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The Path of Most Persistence: An Evolutionary Perspective on Path Dependence and Dynamic Capabilities

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Abstract

This paper extends the dynamic capability view and research on organizational path dependence by arguing that path dependence can be a property of capabilities when a contingently-triggered capability path is subject to self-reinforcement (i.e. a set of positive and negative mechanisms that increases the attractiveness of a path relative to others). The paper introduces an evolutionary perspective, which specifies the underlying selection mechanisms of the property of path dependence in internal and external firm environments. This theorization sheds new light on three paradoxes that currently blur the theoretical contribution of path dependence to research at the managerial, organizational, and industry levels: (1) the problematic coexistence of path irreversibility and managerial intentionality; (2) the ambivalent strategic value of lock-in with regard to competitive advantage; and (3) the relative homogeneity in observed dynamic capabilities, despite their (possible) path dependence that should lead to a wider variety of outcomes owing to the presence of contingency. We highlight the contributions of this perspective to strategic management research and evolutionary theories.

Keywords

path dependence, dynamic capability, selection, competitive advantage, intentionality

Introduction

The claim that 'history matters' has become a mandatory starting point in a significant share of social science research seeking to explain historical sequences. Path dependence is an attractive notion since it accounts for how certain organizational features persist over time, independent of

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their actual efficiency. Researchers interested in out-of-equilibrium situations refer to the related notion of lock-in (Arthur, 1989), an outcome of path dependence associated with the irreversible (and sometimes suboptimal) persistence of a particular state of affairs, such as the use of Qwerty keyboards (for a recent discussion, see Reinstaller & Hölzl, 2009). In organization studies, path dependence is used to describe certain firm histories as narrowing trajectories with hard-to-escape outcomes (David, 2001; Sydow, Schreyögg, & Koch, 2009). Explanations based on path dependence seem ubiquitous in organization scholarship, pervading studies of technologies (David, 1985), institutional trajectories (Djelic & Quack, 2007), innovativeness (Danneels, 2002), cognitive processes (Lamberg & Tikkanen, 2006), strategic paths (Koch, 2008), resource accumulation (Karim & Mitchell, 2000), and dynamic capabilities (Zott, 2003).

The dynamic capability view (DCV), rooted in heterodox economics and the resource-based view, has developed for more than a decade to explain how firms evolve along constrained trajectories and deal with the rigidities created by organizational path dependence (Helfat & Peteraf, 2003; Teece, Pisano, & Shuen, 1997; Zahra, Sapienza, & Davidsson, 2006). This paper proposes to further this particular line of research. We synthesize past research and define path dependence as a property of a stochastic process triggered by contingent events and subject to self-reinforcement over time, which tightens actors' choice sets (Vergne & Durand, 2010). In organizations, path dependence manifests itself as a property of features such as capabilities obtained in restricted conditions, namely when repeatable and routinized task-oriented actions originate contingently and are performed more effectively over time owing to self-reinforcement.

A dynamic capability represents a high-order ability to sense and address a need for change in an organization's competence base (Helfat et al., 2007) threatened by persisting rigidities (Schreyögg & Kliesch-Eberl, 2007). The ability to deal more or less effectively with these rigidities contributes to explaining persisting performance differentials across firms. The seminal paper by Teece et al. (1997) takes a first step at conceiving of the emergence of dynamic capabilities as a path-dependent process, and Helfat and Peteraf (2003) explore this idea further by describing capability development in terms of history dependence and path selection. Besides, dynamic capabilities are structured around sets of organizational routines (Dosi, Nelson, & Winter, 2000; Winter, 2003) that can become path-dependent when they benefit from increasing returns to previous learning experiences (Bowman & Ambrosini, 2003; Collis, 1994; Li & Rowley, 2002). Path dependence can thus represent a threat if it incapacitates a capability's dynamic potential.

Three apparent paradoxes need clarification before scholars can further advance our knowledge of dynamic capabilities and organizational path dependence. First, at the managerial level, path dependence questions the ability of organizational members to intervene and change a given course of events, because path dependence is associated with stickiness and irreversibility (David, 1994). Thus an important challenge is to understand whether path-dependent capabilities can really be dynamic or not, and we need to explore under what conditions we can reconcile path dependence with the managerial ability to configure dynamic capabilities — that is, to play on words, with 'managerial dependence'. The second paradox is located at the organizational level. Consistent with the resource-based view, dynamic capabilities can nurture competitive advantage only if they are hard to codify, transfer, or imitate (Teece, 2007). A dose of idiosyncrasy is thus required if the value potential of dynamic capabilities is to be unleashed at the competitive level. In this respect, the path-dependent development of capabilities along firm-specific trajectories, rooted in contingent historical events, represents a sustained source of uniqueness that can prove very valuable in the long run. However, shifting environmental conditions may rapidly transform path-dependent capabilities into underperforming, cash-consuming assets (Tripsas & Gavetti, 2000). As a result, the same property, namely path dependence, seems to confer an advantage to dynamic capabilities

and to concurrently represent a threat to the sustainability of that advantage. Finally, if dynamic capabilities develop path-dependently, a large variety of capabilities should coexist at the industry level, owing to the contingency inherent in unique firm trajectories. Yet, scholars recognize that dynamic capabilities share many commonalities across firms and that, in fact, multiple paths seem to lead to similar organizational outcomes (Eisenhardt & Martin, 2000). This remains puzzling given the unpredictability that should be implied by the contingent nature of path-dependent trajectories. In sum, the relationship between path dependence and dynamic capabilities poses a triple theoretical challenge at the managerial, organizational, and industry levels.

Recent studies have argued that resources and capabilities per se have little effect on firm performance; rather, it is their properties — such as rareness or inimitability — that can enhance a firm's competitive position over time (Durand & Vaara, 2009; Newbert, 2007, 2008). We draw on this approach and argue that path dependence should be conceived of as a possible property of dynamic capabilities selected by the internal and the external firm environments. Specifically, we argue that the types of self-reinforcement that sustain path dependence are both the object of managerial discretion inside the firm and the locus of selection in the external environment. By offering this evolutionary perspective on path dependence and DCV, we deal with the three paradoxes outlined above and position our findings within a broader discussion of competitive advantage, managerial intentionality, and organizational evolution (Huygens, Baden-Fuller, Van Den Bosch, & Volberda, 2001). Before discussing the framework in detail, we examine the three paradoxes more comprehensively and provide a non-metaphorical definition of path dependence as a conjunction of contingency and self-reinforcement. For this purpose, we synthetically review a broad range of literature streams on path dependence and emphasize the importance of negative externalities in the process leading to path selection.

The DCV and Three Paradoxes of Organizational Path Dependence

A dynamic capability is defined as an organization's 'ability to integrate, build and reconfigure … competencies' (Teece et al., 1997, p. 516). Dynamic capabilities are high-order abilities that can manipulate resources and capabilities used to produce tangible or intangible outputs (Winter, 2003; Zahra et al., 2006). The numerous benefits of dynamic capabilities can be leveraged to acquire new competences (Zollo & Winter, 2002), develop new business (Bowman & Ambrosini, 2003), or implement strategic change (Repenning & Sterman, 2002). Recent works have associated dynamic capabilities more closely with managerial abilities:

> 'Dynamic capabilities relate to high-level activities that link to management's ability to sense and then seize opportunities, navigate threats, and combine and reconfigure specialized and cospecialized assets to meet changing customer needs, and to sustain and amplify evolutionary fitness, thereby building long-run value for investors.' (Teece, 2007, p. 1344)

Dynamic capabilities differ from traditional capabilities in that they enable more than incremental change: because they can break the rigidities generated by path dependence at lower levels, they embody higher-order abilities that can translate into internal reconfiguration within the organization. Importantly, since organizational capabilities are hierarchically embedded within one another, dynamic capabilities can only act upon lower-order organizational processes (Collis, 1994; Durand, 2006, p. 106). Consistent with the statement that 'capabilities are embedded in firm routines' (Collis, 1994, p. 145), dynamic capabilities are described as structured patterns of routines accumulated along an organization's unique historical trajectory (Dosi, Nelson, & Winter, 2000; Winter,

2000, 2003). Because routines themselves can be or become path-dependent under the effect of self-reinforcing mechanisms (e.g. Li & Rowley, 2002; Lumpkin & Lichstenstein, 2005), 'it is likely that these corporate capabilities would be path dependent' (Bowman & Ambrosini, 2003, p. 301). As such, path dependence can diffuse high up in the embedded hierarchy of organizational capabilities and become a property of dynamic capabilities. This routine-based perspective complements the more metaphorical view that sees dynamic capabilities as high-order abilities that emerge path-dependently (Helfat & Peteraf, 2003, p. 1003). These definitions disentangle the various sources of path dependence but do not clarify the three paradoxes that result from the relationships between path-dependence and dynamic capabilities.

Paradox 1: Managerial Level; Path Dependence vs Managerial Dependence

Strategic management assumes that purposive action drives organizational life, whereas path dependence emphasizes contingency and irreversibility, albeit at different stages of path development (Sydow et al., 2009; Vergne & Durand, 2010). At an early stage, contingency implies that current events cannot be perfectly determined by previous action, as random shocks or chance coincidences ensure that outcomes are affected by a dose of unpredictability (Arthur, 1989; De Rond & Thiétart, 2007). Later along the path, irreversibility means that outcomes may not be modifiable endogenously within reasonable time or cost parameters: this can be a serious problem if organizations become locked into outcomes that are not what managers had intended.

The DCV suggests a logic whereby managerial intentionality is at the heart of capability building (Teece, 2007). By acting strategically, managers dynamically control novel situations, reduce the influence of contingency, shape organizational paths, and overcome rigidities to reach intended outcomes. Yet, such a conception may amount to emptying the very substance of dynamic capabilities, as it leaves aside some of their core attributes, such as complexity, organizational embeddedness, repeatability, and history dependence. If 'dynamic capabilities reside in large measure with the enterprise's top management' (Teece, 2007, p. 1346), and are used to overcome lower-order path dependence, then it means that top managers are able to master path dependence — a surprising conclusion given the traditional view of path dependence as a constraining force. Furthermore, the notion of dynamic capability may appear redundant if we tie it tightly to top management teams. Put simply, *path* dependence is hardly compatible with *managerial* dependence, because dynamic capabilities mediate the action of managers on sticky capability paths in non-trivial ways. To face this challenge, this paper argues that managers can cope with, and even benefit from, path dependence if they are able to select the appropriate self-reinforcing mechanisms along the capability paths that emerge from the firm–environment interaction.

Paradox 2: Organizational Level; Path-dependent Competitive Advantage vs Path-dependent Failure

The second puzzle has its roots in the widespread recognition that dynamic capabilities can foster sustained competitive advantage (Teece et al., 1997). By reconfiguring the organization internally in the face of changing environment conditions, dynamic capabilities ensure that organizations remain competitive in the long run. Building dynamic capabilities requires the careful coordination of organizational routines (Teece, 2007; Zollo & Winter, 2002), namely, the 'knowledge sets' embedded in technical systems, human learning, managerial practices, and organizational values (Leonard-Barton, 1992; Oliver, 1997). Hence, dynamic capabilities as higher-order abilities reflect

the idiosyncratic nature of organizations. This inherent singularity of dynamic capabilities is hard to codify, transfer, or imitate, thereby providing a source of competitive advantage. Nevertheless, a dynamic capability's path dependence, which has brought idiosyncrasy and underpins the ensuing advantage, may not enable the firm to avoid failure when external conditions change and the 'misfit' between internal capabilities and environmental conditions widens (Henderson & Clark, 1990). Noda and Collis (2001) argue that path dependence can account for a firm's inability to respond successfully to environmental change because of repeated commitment to underperforming strategies. Thus, continued investment in resources at odds with available production opportunities, or cognitive blindness to promising alternatives based on prior success (Tripsas & Gavetti, 2000), prevent organizations from seizing the right opportunities for change.

Therein lies the second difficulty: path-dependently built dynamic capabilities potentially lead to sustainable competitive advantage (Collis, 1994), yet path dependence can threaten competitive advantage when organizations experience lock-in. Thus, the value of path dependence seems to be influenced by factors located beyond the organization's scope of action. Dynamic capabilities depend on exogenous conditions to produce their effects, such that both the benefits and the detriments of path-dependent dynamic capabilities are contextual. Environmental characteristics are essential to explain the causal power that resides in dynamic capabilities, yet scholarly work tends to overemphasize a firm's *internal* ability to sense and seize opportunities (Teece, 2007), or to guide organizational evolution (Lovas & Ghoshal, 2000). Both opposing arguments — environmental contextualization and organizational power — downgrade the residual explanatory power left to dynamic capabilities for explaining competitive advantage. Our new assessment of path dependence suggests a perspective from which scholars and managers can make sense of such problematic features. We propose a clear analytical distinction between the internal firm environment wherein organizational members contribute to selecting reinforcing mechanisms, and the external environment wherein broader competitive and institutional forces select organization-level properties based on different selection criteria.

Paradox 3: Industry Level, Dynamic Capabilities; Diversity vs Commonalities

The third paradox refers to the apparent contradiction between the path-dependent character of capability formation and the relative homogeneity we observe across firm capabilities. Because 'dynamic capabilities are often characterized as unique and idiosyncratic processes that emerge from path-dependent histories of individual firms' (Eisenhardt & Martin, 2000, p. 1108), and because path-dependent trajectories originate in firm-specific contingent events, we should be observing a large variety of dynamic capabilities across firms. Additionally, this between-firm variety should be preserved over time as capability trajectories stabilize based upon each firm's specific history under the action of self-reinforcement (Helfat et al., 2007; Zollo & Winter, 2002; Zott, 2003). However, empirical observations seem to point to the opposite: organizations appear to have similar capabilities. For example, dynamic acquisition capabilities across firms often share common traits: many firms conduct cultural diversity assessments, monitor the speed of integration, and strategically track the process of asset redeployment (see Eisenhardt & Martin, 2000, for a review of empirical evidence). According to Eisenhardt and Martin (2000, p. 1108), 'these commonalities arise because there are more and less effective ways of dealing with the specific organizational, interpersonal, and technical challenges that must be addressed by a given capability'. Such an explanation implies a very flexible view of capabilities as adaptable sets of routines progressively and naturally evolving toward greater efficiency.

Yet, the path-dependence property of dynamic capabilities, which gives them strategic value, should mitigate the possibility of such a high adaptability. It thus remains puzzling that firms end up with similar dynamic capabilities, despite their path-dependent character that should have led to very diverse organizational outcomes at the industry level. Our selection perspective will reconcile capability variety with capability similarity by arguing that the internal firm environment does generate a large variety of dynamic capabilities, yet eventually only a few of them are retained and observed owing to external selection pressures.

In summary, the relationship between DCV and path dependence is characterized by a triple paradox: (1) at the managerial level, there is a need for clarifying the respective influences of managerial action and path dependence; (2) at the organizational level, by stressing both the beneficial consequences of path-dependent capabilities and the dangers of locked-in path-dependent processes, scholars have left us with an unsatisfactory view of competitive advantage; and (3) at the industry level, path dependence, rooted in contingent events and peculiar organizational contexts, should lead to a large variety of dynamic capabilities observed across firm, whereas, in fact, homogeneity seems to prevail.

Defining Path Dependence

This section synthesizes previous works on path dependence to offer a definition that stresses the role of both positive and (previously overlooked) negative self-reinforcement mechanisms. Path dependence is about stochastic processes triggered by contingent events and subject to self-reinforcement over time. A path-dependent process contains at least two possible equilibria, selected contingently along the path (David, 2001). In organizations, path dependence translates into features (e.g. capabilities) that persist over time and appear hard to change because of technological, institutional, or cognitive rigidities. A path-dependent process can be seen as falling into three stages (Sydow et al., 2009): path origin, path development, and path outcome.

Path Origin

Path dependence 'is a property of a system such that the outcome over a period of time is *not determined* by any particular set of initial conditions' (Goldstone 1998, p. 834). However, path dependence only obtains when contingent events trigger self-reinforcing paths. Social scientists with different backgrounds share the story that 'insignificant events' (Arthur 1989, p. 116), 'small or contingent events' (Pierson, 2000, p. 251), or 'chance elements' (David 1985, p. 332) have a lasting influence on the path-dependent selection of a given equilibrium. In a seminal paper, Arthur (1989) argues that path-dependent processes are contingent in the sense that their final outcomes depend on earlier events that occurred somewhat randomly.

Contingent events must exist at the origin of a path-dependent process for two reasons. First, they allow for the possibility that multiple paths be pursued: without such events, a new or unexpected path could not be created. Second, contingent events at the beginning of a sequence ensure that what initiates the path is distinct from what later reproduces it (i.e. self-reinforcement). If the same causal force explained both path creation and path reproduction, path dependence would amount to a redundant structural explanation (Schwartz, 2004). For example, path dependence becomes a superfluous explanation in the case of Qwerty if one believes that the keyboard's early *and* subsequent adoptions are both attributable to its maximizing consumer utility compared to other keyboards (Liebowitz & Margolis, 1990). In particular, without contingency, path dependence reduces to the mere acknowledgement that increasing returns, externalities, or asymmetries are at play. The study of such processes has occupied economists for at least a

century (e.g. Chapman, 1908; Young, 1928), so organizational scholars should clearly specify how path dependence goes beyond those mechanisms to articulate contingency, intentionality, self-reinforcement, and lock-in.

Path Development

Once a path has been contingently selected, its development is nurtured by self-reinforcement, which provides another necessary condition for path reproduction and thus path dependence. Self-reinforcement is best understood as a set of mechanisms put into motion that sustain the contingently selected path. Self-reinforcement may consist of positive mechanisms that directly support the chosen path (e.g. increasing returns to scale) and negative mechanisms that indirectly sustain it by rendering alternative paths less attractive (e.g. negative externalities). Noda and Collis (2001) identify three types of positive mechanisms that reinforced the organizational paths in the early US cellular phone industry: economies of scale, sociopolitical 'virtuous circles', and increasing managerial cognitive focus, which also created negative externalities that decreased the attractiveness of alternative paths by directing most available resources toward the development of a single product category. Path reproduction is thus caused by this reinforcing ensemble of positive and negative mechanisms, whose intensity influences the speed at which lock-in is likely to occur (see Appendix for more detail).

A path is further reinforced as alternative paths become relatively less attractive. Page (2006, pp. 110–112) demonstrates formally that at least one negative externality is required for such reinforcement, because path dependence requires a force to drive alternative paths out of the actors' choice set. For instance, Qwerty adoptions display increasing returns (i.e. the more Qwerty typists use it, the more valuable the keyboard layout becomes), but they also produce two negative externalities that diminish the probability that competing keyboards will be adopted in the future. First, becoming a Qwerty user involves intrapersonal sunk costs that decrease the attractiveness of learning to type on another keyboard. Second, at an interpersonal level, the more consumers adopt Qwerty, the less attractive it is for a prospective user to learn to type on a different keyboard. Without negative externalities, the adoption probability of competing keyboards would also increase, and consumers would not get locked into the Qwerty path.

Self-reinforcement, or the set of positive and negative mechanisms that sustain the focal path and eliminate alternative trajectories, is thus necessary for path dependence. In Page's model, which uses selection of sequential choices, the negative externality is the only necessary component of self-reinforcement, though additional mechanisms (such as increasing returns) accelerate the move toward lock-in. This result is important, because 'in many of the examples of path dependence, while increasing returns do exist, negative externalities are the true cause. This is not merely a reframing of positive relative returns as negative relative returns; it requires a fundamental rethinking of the causes of path dependence' (Page, 2006, p. 90).

From our perspective, switching the focus from positive to negative externalities reveals the flip side of the coin: path dependence is less about how actual paths are chosen and more about how alternative paths get selected out. This further justifies our theoretical move toward a selection perspective. In summary, contingency and self-reinforcement represent two necessary and sufficient conditions for path dependence, in the absence of exogenous shocks.

Path Outcomes

The final outcome of a path-dependent process emerges as possible alternatives get selected out (David 1994, 2001). Three important ideas need clarification. First, without exogenous shocks,

path dependence leads to lock-in, namely, a situation with a very low potential for endogenous change. Most of the theoretical interest of path dependence lies within this implication. Management scholars can think of lock-in as an organizational situation that can be altered only at a prohibitive cost and in response to strong exogenous pressures (e.g. economic crisis, radical technological change, political turmoil). Yet lock-in is not a synonym of 'inefficiency', 'market failure', or 'suboptimality', because it does not imply a deviation from Pareto optimality (David, 2001; Liebowitz & Margolis, 1995). Contingent events may well drive a path-dependent process toward an optimal equilibrium (e.g. using the best available technology, having the most cost-efficient firm capabilities). Second, path dependence implies lock-in, but lock-in can exist without path dependence. Arthur's (1989, p. 119) payoff tableau describes a non-stochastic (therefore *non*–path-dependent) process that still illustrates lock-in. Other mechanisms (e.g. structural inertia) can create a low potential for endogenous change and they should not be confused with path dependence. Third, after a while, beneficial lock-in sometimes turns into harmful lock-in. Martin and Sunley (2006) argue that positive outcomes of path dependence cannot last very long if organizations are unable to maintain some flexibility to deal with the need for future structural adjustment. For these reasons, a deeper theorization of the evolutionary processes within which path dependence is embedded is necessary.

An Evolutionary Perspective on Path Dependence and Dynamic Capabilities

Self-reinforcement is a conjunction of positive and negative mechanisms that decrease the likelihood that alternative paths will be selected. Our emphasis on selection points toward embedding path dependence into an evolutionary framework. Theoretically speaking, our framework has three important features.

First, as evolutionists argue, selection operates on properties and not on objects (Sober 1984; Durand, 2006). For example, a sieve does not select an object (sand, dust, or bacteria) but a property of the object (its size). By considering path dependence as a property of capabilities, we avoid the conceptual confusion between *what causes* competitive advantage (a property such as rareness) and *where it is located* (the capability). This long and painful confusion has crippled the resource-based view and likewise threatens the DCV, leading to logical inconsistencies, ontological indeterminacy about what are strategic resources and capabilities, and tautology — the outcome being preordained (Powell, 2001; Priem & Butler, 2001). These impairing confusions can be avoided if we recognize that the reason why resources and capabilities provide firms with advantages is because they possess certain properties (rareness, inimitability, or — as we argue here — path dependence) favored by environmental selection criteria (Durand & Vaara, 2009).

Second, an evolutionary perspective does not only imply the study of a path over time, but also recognizes that many paths may coexist and interfere with one another. The more consumers commit to the Qwerty path, the less attractive the Dvorak path becomes. But there are other ways to get text onto a computer screen (e.g. voice recognition systems), and increased commitment to Qwerty does not influence the future attractiveness of other alternatives with the same intensity. That is, relative to Dvorak, consumers appear locked into Qwerty, but relative to other paths, this equilibrium can become much easier to disrupt.

The third feature of our evolutionary framework is partly implied by the previous example. That is, an evolutionary perspective requires a multilevel view, for it is pointless to examine a given path over time without considering the environment-level selection pressures to which it is subject. Therefore path dependence research should not focus on describing isolated trajectories, but

instead on studying, over time and cross-sectionally, the interactions between comparable paths and their broader environment. To differentiate the various types of selection pressures at work, we thus distinguish between the internal firm environment, wherein managerial discretion can have significant scope, and the external firm environment, wherein broader economic and institutional forces may apply.

Over time, a firm like Microsoft has certainly developed capabilities that are sustained by self-reinforcement mechanisms, both externally (i.e. the more users adopt Windows, the more attractive Windows becomes) and internally (i.e. the more proprietary software Microsoft develops, the easier it gets to develop new code that builds upon and complements previous releases). A key property of Microsoft's programming capability is its rareness, protected by the proprietary character of most of the firm's releases. However, external selection criteria in the software industry are undergoing major changes. Alternative open source paths are being explored by competitors in several segments of the market (e.g. operating systems, web browsers, office software), creating a new kind of positive network externalities between users and software programmers. As a consequence, the rareness of Microsoft's programming capability is no longer a necessary condition for achieving competitiveness in the marketplace, as expert user communities contribute on a voluntary basis to the constant improvement of open source projects. Selection forces apply in new ways to the property of rareness, thereby reshuffling the competition in the industry (e.g. alongside the traditional Windows and Mac OS paths, the Linux/Ubuntu path obeys different selection rules and yet is attracting an increasing number of users). This, in turn, modifies the selection forces around the property of path dependence as sustained by the self-reinforcement mechanisms described above. Inside a firm like Microsoft, asset complementarities between proprietary pieces of software are still favorably selected, yet they no longer constitute the sole source of competitive advantage in the external environment.

Distinguishing between an internal environment (organization level) and an external environment (market level) is necessary to deal with the DCV paradoxes associated with path dependence. In their internal environment, firms act as 'selectors', because managers strategically develop and enact capabilities in choosing to follow deeply rooted routines or to implement novel ones (Durand, 2001; Henderson & Stern, 2004). In the external environment, some organizations are more competitive than others, some markets provide more opportunities, and some dynamic capabilities are better suited for a given activity, so the value of path dependence is relative, as it is conditioned by the nature of the environment. In particular, the environment endows various self-reinforcing mechanisms with different potentials for value generation (e.g. asset complementarities are less self-sustaining in an open source environment).

Dealing with the Three Paradoxes from an Evolutionary Perspective

Drawing on this richer definition of path dependence, we address the three paradoxes and propose a view of competitive advantage that neither recurs to omnipotent managers nor negates the capacity of organizations to adjust their choices in the face of selection pressures.

Paradox 1: Managerial Level. The first paradox that undermines the DCV relates to the unclear relationship between managerial intentionality and path irreversibility, which hinders managerial discretion. Our analysis shows that truly path-dependent capabilities originate in contingent events beyond managerial intentionality. It is reasonable to assume that managers behave in predictable ways, yet they do not always react rationally to environmental factors (Nelson & Winter, 1982; Tripsas & Gavetti, 2000). The perspective we offer here recognizes a level of contingency in

organizational life that can trigger non-metaphorical path dependence. Chance encounters, coincidences, sudden insights, and creative thinking set the stage for unpredictable path creation, resource and capability reconfiguration, and many new ventures are likely to stem from unpredictable, non-purposive, random events. Face-to-face interactions such as casual discussions with strangers on university campuses, in sports clubs, or on a plane can lead to unforeseeable variations (Campbell, 1994). Discovering new chemical properties by inadvertently breaking tubes in a lab, incidentally stumbling on a better way of doing things by making a procedural error, or simply having to improvise due to a lack of time (Moorman & Miner, 1998) are all trivial situations which can nevertheless lead to path-creating novelties (Garud & Karnøe, 2001) and path dependence in the presence of self-reinforcement.

When subsequent events unfold in a path-dependent manner and lead to routinization, a manager's role consists in influencing the selection of appropriate self-reinforcing mechanisms to cope with, or even benefit from, path-dependence. When path dependence at lower routine orders diffuses upwards and incapacitates a capability's dynamic potential, managers should assess how harmful it can be depending on the expected performance consequences of lock-in. If a threat is identified, higher-order dynamic capabilities can be activated to, so to speak, redynamize the vanishing advantage by reshuffling the underlying routine structure.

Hence, managers are important sources of intra-organizational selection in our view of organizational path dependence (Henderson & Stern, 2004). For example, a manager can decide to rely on a growth strategy based on increasing returns to scale, a self-reinforcement mechanism that implies a careful selection of the product features requiring standardization and an offensive commercial policy to rapidly gain market share. By favoring certain self-reinforcing mechanisms over others, managers contribute to shape, curb, or refocus organizational paths whose long-run trajectory will nevertheless be partly beyond their control (e.g. the ability to realize scale economies is not an immutable selection criterion).

Thus, there is no contradiction between managerial intentionality and the path-dependent character of dynamic capabilities, as long as we recognize the importance of contingency and the fact that managers operate *only* as intra-organizational selectors of self-reinforcing mechanisms and contingently triggered paths.

Paradox 2: Organizational Level. The second paradox deals with competitive advantage and lock-in, both of which can result from the development of path-dependent dynamic capabilities. Interestingly, the fact that dynamic capabilities develop in a path-dependent way does not per se constitute a liability that requires managerial counteraction. The strategic importance lies instead in how selection forces in a firm's external environment alter the properties of capabilities, as well as how such changes can increase or decrease the likelihood of an organization being competitive (Barnett, 1997; Barnett & McKendrick, 2004).

Reference to an external environment is necessary to understand the effect of dynamic capabilities on competitive advantage and performance. As a property applicable to several entities (routine, dynamic capability, organizational trajectory), path dependence is subject to multilevel selection pressures. Our analytical elaboration of path dependence argues that, when the external environment is favorable (inauspicious) toward the type of self-reinforcement that sustains an organization's dynamic capability, path dependence is beneficial (detrimental) to the organization. Therefore the second paradox exists when the DCV mistakes capabilities (e.g. product innovation, routine monitoring) for properties (e.g. rareness, path dependence). As noted above, it is the properties conveyed by the capabilities, rather than the capabilities themselves, that get selected at the industry level. For instance, selection criteria may favor cost efficiency (e.g. in the paper industry)

or speed of diffusion (e.g. in the video game industry): in the former case, increasing returns to scale as part of self-reinforcement will favor path-dependent trajectories among large firms, but in the latter, asset complementarities between different components (e.g. software and hardware) will have a similar function. Still, a new entrant might innovate in such a way that the (beneficial) lock-in obtained in either case by incumbents becomes suboptimal.

For example, Polaroid's obstinate adherence to its original business model stemmed from internal selection criteria (e.g. traditional picture quality as a benchmark, software–hardware combinations, focus on generalist retail channels) that conflicted with new market selection criteria (e.g. rapid picture visualization, storage, exchangeable images). While the self-reinforcing mechanisms that buttressed path-dependent capabilities in production and marketing received consistent support from top executives, they were no longer favored by the external market environment. If we consider path dependence an intrinsic property of dynamic capabilities, and analyze whether selection pressures favor the associated self-reinforcing mechanisms in both the internal and external environments, we can avoid logical inconsistencies and leave some explanatory power to dynamic capabilities with respect to organizational outcomes.

Finally, it should be noted that the path-breaking potential of a dynamic capability is likely to be limited for application to lower-order organizational processes. A path-dependent dynamic capability cannot monitor itself reflexively to avoid lock-in — a higher-order process is then required (Schreyögg & Kliesch-Eberl, 2007). This is consistent with a view of capabilities as embedded learning patterns: for example, a dynamic product innovation capability can rely on lower-level dynamic capabilities such as manufacturing process innovation or technology monitoring, which itself draws on lower-level capabilities such as the ability to network with research universities. Path dependence can lead to harmful lock-in at the technology monitoring level as routines develop to keep track of only a particular type of technology development (e.g. film photography), while the external environment may be selecting another path (e.g. digital photography). If the embedded product innovation capability is truly dynamic, it should help managers sense the threat and help them break this lower-level path dependence. Pfizer scientists managed to overcome the path dependence of Pfizer's drug development capability (that had proved very successful in the past) by convincing top managers that the usual 'stage-gate' drug evaluation routines should be overridden in the particular case of their unsuccessful 1985 hypertension drug, which eventually led to the development of the Viagra blockbuster (De Rond & Thiétart, 2007). In a nutshell, our multilevel view contributes to breaking the circular causality that links dynamic capabilities and competitive advantage in strategy research.

Paradox 3: Industry Level. The third paradox refers to the discrepancy between the large variety of path-dependent capabilities that should be observed in the presence of contingency and the relatively homogenous dynamic capabilities observed across real-world organizations. As a property tied to a self-reinforcing mechanism, and subject to both internal and external selection pressures, path dependence should thrive along dynamic capabilities when favored by the two selection environments. Internally, managers may choose not to follow the path taken by competitors, which over time creates market differentiation (e.g. niches) or leads to failure. For example, the giant US steel companies have been partly condemned by a redefinition of selection criteria triggered by mini-mills such as Nucor — smaller plants, first-use of novel techniques, utilization of scrap as raw materials. All the paths sustained by challengers in the steel industry have dynamically interfered with existing alternatives, thereby modifying the relative attractiveness of the various trajectories. Therefore, while a multiplicity of contingent paths emerges from haphazard encounters and unpredicted resource combinations in multiple organizations, only certain self-reinforcing mechanisms

can sustain path dependence and eventually shape viable dynamic capabilities at the industry level. Depending on the external environment's selection criteria, only a portion of these dynamic capabilities develops into locked-in outcomes, some of which constitute a competitive advantage (for Nucor or Chaparral Steel), whereas others represent irreversible dead-ends (for U.S. Steel and Bethlehem Steel).

Thus, when observing path-dependently built dynamic capabilities among survivors within a homogeneous industry segment, we should not be surprised that they share many commonalities. Past internal selection events lead to industry segmentation (e.g. generalist carmakers see scale economies as a crucial selection criteria, while high-end sport cars producers focus on high performance and craftsmanship) and, within each industry segment, external selection disfavors the competitors that do not possess the adequate dynamic capabilities and therefore do not select the appropriate paths. These successive selection phases result in the homogeneity observed, after many alternative paths have been selected out on the way to long-term survival. Although, at first sight, logical reasoning predicts the emergence of a rich variety of path-dependent dynamic capabilities, only a few are actually observable, due to selection filtering in both the internal and external environments.

Concluding Remarks and Research Agenda

Contingency and self-reinforcement (with at least one negative externality) are two conditions for path dependence that are both necessary and sufficient, and lead to an irreversible outcome called lock-in. This paper conceives of path dependence as a property that can (but need not) characterize dynamic capabilities. Importantly, path dependence is a property whose consequences vary depending on the relationship and overlap between the selection criteria conveyed within the internal and external environments of organizations. The view of path dependence offered here calls for a novel approach. We recommend complementing the analysis of the *type* of dynamic capabilities ('sensing', 'seizing', or 'managing', as in Teece, 2007) with a careful investigation of their *properties*, among which path dependence plays a prominent role. Consequently, the focus should be on the selection criteria that prevail within the internal and external environments, and on the kind of properties that the latter favors. When both sets of selection criteria match, self-reinforcement is likely to be fast and to pave the way for a stable lock-in situation. When they do not match, organizations are more likely to disappear and industries may enter long periods of instability (for a historical perspective in multiple industries, see Durand & Vergne, 2010). This view of organizational path dependence can inform our knowledge of the DCV and, more generally, of organizational evolution.

We contribute specifically to the DCV by providing a perspective that clarifies three apparent paradoxes at the managerial, organizational, and industry levels. First, our view helps scholars and managers acknowledge the role of contingency and managerial intentionality by stressing how managers can select self-reinforcing mechanisms (e.g. scale economies) and exploit unexpected opportunities (e.g. surprising lab test results). Second, our focus on path dependence as a possible property of dynamic capabilities helps disentangle the circular causality that undermines DCV research on competitive advantage. To deal with the two previous paradoxes, some DCV researchers used to overemphasize the managerial ability to reconfigure organizational paths (Teece, 2007), resulting in a transfer of explanatory power from dynamic capabilities to top managers' abilities. We qualify this view and suggest that dynamic capabilities have a true substance that is distinct from managerial action. Third, by emphasizing the selection processes underlying path dependence, we account for the apparent equifinality in observed dynamic capabilities. Importantly,

our argument about selection shows how the DCV approaches tautology when it maintains that possessing dynamic capabilities is sufficient to lead unconditionally to competitive advantage; rather, what matters is capability *properties* (e.g. rareness, non-imitability, path dependence) and how such properties get selected (Durand, 2006; Durand & Vaara, 2009). A research agenda based on these features would make path dependence part of a truly evolutionary theory of organizations rooted in a sound conceptual ground.

A limitation of the argument developed in the paper is the threat of infinite regress around the idea that dynamic capabilities can only break path dependence at lower levels in an embedded capability hierarchy. According to this thesis, a higher level is always required to get rid of path dependence in organizations; yet it is problematic to assume that there is an infinite number of levels or, alternatively, that there is an ex ante identifiable highest level. Collis (1994, pp. 149–150) discussed this infinite regress issue, and we propose a similar solution to avoid logical inconsistencies. Assuming that the organizational level where (harmful) path dependence is at work has been identified, organizations can either rely on a readily available, higher-level dynamic capability to break path dependence, if they possess one, or they can try to develop the ability to change the incriminated routines. This ability need not become codified; it can be developed as a temporary change program designed to overcome localized path dependence. Conceptually, this means that the number of capability levels in organizations is not exogenously given: careful managers can decide to develop an ability to change certain routines — internally or with the help of external experts. Such reflexive organizational design implies the temporary creation of a higher level, consistent with Collis (1994) and this paper's argument.

This article leaves two essential questions unanswered. First, is path dependence a pervasive organizational phenomenon, or is it an exceptional feature unlikely to affect most organizations? Based on prior research, we argued that organizations experience contingency on a daily basis, and we have reviewed several common, self-reinforcing mechanisms that may be in play. Yet, a conjunction of contingent events sufficient to trigger a path, and amplified in the long run by stable self-reinforcing mechanisms, may not be widespread across organizations. This is consistent with Zott (2003), who finds that *only some* dynamic capabilities are path-dependent. Also, managers act as internal selectors of self-reinforcing mechanisms, consciously or not, for right or wrong reasons, raising the issue of intentional or unintentional path-dependence in capability creation. Hence, we need further elaboration to understand the role of intentionality in dynamic capability building, maintenance, and break-up.

Second, what kind of empirical observations can lead scholars to conclude that a given process is path-dependent? In this paper, we provide several real-world examples of firm trajectories that we only *assume* are path-dependent for the sake of illustrating our argument — yet establishing path dependence requires robust evidence. Some empirical settings are better suited than others to nourishing path dependence. Typically, high-velocity environments may be too unstable to sustain path dependence, for frequent exogenous shocks 'derail' path dependence before lock-in occurs (Eisenhardt & Martin, 2000). A task for future path dependence research is to examine more closely lower-velocity environments in which exogenous shocks are less common, and path dependence more readily observable at the capability level. In a similar vein, path dependence may be more common among organizations recurring to organic growth than among acquisition-prone corporations, whose ability to escape constrained paths may be enhanced by frequent absorption of new resources and capabilities (Karim & Mitchell, 2000).

Regarding empirical observations of path dependence, we wish to emphasize the need for further methodological insights. In his study of persistent interregional differences in Poland, Zukowski (2004, p. 967) recognizes that 'if the strict approach to path dependency is employed, the waves of

immigrants from the west cannot be considered a contingent event, since this occurrence is easily explicable on the basis of our knowledge'. In other words, these immigration waves are part of the same structural explanation that accounts for the observed persistence. Logically, then, Zukowski concludes that his study illustrates a case of 'institutional persistence' rather than one of path dependence. Proving path dependence empirically might be more difficult than it appears at first sight; in particular, we would need to be able to prove that some events were actually contingent. This point represents one of the issues that challenge the possibility of simply applying non-metaphorical path dependence to the empirical study of real-world phenomena, and further research can, perhaps, provide empirical scholars with additional guidance on how to advance the dynamic capability research agenda while avoiding the delusional traps of unfalsifiability, unobservability, or untestability. A recent study by Newbert (2008), focusing on the relationship between resource properties (e.g. rareness) and competitive advantage, constitutes an excellent first step in this direction. We hope that more studies consistent with this research agenda (e.g. Vergne & Durand, 2010) will help develop a more distinctive and workable definition of path dependence that contributes to our understanding of historical causality.

Appendix: Externalities and the Various Mechanisms of Self-Reinforcement

Allegedly, increasing returns may be the main mechanism of self-reinforcement that sustains path reproduction (Arthur 1989, 1990; Pierson, 2000). Increasing returns mean that a choice made at time t becomes more likely to be made again by the same agent at time $t + 1$. Economies of scale provide a particular instance of increasing returns: producing more decreases unit cost and therefore encourages future production increase. Increasing returns to education or learning can also nurture path dependence (e.g. the more I learn a foreign language, the easier it is to communicate abroad, and the more I learn from interacting with foreigners).

Positive (negative) externalities differ from increasing (decreasing) returns in the sense that they modify the utility function of agents not directly involved in the initial decision (e.g. users of a different product, future users, stakeholders). For instance, if I decide to use a car downtown, I create a negative externality by imposing the resulting pollution on people who use a bicycle. Positive externalities, which obtain when current adoption provides additional benefits to future adopters, entail another possible mechanism of self-reinforcement that may feed path dependence (e.g. the more cell phone users now, the more future cell phone adopters will benefit from the technology, because they will be able to communicate with a larger community).

Interestingly, increasing returns or positive externalities are not per se necessary conditions for path dependence, because they do not imply lock-in (i.e. they do not guarantee the elimination of alternative paths). Furthermore, other mechanisms of self-reinforcement can play similar roles (e.g. sunk costs, asynchronic decision making: David, 1994; for a formal proof, see Balmann, Odening, Weikard, & Brandes, 1996). Sunk investments in a given productive activity make it attractive for an agent to acquire skills related to that activity, even if other activities could be relatively more profitable. This can explain the difficult transition from agriculture- to industry-based economies in countries where families transmit farm-related assets from generation to generation. Similarly, asynchronic decision making induces complementarities between knowledge and assets that can drive path dependence. In this vein, Altman (2000) uses realistic behavioral assumptions to argue that path dependence can occur under constant or decreasing returns. For instance, if actors *must* choose between only two possible paths, both of which yield decreasing returns, lock-in will occur on the path whose returns decrease the more slowly.

Sydow et al. (2009) synthesize most positive mechanisms of self-reinforcement that can occur along organizational paths. They identify cognitive, social, and resource aspects of the organization that can lead to economies of scale or scope, escalating commitment, cultural traps, sunk costs traps, coordination and complementarities, learning loops, and expectation-based path sustainability. Page (2006) underlines intra- and interpersonal mechanisms that can nourish the negative mechanism of self-reinforcement (e.g. how alternative paths get selected out). As noted by Martin and Sunley (2006), since Arthur's (1989) seminal paper, path dependence scholars tend to conflate 'hard' (e.g. scale economies) and 'soft' (e.g. cultural traps) mechanisms of self-reinforcement, for the sake of simplicity. While the price and market mechanisms associated with these different kinds of returns/externalities clearly differ, path dependence research traditionally considers that they belong to the same category to the extent that their effect on path self-reinforcement has the same direction (i.e. positive or negative). We adopt a similar strategy in this paper, also for the sake of simplicity. For a more detailed description of externalities, please refer to Papandreou (1994) and Cornes and Sandler (1996). For a refined discussion of network externalities specifically, see Katz and Shapiro (1985) and Liebowitz and Margolis (1994).

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