DYNAMIC CAPABILITIES
AND KNOWLEDGE-DRIVEN
MICRO-EVOLUTION:
PERFORMANCE EFFECTS OF
INTRAFIRM VARIATION,
SELECTION, AND RETENTION
PROCESSES

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ABSTRACT

This chapter suggests that evolutionary processes of variation, selection, and retention (VSR) operate inside firms to create dynamic capabilities. We argue that differences in the rates of change of VSR activities within firms lead to differential performance among firms. We test how varying levels of VSR activities affect firm performance in a sample of Fortune 500 firms. The findings suggest that higher levels of VSR activities, in combination, lead to better adaptive outcomes as evidenced by above-average firm performance.
Over the past 30 years, one of the "divides" in the organization science literature concerns adaptive change versus "death and replacement." Some scholars claim that organizations adapt, survive, and grow because of their evolving dynamic capabilities. Others hold that industries evolve as a result of the death and replacement of member firms suffering from inertia. The dynamics across this "divide" now appear to be shifting as knowledge-intensive resources become increasingly crucial to firm performance and survival. As environmental change speeds up, for example, the number of industries changing by death and replacement could be expected to grow dramatically, unless firms' dynamic capabilities also speed up substantially.

Theory on the organization of capabilities recognizes that if we view a firm as subject to external selection forces, then we should also consider a firm's internal selection environment where capabilities are developed (Loasby, 1998; Aldrich, 1999; Zollo & Winter, 2002). Building on this view, recent research cites intra-organizational evolutionary learning activities of variation, selection, and retention (VSR) as crucial to the development of dynamic capabilities (e.g. Zollo & Winter, 2002; Helfat & Peteraf, 2003; Zott, 2003). The dynamic capabilities of firms are those that contribute to "...appropriately adapting, integrating, and re-configuring internal and external organizational skills, resources, and functional competences..." in changing environments (Teece, Pisano, & Shuen, 1994, p. 12). Such capabilities govern the rate of change of ordinary (or operational) capabilities (Winter, 2000, 2003) and therefore should play an important part in determining the co-evolutionary success of firms competing against each other in an industry.

Even though empirical research in strategy recognizes that firm evolution is usually explained by both firm factors and industry factors, competing theories of evolution are implicit in these explanations. Lamarckian (adaptation) perspectives focus on the intra-organizational level of analysis and emphasize that the evolution of industry populations reflects changes in the strategy, structure, knowledge, and capabilities of member firms in response to environmental pressures and opportunities (e.g. Cyert & March, 1963; Lawrence & Lorsch, 1967; Thompson, 1967; Child, 1972; Nelson & Winter, 1982; Teece et al., 1994). In this perspective, firms' internal rates of change largely determine firms' fates. Darwinian (selection) views emphasize that structural inertia (e.g. Hannan & Freeman, 1977, 1984) present in firms mitigates against dynamic capabilities, arguing instead that industry evolution primarily occurs via the death and replacement of member firms due to external selection pressures (e.g. Hannan & Freeman, 1977). In this perspective, external selection pressures guide firms' fates.
This chapter helps to integrate these competing explanations. We hypothesize that Darwinian principles of natural selection operate inside firms to create dynamic capabilities. These capabilities, in turn, thwart the effects of inertia, thereby increasing an organization’s adaptive ability and its chances for improving performance. Linking internal selection activities to firm performance illuminates one set of mechanisms underlying dynamic capabilities and suggests a form of rapprochement between selection and adaptation perspectives.

What is the relationship between these mechanisms and firm performance? To begin, we argue that variation (knowledge creation), selection (knowledge evaluation), and retention (knowledge preservation and dispersion) – which we collectively refer to as “VSR” activities – each represent a baseline activity that is necessary for the development of a dynamic capability. Together, these activities form an “engine” for new knowledge production and application within firms. Fig. 1 lists some of the general activities underlying each VSR component of this knowledge production engine. In addition, firms may adjust the balance among internal VSR activities to address external selection pressures (Burgelman, 1991; Miner, 1994). Some research suggests that tradeoffs in the amount of resources dedicated to each of these activities influences the development and distribution of knowledge within firms across time (March, 1991).

Building on these observations, we suggest that to maintain performance in a competitive environment, a firm must engage in all three VSR activities simultaneously, but must develop a particular balance among the rates of its VSR activities, so that the amounts of output of these activities (specific variations, selections, and retentions) can be effectively utilized to achieve successful adaptations. In effect, we suggest that, for example, it does not pay to speed up the variation rate (increasing the amount of variations generated) to match rapidly shifting industry conditions if selection and

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**Fig. 1.** General Activities Underlying Intrafirm VSR as a Knowledge Production Engine.
retention rates remain stagnant. We refer to an effective balancing of VSR activity rates within a firm as the attaining of “balanced continuity.” Consistent with Loasby (1998), our concept of balanced continuity emphasizes that a firm’s proficiency in shaping and coordinating the VSR activities underlying its process of trial-and-error learning helps the firm expand its range of possible behaviors for addressing its environment and thereby contributes to its performance. As a first step in exploring these ideas, this chapter tests hypotheses about the relationship between internal VSR activities and firm performance. We then build on our hypotheses to derive broader propositions related to the balanced continuity concept.

The chapter begins by discussing different forms of evolution. We then discuss the role of internal VSR processes in driving intrafirm change and adaptation. The chapter then proceeds to the hypotheses and propositions, presents the research design employed, and discusses the results of our tests. We conclude by suggesting implications of this research for the study of competence development and other areas of research.

**EVOLUTION: – TWO PROCESSES OF CHANGE**

Organizational evolution holds that performance differences among industry populations and their member firms can be attributed to a continuous process of change (slight or dramatic) over a long period of time (Aldrich, 1979, 1999; McKelvey, 1982; Nelson & Winter, 1982). An industry population is defined as a group of interacting organizations embodying similar combinations of key competencies (McKelvey, 1982; Baum & Singh, 1994a, p. 10). Evolutionary change involves a change in the blueprints (Hannan & Freeman, 1977), competencies (McKelvey, 1982), or routines (Nelson & Winter, 1982) held by a firm’s member that ultimately are diffused throughout a population. Routines and competencies reflect a firm’s learned, repetitious, or quasi-repetitious patterns of behavior grounded in tacit or semi-explicit knowledge (McKelvey, 1982; Nelson & Winter, 1982; Winter, 2003). In this view, firms have at their disposal at any one time configurations of routines and competencies temporarily embodied in tacit or semi-explicit knowledge held by their employees (Teece et al., 1994).

For the most part, ecological perspectives take a *firm* level of analysis, focusing on the adaptation, or death and replacement, of firms with respect to an exogenous context (e.g. Hannan & Freeman, 1977; see Baum, 1996 for a review). This macro view emphasizes the role of external selection pressures on firm development. More recently, empirical studies have begun
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applying Darwinian principles to intrafirm parts (e.g. Burgelman, 1991, 1994; Baum & Singh, 1994b; Galunic & Eisenhardt, 1996; Usher & Evans, 1996; Madsen & McKelvey, 1996; Madsen, 1997; Madsen, Mosakowski, & Zaheer, 2002, 2003). These “micro-evolutionary” approaches highlight the role of internal selection activities in firm development (we define micro-evolutionary processes formally below).

We next define the Darwinian and Lamarckian views of evolution as they typically apply at the firm level of analysis. We then discuss intrafirm levels of analysis.

Darwinian Evolution: Natural Selection

Most research in organizational evolution adopts the Darwinian view of population dynamics, in which a firm’s ability to institute adaptive changes is severely constrained by inertial forces, and change occurs within a population as the result of environmental selection forces rather than internal adaptation (Hannan & Freeman, 1977, 1984). Variations at the population level of member firms only arise by chance as entrepreneurs start up new firms. Failing firms remain locked into obsolete capabilities, while replacement firms survive because they have more advantageous capabilities, given current environmental conditions. External selection forces, in the form of competitors and environmental constraints, provide a context in which some firms thrive and are selected favorably, while others fail and are replaced. Darwinian evolution occurs only when all four principles of natural selection are simultaneously in effect (McKelvey, 1982):

1. Principle of Variation: Differences in competencies and fitness occur across organizations.
2. Principle of Selection: Environmental forces selectively discriminate against some organizational variations and favor others within a population.
3. Principle of Retention and Diffusion: Favored variations are retained and diffuse throughout the population.
4. The Struggle for Existence: The competitive context is such that organizations holding a larger proportion of favored competencies will deprive organizations holding fewer favored competencies of required resources, leading to the eventual failure of the latter.

The fourth principle emphasizes the role in organizational evolution of competitive pressures in securing resources (Sanchez & Heene, 2004). In
such a competitive context, a firm’s performance may be maintained when it holds favored capabilities and resources that are valuable and isolated from imitation and substitution (Barney, 1991).

Lamarckian Evolution: Organizational Adaptation

Lamarck (1809) defined the earliest complete theory of evolution. His view has since been discredited in biology (Mayr, 1982), but it offers a useful alternative to Darwinian theory for understanding organizational evolution. Darwinian theory holds that variations only arise by chance and are “blind” as to their adaptive efficacy and it is environmental constraints that impose selection forces on firms. In applying Lamarckian theory to firms, however, internal adaptive changes are seen to arise purposefully in response to shifting environmental pressures observed by a firm’s members, not by chance. Other research stipulates that adaptation is often too perfect to be accounted for simply by chance, and that some changes must arise as the result of managerial responses to environmental pressures (e.g. Penrose, 1952; Goldschmidt, 1976). Lamarckian (adaptation) perspectives suggest that people in organizations purposefully search for alternatives, and firms are thereby able to successfully adapt to shifting environmental conditions to ensure performance and continued survival (Lawrence & Lorsch, 1967; Thompson, 1967; Pfeffer & Salancik, 1978; Andrews, 1980). The extant literature cites several internal factors that may influence organizational change and adaptation, for example:

- Structural Contingency Theory (Burns & Stalker, 1961; Lawrence & Lorsch, 1967; Thompson, 1967)
- Goals, Expectations, Choice, and Control (Cyert & March, 1963)
- Organizations as Institutions (Zucker, 1983, 1987)
- Resource Dependence Theory (Pfeffer & Salancik, 1978)
- Organizational Learning (Levitt & March, 1988; March 1991)
- Organizational Change (Bennis, Benne, Chin, & Corey, 1976; Goodman & Associates, 1982; Kanter, 1983)
- Organizational Development (French et al., 1994)
Selection vs. Adaptation

Weick (1969, 1979) developed the earliest rapprochement between Darwinian and Lamarckian approaches to studying organizations. In Weick’s view, purposeful adaptive outcomes are achieved through processes of internal natural selection. Managers, having studied the constraints of their firms’ external environments, and understanding the adaptive needs of their firms, “enact” programs of action. These enactments are Weick’s equivalent to Darwin’s variations—“Enactment is to organizing as variation is to natural selection” (1979, p. 130). Firms adapt to their surroundings by exploring new variations and environments, selecting alternative courses of action, implementing adjustments to environmental changes, and exploiting existing environment and organizational competencies in novel ways.

Other authors suggest that selection and adaptation are interrelated processes of change. For instance, Burgelman (1991) suggests that adaptive processes of internal selection may combine with death and replacement processes to explain change in populations. Levinthal (1991) argues that adaptation and selection are interrelated through processes of learning and inertia. Examining organizational change and mortality, Singh, House, and Tucker (1986) consider whether adaptation arguments are more consistent with the empirical relationships between organizational change and mortality than ecological arguments. Their findings indicate that all changes are not adaptive with respect to survival and that organizational change does not always increase organizational death rates. Usher and Evans (1996) conclude that optimal patterns of behavior may emerge via processes of selection and adaptation. Building on this research, we suggest that empirically examining the relationship between VSR activities and firm performance will move us one step closer to understanding the relationship between selection and adaptation.

RATES OF CHANGE AND INTRAFIRM EVOLUTIONARY LEARNING PROCESSES

The only thing that gives an organization a competitive edge—the only thing that is sustainable—is what it knows, how it uses what it knows, and how fast it can know something new! (Prusak, 1996, p. 6)

How organizations create, acquire, retain, share, and transfer knowledge continues to attract attention from diverse fields of study, including artificial
intelligence (e.g. Hutchins, 1990, 1991; Carley, 1999; Carley & Gasser, 1999),
group dynamics (e.g. Ancona & Caldwell, 1998; Argote, 1999; Moreland &
Myaskovsky, 2000; Paulus & Yang, 2000), strategic management (e.g.
Nelson & Winter, 1982; Henderson & Clark, 1990; Heene & Sanchez, 1997;
Hoopes & Postrel, 1999; Argote, McEvily, & Reagans, 2003), and organi-
zation theory (e.g. Kogut & Zander, 1992; Darr, Argote, & Epple, 1995;
Argote, 1999; Grandori & Kogut, 2002; Zollo & Winter, 2002; Madsen et al.,
2003). Much of this work focuses on how firms might increase their
amounts of organizational learning. Yet, increasing an organization’s rate
of learning is equally important and could be even more important for
firms competing in industries characterized by rapid rates of change (Argote,
1999).

Given this, effective strategy is no longer just about creating or entering
the right industry. Instead, it is about positioning a firm to be continuously at
or near the frontier of its industry’s evolution — such that the firm’s knowl-
dge base changes at a rate that enables the firm to create and sustain greater
value for its customers and at a cost lower than that of its rivals (see Hoopes,
Madsen, & Walker, 2003). In sum, a firm’s ability to speed up or slow down
its rates of change — in capabilities and in the inputs to those capabilities like
knowledge, learning, resources, and routines (see Winter, 2003) — is in-
creasingly important.

It’s not the BIG that eat the SMALL ... It’s the FAST that eat the SLOW.
(Jennings & Haughton, 2000: front cover)

Firms vary in their intrafirm rates of change — that is, in their dynamic
capabilities which govern the rates of change of ordinary or operational
capabilities (Winter, 2000, 2003). One reason for this variance is that firms
operate in environments with different rates of macro-environmental
change. However, the relative importance of firms’ internal rates of change
versus the rates of change in their industry macro-environments also partly
depends on the rate of a firm’s internal micro-evolution — which we define
here as the interactions of a firm’s internal processes of VSR. We also now
define the concept of micro-coevolution as the reciprocal interactions of
micro-evolving firms within a population of firms (e.g. an industry).

Both micro-evolution and micro-coevolution can occur at different rates
and in different directions. One possible form of what we term rapid micro-
coevolution could be that two rapidly micro-evolving firms continuously
adapt by increasing their knowledge and capabilities, perhaps even setting
the pace of competitive evolution in their industry. Another possible out-
come of this rapid micro-coevolution scenario, however, might be that the
weaker of the two rapidly micro-evolving firms may seek to avoid the Red Queen Paradox (Van Valen, 1992) of simply running faster and faster in place and instead seek to survive in the long run by changing the direction of its micro-evolution towards a niche market in which it does not compete directly with the other, stronger rapidly micro-evolving firm. In both the cases in this scenario, each firm’s internal rate of micro-evolution is more important in explaining its evolutionary outcome than the rate of change of their overall industry macro-environment. In other words, adaptation in this scenario is primarily a function of a firm’s internal VSR rates and, thereby, the outputs of its VSR processes (e.g. the amounts of knowledge produced by each firm’s rate of knowledge production/evolutionary learning).

The “inertia argument,” upon which population ecology depends (Hannan & Freeman, 1984), is the opposite of the rapid micro-coevolution scenario we have posed above. Under what we now refer to as slow micro-coevolution, in which a firm’s inertia is a strong effect and its ability to micro-evolve internally is a relatively weak effect, industry macro-environmental evolutionary effects will determine which firms survive and thus regulate the size and composition of the population of firms in an industry. Under these conditions, the rates of change of the industry macro-environment will predominantly explain evolutionary outcomes for individual firms.

The distinction between rapid and slow micro-coevolution focuses attention on firms’ internal VSR rates relative to the rates of change of their industries and possibly larger environments. It also invites attention to the workings of an evolutionary hierarchy. Firms evolve through cycles of VSR that occur at multiple hierarchical levels – e.g. intrafirm (individual, work groups, department, division), firm, industry population, community (Aldrich, 1979; Baum & Singh, 1994a; Sanchez, 2000). In population ecology, selection is a contextual (or external) property that determines retention of variations. If we think of evolution as a multilevel process that also includes processes within firms, however, an obvious question for investigation is how VSR at one level of analysis interacts with the next higher VSR level in this evolutionary hierarchy.

In a minimal hierarchical view, variation and selection processes weed out variations at two levels: (1) intrafirm to firm level – firms develop internally a portfolio of variations from which managers select preferred models, and (2) population level – external agents (or larger macro-environmental forces) select some firms over others based on the variations retained by the firms. Two levels of retention may also exist: (1) intrafirm to firm level – variations selected by managers and retained by a firm are dispersed throughout the firm’s operations, and (2) population level – variations retained by a firm
and favored by external selection agents are dispersed throughout the population, and firms with retained variations that are favored by external selection agents are retained in the population. Two types of experiential learning opportunities can therefore be identified at the firm level: (1) generative learning, in which managers may discover novel knowledge during trial-and-error experimentation, and (2) inferential learning, in which managers may gain knowledge about the efficacy of a retained variation once it is dispersed across the firm. Similar learning processes can occur within work groups, departments, and divisions of a firm. In this way, VSR activities interact inside a firm to form an “engine” for producing knowledge (Madsen et al., 2002; Zollo & Winter, 2002).

Importantly, these learning engines operate at different rates within different firms, depending on each individual firm’s rates of VSR. For instance, a firm may have a rapid variation rate, but slow selection and retention rates. Such a firm might generate large amounts of alternatives (variations or trials) continuously over time, but given its slow selection process, previously retained variations may continue to dictate the firm’s behavior. Of course, under stable industry conditions, such a mismatch among rates may matter less then in rapidly changing industry conditions. However, we suggest that regardless of industry conditions, a firm that lacks dynamic capability in coordinating rates of VSR activities is likely to be in a weaker position relative to a firm that has developed a capacity to change through balanced VSR rates. Even in stable industries, a firm with a superior capacity to change may be able to introduce organizational innovations that provide it with a competitive edge over the competition. Moreover, a firm with a superior capacity to change will also be better positioned to respond in a timely fashion to rivals’ actions and to any industry-level changes that emerge. We expand on this critical balancing of VSR dynamics in the “balanced continuity” section of the chapter (below).

The following subsections present our hypotheses, define internal VSR processes more fully, and identify the mechanisms which facilitate each kind of VSR activity. We also note here that all the hypotheses we put forward below are expected to hold more strongly in environments where the intensity of the competitive struggle for existence is high.

Variation

In our knowledge-based perspective on micro-evolution, variation involves the creation of knowledge that generates novel changes in a firm’s ways of
operating. Intrafirm variations may occur through (1) intentional or unintentional trials (experiments), (2) focused or unfocused trials, each of which may be supported by (3) direct or indirect incentive systems (Miner, 1994). Whether intentional or unintentional, processes that generate intrafirm variations are mostly "blind" (Campbell, 1969; Aldrich, 1979; Weick, 1979), because managers, under conditions of uncertainty and competition, are unlikely to know in advance which variations will lead to successful adaptive outcomes and consequently enhance firm performance. Variations may occur purposefully in response to specific environmental changes, they might be planned but not necessarily responsive to a particular environmental condition, or they might "just happen" (Campbell, 1969; McKelvey, 1994). Variations might also arise by combining old and new routines that are not currently recognized as distinct competencies within a firm (Nelson & Winter, 1982; Zollo & Winter, 2002). In this sense, a firm's variation capability is consistent with what Schumpeter (1934) referred to as entrepreneurship – that is, the ability to create new ways of operating and new opportunity sets via combinative learning (Zollo & Winter, 2002).

Firms may use a variety of mechanisms to promote variation activity. Some firms believe in the value of unfocused experimentation or "galumphing" (Weick, 1979, p. 248) and encourage boundary-spanning activities, the exploration of new environments, the creation of a diversity of ideas, and new competence acquisition (e.g. March, 1991; Kanter, Stein, & Jick, 1992). Firms also often create safe havens for learning such as "skunkworks," which facilitate informal work on new ideas (e.g. Peters & Waterman, 1982). Such contexts may be established by managers to encourage the development of a wide range of ideas and thus are generally characterized by an absence of control mechanisms (Loasby, 1998). Firms may also promote variation activity through focused experimentation activities, such as formalized research and development (Miner, 1994), identifying "champions of change" who shape a vision within firms and lead focused experimentation efforts (Nadler & Tushman, 1991; Kanter et al., 1992), and creating parallel projects in which several teams work on the same problem to generate competition in creating potential new product ideas or technology variations (Miner, 1994).

Reward systems that provide direct or indirect incentives to individuals may contribute to increased variation activity (Lawler, 1991; Kanter et al., 1992; Miner, 1994). For instance, incentives that reward useful innovation as part of an employee's standard responsibilities, compensate individuals for patents or innovative work, or allocate limited resources based on a competition between employees may motivate variation activity.
Organizations differ in how they structure their variation activities, in how much they promote focused or unfocused experimentation, and in how they use variation-inducing incentive systems. Research suggests that developing a portfolio of variations (change alternatives) will enable a firm to respond more effectively to environmental change compared to firms that lack identified alternative courses of action and have little or no experience with experimentation (e.g. Nadler & Tushman, 1988; Kanter et al., 1992). Firms that are slow or fail to generate and adopt changes in behavior and that continue to invest in obsolete practices are likely to suffer in their competitive environments. On the other hand, while an openness to wholesale change or "non-institutionalized innovation" increases the potential for successful adaptation, it also increases the risk of firm failure (Zucker, 1987). Consequently, firms need to achieve a balance between introducing change and building on past experience to reinforce current practices.

Firms that pursue high rates of variation activity may invest an inordinate amount of resources in experimentation activity and might encounter high costs of experimentation without realizing compensating benefits (March, 1991) and limit potential returns from their past experiences. Under these conditions, a firm may possess a portfolio of new undeveloped ideas but may not become proficient at any one skill or task. In other words, for a number of reasons, excessive rates of variation (if selected and retained internally) may be disruptive and risky to a firm as a whole (Hannan & Freeman, 1984).

In a study of the Finnish newspaper industry, for example, changes in product content and frequency of publication were associated with an increase in the hazard rate of firm failure (Amburgey, Kelly, & Barnett, 1993). Also, the cost of ramping up variation activity in order to generate a large pool of variations may be detrimental to firm performance in the long run and may place a firm at risk of losing market share, because funding creation of large numbers of variations may drain a firm's resources and reduce funds available to pursue new opportunities or to exploit existing capabilities. Moreover, searching for and developing alternative courses of action may simply have lower potential and less certain outcomes than building on existing capabilities. Frequent change also may generate random drift, rather than performance enhancement, when a firm's operations are altered prior to the firm fully understanding its competitive environment (Lounamaa & March, 1987). Nevertheless, even though reducing the frequency of change might provide managers with time to build a better understanding of environmental conditions, a tradeoff exists between realizing the potential benefits of an increase in understanding of one environmental
state versus the consequences of a decrease in information about possible other states. This dilemma calls attention to a fundamental question in organization science and strategy: What rate of change is most appropriate to sustain a firm’s overall (short- and long-term) performance in a dynamic environment?

Thus, even though high rates of internal variation activity may be necessary to develop sufficient requisite variety (McKelvey & Aldrich, 1983), too much variation activity may send a firm into a downward spiral (Hannan & Freeman, 1984; Hambrick & D’Aveni, 1988). In contrast, when a firm’s rate of variation activity is too low or variation activity is infrequent, a firm’s manager will have a limited amount of variation alternatives to select from. Such a limited pool of alternatives may reduce the firm’s chances of selecting and retaining an optimal or even viable solution and thereby put the firm’s performance at risk. Such firms may also lack experience with experimentation, one possible implication of which is reduced efficacy in implementing alternatives developed in its variation process.

We therefore hypothesize that, in a competitive environment, inappropriately high or low rates of variation activity may lead to micro-evolutionary dysfunctions that adversely affect firm performance.

**Hypothesis 1.** Firm performance varies non-monotonically (following an inverted U-shape) with rates of internal variation.

**Internal Selection**

We characterize internal selection as the process by which managers choose variations (Weick, 1979). Firms influence their internal selection processes primarily through administrative and cultural control mechanisms (McKelvey & Aldrich, 1983; Burgelman, 1991; Miner, 1994; Sanchez & Heene, 2004). Administrative control mechanisms include strategic planning, goal setting, and rules governing resource allocation (Weick, 1979; Burgelman, 1991), as well as project evaluation criteria, schedules or basic pre-screening criteria for projects, intrafirm competition for resources or standards, and informal intrafirm competition (Miner, 1994). Cultural control mechanisms include behavioral norms, allegiance to which may influence internal selection processes. For instance, norms against offering suggestions, against experimenting, or against taking initiative may lead managers to select against potentially beneficial variations, thereby contributing to maintaining a status quo. Firms may also promote selection activity by managers by defining goals but not explicitly identifying the
actions to be taken to achieve the goals. In this setting, managers may use firm goals to guide their selection of available variations in determining a course of action (Miner, 1994).

In the absence of operative administrative and cultural selection mechanisms, variations are less likely to be selected or retained, and previous firm behavior is likely to drive current behavior and determine firm performance. Consequently, a firm may progressively become less fit with its environment over time as reinforcement of past behavior contributes to inertia and reduces attention to environmental change (Hannan & Freeman, 1984; Meyer & Zucker, 1989). Other factors within a firm, such as political coalitions, may also influence its managers' selection behaviors in the absence of administrative and cultural controls (Meyer, 1994). Moreover, a firm's members may resist adopting a change when the change may place them at risk of losing private gains. In such settings, variations may be selected without regard to whether they benefit the firm as a whole.

By the same token, a high rate of selection driven by rigid administrative control processes may negatively impact firm performance (Weick, 1979; McKelvey & Aldrich, 1983). Overly specified evaluation criteria may slow down the selection process and/or necessitate high levels of managerial effort and other resource allocations to assess the efficacy of the variations developed within a firm. Adherence to behavioral norms may also adversely affect the selection process when potentially successful variations are weeded out as the result of overly strong cultural controls. Managers may also hesitate to evaluate and select particular variations when maintaining a previous course of action simply requires less effort than adopting a change in a behavior or operating routine.

The above arguments lead us to predict that in a competitive environment, inappropriately high or low rates of internal selection activity may lead to micro-evolutionary dysfunctions that adversely affect firm performance.

**Hypothesis 2.** Firm performance varies non-monotonically (following an inverted U) with rates of internal selection.

**Retention**

Retention is the preservation of variations in behavior adopted by an organization through dispersion of these changes across its operations and subunits. The knowledge content of a variation that is retained by a firm embodies knowledge about both its existing and past behaviors and will be
stored in different organizational "retention bins" that form the firm's memory (Walsh & Ungson, 1991). Dispersion involves internally replicating a retained variation across organizational space and time. Through processes of dispersion, a firm leverages its new and past knowledge (Sanchez, 2000).

Firms may facilitate retention (1) through control processes focused on maintaining consistency between selected actions and the actual behaviors of individuals, (2) through leadership that creates commitment to change efforts (Nadler & Tushman, 1991; Kanter et al., 1992), and (3) through organizational designs that facilitate communication and transfer of information across units about the results of previously retained variations (Nadler & Tushman, 1988). Continuous communication and review of change implementation efforts through management information systems, budgets, and schedules may thereby assist in propagating consistent behavior across a firm's operations (e.g. Kanter et al., 1992).

A high rate of retention activity implies repeated exploitation of a firm's current and past knowledge and competencies. With repetition, each retained variation becomes more routine to a firm and thereby increases the chances that it will be used again in the future (e.g. Nelson & Winter, 1982; Levitt & March, 1988). Familiarity with retained activities may create "blind spots" to opportunities that arise from changes in a firm's environment (Andrews, 1980). When environments change, prior firm practices and procedures may no longer be effective (Chakrabarty, 1982), and inappropriately high retention rates may operate as inertial mechanisms that limit a firm's ability to benefit from any internal variation and selection processes a firm may have, and this dysfunctionality may pose obstacles to maintaining a firm's performance.

A low rate of retention activity may also lead to low firm performance. Low firm retention rates may indicate that a firm is not building on its experienced-based knowledge, perhaps because it is not systematically gathering and evaluating feedback on performance outcomes of previously implemented variations, or perhaps because it is not effectively dispersing selected variations across the firm's operations. Levinthal (1991) argues that building on existing knowledge enhances a firm's survival chances. Not utilizing current know-how or experience, however, may expose a firm to the survival risks associated with young firms (Stinchcombe, 1965). Retention also provides a consistent base of experience from which to compare future courses of action. Establishing associations between past actions and subsequent performance is necessary for organizational learning to occur (Fiol & Lyles, 1985). Without feedback from the performance outcomes of previously
retained variations, trial-and-error learning breaks down because managers cannot determine which variations resulted in effective or ineffective outcomes, or why they did so (Levinthal & March, 1993).

Lack of dispersion of retained variations throughout a firm also may result from an inability to integrate knowledge across the firm, a lack of effective leadership for change efforts, or a failure to transform experience into routines and embed routines in the firm's memory (Levitt & March, 1988). Adequate processes for distilling knowledge from past experience or for dispersing knowledge-based variations may not exist in the firm. When selected variations are not dispersed, various parts of a firm may continue to base their behaviors on previous experiences which may not address adequately the environmental conditions the firm as a whole currently faces. We hypothesize that, in a competitive environment, inappropriately high or low rates of retention activity will result in micro-evolutionary dysfunctionalities that adversely affect firm performance.

**Hypothesis 3.** Firm performance varies non-monotonically (following an inverted U) with rates of retention.

*Balanced Continuity*²

We have described how internal natural selection VSR requires a continuous chain of events (Campbell, 1969; Weick, 1979) that allows firms to generate, adopt, and implement changes which satisfy external or internal pressures for change (Burgelman, 1994). We have also argued that each activity in a firm's internal VSR process is necessary for the eventual adoption of variations. The preceding sections argue that inappropriately high or low rates of VSR activities create internal micro-evolutionary dysfunctionalities that constrain a firm's ability to adopt changes and limit the firm's responsiveness to internal and external pressures.

While Campbell (1969) and Weick (1979) emphasize that internal natural selection is a continuous process, they say less about what rates of variation activities or what amounts of variation, selection or retention outputs are necessary for adaptation to occur. As McKelvey and Aldrich (1983, p. 125) state, "Managers should attempt a balanced emphasis on all four principles [of natural selection] as the best way of increasing the chances of the survival of their organization." Tushman and Romanelli (1985) argue that successful organizations are those which develop a balance between change and stability, while March (1991) calls for balancing exploration and exploitation.
The concept of *balanced continuity* that we develop now builds on these arguments.

Firms differ in how they configure and govern internal VSR processes. Depending on this, the rates of each VSR activity and the amounts of variation, selection and retention realized will vary across firms. Such differences give rise to heterogeneous capacities for and actual rates of change across firms, and these variations create the variance in firms’ dynamic capabilities. As we have suggested, how effectively a firm manages the rates of its VSR activities influences the firm’s ability to learn from past experience, generate new variations (opportunities for change), and control the types of changes adopted. In a competitive environment, a condition of *balanced continuity* exists in a firm when the rates of all three internal VSR activities are brought into a balanced relationship that enables a firm to achieve adaptive outcomes that maintain or enhance its performance.

By finding a more appropriate balance among rates of VSR activities relative to rates of industry-level environmental change, a firm may develop a performance advantage over rivals and prosper in its competitive environment. In the absence of balanced continuity, however, a firm may lack the ability to generate and adopt changes necessary to maintain or improve performance in a timely fashion, and as a result, may become more subject to external selection forces. In effect, under conditions that we have characterized as slow micro-coevolution, a firm’s fate is largely driven by selection forces in its environment. In contrast, when a firm achieves balanced continuity by sustaining what we have characterized as rapid micro-evolution, we argue that internal natural selection will lead to adaptation and will dominate over external selection forces.

Hypotheses 1–3 therefore lead to the derivation of two broader propositions that, in effect, summarize the micro-evolutionary theory we develop here and connect the balanced continuity concept to the broader body of evolutionary theory. More specifically, these propositions link selection and adaptation forms of firm evolution and identify the conditions that give rise to the dominance of one form of evolution over the other.

**Proposition 1.** In a competitive environment, when balanced continuity is achieved within a firm, internal natural selection leads to effective adaptation and dominates over external selection forces.

**Proposition 2.** In a competitive environment, when balanced continuity is not achieved, external selection forces dominate over internal adaptation in organizational evolution.
RESEARCH DESIGN

Data

Data from a questionnaire on organizational learning, culture change, and competitiveness are used (Ulrich, Von Glinow, Jick, Yeung, & Nason, 1993). Approximately 2,000 surveys were submitted to 382 business units, and 1,359 responses were received from 380 firms worldwide (response rate = 68%). The data were collected following key informant methodology in which respondents are selected based on their ability to provide an informed response about their business (Campbell, 1955; Siedler, 1974; Phillips & Bagozzi, 1986). The respondents are senior managers with an average tenure of 15.8 years and an average age of 45.7 years. Given their tenure, the senior managers are assumed to be familiar with their firms’ rates of change. The senior managers span an array of functional areas, including finance, general management, human resources, manufacturing, marketing/sales, and research and development. The firms represent 10 major industry groups (including electronics and computers, chemicals and pharmaceuticals, wholesaling and retailing, finance, services, aircraft, and automobiles) and one miscellaneous manufacturing group. The sample is skewed toward larger, older firms.

We test our hypotheses using data on all the North American firms in the sample (N = 193). Following multiple informant methods, data are aggregated by firm for firms having three or more respondents (Siedler, 1974). Cases with high disagreement among respondents in key variables, such as the size or age of the business unit, are treated as missing values. After these adjustments, the average size and age of the sample does not differ significantly from the total sample. The responses of the informants that are members of the same firm have been averaged and treated as an aggregate score for each questionnaire item.

Dependent Variable

Our measure of firm performance is based on a composite measure that is consistent with multi-dimensional performance measures recommended by Venkatraman and Ramanujam (1986) in their review of performance measures for strategy and organizational research. Respondents were asked to (1) rate their firm’s financial performance compared to major competitors on a 6-point Likert scale ranging from “much worse” to “much better” (one
questionnaire item); (2) similarly rate their firm’s performance relative to other competitors in the five functional areas of customer relations, distribution channels, globalization, marketing and sales, and research and development (five questionnaire items); and (3) rate their firm’s cycle time for innovation and its reputation as an innovator compared to major competitors (two questionnaire items). We sum these eight questionnaire items by firm to construct each firm’s performance measure. Cronbach’s alpha for the performance measure is 0.76.

Variables

The main variables of interest, variation, selection, and retention, are empirically developed using orthogonal factor analysis (varimax rotation). The factor analysis consists of 3, 4, and 5 factor rotations; a three-factor solution is extracted. Consistent with Harman’s one-factor test (Podsakoff & Organ, 1986), the different stages of factor analysis revealed 3 factors with eigenvalues greater than 1; none of the factors explained more than 20% of the total variance in the data. This finding suggests that common method variance (CMV) does not appear to undermine the validity of our data construction. The discussion section following our analysis offers additional explanations for why CMV does not pose a significant threat to our analysis.

The factor analysis yields measures for variation, selection and retention based on the behaviors underlying firms’ rates of VSR. Variations are taken here to include alterations in the state, form, or function of a firm and may occur through focused or unfocused experimentation and under direct or indirect incentive systems. Variation reflects the extent to which a firm (1) encourages the acquisition of competencies; (2) continually seeks new ideas; (3) continually seeks new ways to do work; (4) embraces experimentation; (5) strives to be the first to market with a new process or product; and (6) embraces change. The mean score of items 1–6 represents the rate of a firm’s variation activity. Cronbach’s alpha for the variation scale is 0.84.

Selection, the managerial choice of variations, is assumed to be carried out primarily through administrative and cultural control mechanisms. The following items load high on Factor 1 and reflect the extent to which each firm (1) performs problem analysis prior to implementation of ideas, (2) employs procedures that “make a difference” in the organization, (3) employs behaviors that redress past mistakes, (4) considers the implications of change, and (5) ensures actions are consistent with goals. The
mean score of items 1–5 defines the amount of a firm’s selection activity. Cronbach’s alpha for the selection scale is 0.84.

Retention is the preservation and dispersion of selected variations. Items that load high on retention reflect the extent to which a firm and its managers (1) transfer learning from one site to another, (2) integrate a business change into the firm’s overall business process, (3) track progress on business changes, (4) share results widely within the firm, and (5) provide specific and frequent feedback that improves performance. The mean score of items 1–5 defines the amount of a firm’s retention activity. Cronbach’s alpha for the retention scale is 0.85.

We also include variables to control for firm characteristics and environmental conditions. As for firm characteristics, research suggests that large size reflects a degree of institutional insulation and bureaucratization that might make large firms less responsive to shifting industry conditions (Haveman, 1993). Alternatively, if large size is related to the accumulation of endowments and market power, then large firms may be more able to reposition than small firms. Consistent with this view is the notion that small size limits a firm’s ability to adjust to environmental conditions and thereby threatens its performance (Delacroix & Swaminathan, 1991). We control for these effects using firm size, defined as a firm’s number of employees. We use the natural log of firm size to reduce the skewness of the distribution. Under this approach, a one-unit change in the size of a small firm will have a larger impact than a one-unit change in the size of a large firm.

Research also suggests that that firm age may differentially affect a firm’s performance. Findings on the liability of newness suggest that old firms benefit from accumulated experience (Carroll & Delacroix, 1982; Freeman, Carroll, & Hannan, 1983). The counter argument is that firms become increasingly ossified as they age (Barron, West, & Hannan, 1994) and face increasing difficulty to change in a timely manner. We include a control variable for a firm’s age, defined as the number of years since founding. We use the natural log of firm age to reduce the skewness of the distribution.

Environmental conditions, such as the degree of environmental uncertainty and dynamism, may also affect firm behavior and performance. Environmental uncertainty is defined here as the extent to which future changes in an environment are unknown (Lawrence & Lorsch, 1967; Duncan, 1972; Khandwalla, 1977; Romanelli & Tushman, 1994). Using a 6-point Likert scale, respondents rated the extent to which changes in their industry are predictable over the next 3 years; a high score on this variable indicates a very high amount of unpredictability and thus environmental uncertainty. Dynamism is defined as the extent to which changes occur in a firm’s
business environment (Aldrich, 1979). Building on prior research, we operationally defined dynamism by asking respondents to rate the extent to which 14 functions or activities are changing in their business (e.g. customer buying criteria and customer relations, distribution channels, organization structures, research and development, production capability, and sales and marketing) on a 6-point Likert scale, with a high score indicating a very high degree of change. The dynamism index is a summation of the 14 scores for each firm.

**Model Specification**

We use ordinary least-squares regression to test the relationship between the internal VSR variables and firm performance. The model is specified as follows:

\[
\text{Firm Performance} = \beta_0 + \beta_1 \text{ Variation} + \beta_2 \text{ Selection} + \beta_3 \text{ Retention} \\
+ \beta_4 (\text{Variation})^2 + \beta_5 (\text{Selection})^2 + \beta_6 (\text{Retention})^2 \\
+ \alpha F + \delta I + \varepsilon.
\]

where *Firm Performance* is the composite measure of firm performance; \(\alpha\) is a vector of coefficients representing the effects associated with \(F\), the vector of covariates capturing a firm’s characteristics; \(\delta\) is a vector of coefficients associated with \(I\), the vector of covariates representing the environmental characteristics; and \(\varepsilon\) is the error term.

We first test a baseline model for the effects of firm and environmental characteristics on performance. We then add the first-order terms for variation (model 2), selection (model 3), and retention (model 4) followed by the second-order terms for each construct (models 5–7 respectively). These analyses make it possible to determine whether the internal natural selection process explains firm performance after controlling for heterogeneity in the sample due to differences in firm characteristics and environmental characteristics. The combination of first and second order effects of variation, selection, and retention test the hypotheses that firm performance varies non-monotonically (following an inverted U-shape) with each construct.

**Descriptive Statistics**

Table 1 presents the means, standard deviations, and correlation matrix. The large standard deviation in firm size and dynamism indicates large
Table 1. Means, Standard Deviations and Correlations.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Performance</td>
<td>23.12</td>
<td>0.53</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Ln(size)</td>
<td>9.27</td>
<td>1.81</td>
<td>-0.17**</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Ln(age)</td>
<td>4.25</td>
<td>0.81</td>
<td>-0.03</td>
<td>0.25**</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Uncertainty</td>
<td>1.94</td>
<td>0.53</td>
<td>0.12*</td>
<td>-0.01</td>
<td>-0.15*</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Dynamism</td>
<td>46.41</td>
<td>4.27</td>
<td>0.03</td>
<td>0.28**</td>
<td>0.11</td>
<td>0.10</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Variation</td>
<td>3.22</td>
<td>0.50</td>
<td>0.50**</td>
<td>-0.01</td>
<td>-0.08</td>
<td>-0.19**</td>
<td>0.27**</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Selection</td>
<td>3.31</td>
<td>0.52</td>
<td>0.45**</td>
<td>-0.26**</td>
<td>-0.22**</td>
<td>-0.05</td>
<td>-0.08</td>
<td>0.33**</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>8. Retention</td>
<td>3.08</td>
<td>0.45</td>
<td>0.38**</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.12*</td>
<td>0.53**</td>
<td>0.51**</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*p<0.05. **p<0.01.

differences in the sample of 193 firms. Firm performance is positively correlated with the VSR constructs, as expected, and negatively correlated with firm size and age. Firm size and age also are negatively correlated with variation and selection, but positively correlated with retention. Moderate positive correlations exist among the three main VSR constructs. The positive correlation between variation and retention is consistent with the idea that these activities are reinforcing rather than opposing. Environmental uncertainty and dynamism negatively correlate with selection and retention, but positively correlate with variation. This suggests that under conditions of significant uncertainty and environmental change, firms do pursue more variation activity, but may be more reluctant to commit to the variations they generate. Some variance overlap may exist among the independent variables, given their moderate correlations. Variable inflation factor tests indicate a lack of multicollinearity (VIF<1.4 in all cases).

RESULTS

Table 2 reports the results of the hierarchical regression analysis. We begin by discussing the linear effects for variation and selection. Model 2 shows a positive and significant relationship between firm performance and variation. This model fits the data significantly better than the baseline model (1) which contains only the control variables: ΔAdjusted $R^2 = 0.26, p<0.01$.

The next two models add first-order selection and retention effects, respectively. The coefficient for selection is positive and significant and the coefficient for retention, while positive, is not significant. Model 3 shows that
Table 2. The Effects of Internal VSR on Firm Performance.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ln(Size)</td>
<td>-0.032*</td>
</tr>
<tr>
<td>(0.11)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Ln(Age)</td>
<td>0.07</td>
</tr>
<tr>
<td>(0.27)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>Environmental Uncertainty</td>
<td>0.69</td>
</tr>
<tr>
<td>(0.36)</td>
<td>(0.36)</td>
</tr>
<tr>
<td>Dynamism</td>
<td>0.05</td>
</tr>
<tr>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Variation</td>
<td>3.27***</td>
</tr>
<tr>
<td>(0.41)</td>
<td>(0.41)</td>
</tr>
<tr>
<td>Selection</td>
<td>1.79***</td>
</tr>
<tr>
<td>(0.43)</td>
<td>(0.44)</td>
</tr>
<tr>
<td>Retention</td>
<td>0.09</td>
</tr>
<tr>
<td>(0.54)</td>
<td>(0.53)</td>
</tr>
<tr>
<td>Variation²</td>
<td>1.16*</td>
</tr>
<tr>
<td>(0.52)</td>
<td>(0.52)</td>
</tr>
<tr>
<td>Selection²</td>
<td>-0.90</td>
</tr>
<tr>
<td>(0.48)</td>
<td>(0.48)</td>
</tr>
<tr>
<td>Retention²</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>(0.67)</td>
</tr>
</tbody>
</table>

$R^2$                  | 0.05      | 0.30      | 0.38      | 0.38      | 0.39      | 0.41      | 0.41      |
| Adjusted $R^2$        | 0.03      | 0.29      | 0.35      | 0.35      | 0.37      | 0.38      | 0.38      |
| ΔAdjusted $R^2$       | 0.26**    | 0.07***   | 0.02*     | 0.01      |
| $F$                   | 2.47*     | 16.74***  | 18.91***  | 16.13***  | 15.05***  | 13.97***  | 12.77***  |

Standard errors are in parentheses.

*p < 0.05.

**p < 0.01.

***p < 0.001.

The selection parameter in the model significantly improves fit to the data over model 2 containing only the control variables and variation: ΔAdjusted $R^2 = 0.07$, $p < 0.01$.

The second-order effects of VSR are added in models 5–7, respectively. We discuss the results of the full model, model 7. Hypothesis 1 predicted that firm performance would vary according to an inverted U-shape with the rate, or amount, of variation activity a firm pursues. The results show
that, with the inclusion of the second-order term for variation, the first-order effect is negative and not significant but the coefficient for the second-order term is positive and significant. These findings suggest that firm performance may increase at an increasing rate with variation activity.

Hypothesis 2 predicted that firm performance would vary according to an inverted U-shape with internal selection. The findings are consistent with this prediction. The coefficient for the first-order selection parameter is positive and significant and the coefficient for the second-order selection parameter is negative and significant. The inverted-U also reaches its peak within the observed range for the selection variable.

Last, Hypothesis 3 predicted that firm performance would vary according to an inverted U-shape with retention. The findings do not support our prediction. The coefficients for the first- and second-order retention parameters are not significant in model 7. The lack of a change in adjusted $R^2$ from models 3 to 4 and models 6 to 7 suggests that the addition of the first- and second-order retention terms does not significantly enhance the explanatory power of the models.

Results: Pictures from a Different Angle

In addition to the above analyses, two other hierarchical regression analyses were performed in order to test the hypotheses from a different vantage point – rather like moving a camera in the middle of a forest to alter the effect of obstructing trees. Table 3 presents the results of the second approach, which uses factor scores for the VSR constructs rather than an average of the survey items that mapped to each variable. The coefficients for each VSR activity have a statistically significant association with firm performance. This finding is consistent with one part of the reasoning underlying the concept of balanced continuity – that all three VSR activities matter for firm performance. In addition, model 4 shows a significant improvement in fit to the data over model 3 containing only the control variables and variation and selection: $\Delta$Adjusted $R^2 = 0.04$, $p < 0.01$. Consistent with the first set of analyses, model 7 is consistent with Hypothesis 2. Model 6 also is consistent with Hypothesis 2. Firm performance varies non-monotonically (following an inverted U-shape) with selection.

A third perspective was taken by revising the order in which the first- and second-order terms for the independent variables are added in the model. Table 4 presents results of the third view. Consistent with the first two sets of
Table 3. The Impact of VSR on Firm Performance (Models Using Factor Scores for VSR Variables).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dependent Variable: Firm Performance</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Ln(Size)</td>
<td>-0.032*</td>
<td>-0.27*</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Ln(Age)</td>
<td>0.07</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(0.25)</td>
</tr>
<tr>
<td>Environmental Uncertainty</td>
<td>0.69</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.39)</td>
</tr>
<tr>
<td>Dynamism</td>
<td>0.05</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Variation</td>
<td>1.30***</td>
<td>1.28***</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Selection</td>
<td>1.39***</td>
<td>1.07***</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Retention</td>
<td>0.61***</td>
<td>0.63***</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.18)</td>
</tr>
<tr>
<td>Variation²</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>Selection²</td>
<td>-0.26*</td>
<td>-0.25*</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>Retention²</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.05</td>
<td>0.20</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.03</td>
<td>0.18</td>
</tr>
<tr>
<td>ΔAdjusted $R^2$</td>
<td>0.15**</td>
<td>0.12**</td>
</tr>
<tr>
<td>$F$</td>
<td>2.47*</td>
<td>9.81***</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses.

$^{*}p<0.05.$

$^{**}p<0.01.$

$^{***}p<0.001.$

Analyses, performance varies non-monotonically with selection, the coefficient for the first order variation parameter is positive and significant until the second-order variation term is included, and the coefficient for the second-order variation parameter is positive and significant. Consistent with the first set of analyses, the coefficients for the retention parameters are not significant.
Table 4. The Impact of Variation, Selection and Retention on Firm Performance (Models with Different Order of Entry for Independent Variables vs. Models in Table 2).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dependent Variable: Firm Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Models</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ln(Size)</td>
<td>-0.032*</td>
</tr>
<tr>
<td>(0.11)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Ln(Age)</td>
<td>0.07</td>
</tr>
<tr>
<td>(0.27)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>Environmental Uncertainty</td>
<td>0.69</td>
</tr>
<tr>
<td>(0.36)</td>
<td>(0.36)</td>
</tr>
<tr>
<td>Dynamism</td>
<td>0.05</td>
</tr>
<tr>
<td>(0.05)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Variation</td>
<td>3.27***</td>
</tr>
<tr>
<td>(0.41)</td>
<td>(3.58)</td>
</tr>
<tr>
<td>Variation²</td>
<td>1.17*</td>
</tr>
<tr>
<td>(0.54)</td>
<td>(0.51)</td>
</tr>
<tr>
<td>Selection</td>
<td>1.76***</td>
</tr>
<tr>
<td>(0.38)</td>
<td>(3.13)</td>
</tr>
<tr>
<td>Selection²</td>
<td>-0.91*</td>
</tr>
<tr>
<td>(0.47)</td>
<td>(0.48)</td>
</tr>
<tr>
<td>Retention</td>
<td>0.20</td>
</tr>
<tr>
<td>(0.53)</td>
<td>(4.13)</td>
</tr>
<tr>
<td>Retention²</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>(0.67)</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses.

*p < 0.05.

**p < 0.01.

***p < 0.001.

For the most part, the various angles capture the same snapshot with subtle differences. Evidence regarding the relationship between internal VSR activities and firm performance is summarized as follows:

1. Performance varies in an inverted U-shape with selection.
2. Performance increases with increases in the amount of a firm’s variation activity.
DISCUSSION

Our theory suggests that, in combination, internal VSR activities underlie a firm's dynamic capability. Following Winter (2000, 2003), dynamic capabilities govern the rate of change of ordinary capabilities. Building on this work, we argued that firms must balance the rates and resulting amounts of variation, selection, and retention activities. As a first step in understanding the relationship between VSR activities and firm performance, we relate the behaviors underlying intrafirm variation, selection and retention rates to firm performance. We hypothesized that performance varies non-monotonically (following an inverted U-shape) with a firm's internal variation, selection and retention activities. Our results are partially consistent with the hypotheses. Firm performance varies according to an inverted U-shape pattern with selection. High or low amounts of administrative and cultural control adversely impact performance. The non-monotonic relationship between performance and variation is neither corroborated nor refuted. Instead, results suggest that firm performance increases as variation increases within the range of variable values observed in our study. A lack of support exists for the hypothesis that too much or too little retention is associated with low firm performance, suggesting a possible need to revisit our construct for representing retention, or even to rethink the effects of retention on overall VSR activities.

It is worth noting some of the limitations of this work. For one, the measures for the independent and dependent variables serve as proxy measures of varying quality. In general, constructs and measures of the independent variables seem to align with the theoretical definitions, but may not be as valid as one might prefer. A better alignment between theoretical and operational definitions might be achieved by incorporating more objective measures of VSR rates and amounts and firm performance. As mentioned, this cross-sectional study is only one step towards establishing a link between internal VSR activities and firm performance. However, more dynamic analyses would be desirable. For instance, a systematic longitudinal study that tracks the VSR activities of all the firms competing in an industry and examines how these activities affect the firms' performance over time could further inform the study of evolution across levels of analysis.

Second, a possible common method variance (CMV) problem exists (all data stem from the same questionnaire), though the findings seem to argue against this possibility. The lack of a statistically significant retention effect finding goes against CMV expectations — why would executives not, following conventional wisdom, make connections between change orientation
in shifting environments and higher performance? The non-monotonic nature of the selection finding seems unlikely to be CMV-caused, since the potential dysfunctionalities that can result from too much variation and selection (analysis and procedure) may lie outside conventional managerial wisdom. The performance/variation result could indicate CMV, but if this were so, consistency would suggest that respondents would also make connections between variation and environmental uncertainty and dynamism, which they do not appear to do. We conclude that if there is a CMV effect, it is not consistent or obvious, and it should not turn off or on depending on which variable is picked. One might consider substituting "hard" constructs and measures such as ROI or stock returns in place of the "managerial perceptions" used in this study, but there are usually as many issues surrounding use of hard measures as use of perceptual measures. Studies using both kinds of constructs and measures would be useful.

Third, while this research controls for environmental uncertainty, dynamism, firm size, and age, it lacks assessment of other environmental and firm characteristics. Firms in the sample compete in different industries and face different sets of environmental pressures; these differences may affect the relative importance of intrafirm rates of change versus external rates of change. For example, a firm in an industry with rapid ongoing change may find that the required VSR balance differs from that required in a firm facing a slower rate of environmental change. Including additional metrics for industry-specific rates of change might further inform our hypothesizing and sharpen our results. Alternatively, future research might focus on a more refined set of industries and collect data on all the firms competing in each industry. Empirical analysis might then examine firm-specific VSR effects in each industry and provide a comparative analysis across industries.

On the firm side, hidden factors such as technological interdependencies, imprinting, or individuals adapting to a firm might influence intrafirm processes (Meyer, 1994; Miner, 1994). While we control for two firm characteristics (size and age) common in studies explaining firm performance, given our sample size we are not able to control for unobserved heterogeneity in the traditional way – by including a dummy variable for each firm. As discussed above, the effects for firm size and age are statistically significant in the full models for each set of specifications.

We now discuss the findings in the context of the foregoing limitations. Our results show that natural selection at the intrafirm level of analysis partially explains performance at the firm level. Thus, the selection activities that drive Darwinian evolution within an industry may guide or inform VSR activities that drive Lamarckian evolution within a firm in that industry.
The question for future research remains: What balance among VSR activities – as essential components of a dynamic capability – is necessary to enhance performance in a competitive environment? Our results provide some direction for future research. High firm performance is positively associated with high rates of variation. This suggests, in effect, that the greater the amount of variations a firm generates, the higher likelihood that some of the variations it generates may lead to enhanced performance (Aldrich, 1979; Weick, 1979). It is possible that our sample of firms had not reached the dysfunctions that can result from inappropriately high rates of variation – many firms have trouble reaching adequate levels of innovation activity, let alone too much. This may be the reason why there is no indication in our study of the right (downward sloping) side of the inverted U effect that we hypothesized. We do find that too much or too little selection tends to adversely affect performance. In combination, these results suggest that a large number of trials (high rates of variation) in conjunction with a moderate amount of selections (moderate rates of selection), may be associated with higher firm performance. The regression analyses using factor scores (Table 3) also suggest that firms with high retention rates (i.e., behaviors reinforcing previous selections) experience higher levels of performance than firms with low retention rates. In other words, the firms in our study appear to be at least somewhat better off if they exploit their past experience than if they do not.

While multicollinearity tests indicate independence among the variables, potential variance overlap may exist between variation and selection, based on the nature of the constructs. For example, the rate at which a firm’s managers select variations may influence the rate at which employees generate variations. In effect, selection processes may serve as a signaling device between managers and employees who could become involved in experimentation efforts. Moreover, extensive control mechanisms may constrain experimentation and retention activities – a condition that may be a characteristic of the sample’s strong representation of large, old firms (average age = 69 years). Research shows that large, old firms are more prone to bureaucratic rigidity effects (Haveman, 1993). However, the positive association between performance and the second order effect for variation in these firms seems to argue against this simple explanation.

CONCLUSIONS

This chapter attempts to establish links between firm performance and a firm’s internal VSR activities. An underlying theoretical goal was to enhance
our understanding of the relationship between natural selection and adapta-
tion. The findings provide partial evidence that selection and adaptation are not
mutually exclusive, but are linked via internal selection processes. The results
suggest that managerial action can influence a firm’s internal evolutionary
processes and, in turn, the evolutionary context in which the firm is embedded.
This contradicts strict environmental determinism views that the nature and
distribution of resources in the environment play a larger role in organizational
evolution than the internal operation of the organization. Moreover, examining
the mechanisms through which internal VSR activities may function helps to
draw together previously distinct theoretical perspectives and lines of research.

Our results suggest several avenues for future empirical research, including

(1) Additional testing of the relationship between intrafirm VSR rates and
firm performance.
(2) Evaluating the interactions between micro and macro, or internal and
external, evolutionary processes when VSR “engines” are present at
multiple levels.
(3) Testing potential specific drivers of variation, selection and retention.
(4) Examining different environmental conditions and their performance
relationship to VSR rates of firms.
(5) Investigating the implications for firm performance of reinforcing and
constraining interdependencies among VSR activities.
(6) Comparing the importance of balanced continuity in VSR processes to
other internal processes that might foster dynamic capability.

Such research could refine our basic hypotheses by identifying the condi-
tions that qualify the hypotheses as they apply in various contexts.

In conclusion, the theory and research presented here propose that ad-
aptation and selection are interrelated processes of change and that evolu-
tionary attributes at the intrafirm level are partially associated with
performance outcomes at the firm level of analysis. Our empirical tests of
VSR activities relative to firm performance suggests that VSR processes do
operate at multiple levels of analysis and that intrafirm VSR activities, in
combination, are positively associated with adaptive outcomes that main-
tain or improve performance.

Clearly, we have not resolved the debate between Lamarckian adaptation
and Darwinian selection theorists, but we believe we have shown how an
internal Darwinian engine may drive a Lamarckian adaptation process.
Adopting an exclusively firm-level selection or adaptation view misses
insights, which may be gained when these theories of evolution are seen as
interrelated intrafirm processes of change.
Last, our findings offer some preliminary insight into the nature of the evolutionary principles and change processes underlying the dynamic capabilities concept that is important in both the competence- and the resource-based views in strategic management. By drawing attention to vertical interactions across the evolutionary hierarchy of intrafirm processes, firm, and industries, this chapter highlights potentially rewarding lines of inquiry in the study of organizational evolution, dynamic capabilities, knowledge management, and competence development.

NOTES

1. Though Levins' classic 1968 book is the basis of organizational population ecology studies (Hannan & Freeman, 1977), he also observed that mutation rates driving micro-coevolution should be higher in changing environments (1968, p. 97). Indeed, since the 1930s biologists have debated the principle causes of selection, whether individual, species, population, or geographical. Fisher's (1930) fundamental theorem of natural selection holds that "the rate of evolution of a character at any time is proportional to its additive genetic variance..." (Slatkin, 1983, p. 15; our italics). Density- and frequency-dependent effects, that is, population-level effects, moderate this theorem, however. This focuses our attention on the relative rates of intraindividual variation vs. population, ecological, and geographic variation (Slatkin, 1983). In our study, the "intraindividual" is the intrafirm or intra-organization level of analysis.

2. We think balance may be interpreted in two ways: (1) the traditional "March 1991" way which is "equal portions at the same time;" and (2) a more recent "dynamic rhythm" way (Thomas, Kaminska-Labbé, & McKelvey, forthcoming) in which there is timely and rhythmic oscillation among the three VSR elements.

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