Introducing an Epigenetic Approach for the Study of Internet Industry Groups

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1 Introduction

The aim of this first chapter is to study how organizations adapt to extremely fast qualitatively significant changes in the environment. As opposed to the prevalent Darwinian approach in which the logic of the phenotype is seen as a slow and moderate adaptation of social organizations to changes, our view focuses on rapid adaptation to quickly changing environments.

The analytical framework we put forth in this chapter, through the concept of Epigenetic Economic Dynamics (EED), comes from different fields of knowledge. This concept finds its roots in: (i) new discoveries in molecular biology; (ii) the complexity theory, which is a theoretical framework stemming from very diverse sciences; (iii) current approaches in terms of organizational routines in management; (iv) economic theory on competition and profits; and (v) innovation studies from a Schumpeterian approach.

Three related points could be cited as where to focus analyses concerning organizations' adaptation to changing environments: The mechanics of change in routines; the necessary capabilities that organizations require; and the resulting

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dynamics observed in them. The adaptation to changes in the environment in each case makes it possible to study these three approaches in a related manner.

This chapter will be particularly focused on molecular biology and business routines, respectively.[1] As Vosniadou and Ortony (1989: 1) discuss, "the ability to perceive similarities and analogies is one of the most fundamental aspects of human cognition. It is crucial for recognition, classification, and learning and it plays an important role in scientific discovery and creativity." The analogy from biology has been included in a great deal of the literature on organizational routines for over 50 years (Campbell 1965). Nelson and Winter's (1982) seminal work was a key reference for the dissemination of the evolutionary approach in economics (Witt 2008; Witt and Cordes 2007). Authors such as David (1994), Dosi (1982), Cordes (2006), Freeman (2002), Nelson (1995, 2007) and other post Schumpeterians use a Darwinian type of argument to defend their views. The principle of selection is a key part of Darwinian methodological approaches. According to it, organisms would gradually adapt in response to conditions determined by environmental factors. This analogy was greatly strengthened by the contribution concerning evolution of the genotype and phenotype and the latter's link with the 'plasticity' concept, which measures the degree of adaptation to change that defines the selection mechanism (Levinthal 1997; Levinthal and Marino 2013). The greater the plasticity, the lower the capacity to replicate, thus weakening the stability of routines. In contrast, without plasticity organizations would not have the ability to evolve and adapt so as to anticipate potential changes in the environment.

Paths of adaptation and learning have been explored for several decades in literature on management (Argote 1999; Levitt and March 1988). Parallel to this, new perspectives on dynamic capabilities have been developed (Teece et al. 1997), providing some methodological bases to advance in new directions. The complexity theory has been developed within the framework of organizational studies and strategic management. The interest of our conceptual contribution lies in understanding how organizations and businesses adapt to their environment in uncertain conditions. Organizations are hereby approached as complex adaptive systems, which show different principles such as self-organization, interdependence, co-evolution, complexity, and chaos. These principles form part of the development of our EED concept. Coevolution, as a case in point, means that entities, industries, or economies are partially linked to other organizations, or also that an organization changes according to the context (Kauffman et al. 1995).

Mitleton-Kelly develops (2003) and analyzes various perspectives on organizations and complex systems. She forms a theoretical framework that has been examined from very diverse sciences such as biology, chemistry, physics, mathematics, computation theory, economics, and the evolution of interactions, generally in ecosystems (Arthur 1999; Gleick 1987; Holland 1998; Petrosky and Prigogine 1990). As Mitleton-Kelly points out: "Although we make a conceptual

[1]Despite part of the current approaches to business routines being based on the complexity theory, we will not develop this point as it goes beyond the objectives set for this book.

distinction between a system and its environment, it is important to note that there is a dichotomy or hard boundary between the two, in the sense that a system is separate from and always adapts to a changing environment" (2003: 7). Kauffman (1993) suggests that natural selection is not the only source of order in organisms and that it is important to take self-organization into account because organisms also evidence spontaneous order, which is precisely self-organization.

Extrapolation of results from the past to the present becomes impossible when there is great complexity and dynamism in the environment. Reacting to changes in the environment through rapid flexible responses is sometimes the only solution. Many firms shift to an environment-driven orientation while others remain successful using their traditional formulas. Ansoff and Sullivan (1993: 1) "present a formula for strategic success which states that the profitability of a firm is optimized when its strategic behavior is aligned with its environment." In turbulent environments where there are large-scale changes, these can also be extremely rapid. "Thus, it is practically impossible to make predictions about the future, in which past experience would contribute little to adaptation. Even efficiently managed businesses will experience strategic surprises. In fact, the environment would change more quickly than possible responses and, in any case, strategic responses would seek new changes based on creativity" (ibid: 4).

In turbulent environments, where big changes are occurring, these adaptation processes need to be extremely rapid. Epigenetic changes form part of emerging processes. Emergence may take place as a result of significant changes in the environment and at greater or lesser speeds over time. It would be extremely useful in our model (i.e. EED) to be able to gauge the intensity and speed with which the successive epigenetic dynamics appear. Very rapid and turbulent changes in environments such as those that come from shifts in technoscientific paradigms have a considerable impact on business group dynamics (Gómez-Uranga et al. 2013). We think that these related facts are not always dealt with accurately and, in most cases, are not even envisaged in part of the literature that includes some type of biological analogy in its approach. This would be the case of the analysis of organizational routines or other advanced fields such as competitive models. One of our objectives when putting forth the EED concept is to explain situations found in real life and where the changes in the environment are extremely rapid and have a great impact. In this article we aim to contribute to better understanding of these dynamics.

The EED approach is understood as the study of the epigenetic dynamics generated as organizations adapt to major changes in their respective environments (Gómez-Uranga et al. 2014: 178). The concept shows its highest explanatory power in rapidly changing environments, which entail fast organizational moves and/or decisions. Some of the multiple causes of these changes include crises, changes in technoscientific paradigms, regulatory changes, massive acquisitions of intellectual property or other dynamic capabilities, strategic moves by competitors, etc. Insofar as these dynamics are disruptive, they can have economic (e.g. in terms of inefficiency), social, institutional, regulatory and even moral consequences.

Epigenetic dynamics are mainly due to economic rationality, which is also related to better innovation (in Schumpeter's sense of the term). Turbulent environments call for the adaptive capacity to act quickly. Thus, opening up new paths and achieving new objectives will also require participation from external bodies (business organizations or economic spaces) such as rapid actions to acquire and buy assets generated by other groups or in other places.

The chapter is structured as follows. The next section introduces the research gap addressed in the book, namely, how evolutionary economics cannot explain certain dynamics observed in high-velocity environments, and how new findings in biology, particularly those related to epigenetics, can help to bridge this gap. Section 3 provides an illustration of the complexity of the human genome, which serves as a starting point to introduce the concept of epigenetics and the advancement it provides to the understanding of evolution. Section 4 focuses on analysis of the organizational routines, and how these can also be studied through an epigenetic lens. Finally, Sect. 5 introduces the epigenetic economic dynamics (EED) approach, which is the cornerstone of the book, and which will be used to explain the dynamics observed in the Internet ecosystem.

2 Evolutionary Economics and the Research Gap

Since its beginnings, economics, as a scientific discipline, has imported knowledge which developed in other sciences (i.e. physics, ecology, biology, mathematics, etc.). In recent decades, biology has broadened its scope to penetrate a considerable part of the scientific production on economics.

Evolutionary economics finds its roots in a biological analogy, whereby economic systems behave like biological systems. Analogies are here understood as statements "about how objects, persons, or situations are similar in process or relationship to one another" (Van Gundy 1981: 45). The evolutionary approach toward the economy, following the principles of Darwinian theory, considers the changes that take place within economic systems as slow, gradual, and moderate. Thus, evolutionary economics is opposed to neoclassical economics, according to which economic systems are in situations of sustained equilibrium. In contrast, evolutionary economics would be in a state of continuous dynamism, although this dynamic may occur in a slow, gradual and progressive manner.

The main pillar of Darwinian principles centers on inheritance, where mechanisms such as replicas and descent act, and through which information concerning adoption is retained, preserved, transferred or copied over time (Darwin 1859, 1871). The principles of variance, selection and retention are a key part of Darwinian approaches. According to these, organisms would show a slow, moderate and progressive adaptation in response to conditions determined by environmental factors in order to survive, thus adopting different patterns and behaviors (Ansoff and Sullivan 1993). That is to say, adaptation is distinctive for being a slow, progressive and moderate process of evolution. However, as discussed by Gómez-Uranga et al. (2013, 2014), the interpretation of inheritance in an evolutionary classics framework is not the most suitable when trying to understand the evolution of the large Internet industry groups (see

Chapter "Epigenetic Economics Dynamics in the Internet Ecosystem" in this book by Zabala-Iturriagagoitia et al.). Just as human genome sequencing has, unfortunately, not completely explained the origin of modern illnesses, nor have evolutionary methodologies been able to decipher, and even less solve, the problems we encounter when interpreting the dynamics of Internet industry groups, which are the fastest growing on the world economy. Some of the defining characteristics of theories in the field of evolutionary economics are:

- The decisive role of the origins of each group as well as organizations' initial routes and DNA, or the 'first choice theories', which make it possible to explain later the paths they later follow.
- The evolution paths are almost charted, as is the case of: natural paths, the lock-in effect, replication, imitation, transmission of hereditary traits, selection and adaptation through gradual diffusion, etc.

Of the three key principles of Darwinism, variation, inheritance and selection, it is the latter that manages adaptive complexity (Hodgson and Knudsen 2006a, b). The selection principle shows why a group of self-organized units are able to survive by gradually adapting to their environment (Stoelhorst 2008). In business environments, this selection involves: conscious and deliberate choices, competitive pressure, market forces, environmental restrictions; all of which are put into practice through habits, routines, customs, technologies, institutions, regions, economies, etc. (Hodgson and Knudsen 2006a, b; Schubert 2012).

Geels (2014) has analyzed how evolutionary economics, neo-institutional theory and economic sociology conceptualize the co-evolution of firms and their environments, studying mechanisms of selection and adaptation and the tensions between them. In this regard, there has been a debate (particularly in Europe) on the extent to which analogy constructions using inputs from natural selection theory are useful in the evolutionary framework (Witt 2014). On the one hand, we find authors like Hodgson, who has influenced the development of evolutionary economics and evolutionary economic geography, and who introduced the concept of Generalized Darwinism. This concept follows the Darwinian analogy, although from a nondogmatic approach; i.e. with enough flexibility to be extended to various fields of the social sciences and economics. On the other hand, scholars such as Pelikan (2010, 2012) defend the need to transpose all genetic instructions, mechanisms and imprints into the biological analogy. From this latter perspective, the use of analogies would not be valid when concepts such as rules or routines are discussed unless they incorporate a series of precise instructions which could even be transposed into logical algorithms. Accordingly, Witt (2014) concludes that evolutionary economics today represents a patchwork of unconnected approaches. However, for evolutionary economics to be rethought, it first needs to include the general principles of new emerging fields, and then transpose them into concrete logics as suggested by Pelikan. Herstatt and Kalogerakis (2005) consider that analogies are based on surface and structural similarities. While surface similarities describe "the resemblance of target-objects to base-objects… structural similarities exist if relations between elements of the base object are similar to relations between various elements of the target object" (ibid: 333). In this regard, they consider that "the transfer of far analogies happens on a more abstract level than the transfer of near analogies and depends strongly on structural similarities" (ibid). One of these distant fields that might allow us to make an analogy for the purposes of this book is epigenetics.

The changes being perceived at the present time are characterized by their speed, constituting high-velocity markets and high-velocity environments (Eisenhardt and Martin 2000). It is in such environments that a number of dynamics are not being explained by evolutionary principles. As an illustration of the abrupt changes occurring in these high-velocity environments, the book focuses on the dynamics in the Internet ecosystem (Fransman 2014).

The principles that underpin evolutionary economics (i.e. path dependency, lock-in, replication, imitation, transmission of hereditary traits, selection and gradual adaptation) do not help to explain these fast dynamics. Evolutionary economics is thus unable to explain the dynamics observed in the Internet ecosystem (as an example of high-velocity markets) (Basole 2009; Jing and Xiong-Jian 2011). It therefore becomes necessary to redefine the principles of evolutionary economics in order to explain these fast changes that are increasingly occurring in most world economies. Addressing this failure and contributing to advancing the theory of evolutionary economics are the ultimate goals of this book.

This challenge (i.e. research gap) is relevant due to the systemic consequences that these dynamics are having on innovation systems (e.g. patent system, tax regulations, mobility of employees, training, etc.). It is also important to focus on this project at this particular time when the consequences of the previous dynamics are starting to be observed in multiple spheres worldwide (i.e. economic inefficiencies, blockage of competition, barriers to innovation, tax evasion).

As indicated, the book targets the literature on evolutionary economics, aiming to contribute to its further development by providing new parallels from biogenetics. Just as the origins of evolutionary economics go back to a (Darwinian) biological analogy, our positions come from that same starting point. Our reason for also supporting such an analogy is that, although the biological analogy allowed the development of the principles that laid the groundwork for the introduction of a theory on evolutionary economics, it has not been updated. The originality and ambition of the book lie in the fact that this stream of research has not been rethought in view of new findings from different fields within biology such as molecular biology, as discussed earlier, despite the origins of evolutionary economics, which go back to a biological analogy. That is to say, evolutionary economics is still governed by the same biological principles that were known in the 1970s and 1980s. To cover this research gap we will rely on the latest advances in the field of molecular biology, which, in recent years, have introduced the principle of epigenetics.[2]

[2]The biological analogy, following classical Darwinism, has been widespread for several decades. In fact, in the early 1990s some North American economists started a research stream around bioeconomics, from which journals such as the 'Journal of Bioeconomics' or the 'Journal of Evolutionary Economics' emerged. The biological analogy is, for example, dominant in some areas such as economic geography, within the evolutionary realm. Therefore, when introducing epigenetics, we do not require any legitimacy, as we are acting on an area where Darwinian biology has been widespread for decades.

The concept of epigenetics appeared some decades ago (Waddington 1953), but began to gain scientific relevance in the last decade of the 20th century (Francis 2011; Carey 2012). The reason for our focus on epigenetics, as social scientists with a focus on innovation studies, responds first to an inability to explain certain realities. This lack of a satisfactory explanation concerning certain realities is due to the fact that the biological analogy based on orthodox Darwinism is highly deterministic. In it, the gene determines the development of evolution. As stated, we observe that even if many expectations had been raised by the human genome sequencing, there is a certain amount of pessimism, because it has not lived up to the aspirations. And that is where epigenetics comes into the picture.

Epigenetics has shown that the DNA of organisms is not only susceptible to phenomena such as heredity, variety and selection (as derived from the Darwinian-type of biology). Instead, changes in the DNA of organisms can also be derived from (i.e. as a response to) changes in the environment. The environment in which an organism lives would therefore act as a ‘traffic light’ by activating or deactivating the expression of certain genes. Thus, the DNA of two organisms (e.g. twins), which is identical in origin, could evolve into different gene expressions depending on the environment they live in (e.g. whether one of the twins smokes, does sports, has different eating habits, lives in a city with high environmental pollution, experiences long-term unemployment that creates psychological stress, etc.).

Epigenetics allows us to update the previous evolutionary principles, as it is shown to be valid both in stable environments (i.e. slow, gradual and moderate changes) and in high-velocity markets and environments (i.e. fast, abrupt and unforeseen changes). In this book we focus on the latter type of environment. From the epigenetics perspective, we support the idea that adaptation of organisms/companies need not be gradual (Aldrich et al. 2008), and as will be illustrated, is sometimes very fast and even extremely abrupt.

In principle, epigenetics is linked to a different orientation of biology where molecular biology has become one of the dominant fields in recent years and new research fields are being opened up. We acknowledge that our initial point of departure is a heuristic approach. However, we have subsequently been able to create an ad hoc concept (i.e. EED) to explain these emerging realities in the Internet ecosystem. That is, we are able to develop an analytical framework and a methodological approach stemming from an initial conceptual dissatisfaction and which might be appropriate to explain the development and evolution of large business groups on the Internet that are becoming increasingly important and have dominated the world economy since 2004. The fast and intense development of these groups, places them at the forefront worldwide as per both market value and business profits (see Chapter “Epigenetic Economics Dynamics in the Internet Ecosystem” in this book).

The seminal work by Nelson and Winter (1982), provided the basis for the development of a microeconomic theory of organizational routines, based on a genetic analogy and following Darwinian principles. In addition, in recent years we find some approaches that may be close to what we observe in the field of epigenetics, namely, the development of a complexity theory in organizational studies (i.e. management), where organizations are treated as complex adaptive systems, and which present characteristics such as self-organization, interdependence, co-evolution, complexity and chaos (Holland 1998; Pohl 1999). Accordingly, our epigenetic approach is complemented or may be complemented by very different theories either related to the complexity theory or now being developed in other environmental sciences such as ecological systems (Folke et al. 2010).

With the EED approach we aim to identify the evolutionary dynamics of high-velocity environments such as the one found on the Internet. However, the key point of the definition of EED is that the adaptive changes are due to rapidly changing environments. Therefore, the decisions to adapt to these environments must be adjusted to the speed of the changes taking place in them. Some of the multiple causes of these changes, which should be identified, could include economic crises, changes in technoscientific paradigms, regulatory changes, values crises, massive acquisitions of intellectual property or other dynamic capabilities, strategic moves by competitors, etc.

Insofar as these dynamics are disruptive, they can have economic (e.g. in terms of inefficiency), social, institutional, regulatory and even moral consequences. In-depth analysis of these consequences is still needed. So far, in a previous research we have only pointed out some of the potential consequences of these dynamics for the patent system (see Gómez-Uranga et al. 2014). However, analysis of the previous type of consequences also needs to be addressed. An example currently under discussion in the European arena, are the increasing tax engineering practices of the large Internet business groups, which are having an increasingly greater influence in more European countries (Corkery et al. 2015; Heckemeyer et al. 2014; Li 2014). In this regard, the European Union is trying to stop or mitigate these tax engineering practices, which are affecting their respective member states.

In a recent article, Martin and Sunley (2014) intend to build a new framework for evolutionary economic geography. These authors believe that both the seminal work by Nelson and Winter (1982) and the studies by Boschma and Frenken (2006, 2009) see genes as the main replicators of biological information and recognize them as equivalent to business routines. Witt (2008) is of the opinion that the metaphors of conventional Darwinism cannot understand human creativity and learning. In turn, Nelson (2005) differentiates between sociocultural and biological perspectives.

Although the authors cited above do not adhere to some of the postulates proposed by Generalized Darwinism, neither do they reject them completely. From the perspective of the EED, the genome can be modified by changes in the environment (i.e. changes in the environment can lead to gene regulation causing them to express themselves or not), which would mean that there would not be a sole deterministic genetic inheritance. This is not envisaged in Generalized Darwinism. What they do propose is a wider array of concepts through a new methodological space that ideates two complementary research areas: Evolutionary Developmental Biology (EDB) and Developmental Systems Theory (DST).

Developmental Biology is concerned with ontogeny, with "the origin and development of an individual organism through its life span" (Martin and Sunley 2014: 717). One of the seminal works on Developmental Systems Theory (DST) is by Gottlieb (2001), who discusses the developmental systems view or probabilistic epigenesis. Another source is the DST put forth by Lewontin (1982, 1983), who criticizes the "lock and key model" approach in which organisms follow evolution adapted to the predetermined niche for which they were conceived and cannot leave. As we shall see in the following sections, an analogy could be drawn with the deterministic approach of path dependency (Martin 2012b).

The DST "stresses the delicate dependence (contingency) of development on a rich matrix of factors outside the genome" (Griffiths 1996; Griffiths and Gray 2005: 419). Advocates of DST criticize what they call genocentrism and align against those theories that understand evolution as revolving around DNA accompanied by some classic selection mechanisms. The authors place greater importance on factors other than DNA and defend the multiple factors of epigenetic inheritance. The properties of robustness and plasticity are defined in the analytical framework of DST. The first of them could be translated as the capacity to adapt to disturbances while maintaining system-specific functions (Kitano 2004).

Martin and Sunley (2014) use a metaphor for DST, stating that genes should be contextualized, as the environment sets new emerging (genetic) realities. Self-organization and emergence are the core DST properties most highlighted by these authors. As regards self-organization, the system components themselves change as a result of the activities they undertake. Interaction between system components leads them to greater complexity without there being any previous detailed instructions to follow. From our point of view, there are considerable parallels between the properties of emergence (Martin and Sunley 2014), adaptability (Boschma 2015) and plasticity, which we introduced in the previous section, and with successive epigenetic type processes, which form a logical base for our EED model.

On the other hand, the above authors highlight development as an "emergence process." Systems are formed at less-complex interaction levels in these development and emergence processes. The biggest generator of emerging evolutionary innovation is the environment (Oyama et al. 2001; Robert et al. 2001). Emergence is understood as a source of innovation and a dynamic process. New products and new firms in economic development systems can emerge as externalities from spatial agglomeration in the systems (Martin and Sunley 2007). A local cluster might shape a broader field or industry which it joins and then acquire an external reputation, which would in turn influence its own resources and lead to a better market position. Put differently, firms influence the environment and it therefore impacts local firms. Following this logic, path dependency could be understood as a type of emergence similar to the one we observed in some of the examples where we compared the dynamics of certain business groups studied in Gómez-Uranga, et al. (2014).

Evolutionary Developmental Biology (EDB) coincides with DST from another perspective. EDB goes beyond what is called Neo-Darwinist synthetic theory. EDB (dubbed Evo-devo) is based on advances in molecular genetic biology and envisages new genes being created from parts of old ones. It includes the authentic logic of epigenetics, which is gene regulation. It has been shown that evolution alters developmental processes to create new and original structures from the old gene networks. The differences between species are not found so much in the genes as in their expression (i.e. genetic switch).

Both approaches, therefore, coincide on the role of the ecological development context, which includes non-DNA factors and exerts a causal influence on gene expression (Gilbert 2001). That environment is the product of evolution (Griffiths and Gray 2005). This is the exact definition of epigenetics which inspires the concept of EED we use in this text.

EDB also envisages the property of plasticity and shows that phenotypes are not necessarily determined by their genotypes (West-Eberhard 2003). The existing morphological variety is not always reflected in the genome. Epigenetic dynamics are formed as mechanisms for evolutionary innovation.

Complex Adaptive Systems (CAS) focus on the instruments and agents that participate in decision-making in complex situations. In this case, the analytical tools (above all, mathematics) must adjust to nonlinear and nondeterministic processes (Holland 1998) as opposed to rationalism capable of mathematical predictions, operating on a previous order of subsystems which form an integral system in an organized manner.

Complex systems work as a network of different groups that act on identical time coordinates in order for each one to adapt to its environment (e.g., these may be individuals, social agents, firms, governments, etc.) (Pohl 1999). They adapt to their experience in the system and find themselves subject to the laws of natural selection (Holland 1998).

The variety of institutional frameworks that affect a system (rules, routines, habits, etc.), and the interaction between agents indicate its complexity. For several decades, there has been a great deal of literature on national, regional, and local systems where innovation plays a key role (Lundvall 1992; Cooke et al. 1997; etc.). These could also be understood as complex systems.

In this chapter, it is important to point out that the universe of complexity connects as a logical derivative with the property of unpredictability, which coincides with our EED methodological approach. CAS evolution mechanisms are related to low-level interactions between different agents in the system. Control and steering of the systems should focus on a decentralization logic, as opposed to centralization, monopolistic, and/or hierarchical structures. All in all, interaction in networks comprises key properties for systems that are adapting over time, all of which would be analogous to natural selection mechanisms (Pohl 1999). According to our vision, these CAS models (particularly concerning control and leadership) would not serve for adaptation to very dynamic environments.

We find methodological bases in the chaos theory to evaluate some of the areas we are most interested in exploring. For instance, the chaos theory sheds light on decision-making with its vision of how reality flows, seeing it not as exclusively chance occurrence (i.e. probability) but neither as a purely deterministic result. Neoclassical economics imitates classical physics, arguing in favor of stability (negative feedback), whereas the chaos theory envisages change and instability (positive feedback). Positive feedback establishes covariance relationships: when one variable increases, so does the other.

The analogy of the climate (i.e. environmental) is widely used in the social sciences. Organizations and territorial systems have predictable and unpredictable behaviors and it is not possible to discover all the factors affecting them, as sustained by Godel's incompleteness theorem. In contrast to behavior in terms of balance, organizations are out of balance, in situations that lead to change, in other words, to new imbalances and so forth.

We have already raised one of science's key issues, which is "reality." The complexity paradigm revolves, above all, around how we perceive reality rather than reality as objective information. Therefore, fractal geometry is used. Fractals are used to study nonlinear dynamic systems, and are also very useful to study decision-making in uncertain situations, for example, situations that shift very rapidly from stability to severe disturbance.

Decision-making agents are not individual actors. There is a social decision apparatus (Lara 1991) which is, in essence, a group of individuals who have the responsibility of high impact decision-making (for the future of an organization or territory). They should be capable of anticipating the behavior of the environment (Hernández-Martínez 2006).

Time in organizations can be seen from two perspectives: The first is irreversible and the second may be reversible (Etkin and Schvarstein 1995). Strategic decisions center on achieving the organization's medium and long-term objectives. Many of the variables that involve organizations are beyond their control and are therefore closely related to the time required to adapt to the external environment. In contrast, others take the organization's own internal dynamics or those of the actors in the different systems they belong to as their references.

In terms of external time, the response has to be agile to address the competition's actions and possible rapid market developments. In terms of internal time, however, this should not be considered long or short but simply synchronized with the organization's other cycles or those of the system concerned. Time cycles can accordingly be situated in different dimensions. For instance, we would not be in the same time space if we compared a software company, where the pace of technological development forces rapid strategy development, with a higher education institute where the cycles of current scientific knowledge are longer and strategies can therefore cover longer time periods.

Time is a key element in any analysis of adaptation, and thus of evolution. In our analytical framework (i.e. EED), we think a fast competitive response (from an economic viewpoint), and using exclusively the capabilities provided by the internal (or own) organizational/geographic framework would only be possible if the assets obtained through a significant efficient adaptive process were available at that moment, following a certain path dependency. According to our logic, two types of reactions with different characteristics would be observed (Table 1).

We would also like to underscore the differences between organizations' and territories' decision-making in extremely dynamic environments and in other more stable environments. In the first case, decisions should be made in very short time periods to achieve good adaptation and adaptive capacities should therefore be available either internally through possible acquisitions or as the result of cooperation with external agents established beforehand (i.e., not as a reaction to the situation). In rapid adaptation, the most efficient results could be achieved when

Table 1 The timing of adaptation in complex systems

(Radical) adaptation to the environment in the short term	Gradual adaptation over time
Faster and breaking with the past	Slower and extended over time
Relatively short time periods	Longer time periods
Greater previous adaptability	Less adaptability a priori, routinized operations
Adaptive dynamic capabilities	
Top management plays a key role in policy-making	Economic agent systems structured around path dependency
There is indirect influence from a wide variety of agents	The role of stakeholders
Decision-making authority concentrated in few hands	Very diverse agents
Decisions based on simple norms, heuristics, and specific programs	Decisions based on governance over time
Action based on structured information (i.e. reports on the economic environment, above all, competitors), and some actions improvised in a very short time	More formalized (routinized) actions
	Heterogeneous decisions over time
	Previous designs of Porterian clusters

Source Own elaboration

strategic decision-making is more concentrated, which would enable management to base it on simple rules and heuristics (Bingham and Eisenhardt 2011, 2014). A group of actors may influence management/policy makers. However, they do not play a direct role in strategic decision-making. Conversely, in more gradual adaptation processes that are sustained over time (i.e. they occur in stable environments) decision-making can be more routinized. That is to say, it can involve a wide variety of agents that form the system (i.e., complex systems), thus meaning that governance (either at the business or territorial level) is considered to be important. However, in spite of the inherent complexity of these multiagent systems, decisions are normally made by a small group of agents or individuals (e.g., CEOs and managers at the company level, ministers, etc. at the territorial level).

If a gene is not regulated (because the environment does not act on it) time may tend to slow down. In contrast, if the context (the environment) makes it regulate, time could be accelerated (a quicker intervention would be needed over time). That is to say, if certain institutions (routine, habits, rules, etc.) are maintained without the environment inducing an institutional change, time may go more slowly and even stop, until the moment when changes become inevitable because the organization or territory's very existence is being threatened.

Measuring time (objectively) is not the most significant point in our case. For example, the time shown in Fig. 1 that elapses between t_0 and t_1 is the same in both cases. However, the content of the changes from t_0 to t_1 is completely different because there are changes in both the environment and its intrinsic characteristics. We are not as interested in measurable time (t_0 to t_1), which is the same in both cases, but focus on the changes that occur in the environment during that same time interval.

The time elapsed would be the same in the two cases. However, in the second case, the amount and scope of the changes are much greater. In this case, the short, medium, or long terms do not mark measurable time, but the changes that are

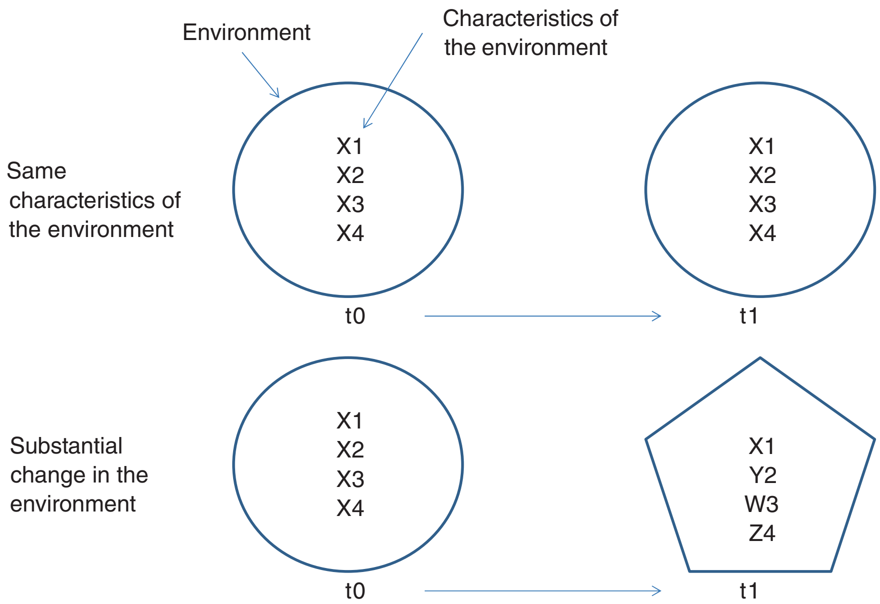

Fig. 1 Time and substantial change in the environment. *Source* Own elaboration

taking place. Therefore, the dynamics would not be studied by measuring time (in normal time units) but by analyzing the changes that occurred. In that case, the responses cannot be dated over time, but would occur according to the intensity and extent of the changes, such as for instance, significant intense changes in the environmental factors. We could calculate what changes in the environment (the arrangement and volume of its factors) call for reactions and also find out what level of reactions.

When we say an environment changes very quickly, we mean that we have a perception, a memory of the changes being faster than at other times when we perceived them to be more normal. For instance, in crises there are dynamics that move much faster than during noncrisis periods. If the pressure of competition from business groups increases, decision makers may have the perception that they are pressed for time and have to react or face changes as quickly as possible and should therefore devote exceptional effort to making time periods shorter. On the contrary, if there were no pressure from the competition, time would seem to pass much more slowly even if the measurable time were the same in both cases.[3]

[3]If, for example, we compared the changes that will occur in Internet industry group environments with the recent past, perhaps we should not talk about very fast changes because the current speed of change has become 'quite normal'.

Complexity can only be compatible with the irreversible (and often unpredictable) nature of processes, and this last concept is in some manner the opposite of resilience understood in a more mechanistic sense, used, as we have seen previously, in certain models of thinking in disciplines such as engineering or economic geography.[4]

Evolutionary approaches point to a trade-off between adaptation and adaptability. Adaptation concerns those changes within preconceived paths (Boschma 2015: 4). In turn, adaptability would respond to dynamic capabilities with multiple potential paths that evolve and place the local economy in a better position to face up to possible unforeseen developments. There would therefore be two different types of resilience, one that shows adaptation of previously existing conditions (new paths, inertia, and weak attachments between the place's social agents, etc.) in the short term. The other would be a response that would have to be formulated in the long term, involving certain breaks from existing conditions (new paths, weak inertia, and weak links between agents).[5]

The following can be cited as authentic examples of different types: system shocks such as natural disasters in certain geographical areas, global economic crises, technologies becoming obsolete, and slow burns or long-term movements such as reindustrialization, modernization, urban renewal, political transformations, etc. (Pike et al. 2010; Pendall et al. 2010; Boschma 2015; Martin 2012a). In our approach (EED), external shocks are not only those resulting from changes in natural environments, or even those macroeconomic problems caused by a crisis. They also come from competition, mergers, and massive patent acquisitions, changes in technological paradigms, changes in demand, etc. which are more similar to the dynamics of business groups (Gómez-Uranga et al. 2014). Long-term strategies call for changes and innovations, institutional changes, as well as strategies to destroy old ones and allow the creation of new paths (Martin and Sunley 2007) to address changes in the environment.

Adaptability is more closely associated with the concept of plasticity (Levinthal and Marino 2013). From our point of view, literature on evolutionary economic geography is taking a mechanistic approach when presenting the concepts of adaptation and adaptability. In our opinion, adaptability is a property that serves to adjust to changes in the environment. However, without adaptability there cannot be adaptation in the short or long term.

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[4]From another perspective, the second law of thermodynamics has one main purpose: Impose a strict world symmetry on the directions of the time axes towards the past and the future (Davies 2002). That is to say, there is asymmetry in both directions, past and future. And the essence of this asymmetry lies in the changes that have taken place. As Davies states (2002: 10) we do not really observe the passage of time, but we are actually observing how the later states of the world differ from earlier states that we still remember. A watch does not really measure the speed with which one event follows another. Therefore, it appears that the flow of time is subjective, not objective (ibid: 11).

[5]Folke et al. (2010) develop a concept of resilience, which we believe has a greater scope than the one used by other authors. In their approach, resilience is formulated as the capacity that a complex 'social ecological system' has to continuously adapt, which is a more reasonable and less 'mechanistic vision than others used for the concept, as they are mainly limited to the field of economic geography.

The more diversified economies are, the more adaptable they will be in the long run, and therefore, the greater their capacity to adapt to new growth paths (Pike et al. 2010; Frenken and Boschma 2007). In this sense, extensive empirical evidence surrounding the concept of related variety concludes that the industrial path (i.e., history) of each territory is key to understanding the new adaptation processes that are going to occur in them (Boschma 2015).

At certain times and in certain situations, particularly in a globalized economy where related varieties are global, industrial activities can also take place outside the region. In other words, this is not only an endogenous approach. If there is an external shock, one fast way to adapt is, for instance, to buy patents, form alliances, mergers, joint ventures, etc. with agents from outside the region. That is to say, the bases needed to establish related variety may not only come from within the territory. In a global economy, we have to consider that related variety is also generated in industries and agents located outside it, which means that we have to resort to industries/agents located beyond the territory. Furthermore, spin-offs stemming from ex novo relationships with other agents such as universities, technology centers, etc. which have very little to do with the territory's history could appear (i.e. unrelated variety). According to Boschma (2015: 9), unrelated variety would guarantee adaptability, while related variety would secure adaptation. Therefore, having both types of variety would make a territory (i.e., an organization) truly resilient.

In biological complexity, variety also means that not everything comes from some initial origins (i.e., such as genes). Total path dependency does not exist as there is a part which stems from the environment. A part of regional development clearly comes from each territory's history, the existing values, its institutions, etc. However, there are activities which lead to dead ends in spite of having a historical base (e.g., appliances in historical industrial regions). Or activities having an ex novo nature take place, which do not come from any previously existing relationship or related activity that may have existed in the region prior to that time.

Geographers such as Pike (2002) base their idea of adaptation on previously existing paths. The focus would be on adapting to major turbulences such as emergencies or disasters. Authors like Teece (2007) believe that ordinary or previously existing capabilities are due to routinized behavior. While geographers view adaptability as a systemic property responding to slow changes taking shape in the long term, Teece's dynamic capabilities are based on changes and adaptation to fast changes in the environment, a view which has also been shared and reinforced by Eisenhardt and Martin (2000).

Environmental changes are the ones that mark time for organizations because they must deploy the most suitable adaptation dynamics. Going one step farther in our argument, in order to put it into practical terms for system agents, it is necessary to know the time (measurable) that would be needed for environmental changes to take place. However, since prediction is impossible, in any case, comparison can be made between the time and/or frequency that they appear with the frequency of other similar changes that we have known or remember. This is what occurs with predictions about scientific progress in the future (e.g., shifts in scientific-technological paradigms). In this way, we could classify them as fast, very fast or slow. It is much more difficult to predict when those changes in the environment will happen than to foresee what the response should be (for example, from organizations) when they occur.

3 Epigenetics Beyond Darwinism: The Complexity of the Genome and (Human) Life, and Importing These Concepts to the Social Sciences

Life is a major source of complexity, and evolution is the process describing the increase in this complexity. In other words, evolution leads to higher complexity, and complexity and emergence are two interrelated processes. As discussed by Corning (2002: 27), "*in evolutionary processes, causation is iterative; effects are also causes. And this is equally true of the synergistic effects produced by emergent systems. In other words, emergence itself… has been the underlying cause of the evolution of emergent phenomena in biological evolution; it is the synergies produced by organized systems that are the key… a change in any one of the parts may affect the synergies produced by the whole, for better or worse. A mutation associated with a particular trait might become "the difference that makes a difference"…, but the parts are interdependent and must ultimately work together as a team. That is the very definition of a biological whole.*"

To introduce the EED approach in greater detail, we need to go back slightly to the state-of-the-art in biology and then move beyond classical and orthodox Darwinism. The most recent results found in molecular biology have shown that genetic structure is highly diverse and complex. As an example, the human genome only contains a small number (approximately 2 % of the total) of modifying genes that encode (transfer the hereditary information/instructions), the proteins. There are also other noncoding genes (RNA) which act on the coding genes as "messengers." In recent years, it has been discovered that RNA also has other functions that have not yet been clearly defined. RNA is known to play a role in regulation, which is carried out jointly with other nongenetic elements (ENCODE Project).[6] There is also another part of coding DNA whose function is still not clearly understood to date.

Some years ago, it was believed that once the human genome was sequenced, it would provide us with a map to decipher/interpret everything that could happen during a person's life. However, this has failed, at least in part. The geneticist and philosopher Ayala (2013) proposed the following analogy with computers to explain life: the information on how to build the computer is also contained in the computer itself. In other words, it needs both parts, hard (to process the information) and soft (the information itself). This metaphor illustrates the complex meaning of life.

[6]See https://www.encodeproject.org/ (last access October 2015).

Gene expression is highly regulated, thus enabling it to develop multiple phenotypes (Masuelli and Marfil 2011) that characterize the different cell types in an organism, thus providing cells with the elasticity to adapt to a changing environment. In other words, genes can be expressed or not expressed in terms of interactions, depending on how these occur with the environments (Lewontin 1982, 1983). Changes in the environment may cause chemical changes that affect certain proteins (histones). Depending on the conditions, they may alter gene expression, activate or deactivate coding genes and their expression (i.e., like a ‘traffic light’). These are called epigenetic processes (Carey 2012).

Waddington coined the term epigenetics in 1953 to refer to the study of interactions between genes and environment that take place in organisms. Epigenetics centers on knowing how, when, and why gene expression is regulated. In developmental genetics, epigenetics refers to the gene regulation mechanisms which do not involve changes in DNA sequences, but are still passed down to other generations (Francis 2011). It mainly focuses on understanding the influence of the environment on genome expression; in other words, changes in gene expression that can also be transmitted and inherited (Canetti 2003). One of the key sources of gene modification is the environment, and it can affect one or several genes which carry out multiple functions (Carey 2012). Epigenetic regulation shows how the plasticity of the genome enables it to adapt to the environment, resulting in the formation of different phenotypes determined by the environment that the organism is exposed to (Cavagnari 2012; García Azkonobieta 2005; Waddington 1947, 1953).

According to Evolutionary Developmental Biology (Evo-Devo), the morphological variety shown in the various “*clodes”,* is not always present in the genome but is also caused *by* mutation-driven changes in gene regulation.[7] Biodiversity is often not brought about by differences in genes but by gene regulation (epigenetic changes) (Carroll 2005).

Epigenetics is understood as changes in gene expression that are transmitted to cell division and sometimes between generations but do not involve changes in the underlying DNA sequence (which was the mainstream belief in twentieth century evolutionary science).[8] The epigenome enables a relatively rapid adaptation to the environment, without the change being recorded in the genome (Weitzman 2011). The phenotype is determined by the activity of many enzymes and their interaction with proteins. Thus, changes in the environment (e.g., temperature, pollution) can lead to changes in the phenotype.

Epigenetics leads to abnormalities and changes in what is programmed or initially encoded. Changes in external conditions determine the different ways habits and routines are expressed. Business routines should go hand in hand with circumstances or features needed for them to be expressed properly. A change or modification in these accompanying features may lead to changes in the normal

[7]The capacity to transmit epigenetic marking between generations translates as chemical changes in the chromatin structure, which may be greatly determined by environmental factors.

[8]See http://www.epigenesys.eu (last access October 2015).

expression of those business routines. For instance, they may be translated as inexplicable behavior or practices (i.e., an illogical result) of the initial information transmitted from generation to generation (i.e., as if they were mutations).

In our conceptual business analogy, evolution is much faster than in biology (Abatecola et al. 2015). Genes mutate or change in much shorter time periods. We run into a different time dimension. The characteristics that identify business groups' genomic instructions evolve over time so that they are sometimes a mere enlargement of previous functions and at other times are more radical changes. However, they always maintain a thread connecting them to the business's initial specialist field.

According to Mortara and Minshall (2011: 591) these "revolutionary changes" are needed in certain industries due to the speed at which changes occur in their high-velocity, turbulent, and unstable environments (Eisenhardt and Martin 2000; Suárez 2014). The dynamics that we refer to as epigenetic cannot be interpreted or foreseen from organizations' initial competences, activities, resources, and routines. Above all, epigenetic dynamics respond to an economic rationality, which is also linked to the development of innovation (in Schumpeter's sense of the term).

In the biology of species, individuals have to behave differently when faced with the need to compete or defend themselves. This synergistic adaptation to the environment may produce a more favorable phenotype (Gilbert and Epel 2009). The complexity of life (particularly human life) cannot be translated or treated merely as genetic code sequencing: the human genome provides necessary information for a coordinated regulated expression of the genetic makeup. The set of "expressed" (i.e., active) proteins (i.e., the proteome) carries out most of the cell functions (e.g., enzymatic, metabolic, and regulating) through an enormous amount of practical networks. These are the cells' structural makeup that forms the tissues and organs of living beings.[9]

Table 2 provides some simple features of epigenetics. The bases of the genome are more complex than expressed in orthodox Darwinisim, as there are some knowledge gaps concerning the exact functions of the different elements that make up the genetic structure (e.g. RNA, nongenic bases, genetic garbage, etc.). In recent years, it has been observed that these parts, which did not a priori play a role in bringing such information to proteins for the development of life, play a more important role than previously expected. Our main point of interest lies in classic selection processes. It is here that we find the part of both biology and genetics that expresses the gradual and moderate adaptation of species, which adapt to changes that could lead them to become more efficient. These changes may contribute to the genetic heritage, together with the acquired characteristics, mainly in stable environments. In turn, epigenetic processes occur through changes in unstable or turbulent environments. The EED approach is highly suited to explain the adaptation to the latter type of contexts, where the contribution to the genetic heritage would occur together with the acquired characteristics as a result of these adaptation processes to very rapidly changing environments.

Another property of epigenetics that must be taken into account before we move forward to conceptualize our EED approach is the underlying uncertainty about the

[9]In this sense, human cells resort to splicing, producing several proteins with very different functions from the same gene (ENCODE Project).

Table 2 Some features necessary to understanding epigenetic dynamics

Bases of the genome	Phenotype and epigenome	Results
Complexity	Classic selection processes through gradual moderate adaptation	Contribution from genetic inheritance jointly with features acquired as a result of (gradual) adaptive processes to (stable) environments
	An epigenetic process through rapid changes to adapt to turbulent environments	Contribution from genetic inheritance jointly with features acquired as a result of (rapid) adaptive processes to (unstable) environments
Different RNA functions		Human influence in epigenetic changes themselves
Knowledge gap concerning the precise functions of the different elements that make up the genetic structure (RNA, nongenetic, etc.)		Uncertainty concerning the results of the processes

Sources Own elaboration

results of these processes. When we draw the analogy to bring the concept of epigenetics into the study of the dynamics of Internet business groups, the main feature is the inability to forecast the possible or potential dynamics that will characterize the evolution of these groups (see Chapter "Epigenetic Economics Dynamics in the Internet Ecosystem"). Our goal is to find an analytic framework that allows us to better understand that these epigenetic dynamics are not marginal, but rather voluntarily sought and thus, are due to the economic rationality of these business groups, which is evidenced by the new paths, activities, and industries they move into, following different strategies. However, given the fact that the prognosis of their evolution is very difficult, it is possible to refer to this industry as a highly uncertain environment.

Going back to orthodox Darwinism, many authors have imported Darwinian principles of biology to fields and methodologies in the social sciences such as evolutionary economics or evolutionary economic geography (Breslin 2011; Aldrich et al. 2008; Boschma and Martin 2007, 2010; Essletzbichler and Rigby 2010; Hodgson and Knudsen 2004, 2006a, b, 2012; Pelikan 2010, 2012). Hodgson (1993, 2009, 2010, 2012), who has been influential in fields such as evolutionary economics or evolutionary geography, can particularly be cited as one of the authors who most centered on transferring these principles from biology to the social sciences. Hodgson, in line with other scholars, introduced a more flexible approach than orthodox Darwinism and called it Generalized Darwinism (Mayr 1988, 1991; Aldrich et al. 2008; Hodgson and Knudsen 2006a, b, 2012; Levit et al. 2011), which takes a non-dogmatic approach to the Darwinian analogy (i.e., namely, with enough flexibility to be extended to various fields of the social sciences and economics).[10]

[10]"Given that the entities and processes involved are very different; these common principles will be highly abstract particular domain. For example…, we can generalize principles that apply to all the phenomena, despite major differences in their features. In biology and in the social sciences, the phenomena are so complex that scientists supplement general principles by many more auxiliary and particularistic explanations, thus differentiating these sciences from physics" (Aldrich et al. 2008: 580).

We agree with part of Aldrich et al.'s (2008: 578) arguments in defense of this concept when they observe that the principle of selection "could help explain survival not only for individuals, but also of groups, customs, nations, business firms and other social institutions."

> There must be an explanation for how useful information concerning solutions to particular adaptive problems is retained and passed on. This requirement follows directly from our assumptions concerning the broad nature of complex population systems, wherein there must be some mechanism by which adaptive solutions are copied and passed on. In biology, these mechanisms often involve genes and DNA. In social evolution, we may include the replication of habits, customs, rules and routines, all of which may carry solutions to adaptive problems (Aldrich et al. 2008: 584).

However, from our point of view, proponents of Generalized Darwinism encounter a number of difficulties to adapt this approach to a relevant share of the changes that occur more and more rapidly, particularly in times of crisis, and which are becoming more important and having bigger impacts on a number of dimensions (i.e. social, technological, economic, institutional, moral, etc.). The central argument in Generalized Darwinism continues to be based on a phenotypic selection, and therefore differs only slightly from an orthodox conception of Darwinism.

Darwinism considers that organisms gradually adapt in response to conditions determined by environmental factors. This interpretation of inheritance followed by the classical evolutionary framework is not the most suitable when trying to understand the evolution of large Internet industry groups, which are characterized by their sudden and radical dynamics (Deighton and Kornfeld 2013).

For Hodgson and Knudsen (2012), replicators are the basis for genetic inheritance and are specifically found in processes such as the transfer of rules, norms, and business routines. The authors distinguish between replicators and interactors.[11] From our perspective, the epigenetic analogy could go farther if we consider that the initial bases which are to be replicated can be expressed in different ways (Gillham 2001). In other words, this would not be a selection or adaptation process of the immutable inherited base in its strictest sense, as is understood in the most widely accepted and frequent interpretations in biology.

As they advanced in their studies, Hodgson and Knudsen proposed understanding Lamarckism "as the inheritance of acquired characters" (2012: 14) when identifying the social replicators (genotypes) and social interactors (phenotypes). The same authors went on to state that "*in order to consider and understand the possibility of Lamarckian inheritance we must first identify the replicators and interactors in the social domain. We must then consider that the acquired character of an interactor can affect its replicators… Further examples of social replicators include routines, by which we refer to dispositions within organizations to carry out sequences of actions. Routines are hosted by organizations as their interactors, and in turn are built on the habits of the individuals involved*" (ibid: 16).

[11]The main controversy between Hodgson and Knudsen (2012), Pelikan (2010, 2012) and Levit et al. (2011) centers on the role that replicators play in evolution.

We believe Lamarck's approach still proves useful as a means to go beyond the orthodox lock-in. Hodgson and Knudsen's contributions when searching for a type of Lamarckism that could be useful in the social field are also interesting. However, in view of what we are observing in this book, we think it is logical to follow a more direct path. In order to do so, we make use of current contributions from the sciences: genomics, proteomics, etc. Moreover, we focus on a more flexible concept of organizational routines than what we find in today's literature on management.

4 Routines: Complexity and Adaptation

In our methodological approach, routines or replicators are flexible and complex. We observe an analogy with the latest findings from molecular biology which we mentioned in the previous section. Certain routines are replicated and others are not. Instructions can be transmitted exactly as they are formulated while others disappear and give way to new ones. Transmission is neither simple nor automatic and, on certain occasions, elements that are not in the body of instructions are transmitted.

Recent studies on routines, in the field of phenotypes, deal with the mechanics of change in the internal and external routines of organizations to enable them to adapt to rapid changes in the environment. Changes in routines, as well as the plasticity needed to readjust routines on a permanent basis, depend on the capacity to reconstruct and reorganize resources and competences (in Teece's terms) to adapt to new demands in the environment. So, the results of changes in routines are evidenced in the dynamics of organizations (EED in our methodological approach).

One model that reframes the dynamic capabilities approach is that provided by Eisenhardt and Martin (2000), built on the resource-based view of the firm. The purpose of their model is to know how an organization's competitive edge can be maintained over time. The authors distinguish between two types of environments: moderately dynamic markets and high-velocity markets.[12] In this sense, moderately dynamic markets would be those distinctive for their stability, analytically detailed routines and predictable results, while high-velocity markets would be characterized by ambiguous structures, blurred boundaries where routines are linked to newly created knowledge and unpredictable results. It is the latter type of environment that we find most interesting from our approach. It is important to note the emphasis that

[12]The resource-based view of the firm "is enhanced by blending its usual path dependent strategic logic of leverage with a path-breaking strategic logic of change. [It] encounters a boundary condition in high velocity markets where the duration of competitiveness and advantage is inherently unpredictable, and dynamic capabilities are themselves unstable. Here the strategic imperative is not leverage but change" (Eisenhardt and Martin 2000: 1105).

Eisenhardt and Martin place on the velocity and/or rhythm of the changes. The dynamism of the environment is distinctive for the following properties (Davis et al. 2009):

- Velocity: The velocity at which new opportunities emerge (similar to epigenetic dynamics in our model).
- Complexity: The number of characteristics of an opportunity that must be correctly executed to better adapt to the environment
- Ambiguity: The degree of difficulty involved in distinguishing opportunities.
- Unpredictability: This would represent the amount of disorder in the flow of opportunities, which are less consistent with a previous framework.

Teece et al. (1997) introduce the concept of dynamic capabilities, defined as those which determine the firm's ability to integrate, build, and reconfigure internal and external resources/competences to address, and possibly shape, rapidly changing business environments. The analytical framework provided by the concept of EED seems to be a good fit with these authors' proposals. First, Teece (2007, 2010, 2012) recognizes changes in the initial routines, which in our EED model coincide with changes in the epigenome (i.e., initial routines of organizations). Second, Teece believes that changes in routines can and should be made in interaction with other external agents rather than exclusively as a result of an organization's own dynamic capabilities. Hence, Teece's dynamic capabilities acknowledge that the only way to adapt is through relationships with external agents from the environment (e.g., mergers and acquisitions, patent acquisitions, etc.). Finally, it is also important to underline the plasticity or adaptability property (Levinthal and Marino 2013), both in our model as well as in Teece's dynamic capabilities.

We find interesting that our methodological approach (i.e. EED) is close to what is defined as flexible and complex routines in the literature on strategic management. On the one hand, it strengthens our concept as it is similar in certain ways to said authors' development of dynamic routines. That is to say, it can be affirmed that a certain confluence is reached from different sources. Dynamic capabilities are initially related to EED insofar as there are routines that are inherited, replicated, and would fit with the most orthodox Darwinism although others would not. In other words, we can state that when studying genetics from the point of view of biology, there is a part of what would be the genome that is transmitted, although there are others that would form part of what we would call intense gene regulation which is envisaged in the EED methodology. Therefore, transmission is not so simple and mechanical, and elements that are not found in the body of instructions are sometimes transmitted. There was debate on this topic, above all in Europe. Hodgson (2010) and Pelikan (2010, 2012) took part and it was Pelikan's stricter approach which contended that, routines or instructions should be very clear from the point of view of genes, and even capable of being included in logical algorithms for it to be a valid analogy. Scholars such as Pelikan (2012) argue for the need to transpose all genetic instructions, mechanisms, and imprints into the biological analogy. Therefore, when neo-institutionalist actors talk about rules, for example, and others refer to routines, the analogy would not be valid if those rules or routines did not include a series of precise instructions.

As we discussed in the introduction to this chapter, three related points of attention could be cited as where the analyses concerning organizations' adaptation to changing environments should focus: the mechanics of change in routines; the necessary capabilities that organizations require; and the resulting dynamics observed in them. The EED approach also looks to analyze how the results of the dynamics followed by organizations impact the various systems (economic, social, etc.). This section will review the routines models that follow an evolutionary approach.

Table 3 provides an illustration of current authors' views on routines through the lens of the EED approach. Khalil (2012) points out a conceptual difference between instincts and routines, the first of which are abstract while routines are specific detailed remakes of abstract propositions written into instincts, which are practically unchanging. This dual concept addresses a biological interpretation made between genes and the environment (genotype/phenotype). Instincts have a very low degree of adaptive flexibility while this is relatively high for routines. In this analytical framework, routines would normally be in a state of adaptive variability and it could be inferred that "behavior ossifies in routines when the conditions in the environment continue to be stable" (Jablonka and Lamb 2005: 43).

Routines as adaptation to the environment will be of key interest in this study.[13] We also find the criteria used in Khalil's model interesting: economic rationality to assess adaptation of routines. The idea that agents are willing to reassess their routines on a permanent basis, which means that phenotype plasticity is not merely determined by genes, is also a relevant point in our opinion. However, we believe that plasticity must be very high to adapt to drastic changes in the environment.

If we take key developments in modern biology as a reference, it would then be possible to distinguish the coding genes which transmit (inherit) without changes from those which vary or are regulated. In this analytical framework, a conceptual separation between routines and the other hereditary and transmissible part without changes does not allow us to draw an analogy between instincts and genomes. Nor can instincts be called initial routines because they correspond solely to the part of the genome that is transmitted but not to the entire genome. In our view, the separation raised between instincts and routines reduces the operability and plausibility of Khalil's model. The difference between ostensive and performative routines (Pentland and Feldman 2005) may prove to be very useful.[14] At times, however, routines come from outside the organizations themselves and are put into practice in very short time periods. These "incorporated routines" may be very different from those observed in the organization itself and are carried out by different players. Agents' and organizations' actions and results do not always come from ostensive or performative routines; nor do they take shape as the same artifacts.

[13]We have seen that the epigenome is subject to the influence of the environment. Epigenetic inheritance is related to phenotype plasticity, which supports a Lamarckian interpretation (Jablonka and Lamb 2005).

[14]The concepts of ostensive and performative routines are defined in Table 3.

Table 3 Summary of views on routines seen from the EED perspective

Authors	Distinctive aspects of routines	Remarks from an EED perspective
Teece et al. (1997)	Introduce the concept of dynamic capabilities, defined as those which "determine the firm's ability to integrate, build and reconfigure internal and external resources/competences to address, and possibly shape, rapidly changing business environments"	The analytical framework provided by the concept of EED seems to be a good fit with these authors' proposals
Eisenhardt and Martin (2000)	Distinguish between: – moderately dynamic markets (characterized by stability, analytically detailed routines and predictable results) – high-velocity markets (characterized by ambiguous structures, blurred boundaries where routines are linked to newly created knowledge and unpredictable results)	They broaden the dynamic capabilities model
		High-velocity market environments are very similar to our understanding of changes in the environment
Zahra and George (2002)	Absorptive capacity defined as a set of organizational routines	The authors gave a positive response to our remarks on Massini et al. (2005)
Feldman and Pentland (2003)	They understand routines as permanent changes in systems	The most relevant point seems to be the study of significant changes in organizations such as: their products, business scope and model, strategic decisions (including purchasing other firms' assets), etc.
	The tasks to be carried out are analyzed with precision	
Pentland and Feldman (2005)	They distinguish between: – Ostensive routines (abstract cognitive regularities to guide the actions of routines) – Performative routines (specific persons' actions at certain times – Artifacts (actions materialize as norms, written documents, procedures, algorithms, etc.)	Routines are sometimes brought in from external sources
Massini et al. (2005)	Two meanings: inherited genetic material and external routines	External purchase of knowledge assets and joint ventures should also be considered
	They adapt to and learn from stakeholders and the external context	
Khalil (2012)	Routines classified as: – Instincts (written, unchanging instructions) – Routines (permanent remakes of instructions, plasticity)	The complexity of the genome is not taken into account
Levinthal and Marino (2013)	They introduce plasticity, which links changes to phenotypes	Not all adaptation practices translate as improved evolution (result of the best practices)
	The higher this is, the lower the replication capacity	
	The concepts of mutation and phenotype are separated	

Source Own elaboration

Another view complementary to Khalil's (2012) would be the one put forth by Massini et al. (2005) on the double perspective of routines: as inherited genetic material on the one hand and based on a permanent modification of routines over time to address unforeseen changes in the environment on the other. This adaptation rests mainly on external or meta routines in which each organization takes advantage of external experiences to increase its own level of cognition, learning from stakeholders (partners, suppliers, clients, etc.). In other words, external learning is combined with internal learning dynamics. From a Lamarckian view, the authors link internal absorptive capacity to investment in R&D and to the interrelation between external routines and the context of national innovation systems.

From our point of view, capturing external knowledge would often have to be rounded off with possible acquisition of assets found in other firms. This would be the case of assets linked to intellectual property and, at times, they might also be acquired by purchasing or entering into joint ventures with other firms. These strategic actions we have mentioned, and all external strategic moves, are related to internal learning. Thus, when agents act within their own organizations, they learn from the new concepts brought in from the outside in order to adapt to changes. Networking with technicians, engineers, and managers from other organizations that have been taken over or incorporated are important in these cases.[15]

Zahra and George (2002: 186) define absorptive capacity as "a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability." As Pentland et al. (2012: 1489) note, "if the routines display inertia, absorptive capacity will be low, learning will be low, and the capabilities of the organization may not be particularly dynamic." Pentland and Feldman (2008), acknowledge that routines are nonfixed generative systems. They are varied and undergo change on a permanent basis. Their model is functional and can be used for precise analysis of routines in actual practice.

However, an EED approach would not focus on precise knowledge of what each employee does, the workload or content as each task is carried out or the specific programs or formats formed by these tasks or results (artifacts). Our view centers on finding out the changes in organizations, in the products or services offered, in the field or market segments they enter, the range of necessary qualifications, the business scopes, the strategic assets needed and what makes them up (including those related to intellectual property) and the key strategic decisions made (including purchase/sale of assets and/or other firms).

Levinthal and Marino (2013) believe that selection is determined by adaptation, which is linked to learning and that the concept of routines emphasizes replication, as is clearly shown in Nelson and Winter's (1982) work. We find the importance placed on the concept of plasticity in the article by Levinthal et al. to be especially interesting: the higher the plasticity, the lower the replication capacity, which would weaken

[15]These perspectives have often been approached from the literature on open innovation (Chesbrough 2003; Huizingh 2011; Mortara and Minshall 2011; Van de Brande et al. 2009).

the stability property of the routines. On the contrary, without plasticity, organizations would not have the possibility to change and transform their resources to anticipate changes in circumstances (Teece et al. 1997). It can thus be said that the highest effectiveness in phenotype changes would be linked to plasticity. Levinthal and Marino (2013) propose some examples of adaptive internal selection such as policies to disseminate good practice and successful experiences which can be extended to other organizations.

In Levinthal et al.'s opinion, selection would, on the one hand, preserve the results of the best practices, while on the other, it would reject or suppress others which are found to be worse. From the viewpoint of EED, not all adaptive practices are due to evolutionary improvement. The results or consequences of epigenetic dynamics are more likely to be regressive and/or inefficient for the economic system in many cases. These dynamics can also clash with certain values or beliefs. Modulating beliefs and values would be analogous to silencing some genes, which would mean that a dynamic institutional/cultural framework in which certain values or beliefs disappear, giving way to new ones, could lead to the development of new epigenetic dynamics.

Lastly, as in the case of EED, Levinthal and Marino (2013) set up a clear methodological separation between mutation and phenotype. However, the latter is set within a slow adaptive process. Our model, nevertheless, places more emphasis on adaptive processes that may be fast and abrupt, but which would not be mutations in the strictest sense because epigenetic logic is very different from that of genetic mutation. In other words, these would not be failures in some gene that mutates, such as changes that occur in regulation of the genes themselves, and would therefore not be a strictly casual mutation.

Our approach identifies more closely with Teece et al.'s (1997) concept of dynamic capacities, which are defined as "higher level competences that determine the firm's ability to integrate, build, and reconfigure internal and external resources/competences to address, and possibly shape, rapidly changing business environments" (Teece 2007, 2010, 2012: 1). Teece distinguishes between what would actually be organizations' (group) and individuals' routinized behavior, and those dynamic capabilities that fall outside standardized analyses that search for the optimum situation. Teece identifies ordinary capabilities with routines that are a result of repetitive paths over time, which are embedded in organizations and employees and would be imprinted in the algorithms and heuristics of how businesses carry out and develop their everyday activities.

However, dynamic capabilities include changes and adaptation, often creating "fast moving competitive environments that require continuously modifying, and, if necessary, completely revamping what is doing so as to maintain a good fit with (and sometimes transform) the ecosystem that the enterprise occupies" (Teece 2012: 3). Business groups generate a specific framework of dynamic capabilities and competences which enables them to achieve a competitive edge over other groups in the face of rapid changes in the firms' environment. These may have to do with technology, access to markets, expectations and the competition's conditions, etc. These adaptations to the environment require renewing, rebuilding, and reconfiguring both the firm's internal and external competences. Management's coordination of firms' internal and external activities plays a key role. Learning processes are not exclusively generated internally but also occur in the framework of interorganizational relationships (Teece et al. 1997).

In Teece's words, "although some elements of dynamic capabilities may be embedded in the organization, the capability for evaluating and prescribing changes to asset configuration (both within and external to the organization) rests on the shoulders of top management" (Teece 2012: 4), which means that dynamic capabilities would preferably be found at high management levels. Top management is thus associated with the capacity to face the challenges stemming from changes or lack of adaptation to highly variable environments. When studying Internet industry groups, one of the most remarkable references besides their top management are the exceptional individuals that represent the firm's brand.

Although our approach is mainly limited to organizational routines, we do think our view could be broadened to consider what Pelikan (2010, 2012) put forth, which was that institutional norms, in North's terms (1990), may be equivalent to instructions. This new institutional orientation and North's ideas have a sociohistoric nature and are less appropriate for studying business organizations. From this perspective, analyses in terms of norms may be enriched when highlighting the change in institutional norms over relatively short time periods. It would make less sense to include the concept of learning on these coordinates of changes in norms whereas it is easier to see the concept of self-organization.

5 Introducing the EED Approach

In our opinion, epigenetic models may prove to be very useful when explaining the evolution of big Internet and telephone industry groups (Gómez-Uranga et al. 2013). However, the epigenetic analogy we use will not center on finding exhaustive precise parallels with the studies being carried out in biochemistry and genetics. We will focus solely on searching for relatively simple equivalencies that give a rough idea of the work being done on epigenetics in applied biology to ensure that we are using valid realistic analogies.

Epigenetics prompts the appearance of abnormalities or changes in what is programmed or initially encoded. In society, habits and routines are expressed in different ways, according to changes in external conditions. Change or modification of the aspects that accompany them may lead to changes in the normal expression of those business routines.

One of the properties that must be understood to conceptualize epigenetics is the uncertainty about the results of adaptation processes. When the analogy to "translate" the concept of epigenetics into the study of the dynamics in the Internet ecosystem is made, the main feature is the inability to make predictions about the potential dynamics that will characterize the evolution of the main Internet industry groups. That is why we can talk about highly uncertain environments.

The three-stage methodology proposed by the EED approach is as in Fig. 2.

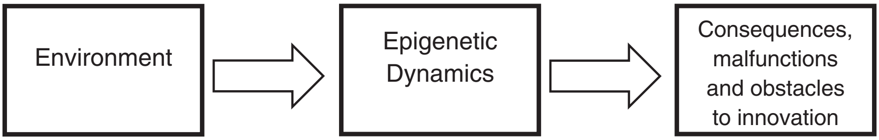

Fig. 2 The epigenetic economic dynamics (EED) approach. *Source* Own elaboration

5.1 Analysis of the Environment and Identification of the Genomic Instructions Which Are Transmitted Over Time

Methodologically, our point of departure is genetics. Thus, we look to identify the initial routines (i.e., the DNA) for each of the business groups included in our study. The first innovative products that are most closely identified with the business groups' initial activities would be those forming the essence of each company (i.e., most distinctive products) from its beginnings (e.g. Google's search engine, Microsoft's operating system, Apple's Mac, software, design and mobile phones, the possibility of downloading e-books in the case of Amazon and the social network concept developed by Facebook), and which made some of them market leaders. Their genome would also contain information about the routines and operating principles that would form their genetic footprint, such as: application of knowledge and technologies to enhance their value, market subordination, knowledge property management, separate assets (patents, brands, designs, copyrights, secrets, leadership), competition principles, profit goals, business models (e.g. free services, advertising, design), etc. These characteristics are assumed to be located in the DNA of these organisms or individual agents and are transmitted over time (similar to genes).

Business organizations' environments are exposed to great changes such as: developments in technologies[16]; fast-moving globalization, which implies considerable changes in business ecosystems (suppliers, customers, mergers and takeovers between groups, etc.) as well as power concentrated in the hands of big investors and higher competition between business organizations. Lastly, business models quickly become obsolete and product life cycles are increasingly shorter.

We will now focus on analyzing environmental influences such as: the evolution of the competition, evolution of technologies, changes in cultural patterns, etc. which affect each business group, institution, or agent and may lead to shifts in their initial routines. In this phase of epigenetic development, during which the relationship of the genotype is no longer a determining factor, conditions are created which may later lead to complications for the system and even extremely negative dynamics and dysfunctions in the companies themselves, affecting users and customers (Schubert 2012). As a result of the influence, introduction or addition

[16]Disruptive innovations place rapid limitations on what organizations are doing and how they usually carry out their activities (Gómez-Uranga et al. 2013).

of epigenetic factors, abnormalities and dysfunctions that stop innovation and/or block development of competition at different levels (intellectual property rights, abuse of monopoly power, etc.) may arise.

These business groups face an environment with the following characteristics: intense increase in intergroup competition, exponential growth of the markets and users in other (related) business areas, a high demand for innovation, increase in the number of applications and their content, fast multivectorial technological change and rapid planned obsolescence (Miao 2011), modularity in the behavior of business ecosystems, higher advertising and marketing expenses, and an exponential increase in the patent portfolio. The rapidly growing number of users puts such pressure on the demand that it leads to major changes in the dynamics of the environment, prompting growth and thousands of new user applications. Above all, the entire process is occurring extremely fast. The previous actions are due to the high variability of these big groups' environments. The drastic rapid changes in the environments and the high-velocity markets in which they operate, such as those that come from shifts in science and technology paradigms, have a considerable impact on the dynamics of these business groups (Eisenhardt and Martin 2000; Wirtz et al. 2007). These environments are undergoing extraordinarily fast changes in the fields of technologies, business logic, intensified intergroup competition, ways to access knowledge on a patents scene characterized by saturation and litigation, and above all, dramatic growth in user demands for existing products and services on different platforms.[17]

5.2 Identification of Epigenetic Dynamics

This second stage focuses on analyzing the changes observed in the business ecosystem in response to influences from the environment. Some examples would be evolution of the competition and technologies, changes in cultural patterns, etc. that influence each business group, institution, or agent and can induce change, variation, or add functions to their corresponding DNAs.

As mentioned before, business groups are conditioned by their environment, as a result of which "genetic disorders" may be created. These changes resulting from the environment where the business groups operate build new paths that become part of their new identity. Previous identities are modified as these new ones are transmitted or replicated over time (David 1985, 1994). However, these changes occur abruptly rather than gradually, as if they were mutations. It is worth noting that these mutations (like learning) are deliberate. In other words, they do not happen by chance as we might deduce from the Darwinism that has dominated evolutionary thought to the present time.

[17]We consider that alternative approaches such as that introduced by Geels (2002) on technological and sustainability transitions could also be compatible with the EED, in particular when addressing the analysis of the changes in the environment.

What we find most enlightening in our analysis is epigenetic dynamics as a response to changes in the environment. Put differently, how organizations adapt and what dynamics they adapt to. At this point, we find this adaptation has some core factors, for instance, these business groups' purchases and acquisitions (see Chapter "Epigenetic Economics Dynamics in the Internet Ecosystem"). Some of these groups' frenetic dynamics are revolutionizing the entire Internet industry. In this section, we offer some examples and, in a certain manner, highlight the big differences that exist when establishing more or less acceptable competition because the power of these groups is somehow so dominant (economically and financially) that it practically wipes competitors (and even potential competitors) off the map.

Epigenetic dynamics follow an economic rationality, which means that these groups need (as a result of the changes which have occurred in their environments) to sustain profit growth. Among other reasons, this is to meet their investors' demands for profitability and justify their investments. At the same time, these groups need to obtain significant results in innovative terms. Improved innovation makes them more successful when competing in these disruptive environments. Schumpeter's dialectics of entrepreneur/innovator are perfectly applicable and hence give meaning to these epigenetic dynamics.

In order to adapt to this environment, business groups sometimes have to acquire external knowledge since they cannot find it in-house (Mortara and Minshall 2011). This external knowledge very often needs to be supplemented with the acquisition of other firms' assets (i.e. patents, acquisition of companies, joint venture agreements, etc.). As a matter of fact, the acquisitions made by Facebook between 2005 and 2014 totalled more than 23 billion USD, some of them being particularly noteworthy, like Instagram (1 billion USD), Whatsapp (19 billion USD), or Oculus (2 billion). In the case of Google, the number of acquisitions between 2003 and 2014 rose to 153, representing a total investment of 137,000,000 billion USD. Therefore, the financial surplus of business groups is essential to acquire knowledge which is not available internally and allow them to adapt to the environment and compete in it.

The epigenetic framework which is gradually designed for each organization or agent also affects how it works and the result of its main function (i.e. DNA). However, veering from the path marked by the DNA is not so simple, and carries a price. At the time, Microsoft did not consider it a good business move to penetrate the search engine segment so its first efforts on the Internet centered on browsers, firstly competing against Netscape and later against Mozilla (Cleland and Brodsky 2011; Suárez Sánchez-Ocaña 2012). Later, in a 'natural evolution' framework, Google absorbed other thematic search engine companies such as Aardvark, Metawen, Plinkart, ITA, Like.com, etc. This prompted new dynamics and evolution in these agents, leaving new fingerprints that are transmitted over time. These epigenetic dynamics are perceived as an institution which lasts for a long period of time. A case in point is Google. The group works in many different fields other than search engines, but will always be identified with that main function, which is in its DNA. However, the means through which they are passed on are not so easy to identify as DNA.

Iansiti and Richards (2006) draw an analogy between competition and evolution of the species in the sense that some animal species 'run a race' to adapt in their evolution (Dawkins 1976, 1982, 1983). This enables them to defend themselves from their predators to avoid their extinction as a species. From an evolutionary perspective, for the large Internet industry groups competition means permanently resizing and readapting to maintain an identity, a place on the market which may sometimes be the leading position, and which requires strategies to take over and merge with other groups. We could say that these business groups' genome contains the need to compete in order to maintain their leadership, but also to survive (as a group).

Some of the characteristics of these epigenetic dynamics include: massive acquisition of small firms and/or their intellectual property (i.e., patent portfolio) to block potential structural changes and to defend themselves from competition; aggressive acquisition strategies to sustain profit growth, presence on global markets and gain access to new technologies and innovations; asymmetric negotiations between large business groups, application developers and content providers; entry of large business groups in activities not related to their original purpose (DNA); high-entry barriers posed by large incumbents; and financial strength as the main protective industrial instrument.

5.3 Consequences (in Terms of Innovation) as a Result of Epigenetic Factors

The third stage leads to conclusions about the abnormalities, malfunctions, or obstacles to innovation, and/or blockage of the competition's development at certain levels (intellectual property rights, abuse of monopoly power, etc.) that are observed in the ecosystem and which may arise as a result of the influence, introduction, or addition of epigenetic factors. Some of the implications or consequences of the previous epigenetic dynamics include: existence of a gap between R&D investments and patenting results; distorted patenting rationale; excessive transaction (and litigation) costs; high-entry barriers to SME patenting; problems in standards definition and development; overload in patent offices and regulating agencies due to the existing patenting inflation.

Patents are one of the strongest environmental properties of the Internet ecosystem. The field of patents shows just how fierce the competition is. Lawsuits for patent infringement or violation are quite common (Cunningham 2011). Companies sometimes seriously alter competition through their lawsuits, filing claims to stop the sale of their rivals' products. In theory, patents ensure progress and technology advances. In practice, they have become a battlefield for cross-claims which questions one of the key objectives of patents systems. Patents are now being used to hinder competitors' growth (The Antitrust Bulletin 2005). The meaning of patents has changed: they used to be the result of innovation and companies could pay for the use of license rights, but now they seek exclusive rights so as to include them in their ecosystems and thus hinder rivals companies' growth (i.e., blocking the potential innovation capacity of competitors rather than creating the necessary incentives to innovate).

For the main Internet business groups, patents are a source of big expense, especially as regards human resources. Keeping up a patent and license portfolio through litigation involves huge expenses. Armies of engineers and lawyers spend more time working on patents than on what is strictly R&D. Furthermore, in an Internet economy, increasingly larger proportions of revenues must be devoted to R&D to confront stiff competition. In addition to these huge expenses, litigation acts as a disincentive for innovators.

It is also important to take into account the impact caused by inefficiencies in the patent system as per the high price of the end product/service as well as higher transaction costs resulting from patenting expenses and related lawsuits (Encaoua and Madiès 2012). This inefficiency implies that products/services take longer to reach the market because of the time involved in patenting and the lawsuits which may result. Bessen and Meurer (2008) state that the intellectual property rights system has failed as a form of protection and information for companies in the USA. Lawsuits for infringement of intellectual property could even be affecting the share price of different business groups. Although the situation of patents and incentives for innovation varies according to the industry, software patents are very abstract and poorly defined. This makes it much more complicated to achieve reasonably efficient market contracts (Bessen and Meurer 2008, 2012). Therefore, we could say that market failure is due to poorly defined property rights. All of these issues lead us to ask if patents systems can no longer fulfill their primary objectives.

Efficient patent policy enables companies to compete in better conditions. Thus, the need for antitrust and competition oversight bodies, or the Department of Justice in the USA and the European Commissioner for Competition to act. The Department of Justice itself brought out a guide focused on a flexible approach to the most common problems in June 2011 (Department of Justice 2012). Possible remedies include mandatory licensing on fair and legal terms, acting to stop retaliation from merged firms and also banning certain contracting practices (Fischer and Henkel 2012; Knable Gotts and Sher 2012; Turner 2011).

Sharp growth in the number of patent applications, as well as their voluminosity (size and scope) has been especially noticeable in patent offices in recent years (van Zeebroeck et al. 2009; Gómez-Uranga et al. 2014). Similarly, the acquisitions of large patent portfolios from smaller companies (i.e. start-ups) have also given more market power to the largest Internet business groups. These acquisitions sometimes consist of thousands of patents, giving the buyers leverage to block the growth of these new entrants.

The EED approach therefore allows the inclusion of the consequences of epigenetic dynamics, which so far have been addressed in a limited manner in the case of patents (Gómez-Uranga et al. 2014). However, we still need to expand the analysis of the consequences to other areas that we believe may be as interesting or more that the patent system.

Table 4 includes a diagram of the epigenetic process. We believe this model will enable us to establish the adaptations/relationships between the environment and the dynamics (which we call epigenetic dynamics) and also the results of these (through consequentialist logic) which may lead to improvements in the

Table 4 An epigenetic approach to understanding the economic and social impact of ecosystem dynamics

A. The ENVIRONMENT	
Intense increase in intergroup competition	
Exponential growth of the markets and users in other (related) business areas	
Increase in the number of applications and their content	
Fast multivectorial technological change and planned obsolescence	
Modularity in the behavior of business ecosystems	
Exponential increase in advertising as a share of turnover	
Increase in marketing expenses	
Exponential increase in patent portfolios	
Industry, market, and institutional structures	
B. EPIGENETIC dynamics in response to the ENVIRONMENT	
High entry barriers posed by large incumbents in certain industry niches	
Risk-averse industrial strategies implemented by large companies	
Massive acquisition of patent portfolios	
Financial strength as the main defensive industrial instrument	
Asymmetric negotiations between large business groups, application developers, and content providers	
Acquisition of small firms and/or their intellectual property to block potential structural changes and to defend themselves from competition	
Aggressive acquisition strategies to sustain profit growth and their presence on global markets and to gain access to new technologies and innovations	
Entry of large business groups in activities not related to their original purpose (DNA)	Some examples: OS (Android), IOS (Apple), Symbian (Nokia), Bada (Samsung), new tablets (Nexus 7-Google, iPad mini-Apple, Kindle Fire HD-Amazon, Galaxy tab. 27.0-Samsung)
C. An illustration of the consequences, malfunctions and implications of epigenetic dynamics	
Conservative and defensive innovation strategies of large corporations	
Blocking competition—difficulties for new firms' to grow—risk of lock-in	
R&D gap/patenting results	
Distorted patenting rationale	
Excessive transaction (and litigation) costs	
High entry barriers to SME patenting	
Problems in standards definition and development	
Overload in patent offices and regulating agencies	
Efficiency of business firms	Knowledge and technology transfer
Economic growth	Growth of inequalities
Innovation in organizations	Employment generation
Innovation in territorial spaces	Property right regulations (particularly intellectual)
Innovative capacity of small firms, start-ups or individuals	Sectoral and global economic competition
Innovation-friendly environment	Inequalities in access to information and knowledge
Relative negotiation power of users and customers unveiled	Monopolistic entry barriers
Fiscal justice	Tax evasion
Moral values exposed	etc.

Source Own elaboration based on Gómez-Uranga et al. (2014)

system, or in this case, functional failures, system failures, and in other cases, moral problems. In Table 4, we place strong emphasis on the implications of the epigenetic dynamics derived from the need to adapt to the environment.[18] In this sense, we consider that epigenetic dynamics may result in the improvement or deterioration (i.e., degradation) of the following objectives.

As was pointed out previously, the environment is one of the main factors influencing the behavior of business groups and territories. The environment conditions business groups and regions, and may even damage their very origin (i.e., their genotype, their initial routines), for instance: their image, reputation, action areas, etc.; values that nurture the foundations of their acceptance (as well as that of their products/services), their growth, etc. These changes stemming from the environment in which business groups operate lead to the formation of new paths to follow.

References

Abatecola, G., Belussi, F., Breslin, D., & Filatotchev, I. (2015). Darwinism, organizational evolution and survival: Key challenges for future research. *Journal of Management & Governance*, 1–17.

Aldrich, H. E., Hodgson, G. M., Hull, D. L., Knudsen, T., Mokyr, J., & Vanberg, V. J. (2008). In defence of generalized Darwinism. *Journal of Evolutionary Economics, 18*, 577–596.

Ansoff, H. I., & Sullivan, P. A. (1993). Optimizing profitability in turbulent environments: A formula for strategic success. *Long Range Planning, 26*(5), 11–23.

Argote, L. (1999). *Organizational learning: Creating, retaining, and transferring knowledge*. New York: Kluwer Academic Publishers.

Arthur, W. B. (1999). Complexity and the economy. *Science, 284*, 107–109.

Ayala, F. J. (2013). Aquí se producen científicos y el resto del mundo se beneficia de ellos. *Revista Kampusa*, *73*, 10–11.

Basole, R. C. (2009). Structural analysis and visualization of ecosystems: A study of mobile device platforms. In *Proceedings of the Fifteenth Americas Conference on Information Systems*, San Francisco, California, August 6–9, 2009.

Bessen, J., & Meurer, M. J. (2008). *Patent failure: How judges, bureaucrats, and lawyers put innovators at risk*. Woodstock: Princeton University Press.

Bessen, J., & Meurer, M. J. (2012). The direct costs from NPE disputes. Working paper 12–34. Boston University School of Law.

Bingham, C. B., & Eisenhardt, K. M. (2011). Rational heuristics: The 'simple rules' that strategists learn from process experience. *Strategic Management Journal, 32*, 1437–1464.

Bingham, C. B., & Eisenhardt, K. M. (2014). Heuristics in strategy and organizations: Response to Vuori and Vuori. *Strategic Management Journal, 35*(11), 1698–1702.

Boschma, R. (2015). Towards an evolutionary perspective on regional resilience. *Regional Studies*, *49*(5), 733–751.

Boschma, R. A., & Frenken, K. (2006) Why is economic geography not an evolutionary science? Towards an evolutionary economic geography. *Journal of Economic Geography*, *6*(3), 273–302.

Boschma, R. A., & Frenken, K. (2009). The spatial evolution of innovation networks. A proximity perspective. In R. Boschma, & R. Martin (Eds.), *The handbook of evolutionary economic geography* (pp. 120–135). Cheltenham: Edward Elgar.

[18]For an illustration of the main features characterizing items A (environment) and B (epigenetic dynamics) see Gómez-Uranga et al. (2013).

Boschma, R. A., & Martin, R. (2007). Constructing an evolutionary economic geography. *Journal of Economic Geography, 7*, 537–548.

Boschma, R., & Martin, R. (2010). The aims and scope of evolutionary economic geography. In R. Boschma & R. Martin (Eds.), *The handbook of evolutionary economic geography* (pp. 3–39). Cheltenham: Edward Elgar.

Breslin, D. (2011). Reviewing a generalized Darwinist approach to studying socio-economic change. *International Journal of Management Review, 13*, 218–235.

Campbell, D. T. (1965). Variation and selective retention in socio-cultural evolution. In H. R. Barringer, G. I. Blankstein, & R. W. Mack (Eds.), *Social change in developing areas: A reinterpretation of evolutionary theory* (pp. 19–49). Cambridge, MA: Schenkman.

Canetti, E. (2003). Epigenética: una explicación de las enfermedades hereditarias. *Perinatología y Reproducción humana, 17*, 57–60.

Carey, N. (2012). *The epigenetics revolution. How modern biology is rewriting our understanding of genetics, disease and inheritance*. New York: Columbia University Press.

Carroll, S. B. (2005). *Endless forms most beautiful: The new science of evo devo and the making of the animal kingdom*. New York: W.W. Norton.

Cavagnari, B. M. (2012). Regulación de la expresión génica: cómo operan los mecanismos epigenéticos. *Archivos argentinos de pediatría, 110*(2), 132–136.

Chesbrough, H. (2003). *Open innovation. The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Publishing Corporation.

Cleland, S., & Brodsky, I. (2011). *Search and destroy: Why you can't trust Google Inc*. St. Louise, Missouri: Telescope books.

Cooke, P., Gomez Uranga, M., Etxebarria, G. (1997). Regional innovation systems: Institutional and organizational dimensions. *Research Policy*, *26*, 475–491.

Cordes, C. (2006). Darwinism in economics: From analogy to continuity. *Journal of Evolutionary Economics, 16*(5), 529–541.

Corkery, T., Forder, J., Svantesson, D., & Mercuri, E. (2015). Taxes, the internet and the digital economy. *Revenue Law Journal*, 23(1), Article 7.

Corning, P. A. (2002). The re-emergence of "emergence": A venerable concept in search of a theory. *Complexity, 7*(6), 18–30.

Cunningham, S. (2011). Mobile patent suits: Graphic of the day. http://blog.thomsonreuters.com/index.php/mobile-patent-suits-graphic-of-the-day. Accessed 3 October 2015.

Darwin, C. R. (1859). *On the origin of species by means of natural selection, or the preservation of favored races in the struggle for life*. London: Murray.

Darwin, C. R. (1871). *The descent of man, and selection in relation to sex*. London: Murray.

David, P. A. (1985). Clio and the economics of QWERTY. *American Economic Review, 75*(2), 332–337.

David, P. A. (1994). Why are institutions the 'carriers of history? Path dependence and the evolution of conventions, organizations and institutions. *Structural Change and Economic Dynamics, 5*(2), 205–220.

Davies, P. (2002). La flecha del tiempo. *Investigación y Ciencia*, November 8–13.

Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. (2009). Optimal structure, market dynamism, and the strategy of simple rules. *Administrative Science Quarterly, 54*, 413–452.

Dawkins, R. (1976). *The selfish gene*. Oxford: Oxford University Press.

Dawkins, R. (1982). *The extended phenotype: The long reach of the gene*. Oxford: W.H. Freeman and Company.

Dawkins, R. (1983). Universal Darwinism. In D. S. Bendall (Ed.), *Evolution from molecules to man* (pp. 403–425). Cambridge: Cambridge University Press.

Deighton, J. A., & Kornfeld, L. (2013). Amazon, Apple, Facebook and Google. *Harvard Business School Case,* 513-060.

Department of Justice. (2012). Statement of the Department of Justice's Antitrust Division on its decision to close its investigations of Google Inc.'s Acquisition of Motorola Mobility Holdings Inc. and the Acquisitions of certain patents by Apple Inc., Microsoft Corp. and Research in Motion Ltd. 13th February 2012. http://www.justice.gov/opa/pr/2012/February/12-at-210.html. Accessed 3 October 2015.

Dosi, G. (1982). Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. *Research Policy, 11*(3), 147–162.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal, 21*(10–11), 1105–1121.

Encaoua, D., & Madiès, T. (2012). Dysfunctions of the patent system and their effects on competition. http://hal.archives-ouvertes.fr/docs/00/74/07/16/PDF/ENCAOUA-MADIES_DYSFUNCTIONS_.pdf. Accessed 3 October 2015.

Essletzbichler, J., & Rigby, D. L. (2010). Generalized Darwinism and evolutionary economic geography. In R. Boschma & R. Martin (Eds.), *The handbook of evolutionary economic geography* (pp. 43–61). Cheltenham: Edward Elgar.

Etkin, J., & Schvarstein, L. (1995). *Identidad de las Organizaciones. Invariancia y Cambio*. Buenos Aires: Paidós.

Feldman, M. S., & Pentland, B. T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly, 48*, 94–118.

Fischer, T., & Henkel, J. (2012). Patent trolls on markets for technology: An empirical analysis of NPEs' patent acquisitions. *Research Policy, 41*, 1519–1533.

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4), article 20.

Francis, R. C. (2011). *Epigenetics. How the environment shapes our genes*. New York: W.W. Norton & Company.

Fransman, M. (2014). *Models of innovation in global ICT firms: The emerging global innovation ecosystems*. Luxembourg: European Union.

Freeman, C. (2002). Continental, national and sub-national innovation systems—complementarity and economic growth. *Research Policy*, *31*(2), 191–211.

Frenken, K., & Boschma, R. A. (2007). A theoretical framework for evolutionary economic geography: Industrial dynamics and urban growth as a branching process. *Journal of Economic Geography, 7*(5), 635–649.

García Azkonobieta, T. (2005). Evolución, desarrollo y (auto)organización: Un estudio sobre los principios filosóficos de la evo-devo. PhD thesis. San Sebastian: University of the Basque Country.

Geels, F. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy, 31*, 1257–1274.

Geels, F. (2014). Reconceptualising the co-evolution of firms-in-industries and their environments: Developing an inter-disciplinary triple embeddedness framework. *Research Policy, 43*(2), 261–277.

Gilbert, S. F. (2001). Ecological developmental biology: Developmental biology meets the real world. *Developmental Biology, 233*, 1–22.

Gilbert, S. F., & Epel, D. (2009). *Ecological developmental biology*. Sunderland, MA: Sinauer Associates.

Gillham, N. W. (2001). Evolution by jumps: Francis Galton and William Bateson and the mechanism of evolutionary change. *Genetics, 159*, 1383–1392.

Gleick, J. (1987). *Chaos: Making a new science*. New York: Penguin books.

Gómez-Uranga, M., Zabala-Iturriagagoitia, J. M., & Miguel, J.C. (2013). Evolutionary epigenetic economics: How to better understand the trends of big internet groups. SSRN. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2200421. Accessed 3 October 2015.

Gómez-Uranga, M., Miguel, J. C., & Zabala-Iturriagagoitia, J. M. (2014). Epigenetic economic dynamics: The evolution of big Internet business ecosystems, evidence for patents. *Technovation, 34*(3), 177–189.

Gottlieb, G. (2001). A developmental psychobiological systems view: Early formulation and current status. In S. Oyama, P. E. Griffiths, & R. D. Gray (Eds.), *Cycles of contingency: Developmental systems and evolution*. Cambridge, MA: MIT Press.

Griffiths, P. E. (1996). Darwinism, process structuralism and natural kinds. *Philosophy of Science, 63*, S1–S9.

Griffiths, P. E., & Gray, R. D. (2005). Discussion: Three ways to misunderstand developmental systems theory. *Biology and Philosophy, 20*, 417–425.

Heckemeyer, J. H., Richter, K., Spengel, C. (2014). Tax planning of R&D intensive multinationals. ZEW Discussion Papers, 14-114.

Hernández-Martínez, A. G. (2006). La decisión y su relación con el tiempo: estrategia, procesos e identidad. *Revista Facultad de Ciencias Económicas: Investigación y Reflexión, 14*(1), 23–43.

Herstatt, C., & Kalogerakis, K. (2005). How to use analogies for breakthrough innovations. *International Journal of Innovation and Technology Management, 2*(3), 331–347.

Hodgson, G. M. (1993). *Economics and evolution: Bringing life back into economics*. Cambridge: Cambridge Polity Press.

Hodgson, G. M. (2009). Agency, institutions and Darwinism in evolutionary economic geography. *Economic Geography, 85*(2), 167–173.

Hodgson, G. M. (2010). Darwinian coevolution of organizations and the environment. *Ecological Economics, 69*(4), 700–706.

Hodgson, G. M. (2012). The mirage of microfoundations. *Journal of Management Studies, 49*, 1389–1395.

Hodgson, G. M., & Knudsen, T. (2004). The firm as an interactor: Firms as vehicles for habits and routines. *Journal of Evolutionary Economics, 14*(3), 281–307.

Hodgson, G. M., & Knudsen, T. (2006a). Why we need a generalized Darwinism, and why a generalized Darwinism is not enough. *Journal of Economic Behavior and Organization, 61*, 1–19.

Hodgson, G. M., & Knudsen, T. (2006b). Dismantling Lamarckism: Why descriptions of socio-economic evolution as Lamarckian are misleading. *Journal of Evolutionary Economics, 16*, 343–366.

Hodgson, G. M., & Knudsen, T. (2012). Agreeing on generalised Darwinism: A response to Pavel Pelikan. *Journal of Evolutionary Economics, 22*(1), 9–18.

Holland, J. H. (1998). *Emergence: From chaos to order*. Redwood City, CA: Addison-Wesley.

Huizingh, E. K. R. E. (2011). Open innovation: Sate of the art and future perspectives. *Technovation, 31*, 2–9.

Iansiti, M., & Richards, G. L. (2006). The information technology ecosystem: Structure, health, and performance. *The Antitrust Bulletin, 51*(1), 77–110.

Jablonka, E., & Lamb, M. J. (2005). *Evolution in four dimensions: Genetic, epigenetic, and symbolic variation in the history of life*. Cambridge, MA: MIT Press Books.

Jing, Z., & Xiong-Jian, L. (2011). Business ecosystem strategies of mobile network operators in the 3G era: The case of China Mobile. *Telecommunications Policy, 35*, 156–171.

Kauffman, S. (1993). *Origins of order: Self-organization and selection in evolution*. Oxford: Oxford University Press.

Kauffman, J. B., Case, R. L., Lytjen, D., Otting, L., & Cummings, D. L. (1995). Ecological approaches to riparian restoration in northeastern Oregon. *Restoration and Management Notes*, *13*, 12–15.

Khalil, E. L. (2012). Are instincts hardened routines? A radical proposal. Monash University. Department of Economics, Discussion Paper 25/12. Retrieved October 3, 2015 from http://www.buseco.monash.edu.au/eco/research/papers/2012/2515areinstinctskhalil.pdf.

Kitano, H. (2004). Biological robustness. *Nature Reviews Genetics, 5*, 826–837.

Knable Gotts, I., & Sher, S. (2012). The particular antitrust concerns with patent acquisitions. *Competition Law International*, August, 30–38.

Lara, B. (1991). *La decisión, un problema contemporáneo*. Madrid: Editorial Espasa Calpe S.A.

Levinthal, D. A. (1997). Adaptation on rugged landscapes. *Management Science, 43*(7), 934–950.

Levinthal, D. A., & Marino, A. (2013). *Three facets of organisational adaptation: Selection, variety, and plasticity*. The Wharton School: University of Pennsylvania.

Levit, G. S., Hossfeld, U., & Witt, U. (2011). Can Darwinism be 'generalized' and of what use would this be? *Journal of Evolutionary Economics, 21*, 545–562.

Levitt, B., & March, J. (1988). Organizational learning. *Annual Review of Sociology, 14*(1), 319–340.
Lewontin, R. C. (1982). Organism and environment. In H. Plotkin (Ed.), *Learning, development, culture* (pp. 151–170). New York: Wiley.
Lewontin, R. C. (1983). Gene, organism and environment. In D. S. Bendall (Ed.), *Evolution: From molecules to men* (pp. 273–285). Cambridge: Cambridge University Press.
Li, J. (2014). Protecting the tax base in the digital economy. Papers on selected topics in protecting the tax base of developing countries. Paper No. 9, June 2014. New York: United Nations.
Lundvall, B. -Å. (1992). *National innovation systems: Towards a theory of innovation and interactive learning*. London: Pinter.
Martin, R. (2012a). Regional economic resilience, hysteresis and recessionary shocks. *Journal of Economic Geography*, *12*, 1–32.
Martin, R. (2012b). (Re)Placing path dependence: A response to the debate. *International Journal of Urban and Regional Research*, *26*(1), 179–192.
Martin, R., & Sunley, P. (2007). Complexity thinking and evolutionary economic geography. *Journal of Economic Geography, 7*, 573–601.
Martin, R., & Sunley, P. (2014). Towards a developmental turn in evolutionary economic geography? *Regional Studies, 49*(5), 712–732.
Massini, S., Lewin, A. Y., & Greve, H. R. (2005). Innovators and imitators: Organizational reference groups and adoption of organizational routines. *Research Policy, 34*(10), 1550–1569.
Masuelli, R. W., & Marfil, C. F. (2011). Variabilidad epigenética en plantas y evolución. *Journal of Basic and Applied Genetics, 22*(1), 1–8.
Mayr, E. (1988). *Toward a new philosophy of biology: Observations of an evolutionist*. Cambridge, MA: Harvard University Press.
Mayr, E. (1991). *One long argument: Charles Darwin and the genesis of modern evolutionary thought*. Cambridge, MA: Harvard University Press.
Miao, C.-H. (2011). Planned obsolescence and monopoly undersupply. *Information, Economics and Policy, 23*(1), 51–58.
Mitleton-Kelly, E. (2003). Ten principles of complexity & enabling infrastructures. In E. Mitleton-Kelly (Ed.), *Complex systems and evolutionary perspectives of organisations: The application of complexity theory to organizations* (pp. 23–50). Elsevier.
Mortara, L., & Minshall, T. (2011). How do large multinational companies implement open innovation? *Technovation, 31*(10–11), 586–597.
Nelson, R. R. (1995). Recent evolutionary theorizing about economic change. *Journal of Economic Literature, 33*(1), 48–90.
Nelson, R. R. (2005). Evolutionary social science and universal darwinism. CCS Working Paper 5. Center on Capitalism and Society, The Earth Institute at Columbia University Working Papers Series.
Nelson, R. R. (2007). Universal Darwinism and evolutionary social science. *Biology and Philosophy, 22*(1), 73–94.
Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change*. Cambridge, MA: Harvard University Press.
North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge: Cambridge University Press.
Oyama, S., Griffiths, P. E., & Gray, R. D. (2001). *Cycles of contingency: Developmental systems and evolution*. Cambridge, MA: MIT Press.
Pelikan, P. (2010). Evolutionary developmental economics: How to generalize Darwinism fruitfully to help comprehend economic change. *Journal of Evolutionary Economics, 21*, 341–366.
Pelikan, P. (2012). Agreeing on generalized Darwinism: A response to Geoffrey Hodgson and Thorbjörn Knudsen. *Journal of evolutionary economics, 22*, 1–8.
Pendall, R., Foster, K. A., Cowell, M. (2010). Resilience and regions: Building understanding of the metaphor. *Cambridge Journal of Regions, Economy and Society*, *3*, 71–84.
Pentland, B. T., & Feldman, M. S. (2005). Organizational routines as a unit of analysis. *Industrial and Corporate Change, 14*(5), 793–815.

Pentland, B. T., & Feldman, M. S. (2008). Issues in empirical field studies of organizational routines. In M. C. Becker (Ed.), *Handbook of organizational routines* (pp. 281–300). Cheltenham: Edward Elgar.

Pentland, B. T., Feldman, M. S., Becker, M. C., & Liu, P. (2012). Dynamics of organizational routines: A generative model. *Journal of Management Studies, 49*(8), 1484–1508.

Petrosky, T. Y., & Prigogine, I. (1990). Laws and events: The dynamical basis of self-organization. *Canadian Journal of Physics, 68*(9), 670–682.

Pike, A. (2002). Task forces and the organisation of economic development: The case of the North East region of England. *Environment and Planning C*, *20*, 717–739.

Pike, A., Dawley, S., & Tomaney, J. (2010). Resilience, adaptation and adaptability. *Cambridge Journal of Regions, Economy and Society*, *3*, 59–70.

Pohl, J. (1999). Some notions of complex adaptive systems and their relationship to our world. Presented at InterSymp-99, Advances in Collaborative Decision-Support Systems for Design, Planning and Execution (pp. 9–24). Baden-Baden, Germany, August 2–7, 1999.

Robert, J. S., Hall, B. K., & Olson, W. M. (2001). Bridging the gap between developmental systems theory and evolutionary developmental biology. *BioEssays, 23*, 954–962.

Schubert, C. (2012). Is novelty always a good thing? Towards an evolutionary welfare economics. *Journal of Evolutionary Economics, 22*(3), 585–619.

Stoelhorst, J.W. (2008). The explanatory logic and ontological commitments of generalized darwinism. *Journal of Economic Methodology*, *15*(4), 343–363.

Suárez, D. (2014). Persistence of innovation in unstable environments: Continuity and change in the firms' innovative behavior. *Research Policy, 43*(4), 726–736.

Suárez Sánchez-Ocaña, A. (2012). *Desnudando a Google: La inquietante realidad que no quieren que conozcas*. Barcelona: Editorial Deusto.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*, 1319–1350.

Teece, D. J. (2010). Technological Innovation and the theory of the firm: The role of enterprise-level knowledge, complementarities and (dynamic) capabilities. In B. H. Hall & N. Rosenberg (Eds.), *Handbook on the economics of innovation* (pp. 679–730). North-Holland: Elsevier.

Teece, D. J. (2012). Dynamic capabilities: Routines versus entrepreneurial action. *Journal of Management Studies, 49*(8), 1395–1401.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.

Turner, J. L. (2011). *Patent thickets, trolls and unproductive entrepreneurship*. Athens, GA: Department of Economics, Terry College of Business, University of Georgia.

Van de Brande, V., De Jong, J. P. G., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation, 29*, 423–437.

Van Gundy, A. B. (1981). *Techniques of structured problem solving*. New York: Van Nostrand Reinhold Company.

Van Zeebroeck, N., Pottelsberghe, Van, de la Potterie, B., & Guellec, D. (2009). Claiming more: The increased voluminosity of patent applications and its determinants. *Research Policy, 38*(6), 1006–1020.

Vosniadou, S., & Ortony, A. (1989). *Similarity and analogical reasoning*. Cambridge: Cambridge University Press.

Waddington, C. H. (1947). *Organisers and genes*. Cambridge, MA: Cambridge University Press.

Waddington, C. H. (1953). Genetic assimilation of an acquired character. *Evolution, 7*, 118–126.

Weitzman, J. (2011). Epigenetics: Beyond face value. *Nature, 477*, 534–535.

West-Eberhard, M. J. (2003). *Developmental plasticity and evolution*. New York: Oxford University Press.

Wirtz, B. W., Mathieu, A., & Schilke, O. (2007). Strategy in high-velocity environments. *Long Range Planning, 40*(3), 295–313.

Witt, U. (2008). What is specific about evolutionary economics? *Journal of Evolutionary Economics, 18*, 547–575.

Witt, U. (2014). The future of evolutionary economics: Why the modalities of explanation matter. *Journal of Institutional Economics, 10*(4), 645–664.

Witt, U., & Cordes, C. (2007). Selection, learning and Schumpeterian dynamics: A conceptual debate. In H. Hanusch & A. Pyka (Eds.), *The Elgar Companion to Neo-Schumpeterian Economics* (pp. 316–328). Cheltenham: Elgar.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203.

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