

MPRA

Munich Personal RePEc Archive

Network Co-Evolution

Todeva, Emanuela

2007

Online at <https://mpra.ub.uni-muenchen.de/52842/>
MPRA Paper No. 52842, posted 10 Jan 2014 18:27 UTC

Network Co-evolution¹

Emanuela Todeva, University of Surrey

The concept of co-evolution has been introduced by the biological sciences where it refers to a series of reciprocal steps during which two or more ecologically associated species interact with one another and influence each other's evolution. Co-evolution occurs because individual agents or groups of organisms, over a period of time, benefit from a continuing interaction. In the context of networks, the term co-evolution is used to describe cases where the structural and behavioural attributes of actors evolve in association and dependence of one another.

Definition

Network co-evolution is the process of mutual adaptation of two or more populations of network actors, or reciprocal evolutionary change in interacting individuals and groups with their environment.

Conceptual Overview

The fundamental concept of co-evolution implies the evolution in two or more entities brought about by the interactions between the entities and the reciprocal selective effects. As such, it implies interactions between the two entities that lead to cumulative effects on both entities, and hence – an evolutionary dependency between them. The biological literature recognizes two distinctive types of co-evolution according to the interaction mechanism (including *symbiosis* and *competition*). Symbiosis is an obligatory relationship where partners are constantly in contact with each other and often implies *mutualism* – meaning obligatory or non-obligatory (i.e. facilitative) interaction. In the case when competing species share a common environment (predator and prey), their co-evolution depends on how they constraint each-other's growth to control for depletion of the environmental resources, so to maintain the balance of the ecosystem.

There are also and different types of co-evolution according to the effect of interaction *mutualism* (+,+) when both entities experience positive effect; *parasitism* (+,0) when one of the entities (parasit) experience a positive effect, while the other experience neutral effect (host); *competitive* (+,-), when one entity (predator) experience a positive effect, while the other experience negative effect (prey); *detrimental* (-,-), when both entities experience negative effect or (-,0), when the effects are either neutral or negative for the interacting entities; and *neutral* (0,0), when both entities experience no effect.

¹ In: International Encyclopedia of Organization Studies, 2007, Sage.

The concept of network co-evolution explains why a lot of research on social networks refers to social ecosystems, social milieu and complex socio-economic systems. In complex ecosystems all entities (actors or agents) are part of the environment, which is rich in living and non living elements, all of which interact with each other in some fashion. An actor's interactions with its environment are fundamental to the survival of that actor and the functioning of the ecosystem as a whole. Network co-evolution hence implies parallel adaptations within the network that secure its survival through selection of actors and interactions.

The concept of co-evolution has been applied simultaneously to co-evolving individuals and groups of entities, in multiple disciplines, and cross disciplinary areas (molecular biology; genetics; artificial intelligence; astronomy; the co-evolution of mind and language; of climate and life; of communities and individual traits). Each of these co-evolutionary closures can be represented by a complex and heterogeneous network of interacting entities. Overall network co-evolution is interpreted as the adaptive moves of coupled players, and analytically efforts are made to distinguish between behavioral attributes and individual traits that evolve as a result of the coupling, and the co-evolutionary interactions, and those characteristics that evolve independently. This distinction between effectively dependent and independent transformations highlights the difference between individual adaptations and mutual adaptations, or traits that emerge as a result of the interaction, and those that are present before hand in the network. The reciprocal evolutionary changes are those that demonstrate the network effect of the co-evolution.

Network interactions can be direct or indirect through intermediaries such as shared resources or common enemies and friends, and can vary over a period of time, implying that the co-evolutionary effects can be both a result of long-term or short term interactions and their selection.

Co-evolution most often is understood as an evolutionary process that effects interacting parties and involves development, transformation, dynamic change, continuous transition from a lower to a higher level, mutual dependency and mutual adaptation in the process of living. The understanding of co-evolution is entangled with the concept of mutualism. As such it implied both cooperation and competition.

Authors such as Nuismer and colleagues model mutualism and antagonism over time and space testing the geographic mosaic theory of co-evolution that argues for the spatial variable patterns of local adaptations, selections and other evolutionary forces. Overall the conclusions are that mutualistic interactions generate co-evolving matching traits, while antagonistic interactions lead only to a small fraction of adaptive cases. This research in biology has challenged research in

economics on competitive vs. cooperative behavior, where the focus has been on short term performance, rather on long-term evolutionary trends.

Co-evolution implies also learning, comparison of alternatives, and selection, the latter of which is based on the cumulative effect from the interactions and the selective pressures that each individual exert on the other. Learning is a fundamental capability of agents interacting with their environment. It refers to the object of interaction (environmental factor or another actor to interact with), and to the content of interaction (how to act and what to exchange). Learning represents the adaptive dynamics that take place in co-evolutionary processes. Network co-evolution ultimately involves learning IN networks, or developing new capabilities to act and interact, to actualise behaviour following some intrinsic behavioural strategies. This enactment is embedded in a dynamic set of relationships which are subject to continuous change – both at the level of relational structure and at the level of individual and collective strategies. Learning is enactment of search behaviour that can be either of the form of exploration, or exploitation of existing patterns and routines. The learning processes is affected directly by feedback and increasing return effects in relation to ‘investment’ and positioning strategies, or motivation and contagion dynamics effects.

Research on network dynamics acknowledges that value creation from network relationships is contingent on the mutual commitment from business partners, which serves as a vehicle for developing inter-firm systems of workflow. The co-evolution of this system along with the increasing interdependence between partners in network relationships creates relational value which is then re-distributed through continuing interactions. This research also supports the co-evolution between firms and business markets driven by the interactions in business relationships which lead to the emergence of unbounded structure of interdependent activities at industry and inter-firm level.

There is also a cultural interpretation of network co-evolution which refers to the co-evolution of cultural artefacts, or ‘memes’ (i.e. cultural modes of thought, ideas, beliefs, assumptions, values, interpretative schema, and know how’, their exchange inn symbolic communication, their interpretation and reinterpretation, and their enactment, as well as the selection, variation and retention of memes.

Critical Commentary and Future Directions

Analytically network effects are by definition co-evolutionary effects as they result from the cumulative effects of interactions. Both network effects and co-evolutionary effects can be represented as behavioural transformations or as structural changes. As part of the structural transformation of networks, it is recognised also that co-evolution may take place either in a

focused coupling of actors, or as a diffused process across the entire network, where changes can not be tracked down to specific interactions, but can be explained as diffusions and as adaptive relations, or as cumulative effects of the evolution of the entire network.

Co-evolution in organization theory has been defined as the simultaneous evolution of organizations and their environments, and as the to outcome from managerial intentionality (action), environmental conditions, and institutional effects. Among the main co-evolutionary mechanisms and principles are the following: multilevelness, embeddedness, multi-directional causalities, non-linearities, positive feedback loops, path dependency and history dependency.

Network co-evolution involves three distinctive components that have to be co-present in an actor – sensing environmental or relational changes, processing information or learning, and acting or engaging with the other coupled actors. Concordant behaviour emerges either as a result of co-specialisation, or as ‘colonisation’ of one actor by another, and both could exhibit evolutionary changes and adaptive behaviour.

The dynamics between innovation and imitation resembles the dynamics between foundation and proliferation of capabilities. It follows from the distinction between explorative and exploitative search by network actors and excludes actor’s learning. Studies on industry co-evolution has been able to explain the selection of search behavior and the changes in industry structure, but has not been able to offer a reasonable explanation why some firms select to explore and innovate, while others chose to exploit.

Some organisation studies based on evolutionary theory have suggested that search behaviour in the context of competition from new market entries leads to evolution of new business models and organisational forms. This theorizing is based on the Schumpeterian argument for creative destruction that explains the dynamics of change in industry populations as stemming from the endogenous forces within firms to innovate and change methods while trying to outperform rivals. It is also consistent with Henderson and Mitchell or McKelvey, who argue for the endogeneity and reciprocal relationship between firm capabilities and competition in product markets – shaping each other and co-evolving over time. This research acknowledges that network co-evolution and adaptation occur not only between actors, but also in the environment.

Co-evolution at industry level has been explained as resulting from search behaviour of firms that culminates in capability development, creating competitive advantage, or building dynamic capabilities. All these forms of strategic adaptive behavior are intrinsically integrated into the competitive process itself which includes emergence and implementation of new capabilities or replication of capabilities of competitors. Non of these co-evolutionary outcomes

supposes cooperative efforts, and all assume the totality of the competitive forces shaping the environment and the adaptations occurring at firm level.

At the same time, research acknowledges that among the effects of co-evolution at industry level are network structures, cooperative behavior and the emergence of non-competitive entities such as shared supply chains, cooperative groups, business clusters and associations of firms addressing the issues of technological standards, compatibility, and transferability. Sturgeon and colleagues argue that the emergence of a shared supply chain in the global electronic industry is a result of the increased strategic outsourcing by the leading firms. This change of the industry structure is a result not so much of the head-to-head competition in final product markets, but is an outcome of the co-evolution between the global business environment and the organisational restructuring of the strategic operations of firms. In addition, the authors confirm that the new inter-firm relationships are neither mutualistic or symbiotic and cooperative, nor they are antagonistic, competitive and exploitative. The new relational landscape is chartered with flexible, modular and self-reliant associations between firms that simultaneously compete and cooperate.

Empirical research also confirms that co-evolutionary changes at industry level generate modular network structures of different types in different countries, such as the umbrella holding company in France, the flexible embedded network in Italy, and the virtual network organization in the US. The co-evolution of inter-organisational interactions in industries generate community type of networks and alliance structures, or cooperative technical bodies that have significant impact on sharing of knowledge and information and enhanced learning across the industry space.

See also: evolutionary theory, co-evolution, action, learning

Further Reading and References

- Baum, J. and Singh, J. (1994) 'Organization-Environment Co-evolution', in J. Baum and J. Singh (eds) *Evolutionary Dynamics of Organizations*, New York: Oxford Univ. Press.
- Djelic, M. and Ainamo, A. (1999) 'The Co-evolution of New Organizational Forms in the Fashion Industry: A Historical and Comparative Study of France, Italy, and the United States', *Organization Science*, 10(5): 622-637.
- Henderson, R. and Mitchell, W. (1997) 'The Interactions of Organizational and Competitive Influences of Strategy and Performance', *Strategic Management Journal*, 18: 5-14.
- Huygens, M., Baden-Fuller, C., Van Den Bosch, F., Volberda, H. (2001) 'Co-evolution of Firm Capabilities and Industry Competition: Investigating the Music Industry 1877-1997', *Organization Studies*, vol. 22, no. 6, p. 971-1011.
- Lewin, A. and Volberda, H. (1999) 'Prolegomena of Co-evolution: A Framework for Research of Strategy and New Organizational Forms', *Organization Science*, 10(5): 519-534.
- McKelvey, B. (1997) 'Quasi-Natural Organisation Science', *Organisation Science*, 8(4): 352-380.