Factor markets, actors, and affordances

FACTOR MARKETS, ACTORS AND AFFORDANCES

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Abstract

In this article we challenge the notion of the efficiency of factor markets and provide an alternative. We specifically identify both the environment- and actor-related origins of heterogeneity in markets. We first discuss how environments have an exaptive nature, where new uses and possibilities emerge continuously and are poised for the taking. We then highlight how actor perceptions result in heterogeneous outcomes and how the identification of novel affordances—new uses or functions—for factors is a central origin of heterogeneity. We also discuss the existence of actor- and environment-related pressures toward homogeneity and seeming market efficiency. In conclusion we highlight the implications of our arguments for the strategy and innovation debate, and for our understanding of the nature of markets and economic activity.

key words: factor markets, efficiency, heterogeneity, exaptation, affordances, functional fixedness

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1. Introduction

A central assumption of the resource-based view is that factor markets are efficient (Barney 1986; for an overview see Leiblein 2011). Thus it is argued that value *cannot* be created by purchasing resources in factor markets, but rather value is largely created by utilizing the extant 'endowments' of resources that firms already possess (Barney 1991; Peteraf 1993). A key assumption of the resource-based view, then, is that markets are characterized by what might be called 'exhaustive entrepreneurship' (Denrell et al. 2003), specifically where the factors—that might be purchased—are already put to their best use and thus are not a possible source of value. Factors are 'fully priced', which means that it is difficult to purchase factors for less than they in fact are worth, making arbitrage and entrepreneurship impossible.

In this article we challenge the notion of the efficiency of factor markets, arguing that markets are inherently characterized by *heterogeneity*. We highlight both *environment*- and *actor*-related origins of this heterogeneity. We discuss how environments have an exaptive nature, where new uses and possibilities emerge continuously and are poised for the taking. We then highlight how actor perceptions result in heterogeneous outcomes and how the identification of novel affordances—new uses or functions—for factors and resources is a central origin of heterogeneity. While we challenge the idea of the efficiency of factor markets (and the 'all seeing eye' assumed by extant work), we concurrently also highlight how there are simultaneous environment- and actor-related pressures toward the seeming efficiency and homogeneity of markets. We conclude with a discussion of the implications of our arguments for the strategy and innovation debate, and for our understanding of the nature of markets and economic activity.

2. Efficient Factor Markets and Strategy

The notion of *market efficiency* occupies a central position in a debate that spans several branches of literature. In economics, the central premise of market efficiency is that prices are informationally efficient since they reflect—to different degrees (weak, semi-strong and strong versions)—all the relevant information about the underlying resource (Fama 1970). The main consequence is that prices already reveal the full information (and essentially, the future) of the economy, and all possible uses of resources. Thus there are no agents who somehow can 'beat' average market returns (Farmer and Geanakoplos 2009). The notion of efficient markets assumes that markets are populated by homogenous agents that have 'rational expectations'. As put by Thomas Sargent, 'the fact is that you simply cannot talk about differences within the typical rational expectations model. There is a communism of models. All agents inside the model, the econometrician, and God share the same model' (Evans and Honkapohja 2005: 566).

The notion of market efficiency has been adopted (although not always explicitly) by the resource based view in strategy in order to support the claim that the sources of sustained competitive advantage lie in a bundle of unique and 'non-purchasable' resources that are already at the firm's internal disposal (Barney 1986; Barney 1989; Dierickx and Cool 1989; Makadok and Barney 2001; Wernerfelt 1984). In other words, value-generating resources cannot be purchased and the assumption is that firms are 'endowed' with heterogeneous resources (Peteraf 1993: 180). As discussed by Leiblein (2011), the concern for *a priori* resource endowments is central for strategy as it provides the underlying rationale for the focus on internal rather than external factors (the possibility of purchasing resources which might generate value).

Traditionally markets are assumed to be efficient when there are a large number of buyers and sellers for factors, and data about the quality of factors and products that are readily available (Leiblein 2011: 913). It is assumed that the large number of buyers will somehow exhaust all possible uses for factors. Thus market efficiency holds if we assume what Denrell et

al. (2003) call 'exhaustive entrepreneurship', where all possible uses of *factors* have already been explored, delineated and priced.

However, entrepreneurship in the economy can only be seen as exhaustive if all factors are fully priced for all possible uses[i]—an assumption which we challenge. The value of a factor, from an efficient markets perspective, necessarily needs to also include future contingent states of the world in which the factor might be used. The notion of 'state-contingent claim' is critical (Arrow 1964; Heathcote et al. 2009). Contingency entails space-time considerations about the possible use of a resource. But any factor or resource can be combined with an infinite variety of other factors, and the full set of all these combinations cannot be tried, let alone exhausted, in any meaningfully way (cf. Felin, Kauffman, Koppl and Longo, 2014).

Existing research of course has wrestled with the problem of market efficiency in the field of strategy. For example, some work has highlighted how investments in information gathering (e.g., Makadok and Barney 2001), information asymmetries (Schmidt and Keil, 2013) or resource complementarity (Abegdesan 2009) might lead to potential sources of value. However, in this article we discuss alternative factors and mechanisms behind heterogeneity, related to both environments and actors.

3. The Origins of Heterogeneity

3.1 Exaptation and Environmental Heterogeneity

As introduced above, the idea of the efficiency of markets necessarily presumes that all possible uses of a factor can be specified. However, the set of possible uses and functionalities of any product or factor are unspecifiable. The set of possible uses for anything, say an umbrella, are not, and cannot be, entailed. A focus on the efficiency of markets does not allow us to consider other uses related to the complex ecology of possibilities enabled by the continual emergence of other artefacts (again, whether available now or in the future). For example, an umbrella could

be connected to a smartphone and used as a satellite-dish parabolic antenna. This novel use of an umbrella was impossible before the invention of smartphone.

Thus economic environments are characterized by continual emergence. As discussed by Kauffman (2000: 212), 'the most awesome feature of the econosphere […] has been a blossoming diversity'. To illustrate, Beinhocker (2007) provides a back-of-the-envelope estimate of about 10 billions goods for sale in NYC, which suggests that the amount of goods and resources in the global economy has grown radically since the times of our pre-historic ancestors. One way of thinking about the radical explosion of new goods and uses is in terms of Schumpeterian avalanches of extinction and speciation events of new markets, goods and new ways of using existing goods. The invention of the brick made the hut extinct. At the same time, with bricks came the house, windows, doors, as well as new ways of using (to pick a random object), say a screwdriver (e.g., to prop a door open at night).[ii]

Thus the hypothesis that markets are complete and all possible contingent goods and their uses can be prestated, is implausible. Environments can best be discussed in terms of 'exaptation'. As argued by Kauffman (2000: 2015): we can be 'deeply suspicious of the claim that we can finitely prestate all possible exaptations – whether they be new […] functionalities or new goods – that arise in […] an econosphere'. On the contrary, continually new economic opportunities emerge and can be heterogeneously seized to the extent that the business environment is not a closed system, but an open system in which new exaptive possibilities emerge continuously.

The concept of *exaptation* was originally introduced by Gould and Vrba (1982: 6) to refer to biological 'characters evolved for other usages (or for no function at all) and later 'coopted' for their current role.'[iii] For example, a hypothesis has been advanced that links birds' wings to one or more pre-flight movements that served different ancestral functions, such as climbing trees or capturing preys (Gatesy and Baier 2005). Exaptation has been recently introduced into

the innovation and management literatures (Andriani and Cohen 2013; Andriani and Carignani 2014; Cattani 2005, 2006; Dew et al. 2004; Furnari 2011; Lane et. al 2007; Mokyr 1997). It usually refers to a human artefact that is fit for its current use because of technological features that were selected for old uses—or that had no use at all—and were later 'co-opted' for their current one. Mokyr, a historian of technology, has argued that 'in the history of technology, exaptation is probably more common than in natural history' (Ziman 2000: 57). Gutenberg's invention of the printing press resulted from the discovery of a new use for the wine press (Johnson 2010). The invention of the microwave oven resulted from the discovery of a new use of an internal component of the radar: the magnetron (Osepchuk 1984). The invention of Gillette's safety razor consisted in the exploitation of a new way to use the razor module (Andriani and Carignani 2014). The Marsilid, an anti-depressant drug, was originally conceived as an anti-tubercolosis drug (Andriani and Carignani 2014).

From an exaptive perspective, innovation is not just a matter of the transformation of technology 'but speciation—the application of existing technology to a new domain of application' (Levinthal 1998: 217). Exaptations are a consequence of the existence of an undefined and inherently unbounded set of uses and functions, only a subset of which are (presently) utilized, while the other uses and functions remain 'latent' but possible (cf. Bonaccorsi 2011). Their emergence is triggered by the interaction between the artefact and its ecosystem and context, which can consist of other artefacts, goods and technologies—*and* actors (which we will discuss further below). The increase in the number of artefacts in the econosphere further increases the number of contexts of exposure and the size of the possible interaction space, specifically where the 'system becomes autocatalytic, and the space of exaptation explodes combinatorially' (Andriani and Carignani 2014: 1609; Kauffman, 2000).

Returning back to the context of factor markets: any resource or factor is endowed with a latent but un-prestateable set of uses and there is no entrepreneurial calculation or search

procedure able to identify all possible uses (Felin et al. 2014). Thus factor markets cannot be efficient, in any operational, practical or meaningful way. Market activity is always non-exhaustive and autocatalytic, allowing for entrepreneurship. The set of possible uses for any one factor (alone or in combination) is un-prestatable, suggesting the continual emergence of new goods and uses into the 'adjacent possible' (Kauffman 2000), leading to a condition of non-exhaustive entrepreneurship. As discussed by Kauffman (2000), the economy is characterized by an incessant increase in the number of artificial forms whose ontological status is *un-prestatable* till it comes into being[iv]. The 'activation' of latent uses lacks any kind of 'prestateability' since it results from contextual interactions between 'Kantian wholes' (Longo et al. 2012) and selection-independent mechanisms such as exaptation. Exaptation—the co-option of existing resources for emergent uses—therefore occupies an important and yet neglected role in a debate that spans the fields of strategy and economic thinking: a debate on the market process and on the existence and persistence of economic opportunities.

3.2 Actors, Perceptions and Affordances

The emergence of novelty (and exaptations)—in the economic sphere—is not necessarily automatic. Rather, new uses and functionalities emerge as actors interact with their environments. Thus the distinction between actor and environment represents an effective analytical device for disentangling the respective contribution of each to the origins of heterogeneity. Here we specifically highlight the actor-related origins of heterogeneity in factor markets, with a specific focus on perception and affordances.

3.2.1 Perceptions in Factor Markets

The lack of attention on actor *perceptions*—including recent (alternative) theories of perception—is surprising in the context of factor markets. The specific problem is that the factor markets

literature implicitly builds on an outdated view of perception, essentially presuming an 'all seeing eye' that (somehow) objectively captures and exhausts all possibilities in the environment[v]. Perception is implicitly assumed to be the equivalent of information processing and veridical representation of the environment, where omniscient or exhaustive, social processing deplete any opportunities for creating value. These approaches rely on an outdated model of perception where markets—perhaps due to the fact that there are many buyers (or perceivers) involved in assessing uses, prices and value—somehow provide a social proof of efficiency and thus exhaust any possibility of entrepreneurship. It's as if the fact of multiple perceivers (the large set of potential buyers in a market, a key condition for the efficiency of markets) creates an all-seeing eye that exhausts any possibility of seeing alternative, new uses for factors that might allow for arbitrage and the generation of value. Well-established or agreed-upon collective representations (e.g., the specification of the best use for a factor) further exhaust the possibility of any novelty. This is readily evident not just in efficient market-type theories, but also models of bounded rationality which focus on computation and veridical representation[vi] of the environment (Felin et al. 2014).

But the all seeing eye of the market—and any associated notions that markets are efficient—is an illusion. The view of perception that we advance here is one where environments are actor- and organism-specific. From a biological and physiological perspective this means that perception is not so much the act of seeing or representing reality as it is of constructing reality (e.g., Singh and Hoffman 1997). This difference is significant, as the emphasis shifts from understanding the nature of the environment to understanding the nature and specific perceptions of the organism or actor in question. From this perspective, 'we do not have direct access to the physical world' (Frith 2007: 40)—a line of thought that goes back to Plato, Berkeley, Helmholtz, Wundt and many others (e.g., Popper, Peirce) [vii]. Perceptions and observations are more about theorizing, hypothesis development and testing, invention,

attention—rather than representation. This intuition reflects a radical shift in how we think about perception, representation and reality—and points toward the need to understand the 'beholder's share' (Gombrich 1956). Humans don't simply represent, process and capture realities, but rather they bring their own theories, models and constructions to bear when perceiving. As put by surrealist Rene Magritte, 'perception always intercedes between reality and ourselves'. Perceptions construct and drive our conceptions of 'reality' rather than the other way around. This view of perception has radical consequences for how we think about the origins of heterogeneity and the very nature of strategy and markets.

3.2.2 Perceptions and Affordances

One powerful way to link actors and their perceptions with the origins of heterogeneity in factor markets is through the idea of *affordances*. Affordances are the *perceived* possibilities that actors or organisms have related to objects and their environment (see Uexküll 2010)[viii]. The factor market intuition presumes that the sets of affordances for factors are listable, exhausted and priced—fully specified—while we argue that the set of affordances for any object, resource or factor simply are not possible to list. This means that environments in no meaningful sense are objective, where the possibilities associated with factors can readily be listed or captured or represented in camera-like fashion.

To be more specific, affordances can be discussed as the set of uses and functions made available by specific features or objects in an environment (Gibson 1977, 1979). For example, a ball affords kicking or throwing or bouncing; a kettle and its handle afford lifting and pouring, and so forth. Many of these affordances, functions and uses, are obvious and often specifically designed into manmade objects. The biological sphere also features a host of affordances, for example in the morphology and build of specific species or by the very nature of certain biological characteristics and traits (Felin et al. 2014).

But new affordances can emerge as actors interact with situated objects and their environment[ix]. Affordances are not given. Thus the notion of affordance represents a fundamental speculative device to understand the nature of exaptive phenomena and offers a way of thinking about the origins of heterogeneity. Future affordances cannot be anticipated or prestated, as discussed previously. The possible affordances of a simple artifact, such as a chair, are not prestateable and the activation of novel uses cannot be fully described to the extent that there is no 'basement language of a set of simple functionalities […] that […] can be derived logically' (Kauffman 2008: 153). The exaptation of a chair cannot be universally described, since a chair is perceived only by humans as (for example) an L-shaped, body-sized object that invites to sit on. Note that affordances also are species-specific. For example, trees might have an affordance of shelter or climbing for humans, but trees have a very different set (though perhaps in small part overlapping) of affordances for an earthworm or a bird.

The set of possible new uses and affordances, in an economic context, doesn't necessarily need to be revolutionary to create significant amounts of value. For example, a company like Airbnb has identified a new use and source of value for one's house by matching travelers with those willing to rent out their home to strangers. Similarly, a company like Uber has created a mechanism where excess or latent capacity for traveling is matched with those needing a ride to a particular destination.

The notion of affordances brings to the foreground the embodied nature of actor-environment *interactions* in order to unpack 'the vast, organism-level heterogeneity and possibility that lurks directly beneath blanket ascriptions of environmental importance […]' (Felin et al. 2014). Resources, artifacts and objects are not ontologically endowed with specific uses and functions. This is consistent with a strand of research in cognitive linguistics and psychology, which demonstrates that the categories of language are nominal rather than relying on ontological properties. That is, humans categorize objects depending on how they use them

instead of relying on an alleged ontological status (cf. Rosch 1975; Wittgenstein 1953). Under this view a category (e.g. a 'chair') is a fuzzy field of objects sharing a family resemblance rather than common structural or ontological features (Lakoff 1987).

This is consistent with the philosophical investigations of Wittgenstein (1953) of how we categorize the world. Uses are not ontological properties of a resource per se, but rather are attributions of specific actors, to the extent actors perceive resources—as affordances—by means of the potential uses that such resources enable. This has a semiotic and social dimension. Wittgenstein (1953: 454) for example asks, 'How does it come about that [an] arrow points? Doesn't it seem to carry in it something besides itself? – 'No, not the dead line on paper; only the psychical thing, the meaning, can do that.' [...] The arrow points only in the application that a living being makes of it'. Thus social conventions and culture can provide meaning to specific things, like Wittgenstein's pointing arrow.

The general notion of 'embodied cognition'[x] and the particular notion of 'affordance' can cast new light on how economic actors cognitively engage with their environments. Economic actors may utilize cognitive representations of the environment in order to critically evaluate their opportunities: 'managers [and entrepreneurs] create cognitive simplifications of their decision problems and come up with solutions on the basis of such simplifications' (Gavetti et al. 2005: 708). But the nature of such simplifications—though there is a question of whether simplification and particularly representation is the right approach—is crucial. Felin and Zenger (2009) emphasize the role that entrepreneurial or managerial "theorizing" plays in this process: 'Entrepreneurs theorize […]—triggered by observational and experiential fragments—by imagining entrepreneurial possibilities for courses of future action, by reasoning and justifying possibilities, and by forming shared beliefs about possible futures and collective intentions to test or try their theories'. The nature of such 'observational and experiential fragments'—and entrepreneurs' reasoning—requires an embodied dimension. Economic actors do not

necessarily need to (in fact, they can not) rely on abstract representations (à la fitness landscape) of the environment in order to critically evaluate possible economic opportunities: the seizing of economic opportunities does not necessarily assume 'search' on a landscape because any representations of reality are fiction and illusion as the future inherently is un-prestateable. The very nature and metaphor of a search landscape has been recently debated (for a specific discussion see Felin et al. 2014; Koppl et al. 2014). Thus economic actors theorize and use models to generate possibilities, along with using extant resources in novel ways, through recombination, analogy and other mechanisms. For example the creation of Google geo-applications (e.g. Google Earth) was not due to foresight abilities but was just a business possibility enabled by the existing Google knowledge base. Geo-applications were affordable[xi] for Google, due to its pre-history; in this perspective the notion of affordance is consistent with the one of pre-adaptation (Cattani 2005, 2006).

Note that we are here emphasizing an approach to understanding heterogeneity that does *not* focus on rationality (whether bounded or omniscient), experience, representation, heuristics or search. Rather, we give human actors (and organisms more generally) their respective due in terms of their underlying nature and associated, endogenous possibilities. A central distinction here, then, is that the mind is not so much "associative" (Gavetti, 2011) as it is generative and theoretical (Felin and Zenger, 2009). We also add the need for a theory of perception to further understand the origins of heterogeneity.

Moving from such considerations it is possible to re-conceptualize the notion of, for example, 'analogy-making' (Gentner 1998) to cast light on the nature of economic opportunities. The reuse in new contexts of things previously learned is seemingly a fundamental mechanism in extant work: 'in novel situations, wisdom from prior experience in other contexts can be particularly powerful' (Gavetti et al. 2005: 708). For example, Gavetti et al. (2005) model analogical transfer as a mapping between two pre-stated and abstract

structures—base domain and target domain—representing the old and the new business context. In doing this they neglect that such structures are not objectively given and the criteria for similarities are problematic (Chalmers et al. 1992). In other words they adopt an analogy-making framework based on pre-specifiable, abstract representations, and leave aside that the meaningful representations require an embodied interaction[xii].

But, the very basis for making associations or analogies requires some kind of origin, as the set of possible associations among factors in the world is infinite. Thus appeals to association or analogy are not sufficient. As highlighted by Samuel Coleridge (long ago, in reaction to popular theories of association in his time), "all association demands and presupposes the existence of the thoughts and images to be associated" (1817: 65). Thus, what is needed is a "theory of perception" that "explains the formation of the associable" (1817: 62). Focusing on endogenous factors associated with organisms themselves, we argue, can begin to provide this type of theory (cf. Felin, 2012).

From our perspective, the very nature of recognition lies in creating ex novo such partial representations which fit the original reasons for making an analogy, without necessarily relying on isomorphism and continuity with past experience. As put by Kauffman (2008: 242): 'Sometimes, based on these past experiences, we weigh these analogies and make a decision. Sometimes, we act in a different way: we invent an entirely new solution with which we have no previous experience to build from'. The condition for an exaptation to occur does not *necessarily* lie in what the actors, basing on their knowledge-base and 'experience', transfer from one domain to another. In other words, new creative uses and exaptations also emerge as a result of affordances conceived of by organisms—and do not only depend on past experience. For instance, creative outcomes such as the discovery of novel affordances have been systematically observed in young individuals, despite the scantiness of their experiential background (see German and Defeyter 2000, and our discussion on functional fixedness in the following

section). Thus the origins of novelty can be also tied to factors such as abductive, theoretical and intuitive reasoning (cf. Peirce 1957), rather than simply as a function of experience, stimulus or recombination.[xiii]

3.2.3 Affordances and Functional Fixedness

An actor-related factor that relates to both perceptions and affordances—and thus the origins of heterogeneity—is the idea of *functional fixedness*. While a host of biases in fact might be related to heterogeneity in markets[xiv], the notion of functional fixedness is particularly relevant for understanding the origins of heterogeneity. Given our previous emphasis on affordances, functions and uses, the idea of fixedness points toward a particular human propensity that might limit the extent to which (new) affordances are realized. Thus functional fixedness can cast light on how factors in markets might *seemingly* be efficiently priced, due to the fixed (and even social) nature of actor perceptions about what is possible.

The psychologist William James (1890: 222-224) foresaw central aspects of functional fixedness more than a hundred years ago: 'many objects of daily use - as paper, ink, butter, overcoat - have properties of such constant unwavering importance, and have such stereotyped names, that we end by believing that to conceive them in those ways is to conceive them in the only true way. Those are no truer ways of conceiving them than any others; there are only more frequently serviceable ways to us'.

The concept of functional fixedness was further discussed in Gestalt psychology by Karl Duncker, who defined it as a 'mental block against using an object in a new way that is required to solve a problem' (Duncker 1945). More recently, German and Barrett (2005: 1) have stressed that 'cognitive systems underwriting the acquisition and representation of knowledge about artefacts' are generally subject to functional fixedness, where the uses of a thing are determined by common, public understandings and history rather than novel possibilities. Functional

fixedness of course can also be seen as a central and important element of knowledge acquisition and education, specifically where agreed-upon uses for artefacts and (even) language provide a common code allowing for effective human interaction. But this fixedness also has a significant downside, particularly in terms of the generation of novelty.

Margolis and Laurence (2007) provide an exhaustive review of the experimental evidence on functional fixedness, such as the two-ring experiment. In this experiment participants were asked to fasten together two heavy rings of steel using only a long candle, a match, and a two-inches cube of steel. Many participants opted for melting the wax of the candle in order to stick the rings together (though it wasn't strong enough for that purpose), instead of noticing that the wick of the candle could be used, in a novel way, to tie the rings together after scraping away the wax on the cube of steel (McCaffrey 2012). The effect of functional fixedness is higher when an artifact (e.g. the candle) is 'primed' to participants in its typical use or function (Adamson 1952). Providing previous examples of potential uses and solutions to a problem also leads to fixation (Jansson and Smith 1991; Purcell et al. 1993). Moreover, the generation of creative ideas tends to be constrained by the features of primed examples (Smith et al. 1993) even if such examples include inappropriate elements (Chrysikou and Weisberg 2005).

Overall, the prior experience with an artifact hides secondary properties and latent functions that lead to unconventional uses (Birch and Rabinowitz 1951). Functional fixedness has been also observed in non-industrial cultures as well (German and Barrett 2005), and this suggests that is not culturally-specific. It is rather related to fundamental developmental considerations, and to the fact that young individuals (of about 5 years old) are systematically less subject to priming than adult individuals and therefore less subject to fixedness (German and Defeyter 2000). The notion of functional fixedness highlights a general bias that exists in seeing things in a conventional way, as fixed. However, as with other cognitive biases[xv] (Stanovich 2011), there is significant individual-level heterogeneity in actor perceptions and their

potential likelihood to see something as fixed, versus seeing the novel, unconventional possibilities associated with a particular form.

Functional fixedness highlights the existence of cognitive bounds that may act in those kind of situations—e.g., so called 'insight problems' (Zhang et al. 2004)—that cannot be reduced to search problems and that rather require creative and 'out-of-the-box' thinking. Insight problems are related to ill-structured problems characterized by ambiguity and incomplete information, and cannot be solved, without criticality, by means of algorithmic processes (Simon 1973). Recently, Felin et al. (2014) have explicitly placed the emphasis on the limitations of 'fitness landscape' approaches of search (Kauffman and Levin 1987; Kauffman and Weinberger 1989), arguing that the entrepreneurial activity is not about computation or calculation. It can be rather described in terms of 'frame' problems (McCarthy and Hayes 1969), which consist in 'explaining the full task set of activities and *possible* functionalities and uses for operating in the world'.

The notion of functional fixedness can cast light on the nature of cognitive impediments on strategy formation. Gavetti (2012: 268) moves from the idea that 'establishing what causes violations of market efficiency shows what causes opportunities to exist'. According to Gavetti (2012) superior performance of firms is hindered by the presence of behavioural failures that are impediments, mental in origins, to the ability to compete for opportunities. We argue that functional fixedness is one of such impediments: it prevents the creative use of current resources and limits the entrepreneurial possibilities of re-orienting the business toward novel opportunities. Due to functional fixedness entrepreneurs are subject to the same mechanism that enables exaptation: the collapse of the physical form of an artifact to the function(s) that it enables. Entrepreneurs are constrained by their own (as well as social) ontological reductions, whenever they are not able to disentangle the physical dimension of an economic resource from its (possible) functions. Functional fixedness leads to the reification of resources and is part of

the 'economy' of nature: attributing fixed uses to resources allows actors to save on cognitive efforts and live in a stable, observable and 'collapsed'[xvi] reality without the need of a continual re-structuring of its meaning. Without this cognitive collapse, there would be no artifacts but just possible functions and meaningless forms.

From this perspective, functional fixedness can cast light on the nature of myopia of organization: the exploitation of current resources (and their specific affordances and uses) represents a trap for the exploration of new possibilities (Levinthal and March 1993; March 1991). Functional fixedness provides a behavioral explanation of organizational inertia and can cast light on the micro-foundations of routines, emphasizing the role of un-intentional and automatic behaviors of actors (for a critical discussion, see Felin and Foss 2009). Indeed functional fixedness is what allows one to exploit, in a stable manner, the environment—given the attributed functionality—and, at same time, what prevents the exploration of *unactualized* possibilities for novel uses. If possibilities are embedded—though in an un-decidable manner—in current configurations (the state of nature) and come into being in terms of new uses, there are reasons to think that the privileged directionality of exploration is largely affected by functional fixedness. Functional fixedness implies a reification of the economic resources, and such reification is the main constraint for entering into the 'adjacent possible' [xvii](Kauffman 2000, 2008), that is, innovations that are directly achievable given the current state. That fact that many possibilities of course remain unactualized [xviii] (though, of course we do not have a counterfactual for this) is probably due to the inertial dimension that fixedness implies. [xix]

4. Discussion

We next discuss the implications of our arguments for four central areas within the domain of strategy and innovation.

First, our arguments can be seen as offering insights for one of the re-occurring questions and debates in strategy, the role of *luck* versus *foresight* (Barney 1986, 1997; Cattani 2005; Cockburn et al. 2000; Denrell 2004; Garud et al. 1997; Winter 2012). As argued by Barney (1997: 15), differences in firm performance cannot only be attributed to firms' abilities to anticipate opportunities for value creation, since 'it may simply be the case that some firms are lucky in their technology choices and others are unlucky'. Our arguments can be seen as siding with Cattani (2005: 576) who argues that both foresight and luck play a role, and the real 'challenge is to clarify when each of these forces is more likely to be at work' [xx]. Specifically, we argue that it is in the nature of environments to be exaptive, where possible, novel uses are poised and available for the taking. But, actors also play a central role in imposing their points of view on these environments, specifically where they have conjectures and theories about novel affordances and uses. Therefore, rather than assuming their automatic nature, we hope to infuse actors into factors markets and shed light on how they interact with environments, how they conceive and develop new uses, affordances and recombinations, and how they organize the activities to take advantage of new economic opportunities. Luck undoubtedly might play an important role, as our central point in fact is that it is impossible to foresee all future uses that later might be harnessed. But actors are required to animate and organize around potentially novel uses and economic opportunities. More generally, our arguments offer insights for one of the foundational issues in strategy: the role of emergent versus deliberate strategies (Mintzberg and Waters 1985) and the related distinction between emergent and rational approaches (Faulkner and Campbell 2003). During the early days of strategy—as a field of study—rational approaches were predominant and consisted in a sequential process of assessment (of the environment), strategy formulation and implementation. However, rational approaches began to falter in the face of accumulating evidence that 'successful firms often seem to have achieved their position without going through the processes of analysis, formulation, and implementation

that the rationalist school implies' (Faulkner and Campbell 2003: 35). At the deepest level, our arguments suggest a particular view of the underlying nature of economic actors, a view that contrasts with existing models that tend to heavily focus on their 'rationality'. Our conceptualization of the nature of actors is not anchored on any kind of calculative or computational rationality (cf. Felin et al., 2014). Rather, we focus on the anticipations, theories and forward-looking perception that actors themselves might have as they seek to create value. Our arguments have mainly focused on the aspects that lie at the individual-level of analysis such as perceptions and affordances, and fixedness. Future research might explore both the social and organizational aspects of this activity. Specifically, how do organizations 'perceive' affordances during the process of 'reactivation and synthesis' of their internal technological storehouse (cf. Garud and Nayyar 1994)? How does fixedness work in an organizational setting (where there might be heterogeneity and differences of opinion)? What is the role played by individuals versus groups inside the organization? Siding with Cattani (2005: 577) we believe that, 'though organizational memory does not necessarily coincide with individual memory', single individuals such as inventors/entrepreneurs may constitute a 'storage point […] that is both idiosyncratic and of great importance to the organization' (Nelson and Winter 1982: 115). We leave these questions to future research.

Second, our arguments can cast light on the uniqueness paradox and the social categorization of industries. Economic sociologists have pointed out how markets are characterized by what has been labeled a 'categorical imperative'—by a need for firms to belong to well-established, legitimated and understood industries, so as to not be discounted by those who evaluate and make recommendations, such as analysts (Litov et al. 2012; Zuckerman 1999). The need to fit established categories might be linked with the more general notion of functional fixedness, specifically where multiple social audiences—not just entrepreneurs—are focused on fixed and established ways of doing things, and where novelty is explicitly avoided

and discounted (perhaps due to inabilities to appropriately assess the economic opportunity, or due to various forms of social legitimacy). The human propensity to categorize serves a valuable function in reducing complexity. But these external categories also delimit entrepreneurship and the emergence of novelty (though undoubtedly also enabling it), as they create a social filter that re-enforces homogeneity. We think there is a significant opportunity to unpack how slippage occurs in categories and how different stakeholders play a role in new and emergent forms in markets. There are reasons to think that novelty emerges whenever new affordances of existing resources are perceived; in this manner, existing social categories of industries are changed because audiences start to use new cognitive reference points—new prototypical artifacts and services—in order to reduce the complexity of the market ecology and save on cognitive efforts. For instance, Uber is likely to be imposing a new Gestalt in the perception and categorization of the urban transport industry.

A third implication of our arguments (though admittedly speculative), is the possibility of linking our arguments with quantum-like frameworks of and intuition about cognition[xxi]. Quantum cognition builds on the principles of quantum physics, which posits that the absence or presence of measurement of a phenomenon affects the type of observable—wave-like versus particle-like behavior respectively[xxii]—thus linking with our ideas that there are no inherent fixed points but multiple, possible ones. Quantum cognition posits that the absence or presence of a conscious formulation of a decision problem (which is the equivalent of measurement) determines the modality of decision making. In the absence of a conscious formulation, cognitive processes would oscillate in a state of 'superposition' characterized by indefiniteness, ambiguity and uncertainty, and interfere according to quantum dynamics that would generate wave-like decisional outcomes. On the other hand, in the presence of conscious formulation, cognitive processes would collapse on 'classical' behavior and decisional outcomes could be reconducted to Bayesian probability (Busemeyer and Bruza 2012). As noted by Busemeyer and

Bruza (2012: 3) 'the wave nature of an indefinite state captures the psychological experience of conflict, ambiguity, confusion, and uncertainty; the particle nature of a definite state captures the psychological experience of conflict resolution, decision, and certainty'[xxiii]. These issues have been the object of study in a number of experiments that have been conducted in cognitive science in the last decade. We refer the interested reader to these studies (see Bruza et al. 2009; Busemeyer and Bruza 2012; Wang et al. 2013). But overall quantum cognition could help us to better disentangle the tension between potential affordances—which would correspond to a state of indefiniteness and ambiguity—and the 'collapse' on a specific affordance that would happen through fixedness. Gabora, Scott and Kauffman (2013) have adopted a quantum framework in order to formalize exaptive processes in biological and cultural evolution. Future research could further elaborate on these principles of quantum cognition and on how they relate to fundamental questions in innovation and strategy, such as the above-mentioned tension between emergent versus deliberate strategies, the luck versus foresight dichotomy, and the process of serendipitous discoveries. In many situations, individuals seemingly make discoveries—at the nexus of accident and intention—of 'things which *they were not in quest of'* in a conscious way (our italics; see Merton and Barber 2004: 234). Quantum cognition could help shed light on issues such as entrepreneurial 'alertness' and frame it as a cognitive state of superposition characterized by true 'confusion' or foolishness, psychological ambiguity and uncertainty. We hope that future research will explore these kinds of questions.

Fourth and finally, our arguments offer new food for thought for domain of complexity economics, with important implications for the field of strategy. Specifically, 'complexity economics'—broadly conceived—builds on a fundamental proposition: the economy is in a continual status of disequilibrium and inefficiency. One of the main assumptions is that disequilibrium is endogenously generated by technological innovation, calling to the mind the Schumpeterian 'new combinations' of technology that 'disrupt any equilibrium that may be

attained' (Schumpeter 1912). This view puts technological innovation in the foreground and the formation of economic variables—such as prices and quantities—into the background (Arthur 2014). As recently noted by Arthur (2014: 7), 'a novel technology […] is a permanent ongoing generator and demander of further technologies' and this sides with our notion of unprestatability, affordances and the affirmation of the 'existence of an evolutionary logic in the multiplication of goods over time' (Koppl et al. 2014: 3). Starting from the basic premise that technological recombinations are exaptation-enabled and not only adaptive (Andriani and Carignani 2014), our paper explicitly brings exaptation into this far-reaching debate on economic thinking: the debate on market process, on economic disequilibrium and inefficiency, and on the existence and persistence of economic opportunities. More importantly, we expound on the perception of affordances/fixedness as fundamental cognitive-related conditions that respectively foster/limit exaptation and direct the market process towards states of disequilibrium. Overall, we contribute to the emergent research program that deals with central issues such as the 'formation' of an economy—and of heterogeneity itself—rather than the 'allocation' of resources within an economy (Arthur 2014). As noted by Kauffman (2000: 215), the 'overarching [and yet neglected] feature of the economy' is the 'secular increase in the diversity of [technologies,] goods and services'. Future research should start to investigate how the dynamics of price formation, the organization of entrepreneurship and the structure of markets respond to the emergence of exaptive innovations.

5. Conclusions

In this article we have argued that the prominent hypothesis of efficiency of factor markets is problematic, not just for the field of economics but also the field of strategy. We have argued that markets are systematically characterized by heterogeneity, and we have sought to cast light on both the environment- and actor-related factors associated with the origins of heterogeneity.

We have first discuss the 'exaptive' nature of environments and the continual emergence of new uses and functions, and then the role played by actor perceptions of novel affordances as central sources of heterogeneity. However, we also discuss how certain forces, such as functional fixedness, suggest that there are pressures toward homogeneity and seeming efficiency in markets. Overall we argue that markets are predominantly characterized by heterogeneity due to the open and emergent nature of environments and the opportunities that persist for agents to act entrepreneurially as they organize to create value.

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Endnotes

[i] Hayek emphasized that knowledge (of uses) is a 'crucial aspect of the economic problem', which is 'not merely a problem of how to allocate 'given' resources. […] It is rather a problem of how to secure the best use of resources, […] of the utilization of knowledge which is not given to anyone in its totality' (Hayek, 1945: 77; see also Thomsen, 1992: 15).

[ii] This phenomenon has received its own name: *cambiodiversity*, which is an analogy to biodiversity and refers to the diversity of traded goods (Koppl et al. 2014) that correlates with wealth (see Hidalgo et al. 2007).

[iii] Gould and Vrba further clarify… 'We suggest that such characters […] be called *exaptation*s. [...] They are fit for their current role, hence *aptus*, but they were not designed for it, and are therefore not *ad aptus*, or pushed towards fitness. They owe their fitness to features present for other reasons, and are therefore *fit (aptus) by reason of (ex)* their form, or *ex aptus* ' (Gould and Vrba, 1982: 6).

[iv] As noticed by Kauffman, the world is doing something literally 'incalculable, nonalgorithmic, and outside out capacity to predict' (Kauffman, 2000). In other words, it is not possible to predict and model innovation in terms of causal explanations (Koppl et al. 2014), but just in terms of enabling conditions.

[v] Jan Koenderink (2014) discusses the notion of an 'all seeing eye' and how this idea has predominated ideas of perception, despite significant flaws.

[vi] Representation-dominant models of economic activity suffer from the problem of confusing the map with the territory. These ideas of course have a long history (e.g., Berkeley's subjective idealism), but they also link with more recent scientific evidence from cognitive psychologists and neuroscientists who study the relationship between perception and reality (Hoffman 2000). The central point for our purposes is that it is impossible to somehow fully capture current, let alone emergent, realities in any fine-grained detail.

[vii] Beyond the biology and physiology of perception, the central point here is that something intervenes between perception and reality. The set of factor that intervene between perception and reality have been discussed under the auspices of many different factors. For example, Popper (1969) discussed the mind-dependent nature of reality. Peirce (1957) highlighted how our theories about reality construct our perceptions of reality.

[viii] Von Uexkull (1934) identified an evolutionary relation between cognition and environment and introduced the concept of 'umwelt', which refers to the sensibility of perception to specific environmental traits of the environment in which an organism is embedded. For a review of the topics, see Hutchins (2010).

[ix] The notion of 'situated cognition' is crucial here. Situated cognition relies on 'first-person' experiences of the environment that differ from abstract, non-partial and third-person representations (Clancey, 1993, 1997). What matters in the reduction of the environment relies more on the situated interaction of the actor with the environment, than on allegedly-objective properties. Objective, non-situated representations of the environment (memorized as a 'know-that') are marginal with respect to such abilities (know how) that provide a reliable (although un-articulable) guidance for acting in the environment (Kauffman, 2000).

[x] The notion of embodied cognition (Wilson 2002), which emerged in the last fifty years, constitutes a framework that can also shed light on the nature of affordances. By rejecting the Cartesian mind/body dualism and the Connectionist epiphenomenalism, embodied cognition explicitly challenges the Cognitivist paradigm moving from the general hypothesis[x] that cognitive processes cannot be abstracted by the bodily states of subjects: cognition is not based on abstract representations of reality and is not information processing (as in the metaphor of 'mind as a computer') but it constitutively relies on the morphological traits of human body (Gomila and Calvo 2008).

[xi] 'Effectuation theory' is somehow consistent with the notion of affordance. It contradicts the common assumption that entrepreneurs first identify external opportunities and then evaluate the internal means in order to reach them: in reality, they evaluate which external and affordable opportunities can be effectuated given the internal means (Sarasvathy, 2001).

[xii] From the above perspective, the embodied features—both endosomatic forms (human morphological traits) and exosomatic forms (artifacts)—specify the possibilities *and* the constraint for the 're-cognition' of novel creative uses, that is, which exaptations are affordable. This mechanism is consistent with an analogy making based on 'inference-preserving-cross-domains mappings', that is a projection of an inferential structure from a physical source domain -usually endosomatic traits- into a target domain, usually a more abstract one (Lakoff and Johnson 1999). For example, the alleged-abstract idea of 'time' presents body correlates to the extent that 'future' are the objects in front of us, and 'past' are the objects behind us; on the basis of these arguments we could argue that a jelly fish -whose morphological traits do not include the presence of a front and a back- would not able to arrive to such idea or analogy. As put by Núñez (2008: 351) 'biological properties and specificities of human bodily grounded experience impose very strong constraints on what concepts can be created'.

[xiii] Charles Peirce emphasized the role of abduction not just in generating novelty, but as a fundamental mechanism behind learning and knowledge itself: "man's mind has a natural adaptation to imagining correct theories of some kind…If man had not the gift of a mind adapted to his requirements, he could not have required any knowledge (1957: 71).

[xiv] While we focus the bias of functional fixedness, clearly a whole host of other biases and cognitive limitations may also play a role in delimiting the set of possible uses for a factor. For example, biases such as anchoring or essentialism could play a role, as could social biases like herding, shared information, system justification, etc. Additional work about how these respective biases impact markets, and how they relate to each other, is needed.

[xv] Functional fixedness may not be the only cognitive bias that relates to the perception of possible uses: other cognitive biases such as 'anchoring' may play a similar role. Other cognitive mechanisms—such as priming—are also related to fixedness and have already been discussed in the fixedness literature, to which we refer the interest reader. However, while other cognitive mechanisms play an 'ancillary' role, functional fixedness is strictly related to exaptation and therefore occupies a central position. The centrality of functional fixedness in Margolis and Laurence (2007)'s theory of human artifacts and their representation illustrates our argument.

[xvi] Functional fixedness produces the 'collapse' of the possible states of a physical form on a specific use or function, calling to the mind the role of conscious observation in producing wave-function collapse in quantum mechanics. The need to incorporate notions of potentiality and collapse has indeed stimulated the adoption of 'quantum' formalism in the modeling of phenomena such as exaptive innovation (Gabora et al. 2013).

[xvii] Nature is *non ergodic*, since it does not explore the space of all possibilities and only a few of them come into being (Longo et al., 2012).

[xviii] See Quine (1961)'s notion of 'unactualized possible'.

[xix] We might briefly note the other side of the argument. Eventual fixedness of course also serves a valuable role. Fixing functions is also inherently part of the entrepreneurial role, allowing for exploitation, the raising of funds and organization. We need a "classical" economic world to exist and from which we can grow.

[xx] As noticed by Cattani (2006: 310), 'It is difficult to explain a firm's behavior by simply looking at its stock of knowledge, because it is unclear how widely this stock can be used'. In other words, 'Firms often select new technological trajectories on the basis of how well their stock of knowledge matches the requirements of novel applications'.

[xxi] Quantum cognition differs from those theories of the brain as physical quantum device -the so called theories of the quantum brain (Penrose 1994). Nevertheless, the two approaches are somehow compatible. For the sake of simplicity, we omit the discussion of these aspects.

[xxii] As in the well known double-slit experiment.

[xxiii] In a certain way, it could be argued that consciousness-triggering judgments impose specific and definite states to cognition rather than the opposite (definite cognitive states pre-exist the formulation of judgments).