Firm Selection: An Integrative Perspective*

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Abstract

This paper highlights the variable intensity of selection pressure on firms. Failing to include a theory of selection pressure in assessing a firm's performance can lead to ambiguous or incomplete judgements on the rationales of the firm's success. Building on previous threads of literature (population ecology, evolutionary economics, and the dynamic resource-based view of the firm), this paper paves the way for a unified theory of selection through seven research propositions. Emphasis is placed on the fact that managers can use the determinants of selection strategically, either to avoid the direct pressure of selection or to pass it on competitors.

Descriptors: selection, evolution, population ecology, evolutionary economics, resource-based view

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Introduction

The problem this paper addresses concerns the way selection operates and fluctuates over time. The commonly shared definition of selection, which more often than not remains unquestioned, is deeply rooted in and tacitly underlies our traditional arguments about strategic success. Selection is a process that results in success or failure. According to evolutionary theorists, selection is one of the three stages of the evolution process (Campbell 1965; Aldrich 1979; Baum and Singh 1994 a,b,c; Baum and McKelvey 1999). The first stage of this process is variation, implying multiplicity of elements. For instance, technological variation is characterized by multiple standards, techniques, or processes. The second stage is selection occurring through external and internal pressures faced by organizations. The last stage is retention, indicating that firms are able to identify the selected variations and reproduce them in order to increase their likelihood of survival (Weick 1979; Winter 1995; Aldrich and Kenworthy 1999).

Campbell (1994: 32) sharply connected this theory of firm selection with strategic management:

'The competition of business firms, with selection by bankruptcy and by voluntary going-out-of-business, systematically selects for organizational forms, rules, collective atmospheres, and customs that *improve the longetivity and prosperity of the firm, per se* (with no necessary relation to the optimization of the economic well-

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being of the CEOs or other individual personnel). This point of view is a subspecies of the view that there are general principles of better and worse industrial organization and management (e.g., such as might be taught in schools of business, and departments of business policy, management, and organizational behaviour). Firm-level selection is one proposed explanation of how such superior traits might come to be prevalent.'

In this traditional presentation of selection, firms are shuffled as units of selection. Variation generates the raw material from which selection is made (Baum and Singh 1994b; Foss et al. 1995). Retention processes preserve the selected variation. Selection does not operate by comparing any one variation to some hypothetical optimum, it chooses among presented variations that which most improves the organization's fitness (Baum 1999). However, if the process seems immutable, does this imply that selection pressure remains stable over time? How can selection itself be an object for change? How can a firm influence selection pressure — if not the process — so as to increase its odds of success? Population ecology has introduced a taxonomy for different selection types at the population level. Stabilizing, directional, and disruptive selection types are differentiated according to the locus of their action on a population (Amburgey et al. 1994: 241). However, no theory really details the intensity of selection pressure borne by a firm at the firm level of analysis.

Another way to formulate the problem posed by this paper is to explain why a firm's success has a different merit over time. What does it mean to argue that some periods are more favourable to expansion, when others are inauspicious? How can we account for a varying selection pressure over time and across firms? Then, what are the unfolding consequences of our analysis on the 'general principles of better and worse industrial organization and management', to rephrase Campbell's quote. Industry organization does not adequately address the fluctuant conditions of selection since selection operates through mere efficiency and is exogenous to firms (Foss 1996b). Likewise, although management research acknowledges that time effects apply to firms (Porter 1991), it does not deal with the effects of time in the firm selection process itself. This paper questions the immutability of selection as a fundamentally exogenous principle, particularly at the firm level of analysis, so as to develop a strategic view of selection pressure.

In this endeavour, the three major streams of evolutionary research are examined successively according to their potential contributions: population ecology (Hannan and Freeman 1989), evolutionary economics (Nelson and Winter 1982), and the dynamic resource-based view of the firm (Teece et al. 1997). Firm selection is a multi-level phenomenon that should be considered as a variable rather than a constant. In this paper, I argue that selection pressure varies dramatically in intensity over time and across firms depending on several factors, including a change in the carrying capacity of the environment, organizational inertia, the firm's involvement in new technological designs, search routines, dynamic capabilities and absorptive capacity. In addition, I suggest that selection is firm specific, i.e. that selec-

tive pressures are different for each firm, leading to interesting strategic games among rivals.

The paper begins by comparing the three streams of research related to selection. A certain number of convergences are underlined here as well as some nuances, and this contributes to the positioning of this paper. The subsequent parts present various propositions for founding an integrative conception of firm selection based on the three research perspectives. In the last section, I discuss and summarize the contributions of this research.

Comparison of Perspectives on Selection

This paper reviews the contributions of three organization theories in order to shed some light on how selection can be modelled by independent factors. Integrating population ecology, evolutionary economics, and a dynamic capability view may turn out to be a challenge. Yet the conception of selection used by the three theories rests on common grounds. Table 1 summarizes the convergent assumptions between the three theories and acknowledges some nuances. This comparison serves two purposes. First, the identification of fundamental commonalities in the definition of selection by these frameworks demonstrates the possibility of integrating some apparently irreconcilable fields around precisely identified notions. For instance, one can argue that population ecology and the dynamic resource-based view of the firm are irreconcilable as representative of two poles of a continuum, between environmental determinism and strategic choice. However, this has already been criticized and both research streams have mitigated their own rigidities (Hrebiniak and Joyce 1985; Child 1997). As a fundamental dimension structuring these theories, selection is a critical notion that must be studied *per se* (Lewin and Volberda 1999). Second, the three theories present some nuances in the application of selection in their frameworks. These nuances highlight the potential for taking firm selection as a dependent variable, for integrating their contributions, and for filling a gap in the literature.

Convergent Emphases on Selection

According to the three theories, heterogeneity and variation are the premises for selection. Population ecologists adopt this posture: 'The ecological perspective focuses on the ways in which *various strategies* fit in with an environment that selects for or against these strategies by encouraging foundings and discouraging failures' (Freeman 1995: 222). Accordingly, evolutionary economics and the capability view 'place major emphasis on the *heterogeneity* of the population of business firms and on the sources of that heterogeneity in the idiosyncratic internal features of individual firms' (Winter 1995: 147). Beyond this common premise, there are other areas of substantial overlap.

Second, another commonality between these views on organizations con-

Table 1
Comparison of Evolutionary Perspectives on Selection

Central Elements	Population Ecology	Evolutionary Economics	Dynamic Resource-based View	Integrative Perspective on Selection
Convergence				
Variation as a first step for selection	Various organizational forms and strategies	Firm idiosyncrasy	Resource heterogeneity	Selection is one step of the Variation-Selection-Retention Model
Actors have a bounded rationality	Blind perception for individuals	Actors are satisfiers (not optimizers)	Knowledge intangibility	Selection is recognized *ex post*
Making up for causal ambiguity on selection	Reliability and accountability (structural inertia and institutionalization)	Routines	Learning	Organizations develop means to fight causal ambiguity
Deferred selection effects	Difficult strategic reorientation	Path dependency	Path dependency (organizational trajectory)	Firms have a low short-run capacity for avoiding selection effects
Search for long-term uniqueness	Niche strategy	Innovation	Unique resources processes, and trajectories	Firms can reduce selection pressure through uniqueness
Differences				
Level of analysis	Population of organizations	Firms and routines	Resources, competencies, and trajectories	Selection is a multi-level phenomenon
Mode of selection	External selection	Rather internal selection	Internal selection	Studying selection pressure requires to choose an intermediary level of selection
Place of strategic management	Little place	Variable	Large place for orientating a firm's future	Posing selection pressure as variable indicates that strategic management may have a role in influencing it

cerns the cognitive aptitudes of actors. All three perspectives consider that rationality is bounded. Individuals alone are unable to perceive the real sources of success for population ecologists (Hannan and Freeman 1977). Accordingly, individuals are eminently satisfiers for evolutionary economists (Nelson and Winter 1982, Part II). Individuals cannot render their capabilities explicit and transmit them to others (Teece et al. 1997: 525). As a consequence, selection is recognized *ex post* and materialized in its effects.

Third, this partial decipherability of the ways through which selection operates is not only related to human cognitive flaws. Causal ambiguity contributes either to masking positive effects or uncovering undesirable outcomes, which are determinant for organizations' future. All three theories share the view that the selection process accommodates causal ambiguity. Each of them offers an alternative designed to protect actors against causal ambiguity and reduce the odds of being selected out. It is noteworthy that there is no incompatibility between these alternatives. Population ecology defends institutionalization through accountability and reliability as a process that helps newcomers to find the appropriate organizational form that has the greatest probabilities of survival (Hannan and Freeman 1984). Evolutionary economics exhibits 'routinization' as a way to save a firm's satisfactory operations from being reconsidered at each use. Teece et al. (1997) and others identify learning as the best way to reduce the level of causal ambiguity rising though the risk of inter-organizational knowledge transfer.

Fourth, when selection applies, its effects are not immediate. A firm does not cease all its activities all of a sudden, but often after a period of poor results. In this context, all three theories emphasize a low short-run capacity for strategic reorientation. To such an extent, population ecology has been long in recognizing the possibility of strategic reorientation. Evolutionary economists have introduced the notion of path dependency to account for time stickiness in strategic action (Dosi and Nelson 1994). As for the dynamic capability view, 'the capability approach sees value augmenting strategy as being difficult and costly. Moreover, it can generally only occur incrementally' (Teece et al. 1997: 529).

Therefore, an organization commits itself to long-term paths. For the three approaches, this commitment is associated with a certain idea of uniqueness (Levinthal 1995: 36). Population ecology considers niche strategy as a particular mode of fitting into environmental conditions. This niche strategy protects a firm against selection (Carroll 1985). Evolutionary economics underlines the enhancing power of innovation versus imitation — innovation is a means of creating uniqueness. The dynamic capability approach demonstrates how uniqueness and idiosyncrasy lead a firm to appropriate rents inaccessible to competitors due to the effects of isolating mechanisms (Mahoney and Pandian 1992).

These are five commonalities between the evolutionary research streams. These commonalities neatly distinguish these approaches from other available theories. For instance, the neoclassical view on survival and selection does not usually integrate notions such as process or bounded rationality, preferring those such as equilibrium and optimization. Causal ambiguity is largely absent from agency theory, as is uniqueness from neo-institutionalism (Aldrich 2000). With respect to more recent models of organizational and economic evolutions, they do not privilege selection, but adaptation. These models subsume idiosyncratic variations at the organizational level, and use adaptation to link organizational behaviour to the competitive and institutional environment levels (Lewin et al. 1999).

However, from this overview of the common traits shared by the three dominant evolutionary theories, the bedrock of a definition on selection emerges. Selection is a process through which some differential types of variations are eliminated. Some unique variations provide units of selection with a determinant advantage for surviving. For actors, the selection process is only partially understandable *ex ante*, and is long and difficult to adapt.

Differences in the Use of Selection

Despite these commonalities, the approaches mainly differ in three ways (Table 1). First of all, the unit to be selected places each approach at different but connected levels of analysis. Population ecology deals with populations of organizations. Evolutionary economics considers firms and routines as the units of analysis. The capability view focuses on resources, competencies, and trajectories. Therefore, the challenge in presenting an integrated perspective of firm selection is to make up for this multi-level characteristic. However, there is a deep relationship between the different levels. In a sense, these are nested levels of selection. Each level constitutes a layer of selection at which organizational units are either retained or eliminated (Baum and Singh 1994 a,b,c; Campbell 1974, 1994).

Second, as concisely presented by Aldrich (2000), selection has two forms depending on the location of the selecting forces. External selection concerns forces external to an organization that affect its routines and competencies. Internal selection concerns forces internal to an organization that affect its routine and competencies (Aldrich 2000: 22). While population ecology belongs to the former type, evolutionary economics — and above all the capability approach — belongs to the latter. Therefore, integrating the various perspectives requires a cautious identification of the level of analysis in order to study selection.

Third, another difference concerns the place of strategic management in the conduct of organizations, and whether or not strategic management has an active role relative to selection. For population ecology, strategy has a reactive role, at best. 'At any given moment, both adaptive and maladaptive firms inhabit local environments — the enigma is that we cannot tell which is adaptive until the environment selects out maladaptive firms' (Aldrich and Kenworthy 1999: 28). In this conception, strategic management cannot have a significant impact on an organization's likelihood to survive. Some evolutionary economics would share this view: 'Thus, to an extent, the market is selecting on strategies and companies, as well as new technologies' (Nelson 1991: 70) while others would give a premium to strategy in avoiding being selected out (see the replication strategy, Winter and Szulanski 1999). The capacity approach clearly privileges an active role for strategic management by defining processes, building positions, and controlling paths and trajectories (Teece et al. 1997).

Positioning This Study

The three major differences amongst evolutionary theories (level of analysis, form of selection, and place of strategic management) command a cautious positioning of this study. First, this study focuses on factors that primarily influence selection pressure rather than on the selection process itself. In essence, selection pressure is neither invariable nor is it as industry-specific as the selection process. Second, grouping theories that have strong commonalities, but deal with different types of selection provides a richer analysis of selection pressure than if only part of the problem were examined. Third, in this paper, strategic management is evidenced by decisions that either directly modify a firm's selection pressure or indirectly modify the selection pressure borne by competitors.

The unit of selection in this paper is the firm. Firm level is the intermediate level between competencies and populations and therefore benefits from the convergence of the propositions made by the three theories. Second, organization studies, and more specifically strategic management, are concerned with executives situated at the top of organizations, who are nevertheless surrounded by macro- and micro-forces. Therefore, it appears that, for both scholars and practitioners, the firm level of analysis offers the best potential for research on selection. Third, the paper acknowledges the difference in conception between external and internal selection. Nevertheless, by considering the firm as the unit of analysis, the intent in this paper is to integrate an external perspective on firm selection with the internal perspective, as two faces of the same coin (Lewin and Volberda 1999).

The following presentation will start from the outside of the firm and move towards the inside. Population ecology deals chiefly with the exogenous conditions of firm selection, whereas research on dynamic capabilities concentrates on internal determinants of firm selection. Evolutionary economics is positioned in between, since some features evidenced by its research concern exogenous factors while others, such as routines, are at the root of an intrinsic definition of the firm. Hence the contributions of population ecology to firm selection are presented first, followed by evolutionary economics, and finally by the dynamic resource-based view of the firm.

Research Streams and Propositions

Population Ecology and Firm Selection

The population ecology of organizations, according to its founders, is interested in describing the diversity of organizational forms and in explaining this diversity (Hannan and Freeman 1989). It examines the sources of variability in organizations as well as the contingent causes of their homogeneity. For Hannan and Freeman (1984), a population of firms is a collection of organizations sharing a common dependency on their material and social environment and on the resources they can obtain. Hannan

and Freeman (1977, 1989) indicate that their conception favours the Darwinian hypothesis of change and selection, rather than Lamarck's conception. The Lamarckian process implies that human actors and firms learn and incorporate learning into their behavioural repertoires. In the Darwinian mode, the fitness of adaptation critically depends on the environment selecting organizational forms. Thus, in the Darwinian competitive process, 'if there is a *rationality* in play, it is the rationality of natural selection' (Hannan and Freeman 1977).

The first construct identified by ecologists that modifies firm selection pressure is the carrying capacity of the competitive environment (Brittain 1994). The carrying capacity is the number of firms or firm populations that can prosper in a given state of the environment. Indeed, the carrying capacity of the environment affects both the degree of population selection and the odds in favour of a firm's selection. The carrying capacity depends mainly on institutional rules, laws and other regulations (Baum and Oliver 1991), and on the availability of environmental resources (Wholey and Brittain 1989). Every modification of institutional variables (abrogation of a law, change of standards) and every change in the availability of external resources (caused by de-regulation, the discovery of a new raw material or technology, of different means of communication or production, etc.) displaces the carrying capacity of the environment and defines its evolution (Tushman and Anderson 1986; Barnett 1990; Barnett and Hansen 1996). Therefore, firm selection is enhanced when the carrying capacity is restricted due to political, legal, or economic events.

However, a change affecting the carrying capacity affects firm selection only if firm populations have already occupied the available space and exploited the accessible resources. In a sense, if the carrying capacity has not been previously attained, the change in carrying capacity will not really affect a firm's selection pressure. For instance, new technological advances (e.g. ADSL in telecommunications) will reduce selection pressure on firms only if the carrying capacity of internet operators is supposed to have already been attained by the current state of competing populations — which was perhaps not the case in Europe, in 2000. In other words, a firm's likelihood of survival is dependent upon the initial state of the carrying capacity, upon how some related events modify the level of selection, and eventually upon the firm's ability to seize opportunities that arise.

Proposition 1: A change increasing the carrying capacity of the environment reduces selection pressure on firms only if the carrying capacity was attained initially.

A firm's ability to seize opportunities depends on the organizational inertia characterizing the population to which the firm belongs. Early on, Hannan and Freeman (1977) focused on the role played by inertia on firm selection. Organizations are subject to inertial forces such as sunk costs, incomplete information, internal political constraints, and their own history (Hannan and Freeman 1977: 931).

For adaptive theories, structural inertia implies reduced energy in adapting or initiating changes. However, population ecologists have refined this analysis. Hannan and Freeman relate structural inertia to society and especially to economic institutions. When the carrying capacity of the environment changes, organizational forms occupy the available space and exploit external resources. In return for their acceptance by economic actors (such as customers, workers, and shareholders), firms must be financially and socially accountable for their actions, and reliable as regards their products and services. These two fundamental conditions render structural inertia necessary as a first step in the establishment of not only firms but, through imitation, firm populations. Hence, Hannan and Freeman deduce their 'first theorem': 'Selection within populations of organizations in modern societies favours organizations whose structures have high inertia' (Hannan and Freeman 1984: 155).

Inertia provides coherence, replicability, and reliability within a firm. Furthermore, inertia gives confidence to the firm's stakeholders as far as its ability to prosper and survive is concerned. Structural inertia is thus a necessary consequence of selection in a competitive environment with a given carrying capacity (Miller and Friesen 1984). The liability of newness phenomena (the above-average demise rate of young firms) finds an explanation in this requirement. The net economy presents a good illustration of the reliability and accountability required of e-companies in order for them to be selected by the environment.

However, there is a threshold to the beneficial relationship that can exist between inertia and firm survival. In this paper, according to population ecology, we assume that this threshold is population-specific. As just mentioned, to a certain extent, a high organizational inertia reduces the selective pressure on a firm. However, even if inertia prevents a firm from disordered ventures and over-diversification, where there is a radical transformation of environmental carrying capacity, an entire population of firms may disappear (Tushman and Romanelli 1994). Accordingly, inertia may cause organizational rigidities that can prove fatal when new competitors appear unexpectedly (Carroll and Hannan 1989; Kelly and Amburgey 1991). If inertia is required to survive, excessive inertia can hamper a firm's development, and, for instance, reduce an e-firm's nimbleness. Indeed, structural inertia affects the amount of time a firm needs for both learning and reacting (Rumelt 1995). Therefore, any firm has to reach a threshold of inertia in order to survive. This threshold differs according to the populations considered. However, once the threshold has been reached, relative inertia determines the level of selective pressure on populations and firms. Consequently, firm selection pressure is reduced as organizational inertia increases up to a point at which any additional relative inertia results in increased firm selection pressure.

Proposition 2: For a firm, an increase in organizational inertia reduces selection pressure to a minimum from which any excess inertia relative to other competing organizations increases selection pressure on the firm.

Another important insight on firm selection also comes from population ecology. Ecology theorists define two principal strategies that firms may adopt: specialists and generalists (Carroll 1985). The odds of survival are different according to the generic strategy retained by the firms and the characteristics of the competitive environment. To decide whether to adopt a generalist or a specialist strategy, firms have to consider the nature of rivalry carefully, since the greater or lesser proximity in form of the competing organizations affects the degree of selection (Kelly and Amburgey 1991). If the forms are very different, this means that firm populations are specialists in one type of environment, but that they lose efficiency in another: for each population of specialist firms, the strategy, structure, and technology are adapted to one single part of the competitive environment. Nonetheless, if the forms are similar, firm populations can compete more efficiently, and the pressures for selection will become harsher (Freeman and Hannan 1983).

Selection, at the firm level, is epitomized by the cost of a sub-optimal strategy for the existing environmental conditions at a point in time, i.e. the cost of being generalist (as opposed to specialist) in a competitive situation that favours the specialist. Both the similarity of the firms competing in an environment and the variability of the environment affect this cost, and consequentially influence selection pressures. When the environment is uncertain about rapid changes initiated by adaptive firms, the environment is said to be fine-grained. In cases where the changing states of the environment are slow and where re-organizations of companies are rare, the environment is coarse-grained (Hannan and Freeman 1989: Chapt. 5).

When the environment is very fine-grained, the specialist prospers, undergoing the variations of the environment, but on average surviving because the periods of fluctuation are close together. However, if the environment becomes coarse-grained, the specialist will not be able to endure the continuous selective pressure on generic resources because s/he has counted on specific resources: the specialist thus risks being sub-optimal (Miner et al. 1990; Boeker 1991) and the generalist firm becomes more competitive through resource diversification. Thus, firm selection is increased by the misfit between (1) the 'grain' of the environment, and (2) the chosen strategy relative to competitors' choice of strategy (Baum and Singh 1994c).

Proposition 3: The better the fit between the nature of environment (fine- or coarse-grained) and the strategy pursued by a firm (specialist or generalist), the lower the selection pressure for the firm.

Evolutionary Economics and Determinants of Firm Selection

Evolutionary economics provides a liaison between the ecology determinants of firm selection, which are out of a firm's immediate control (carrying capacity, strategic misalignment, and organizational inertia), and more manageable determinants of firm selection presented by the dynamic

resource-based view of the firm. In evolutionary economics (Nelson and Winter 1982) technology and time are given as the driving forces of the evolution of firms and industries, thereby echoing the conclusions from population ecology regarding the misfit between the nature of the environment and a firm's strategy. Evolutionary economics also provides concepts such as routine that are fundamental in explaining how firms build and replicate practices to escape from selective zones in the environment.

Technological evolution is the principal factor underlying the ongoing process of change and variety, according to the evolutionary approach. Yet, technological evolution is not a random process, but follows modes of development dependent on technological opportunities, knowledge and beliefs at a given point in time. A technological 'trajectory' describes the technical and learning structures underlying technological evolution (Rosenberg 1976). Nelson and Winter (1977) refer to natural trajectories and technological systems, and Dosi (1982, 1988) to 'technological paradigms', in referring to Kuhn's (1965) structure of scientific revolutions. A good illustration of this phenomenon where technical mastery, knowledge and beliefs converge is the development, in the nineteenth century, of the gasoline automobile rather than the electrical car — a development which could be re-examined in the twenty-first century (Cowan and Hublen 1994).

This path-dependent view of technology evolution is not neutral with regard to selection (Dosi and Nelson 1994). Firm selection pressure has to be variable, depending on the stage of the trajectory considered. At the beginning of a technological trajectory, selection is higher for firms that strive to impose a new standard than for inactive firms. However, in time, by sticking to their old technological trajectory, passive firms may come under higher selection pressure than innovators (Tegarden et al. 1999). To examine further the variation in firm selection, another related construct developed by evolutionists should be introduced — the idea of a dominant design.

At the beginning of a trajectory, firms concentrate on product innovation. At the end of the first stage, the product's essential characteristics are established. This composite of required properties forms the 'dominant design' of the product (Abernathy and Utterback 1978). Once a dominant design has emerged, the competitors direct their attention to fine distinctions likely to be valued by consumers. They no longer consider fundamental changes to the general architecture of the product (Tushman and Anderson 1986). The production techniques become more specialized, and more specific. Thus, a firm does not benefit from introducing a major innovation, if it does not succeed in establishing its design. The example of the medical imaging sector (Mitchell 1991) and the famous example of VHS cassettes (Rosenbloom and Cusumano 1987; Lieberman and Montgomery 1988) illustrate the benefits of establishing a dominant design.

Suarez and Utterback (1995) demonstrate the relevance of technological evolution in the explanation of structural transformations in six industrial sectors and of the survival probabilities of the firms in these sectors.

According to this study, early entry (which allows the pioneer to impose its technological design) or late entry (after the uncertainty about the dominant design has been largely removed) in relation to the appearance of the dominant design increases the probability of firm survival. This model echoes March's (1991) contribution on the respective benefits of exploration versus exploitation. Exploration involves complex search, flexibility, and high uncertainty of the outcome. Exploitation relates to risk-averse behaviours, streamlining production and measuring short-term performance. Exploration effects on performance are variable and distant in time, while exploitation results are more foreseeable and short-term.

Applying these results to selection, it can be seen that selection does not put pressure on firms identically if (1) they have contributed to the establishment of a dominant design, and (2) if they have recognized the appearance of a new dominant design and exploited it early enough (Tegarden et al. 1999; Durand and Coeurderoy 2001). At the beginning of a technological trajectory, firms originating the technological change through exploration bear more selection pressures than those that follow. Pioneering firms commit resources (Lieberman and Montgomery 1988; Ghemawat 1991) in order to pre-empt market positions and ensure their survival (Mitchell 1991). By not investing in the creation of new technology, followers, on the other hand, take the risk of becoming obsolescent. By sticking to the previous technology, they prefer not to bear the selection pressure. However, if, after a while, pioneers manage to impose their dominant design, then followers experience a high selection pressure and have to endure hard times until they are able to join the dominant technology, once it has matured. Therefore, it follows that:

Proposition 4.1: Selection pressure is increased for firms engaged in developing new technology standards.

Proposition 4.2: Selection pressure is reduced for firms that succeed in imposing the dominant design in which they were involved.

This differentiated selection experienced by firms, according to their strategic choices, is deeply rooted in the evolutionary conception of the firm. In evolutionary economics, the conception of an evolutionary firm rests essentially on the definition of organizational routines (Nelson and Winter 1982). The organization's memory and the realization of its know-how characterize routines which define a collection of codified or uncodified organizational interactions and solutions to concrete problems. A firm that has memorized the development of a technological trajectory and is able to manage the diffusion of a dominant design clearly has an internal advantage over its competitors. This amounts to temporarily reducing the pressures of firm selection (see the notion of Time Compression Dis-economies in Dierickx and Cool 1989). For this reason, by increasing their selection hazard in the short term, pioneers strive to increase it for their competitors in the long term.

Nelson and Winter (1982) distinguish three principal types of routines. Operational routines are executed mechanically like a computer program. Generic routines are the foundations for improving firm processes through incremental change. Finally, search routines involve new combinations of factors, and result in true innovation and radical changes which result in long-term improvement in performance: 'finally, we view firms as possessing routines which operate to modify over time various aspects of their operating characteristics' (Nelson and Winter 1982:17). Search routines set the conditions for the emergence of radical innovations, which defines the Schumpeterian inspiration of this conception of economic change.

For evolutionists, firm evolution is synonymous with the evolution of the different firm routines through the triptych: variation-selection-retention (Miner 1994). Thus, strategic reflections on the characteristics of R&D procedures within a firm are necessary in order to evaluate to what degree a firm is held back by its past history (Dosi et al. 1996). Parallel to the notion of a technological trajectory, evolutionists extend the properties of path dependency at the firm level (Szulanski 1996). Hence, they define the 'organizational trajectory' as an endogenous mechanism of firm selection.

The organizational trajectory characterizes the effects over time of unfolding a firm's routines. An organization is engaged in certain actions which are irreversible or have a strong momentum. The combination of these preexisting routines restricts the future development of the firm. By the same token, stakeholders' behaviour may limit the evolution of an organizational trajectory. For instance, customer demand may force firms not to radically modifying or change the genuine product (Iansiti and Khanna 1995). In addition, organizational trajectory is strictly dependent on the presence of search routines. These routines evolve according to the individual qualifications of the firm's employees (Nelson and Winter 1982) and because of the dynamics between firms and competing technologies (Tushman and Rosenkopf 1992).

As a result, the firm has to build on search routines in order to implement its future strategy, and to escape from the adverse influence of its organizational trajectory. Levinthal and March (1993), building on the exploration/exploitation distinction, contend that the long-term viability of a firm depends on its ability to engage in enough exploration. Thus, all things being equal, the breakdown between search routines and other routines has an impact on a firm's selection, relative to its competitors (Lewin et al. 1999). The fewer search routines engaged in by a firm relative to its competitors, the more this firm will adhere to the organizational trajectory. The greater the proportion of search routines, the lower the selection pressures will be on this firm.

Proposition 5: Relative to its competitors, the lower the proportion of search routines for a firm, the higher the selection pressure will be on this firm.

Propositions 4.1, 4.2, and 5 complement each other on three levels. First,

the 'short-run versus long-run' analysis distinguishes the propositions. Proposition 4.1 and 4.2 are more proximate in time than Proposition 5. Second, the 'exploration versus exploitation' distinction helps us to understand the relevance of search routines for the long-term survival of a firm. Finally, 'direct versus indirect' relationships on selection pressure shed light on the competitive game resulting from innovation. Notably, a sustained high relative proportion of search routines (Proposition 5) that do not give birth to new references in the market will eventually cause a company to suffer from this unproductiveness (Proposition 4.1).

Dynamic Resources and Firm Selection

Even though a high proportion of search routines sets the conditions for changes controlled by a firm, it does not really enable the firm to find out which strategic resources are likely to provide it with a defendable advantage. Evolutionary economics does not fully elucidate the source of competitive advantage (Foss and Eriksen 1995). Rather, it pinpoints the causes enabling mutations to occur within the firm, thereby helping it to modify its genetic constitution (Levinthal 1995). However, the distinction between the types of routines does not provide an adequate assessment of a firm's competitive potential. The Resource-Based View of the firm (RBV), and specifically, the trend of dynamic resources makes up for this shortcoming.

The RBV concentrates its analysis on the capacity of firms to liberate rents and to bet on their specificities in order to withstand competition (Wernerfelt 1984). Penrose (1959) puts forth the hypothesis that for a firm to maintain performance over time depends on the economies of growth intrinsic to that firm. Firms' differences underpin their likelihood to succeed. The RBV postulates that a firm's competitive advantage is gained from capturing the value of an asset that is temporarily under-valued by the market. Hence, a firm benefits from asymetrical information. In a sense, a firm is in a position of arbitrage (Barney 1986; Dierickx and Cool 1989). Resource ownership provides a firm with Ricardian rents (Peteraf 1993). A good strategy is one that bets on these resources at the right time so that competitors do not perceive the potential value of the asset quickly enough, or they cannot imitate the firm which is building the competitive advantage (Barney 1991).

Furthermore, according to the trend of dynamic resources, 'competitive advantage comes from dynamic resources rooted in the most profitable routines within the firm, embedded in the organizational process and conditioned by their history. Because of the imperfection of markets, or more precisely of the non-transferability of tangible assets, like securities, identity or organizational experience, these aptitudes cannot be bought; they must be built' (Teece and Pisano 1994: 553). Consequently, the development of new aptitudes is the result of localized learning processes, depending on the past experience of the firm (Teece et al. 1997). In this line, Sanchez (1995) and Sanchez and Mahoney (1996) defend the idea of flexibility as a way of decreasing selection pressure.

The consequences of considering the source of change and variety in industry as stemming from firms' heterogeneity are critical. Concerning firm selection, this implies that some determinants of firm selection are co-evolving with the firm itself (Barnett and Hansen 1996). Firms have to choose not only the markets and businesses they compete in, but they also have to view dynamic resources as a way of alleviating or exacerbating selection pressures. As a matter of fact, the ability to uncover resources and resource potentials is crucial (Makadok 1999). The resources that lead to appropriable rents have an effect on the strength of selection borne by the firm and by its rivals (Durand 1999).

For instance, the dynamic resource perspective re-defines the radical innovation often perceived by population ecologists and evolutionary economists as an exogenous event. On the one hand, evolutionary economics traditionally presents radical innovation as the rupture of a technological trajectory. On the other hand, the dynamic resource perspective regards radical innovation as a factor that destroys competence or modifies a firm's aptitudes to evaluate technological performance (Rosenbloom and Christensen 1994). The progress of a technology is no longer seen as a mere trajectory along a natural regime, enduring breakthroughs, but as the consequence of specific evolutions in the architecture of the technological system (Henderson and Burton 1990). The evolution of several technologies at different levels of the system may render obsolete some technological trajectories, while preserving others — and the underlying technological resources.

Consequently, a way of reducing the odds for a firm to be selected consists of modifying the competitors' perception and displacing the locus of selection towards new capabilities or resources. The emergence of new bundles of resources underpinning success modifies competitors' perception and behaviour (Moran and Ghoshal 1999). Competitors have to imitate, replicate, or substitute the assets. These processes result in the correction of the intrinsic value of the successful firm's resources and capabilities (Barney 1991). Therefore, a change in the bundle of valuable and dynamic resources required in order to be competitive transfers the selective pressures from a firm to its competitors (Chen 1996). Playing with the different services provided by the resources enables a firm to alleviate selection pressures and concurrently to increase selection pressure on its competitors.

Proposition 6: The more dynamic a firm's resources, the lower the selection pressure on this firm will be, relative to its competitors.

The theory of dynamic resources embraces an ambitious project: to construct an alternative conception of the firm based on two central considerations, information and knowledge (Spender 1996). Grant (1996) extends the properties of the RBV to two major types of knowledge: tacit and explicit. Grant (1996) establishes the firm as an economic institution that processes and manages information and knowledge better than the market.

According to his analysis, the degree from which a dynamic capacity is distinctive depends on employees' access to, and integration of, knowledge within the firm. Therefore, the role of the individual as principal actor, recipient of information and creator of knowledge for the firm must be stressed.

The firm is meant to be a body of knowledge and information. It permits the collective utilization of individual knowledge for the accomplishment of common goals (Tsoukas 1996). No single agent can master the whole body of information needed to make optimal use of available resources and skills. Thus, firms are distributed systems of knowledge. A minimal structure is required to integrate knowledge inside the corporation and to build and leverage resources and capabilities. This coincides with the necessary inertia threshold below which reliability and accountability are insufficient for a firm in its relationships with institutions and stakeholders. Likewise, a firm in the dynamic resource perspective is a distributed system of knowledge that is embodied in rules and procedures.

Moreover, the construction of resources and aptitudes rests on the assimilation and integration of new knowledge (Iansiti and Burton 1994; Henderson and Cockburn 1994). The development, as well as the enrichment, of the company's knowledge base depends on its definition of the problems to be solved. At the time of a product's conception, the company has to integrate external knowledge and strategic information in its generic qualities (dominant design) and its distinctive features (differentiation), such as user perception and collaborative agreements between competitors. This reflects a firm's absorptive capacity (Cohen and Levinthal 1990).

When firms implement projects, internal integration must take over: the know-how required by technicians, the organization of work, the learning process by individuals and by teams — all these factors have to be taken into account to achieve maximum efficiency. The 'dynamic performance' of the firm comes from the conjunction of these exchanges of knowledge, both external and internal (Iansiti and Burton 1994: 566), with the firm's extant structure.

Therefore, absorptive capacity, as well as knowledge integration, represents opportunities for a firm to loosen the constraints of selection. Knowledge integration is possible only in companies that are already structured and established. It allows them to fine-tune their level of organizational inertia and to reduce selection pressure. These capabilities enable firms to tap into accumulated knowledge in order to unfold and unravel resources and aptitudes and to alleviate selection pressures within the current competitive arena (Foss 1996a). Not being able to integrate knowledge manifests either the absence of inertia (the firm is unable to overcome the liability of newness) or a detrimental excess of inertia. Some authors emphasize the 'economies of time' made possible by improvements in problem solving (Winter 1995). Put differently, integration of knowledge enables an established firm — i.e. a firm that overcomes the liability of newness — to free itself from path-dependency and to redefine its organizational trajectory.

Proposition 7: The greater an established firm's ability to integrate knowledge, the lower the selection pressure on this firm.

Discussion

The seven propositions presented in this review pave the way for an integrative theory of firm selection, as illustrated in Figure 1. In this figure, the two extremes of selection pressure are represented. The space in the middle of the circles represents the various combinations of the factors identified as having an impact on a firm's selection pressure.

By focusing on firm-level selection, I have voluntarily limited the scope of this paper to a specific unit of analysis. As wholes, firms are composed of elements at lower levels of organizations, and are elements themselves of broader wholes. Each layer in this nested system potentially constitutes a 'node of selection' (Baum and Singh 1994c; Campbell 1974, 1994). However, three reasons led me to choose the firm as a unit of analysis for changing selection pressure. First, the firm is the most common level at which scholars position their inquiry as soon as strategy and organization is involved. Decision-makers conceive and define strategy and organization design at the corporate level. Second, selection theorists have long recognized that there is a level-dependence phenomenon in place. 'Where natural selection operates through life and death at a higher level of organization, the laws of the higher level selective system determine in part the distribution of lower level events and substances' (Campbell 1990: 4). Thus, selection at a higher level shapes and constrains subsequent lower-level selection processes. Firm strategy and organization are therefore partially determined by the firm's environment, which determines how routines and capabilities can evolve (Baum and Singh 1994b; Foss et al. 1995). Finally, the firm constitutes an intermediary level in the system of evolutionary levels mentioned above. At this level, a decision maker has the ability to influence selection pressure at both a macro- and micro-level.

Also, it is noteworthy that 'selection of an entity does not imply that all of its components, taken in isolation, are viable' (Aldrich and Kenworthy 1999: 28). It follows that selective pressure neither insures that firms will fit their environment perfectly nor guarantees that a firm's routines will all be perfectly adapted to the organization context. In this paper, I do not explore the teleological nature of selection. Whether competencies must be perfectly adapted to the organization or whether the organization fits ideally into an environment are questions beyond the scope of this study. I limit my inquiry to the factors influencing a firm's selection pressure. How and whether selection results are optimal or only satisfying is beyond the scope of this work. Nevertheless, this paper potentially enhances theory and research in three ways.

First, failing to include a theory of selection in assessing a firm's performance may lead to ambiguous or incomplete judgements on the rationale of a firm's success. The essence of this argument is that a firm's success

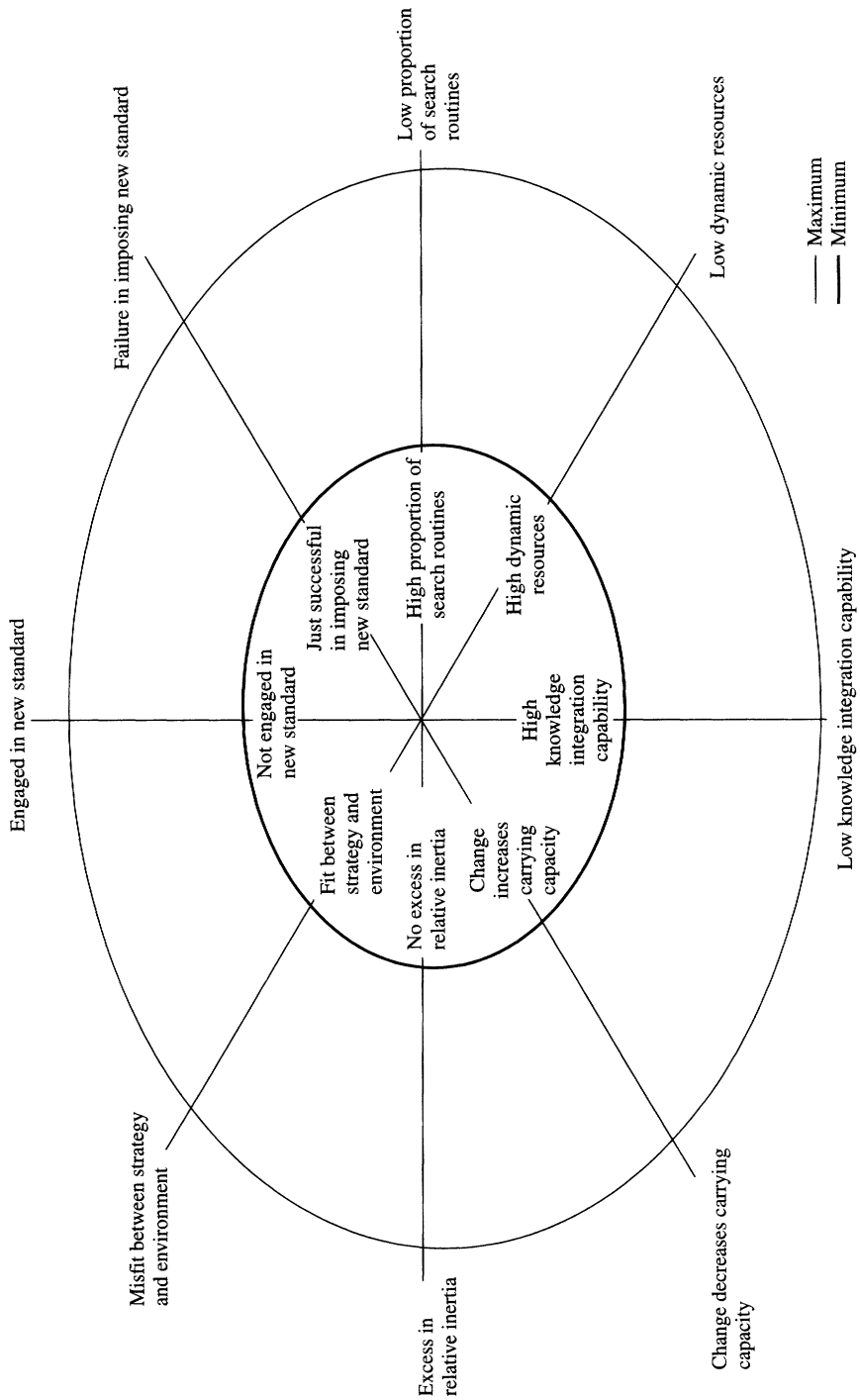

Figure 1. Extreme Cases in Selection Pressure

is highly determined by the dynamic nature of selection. Environmental, technological, and resource-based arguments do not stand alone. However, a combination of their analyses enables scholars to assess better the value of a given strategy. Between the two extreme selection pressures showed in Figure 1, many situations exist that moderate the value of a given firm's strategic choice. Therefore, scholars need to acknowledge selection as a necessary element for estimating the contribution made by strategic management to the analysis of firm performance. As far as empirical research including these results is concerned, it is noteworthy that empirical studies in population ecology, evolutionary economics, and the resource-based view of the firm already provide useful proxies that can be used as either independent or control variables.

The second contribution of the paper is to recognize explicitly the importance of the different types of selection determinants. It is useful to distinguish between population-, firm- and capability-levels of firm selection. It is also important to recognize that selection pressure is firm specific, and that a firm that makes good use of strategy can increase selection pressure for its rivals while attempting to reduce this pressure on itself. Indeed, strategically betting on search routines, dynamic capabilities, and knowledge absorption helps the firm either to ease its selection constraints or to increase its competitors' selection constraints. From this, it follows that selection pressure can be considered to be firm specific, rather than an immutable, blind, exogenous dimension.

This brings us to the last contribution of this paper, which is to underline how managers might use the determinants of selection either to avoid pressure or to pass it on to competitors. For practitioners, the determinants of selection can be summed up under the banner of three essential principles. First, estimating the adequacy of a firm to its population environment. This comes down to assessing the cost of prolonging a strategy when the carrying capacity of the environment has changed, when the fit between the firm's strategy and the nature of the environment deteriorates, and the effects of inertia cease to be beneficial for the firm. Second, evaluating the dynamic nature of the firm's resources, capabilities and search routines enables a firm to manage path-dependent processes, such as shifts in dominant design, and to control its organizational trajectory. Finally, adapting a firm's strategy to the determinants of selection entails focusing on dynamic capabilities embedded in teams and individuals, as well as in promoting knowledge creation and integration within the firm.

These principles cover the distinct facets of an *evolutionary* strategic management. Defining an evolutionary strategy does not simply imply envisioning the effects on performance deriving from the various decisions of the company. It consists of gauging the influence of the decisions on future selection pressure. Selection does not have an atemporal value. It evolves, just as the industries evolve. Thus, managers should take advantage of the determinants that shape selection in order either to escape the pressure of selection or to enhance selection in other markets. This paper helps to decipher how top managers can use their intuition and take

advantage of exploitable opportunities by eliciting the determinants of firm selection.

Conclusion

This presentation of the determinants of firm selection has focused on three evolutionary theories. Although perhaps not exhaustive, it takes fully into consideration the dynamic nature of firms. The view adopted in this paper is that these different theories, while offering contrasting perspectives on evolution, are not necessarily incommensurable when applied to the study of selection.

These research threads strive to account for the same phenomenon, the evolution of organizations. They argue that the structuring dimension of firm performance is not the competitive position but rather the management of institutionalization, and the evolution of technical systems and organizational processes. Thus, evolutionary reflections on strategy move us farther from a representation depicting the structure of the economic environment and of companies as stable and causality as linear. This paper presents an attempt to apply these insights to the too-often-unquestioned notion of selection pressure in management literature.

The source of this research lies in the idea that selection does not immutably reproduce itself as a constant. At the core of organizational evolution lies the magic of firm selection and success, which constitutes the tales of strategic management that are widespread in business schools. By isolating selection pressure as a research object at the firm level of analysis, this paper improves comprehension of a firm's success. Selection pressure does not have the blindness of a random process. Selection pressure varies and can be influenced, thereby connecting organization theory and strategy to organization praxis.

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References

Abernathy, William, and James M. Utterback
1978 'Patterns of innovation in technology'. *Technology Review* 80/ 7: 40–47.

Aldrich, Howard E.
1979 *Organizations and environments.* Englewood Cliffs, NJ: Prentice Hall.

Aldrich, Howard E.
2000 *Organizations evolving.* London: Sage.

Aldrich, Howard E, and Amy L. Kenworthy
1999 'The accidental entrepreneur: Campbellian antinomies and organizational foundings' in *Variations in organization science.* J.A.C. Baum and B. McKelvey (eds.): 19–34. London: Sage.

Amburgey, Terry L., Dacin, Tina, and Kelly Dawn
1994 'Disruptive selection and population segmentation: interpopulation competition as a segregation process' in *Evolutionary dynamics of organizations.* Baum J.A.C. and J. Singh (eds.), 240–255. Oxford: Oxford University Press.

Barnett, William
1990 'The organizational ecology of technological system'. *Administrative Science Quarterly* 35/1: 31–60.

Barnett, William, and Michael T. Hansen
1996 'The red queen in organizational evolution'. *Strategic Management Journal* 17: 139–157.

Barney, Jay
1986 'Strategic factor markets: expectations, luck, and business strategy'. *Management Science* 42: 1231–1241.

Barney, Jay
1991 'Firm resources and sustained competitive advantage'. *Journal of Management* 17: 99–120.

Baum, Joel A.C.
1999 'Evolutionary dynamics of organization'. Paper presented at the Academy of Management Conference, Chicago, IL, August; Thematic session on 'Macro-level perspectives on organizational change and development'.

Baum, Joel A.C., and Bill McKelvey
1999 *Variations in organization science.* London: Sage.

Baum, Joel A.C., and Christine Oliver
1991 'Institutional linkages and organizational mortality'. *Administrative Science Quarterly* 36: 187.

Baum, Joel A.C., and Jitendra V. Singh
1994a *Evolutionary dynamics of organizations.* Oxford: Oxford University Press.

Baum, Joel A.C., and Jitendra V. Singh
1994b 'Organization–environment co-evolution' in *Evolutionary dynamics of organizations.* J.A.C. Baum and J. Singh (eds.), 379–403. Oxford: Oxford University Press.

Baum, Joel A.C., and Jitendra V. Singh
1994c 'Organizational niches and the dynamics of organizational mortality'. *American Journal of Sociology* 94.

Boeker, Warren
1991 'Organizational strategy : an ecological perspective'. *Academy of Management Journal* 34: 613.

Brittain, Jack W.
1994 'Density-independent selection and community evolution' in *Evolutionary dynamics of organizations.* J.A.C. Baum and J. Singh (eds.), 355–378. Oxford: Oxford University Press.

Campbell, Donald T.
1965 'Variation and selective retention in socio-cultural evolution' in *Social change in developing areas: a reinterpretation of evolutionary theories.* H.R. Barringer, G.I. Blanksten, and R. Mack (eds.), 19–48. Cambridge, MA: Schenkman.

Campbell, Donald T.
1974 '"Downward causatio" in hierarchically organized biological systems' in *Studies in the philosophy of biology.* F. Ayala and T. Dobzhansky (eds.), 179–186. London: Macmillan.

Campbell, Donald T.
1990 'Levels of organization, downward causation, and the selection-theory approach to evolutionary epistemology' in *Theories of the evolution of knowing,* Vol 4. G. Greenberg and E. Tobach (eds.), 1–17. Hillsdale, NJ: Erlbaum.

Campbell, Donald T.
1994 'How individual and face-to-face group selection undermine firm selection in organizational evolution' in *Evolutionary dynamics of organizations.* J.A.C. Baum and J. Singh (eds.), 23–38. Oxford: Oxford University Press.

Carroll, Glenn R.
1985 'Concentration and specialization: dynamics of niche width in populations of organization'. *American Journal of Sociology* 90: 1262–1283.

Carroll, Glenn R., and Michael T. Hannan
1989 'Density delay in the evolution of organizational populations : a model and five empirical tests'. *Administrative Science Quarterly* 34: 411.

Chen, Ming-Jen
1996 'Competitor analysis and interfirm rivalry: Toward a theoretical integration'. *Academy of Management. Academy of Management Review* 21: 100–134.

Child, John
1997 'Strategic choice in the analysis of action, structure, organizations and environment: Retrospect and prospect'. *Organization Studies* 18/1: 43–76.

Cohen, William, and Daniel Levinthal
1990 'Absorptive capacity: a new perspective on learning and innovation'. *Administrative Science Quarterly* 35: 128–152.

Cowan, Robin, and S. Hublen
1994 'Accumulation regimes and technological choices: petrol cars vs electrical vehicles' in Proceedings of the Eunetics Conference, Strasbourg.

Dierickx, Ingmar, and Karel Cool
1989 'Asset stock accumulation and sustainability of competitive advantage'. *Management Science* 35: 1504–1511.

Dosi, Giovanni
1982 'Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change'. *Research Policy* 11: 147–162.

Dosi, Govianni
1988 'Sources, procedures, and microeffects of innovation'. *Journal of Economic Litterature* 26: 1120–1171.

Dosi, Giovanni, and Richard Nelson
1994 'An introduction to evolutionary theories in economics'. *Journal of Evolutionary Economics* 4: 153–172.

Dosi, Giovanni, Luigi Marengo, and G. Fagiolo
1996 'Learning in evolutionary environments', Communication to the 6th International J. Schumpeter Society conference, Stockholm, May 1996.

Durand, Rodolphe
1999 'The relative contributions of inimitable, non transferable and non substitutable resources to profitability and market performance' in *Dynamic strategic resources.* Michael Hitt, Patricia Clifford, Robert Nixon, and Kevin Coyne (eds.), 67–95. Chichester: Wiley.

Durand, Rodolphe, and R. Coeurderoy
2001 'Age, order of entry, strategic orientation, and organizational performance'. *Journal of Business Venturing* 16/5: 471–494.

Foss, Nicolai
1996a 'Knowledge-based approaches to the theory of the firm: some critical comments' and 'More critical comments on knowledge-based theories of the firm'. *Organization Science* 5: 470–476 and 519–523.

Foss, Nicolai
1996b 'Research in strategy, economics and Michael Porter'. *Journal of Management Studies* 33: 1–24.

Foss, Nicolai, and Bo Eriksen
1995 'Competitive advantage and firm capabilities' in *Resource-based and evolutionary theories of the firm.* C. Montgomery (ed.), 43–70. Boston: Kluwer.

Foss, Nicolai, Christian Knudsen, and Cynthia Montgomery
1995 'An exploration of common grounds: integrating evolutionary and strategic theories of the firm' in *Resource-based and evolutionary theories of the firm.* C. Montgomery (ed.), 1–19. Boston: Kluwer.

Freeman, John
1995 'Business strategy from the population level' in *Resource-based and evolutionary theories of the firm.* C. Montgomery (ed.), 219–250. Boston: Kluwer.

Freeman, John, and Michael T. Hannan
1983 'Niche width and the dynamics of organizational populations'. *American Journal of Sociology* 88: 1116–1145.

Ghemawat, Pankaj
1991 *Commitment, the dynamic of strategy.* New York: Free Press.

Grant, Richard
1996 'Toward a knowledge-based theory of the firm'. *Strategic Management Journal* 17 (Winter Special Issue): 109–122.

Hannan, Michael T., and John Henry Freeman
1977 'The population ecology of organizations'. *American Journal of Sociology* 82: 929.

Hannan, Michael T., and John Henry Freeman
1984 'Structural inertia and organizational change'. *American Sociological Review* 49: 149.

Hannan, Michael T., and John Henry Freeman
1989 *Organizational ecology.* Cambridge, MA: Harvard University Press.

Henderson, Rebecca, and Clark K. Burton
1990 'Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms'. *Administrative Science Quarterly* 35: 9–30.

Henderson, Rebecca, and Ian Cockburn
1994 'Measuring competence? Exploring firm effects in pharmaceutical research'. *Strategic Management Journal* 15: 63–84.

Hrebiniak, Lawrence G., and William F. Joyce
1985 'Organizational adaptation, strategic choice and environmental determinism'. *Administrative Science Quarterly* 30: 336–356.

Iansiti, Marco, and Clark K. Burton
1994 'Integration and dynamic capability: evidence from product development in automo-biles and mainframe computers'. *Industrial and Corporate Change* 3: 557–605.

Iansiti, Marco, and T. Khanna
1995 'Technological Evolution, system architecture and the obsolescence of firm capabilities'. *Industrial and Corporate Change* 4/2: 333–361.

Kelly, Dawn, and Terry Amburgey
1991 'Organizational inertia and momentum: a dynamic model of strategic change'. *Academy of Management Journal* 34: 591–612.

Kuhn, Thomas
1965 *The structure of scientific revolution.* Chicago: University of Chicago Press.

Levinthal, Daniel A.
1995 'Strategic management and the exploration of diversity' in *Resource-based and evolutionary theories of the firm.* C. Montgomery (ed.), 20–42. Boston: Kluwer.

Levinthal, Daniel A., and James G. March
1993 'The myopia of learning'. *Strategic Management Journal* 14: 95–113.

Lewin, Arie, and Henk Volberda
1999 'Prolegomena on coevolution: a framework for research on strategy and new organizational forms'. *Organization Science* 10: 519–534.

Lewin, Arie, Chris, Long, and Timothy Carroll
1999 'The co-evolution of new organizational forms'. *Organization Science* 10: 535–550.

Lieberman, Marvin, and Daniel Montgomery
1988 'First mover advantages'. *Strategic Management Journal* 9: 41–59.

Mahoney, Joseph, and Rajendran Pandian
1992 'The resource-based view within the conversation of strategic management'. *Strategic Management Journal* 13: 363–380.

Makadok, Richard
1999 'Inter-firm differences in scale economies and the evolution of market shares'. *Strategic Management Journal* 20: 935–952.

March, James G.
1991 'Exploration and exploitation in organizational learning'. *Organization Science* 2/1: 71–87.

Miller, Danny, and Peter Friesen
1984 *Organizations: a quantum view.* Englewood Cliffs, NJ: Prentice Hall.

Miner, Anne S.
1994 'Seeking adaptative advantage' in *Evolutionary dynamics of organizations.* J.A.C. Baum and J. Singh (eds.), 76–89. Oxford: Oxford University Press.

Miner, Anne S., Terry L., Amburgey, and T.M. Stearns
1990 'Interorganizational linkages and population dynamics: buffering and transformational shields'. *Administrative Science Quarterly* 35: 689.

Mitchell, Will
1991 'Dual clocks: entry order influences on incumbent and newcomer market share and survival when specialized assets retain their value'. *Strategic Management Journal* 12: 85.

Moran, Peter, and Sumantra Ghoshal
1999 'Markets, firms, and the process of economic development'. *Academy of Management Review* 24: 390–412.

Nelson, Richard
1991 'Why do firms differ, and how does it matter?'. *Strategic Management Journal* 12: 61–74.

Nelson, Richard, and Sidney Winter
1977 'In search on a useful theory of innovation'. *Research Policy* 7: 36–76.

Nelson, Richard, and Sidney Winter
1982 *An evolutionary theory of economic change.* Cambridge, MA: Harvard University Press.

Penrose, Edith
1959 *The theory of the growth of the firm.* Oxford: Basil Blackwell.

Peteraf, Margaret
1993 'The cornerstones of competitive advantage: a resource-based view'. *Strategic Management Journal* 14: 179–191.

Porter, Michael
1991 'Towards a dynamics theory of strategy'. *Strategic Management Journal* 12: 95–117.

Rosenbloom, Richard, and Clayton Christensen
1994 'Technological discontinuities organizational capabilities, and strategic commitments'. *Industrial and Corporate Change* 3: 655–686.

Rosenbloom, Richard, and Michael Cusumano
1987 'Technological pioneering: the birth of the VCR industry'. *California Management Review* 29/4: 51–76.

Rosenberg, Nathan
1976 *Perspective on technology.* Cambridge: Cambridge University Press.

Rumelt, Richard
1995 'Inertia and transformation' in *Resource-based and evolutionary theories of the firm.* C. Montgomery (ed.), 101–132. Dordrecht/Boston: Kluwer.

Sanchez, Ron
1995 'Strategic flexibility in product competition'. *Strategic Management Journal* 16: 135–159.

Sanchez, Ron, and Joseph Mahoney
1996 'Modularity, flexibility, and knowledge management in product and organization design'. *Strategic Management Journal* 17 (Winter Special Issue): 63–76.

Spender, J-C.
1996 'Making knowledge the basis of a dynamic theory of the firm'. *Strategic Management Journal* 17 (Winter Special Issue): 45–62.

Suarez, Fernando, and James Utterback
1995 'Dominant designs and the survival of firms'. *Strategic Management Journal* 16: 415–430.

Szulanski, Gabriel
1996 'Exploring internal stickiness: impediments to the transfer of best practice within the firm'. *Strategic Management Journal* 17 (Winter Special Issue): 27–43.

Teece, David, and Gary Pisano
1994 'The dynamic capabilities of firms: an introduction'. *Industrial and Corporate Change* 3: 537–556.

Teece, David, Gary Pisano, and Amy Schuen
1997 'Dynamic capabilities and strategic management'. *Strategic Management Journal* 18: 509–535.

Tegarden, Linda, Donald E. Hartfield, and Ann Echols
1999 'Doomed from the start: what is the value of selecting a future dominant design'. *Strategic Management Journal* 20: 495–518.

Tsoukas, Haridimos
1996 'The firm as a distributed knowledge system: a constructionist approach'. *Strategic Management Journal* 17 (Winter Special Issue): 11–25.

Tushman, Michael, and Philip Anderson
1986 'Technological discontinuities and organizational environments'. *Administrative Science Quarterly* 31: 439–465.

Tushman, Michael, and Elaine Romanelli
1994 'Organizational transformation as punctuated equilibrium: An empirical test'. *Academy of Management Journal* 37: 1141–1168.

Tushman, Michael, and Lori Rosenkopf
1992 'Organizational determinants of technological change: towards a sociology of technological evolution'. *Research in Organization Behavior* 14: 311–347.

Weick, Karl.E.
1979 *The social psychology of organizing*. Bloomington, IN: Addison Wesley.

Wernerfelt, Birger
1984 'A resource-based view of the firm'. *Strategic Management Journal* 5: 171–180.

Winter, Sidney
1995 'Four Rs of profitability: rents, resources, routines and replication' in *Resource-based and evolutionary theories of the firm.* C. Montgomery (ed.), 147–178. Dordrecht/ Boston: Kluwer.

Winter, Sidney, and Gabriel Szulanski
1999 'Replication as strategy'. Working paper, Wharton Business School.

Wholey, Douglas, R. and Jack W. Brittain
1989 'Characterizing organizational change'. *Academy of Management Journal* 32: 862–882.