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Exaptation and niche construction: behavioral insights for an evolutionary theory

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Abstract

There is increasing interest in the study of exaptation as a key evolutionary force that generates novelty in economic systems. This article contributes to this growing literature by showing how entrepreneurial behavior may effectually construct new market niches enabled by exapted innovations. Put differently, new technologies—whatever their source—may not spontaneously create new market niches. Instead, exaptation and niche construction—two unconventional forces in evolutionary theorizing—challenge conventional conceptualizations of markets as independent selection mechanisms.

JEL classifications: D4, D52, L1, L26, O33

1. Introduction

An increasing number of scholars are beginning to observe that exaptation is a pervasive phenomenon in the evolution of technology. Exaptation draws our attention to the repurposing of artifacts, technologies, processes, skills, organizations, and resources for emergent uses that they were not (initially) designed for. Just how pervasive exaptation may be is as yet unclear. Scholars have pointed out many fascinating examples of exaptation (Bonifati, 2013), differentiated several categories of the phenomenon (Andriani and Carignani, 2014), and highlighted the importance of exaptation in the invention of new technologies (Cattani, 2006). To paraphrase Andriani and Carignani (2014: 1617), invention occurs in three patterns not two, which are conventionally summarized as demand-pull and supply-push. These two are augmented by exaptation, in which invention flows from the emergence of new functions for old forms. Owing to its pivotal role as a third force in invention, exaptation may kick-start the founding of new market niches, thereby producing novel (and largely unplanned) elements within the market process (Cattani, 2006).

However, a focus on exaptation as a force of origination, important as it is, gets us only part way to understanding the essential place of this concept in explaining technological change and economic evolution. To understand why (and when) exaptations have an economic impact, we need to trace complementary behavioral processes that leverage the initial opportunity an exaptation provides. In other words, we need to acknowledge and challenge the assumption of automaticity in niche construction that is implicit in theories of exaptation. Consider the contrasting examples of Marsilid (an antituberculosis drug that was exapted to serve an existing market for antidepressants) and Viagra [a hypertension drug that was exapted to create a much larger than existent market for erectile dysfunction (ED)].

Marsilid (Iproniazid) was originally developed as an antituberculosis drug until doctors' noticed that one of its side effects was that patients became unusually happy. A chain of events led to Marsilid being presented as an antidepressant at the 1957 American Psychiatric Association meeting (Lopez-Munoz and Alamo, 2009). Within a year, 400,000 patients affected by depression were prescribed Marsilid on an off-label basis (since the drug was only approved for tuberculosis). The astonishing sales of Marsilid highlighted the strong demand that existed for an efficacious antidepressant medication. Marsilid found a market niche ready and waiting for it (Andriani and Carignani, 2014).

In contrast, the discovery of sildenafil citrate (Viagra), meant to treat pulmonary arterial hypertension, did not automatically result in an overnight market for the drug. Quite the opposite. As Lexchin (2006) argues: "Had Viagra been confined to use only in cases of ED secondary to organic causes, the drug would probably have been a modest success for Pfizer." For Pfizer to turn Viagra into a blockbuster, the drug would have to reach a much greater population of men. This meant (Lexchin, 2006):

The perceived prevalence of ED needed to be increased, i.e., the perception created that ED was of significant concern to many men.

The perception needed to be created that any degree of ED might be serious enough to warrant treatment (owing to its psychological effects).

The criterion of success for treating ED had to be redefined.

Ideally, drugs had to be seen as the best treatment option.

Viagra had to be seen as the treatment of choice.

In short, to make Viagra into a blockbuster drug, Pfizer had to proactively construct the market niche for ED drugs, which Viagra initially completely monopolized, and for the most part, still does so today. Note that in both cases, a drug invented to treat one particular disease was exapted into an innovative treatment of another unintended health problem. Yet, the processes that resulted in these new market niches were clearly different, especially in the amount and types of human action involved to construct them.

The contrast between Marsilid and Viagra lays bare the fact that significant variation exists in the resources and effort required to construct new market niches. Marsilid was the "dream" case; its makers did not have to invest much in building the market. Abundant demand already existed for an antidepressant, and although it was withdrawn from global markets in 1961 owing to concerns about its other side effects, Marsilid initially had a monopoly after its antidepressant use became apparent. Moreover, the drug was already in production and—very importantly—institutional practices were well established in the medical profession that allowed it to be prescribed on an off-label basis. An easier case of establishing a new market niche is hard to imagine; in effect, the niche was already available "for rent" (Andriani and Cohen, 2013: 9), and Marsilid was ready to move-in. Viagra, as explicated earlier, was at the other end of the spectrum. Pfizer invested significant resources in making the market for the little blue pill.

Although we do not know the distribution of costs of constructing new market niches, this article is dedicated to the proposition that there exists such a distribution and that the costs include behavioral as well as financial resources. In what follows, we will examine literature that supports this assertion, scrutinize concepts that illuminate the new market niche construction process, and analyze implications following from it. The overall thrust of our argument is that new technologies—whatever their source—may not spontaneously create new market niches. Markets are specific institutional arrangements comprising informal conventions and formal rules that support exchange at scale. Firms may have to make significant investments to bring new market niches into being (Casson, 1982). The construction of new market niches also depends on sufficient user demand for exchange. Sometimes, demand is self-evident enough to guide producer actions, but sometimes, it is not, and producers may need to invest in nurturing demand. To quote Schumpeter: "It was not enough to produce satisfactory soap, it was also necessary to induce people to wash." (Schumpeter, 1939: 243). Since an initial exaptation may become consequential only via follow-on niche construction processes that exploit the opportunity it provides, understanding these processes may be key to understanding the economic impact of exaptations. Therefore, we see exaptation and niche construction as linked, complementary processes that work better when they work together; in fact, the former is often only important as a result of the entrepreneurial work done to make the latter happen. Complementary to this is also the fact that the entrepreneurs' efforts to construct new market niches propels them to keep an eye out for and even actively use exaptive possibilities embedded in existing economic artifacts such as products, firms, and market structures.

Our analysis leads to two sets of implications of some importance for research on economic change. First, because niche construction activities modify the environment, they draw attention to the fact that organizations are not passive subjects of selection, but instead try to proactively influence selection mechanisms. This is important for evolutionary theorizing because it suggests that reciprocal interaction and multiway fitting may be at the root of how organizations and their environments reach accommodation with one another rather than the unidirectional conception of selection as the prime mover in evolutionary systems. Once we theorize market niches—the traditional locus of adaptation in evolutionary theory—as constructed out of interaction between producers and consumers, our view of evolutionary theory is reformulated into one which highlights a balanced, bidirectional interplay between external forces (selection) and internal forces (e.g., niche construction arising from exaptation). This recognizable coevolutionary dynamic is one implication of exaptation that this article aims to highlight and explore (Lewin and Volberda, 1999). It balances the influence of functionalist, outside-in claims (privileging selection pressures, the traditional claim of much evolutionary literature) and inside-out opportunities to construct and shape market niches (thus reshaping the selective forces acting on organizations). The second set of implications is directed at the micro level to theorizing about firm strategy and entrepreneurship. Here, we ask what changes when we migrate from a selection and adaptation-dominated model informing organization strategy to a model in which reciprocal causation and organization–environment matching inform strategy. We highlight several mistakes that emerge in current patterns of strategic thinking when our fundamental model of market evolution is understood differently.

2. Literature review: new market creation, exaptation, and entrepreneurial effectuation

2.1 Exaptation: a missing construct in new market creation

Notwithstanding a few thorough and careful treatments of the topic (e.g., Geroski, 2003), the traditional theoretical picture of new market creation is dominated by two archetypes (Andriani and Carignani, 2014). Both of these archetypes ignore the role of exaptation in new market creation. According to the two traditional archetypes, new markets are either:

Outcomes of exogenous changes in technology, user preferences, or institutions. These continual shifts are exploited by perceptive entrepreneurs who move quickly to take advantage of new market possibilities or

Outcomes of forceful and imaginative entrepreneurs who bring new products to market by recombining resources into new bundles that better serve user needs (Schumpeter, 1976; Teece, 2007).

In the former case, new markets are products of exogenous forces that are exploited by entrepreneurship. For example, in 1997, the US Food and Drug Administration changed its regulation of drug advertising to allow (not for the first time) direct-to-consumer prescription drug advertising (Huh *et al.*, 2010). Pharmaceutical companies leapt on this opportunity, and today, drug advertising is one of the largest categories of advertising in broadcast media in the United States. Indeed, consumer advertising was one of the major opportunities exploited by Pfizer for popularizing Viagra. In the latter case, new markets are endogenously conjured up as a result of entrepreneurial activity, with a focus largely on the invention or innovation of new products and services, for example, the emergence of many new products from the (largely) venture capital-backed biotech industry. However, both cases theoretically exclude exaptation processes, the first by entirely exogenizing the production of novelty, the second by limiting the universe of novel designs exclusively to new combinations (Weitzman, 1998).

Coarse though this summary is, it does capture the essence of these two research streams in their paradigmatic form. Nevertheless, however useful these two conceptualizations have been for the development of research on new markets over the past 50 years, scholars have also pointed to a number of serious issues with them. An important result emerging from modeling innovation as a combinatorial process is that the number of innovative possibilities quickly becomes astronomical (Weitzman, 1998). This suggests a significant search problem at the center of entrepreneurial processes, since the number of seed ideas vastly outstrips the capacity of agents with bounded cognition to process ideas into workable innovations. The challenge for entrepreneurs is how to “find” a good combination from the enormous number available (Weitzman, 1998: 333). Given the search problem and behavioral constraints, Denrell *et al.* (2003) propose that it would not be surprising if good combinations were actually discovered serendipitously. Indeed, the two examples of drugs we have used so far (Marsilid and Viagra) could have arguably been discovered owing to pure chance. It is just that the detailed histories of these two show differential yet important roles for exaptive strategy as well as serendipity.

At the core of many existing theories used in management research is a set of asymmetric behavioral assumptions, e.g., resource-based view, principal-agent theory, and transaction cost economics (Bromiley, 2003). In the case of new market niches, fundamental assumptions about learning (derived from theories of bounded cognition) tend to be applied differently to producers and consumers. Producer learning processes, framed using behavioral insights from the Carnegie school (Cyert and March, 1963), are central to evolutionary interpretations of the workings of the supply side of the market (Nelson and Winter, 1982). However, consumer learning processes are ignored or assumed away. The most influential account of economic evolution that we have—Nelson and Winter (1982)—employs very simplifying assumptions about how markets work as part of its theoretical apparatus. Usselman (1993: 31) remarks: “As Nelson and Winter note at the outset, their theory assumes that the market performs as the neoclassical orthodoxy suggests—large numbers of consumers with access to all information make optimizing decisions” [Nelson and Winter, 1982: 39]. (Usselman, 1993: 32). Therefore, behavioral insights are not incorporated into the market (consumer) side of economic evolution. Similarly, while evolutionary theory stresses the uniqueness, idiosyncratic capabilities, and diversity of producers (again, ultimately stemming from bounded cognition in many instances), the diversity, uniqueness, and idiosyncratic capabilities of consumers tend to be ignored (Vargo and Lusch, 2004). Finally, Nelson and Winter address adaptive innovation (which produces better-faster-cheaper results), whereas exaptation addresses innovation via functional change. Insights into the exaptation process might benefit from behavioral understandings just as insights into adaptation have benefited from applying behavioral principles.

There is ample reason to suppose bounded cognition and learning play just as central a role in exaptation and the development of new market niches as they do in producer learning processes. Consider again Marsilid. Although Marsilid was only available for 4 years before being withdrawn, it dramatically changed the “market” for depression management. Prior to the advent of Marsilid, the dominant medical approach to depression was the Freudian doctrine that depression was a symptom of internal personality conflicts. Under this view, pharmacological treatment of depression was considered a real error (Lopez-Munoz and Alamo, 2009). However, the market (patients and the medical profession) *learned* from using Marsilid that the drug treatment option worked for a large percentage of depression cases. This led to a wider transformation of medical opinion about depression, from it being a disease of the mind to it being a biological disease of the brain (Lopez-Munoz and Alamo, 2009). The development of Marsilid (and follow-on drugs) is therefore regarded by some experts as “the most important advance in the history of modern psychiatry” (Hobson, 1994). Thus, despite sweeping into a “vacant” market niche, Marsilid by no means left that niche unaltered. Patient and doctor demand for treatment options was radically *reshaped* by the introduction of the drug.

Significant issues surround the assumption of preexisting demand being available to act as a selection force on rival entrepreneurial offerings in new market niches (Bonifati, 2013). In some instances, well-defined demand criteria are evident in the marketplace, and producers must compete to meet these selection criteria, e.g., for higher performance microprocessors (Burgelman, 1994), or in the development of novel defense systems such as Polaris (Sapolsky, 1972). However, in other instances where new market niches are created around the emergence of a new technology, demand-side selection criteria may not precede the arrival of suppliers in the market place in the way required by selection theories. According to Bonifati: “A critical point in the explanation of the emergence of new technologies in terms of speciation is that it requires the new fields of application (new niches) with already specified selection criteria to exist *before* an existing technology finds a new application. Indeed, these are the criteria which guide the adaptation and development of new technologies . . .” (Bonifati, 2012: 289; italics added). To illustrate this point, Mike Markkula, who financed Apple Computer at start-up, described the personal computer market at the time: “The problem was, you’d walk down the street in 1976 and talk to 100 people and say, Would you like a Personal computer? And they’d go, What’s that?” (Geller and Golden, 2011). In turn, Steve Jobs, who famously derided customer focus groups and other market research techniques, was described by one commentator as thinking that consumers are “knuckleheads. They have no idea what new products they want” (Kahney, 2008). And Henry Ford is well known to have quipped that if he “had asked people what they wanted, they would have said faster horses.” As these examples highlight, specific demand may lag behind, rather than precede, the supply of new products in the marketplace.

Geroski (2003) offers the theoretical refinement of “inchoate” consumer demand at the initial stages of a new market niche’s development, gradually evolving over time into “articulated” demand through user learning. Users may learn (in a biased way) what works best for them from sampling competitive alternatives. A key issue then becomes the availability of alternatives. In the Marsilid case, producers were initially highly skeptical about demand for antidepressants; in 1957 (the year Marsilid came to market) Hoffmann-La Roche had judged antidepressants to be

an uncertain and inadequate market (Lopez-Munoz and Alamo, 2009: 1567). However, once producers discovered the enormous commercial potential for antidepressants, they quickly introduced alternatives that led to intensified competition and marketing agreements to broaden the sales of antidepressants globally. In a synergistic fashion, this may have propelled the formation of more specific drug preferences by both doctors and patients because it gave them more alternatives to sample from.

From the foregoing, it is apparent that the degree of proactive effort often exerted by producers working in new market niches should not be necessary where markets for new technologies obey the assumptions of economic orthodoxy, in which case they should emerge spontaneously (Olson and Kahkohen, 2000: 1). Arrow (1974: 8) acknowledges that, “Although we are not usually explicit about it, we really postulate that when a market could be created, it would be.” Yet, the fact that new market niches may not emerge spontaneously is precisely why producers may have to invest significant resources in niche construction. One can frame this problem in terms of the costs of transforming inchoate demand into specific demand and the costs of forming market infrastructure. Neoclassical economics exogenizes these costs, assuming that they are outside the model because the model assumes that given, known preferences already exist and that the market process is costless. Sometimes, this assumption is a reasonable approximation of market conditions. But sometimes, it is not, and once we are forced to endogenize demand and market infrastructure into the model, the costs of forming new market niches move inside the model and can be seen to vary considerably.

Therefore, there is a need for alternative explanations of exaptation and new market niche creation. Above all, the status quo approach applies different theoretical assumptions to producers versus consumers, and to adaptation versus exaptation. We need to replace this lopsided and inconsistent approach with an even-handed analysis of all actors in the marketplace based on identical behavioral assumptions. In making realistic assumptions about consumer behavior and learning, we should relax the assumption that demand is always preexisting, instead, maintaining that the shape of demand in new niches may be at least partly supply driven. Instead of knowing what they already want, consumers can often be assumed to only know what they want by learning from consumption experiences. Furthermore, we should conceptualize consumers in one sense as the same as producers, in that they are equivalently diverse in their needs and idiosyncratic in their capabilities for extracting value from products and services. Their demand for products may indeed begin as inchoate, and gradually develop through a learning process that involves sampling new goods, and discovering their own reactions to them. This involves just as much learning about preferences and capabilities on the consumer side as it does learning about what capabilities are valuable on the producer side. For producers, the process of creating new goods and services from combinations of existing resources is conceived of involving such tremendous search problems that make it plausible—perhaps likely—that new product offerings will often emerge in a highly contingent, haphazard fashion, e.g., via exaptation. Lastly, because consumers and producers interact, they influence each other, introducing a set of dynamics that shape new market niches in a much more symmetric fashion than currently conceptualized by selection-driven models of adaptation. Therefore, much proactive work may be involved in constructing new market niches, using processes that are fundamentally entrepreneurial in nature.

2.2 Effectuation at the nexus of exaptation and new market creation

One behavioral theory that has extensively been shown to be associated both with exaptation and niche construction is effectuation (Sarvasathy, 2001, 2008; Sarvasathy *et al.*, 2015). Exaptation is one of several types of transformations that entrepreneurs produce when employing effectual heuristics (Dew *et al.*, 2011). In this section, we explain how effectuation has a built-in propensity to facilitate exaptations. Because of the link between exaptation and effectual heuristics, we conjecture that effectuation may provide a useful baseline framework for understanding the behavioral processes that are likely to produce and leverage exaptations. These processes are fundamentally different from the local search processes that support adaptation, yet originate in, and belong to, the same broad body of behavioral research rooted in bounded rationality and satisficing, e.g., behavioral theories of the firm (Cyert and March, 1963; Nelson and Winter, 1982; Tversky and Kahneman, 1974).

The baseline model of effectuation was induced from a study of expert entrepreneurs’ problem-solving approaches (Sarvasathy, 2008). This study highlighted a handful of distinctive heuristics (rules of thumb) used by subjects that were united by an underlying internally consistent logic that formed a characteristic basis for action. The focus in effectuation is on very local possibilities, in keeping with the principles of bounded cognition (Bromiley,

2003). If framed as a search problem (as opposed to a problem of construction or design), effectuation therefore overlaps with the literatures on local search and satisficing heuristics. However, effectuation provides particular mechanisms of framing local search such as looking for slack resources and re-purposable waste materials, and specific strategies for framing satisficing heuristics such as the affordable loss principle (namely, only consider opportunities that fall within your affordable loss level of investment). Central to effectuation's logic is a rejection of prediction and forecasting in favor of a creative and constructivist approach to problem solving. Accordingly, "Not taking the environment as given and/or predictable also implies that adaptive or other types of reactive strategies are inadequate and even inappropriate in the effectual process. Instead, entrepreneurial firms that use an effectual logic tend to develop exaptive strategies" (Dew *et al.*, 2008: 43).

The potential for exaptation in the effectual process arises from the combination of effectual heuristics that collectively create a *permissive local context* for exaptation. Prior research has highlighted diversity and connectivity as two variables that may influence the frequency of exaptation. According to Andriani and Cohen (2013: 12): "[T]he potential for exaptation cannot be sought in the properties of a tool or its uses but rather must be found in the facilities in the developing context, for new utilities to be engendered." These authors therefore highlight that context is central to the creation of exaptations. A high degree of diversity and connectivity creates a permissive context that increases the likelihood of exaptations.

To see how effectuation creates a permissive local context for exaptation, let us first consider the overall effectual worldview of the future as something that is cocreated and therefore fundamentally unpredictable. Thereafter, we will consider the four effectual heuristics: means-driven action (rather than goals), the centrality of stakeholder interactions (incorporating other people's inputs), the aforementioned affordable loss heuristic (using affordable loss to discriminate between options), and leveraging surprises (the role of contingencies).

At an abstract level, effectuation starts with the notion of "the market as a game without goods" (Buchanan and Vanberg, 1990) and proceeds on the foundation of offering services to others based on available means. The use of an effectual approach will result in outcomes different from using an adaptive approach. It is possible to proceed adaptively by asking "What *should* we do?" given the environmental context. One can also proceed effectually by asking "What are all the things we *could* do with our available means?" and then "What else can we do?" While the adaptive approach fixes the environmental context, the effectual approach treats the environmental context as a variable and is therefore more conducive to exapting different functions from a particular collection of means. Incorporating other people's inputs via stakeholder interactions introduces diversity, new connections, and new means into the effectual process. The self-selected stakeholder heuristic in effectuation therefore introduces a garbage can process in which the local context varies according to the contingent set of stakeholders who choose to get involved (Cohen *et al.*, 1972). Affordable loss biases the selection of options toward exaptation because functional changes are often available for free or at low cost (Andriani and Carignani, 2014). For example, Marsilid was co-opted for a new use for free; however, the purposeful, adaptive development of follow-on generations of antidepressants (e.g., Prozac by Eli Lilly & Co.) today would cost hundreds of millions of dollars. Finally, leveraging contingencies involves seeing and seizing utility in the unanticipated. An example would be an unexpected change in the market environment. Because environment shifts create a more diverse local context, embracing rather than seeking to avoid such shifts will increase the chance of exaptation occurring. In summary, there are a number of reasons for expecting an effectual process to be conducive to exaptation, however useful or worthless those exaptations may prove to be down the road (Dew *et al.*, 2008).

For an example of the effectuation–exaptation connection, consider Kiran Mazumdar-Shaw, founder of Biocon, who is currently one of India's richest women. Ms. Mazumdar-Shaw wanted to follow in her father's footsteps as a brew-master, training in brewing skills in Australia before returning to India to seek a job in the brewing industry. She had no intention of starting a venture or becoming an entrepreneur. However, brewing is such a male-dominated industry in India that Ms. Mazumdar-Shaw failed to obtain a position. It was only in response to a fortuitous encounter with a friend who happened to be an entrepreneur and asked her to partner in a biotech venture that Ms. Mazumdar-Shaw started Biocon. Her initial response to her friend was that she did not know anything about biotech. But, he pointed out to her that the venture would develop and produce enzymes, something she already knew how to do. In Ms. Mazumdar-Shaw's own words: "If you think about brewing, it is biotechnology. And I would say that I was a technologist at heart. So whether I... fermented beer or whether I fermented enzymes, the base technology was the same" (BBC, 2011). Thus, an accidental encounter produced a (very classic) quirky functional shift in the purposes to which Ms. Mazumdar-Shaw's human capital investments as a brewer would be applied

(an illustration of exaptation as applied to an individual's human capital endowment—what they know—e.g., the “cooptation of an existing structure originally built for different reasons”—Gould, 2002). From the production of enzymes, through further exaptations, Ms. Mazumdar-Shaw expanded her business into manufacturing medicines, eventually turning Biocon into a major firm in India's biotechnology sector. Her case provides a good illustration of co-opting skills into new uses based on stakeholder feedback, resulting in the discovery of hidden functionalities that the entrepreneur themselves had not foreseen. Instead, Biocon got its start based on exposure to stakeholders who provided an external viewpoint, an environmental shift of a kind that led Ms. Mazumdar-Shaw to “find” new functions in her personal resources.

Effectuation may draw out exaptations in a variety of ways, partly because the scope for exaptation is larger than it is sometimes thought to be. Exaptation is a multifaceted phenomenon (Andriani and Carignani, 2014). Gould (2002: 1284) argues that theoretically entities are isotropic pools of attributes that have the potential to manifest in innumerable different ways *depending on the context they are put into*. Every entity potentially has yet-to-be-discovered contingent relationships with aspects of its environment, and therefore there is (theoretically) infinite scope for exaptation. The most familiar type of exaptation involves discovering ways to leverage previously unrealized resource qualities (a “Franklin” in Gould's taxonomy). Franklins are re-purposings of something that was already in use and useful (as in the Marsild case or bank-branching strategies in Marquis and Huang, 2010). Such entities prove over time to be multiuse items, e.g., dual-use technologies, in the context of different environmental contexts or circumstances. A second type of exaptation is what Gould refers to as a “Milton” or “Spandrel,” which is a feature that evolved because of design or developmental constraints and is later exapted for a new purpose. Third, exaptations can be rooted in the statistical noise in adaptation processes (“drift”) that result in artifacts having miscellaneous, initially irrelevant, and worthless attributes. These may become useful or valued later when exapted. Lastly, there are unemployed attributes, probably best characterized as “junk.” These are attributes that were present for a long time but were never squeezed out by selection pressures, probably because they did not impose significant costs. If these attributes had imposed costs, they could be characterized as garbage, and we would expect them to have been eliminated by selection pressures. However, as long as an attribute is not too expensive to maintain, it hangs around like junk in your garage as potential fuel for exaptation.

As we can see from Gould's typology, the scope for exaptation is therefore rather rich; coupled with a set of entrepreneurial behaviors that create a permissive context for exaptation, it makes sense that exaptation is a frequent path to novelty creation in economic systems (Andriani and Carignani, 2014).

3. Behavioral factors in new market niche construction processes

In this section, we build on the literature reviewed so far by turning to some behavioral characteristics of consumers that shape the construction of new market niches based on exapted technologies. In biology, niche construction is defined as: “The adaptive modification of an agent of its environment.” (Laland and Sterelny, 2006: 1753). The effectual logic highlighted above observes the same principle that agents' actions result—knowingly or not, deliberately or not—in the transformation of their local, proximate environment. In part, the feasibility of this approach rests on the ambiguity and malleability of consumer preferences and other behavioral factors that affect consumer learning and decision-making processes. Carpenter and Nakamoto (1989) argue that these aspects of consumer behavior may lead to producer influences (either deliberately or unconsciously) on the development of market niches:

“[C]onsumer preferences are, at least in part, the outcome of competition. Lacking fixed, exogenous preferences, buyers learn their preferences through trial and error—on the basis of the available alternatives, prices, and positions-making inferences about what attributes they do and do not like. Thus, preferences for attributes evolve with consumer experience. Competition, therefore, can be viewed in part as a race to shape the nature of consumer preferences.” (Carpenter and Nakamoto, 1994: 571)

Factors affecting user learning about preferences include:

Product prototypicality. Examples of prototypicality include Jeep (which defines the sport-utility vehicle niche), the Apple iPad (prototypical tablet), iPhone (prototypical smartphone), FaceBook (prototypical social networking site), Google (prototypical internet search engine), AK-47 (prototypical automatic rifle), or Glock (prototypical handgun). Prototypicality affects consumer preferences through the representativeness heuristic (Tversky and Kahneman, 1974) in which customers form a preference for a product owing to it being a standard against which products in a particular niche are judged, despite the fact that the product's representativeness provides no relevant

information about the product's quality. For example, Pfizer benefits from Viagra being the benchmark for ED treatments. Viagra defines the ED drug category and sets user expectations for competing treatments in its market niche by establishing a metric that other treatments are evaluated against. Entrepreneurs can exploit prototypicality either when their product is the benchmark in a niche or by imitating the prototypical offering.

Complexity of choice problem. Fiske and Taylor (1984) highlight that decision makers may use cognitive shortcuts when possible, i.e., tactics that simplify complicated choices. These shortcuts affect the learning processes of customers in new market niches in ways that influence their eventual preference structures. In the early stages of a new market niche, customers may know relatively little about the ideal combination of product attributes that would best suit their needs or the relative importance of each product attribute. For all but the simplest of products, such learning is a complex problem for customers (Carpenter and Nakamoto, 1989: 286). Because customers are exposed to product attributes sequentially, their preferences are likewise likely to form sequentially and evolve over time through updating processes. As a result, entrepreneurs (whether individuals or within existing firms) pioneering a niche have more opportunity to shape customer preferences in a niche than do later-entering firms. For instance, early user experience with Viagra may influence how later user experience of other ED drugs is interpreted and valued relative to the preference structure acquired from using Viagra first.

User complementary skills. Skills that users need to learn and master in order to use a product to its full potential form another way in which customer preferences may be shaped by producers (Stigler and Becker, 1977). Prominent examples are software products, though user skills are required in subtle ways for a much wider range of products than the literature has sometimes recognized (Vargo and Lusch, 2004). For instance, even a tin can opener or corkscrew requires user skills to be employed to full effect. As with the example of preference structures, the order in which consumers are exposed to products in new market niches affects the nature of the niche in its mature state, since consumers are averse to investing in updating their skills if they deem their current skills adequate for their needs. To use the Apple iPad as an example, Apple leveraged something already to hand—user familiarity with the touchscreen interface of the iPhone—when it launched the iPad. Apple deliberately worked with the skills users had already developed. Its approach was in line with effectuation research, which suggests that expert entrepreneurs have learned to specifically distrust market research data pertaining to the future. More generally, expert entrepreneurs appear to eschew all kinds of predictive information about the future behavior of customers and markets, preferring instead to work with what is already to hand (Read *et al.*, 2009).

Social influences on consumer preferences. One way in which producers may shape a market niche is by appealing to the signaling value of a product. Social status is a classic social factor in consumption choices that can be, as frequently is, actively manipulated by producers by offering products that have some kind of exclusivity value. What beers are “in,” what electronics are “in,” what Web sites are “in,” what pop stars are “in,” and what fashion is “in” are all examples of market niches that are actively manipulated by producers, often using celebrity endorsements for advertising and social media. To continue with the example of Viagra, the drug became trendy and popular as a “lifestyle” choice among 18–45-year-olds, a trend influenced by Pfizer's advertising campaigns aimed at the National Association for Stock Car Auto Racing races using a 39-year-old baseball star as their spokesperson.

Irrelevant attributes may influence customer choice. Another factor that may influence the shape of new market niches is irrelevant attributes of products. Irrelevant attributes affect the learning challenge customers face when evaluating new products by adding one or more attributes to a product. Product attributes that are irrelevant but difficult to evaluate or highly distinctive may be especially impactful. Highly distinctive attributes may refocus consumer evaluation criteria because consumers “may infer that the irrelevant attribute actually causes the product to perform better” or that it “makes the differentiated brand distinctive in consumers' minds... and therefore preferred” (Carpenter and Nakamoto, 1994: 341). Irrelevant attributes may also help consumers resolve choice conflicts by providing an easy justification for choices (Brown and Carpenter, 2000). For example, Viagra pills are bright blue (the drug is sometimes called “the little blue pill”), which is an irrelevant attribute but one that makes Viagra very distinctive and has added to its notoriety.

In summary, a key insight emerging from a behavioral analysis of new market niche formation is that the bounded cognition of consumers may create scope for producers to transform the nature of market niches. The interpretation of niche evolution therefore demands a somewhat subtle analysis of the two-way impact of producers on niches as well as the impact of consumer sovereignty on producers. Moreover, producers may select market niches to compete in partly based on their perceptions about the scope for influencing the future shape of the market. Thus, producer

entry may reflect both the skills and preferences of the firm, including its estimated ability to alter the selective pressures to which they will subsequently be subjected by entering into a particular market niche.

4. Implications: macro (for evolutionary theorizing)

The notion that entrepreneurial producers may sometimes have a significant role in shaping the nature of markets in which they subsequently compete poses several implications for evolutionary theorizing. While in the short run, one can usefully apply the heuristic of adaptation by selective pressure, over the longer term, it is apparent that new markets are not necessarily created by producers slotting goods into a preexisting market template; instead, consumer behavioral factors suggest that producers may have a significant role in inventing and constructing new market niches. In doing so, over time producers therefore participate in refashioning the universe of markets. These shaping activities may alter the selection forces acting back on producers. As a result, they may subdue some opportunities while boosting others, and diminish some hazards while intensifying others. These observations lead to questions about the universal application of linear one-way causation in which selection dominates the adaptation process since that framework is mismatched with the implications that arise from niche construction. We already saw one major reversal of theory: with exaptation, traits that were mal- or nonadaptive can become adaptive (and vice versa for some traits). We should expect exaptation-fueled niche construction to produce other significant differences that do not conform to the traditional macroevolutionary picture (Laland and Sterelny, 2011). This raises the possibility that market processes may diverge from the manner predicted by received theories of evolutionary economics.

The conventional wisdom about market evolution is widespread not just in evolutionary economics but also implicitly among a body of conventional economics and economics-influenced disciplines, such as marketing and management. The key feature of the standard models is that selection forces drive producers to make products that fit preexisting market templates. Causation can therefore occur in one direction only: the market dictates the constitution of products and therefore which producers survive in the marketplace. As Williams (1992: 484) puts it (in referring to biological organisms): “[A]daptation is always asymmetrical.”

Friedman (1953: 22) provides perhaps the classic statement of the basic assumptions of the selection hypothesis—that the internal mechanisms of organizations can be viewed merely as an isotropic substrate supplying random variation upon which selection operates, with selection alone supplying evolutionary direction:

“Let the apparent immediate determinant of business behavior be anything at all—habitual reaction, random chance or what not. Whenever this determinant happens to lead to behavior consistent with rational and informed maximization of returns, the business will prosper and acquire resources with which to expand; whenever it does not the business will tend to lose resources *[G]iven natural selection, acceptance of the hypothesis [of maximization of returns] can be based largely on the assumption that it summarizes appropriately the conditions for survival.*” (italics added)

Within the evolutionary economics tradition, Metcalfe (1994: 936-937) summarized the common features of the standard models thus:

“The distinctive feature of any evolutionary model is the role which variety in behavior plays in driving a selection process to alter the relative importance of the different behaviors. Market competition provides a canonical example of such a process, with firms seeking competitive advantages through the adoption of traits which are positively selected for in the market process *While there are many specific models of the evolutionary dynamic . . . their common features can be outlined in the following simple framework. A group of firms is competing in a perfect market for the sale of a homogenous good, the only difference in the performance of the firms being associated with their unit costs of production which, in turn, reflect each firm’s different technological competence and bundle of decision routines for organizing production.*” (italics added)

In the marketing literature, a very similar fundamental approach influences how scholars interpret the evolution of producers and markets:

“Conventional product differentiation strategies suggest distinguishing a brand on the basis of something that is meaningful and ‘widely valued’ by buyers The marketing concept implies that an objective of marketing strategy is to be ‘market driven’—meet customer needs—and competitive advantage arises from those who meet customer needs best.” (Carpenter and Nakamoto, 1994: 572)

As these quotes illustrate, the hand-in-glove fit of organizations–markets is conventionally explained exclusively by referring to environmental sculpting, i.e., selection-driven adaptation forces. However, what is needed is a model

of evolution that can incorporate both selection/adaptation processes and exaptation/niche construction processes. These are two theoretically distinct possibilities for creating a fit between organizations and markets. Neither *exclusively* explains organization–market matches.

One way of reformulating this fitting issue is to propose a more general explanatory framework, in which multiway (reciprocal) interaction between organizations and markets is considered to be universal, and adaptation by unidirectional selection is considered a special case of multiway interaction in which feedback is negligible (Laland *et al.*, 2011). Thus, the universal property of evolving systems may be reciprocal causation, with conventional selection being “[U]nusual, an atypical case where reciprocal impacts are minor enough to be ignored” (Laland *et al.*, 2011: 1515). Thus posed, the standard approach to evolutionary thinking may shift from expecting to see selection-driven adaptation to expecting to see reciprocal interaction, resulting in fitting of organizations with markets. This is to recognize that the accommodation of organization–environment is not one-way and is not static; it flows both ways and is interactive. As we saw with Marsilid, even for a case where a seemingly well-formed niche was available, the niche was immediately transformed by the arrival of Marsilid. One should expect multiway interaction to be as business as usual in market niches.

In sum, exaptation and niche selection are unconventional forces in evolutionary theorizing that result in a deep philosophical challenge to the primacy of markets as selection mechanisms, i.e., the assumption that markets are given and act as external selection devices on organizations. We need to gradually transform this theoretical picture into the notion that organizations and markets are interacting systems that vary in selection intensity both when compared to other organization–market combinations and when compared to themselves over the course of their lifecycles.

5. Implications: micro (for organization strategy and entrepreneurship)

In this final section, we turn to analyzing the implications of exaptation in the micro, i.e., for organization strategy and entrepreneurship. What changes when we migrate from an adaptation-dominated model informing organization strategy to a model in which the selection/adaptation paradigm is one component within a broader model based on reciprocal causation, driving organization–environment matching?

One significant implication is how researchers frame processes of creativity and experimentation. In a world in which reciprocal causation is responsible to organization–environment fitting, it is a mistake to treat creativity as random variation. The direction of creativity is less material only when one-way selection completely dominates the evolutionary process (per Friedman, 1953). In these circumstances, treating creativity (and experimentation) essentially as random bets or guesses is reasonable because over time, selection will reliably sift through them (subject to some degree of error). But when reciprocal causation processes drive evolution, the creative product competition between entrepreneurs may shape the consumer learning process, with early market offerings therefore impacting the shape of selection mechanisms down the road. For instance, producers crowding around a small number of new product ideas will probably shape the market differently than if producers make a wide range of fundamentally different product offers to customers. Therefore, it is desirable for researchers to exercise some caution in characterizing new market niches as discoverable via experimentation or probing, since these twin metaphors of discovery and experimentation draw on the scientific method and are only valid inasmuch as the market is exogenous. To the extent that organizations and markets develop in a reciprocal relationship, these metaphors break down because they ignore the two-way causality involved in interactions between organizations and markets. Furthermore, to the extent that entrepreneurial producers compete to shape new niches based on different conceptions of the marketplace, strategic competition creates another layer of unpredictability about the nature of future market niches, since the shape of those markets may depend to some extent on the open-ended competitive interplay between rivals.

The final implication we highlight is that exaptation reminds us to exercise caution any time research depends on the assumption that the fundamental concepts of markets and consumer preferences are fixed and immutable. In the past, March (1978) has been particularly erudite in pointing to the ambiguity in customer tastes; that it is reasonable to expect some uncertainty about the composition of tastes because the preferences of the self today may not be reflected identically in the preferences of tomorrow’s self. Carpenter and Nakamoto (1989, 1994) capitalize on this point to argue that marketers should assume that consumers take time to learn their preferences, and that while consumer preferences are by no means *tabula rasa*, it is a mistake to assume that they are not shapeable. Particularly, in the early days of a new market niche, consumer tastes are likely to be influenced by their experiences with products. As Carpenter and Nakamoto (1994: 571) put it:

“Before this project began, our thinking about competitive advantage paralleled work based in economics that implicitly makes very strong assumptions about consumer decision making and preferences. In particular, consumer preferences are taken as fixed and exogenous—not the outcome of competition but the determinant of it. This is reflected in the marketing concept in that marketing is seen largely as a process of discovery, identifying and meeting consumer needs.”

However, through their studies, they conclude instead that:

“[S]haping consumer tastes . . . may be a central objective of marketing strategy. Competition may then be a race to define consumer tastes, and competitive advantage in that case may arise from crafting a valuable asset—a favorable preference structure and distinct perception in customers’ minds.” (Carpenter and Nakamoto, 1994: 572)

Our analysis in this article similarly cautions researchers against making two simplifying assumptions in their work. First, that there is any such thing as “the market.” As highlighted by [McMillan \(2003\)](#), “THE market” is an abstraction, and is inevitably viewed as an exogenous entity. In reality, a behavioral view that treats producers and consumer theory even-handedly will recognize the idiosyncrasy of market niches and customer segments within them, as driven by behavioral factors, including the evolution of customer capabilities for getting the best out of a product or service ([Vargo and Lusch, 2004](#)). Second, researchers should be cautious not to assume away the ambiguity in customer tastes, in particular in new market niches. Fortunately, this becomes easier to accept when we substitute the notion of “The market” with a view of the infinite “catallaxy” of market niches, each at a different development stage, each evolving its way through its own particular life story, yet each shapeable through action by producers as well as consumers.

6. Concluding remarks

To conclude, we recap the three significant issue areas identified in past research on new market niches. In each case, research can benefit from a behavioral perspective on exaptation and niche construction, which we point out briefly as follows:

- The issue of searching for good combinations in a vast space of alternatives (highlighted by [Weitzman, 1998](#)). The conventional wisdom is heuristic search for an adaptive solution. An alternative approach is exaptation, fuelled by effectual behaviors that create a permissive local context for exaptations to occur.
- The issue of asymmetric behavioral assumptions used in market processes (highlighted especially by [Bromiley, 2003](#)). The conventional wisdom is to treat deviations from rationality as barriers to be overcome in new market niche creation. However, viewed through the lens of behavioral theories, consumer learning and decision-making processes may also be leveraged by producers (deliberately or unconsciously) to influence the shape of new market niches.
- The issue of lack of preexisting selection criteria to guide the development of new technology, products, and services (highlighted by [Bonifati, 2012](#)). The conventional wisdom is guessing what the market might want ([Geroski, 2003](#)). We have highlighted a role for effectuation, which brings the process of variation and selection into direct contact by entrepreneurs interacting with specific stakeholders, offerings variations and negotiating selections.

There are enough issues already identified in the literature to justify proposing a reconceptualization of new market processes centered on a behavioral view of exaptation and niche construction. This starts with the familiar account of exaptation, drawing on the inherent isotropy of technology ([Gould, 2002: 1284](#)), i.e., the fact that one never knows quite what quirky functional shifts a technology might provide under the right circumstances. Traditionally, accounts of technology exaptation focus on it as an emergence process that is passive with regard to the behaviors of economic agents. In evolutionary theory, shifting environments frequently do most of the work; the more the environment varies, the more exaptive possibilities arise. To this, we have added that entrepreneurial behaviors, e.g., effectual heuristics, may help to create a permissive local context for exaptations to occur. The second aspect of exaptation is the story of what happens after an exaptive possibility arises. This story is one of connecting technologies to market niches by building those niches and is part of a larger story about how firms shape their environments. This story of niche construction is theoretically less well developed, particularly with regard to its behavioral aspects. However, it may require proactivity from producers because significant producer effort may be required to work with bounded consumer cognition.

As prior research has pointed out, exaptation and niche construction iterate with adaptation processes in the emergence of new market niches. In a recognizably coevolutionary dynamic, exaptation first links resources to new

users, then adaptations refine the initial offer (Lewin and Volberda, 1999). Several authors have pointed to this exaptation–adaptation pattern (Levinthal, 1998; Andriani and Cohen, 2013). Again, Marsilid proved the market for antidepressants, which led to the targeted development of other antidepressants on an adaptive basis, and an avalanche of effects from multiple feedback processes descending from the initial exaptation event. Lane (2011) refers to this coevolutionary dynamic as a radiative process that unfolds over time. To this analysis, we emphasize that behavioral factors run through and through this radiative dynamic because the engine of economic evolution is individual and organizational action. Integrating behavioral factors was precisely the novelty that enabled Nelson and Winter (1982) to make a major advance in the evolutionary literature. We offer that a significant opportunity to advance the literature may also be available by integrating behavioral factors into our explanations of exaptation, market niche construction, and these associated coevolving and radiating processes.

It has been said that an entrepreneurial start-up is a conspiracy to change the world (Thiel, 2014). Such notions seem far-fetched when viewed through the lens of conventional evolutionary theory, with its emphasis on selection as the determining force in the process. Through that lens, new products and the firms that introduce them are simply grist for the evolutionary mill. However, in reality, it is hard to deny that some entrepreneurs and producers may have a role in shaping market niches, perhaps owing to aspects of exaptation and niche construction processes. Just as in evolution, where adaptation and exaptation can work reflexively together to destroy, create, and remake niches over time, so can effectual strategies continually point to exaptive opportunities in both adaptive defeats and victories over the lifecycles of markets. And if these entrepreneurial forces play a role in reshaping the ecology of markets, then the selection environment operating in economic evolution may not be entirely independent. The overarching model used to analyze economic evolution may need to reflect this by including both selection forces and niche construction forces, neither of which *exclusively* explains how organizations and markets come to fit together. A more generalizable model of evolving systems may be reciprocal causation, within which selection-determined models are but one particularly useful kind.

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