Preliminary theoretical framework for the study of business ecosystems

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Abstract
In this paper a preliminary theoretical framework for the study of business ecosystems is constructed. It is based on theories from the fields of complexity and evolutionary economics. Important concepts include the following: coevolution, self-organization, emergence, conscious choice, limited knowledge, interconnectedness, feedback and the interaction of variation, selection and development.

Introduction
The objective of this paper is to construct a theoretical framework for the study of business ecosystems. This means the identification of important concepts and the definition of their relationships.

The next section summarizes what has so far been written about business ecosystems. The following section, “Application of complexity in the context of a business ecosystem,” considers applicable concepts from theories of complex adaptive systems. The penultimate section, “Application of evolutionary economics in the context of a business ecosystem,” discusses ideas from evolutionary economics, and the paper concludes with an integrated business ecosystem framework.

A business ecosystem as an analogy of a biological ecosystem

Linking the ecosystem analogy to socio-economic phenomena
Hannon (1997: 472) claims that economics and ecology have many obviously common features. They both study dynamic, organically-based systems that have methods of production, exchange, capital stocks and storage. Lewin (1999: 198-199) draws an analogy between biology and the business world by explaining that companies, like biological organisms, operate within a rich network of interactions, forming the local economy on a local scale and the global economy on the global scale. He claims that “businesses do not merely resemble natural ecosystems; rather, they share some fundamental properties”.

Biological ecosystems and economic systems “are complex adaptive systems and thus follow the same deep laws” (Lewin, 1999: 198-199).

It should, however, be pointed out that there are differences between biological and business ecosystems. First of all, in business ecosystems the actors are intelligent and are capable of planning and picturing the future with some accuracy (Iansiti & Levien, 2004: 39). Lewin (1999: 198-199) states that the biggest distinction is the ability of people to make conscious decisions, whereas in biological systems there is no conscious intent of that kind. Second, business ecosystems compete over possible members. This kind of behavior cannot be observed in nature. Third, business ecosystems aim at delivering innovations, whereas natural ecosystems aim at mere survival (Iansiti & Levien, 2004: 39).

Hannon (1997: 480) states that “the ecosystem and the economic system as currently pictured, do differ, but in reconcilable ways.” The analogy is not perfect, but it can be useful in understanding economic systems. “When we understand that the economy is an ecosystem — not a machine isolated and insulated from the environment — we grasp fundamental truths about what makes the economy work” (Baden in Lewin, 1999: 204). In addition, Hannon (1997: 472) claims that ecosystems, as well as economic systems, “are not thought to be optimizing anything.”

The ecosystem analogy has been applied also in the study of other kinds of social and economic systems. Analogies, such as the industrial ecosystem, the economy as an ecosystem, the digital business ecosystem and the social ecosystem, are reviewed in Peltoniemi and Vuori (2005).

Definition of business ecosystem
The business ecosystem concept has been used by several authors, but it still lacks a precise definition. However, some characteristics are reported to be essential in any business ecosystem. First of all, interconnectedness is an important feature. Business ecosystems are characterized by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival. This means that firms in a business ecosystem share their fate with each other (Iansiti & Levien, 2004: 8). The benefits of being a member of a business ecosystem include the opportunity to form alliances and thrive in a network, protected from potential invaders (Lewin, 1999: 210-211). However, interconnectedness may lead to a situation where changes in one part of the network are propagated throughout the system so that an organization may die despite its best efforts (Lewin, 1999: 210-211).

Business ecosystems base their success on both competition and cooperation (Moore, 1993: 76). According to Lewin (1999: 210-211), not merely competitive interactions are important in a business ecosystem, but rather the entire complex of interactions. Iansiti and Levien (2004: 35) state that the features of a business ecosystem include both competition and cooperation, but also fragmentation and interconnectedness.

A business ecosystem can also be defined in terms of landscapes. Lewin (1999: 207-208) defines a business ecosystem as consisting of several companies, each at a certain position in its own landscape. These landscapes then are coupled to each other so that changes in one landscape have an effect on other landscapes, i.e., those of competitors, collaborators and complementors.

Iansiti and Levien (2004) introduce four different roles that organizations can have in business ecosystems. Keystones are the kind of companies that serve as the enablers and have a great impact on the whole system. However, they constitute a small portion of the total number of companies. Niche players, on the other hand, make up the largest mass of the business ecosystem. Dominators and hub landlords are the kind of organizations that attract resources from the system, but do not function reciprocally. Iansiti and Levien (2004: 48) have defined three critical success factors of any business ecosystem, which are productivity, robustness and the ability to create niches and opportunities for new firms.

A business ecosystem consists of a large number of participants, which can be business firms and other organizations. They are interconnected in the sense that they have an effect on each other. Interconnectedness enables various interactions between the members. These interactions can be both competitive and cooperative. Together with interconnectedness they lead a shared fate among the organizations. The members are dependent on each other, and the failures of firms can result in failures of other firms.

The members of a business ecosystem are capable of conscious decisions on their own behalf. Firms aim at innovations and commercial success and hope to take advantage of other members and their capabilities. This is challenging since a business ecosystem is coupled to its environment, which may change rapidly and unpredictably. Thus, a business ecosystem is fundamentally a dynamic structure that evolves and develops in time. The central concepts related to business ecosystems are presented in Figure 1.

Application of complexity in the context of a business ecosystem

Coevolution in a business ecosystem

Evolution in general is often thought of as progress or improvement. However, evolutionary theory does not suggest such
positive and beneficial implications, but defines evolution merely as “cumulative and transmissible change” (Murmann, 2003). Thus, coevolution is also about change with neither positive nor negative connotations.

Merry (1999) defines coevolution as follows: “When the change in fitness of one system changes the fitness of another system, and vice versa, the interdependency is called coevolution. Coevolution is the evolutionary mutual changes of species (or organizations) that interact with each other.” Murmann (2003) defines coevolution as taking place if and only if both of the entities “have a significant causal impact on each other’s ability to persist.” In the context of organizations, fitness may be interpreted as the ability to gain competitive advantage. Thus, coevolution is about two-way interaction where both entities have an effect on each other’s success potential, which may induce change in some direction.

In the context of a business ecosystem, coevolution takes place between organizations that are interconnected and thus have an effect on each other. The decisions that one organization makes can force or enable other organizations to make some other decisions. The development of a new technology by an organization or a group of organizations can trigger many kinds of technology development projects, which can be competitive or complementary, within other organizations.

Pagie (1999) discusses three types of coevolution, namely competitive, mutualistic and exploitative. Competitive coevolution occurs between species which are limited by the same resources. In that case the organisms are forced to change in such a way that they can either take advantage of that resource more efficiently or acquire the resource more efficiently. This kind of evolution is conceptualized as the red queen effect. Mutualistic coevolution, on the other hand, comprises reciprocal relations where all the participants benefit from the interaction and change in the direction of better compatibility. Exploitative coevolution comprises relations where all the participants do not benefit from the interaction.

In the context of a business ecosystem, competitive coevolution consists of competitors making moves in order to gain competitive advantage in relation to each other. A price war is an example of competitive coevolution, as is also the development of competing technologies. Mutualistic coevolution may be observed when organizations develop capabilities for cooperation and complementation in order to compete with a third party. For example, hardware and software are developed to complement each other and the organizations involved develop those technologies in mutualistic coevolution. Exploitative coevolution may be detected in a situation where an organization is significantly more powerful than the others. This could happen in the context of a large corporation and its suppliers. The suppliers aim at developing capabilities that would make them less dependent on the large corporation. The large corporation’s goal is, however, to maintain its bargaining power to ensure low prices and timely deliveries.

In the context of a business ecosystem, coevolution takes place between an organization and its environment, which consists of other organizations and the wider context. This is presented in Figure 2. An individual organization has two sources of triggers of change. Change can be triggered from within the organization, based on its motives and inner logic. However, drastic changes are often triggered by the environment. Any organization is also a part of the environment of some other organization. This leads to coevolution.

There are preconditions that need to be fulfilled in order to have meaningful coevolution. In Peltoniemi (2005b) such preconditions consist of the following:

1. Scarcity of customers that induces selection pressure;
2. Conscious choice that enables the organizations to change;
3. Interconnectedness of the organizations that enables the organizations to have an affect on each other;
4. Feedback processes that carry the long-term consequences of coevolution

Self-organization in a business ecosystem

Anderson (1999: 221) claims that self-organization is a process where “pattern and regularity emerge without the intervention of a central controller.” Goldstein’s thoughts are practically the same since he defines self-organization as “a process…, whereby new emergent structures, patterns, and properties arise without being externally imposed on the system” (in Choi, et al., 2001: 354).
Emergence in a business ecosystem

According to Smith and Stacey (1997: 83) emergence “means that the links between individual agent actions and the long-term systemic outcome are unpredictable.” According to Phan (2004), the Santa Fe Institute sees emergence as “a property of a complex adaptive system that is not contained in the property of its parts.”

The key to emergence is the link between micro and macro behavior. Smith and Stacey claim that as emergence takes place, the behavior observed at the macro level is not obvious while examining the behavior at the micro level. “Emergence means that the links between individual agent actions and the long-term systemic outcome are unpredictable” (Smith & Stacey, 1997: 83). They also state that emergence confuses the links between cause and effect, which makes it impossible for one actor to control the whole system. When the connection between action and long-term outcome is lost in the interaction between agents and the system, it is not possible for an actor outside the system or a powerful agent inside the system to control or design the exact behavior of the system. Instead the behavior emerges (Smith & Stacey, 1997: 83).

Emergence can be observed, for example, in a game of chess. This is noted by Harkema (2003: 343), who states that although the rules underlying the game are fairly simple, the outcome can be very complex. The players have different kinds of strategies and mental models that change according to the opponent’s strategies and mental models. A game of chess is rich with interaction and feedback loops that make the game unpredictable and interesting. Thus, the result emerges bottom-up. The same is true within the context of a business ecosystem. The strategies that the organizations are applying are changed continuously as a response to the strategies of other organizations.

Emergence is a phenomenon that arises from organization-level motives and actions that lead to unpredictable and even surprising population-level behavior. It is induced by each organization’s restricted knowledge of its environment, of its options and of the outcomes of those options. The choice of an option can lead to unanticipated outcomes that induce other organizations to respond with some other choice. Thus, the phenomenon may be amplified in the population and result in an unanticipated situation. In Figure 3, coevolution, self-organization and emergence are presented.

Application of evolutionary economics in the context of a business ecosystem

From Darwin to evolutionary economics

Variation and selection are the key to the theory of evolution introduced by Charles Darwin in 1859 under the title *The Origin of Species*. The competing evolutionary theory at that time was that of Jean-Baptiste Lamarck, which can be summed up in the theories of ‘acquired characteristics’ and ‘descent with modification’.

The use of Darwinian or post-Darwinian ideas to explain economic evolution is, at least, problematic. This is well described in Hodgson’s (1994: 214) text. “If economic development is determined by some process of natural selection, with something analogous to genetic replication and to random variation or mutation, then what role remains for the notions of intentionality, purposefulness or choice, which economists of many schools of thought have held so dear?”

The Lamarckian idea of evolution has clear advantages in the field of economics compared to Darwin’s theory of evolution. It can take into account conscious choice and people’s ability to improve their performance and acquire new characteristics. But it does not have to be a dispute between Darwinists, Lamarckians and those not willing to approve any kind of thought imported from biology to economics. One can study evolution in socio-economic systems in their own right, and not as mere metaphor or analogy from biology.

Economic change as an evolutionary process

Nelson and Winter (1982: 4) state that their evolutionary theory of economic change emphasizes “the tendency of the most
In Nelson and Winter’s evolutionary theory routines play the role that genes play in biological evolutionary theory. Routines are a persistent feature of the organism and determine its possible behavior, while also the environment has an affect on the organism’s actual behavior. Nelson and Winter (1982: 14) explain the heredity of the routines using a plant as an example. When a new plant is built, it has many of the same characteristics as the plants of today based on which it was designed. Selection comes into play since plants “with certain routines may do better than others, and, if so, their relative importance in the population (industry) is augmented over time” (Nelson & Winter, 1982: 14).

According to Foster and Metcalfe (2001: 6-7) there must be variation in the characteristics of a population of selection units in order to have meaningful selection. Furthermore, the process of selection evaluates the characteristics to create a fitness score for each unit and causes the number of fitter-than-average units to increase in the population, heading to a rise in the average fitness. Foster and Metcalfe (2001: 6-7) suggest that in an economic context, variety is generated by innovations in products, organizations and methods of production. This variety is evaluated by market processes causing differential profitability for the firms. The competitive dynamics among firms in the same industry translates differential profitability into differential growth. In addition to variation and selection, development plays an important role in economic evolution. In Figure 4 the interaction of variation, selection and development is presented.

Variation, selection and development

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Emergence: Complexity and Organization

Foster and Metcalfe (2001: 10) state that in an economic system variation is not generated by random processes because they are too slow to explain the observed rates of economic and social change. They go on to suggest that the distribution of profitability of the past, and the present, influence the distribution of future R&D in an industry. Also, the experience gained in production and in market activity is an important determinant of the differential innovative performance. “The development of variety and the selection of variety become inseparable processes” (Foster & Metcalfe, 2001: 10). Thus, variety generation is not a random process; rather, variety is developed in such a way that selection steers the direction of development efforts at all times.

Merry (1995: 175) points out that surviving in evolution is not only about winning in the selection process. He stresses the importance of interaction that incorporates both competition and cooperation. He claims that complexity theory indicates the important part that cooperation plays in evolution. “In the evolutionary process, cooperation and competition complement each other” (Merry, 1995: 175). Thus, in order to survive in the selection process and improve their fitness scores, firms can form alliances to share resources and risks.

An organization faces a selection environment that consists of other organizations and the wider context. Thus, an organization must survive in the present selection environment consisting of existing organizations in order to be present in future selection environments. However, surviving in selection is not only about competing; cooperation may play a central role since in this way organizations can improve their fitness scores compared to other existing organizations.

Figure 5 pictures the role of an organization in an evolutionary process. An organization has an active role and is able to make conscious decisions based on limited and local knowledge that it possesses. It has competitive and cooperative interaction with other organizations in its selection environment. An organization does not optimize, but rather engages in profit-motivated striving.

The integrated business ecosystem framework

There are several overlapping concepts in these conceptual models. For example, emergence and self-organization cannot be separated and treated as independent phenomena. They work in a reciprocal cycle where it cannot be determined which causes which. Emergent properties can be a product of self-organization, but self-organization also emerges bottom-up. Feedback and coevolution describe different aspects of the same phenomena. One can say that feedback enables coevolution. Coevolution is essentially about triggers that travel through the population and cause new triggers to be sent. This is how the actions of each organization at some point will be echoed back to it by the other organizations.

Selective pressure can also be interpreted as a form of feedback since an organization faces selective pressure on behalf of the other organizations, but also constitutes a part of the selective pressure that other organizations encounter. Thus, the selective pressure that an organization encounters will shape its future efforts, which in turn will shape a part of the selective pressure encountered by other organizations. This clearly forms a reciprocal cycle that has a feedback aspect.

Feedback seems to be involved in most of the phenomena discussed in this paper. Feedback is caused by the interconnectedness of organizations. Thus, because of their interconnectedness organizations can have an effect on each other and interconnectedness can also make them dependent on each other. In Figure 6 the links between the concepts of the integrated business ecosystem framework are presented.

In addition to interconnectedness and feedback related to it, conscious choice plays a major role in the behavior and
Emergence and self-organization are products of decentralized decision making in a sense that the system is more than the sum of its parts. If the system were directed from the outside, there would be no need for conscious choice since the decisions would be made for the organizations. Then the emergent properties would also be less since there would be no reciprocal and sequential mechanisms creating them. This would seriously hinder the business ecosystem's ability to adapt.

The integrated business ecosystem framework emphasizes the dynamics that follow on the one hand from conscious choice and the limited knowledge of an individual organization and on the other hand from the interconnectedness and feedback loops of a business ecosystem. Conscious choice is an important observation since it differentiates economic evolution from biological evolution. Limited and local knowledge is assumed since no organization can be perfectly aware of the present state, not to mention the future. If all knowledge were available to every firm at all times, there would be no means of creating a competitive advantage and no incentive to cooperate. Limited and local knowledge leads to profit-motivated striving and not to optimization as neoclassical economics would suggest. A business ecosystem is interconnected through competition and cooperation that can be present simultaneously. This results in feedback loops which carry triggers that can induce change in the behavior of organizations. Thus, a change in the behavior of an organization can induce another organization to change its behavior, which in turn will encourage the initial organization to change its behavior again. These triggers consist essentially of knowledge and information. Conscious choice, limited knowledge, interconnectedness and feedback loops result in a nondeterministic, nonlinear and unpredictable future constructed by organizations.

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References


