

## **Entrepreneurs and the Emergence of New Industry Structures**

This paper is an examination of the role that individual entrepreneurs play in the creation of structure in the emergence of new industries. Bridging between institutional theory, complexity theory, and the strategic management literature, we develop a model that describes how individual entrepreneurs pursuing opportunity in a new industry form a path-dependent basis for the emergence of order and initial structure in that industry. We thereby illustrate how the development of industry structure in the early fluid stages is influenced by both economic effects and institutional effects. Our model explains the self-organization of a new industry through five distinct coordination mechanisms in which entrepreneurs behave as agents within a complex environment. We show how socially networked learning and rent-seeking behaviors of entrepreneurs combine to create an asymmetric transition mechanism that locks in emergent order and results in increasingly complex structure.

## Introduction

Mighty oaks from tiny acorns grow. But, although acorns all look much alike, the fully grown oaks differ widely in their shape and stature. Their growth occurs in a highly path-dependent way, where initial conditions matter very much. The acorn that falls in sandy soil and receives many years of bright sun and gentle rains becomes majestic, while the acorn that falls on sterile soil or that receives years of shade and drought amounts to little. The same can be observed for the sprouting and growth of new industries in the economy. The technological innovation or market discontinuity that gives birth to an industry is similarly dependent on initial conditions to set its evolution on a path towards high growth and significant social and economic benefit. At the time of industry germination, these initial conditions are created largely by entrepreneurs who recognize the latent opportunities and take disruptive actions to nurture their growth (David & Bunn, 1942). While research into institutional entrepreneurship has shed light upon the role that entrepreneurs play in the evolution of existing industries within extant institutional fields (DiMaggio, 1988; Lawrence, 1999) and the mechanisms by which entrepreneurs participate in the structuration of their local environments (Luksha, 2008), the emergence and formation of new industries and institutional fields remains relatively poorly understood (Fligstein, 1997; Maguire, Hardy, & Lawrence, 2004), to the effect that many studies into the industry effects of entrepreneurship continue to take the existence of major industry artifacts as given (Sarasvathy, 2001). In this article we therefore investigate the actions of entrepreneurs during emergence and the causal effects they have on the generation of structure (such as firm boundaries and network relationships) within newly sprouting industries. In so doing, we aim to enrich the explanation of how the initial structures of new industries emerge and how theoretical perspectives from entrepreneurship and strategic management can offer complementary perspectives.

Although entrepreneurship research has been largely focused on emergence at the firm level (Busenitz, 2003; Lichtenstein, Carter, Dooley, & Gartner, 2007; Lichtenstein, Dooley, & Lumpkin, 2006;

Venkataraman, 1997), emergence can be viewed as a multi-level phenomenon where the actions of individuals also matter (Chiles, Meyer, & Hensch, 2004; Phan, 2003). Our goal is to propose a framework, based on complexity perspectives, that examines emergence and organization at the industry level to highlight the critical role that entrepreneurship plays in the initial conditions and paths of industry emergence. With this proposal we are responding to the call of Meyer et al (2005) to extend organizational theorizing to adopt nonlinear approaches and concepts during times of system upheaval and emergence and to especially study systems that are in flux.

The effect of industry structures and their relationships to firms and individuals is often examined from the perspective of institutional theory. We adopt this perspective over the alternative SCP paradigm (Bain, 1956) because we are interested primarily in the initial emergence and development of industry structures rather than their subsequent effects on industry conduct and performance levels. Institutional theory suggests that social and political context can have ongoing influence the decisions of individual actors. This influence arises because the behavior of individuals is governed by institutions and social conventions, not just economic utility maximization (Veblen, 1898). Institutions can be thought of in several ways: as shared mental models (North, 1981), as ‘rules of the game’ (DiMaggio & Powell, 1983; Shepsle, 1989), as a set of taken-for-granted understandings (Berger & Luckmann, 1966), as systems of social relations (Granovetter, 1985), or as coordinating mechanisms for rational political choice (Commons, 1934). All of these perspectives share the view that institutions can influence individual decisions taken by actors.

In the context of a mature industry, institutional theory helps explain the great degree of isomorphism and similarity of behaviors and strategies among firms by suggesting that three types of forces act to cause firms to become similar within an industry (DiMaggio & Powell, 1983):

- Coercive isomorphism – Social sanctions or laws effect an exogenous imposition of structure and order.

- Mimetic isomorphism – Firms observe the structure and performance of each other (e.g., benchmarking). Successful structures are copied.
- Normative isomorphism – Values are socialized through extra-firm organizations (e.g., professionals) to encourage the adoption of selected structural features.

But such traditional organizational perspectives have much less to say about the initial emergence of the industry – how organizational fields are constructed, how the artifacts of the industry (firms, markets, value chains, etc.) are initially produced and organized, and how these result over time from the decisions and behaviors of the early actors (Chiles et al., 2004).

Much of the recent strategy literature on change and evolution in industry structures has drawn from institutional theory's conception of path dependency, which argues that institutions are the culminating result of specific historical processes that have occurred (North, 1981). These historical processes can involve actions that initiate feedback mechanisms that make going back politically impractical, so that paths that were once viable options become lost (Pierson & Skocpol, 2002). These mechanisms can be either reactive sequences, in which each subsequent event is causally dependent on prior steps leading back to the initiating event, or be self-reinforcing sequences in the formation and ongoing reproduction of a new institutional pattern. Such path-dependent mechanisms are characterized by great sensitivity to initial conditions, contingency and indeterminacy in the early historical events, but relative determinacy or 'inertia' in the later events (Mahoney, 2000).

Path dependency suggests that institutional effects can be bi-directional – that individual decisions taken by actors can also influence the formation and evolution of the institutions themselves. For example, the localization of R&D search behaviors and the resulting technology trajectories lead to a path-dependent structuring of the innovative capabilities of firms (Stuart & Podolny, 1996). In the early stages of a new industry, collaboration and structuration by individual actors can form the basis for

‘proto-institutions’ that subsequently develop the facticity to become enduring social forces (Lawrence, Hardy, & Phillips, 2002).

As David and Bunn (1987: 4) describe it, this path dependence is a dynamic property of the allocative process within industries. As such, it should be viewed as a property of the whole industry viewed as a single system. The evolutionary process of the industry system displays path dependence due to punctuations or discontinuities of radical innovation and creative destruction by entrepreneurs (Schumpeter, 1934). These changes destroy the competencies of existing firms in the industry and increase munificence for others (Abernathy & Clark, 1985; Tushman & Anderson, 1986). Discontinuities are initiated by new firms acting entrepreneurially and, because these changes tend to destroy significant competencies of existing players, can have large consequences even when the changes are apparently small (Henderson & Clark, 1990). This sensitivity to small effects makes the path-dependent evolution of industries a non-ergodic process (David & Bunn, 1987), one where individual agents can abruptly and irreversibly alter the probability distribution of possible future states. As a result, a deeper understanding of these dynamics can be had by adopting a perspective that crosses levels, that attempts to explain industry-level system behaviors by examining the actions of individual entrepreneurs as agents in the system.

The creative destruction potential of entrepreneurs in emerging industries has great impact on society (Baumol, 1990), particularly when entrepreneurial actions function as trigger events to an institutionalization or structuration process (Greenwood & Hinings, 1996). So it is important to understand the establishment of initial conditions and how these initial conditions influence the evolutionary path of industries. To that end, we aim to show that significant economic effects of the mature industry as a whole can result from very small actions taken in early days by entrepreneurs as individuals (Wu & Brabazon, 2009). The macro-scale economic phenomenon of a mature industry has its roots in the micro-scale of individual entrepreneurs acting during the ‘fluid’ early days of the new

industry, particularly when the new industry is based on radical disruption of competencies or linkages and a dominant design has not yet emerged (Abernathy & Clark, 1985; Utterback & Abernathy, 1975).

Entrepreneurs who are able to spot latent opportunities, commercialize them, and direct the growth of a new industry are well-positioned to capture very large economic gains for their firms and for the society. Yet, as institutional theory would also predict, this is a very risky time for early entrepreneurs; the liabilities of newness are especially prominent, and innovative agents typically lack both the cognitive and socio-political legitimacy needed to effect significant changes (Aldrich & Fiol, 1994). Moreover, the potential for increasing returns to entrepreneurial innovators can result in situations highly sensitive to random chance or small initial advantages (Arthur, 1989). For example, at the end of the 19th Century, when technological innovation had made the replacement of gas lighting with incandescent electrical lighting a feasible opportunity, two individual entrepreneurs struggled to define the structure and dominant design for the nascent electrical generation and distribution industry. Thomas Edison held the patents on a DC electrical system, while George Westinghouse was trying to commercialize the AC power system invented by Nikola Tesla. Both sides faced huge uncertainties. Neither system had infrastructure in place, a single compelling technical advantage over the other, or strong legitimacy among municipal lighting utilities. Moreover, Edison favored an institutional design in which generation, manufacture of lighting equipment, and manufacture of other electrical devices would be separate businesses. He was able to draw upon his individual resources of patents, capital and social networks to influence the institutional field towards establishment of proto-institutions that reflected his personal vision of a nascent electrical utility industry comprising separate lighting utilities, equipment manufacture, and centralized production firms (Granovetter & McGuire, 1998; Hargadon & Douglas, 2001). Yet, on the question of technology standards, the first practical implementation of industrial-scale AC power generation at Niagara Falls eventually tipped the balance away from Edison's preference and towards lock-in of the Westinghouse AC technology.

It is important to note in this example that no external coercive force acted to create the resulting industry structure. No technical standards body chose the underlying technology, and no governmental agency imposed the dominant design. The structure emerged through the individual actions of the initial entrepreneurs. The new industry organized itself in a process due to the emergent holistic behaviors that becomes possible in sufficiently complex systems.

### **Complexity and Self-Organization**

Complexity theory provides a useful perspective to understand the importance of initial conditions on organizational development and the potential effects of individual early agents (Rivkin, 1998; Rivkin & Siggelkow, 2002), and so provides a potentially powerful lens for examining the role of entrepreneurs in the emergence of complex industry systems. Complex systems are systems having both many components and many constraints to the interactions among these components. It is the interplay of these two defining characteristics that makes complex systems interesting – a system with few interacting components and much constraint is deterministically simple, and a system with many interacting components and little constraint is chaotic yet statistically simple. Complex systems exist at the balance point between these extremes, where simple order begins to break down but has not yet completely dissolved into chaos (Rivkin, 1998; Rivkin & Siggelkow, 2002). Such systems typically exhibit nonlinearity, irreducibility, and a surprising range of emergent behaviors. It is the range of these emergent behaviors that accounts for the increasing use of complexity perspectives to understand very many interesting socio-technical systems and problems. Theories of complexity have been used successfully to better understand biological and physical sciences (Grassberger, 1986; Weng, Bhalla, & Iyengar, 1999), information processing (Radner, 1993; Trevisan & Vadhan, 2007), sociology (Brewer, 2002; Byrne, 1998), market economics (Durlauf, 2005; Rosser, 1999), strategic management (Brown & Eisenhardt, 1997; Houchin & MacLean, 2006), and individual firms and organizations (Anderson, 1999; Fuller & Moran, 2001), as well as the generalized adaptive cycles of innovation and structuration in entire

hierarchies of interrelated systems (Holling, 2001). Even Hayek's catallaxy (a self-organizing system of voluntary cooperation among economic agents) can be viewed as a powerful example of complexity principles of self-organization applied to explain capitalist market formation (Hayek, 1973; von Mises, 1949).

Complex systems may arise through a process of self-organization among a variety of relatively simple agents. Such self-organization is a process by which the internal organization of a system changes without being guided or managed by an outside entity (Di Marzo Serugendo, Gleizes, & Karageorgos, 2005). Complex self-organizing systems typically display emergent properties – holistic properties that cannot be simply predicted through superposition of the properties of the various constituent elements of the system.

As a result, complexity is now starting to be recognized as a powerful tool in the study of entrepreneurship (Bygrave, 1989; Chiles et al., 2004; Ganco & Agarwal, 2009; Johnes, Kalinoglou, & Manasova, 2005; McKelvey, 2004; Stevenson & Harmeling, 1990; Vogel, 1989). It is important to study complexity in the context of entrepreneurial research because complexity science deals with the creation of order during the initial creative phases of a new organization, rather than the subsequent evolution of a well-established organization towards a stable equilibrium condition (McKelvey, 2004). This mirrors an important difference between the study of entrepreneurship and the traditional realms of strategic management.

In the case of entrepreneurs as agents, they demonstrate an interplay of equilibrating and disequilibrating forces acting in the economy – enabling the creation and destruction of local pockets of order that approximate economic equilibrium conditions (Baumol, 1990; Kirzner, 1997; Schumpeter, 1942). In particular, entrepreneurs act to cause the recognition or creation of new opportunities, the formation of new individual firms, and the structuration of new economic processes around these

opportunities (Fuller & Moran, 2001). Entrepreneurs and society co-produce via the rules of social order in a process of structuration (Downing, 2005), by which the social context of entrepreneurs is dynamically enacted through the interplay of the duality between individual actions of entrepreneurs as knowledgeable agents and the constraining rules and forces of social systems and structures (Giddens, 1984). There is no exogenous organizing force – it is self-organized through an emergent process in which the constituent firms of the new industry act independently in pursuing their independent business strategies, yet they collectively achieve the formation and maintenance of the emerging networks and structures (Stuart & Sorenson, 2007). From this perspective entrepreneurs may be viewed as economic agents that impose constraints on the the emerging industry, or that identify attractors in the industry phase-space and drive the economy towards them (Kirzner, 1997). These constraints originate through the embeddedness of individual entrepreneurs, which includes their existing cognitive maps (Mitchell et al., 2004), prior institutional settings (Shane, 2000), imprinting (Levinthal, 1997), and culture (Hayton, George, & Zahra, 2002). This process of self-organization and emergent properties has been repeatedly observed at the firm level, since firms are complex systems comprising the individuals and teams within the firm (Coleman, 1999). Our goal is to now examine the possibility of self-organization at the industry level, a complex system comprising many individual firms.

Self-organization can occur when variations due to actions of individual agents result in local pockets of order and constraint. The actions of agents result in state transitions of the system that, under unconstrained conditions, may be undone by subsequent actions of other agents. But to persevere and grow, it requires some manner of selection by an *asymmetric transition mechanism* (Ashby, 1962) whereby random transitions to states of higher order are more likely and transitions to states of lower order are less likely, and thereby to allow for the retention of this local order. The asymmetry in transition likelihoods is essential to permit these local pockets of order to be sustained and eventually interconnected. With both random fluctuations and an asymmetric mechanism, the system transitions into a more ordered state that becomes the new baseline condition. The system can thereby evolve to a more

complex and interdependent overall structure – even if the individual transitions were solely directed to the goals of the individual agents (or indeed were completely random). The presence of an asymmetric transition mechanism forms a ‘ratchet’ that lifts the system into a more organized whole, without need for any exogenous control.

### **Learning and Self-Organization**

A fundamental problem faced by components in a complex system is the rapid adaptation to changing environmental circumstances. Effective adaptation requires knowledge of the new state of the system. Complete knowledge of this change is difficult because social knowledge is typically dispersed idiosyncratically and not available to a single agent. There is therefore a corresponding need for emergent methods of organization to bring all this knowledge to bear on the problem – to enable agents to discover the nature of the change and to adapt appropriately (Hayek, 1945). By discovering and learning about environmental change, the individual agents can devise appropriate responses and thereby change the overall system behaviors; the system as a whole changes due to the learning by constituent components.

The foregoing suggests that *learning* on the part of individual agents can be a strong candidate for the asymmetric transition mechanism of the system. The asymmetry of this mechanism is provided by the irreversibility of knowledge transfer – something once learned cannot be unlearned. In particular, agents can learn to improve their coordination and thereby achieve joint objectives. For example, a honeybee colony, as a complex system, is forever changed once a scout brings back news of a nearby nectar supply and dances to communicate the details to the entire hive. Similarly, the structure, scope and roles within the mid-1990s nascent e-commerce retail industry were forever changed once Amazon.com demonstrated both the astute choice of products to sell online and a sustainable business model. With each such change, a new baseline condition is established and exploited and, in turn, used as a jumping off point for the next transition – the ratchet mechanism begins operating. Guerin and Kunkle’s example of statistical thermodynamic measures of the explorations of ant colonies (Guerin & Kunkle, 2004) provides an

example from the domain of natural history of asymmetric transition of a system due to learning by constituent agents, an example of sufficient congruence to suggest institutional equivalents (Webb, Lettice, & Fan, 2007). They use their observations to suggest a general four-step model by which a ratchet effect of system organization can be obtained from the combination of random explorations and asymmetric transitions. The mechanism bears strong similarity to Prigogine's theory of dissipative structures (Nicholis & Prigogine, 1989; Prigogine & Lefever, 1972). Figure 1 illustrates the behavior of this model by showing the average distance covered by an individual ant sojourn away from the colony during each of these steps. In this model, (1) a newly discovered food source is thoroughly explored (the new system state is discovered and exploited), (2) a consolidation of knowledge occurs about where food is and is not found (the new systems structures are formed), (3) the food resources are mined in an efficient manner (the structures are maintained for so long as they are useful), and (4) the exhaustion of the food supply forces new explorations of increasingly wide range (the process renews with re-exploration from the evolved system state). This force of re-exploration echoes McKelvey's concept of 'adaptive tension', whereby some external trigger drives the system to change into configurations of better fit (McKelvey, 2004a). Lichtenstein's recently proposed concept of 'opportunity tension', which integrates exogenous pull factors such as environmental change with endogenous push factors such as goal-seeking intentionality, may also be represented in this stage of the model (Lichtenstein, 2009).

[Figure 1 about here]

This model illustrates how learning, on the part of individual agents, can lead to asymmetric transitions on the part of the system as a whole, provided that the knowledge gained by an individual agent to lead to changes in the behaviors of many other agents. Studies of this influence among agents have led to the proposal of five possible mechanisms for their self-organization (Di Marzo Serugendo, Gleizes, & Karageorgos, 2006):

1. **Direct.** Interactions between agents use basic principles such as broadcast and localization, and employ local computations of individuals, to provide a final coherent global state. The

mechanism relies on the ability of agents to occupy subject positions of sufficient legitimacy, to theorize new practices through discursive means, and to institutionalize them with stakeholders (Maguire et al., 2004). This occurs, as a simple example, in the grassroots organization of political groups in society, as individuals with political objectives communicate directly and thereby discover common purposes.

2. **Stigmergy.** A mechanism of spontaneous indirect coordination between agents, where a trace that is left in the environment by an action of one individual stimulates the performance of subsequent actions by the same or a different agent. In Guerin and Kunkle's ant colony this would be seen in the formation of ant trails, wherein each ant leaves chemical traces on the ground and later ants are influenced by these trace chemicals to follow a similar path. At the human scale, a simple example of similar behavior can be seen the gradual wearing of pathways in the grassy lawns of a new public park.
3. **Reinforcement.** Agent behaviors are positively or negatively reinforced and the agents thereby adapt according to the state of the environment, the current individual state, and the probabilistic calculation of the expected payoff of different future behaviors. This mechanism can be observed in the formation and continuation of social fads and fashions of simple or complex scope and magnitude.
4. **Cooperation.** Agents can deliberately chose to become combined or decomposed in response to changes in environmental demands and communication overhead costs, in order to improve their collective response, such as in the collaboration that generates new proto-institutions (Lawrence et al., 2002). For a simple example, when traffic jams occur due to lane closures on a highway individual drivers may choose to combine into queue structures and follow cooperative rules for negotiating the bottleneck.
5. **Generic architecture.** Agents can chose to instantiate some form of extant architectural arrangement by which roles and interrelationships are predefined through a holonic organization of nested subsystems and metasystems (Koestler, 1967) and self-organization occurs through

modification of the holonic hierarchy in response to environmental perturbations (Ulmer, 2002). A simple example can be seen in creation of a new recreational league for team sports, where participants organize themselves by adopting the pre-existing rules and roles of the chosen game. Note that we refer to the emergence of complexity at the league level, in contrast to the emergence of complexity in the cooperative efforts of team members as studied by Bokenko (2009).

Table 1 connects the steps of learning exploration and consolidation of Guerin and Kunkle (2004) with the self-organization mechanisms of De Marzo Serugendo et al (2005), and thereby provides the basis of our framework for analyzing the role of initial agents on the emergence of order and structure in an arbitrary complex system.

[Table 1 about here]

Clearly, learning by networked agents can play a significant role in each of the self-organization mechanisms underlying the formation of complex systems. This observation leads to our first proposition.

*Proposition 1: Learning in social networks is a mechanism for self-organization of systems comprising multiple interdependent agents.*

### **Self-Organization of Industries**

We now apply this general perspective to the specific case of newly emergent industries (e.g., personal computers, digital media, internet, nanotechnology, biotechnology, and alternative energy production). On this basis, the framework of table 1 may be adapted to the entrepreneurial context of new industry formation by examining how each step of the asymmetric learning occurs in each of the different mechanisms. Therefore table 2 gives examples of the five mechanisms of self-organization, as seen in the exploitation of entrepreneurial opportunities and the formation of new industry structures.

[Table 2 about here]

These examples illustrate a close correspondence between the knowledge discovery by entrepreneurs in new industries and the generalized socially networked learning discussed above. This leads to our second proposition.

*Proposition 2: Entrepreneurs acting as agents engaged in socially networked learning can cause the self-organization of complex industry structures.*

We have argued that a new industry comprising many entrepreneurs is a complex system capable of self-organization, and that this organization occurs through the operation of an asymmetric transition mechanism based on social learning. But there may be other forces operating in the entrepreneurial realm that can create other asymmetric transition mechanisms. One such alternative force may be the entrepreneurial motive to create and appropriate economic rents, since one of the most important things entrepreneurs learn is which business models are most profitable in the new industry. The basic asymmetry of this mechanism lies in the observation that an entrepreneur will change strategies and business models if higher profits can thereby be obtained, but will not make the reverse changes that knowingly lead to lower profits. As a result, random experimentation by pioneering entrepreneurs will eventually discover profitable models, and these models will be locked in to form the locally stable pockets of increased order on which the complexity of the industry system and the structuration of industry roles depend.

As an example, consider again the heady days of the early dot-com boom and the discovery of successful e-commerce retail by Amazon.com. Those times were marked by extensive media coverage and hype (Valliere & Peterson, 2004) providing ample opportunity for communication and learning among pioneering entrepreneurs. But they were, to an even larger extent, times of rampant experimentation with business models. From web retailing of pet food to online market-making in petrochemicals, and by using business models developed through both deliberate experimentation and

random accident, entrepreneurs thoroughly explored the profit potential of the new industry space, discovered and preserved the most successful approaches, and catalyzed the structuration of the online commerce industry. The primary mechanism of this progression and asymmetric lock-in appears to have been rent-seeking.

It might seem like this rent-seeking mechanism is implicit in the previously described learning mechanism. But the two should be considered separately since they are not necessarily concomitant. Sometimes the exploitation of the industry opportunity does not involve new learning (other than the initial discovery of the opportunity); the innovation might simply be the application of well-proven extant business models into the new industry context, with little novelty or learning being shared among the agents. In such a situation, ongoing social learning cannot serve as the asymmetric transition mechanism underlying the self-organization of the industry structure. Instead, it is solely the rent-seeking actions of entrepreneurs that catalyze the self-organization of the industry. This leads to our third proposition.

*Proposition 3: Entrepreneurs seeking the creation and appropriation of rents can cause the self-organization of complex new industry structures.*

## **Conclusions**

Industry emergence and structuration follows a variety of processes of self-organization. These processes are highly path-dependent and sensitive to initial conditions. We have argued that entrepreneurs play a critically important role in establishing these conditions and forming the new proto-institutions. Entrepreneurial actions traditionally viewed as Schumpeterian creative destruction can now be viewed as an element of self-organization through the initial exploration and structure-formation steps, while Kirznerian entrepreneurship exemplifies the structure-maintenance step. Together these two entrepreneurial actions constitute an asymmetric transition mechanism that preserves the initial random emergence of local order and thereby allows it to grow into the new institutional field.

We have further argued that learning by entrepreneurs underpins this ratchet through the five mechanisms of direct interaction, stigmergy, reinforcement, co-operation, and generic architecture. Entrepreneurs represent the nexus of learning within the emergent industry, the locus at which profitable and sustainable structures are discovered and promulgated. The individual actions of entrepreneurs can therefore have irreversible consequences, either arising from knowledge transfer or flowing from the entrepreneurial profit motive. These consequences create the small but significant initial conditions that drive the industry towards one set of future states and away from others.

These initial entrepreneurial conditions create a path dependency in the emergence and formalization of institutional fields in the new industry. Therefore industry evolution cannot be fully understood at only the system level. The emergence of industry structure is a level-crossing phenomenon in which small actions of individual agents can have large effects on the overall system behaviors, and these system behaviors in turn enable or constrain further actions by the agents. In this, we argue in support of previous findings of cross-level influences by Chiles et al (2004). We have suggested that the emergence of an industry is influenced by both economic effects and institutional effects. In this paper we have proposed a broad framework, based on complexity-theory perspectives, that integrates the critical role entrepreneurs play in the initial conditions and path dependency for the emergence and organization of new industries, and thereby suggest how this self-organization depends on level-crossing effects. We summarize this effect by proposing the model of Figure 2, in which a complex industry structure emerges through the asymmetric nature of learning transitions on the part of individual entrepreneurs seeking economic objectives, and these transitions are moderated by institutional effects that reflect the influences of the environment and prior institutional fields on these individual actors.

[Figure 2 about here]

The potential significance and influence of early entrepreneurial actions on the eventual growth and evolution of new industries underlines the importance of continued research in this area. The asymmetric transition mechanisms described in this paper have been proposed as sufficient but not necessary causes. On the one hand, their sufficiency is in need of empirical validation. And on the other, the possible existence of other important mechanisms should also be investigated. Each mechanism found will be significant in that it will provide an important dimension for better understanding the early dynamics of the industry system and the resulting future evolutions, and in that it will also provide new insights into potential policy levers for the facilitation of industry growth and ongoing change.

Finally, the potential connection between the generic four-step transition model and the actions of Schumpeterian and Kirznerian entrepreneurs suggests the possibility that the entrepreneurship phenomenon as a whole may constitute an asymmetric transition mechanism that operates at a higher level of abstraction and across multiple industries. Entrepreneurship may thereby form a ratchet mechanism in the entire economy, transitioning the rotation of the economy from one equilibrium attractor to another. The nature of this attractor warrants further study. Such investigation is well outside the scope of this current paper, but worthy of investigation by subsequent researchers.

**Table 1**

*Asymmetric Learning and Self-Organization*

	<b>Self-organization Mechanisms</b>				
<b>Phases of Learning</b>	<i>Direct Interaction</i> (grassroots organizing)	<i>Stigmergy</i> (walkways in a park)	<i>Reinforcement</i> (social fads)	<i>Co-operation</i> (traffic lane blockage)	<i>Generic Architecture</i> (soccer league)
<i>Exploration</i>	Individual experimentation towards goals, local identification of other interested activist parties.	Random walks among areas of interest, constrained by bounded rationality of agents.	Social benefit of being perceived leader, trendsetter, having fun or being cool.	Individual recognition of common objective – allowing <i>you</i> to proceed clears the lane for <i>me</i> .	Deliberate adoption of existing models and roles (e.g., which game, which league, which teams and positions).
<i>Structure Formation</i>	Communication of successes by pioneers and coordination of efforts among local groups (Dal Forno & Merlone, 2009), reduced agent ignorance of overall structure.	Influence of environmental traces (footprints and rough paths), widespread copying, and formal structuration (pave the paths).	Need for affiliation and social approval, jumping on the bandwagon.	Emergent identification of agents and roles (queues of cars form), locally negotiated or cultured rules (taking turns).	Adoption of rulebook, enactment of roles and processes (playing positions).
<i>Structure Maintenance</i>	Local rules govern exchanges for individual benefits, widespread interactions.	Homeostasis of structure regulates agents – ‘Keep off the grass’ signs erected.	Herd behavior and social costs of non-conformance, co-option by the mainstream society.	Local observation of efficacy (net throughput), recognition of switching costs to create alternative mechanisms	Public tracking of performance (statistics), rule enforcement by appointed referees.
<i>Re-exploration</i>	Mass communication, assessment of progress and new status quo.	Expanded boundaries through serendipity or noise (e.g., new point of interest discovered, or new shortcut by busier visitors).	Novelty seeking, boredom, desire to be different.	Environmental change (a lane reopens or another lane becomes blocked) triggers reevaluation of status quo.	Environmental change (winter comes, players change to ice hockey).

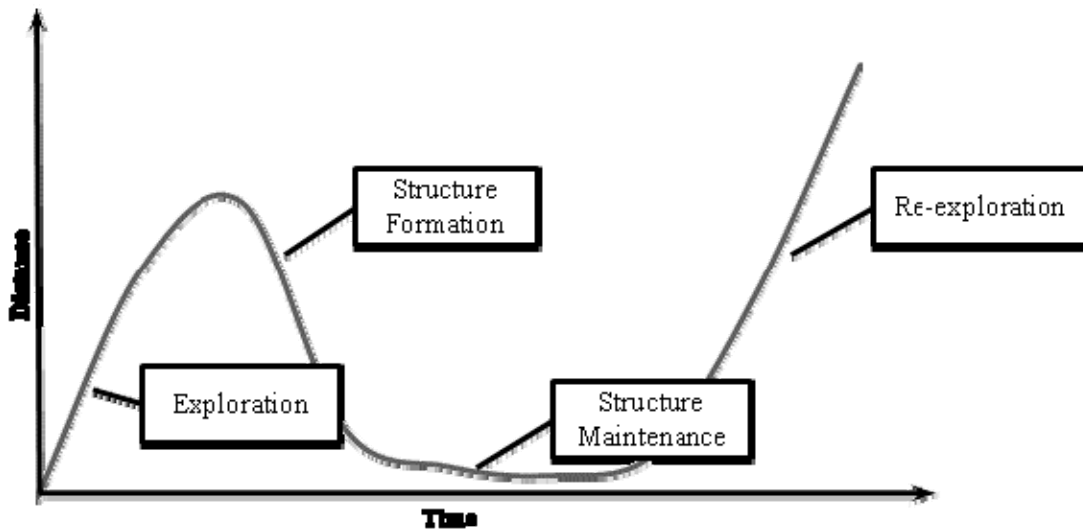
**Table 2**

*Entrepreneurial Self-organization of New Industries*

	<b>Self-organization Mechanisms</b>				
<b>Phases of Learning</b>	<i>Direct Interaction</i> (direct networking)	<i>Stigmergy</i> (indirect networking)	<i>Reinforcement</i> (cultural influences)	<i>Co-operation</i> (experimentation)	<i>Generic Architecture</i> (replication of models)
<i>Exploration</i>	Small, innovative firms seeking access to large markets dominated by existing players	Serendipitous discovery of opportunity by innovative entrepreneurs; high-growth exploitation of opportunities	Pioneering entrepreneurs seeking first-mover advantage through new venture creation; effects of field frames (Lounsbury, Ventresca, & Hirsch, 2003)	Individual recognition of opportunities that require collaboration (complementary products, delivery of ‘whole product’, co-opetition), specialization and communication (Kogut & Zander, 1996)	Opening of a regulated industry opportunity
<i>Structure Formation</i>	Corporate venturing through strategic alliances with entrepreneurial firms	Strategic responses by entrenched players (e.g., copying new business models).	Recognition of first-mover successes. Copying their strategies, or spotting adjacent emergent opportunities (e.g., supplier, distributor)	Entrepreneurial action to facilitate shared objectives, such as open standards and product architectures, creation of industry associations, deliberate induction of new ventures (Kogut, Walker, & Kim, 1995)	Predefined industry participant roles adopted by new and existing firms as they enter the new regulated industry
<i>Structure Maintenance</i>	Contractual mechanisms established (e.g., hub-and-spoke structures)	Structuration of new norms and expectations of existing players, in light of new entrepreneurial actions.	Successful profit-generation by all industry participants; celebration of managerial leadership	Network effects and increasing returns, exponential growth in switching costs	Enforcement by regulator
<i>Re-exploration</i>	Interaction and joint discovery through networking, brainstorming, environmental scanning	Declining margins through Kirznerian entrepreneurs, emergent opportunity for Schumpeterian creative destruction	Innovation and environmental change create opportunities for new pioneers	Environmental change (creating new collaborative opportunities)	Environmental change (especially changes in regulatory regime)

**Figure 1**

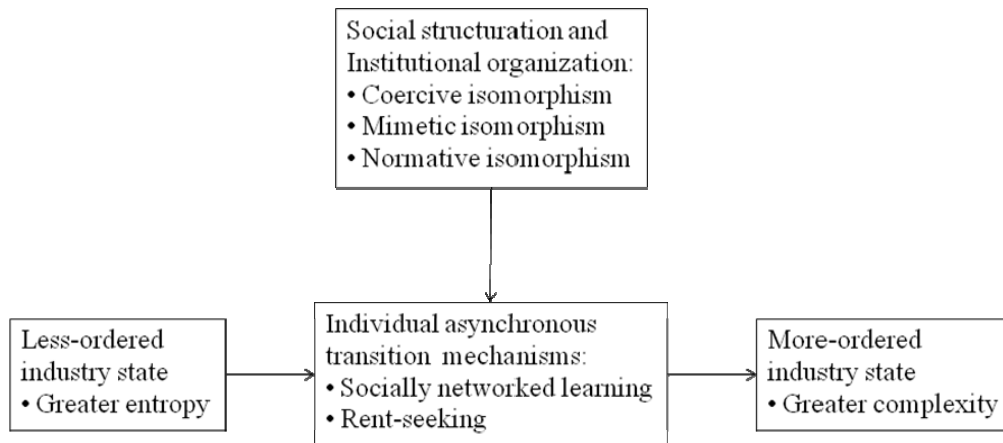
*Exploration, Consolidation of Knowledge, and Institutional Structuration*



(Based on Guerin & Kunkle, 2004)

**Figure 2**

*Individual Moderation of Industry-level Effects*



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