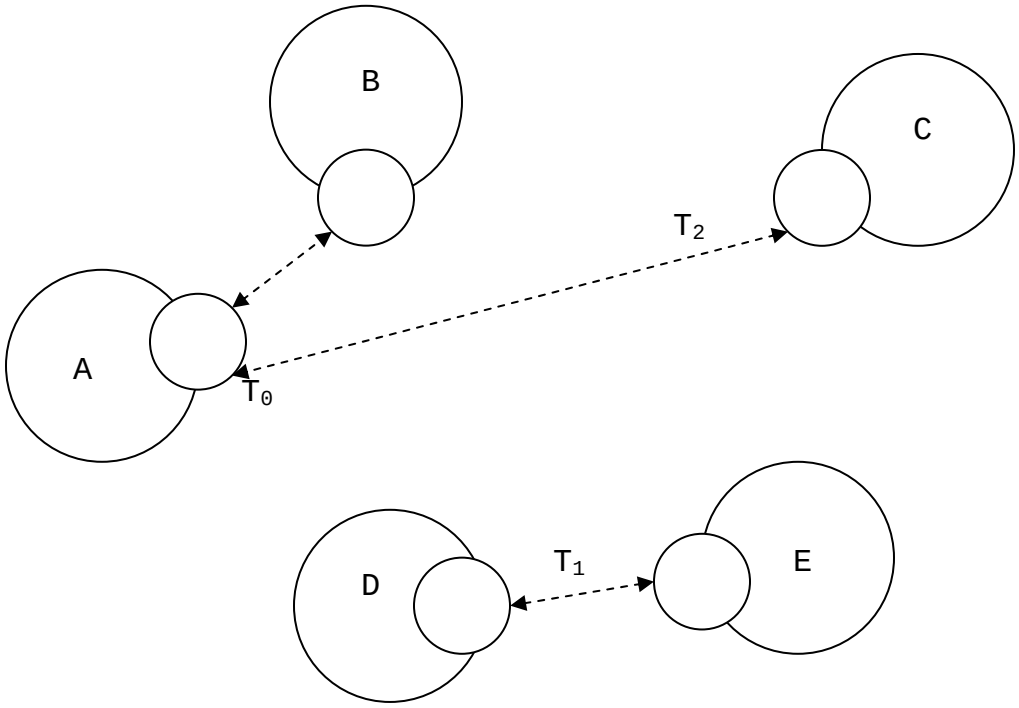

Figure 2. Simple Example of Coevolution

Representing a more complicated instance of the example in Figure 1, Organizations D and E opt to form their own interorganizational collaboration at a later time, T_1, in response to the collaboration between Organizations A and B at time, T_0. After learning of the collaboration between Organizations D and E during a scan of the external environment, Organization A invites Organization C to join the collaboration at still a later time, T_3. The collaboration formed by Organizations A, B and C represents a strategic network. The iterative adaptive responses at times T_1 and T_2 are representative of coevolution.

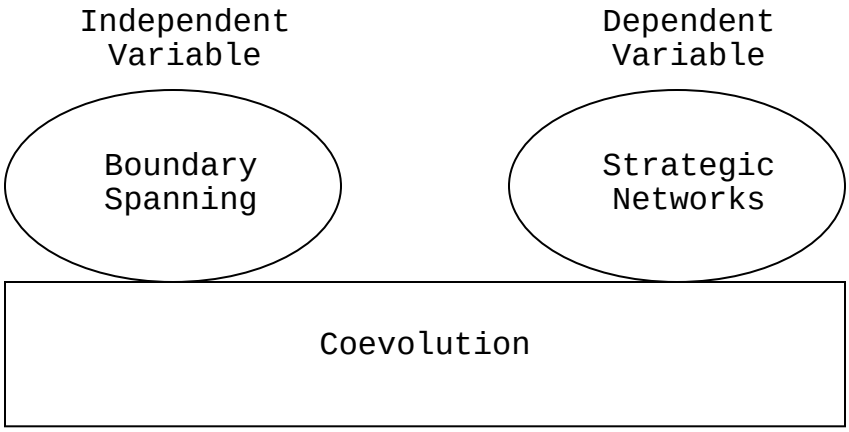

Figure 3. Construct Relationship

This figure is intended to illustrate the relationship of the three theoretical constructs in this study. Boundary spanning represents the independent variable in this study and will be manipulated to explore its effects on the emergence of strategic networks, the dependent variable. The theoretical foundation of coevolution defines the environmental dynamics in this study.

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