

Toward Agent-based Models of the Development and Evolution of Business Relations and Networks

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Firms achieve competitive advantage in part through the development of cooperative relations with other firms and organisations. We describe a program of research designed to map and model the development of cooperative inter-firm relations, including the processes and paths by which firms may evolve from adversarial to more cooperative relations. Narrative event history methods are used to develop stylised histories of business relations in various contexts and to identify relevant causal mechanisms to be included in the agent-based models of relationship and network evolution. The relationship histories provide the means of calibrating and testing the agent-based models developed.

1 Introduction

The importance of collaborative advantage in creating and sustaining firms' competitive advantage is being given ever more attention by academics and practitioners [Davis & Spekman 2004, Dyer 2000]. A firm's performance depends on more than its own efforts and resources; it depends on the efforts and resources of other firms and its relations with them, including customers, suppliers, distributors, competitors and complementors [Brandenburger & Nalebuff 1997, Luo 2004, Sheth & Parvatiyar 2000]. Such relationships are the means by which opportunities and threats are recognized and responded to, non-value-added costs are reduced, valued resources are accessed and co-developed, and value is co-created and delivered to customers and market participants [Wilkinson & Young 2005].

A major gap in the literature is a lack of process models of relationship development and models, which show how management action and government policy affect patterns of relationship development [De Rond & Bouchikhi 2004, Doz 1996] and how relationships can be changed from adversarial to more collaborative forms [Vangen & Huxham 2003]. Existing studies of relations use primarily static models and cross sectional variance-based methods to explain relationship behaviour and performance, which ignore temporal processes, and interaction, order and feedback effects [Buttriss & Wilkinson in press, Van de Ven & Engleman 2004]. Existing studies of business relation histories [e.g. Arino & de la Torre 1998, De Rond, & Bouchikhi 2004, Doz 1996] tend to be one-sided and that fail to document and analyse systematically the processes and causal mechanisms involved. Here we describe research to address these issues. Its aims are: a) To develop dynamic process models of relationship and network development based on prior research and narrative event history mapping of relations in a variety of contexts; b) To develop agent-based models (ABM) of relationships and networks that can be used to assist managers and policymakers.

2 Theoretical Framework

A relationship is a type of complex adaptive system that self-organises and evolves over time through the internal and external interactions occurring [Wilkinson and Young 2002, 2005]. Relationships are multiply complex, involving many types of interpersonal, inter-departmental and inter-firm interactions. The pace of action and change varies for different dimensions, such that changes in technology and resource structures take more time compared to decision-making and planning cycles and the dynamics of attitudes and beliefs have their own tempo, all of which come together to influence the timing of events. Many types of causal mechanisms are involved including, learning and knowledge-development processes, dialectical processes, ageing and maturation processes, teleological processes, diffusion and imitation processes, period effects, and cohort effects [Aldrich 1999].

There is no means of predicting the way business relationship and networks will develop, what types of relationship attractors can and will emerge, how stable they are and how likely cooperative forms are to arise. We also have little understanding of the role management and government can play in shaping these development processes because our research and analytical traditions and intuitions are born of linear rather than non-linear modes of thinking and

analysis, whereas complex adaptive systems involve non-linear processes. This research offers ways forward.

The development of cooperative norms in a relation involves a mutual learning and adaptation process that takes place over time through the actions and interactions of those involved. From a given set of starting conditions, the path of relationship development towards or away from more cooperative forms of interaction depends on feedback mechanisms taking place within the relation over time which support, expand, and/or reproduce the development of cooperation or undermine, reduce and destroy it. Interactions among relations also matter and can reinforce or undermine the path of development to more collaborative forms.

Relationship development is a co-evolutionary process [Koza and Lewin 1998] involving coupled feedback loops among the structure, the interaction processes taking place and the outcomes for each firm in the relation. Each actor engages in various types of activities and inter-actions using its resources (including knowledge, skills and competences) and guided by its theory in use or schemas. The experience and results of these interactions over time lead to continual modifications and co-adaptations of each actor's activities, resources and schemas resulting in the sculpturing of various types of actor bonds, activity links, resource ties and schema couplings which constitute the relationship structure [Hakansson and Snehota 1995, Welch and Wilkinson 2002]. The structure at any time enables and constrains perceptions and action and interaction and changes in structure represent a kind of relationship learning and development [Wilkinson 1990].

The relationship structure that exists at a given time shapes the internal and external interaction processes taking place. At the same time the experience and outcomes of such interactions, including expected and unexpected performance, satisfaction and learning, reproduce and maintain or change the structure via their affects on the parties involved; a dialectic process of implicit and explicit renegotiation continually takes place [de Rond and Bouchikhi 2004]. Existing actor bonds such as trust, commitment, cooperativeness or feelings of dependence can be strengthened or weakened. Resources, including capabilities, skills and knowledge can be enhanced, undermined or depleted. Activity links and routines can be further strengthened or weakened. Schemas can be altered as those involved attempt to make sense of what has happened in the relationship. New possibilities and purposes emerge and second order learning of how to adapt develops.

The starting conditions shape a relation's potential patterns of development. This includes political, cultural and economic contexts. Other more specific conditions include the effects of any prior history of interaction among the parties involved, the position of the relation in relevant business networks and the processes by which partners are identified and chosen. In addition, prior research suggests other factors play a role, such as the motives for collaboration, the degree of agreement or conflict, the relative power/dependence and the prevalence of collaborative relations in the population or business network.

3 Methodology

3.1 Event History Mapping

In the last decade or so new methodologies have emerged that seek to develop a systematic approach to analysing historical social processes [e.g. Abbott 2001, Abell 1993] and the potential value of these methods to the study of business systems is beginning to be appreciated [e.g. Buttriss and Wilkinson in press, Van de Ven and Engleman 2004]. The methods focus on actors acting as the primary unit of analysis, in contrast to variance-based methods that focus on the correlated behaviour of variables and which tend to ignore time order and interaction effects and assume the existence of fixed entities with varying characteristics. They are particularly relevant to management and policy makers because they seek explanation in terms of sequences of events which involve actors acting, including managers and policy makers, rather than in terms of the behaviour of disembodied variables that somehow act through the actions and responses of actors. In this way key patterns and processes of development and their generative mechanisms can be identified that can guide management action. Generalisation is sought not in terms of the associations among variables but in terms of the role and impact of generative mechanisms that play out in different ways over time. The methods involve parsing a history into a set of events involving different kinds of actors or entities (including inanimate actors) and classifying, mapping and linking these events over time to show how they are connected by different types of causal mechanisms. The approach also links to research in complexity, which seeks to understand how large-scale patterns and structure emerge from micro interactions and processes, such as the way relationship development towards a more collaborative form results from ongoing patterns of micro interactions over time among involved actors.

3.2 Agent-based Models

The non-linear and complex nature of the behaviour of complex adaptive systems like relations and networks makes analytical solutions impossible and the researcher must resort to simulation methods to examine the role and impact of key aspects of the system. The prime method employed in complexity research is agent-based simulation to create artificial worlds mimicking key features of a focal system. Such modelling allows for distributed control, via a heterogeneous set of interacting agents (in our case the participants in a relationship and connected relations in a network), which could represent firms, individuals or other objects, with their own goals, resources and rules of behaviour - that change as a result of learning via interaction and feedback. Relations and networks are created and develop through ongoing interactions among agents.

Modelling of this kind can provide insight beyond that of surveys and case studies because studies of actual business relations reveal only one history. They do not tell us whether this is one of a number of possible histories and types of outcomes. Managers need to know which factors influence the likelihood of different types of relationship outcomes emerging, which is impossible when we only have one or a few detailed histories to use. Agent-based models enable us to capture important features of the process, to identify tipping points, and to conduct computer experiments to see how different factors affect processes and outcomes and their stability. Different theories or assumptions about the system can be implemented and examined. McKelvey [2004] sees agent-based models as offering a middle ground between thick and thin descriptions. Thick descriptions result from in-depth case studies of actual histories, that reveal more of the

complex causal processes involved but which cannot be easily generalised. Thin descriptions result from sample survey research, which is more generalizable but which abstracts away from any examination of the processes, events or choices by which different types of variables are interrelated and affect outcomes.

The agent-based models are in the process of being developed. The software tools build on existing agent-based modeling systems such as Repast and MASON and the EIDE suite of software technologies (Arcos et al 2005).

Conclusions

The focus on markets and relations as self-organizing complex adaptive systems challenges traditional concepts of management and policy making [Wilkinson and Young 2005, Wilkinson in press]. The central idea is that firms and policy makers are parts of complex adaptive systems and contribute to the self-organizing process, but this does not mean the results of their actions are predictable. Instead a different form of participatory and adaptive strategy is required in which firms and governments “soft assemble” strategies through their actions and interactions over time. The relevant units of analysis are not the individual firms and government bodies but the ongoing relations and networks in which firms and governments are embedded. Individual firms and organisations are part of extended enterprises which augment their senses, resources, capabilities and cognition. Agent-based models of such complex systems linked to and grounded in real relationship histories and causal mechanisms offer a way forward in terms of examining the impact of different contexts and processes on the patterns of development and evolution of business relations and networks. This will assist both policy makers and management in testing possible implications of different forms of engagement and interaction and in developing their sensitivity to the often non-intuitive behaviour of such non-linear systems.

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