This is to certify that the
dissertation entitled

COEVOLUTIONARY DYNAMICS OF MARKET
COMPETITION: PRODUCT INNOVATION, CHANGE AND
MARKETPLACE SURVIVAL

presented by

MEHMET BERK TALAY

has been accepted towards fulfillment
of the requirements for the

Ph.D. degree in Marketing

Roger J Calantone
Major Professor's Signature

July 31, 2008
Date

COEVOLUTIONARY DYNAMICS OF MARKET COMPETITION: PRODUCT INNOVATION, CHANGE AND MARKETPLACE SURVIVAL

By

Mehmet Berk Talay

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR PHILOSOPHY

Department of Marketing

2008

ABSTRACT

COEVOLUTIONARY DYNAMICS OF MARKET COMPETITION: PRODUCT INNOVATION, CHANGE AND MARKETPLACE SURVIVAL

By

Mehmet Berk Talay

Given a set of competing products, which are more likely to succeed? As decisive as it is for marketing scholars as well as managers, the answer to this question is also more than recondite thanks to the complex dynamics of rivalry among products. This complexity hinges primarily on the "interactive" nature of the competition, which renders the ultimate outcome of any strategic action contingent upon the way the competitors respond to that action. To elucidate the impact of interactive and coevolutionary dynamics in the competitiveness of products, this dissertation advances a stance based on a theory from evolutionary biology named the Red Queen Competition.

Red Queen Competition rests on the idea that competition among the entities in an ecosystem de-selects less fit entities. Entities that survive competition, then, are more fit, and so, in turn, they generate stronger competition. This escalating competitive intensity amplifies both the rate at which less fit entities are de-selected and the pressure for survivors to improve their fit to the ever-changing dynamics of competition, which recursively aggravates the strength of competition, and so on.

Based on this stance, this dissertation is comprised of three essays each of which analyzes the survival effects of 1) the product innovations, 2) the impact of post-launch modifications of the products in the market on their competitiveness, and 3) how these innovations at different levels of a nested hierarchical system of products and companies interact, respectively.

ACKNOWLEDGEMENTS

This dissertation marks the happy ending to one of the most difficult periods of my life, during which I had to cope with innumerable scholarly and non-scholarly challenges. As infelicitous as it would be to expatiate upon those challenges for the reasons of privacy and brevity, it would be equally, if not more, amiss not to acknowledge the tremendous support of some people without whom this dissertation, and the PhD degree it accords, would remain a dream.

Chronologically, I should first express my gratitude to two very special people: Sedef Celik and Celal Aksu, with whom I had the opportunity to meet merely by a twist of fate. I am indebted to them not only for believing in me and encouraging me in a period when even I did not believe in myself but also for supporting my undertaking to start an academic career.

I am also thankful to S. Tamer Cavusgil, who has been my advisor for the first two years of the PhD program, for his invaluable support. It was his prudent and judicious mentoring that facilitated my adaptation both to the program and to the United States. I deeply appreciate his willingness to share his experiences about, and to provide

guidance for, several decisive or picayune matters regarding my research and personal plans.

Roger Calantone, who has been my advisor in the last two years of the program and the chair of my dissertation committee, is the other person to whom I will be grateful forever. Not only has he generously shared his invaluable experience whenever I needed, but also he has unremittingly emboldened me to endeavor many onerous research projects like this very dissertation which simply would not be without his encouragement and mentorship. I also owe him a lot for putting up with my sometimes gallingly sporadic performance. Throughout my academic career I will emulate his receptiveness, creativity, and acumen. Further, I am notably beholden to him for his candor, mentorship, and generosity.

As invaluable as the sagaciousness of these two professors have been, without the help of the other members of my dissertation committee, Ana-Maria Herrera, Tomas Hult, and Clay Voorhees, it would not be possible for me to complete this dissertation neither logistically nor intellectually. Unfeignedly, all of them have been very supportive all the time. I will always be grateful to Ana-Maria Herrera for her discerning guidance as I was striving to find a way out in the labyrinth of econometrics; to Tomas Hult for his insightful advices and his availability whenever I asked for despite his implausibly busy schedule; to Clay Voorhees for his infectious verve and enthusiasm that antecede his meticulous suggestions to improve my dissertation.

I have been fortunate enough to have my family and friends with me in every twist and turn in my life, and the last four years were no exception. It would be wearier, if not impossible, to write this dissertation and complete the PhD program without the prodigious support of those people for whom the gratitude I have is more than immense. My parents, Ali Cahit Talay and Reyhan Talay and my brother Berkay Talay have done everything they could -ranging from mailing me “sucuk” and “pastirma” all the way from Turkey to helping me code data for this dissertation- to help me survive the last four years. I would not be who and where I am without them. I would like to thank my friends who have always been there for me -and when the conditions permit, with me- to share the “best” and the “worst.” My colleagues, on the other hand, have always been exceptional sources of morale, help and inspiration. I hope what we have accomplished together with them is only the beginning of what we will. I will always remember and cherish their comradeship. The last, but certainly not the least, I would like to thank Melike Billur Akdeniz who is far beyond than a friend and a lot more than colleague to me. Without a doubt, she has turned my life upside down from the very moment I met her and she has been my cardinal source strength, motivation and inspiration far more than she realizes. Verily, her impact in my life cannot be overstated.

All in all, I am grateful to many people, of whom I could only name a few here, for their invaluable support for helping me achieve one of the biggest goals of my life. However, it should also be noted that while this dissertation is the product of a team work more than an individual accomplishment of mine, any oversight, error and flaw that might have been overlooked in this dissertation, are utterly my own.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Given a set of competing entities, which are more likely to succeed? As decisive as it is for marketing scholars as well as managers, the answer of this question is also more than recondite due to the complex dynamics of competition among products. This complexity hinges primarily on the "interactive" nature of the competition, which renders the ultimate outcome of any strategic action contingent upon the way the competitors respond to that action. Put differently, the competing entities consistently engage in complex strategic interactions, where the outcomes depend not only on what a focal entity does, but also on what another entity does, given what its rivals will do, given what the focal entity will do, etc (Barnett and Hansen 1996).

These competitive interactions of entities, albeit with different units of analyses, have been of interest to scholars from various fields like economics, management and marketing. In management and economics, for instance, the unit of analysis is, almost exclusively, the firm, or the industry, whereas in marketing competition and success is, on the most part, analyzed at product level.

On the one hand, modern management theories regard competition as it is generated by the firms in a given industry: it is argued that as firms evolve so do their competitive effects, and so do their environment. Although such competitive dynamics often are associated with organizational ecology (Carroll and Hannan 2000; Hannan and Freeman 1989), various theoretical approaches have been developed to comprehend their complexions. Transaction cost economics emphasizes that over time "small numbers" conditions emerge, as competing options become limited (Williamson 1985). Economic sociology illuminates the back-and-forth process through which competitors' roles evolve (White 1981), and related work describes the development of social-status orderings over time among competing firms (Podolny 1993). Organization learning theory focalizes on competitive dynamics among firms with different learning strategies (March 1988; Mezias and Lant 1994), and the diffusion of strategies through learning over time (Greve 1996). If more implicit treatments of competition are considered, then even a broader range of work comes into view – such as the development of implicit competitions over social identities (Zuckerman and Kim 2003) and among new institutional forms (Ruef 2000). Overall, the dynamics, and evolution, of market competition have emerged as a unifying topic in organization theory.

Nonetheless, much of the management research explicitly, and almost exclusively, adopts an organizational-level perspective, explaining population level change as an accumulation of foundings and failures of relatively inert firms (Baum 1996). This perspective has been criticized by management theorists who argue that significant change might also occur within firms (Barnett and Burgelman 1996). Organizational-level selection is also challenged by evolutionary theorists who accentuate the difficulty of applying selection arguments to groups of autonomous agents (Campbell 1994). Their fundamental grounds for examining evolution at a "sub-organizational level of analysis" is that identifiable components of firms may experience evolution independently of the organization as a whole (Ingram and Baum 1997a). While individual sub-units of an organization may be, to a greater or less extent, exposed to similar competitive dynamics, each sub sub-unit, nonetheless, experiences its own idiosyncratic path of evolution that will be dissimilar to those of its sister sub-units. For example, different models of the same automobile company deal with different models of competing firms in different segments with certain amount of latitude of independence. Competitiveness and survival in different segments rely on different factors since the target customers and the competing firms vary from one segment to another. While a compact car owner might be place more emphasis on gas mileage and easy parking, for a potential truck user towing capacity and off-road capabilities may be the main criteria. Furthermore, not all firms in the automobile industry compete in every segment. As the demographics of competing firms differ across segments, so do the coevolutionary dynamics of competition within each segment, hence the necessity to approach the co-evolution with a "sub-organizational level of analysis."

On the other hand, for years marketing scholars have already been focusing on a "sub-organizational level of analysis," in their attempts to find the determinants of product success. In their meta-analysis, Henard and Szymanski (2001) classify the determinants of product success into 4 categories: 1) product, 2) strategy, 3) process, and 4) marketplace characteristics. *Product characteristics* involve services as well as products, and they encompass attributes associated with the "offering," such as price, innovativeness, and managers' perceptions of how well the offering meets customers' needs. *Strategy characteristics* include a firm's concerted actions that bear the potential of accoutering a competitive advantage for the firm in the marketplace separate from any factors related with the new product development process. These strategic elements comprise doling resources to the new product development endeavors, timing of market entry, and capitalizing on marketing and technological synergies. *Process characteristics* refer specifically to elements associated with the new product development process and its execution. They encompass department interactions, firm proficiencies, management support, and marketplace orientation and product development initiatives. They also involve the development, marketing, and launch of new products and/or services. Finally, *marketplace characteristics* comprise elements that delineate the target market and involve market potential, competitive activity, and the intensity of that activity (i.e., turbulence) in response to new product introductions.

Nevertheless, while marketing scholars adopt a “sub-organizational level of analysis,” they considerably overlook the interactive nature of the product-level competition. Stated differently, while the marketing scholars have begun to employ longitudinal studies to understand the time-covarying dynamics of product success, the “interactive” nature of the competition is yet to be analyzed.

Accordingly, this dissertation aims to put 1) innovation-based competition at different levels (i.e., firm- and product-level) and 2) interaction of competitive dynamics between those levels that are nested in a hierarchical ecosystem under scrutiny with particular emphasis on co-evolution of firm and product characteristics over time. Stated differently, this dissertation analyzes the survival effects of 1) the product innovations, 2) the impact of post-launch modifications of the products in the market on their competitiveness, and 3) how these innovations at different levels of a nested hierarchical system of products and companies interact. This focus is related to, and important for, the marketing field because successful products not only contribute substantially to long-term financial success (Bayus et al. 2003) but also fortify the competitive position of the company (Shankar et al. 1998). Likewise, Drucker (1999) argues that only companies with a systematic policy of innovation are likely to succeed. Consequently, it is not surprising that Marketing Science Institute (2002) has named new products a top tier priority topic. However, as consequential as new product development and innovation processes are, there are at least two caveats to a strategy of relying on them to strengthen the company's position. First, new product development initiatives are very risky, in that over 50% of new products fail in the marketplace (Golder and Tellis 1993). Second, they are costly due to high R&D costs. For example, R&D for Gillette's Mach 3 razor blade exceeded $700 million, while R&D costs for major new drugs are typically between 500 million and 1 billion dollars, and new car platforms cost over one billion dollars.

To elucidate the role of co-evolutionary dynamics in the competitiveness of firms and products, this dissertation builds models that allow for competitive interactions among products and firms. In particular, following Barnett and Hansen (1996) it is postulated that an entity (i.e., a product or a firm) facing competition will to respond to that competition, which will then marginally increase the competitive pressures faced by other entities in the system, stimulate a similar process of response in the competitors – which will ultimately exacerbate competitive pressures faced by the focal entity. This will again spark a search for improvements in the focal entity, and so the cycle will continue. This dissertation advances a stance where this reciprocal pattern of causality, dubbed in the evolutionary theory as the "Red Queen" (Van Valen 1973) is a pivotal, driving force behind the co-evolution of competitive success and failure. Theoretical and empirical validation of this stance is the key purpose of the dissertation.

Red Queen competition rests on the idea that competition de-selects less fit products and firms and stimulates innovations. Entities that survive competition, then, are more fit, and so, in turn, they generate stronger competition. This escalating competitive intensity amplifies both the rate at which less fit entities are de-selected and the pressure for surviving products to innovate, which recursively aggravates the strength of competition, and so on. Stated differently, the "innovation process" does not terminate when a given entity increases its performance by improving one or some of its features. Instead, the innovating entity, by improving its own performance, now has intensified the competitive pressures underwent by the other entities in the population. At some point, this increased competitive intensity will reduce performance of other entities to a level that will incite a search for improvement by the marketers of these entities. As each of these marketers finds solutions that restore their performance, in turn, competition again increases for the rest of the population – again triggering the search for improvements in the other entities. Therefore, innovation and competition are linked causally, each inciting the other in the relentless process of Red Queen evolution. Moreover, it is argued that because of this continuous, self-inciting process, entities become viable if they have historically experienced competitive pressures. Nevertheless, their rivals, however, are also stronger competitors if they also have survived akin competitive pressures. Relative to its rivals, then, the competitiveness (i.e., chances of survival) of an entity improving in this way may appear to be unchanged – hence the reference (made initially by the biologist Van Valen in 1973) to the Red Queen from Lewis Carroll's Through the Looking Glass, who explains to the running Alice why her position remains stable relative to others who also are running: "Here, you see, it takes all the running you can do, to keep in the same place."

Given this brief theoretical background, this dissertation is comprised of three essays. The first essay focuses on the firm-level competition, and explains the impacts of innovation and competition on firm survival, whereas the second essay will take the product level competition as the focal phenomenon, and try to explain the impact of innovation on product survival. The third essay conceptualizes and empirically tests a hierarchical model where the impacts of firm-level covariates on product-level dynamics are analyzed.

ESSAY 1: FIRM-LEVEL DYNAMICS OF INNOVATION AND SURVIVAL: EVIDENCE FROM U.S. AUTOMOBILE INDUSTRY, 1895-2000

INTRODUCTION

Following the seminal works of Schumpeter (1934 and 1942), scholars have been trying to comprehend the role of innovation in the co-evolutionary dynamic of market competition with particular emphasis on the inextricable link between innovation, competition and firm survival. Empirical evidence from academic literature evinces that innovations lead to higher profit rates (Bayus et al. 2003; Roberts 1999), boost sales growth (Anderson and Tushman 1990; Tushman and Anderson 1986a; Tushman and Anderson 1986b; Tushman and Murmann 1998), and increase the survival rates of the innovator companies (Banbury and Mitchell 1995; Carroll and Teo 1996; Klepper 1996; Klepper and Simons 2000). However, despite the fact that benefits of the innovations are, at best, temporary and bound to dissipate due to the mimetic behavior of the competitors, spillover effects, and the advances in technology (Khessina 2006; Rogers 1995; Teece 1986), relatively very little attention has been paid to direct and indirect effects of those factors while explaining the benefits gained from successful innovations.

Based on organizational ecology, this essay aims to address this gap by building a conceptual framework in which the absolute and relative survival benefits of innovations are analyzed with particular emphasis on the innovations introduced by competitors. Specifically, it is proposed that firms engage in an arms race, a continuous race on the basis of innovation, where the rewards are reaped by the relatively swift firms whereas those dawdle are ousted from the competition. In this arms race, as modeled in this essay, a firm trying to survive the competition, is likely to respond to that competition by introducing an innovation, thereby increasing its competitiveness, (i.e., fit) to the environment by adapting to the needs and wants of their customers, this increase in fit, in turn, increases the competition, (i.e., selection pressure) felt by its rivals in the industry. Rivals, faced with an increase in selection pressures, will feel compelled to react to that innovation. Eventually, some of the rivals can respond by imitating that innovation, while some others introduce another innovation. Regardless of their nature, these competitive responses will ultimately escalate the competition felt by the first firm, to which it has to respond to survive. This self-inciting, "reciprocal system of causality" (Barnett and Hansen 1996), known in the evolutionary biology as the Red Queen hypothesis (Van Valen 1973), is postulated to be the major driver of the competition among firms on the basis of innovation, which ultimately leads to survival or failure of the firm. The objective of this essay is to provide theoretical and empirical evidence for Red Queen competition of innovativeness.

Following Barnett and McKendrick (2004), Barnett and Hansen (1996), Barnett (1997) and Defus et al. (2008), this study proposes a model that incorporates the Red Queen dynamics of competition as both a positive and a negative force on the survival benefits of an innovation of focal firm where the survival advantages of an innovation (i.e., increased viability and competitiveness) come at the expense of other. Therefore this model contributes to the extant literature by explicitly accounting for the arms race between firms in developing new innovations by introducing "lag load effects."

Data from the U.S. automobile industry are used for empirical tests of the hypotheses. Specifically, rather than a sample, a dataset comprising all automobile manufacturers ever known to compete in the U.S. automobile market from 1895 to 2000 is examined. 1895 is regarded as the beginning of the U.S. automobile industry by many researchers (Carroll and Teo 1996; Dobrev et al. 2002) whereas 2000 is the latest year covered by the major data sources utilized in this essay. Individual fates of all firms are traced during this period to test the proposed hypotheses about the drivers of organizational mortality. Complete coverage of 106 years enables precise analysis of how Red Queen competition affects the industry in general and the competing firms in particular. Moreover, it also allows testing of hypotheses without assuming temporal equilibrium (Carrol and Teo, 1996). The choice for this industry is by no means coincidental. The historical development of this industry is characterized by ceaseless efforts of the automobile manufacturers to introduce innovations, to the extent that this very industry gave birth to many textbook examples of product- and marketing-related innovations like the "assembly line" as introduced by Ford Motor Company and the concept of "planned obsolescence" as introduced by General Motors. Moreover, cumulativity in social science is another motivation of the choice of industry context. As suggested by Dobrev et al. (2002), there are many studies in the literature that use the U.S. automobile industry in the analyses to examine the fundamental ecological problems like age, size, and niche width, this study extends this stream of research by incorporating the concepts of Red Queen competition and lag load.

THEORY AND HYPOTHESES DEVELOPMENT

Innovation Outcomes

As Garcia and Calantone (2002) suggest there is a plethora of unique spins as to what is considered an innovation. As such, a review of literature reveals that an OECD study in

1991 on technological innovations best captures the essence of innovations from an overall perspective: "Innovation is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention." This definition follows the tradition of Schumpeter (Schumpeter 1942; Schumpeter 1934) by emphasizing the sharp dissimilarity between invention and innovation by stressing the economic implications of the latter.

Regardless of the definition, innovation has been identified as an important factor in firm survival (Han et al. 2001; Starbuck 1983; Utterback 1996). However, there is very little empirical evidence on the relationship between the probability of survival and the innovative activities carried out by the firm (Cefis et al. 2005). On the one hand, some scholars have theorized and proclaimed the positive effects of innovation on several aspects of firm performance. Specifically, innovative firms have been shown to obtain greater market shares (Banbury and Mitchell 1995; Henderson 1993; Henderson and Clark 1990), achieve higher profit rates (Bayus et al. 2003; Roberts 1999), generate more sales (Anderson and Tushman 1990; Tushman and Anderson 1986), produce more patents with higher citation rates (Sorensen and Stuart 2000), become market leaders (Christensen and Bower 1996; Christensen and Rosenbloom

1995; Henderson and Clark 1990), and –more relevant for this study- survive longer than less innovative firms (Banbury and Mitchell 1995; Carroll and Teo 1996; Khessina 2006; Klepper and Simons 2000) On the other hand, albeit few in number, negative consequences of innovation have also been discussed in the literature. Specifically, innovation processes are argued to be uncertain and risky endeavors, particularly in new industries, and may never attract customer attention and, as a result, debilitate firm performance and diminish its survival chances (Kline and Rosenberg 1986). Further, some theoretical and empirical studies have suggested that innovation processes may incur significant costs. These studies have proposed and evinced that firms' performance and survival likelihood can be impaired by innovation when innovation processes disrupt organizational routines and structures (Barnett and Freeman 2001; Carroll and Teo 1996; Dowell and Swaminathan 2000). Therefore, the knowledge about possible negative consequences of innovation is far less complete than that of benefits.

Although uncertainty, risk, and future costs are inevitable, innovations are undertaken and implemented in an attempt to counter other risks and costs (i.e., the risks and costs of being unfit to the environment). Stated differently, innovations are means to respond to, and outperform the competitors. The theory of environmental fit suggests that, firms have greater performance and survival chances when their routines and structures are better aligned with the demands of their environment (Hannan and Freeman 1977). Innovative firms (i.e., firms with many successful innovation outcomes) are likely to address the changing environmental demands better than non-innovative firms in that innovation may help firms achieve a greater organization-environment fit in several different ways. First, innovative firms are capable of offering products that better serve changing customer demands and preferences (Schumpeter 1934). Second, innovative firms possess a leverage in attracting and retaining talented and creative employees (Almeida and Kogut 1999; Kogut 1988; Saxenian 1994). Third, innovative firms receive greater public attention and approval (Podolny 1993; Podolny and Stuart 1995; Podolny et al. 1996). Fourth, innovative firms make more preferred partners for joint ventures and research and development alliances (Kogut 1988; Mowery et al. 1998; Stuart 1998). Finally, innovative firms are more likely to get funds from resource-holding agents. For example, venture capitalists tend to favor start-ups with greater technological potential (Bygrave and Timmons 1992). Therefore, it is hypothesized that:

H1: Each innovation by a firm will increase its chance of survival.

Given the empirical evidence that product innovation enables firms to achieve a better alignment with their environment, it can be expected that firms that achieve greater innovation outcomes (i.e., radical innovations) will have competitive advantages in the forms of improved viability and enhanced competitiveness (Khessina 2006). Specifically, firms with greater innovation outcomes are more likely to survive the Red Queen Competition, because they will not only be able to outperform their competitors in meeting the demands of environmental actors (e.g., consumers, suppliers, alliance partners, and governmental agencies) (Carroll and Teo 1996; Christensen and Rosenbloom 1995; Freeman and Soete 1997), but also they will begin to possess an advantage which the other firms not only lack, but also will be less likely to attain in the near future due to the very nature of radical innovations. Therefore, it is possible to predict the following:

H2: In absolute terms, the more radical a firm's innovation (i.e., ignoring competitors' innovations), the greater the innovating firm's chances of survival

What about the competitors? Each firm exists in a population (or in biological terms "taxa") of competing firms where the competition does not reach equilibrium once a given firm improves its performance and competitiveness by implementing an innovation. Instead, the innovating firm, by improving its own performance and hence survival chance, now has increased the intensity of competition felt by the other firms in the population. At some point, this increased competitive intensity will reduce performance in other firms enough to initiate a search for retaliation in these firms. As each of these firms finds solutions that restore its performance, in turn, competition again increases for the rest of the population – yet again triggering the search for improvements. Thus, innovation and competition are linked causally, each accelerating the other in the ongoing process of Red Queen evolution. Stated differently, in order for an innovation to increase the chances of firm survival, it should not be effortlessly and equally counterpoised by competitors, otherwise, the firm will be in a position like that of Alice in Wonderland, where, according to Lewis Carroll's Red Queen (also quoted in Van Valen, 1973), " it takes all the running you can do, to keep in the same place." Therefore, we hypothesize:

H3: In relative terms, the more radical a firm's innovation (i.e, relative to competitors' innovations), the greater the innovating firm's chances of survival.

Niche Overlap

In their seminal essay on organizational ecology, Hannan and Freeman (1977) also introduce the "niche width" theory which speculates about the consequences of intertemporal selection processes in industries that feature environmental variation over time. The theory links environmental change patterns to fitting organizational forms, distinguishing two major types: generalist and specialist organizational forms, distinction between which refer to whether an organization chooses to spread its resources across a broad spectrum of the environment in an hope of balancing its risks (i.e., generalist strategy), or concentrates its resources in a narrow segment of the environment in the hope of earning a high return (i.e., specialist strategy). The underlying arguments that associate the level of performance exhibited by each of these organizational forms to different environmental variation regimes relate to the benefit of specialization, the cost of adjustment, the risk-spreading effect of diversification and the toughness of scale-driven competition, all in relation with the pattern of environmental change.

In this way, niche-width theory provides a general stance about the evolution of different organizational forms over time. Stated differently, niche width theory hinges upon the notion that a specialist, well designed for a particular environmental condition, will always outperform a generalist in that same condition because the generalist must bear extra resources in order to be able to perform in several environmental conditions. Therefore, the specialist "maximizes its exploitation of the environment and accepts the risk of having that environment change" while the generalist "accepts a lower level of exploitation in return for greater security" (Hannan and Freeman 1977: 948).

Niche width theory postulates that specialist organizations will flourish in stable or certain environments, to which the specialist organizations have maximized their routines and resources and in fine-grained environments. In contrast, where environmental conditions are not stable and coarse-grained, specialists may not be able to survive prolonged unpropitious periods where a generalist strategy may prove *comme il faut* (Baum and Shipilov, 2006). As Baum and Shipilov argue (2006) "the key prediction is that in fine-grained environments with large magnitude variations relative to organizational tolerances, specialists outcompete generalists regardless of environmental uncertainty." Specialist organizations are vulnerable to the fluctuations whereas generalist organizations cannot react swiftly enough to operate efficiently (Baum and Shipilov 2006).

Based on the "niche width theory" Baum and Singh (Baum and Singh 1994a; Baum and Singh 1994c; Baum and Singh 1994d) develop the concept of "niche overlap" and test a model of resource overlap, where the competition between any two organizations is directly proportional to the overlap of their targeted resource bases, or organizational niches. Baum and Singh (1994a, 1994b) regard each entity in a population as occupying a unique location in a multidimensional resource space. Baum and Shipilov (2006) define the niche of an organization as an "intersection of resource requirements and productive capabilities at the organization level, depends on where the organization is located and what it does (e.g., the clients it has the capacity to target, how it responds to the environment)" and argue that "the organizational niche is a result, not a cause, of organizational adaptation."

Baum and Singh (1994a; 1994b) argue that the likelihood and intensity of competition between organizations with dissimilar organizational niches are "directly proportional to the extent the overlap in their resource requirements." Probable rivalry between each organization can be predicted by using "overlap density," the cumulative overlap of an organization's resource requirements with those of all others in the population. Therefore, this study hypothesizes that:

H4: Competitors whose niches overlap more with the innovator firm will face a decrease, albeit temporary, in their survival chances, compared to other firms

Lag Load

In its original form, the Red Queen hypothesis (Van Valen, 1973) asserts that each evolutionary progress made by one species in an ecosystem is undergone as a worsening of the environment by other species, and consequently if a species is to survive it must evolve continuously and rapidly (Smith 1976). Stated differently, as suggested by Maynard Smith (1976), "a species will go extinct when the environment, including the biotic environment, deteriorates more rapidly than the species cope with by evolutionary adaptation," which necessitates some measure of the extent to which a species has fallen behind the environment. Maynard Smith (1976) proposes the "lag load" as a possible measure.

Applying the biologic "lag load" concept to organizational ecology, this study postulates a negative relationship between the time period an organization lags to innovate and its chances of survival. It is well-documented in the relevant literature that survival advantages gained by introducing an innovation are not perennial. An innovation may decrease the survival chances of competitors, or even drive some of them from the competition. However, other competitors who can survive the selection pressures of that particular innovation will respond with their own innovations. As such, an innovation, which provided the firm with competitive advantages, will become non-diagnostic in the survival chances of its innovator. Alternatively, firms may be reluctant to respond to new developments in the industry. It is suggested that a firm's existing capabilities, ossified routines, procedures, and information processing abilities, inhibit its ability to develop adaptive intelligence (Arrow 1974; Freeman and Soete 1997; Hutchins 1995; Nelson and Winter 1982; Teece et al. 1997). Moreover, a firm's history limits the scope of its future competitive actions to local, internalized processes for search and response (Aldrich and Ruef 2006; Cohen and Levinthal 1990; Grant 1996; Levitt and March 1988; March and Simon 1958; Nelson 1995; Teece et al. 1997; Tripsas and Gavetti 2000). Therefore, when learning needs to be focused on entities beyond the firm, and when optimum response is a radical change, rather than an incremental one, firms often fall into competency traps, and core competencies become 'core rigidities'(Iansiti 1995; Lane and Lubatkin 1998;

Leonard-Barton 1992; Nelson and Winter 2002; Rindova and Kotha 2001). Extant literature provides empirical evidence about these core rigidities. For instance, Christensen (1997) argue that limited with their existing marketing routines, processes and capabilities, in particular its knowledge about its customers, firm are more likely to develop new products and campaigns that eventually appeal to their existing customer base rather than attracting new customers. In a similar vein, Tripsas and Gavetti (2000) how the Polaroid Corporation has responded to the ongoing shift from analog to digital imaging. They explain, with particular emphasis on unveiling the effects of both capabilities and cognition in explaining organizational inertia, why Polaroid has had difficulty, in adapting to the advances in digital imaging despite its extensive technological know-how in instant photograph developments.

Based on the arguments explained above, this essay attempts to explain the impact of lag load, as an outcome of firm's failure to adapt to changes in its environment. Specifically, two different types of lag load are defined: absolute lag load and relative lag load. In absolute terms, a lag load might be the time between two consecutive innovations of a firm, whereas in relative terms, a lag might be defined as the difference between the average innovation frequency of the firm and that of the entire population (or, its direct competitors i.e., the ones with which the niches of the firm overlaps the most).

H5a: The more a firm lags in introducing innovations, the lower its chances to survive

H5b: In relative terms, the more a firm lags in introducing innovations (i.e., with regard to its competitors) , the lower its chances to survive.

Age

We also believe that experiencing and surviving competition in the past increases a firm's current competitiveness. This is accomplished in two ways: 1) by eliminating less-fit firms, and by "teaching" firms what it takes to compete. Therefore, given two firms, if one has survived an intense competition while the other was not similarly challenged, *ceteris paribus* the survivor of competition is likely to be a stronger competitor, who makes us believe that future probability of firm survival and competitiveness hinges on the degree of competition to which firms have been exposed historically. Unquestionably, some of the differences between firms due to their different competitive histories might be measurable in terms of current-time variables. For instance, survivors of competition might consequently have more advanced or higher-quality products, on average, than firms that have experienced less competitive pressure in the past. Nevertheless, many history-dependent differences will be too implicit to be unambiguously reflected in current-time observables, such as subtle but important dissimilarities in organizational routines or cultures (Barnett and Pontikes 2005). Some scholars in the strategic-management literature argue that such tacit differences are especially important to competitiveness because they are less imitable (Lippman and Rumelt 1982). Consequently, two firms with very similar current-time observables like size, age, and situation in the marketplace while they have very different historical backgrounds (Barnett and Pontikes 2005). In such cases, the differences between these firms with similar current-time characteristics may be captured by the differences in the historical paths they followed to reach their current state.

Red Queen competition explains such history-dependent competition by postulating a recursive and reciprocal view of competition, where 1) the dynamics of extant competition are driven by past competition (recursiveness) and 2) a competition created by a firm is linked to the competition created by other firms in the industry (reciprocity) (Barnett and Hansen, 1996). When a firm faces competition, it is likely to experience some nuisances in retaining resources compared to the context where competition is non-existent. Firms react to such performance problems by exploring for possible solutions (March 1988). This exploration persists until a reasonable solution is reached, which will improve the performance to a pre-determined or passable level, and then the search is terminated (March and Simon 1958). Therefore, it can be argued that when competitive pressures exist, firms will explore ways for amelioration and to counteract the pressures. While explorations for amelioration are terminated when a satisfactory solution is found, firm's adaptive changes, nonetheless, not only improve its immediate performance, but they also will also render the firm a stronger competitor against its rivals (hence the increased chances of survival). These rivals, in turn, now are faced with new challenge and so are, themselves, compelled to initiate their own explorations. This new exploration will end when they implement appropriate solutions, and so improve their performance which will render them stronger competitors as well as offsetting the selection pressures they feel because of the previous improvements of their rivals– triggering "problemistic" search in their rivals. In this incessant, reciprocal process, competition triggers exploration and improvement which further increase competition. Therefore, regarding the process of surviving as a determinant of competitiveness, we hypothesize that:

H6a: The more rivalry a firm has experienced in the past, the lower its chances to survive

H6b: The more rivalry a firm has experienced in the past, the less likely it is to have "lag effects"

Size

Thus far it has been presumed that a firm adapts to its environment by exploring and implementing improvements, large firms, on the other hand, enjoy an alternative to the ceaseless of Red Queen competition. Large firms that have realized positional advantage which might come in the form of strong market position, social prestige, centrality to social networks, political power, and alike, may attenuate or even eliminate the threat of competition from others. In fact, the *raison d'être* of strategic management and business education is to investigate and teach methods for finding safety from the forces of competition, stimulated in large part by Porter's (Porter 1980) application of industrial organization economics to the problem of competitive constraints. In sociology, similar ideas appear in Selznick's (Selznick 1949) early work on cooptation, featuring large organizations of political importance that absorb interests and avert threats. More recently, researchers have found large organizations to be especially capable of staking out and defending their strategic position (Barnett and Hansen 1996; Haveman 1993) and of maintaining interlocks with other important actors (Kono et al. 1998). Nevertheless, precisely because large organizations are capable of averting competitive constraints, they may be less susceptible to the Red Queen process.

When faced, nonetheless, with competitive constraints, large firms also have distinct advantages in coping with these pressures. Large firms typically buffer key parts of the firm from the external environment, especially when they confront complex and changing environments (Meyer and Rowan 1977; Thompson 1967). From the stance of Red Queen competition, this capability implies that some parts of large firms may stay isolated from competitive threats and so may not realize the imperative for change. Contrarily, small firms by and large are less able to isolate themselves from competitive threats. Theory and evidence also suggest larger size enables the firms to decouple strategic activities from competitive pressures (Meyer and Rowan 1977; Pfeffer and Salancik 1978), while for small firms competitive pressures have more direct and immediate impact on internal processes (Hickson et al. 1969). Besides, the top level management of large firms are usually more in isolation than their counterparts in smaller firms (Gusfield 1957) and as suggested by Barnett and McKendrick (2004) "throughout their rank and file see a smaller proportion of organizational members having contact with the external environment" (Blau 1977). Frequently, competitive effects are not abruptly and crashingly felt by large firms (Barron 1999; Bothner 2003) and therefore they are more likely to lag behind the Red Queen Competition.

Lastly, size can also provide the organizations with technical advantages that enable them cope with competitive pressures. Theory and empirical evidence show that larger firms, *ceteris paribus*, are less likely to fail (Carroll and Hannan 2000; McKendrick et al. 2003) due to several reasons: 1) large firms tend to behave more reliably, (Haunschild and Sullivan 2002) 2) due to scale economies, large firms possess cost advantages in various industries over smaller firms (Carroll and Swaminathan 2000; Dobrev et al. 2002). Therefore:

H7a: The larger the firm, the more likely it will be to survive

H7b: The larger the firm, the less likely it will be to be affected by "lag effects"

Population-level Learning

Ingram and Baum (1997a) argue that the experience of other firms competing in the same industry may increase the internal efficiency and competitiveness of a firm, since it is possible for the firms to benefit from other firm's experiences in improving their own routines. Firms can gain insights about the operations of other firms operating in the same or different industries by direct observation; by reading about them in various media; by listening to lectures about them (e.g., reading case studies about various firms); or by recruiting the former employees of other firms. In doing so, firms have a chance to learn about the successes and failures of others which can provide the focal firm with ideas about how to increase its internal efficacy (Ingram and Baum, 1997a). More importantly, through the learning form the actions of the other firms in the population, firms can gain insights to improve their competitiveness as well (Ingram and Baum, 1997a). For instance, firms can gain consequential perspicacity about the preferences of their customers thorough population learning routines. Majority of the firms on a population will strive to unveil the needs and wants of their customers via implementing various market research techniques which will lead to development and execution of various marketing strategies. Since all firms in an industry provides information about customers' preferences (White 1981), indubitably, reactions of customers to these strategies will reverberate across the other firms in the industry. Therefore, just as a firm can observe customers' responses to its own marketing actions, it is also possible for the firm to discern, albeit with less exactitude, customers' responses to the actions of other firms.

Furthermore, learning from the experiences of the other firms in the population bears various avails over own experience for learning due to the fact that any one firm is constrained with its own limited resources, capabilities, and time to optimize its routines by venturing different marketing actions and implementing the best and hence a firm is limited in how much it can learn from its own experience. Besides, as suggested by Ingram and Baum (1997a), "the constraint on experimenting is not just a firm's resources, but also limits on how much variance the firm's internal systems can handle, and external constituents will accept" (Hannan and Freeman 1989; Hannan and Freeman 1984; Haveman 1993). That being said, in a population of firms it is possible to find a wide variety of strategies that do not transgress internal and external standards of consistency and reliability, and hence more varied in their experience than individual organizations (Hannan 1997).

Extant literature involves various studies that account for the impact of population learning on firm survival. Ingram and Baum (1997a) report that both population experience at entry and accumulated since entry had significant negative effects on hotel chain failure rates. In a similar vein, Baum and Ingram (1998) and Ingram and Baum (1997b) challenged the findings for Manhattan hotels, by including population operating experience at founding and since founding based on the operating experience (total rooms operated) other Manhattan hotels had accumulated since a given hotel was founded. In their analyses, where they control for firm-level experience, population-level learning at the time of founding had a significant negative effect on the hotel failure rate while the impact of population-level learning accumulated since a hotel's founding was found to be insignificant. These findings and alike suggest that organizational forms are heterogeneous across time and that consecutive cohorts of new firms in the same industry are better than their predecessors as a function of the experience of the population (Ingram and Baum 1997a). Therefore, we hypothesize that:

H8: As the population-level learning increases, the positive impact of innovation on the survival chances of the firm will diminish.

Competitive History

Affected by competitive threats, large firms are likely to be less responsive than small firms. As Hannan and Freeman

(198

size

larg

to e

form

et a

desi

rout

resp

Furt

occu

smal

coop

peo

fir

pro

cha

sma

exp

be

Har

arg

th

As

Wi

su

(1984) argued in their theory of structural inertia, with size come pressures for reliable behavior. Leadership in large firms tends to become less precipitous in responding to external demands over time because of increased formalization and rule-governed behavior (Bendix 1974; Weber et al. 1958). Consequently, large firms typically are designed, or transformed, to behave according to established routines, continuing to behave in expected ways rather than responding sensitively to performance feedback (Greve 2003). Furthermore, when adjustment to performance feedback does occur, such adjustment is likely to be less profound than in small firms. Change in a small firm necessitates obtaining cooperation from a smaller number of sub-units (e.g., people, groups, and other organizational units). Large firms, by contrast, are likely to require cooperation from proportionately more parties. Moreover, large firms are characteristically both more labyrinthine and byzantine than small firms, and with elevated intricacy comes an exponential increase in the numbers of ways that changes can be blocked (Hannan and Freeman 1984; Hannan et al. 2003a; Hannan et al. 2003b; Haveman 1993). Yet again, these arguments imply that large firms being less responsive to the Red Queen process.

As firms grow larger, it should hence be expected that they will become less disciplined by competition, and hence less susceptible to the forces of Red Queen competition. These arguments apply both to the learning and the selection components of the theory. Confronted by weaker competitive discipline, large firms are less likely to be stimulated to search for improvements. Similarly, competition generates selection processes that are more likely to eliminate small firms from the population if they fail to improve and adapt to the environment. Large firms, by contrast, bear aforementioned advantages to the extent that they will be able to survive despite their failure to respond to competition in a timely manner. Thus, natural selection reasoning also suggests that large firms will be less responsive to the stimulus of competition and consequently less likely to conform to the predictions of the Red Queen model. As suggested by Barnett and Pontikes (2005), if firms become less prone to the effects of Red Queen competition as they attain the power and stature that come with size, then an evidence that Red Queen evolution among small firms more strongly than among large firms should be observed.

Theories of competition that follow a racing logic highlight the strengths of large firms, especially in contexts like the automotive industry, in which technological change is continuous and relatively programmatic and where global reach is particularly consequential. Regarding competition as a constraint, by contrast, puts the dynamics of Red Queen competition on the spot. Following this rationale, the very strengths that enable larger firms to manage constraints also make them less susceptible to the survival- and competitiveness-enhancing consequences of the Red Queen process. By and large, then, it can be expected that large firms thrive when it comes to keeping up in the automotive technology race but to be less enhanced by exposure to competition than are their smaller rivals, which would simply imply:

H9a: Prior exposure to competition when a firm is small reduces its failure rate more than does prior exposure to competition when the firm is large

H9b: A firm's exposure to competition increases the strength of its rivalry, especially when this exposure happens to a small firm.

DATA AND METHOD

Data

The research design used in the analyses of this essay is generally referred to as a population study (Carroll and Teo, 1996). Instead of extracting a sample, a dataset comprising all automobile manufacturers ever known to compete in the U.S. automobile market from 1895 to 2000 is examined. 1895 is regarded as the beginning of the U.S. automobile industry by many researchers (e.g., Dobrev et al. 2002, Carrol and Teo, 1996) whereas 2000 is the latest year covered by the major data sources utilized in this essay. Individual fates of all firms are traced during this period to test the proposed hypotheses about the drivers of organizational mortality. Complete coverage of 106 years enables precise analysis of how Red Queen competition affects the industry in general and the competing firms in particular. Moreover, it also allows testing of hypotheses without assuming temporal equilibrium (Carroll and Teo 1996).

Longitudinal population design is a *conditio sine qua non* for robust investigation of the dynamics of Red Queen competition since the in the core of the analyses is the competition based on innovation, which necessitates the observation of innovations for a long time to be able understand the real gains from them. Specifically, in Red Queen competition, it is postulated that any competitive move (for this essay, an innovation) will not only increase the likelihood of "death" for some firms in the population, but also will cause actual "deaths." However, the remaining firms (i.e., those who could survive the detrimental impact of the innovation) will react to that innovation with their own innovations and the competition will continue until there is only one firm to survive. Hence, it is only with a longitudinal population study that those dynamics, along with their impacts on organizational mortality events, can be observed.

While the data for the analyses are derived from multiple sources, the most comprehensive information is attained from a three-volume encyclopedic source that provides authoritative coverage, well-known to myriad of researches and innumerable automobile enthusiasts worldwide: the Standard Catalog of American Cars. As useful as they are Standard Catalog of American Cars, by definition, do not have any information about the import cars in the U.S. automobile market. The major data source for import cars is the Standard Catalog of Imported Cars. Along with these major data sources, supplementary data are derived from the New Encyclopedia of Motor Cars (Georgano and Andersen 1982), World Guide to Automobile Manufacturers (Baldwin et al. 1987), and Automotive News (1993).

Data in these sources are organized by automobile makes (i.e., brands) or model rather than by firms. Since a) some of the firms manufacture cars under various brands (e.g., Toyota Motor Corporation produces under Lexus, Toyota, and Scion makes), and b) the unit of analysis is firm survival for this essay, the data for all of a firm's various makes are aggregated across time. For example, General Motors currently produces automobiles under various makes (i.e., Buick, Cadillac, Chevrolet, Pontiac, Saab and Saturn. During the observation period of 1895-2000, GM also produced cars under other discontinued makes: Cartercar, Elmore, Ewing, LaSalle, Marquette, Milburn, Oakland, Oldsmobile, Rainier, Scripps-Booth and Welch (Carroll and Teo 1996). Therefore, for each year since the General Motors was founded (i.e., 1908), the data for different makes for General Motors for a given year is aggregated to create single entry for General Motors.

Further, the data sources contain information about of automobile production rather than the complete lifetimes of firms, which might have entered the U.S. automobile market *de alio* (i.e., with a diversification from another market) or exited from the market but still continued its operations in another industry. Any information pertaining to the "alternative" creation and destruction of firms is taken into account while preparing the dataset.

This data collection effort yielded a total of 2,256 firms competed in the U.S. automobile market in the period of 1895 – 2000. Most of the firms in the dataset are rather small, short-lived ones that produced progressive automobiles which stimulated innovation in the industry.

Variables

Dependent variable: exits from the competition:

Firms exit from the competition in the U.S. automobile industry in various ways. First, a firm may be disbanded indicating that the firm failed to compete with its rivals in the industry. Second, a firm may exit to another industry, which again suggests a lack of success. Third, a firm may merge with, or acquired by, another firm (Dobrev et al, 2001). While mergers and acquisitions may indicate a failure of a firm, and result in the exit of one or more firms from the competition, they occur for a variety of reasons. As Dobrev et al (2002) point out, owners of an unsuccessful firm may choose to recover their loss by selling the firm or sometimes a firm's potential to be successful may be realized by some other firms which may acquire, or merge with, that firm. While the acquisition of Skoda by Volkswagen Group is an example for the latter driver of mergers and acquisitions, some of the other acquisitions that occurred in the IT industry in recent times also set good examples as well like Google Inc.'s acquisition of DoubleClick in March 2008 for US$ 3.1 billion, which develops Internet ad serving services and Microsoft's acquisition of Hotmail in 1997. In sum, due to the ambiguity of the motivation behind a lot of mergers and acquisitions, the analyses of this essay are based on disbanding and exit to another industry. Following Dobrev et al. (2002) and many others (Carroll and Teo 1996; Dobrev and Carroll 2003; Dobrev et al. 2003; Hannan et al. 1998a; Hannan et al. 1998b; Hannan et al. 1995) (firms that are known to have exited the industry by any other reason (e.g., merger, acquisition, etc) are treated as right-censored at the times of those events.

Independent variables:

Extensiveness of innovation: This variable is operationalized based on the classification of by Abernathy et al. (1983), who provide a chronological listing of product and process innovations that could be used to gain better sense of the impact of new technology on competition. Utilizing various sources, Abernathy et al. (1983) compiled an extensive firm-specific chronological list of innovations for the period of 1893 – 1981. Specifically, Abernathy et al. (1983) list, and weight on a 7-point Likert scale, 631 innovations that can be used for the analyses. However, 26 of those innovations are excluded from the analyses since they are attributed to component suppliers.

As this essay covers a broader observation period (i.e, 1895- 2000) and includes non-U.S. automobile companies that compete in the U.S. market in the given observation period, further data collection is performed. A comprehensive list of innovations that have been introduced by the U.S manufacturers for the period of 1982-2000, as well as the innovations by non-U.S. manufacturers has been gathered from various sources including, but not limited to, the books about individual company histories, press releases, periodicals about the automobile industry (e.g., Automotive News), and industry experts. After gathering the list of the innovations, expert opinions are used to weight them on a 7-point scale, with painstaking emphasis on the alignment of this weighting with that of Abernathy et al.'s (1983). This data collection effort yielded 126 innovations for the period of 1982 – 2000.

Innovations for the period of 1895 – 2000 are matched with the corresponding firm-year and used to operationalize the time-varying extensiveness of innovation construct, which is used to test hypothesis H2. For other hypotheses about the innovation (i.e., H1 and H3), a dummy variable that takes the value of 1 when a firm introduces an innovation and the difference between the extensiveness of an innovation and the average industry level of innovativeness are used respectively.

Niche overlap: Niche overlap has been operationalized with a two-step process. First, following Dobrev et al. (2002) niche width of each firm is defined using the range of engine capacity in horsepower across all models produced by each firm at any given point in time. Second, niche overlap is for all the firms by counting the number of competitors whose niche widths intersect with the focal firm. For instance, French automaker Peugeot, offered engines with the horsepower values of 71, 80 and 97 in 1984, so its niche width is defined as 71 – 97. In the same year, Japanese automaker Mitsubishi offered engines with the horsepower values of 88, 116, and 145, which makes its niche width 88 – 145. Since the niche width values of Peugeot and Mitsubishi intersect for the year 1984, the niche overlap value for those firms is increased by 1 for that year.

Lag load: Lag load is operationalized in two different ways for hypotheses H5a and H5b, where the effects of absolute and relative lag loads are tested respectively. For operationalization of absolute lag load for a firm (i.e., for H5a), the number of years since its last innovation is used. For instance, according to Abernathy et al. (1983), Hudson introduced sliding bench seat in 1922 and did not introduce any other innovations until the starter button on dash in 1925. Therefore, Hudson's absolute lag load is 1 for 1923, 2 for 1924, and is reset to zero in 1925.For the relative lag load, annual innovativeness average for the industry is calculated taking into account the extensiveness levels of all the innovations introduced in a given year as the first step. Then, the difference between the extensiveness of the firm's innovation and the annual industry average is calculated for the given year. Then, this difference is cumulated annually over the lifespan of the firm.

Age: While calculating the age of a firm, its tenure in the automobile industry, rather than its organizational age is used. Stated differently, for a *de alio* firm, the age count is started when that firm extends its operations to the automobile industry, regardless of how many years that firm existed before (Klepper 2002). For *de novo* firms in the automobile industry organizational age and tenure in the industry are, by definition, equal. Tenures in the automobile industry can be calculated straightforwardly when the sources provide exact or near exact dates for the commencement of operations. Unfortunately, sources used in this study contain different degrees of precision for dates. Sometimes, exact date for initiation is available whereas, at some other times, only the month and/or the year are provided. Following Hannan et al. (1998a), in this essay all of the information about timing will be converted into decimal years so that the analyses will be tractable. Dates given only at the year level will be coded as occurring at the midpoint of the year. In this case, the starting time for a firm is coded as the middle of the first year and by the end of the midpoint of the next year, firm is given a completed tenure of 1 year. These rules, which are consistent with Petersen's (1991) recommendations for dealing with the problem of time aggregation (Dobrev et al. 2002), are used to handle all of the similar cases encountered during the coding process.

Size: Following Hannan et al (1998a), the size of the firm is measured as the scale of operations, specifically the firm's annual sales of automobiles for the given firm in a given year. This operationalization is not only available more regularly than accounting-based performance measures (e.g., net profit, return on equity, etc) but also is more reliable in such a population study in which firms from various countries using different accounting principles, are included in the same dataset. For firms for which some but not all information on capacity could be found, the missing years are be interpolated as Carroll and Teo (1996) show that interpolation does not have great effects on findings. To test hypotheses H10a and H10b (i.e., the hypotheses about the competitive history), a categorical measure that distinguishes between large and small firms is used. This time-varying categorical variable is updated annually using archival sources, which list major competitors in the U.S. automobile industry each year.

Population-level learning: Following Ingram and Baum (1997b), this variable is operationalized by the count of failures in the industry. For instance, the withdrawal of Alfa Romeo from the U.S. market in 1995 will increase the population-level learning by 1 point.

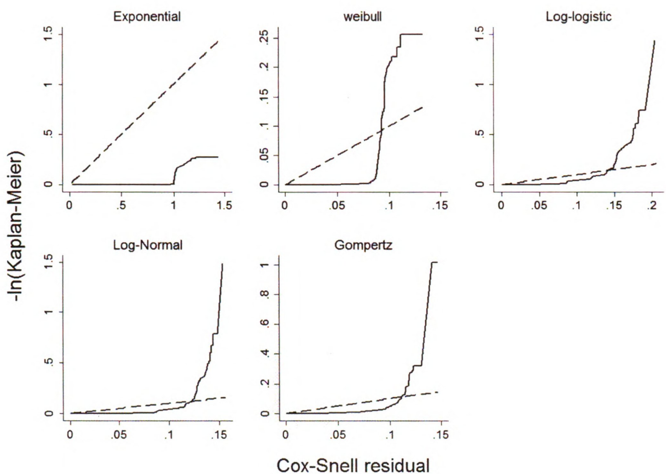
Competitive experience: Following Barnett and McKendrick (2004), this variable is operationalized as a categorical variable that distinguishes between large and small firms competing in the U.S. automotive market. This categorical variable is defined for each firm relatively for each year the firm competed in the market and updated annually. This designation is made by examining historical documents like the Standard Catalog of American Cars (Flammang and Kowalke 1999; Gunnell 1982; Kimes 1996), Standard Catalog of Imported Cars, the New Encyclopedia of Motor Cars (Georgano and Andersen 1982), World Guide to Automobile Manufacturers (Baldwin et al. 1987), and Automotive News (1993).

Model Specification and Estimation

The available theory in organizational ecology literature in particular and social sciences in general do not necessarily provide guidance to choose one parametric model over another in event history analysis. Therefore, it is of crucial importance to empirically check the adequacy of the models upon which the inferences are based. While using likelihood ratio tests as a tool for comparing goodness-of-fit of alternative models is a common way of doing this, the fact that they are limited to nested models necessitates an alternative approach for the evaluation and comparison of alternative parametric assumptions. Following Blossfeld et al. (2007), pseudoresiduals (a.k.a. generalized residuals) suggested by Cox and Snell (1968) are used to evaluate distributional assumptions.

Cox-Snell residuals of the same model are generated for different distributions (i.e., Exponential, Weibull, Log-logistic, Log-Normal, and Gompertz). If a model fits the data, Cox-Snell residuals should have standard exponential distribution. To check this, an empirical estimate of cumulative hazard function via Kaplan-Meier survival estimates are calculated as the first step then plotted cumulative hazard against the Cox-Snell residuals with each distributional assumption. The plots should approximate a straight line in order to indicate a good fit of the model to the data (Figure 1.1).

Figure 1.1 Graphical Check for Pseudoresiduals .
Plots of Logarithm of Survivor Functions of (of Residuals) vs. Residuals for Essay 1



As it is presented in Figure 1.1, for none of the distributions, the conditions stated above are satisfied. This was no surprise as the extant organizational ecology literature has no study that has a hazard function similar to any of those distributions stated above. Therefore, I used discrete-time event history analysis, for which postestimation analyses indicated very strong fit of the model to the data. The hypotheses of this essay are incorporated into the discrete-event hazard rate model presented below:

$$\log\left(\frac{\lambda_i}{1-\lambda_i}\right) = \begin{bmatrix} \beta_1 I_j + \\ \beta_2 AEI_j + \\ \beta_3 REI_j + \\ \beta_4 NO_j + \\ \beta_5 ALL_j + \\ \beta_6 RLL_j + \\ \beta_7 AGE_j + \\ \beta_8 PC_j + \\ \beta_9 PC_j * AGE_j + \\ \beta_{10} SIZE_j + \\ \beta_{11} FAIL_t + \\ \beta_S E_{Sj} + \beta_L E_{Lj} + \alpha_S\left(\sum_{Sk \neq j} E_{Sk}\right) + \alpha_L\left(\sum_{Lk \neq j} E_{Lk}\right) \end{bmatrix}$$

In this model, I_j is a dummy variable equal to 0 until firm j introduces an innovation I at time t. AEI_j is the absolute extensiveness of the innovation of firm j, whereas the REI_j is the relative extensiveness of that particular innovation. NO_j represents the number of firms with which the innovator firm's niche overlaps at given year t. ALL_j and RLL_j represent the absolute and relative lag load values form firm j respectively. AGE_j and PC_j represent the age of the firm j and the competition it experienced since it was founded, respectively. $SIZE_j$ is the total number passenger cars sold by the firm j in year t. $FAIL_t$ represents the total number of withdrawals (i.e., the population learning) from the U.S. market until the year t. The last line of the model is for testing the hypotheses H10a and H10b. Specifically, E_{Sj} refers to firm j's prior competition experienced at times when it was a small firm, and E_{Lj} is j's prior competitive experience during times when it was a large firm. Similarly, E_{Sk} and E_{Lk} represent the prior competitive experience of j's rivals k, distinguishing between competition experienced when these rivals were small or large organizations, respectively. Specifically, $\beta_S < 0$ and $\beta_S < \beta_L$ will indicate a support for H10a, whereas, $\alpha_S > 0$ and $\alpha_S > \alpha_L$ will indicate support for H10b.

RESULTS

Table 1.1 presents the descriptive statistics of the variables included in the analyses and Table 1.2 presents the results of discrete-time event history analyses. Model 1 verifies the findings in the extant literature that innovations decrease the exit rates (Bygrave and Timmons 1992; Carroll and Teo 1996; Klepper and Simons 2000; Podolny and Stuart 1995; Roberts 1999; Schumpeter 1934). It is also found that there is a negative relationship between the extensiveness of innovation and the exit rates, suggesting radical innovations more likely to increase the survival likelihood when compared to incremental innovations. Last, but not least, the negative and statistically significant coefficient of the "relative extensiveness of innovation" variable suggests similar a similar relationship. All these findings of Model 1 confirm the ideas already established in the innovation literature and, by doing so, validate the dataset as well.

Model 1 is extended to include the “absolute lag load” variable in Model 2. A positive relationship between absolute lag load and exit rate of a firm is found. Absolute lag load represents the innovativeness of a firm, which is captured as the time between two consecutive innovations of the firm, without any regard to the competition. This finding suggests that in Red Queen competition, the advantageous position in the competition attained by an innovation is short-lived; therefore firms need to continuously innovate to be able to maintain survival and competitive advantages.

In order to unveil more insights about the relationship between the lag load, extensiveness of innovation, and firms’ likelihood of survival, another model (i.e., Model 3), into which “relative lag load” is incorporated, is tested. Relative lag load represents innovativeness of a company with regard to its competition. Stated differently, relative lag load is the measure of the extent to which a firm compares to its competitors in terms of innovativeness. Model 3 reveals a significant positive relationship between the relative lag load and the exit rate, suggesting that lag load is detrimental for companies when the pace of innovativeness in an industry is also taken into account. Moreover, it is also found in Model 3 that when the effects of lag load are taken into account (i.e., absolute and relative lag loads), the relationships between innovation variables and the exit rates become insignificant.

Table 1.1: Descriptive Statistics for Essay 1

Variable	Minimum	Maximum	Mean	Standard Deviation
Innovation	1	6	0.091	0.427
Absolute Extensiveness	0	22	0.195	1.027
Relative Extensiveness	-7.5	21.862	-0.003	1
Niche Overlap	0	358	83.121	79.071
Absolute Lag Load	0	91	10.225	4.342
Relative Lag Load	-21.391	253.046	3.841	25.087
Firm size	-2.31	16.249	13.989	2.142
Population Learning	0	2119	1255.231	251.994
GNP	10.4	9,817	1293.098	2337.241

After unveiling the importance of competition on innovativeness on the likelihood of survival in the industry, Model 4 is developed to delve further into the relationship between the competition, innovation, and exit rates. The results of the discrete-time survival analysis suggest no significant relationship between the past rivalry experience and the exit rates. As such past rivalry does not moderate the relationship between relative lag load and likelihood of survival, either. In this model, the effects of the competitive experiences of both the focal firm and its competitors are incorporated into the model to test the hypotheses H9a and H9b. Results reveal that firms that are exposed to competition when they are small are more likely to survive than those who gained competitive experience when they were large. On the other hand, results also show that competitors, which experienced more competition when they were small, increase the failure probability of the focal firm. These results not only suggest that selection pressures a firm faces due to its competitors are more intense, if the competitors learned to compete when they were small, but also show that competitive experiences of the rivals does not have any impact on the likelihood of survival of the focal firm if those experiences are gained when the rivals were large.

Model 5 shows the results of a complete model specification which tests all of the hypothesized relationships. Similar to Model 3 and Model 4, it is found that neither the innovation-related variables nor the rivalry-related variables have no significant impact on exit rates and both lag load variables significantly increase the exit rates.

Table 1.2: Estimation Results for Essay 1

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Innovation	-.895**	-.923*	-.704	-.673	-.278
Abs. Extensiveness	-.445**	-.478*	-.179	-.183	-.752
Rel. Extensiveness	-.805**	-.796**	-.013	-.022	-.043
Niche Overlap					.005
Abs. Lag Load (A-LL)		.039**	.012*	.014*	.011*
Rel. Lag Load (R-LL)			.059**	.060**	.062**
Past rivalry				.003	.001
Past rivalry & R-LL				.008	-.004
Firm size					-1.170**
Firm size & R-LL					.011**
Population Learning					.004**
Small firm's competitive experience				-.003**	-.002**
Large firm's competitive experience				-.001	-.001
Small competitor's competitive experience				.005*	.001
Large competitor's competitive experience				-.002	-.001
GNP	-.004**	-.004**	-.003**	-.002**	-.001**

Therefore, hypotheses H1, H2, H3, H6a, and H6b are not supported, whereas H5a and H5b are supported. It is found that the niche overlap has no significant impact on the likelihood of survival, therefore hypothesis H4 is not supported. On the other hand, results of Model 5 lend support to hypothesis H7a. Specifically, it is found that larger firms are less likely to exit the industry. However, moderating effect of the firm on the relationship between lag load and exit rates is found to be positive and statistically significant, hence H7b is rejected. Population learning is found to be detrimental for the firms as well. Specifically, it is found that as the amount of learning in the population learning increase, the firms are more likely to exit the industry. Similar to Model 4, the effects of the competitive experiences of both the focal firm and its competitors are incorporated into the model. Results reveal that firms that are exposed to competition when they are small are more likely to survive than those who gained competitive experience when they were large, indicating support for H9a. However, in this model, the competitive experiences of rivals turned out to be insignificant, be them gained when they were small or large. Therefore hypothesis H9b is not supported in Model 5.

GNP, which is included in all of the models to control for the effects of the overall economic welfare in the U.S., is found the decrease the exit rate in all models. Summary of the findings of Model 5 are presented in Table 1.3.

Table 1.3: Summary of Results for Essay 1

Hypothesis	Result
H1: Each innovation by a firm will increase its chance of survival.	Not Supported
H2: In absolute terms, the more radical a firm's innovation (i.e., ignoring competitors' innovations), the greater the innovating firm's chances of survival	Not Supported
H3: In relative terms, the more radical a firm's innovation (i.e, relative to competitors' innovations), the greater the innovating firm's chances of survival	Not Supported
H4: Competitors whose niches overlap more with the innovator firm will face a decrease, albeit temporary, in their survival chances, compared to other firms	Not Supported
H5a: The more a firm lags in introducing innovations, the lower its chances to survive	Supported
H5b: In relative terms, the more a firm lags in introducing innovations (i.e., with regard to its competitors) , the lower its chances to survive.	Supported
H6a: The more rivalry a firm has experienced in the past, the lower its chances to survive	Not Supported
H6b: The more rivalry a firm has experienced in the past, the less likely it is to have "lag effects"	Not Supported
H7a: The larger the firm, the more likely it will be to survive	Supported
H7b: The larger the firm, the less likely it will be to be affected by "lag effects"	Supported
H8: As the population-level learning increases, the positive impact of innovation on the survival chances of the firm will diminish.	Supported
H9a: Prior exposure to competition when a firm is small reduces its failure rate more than does prior exposure to competition when the firm is large	Supported
H9b: A firm's exposure to competition increases the strength of its rivalry, especially when this exposure happens to a small firm.	Not Supported

DISCUSSION

The primary objective of this essay is to provide evidence of the Red Queen evolution in the relationship between of innovations and firm survival. The extant literature comprises a myriad of studies analyzing the benefits and costs of innovations. On the one hand, Tushman and Anderson (1986a), Banburry and Mitchell (1995); Klepper and Simmons (2000) and many others report that innovators enjoy significant competitive advantages over non-competitors On the other hand, Carroll and Teo (1996), Barnett and Freeman (2001) and many others emphasize the negative aspects of innovations that innovations are not only costly, but also may change the organizational structure, both of which reduce the survival chances of a firm.

This study approaches the survival effects of innovations from a different perspective: Red Queen Competition. Following Barnett and Hansen (1996), it is suggested that the actual impact of an innovation, be it positive or negative, on the survival chances of a firm can only be understood by accounting for the "reciprocal system of causality" in the competition, known in the evolutionary biology as the "Red Queen" (Van Valen 1973). Leigh Van Valen (1973), using the metaphor of an evolutionary arms race to describe the dynamics of evolutionary processes with, proposed the Red Queen's Hypothesis as an explanatory tangent to his proposed Law of Extinction (also 1973) Van Valen, based on the idea that the ability of a family of organisms to survive does not improve over time, suggests that every improvement in one species provides a selective advantage for that species over other species in the environment, since in most of the ecosystems, different species co-evolve. This advantage will enable the" innovator" species to capture a larger share of the resources in the ecosystem, suggesting that the fitness increase in one evolutionary system (e.g., a species) will tend to lead to fitness decrease in another system (e.g., another species). One of the most common example of this "arms races" pertain to between predators and prey (e.g. Vermeij, 1987), where the only way predators avoid extinction due to a better defense developed by the prey (e.g. rabbits running faster) is by developing a better offense (e.g. foxes running faster).

Based on this view, it is argued that innovation and competition are linked causally, each stimulating the other in the continuous process of Red Queen evolution in that the survival advantages attained by an innovation should be evaluated with regard to other innovations in the industry. For instance, the first application of the modern cruise control system (also known as a speedostat) was on Chrysler Imperial in 1958. This innovation, invented in 1945 by the blind inventor and mechanical engineer Ralph Teetor, whose idea was born out of the frustration of riding in a car driven by his lawyer, who kept speeding up and slowing down as he talked, increased the survival chances of Chrysler. However, this advantage was only temporary since General

Motors started offering the same system on all Cadillac by 1960. Therefore, relative to its rivals, then, a survival chances of a firm may appear unchanged *proviso quod*, the competitors requite the innovation by developing the identical innovation themselves or by introducing another innovation, hence the reference (made initially by the biologist Van Valen, 1973) to the Red Queen from Lewis Carroll's Through the Looking Glass, who explains to the running Alice why her position remains stable relative to others who also are running: "Here, you see, it takes all the running you can do, to keep in the same place."

Results of the analyses provide support for the Red Queen competition among the manufacturers in the U.S. automobile industry. Specifically, it is found that firms which can keep up with, if not outrun, the pace of innovation in the industry, are less likely to fail. Lag load, as defined in this essay as the degree to which a firm lags behind the innovations in the industry, has been found to be a significant determinant of firm survival to the extent that the positive and significant impacts of introducing innovations have been suppressed by the impact of lag load. This finding supports the main idea of the dissertation that it takes all the running a firm can do just to remain industry. Specifically, in tandem with the extant literature, it is first found that innovativeness, along with the extensiveness of innovations, are diagnostic in firm survival when other factors are discounted. However, when Red Queen competition is taken into account, those factors become insignificant.

Results also suggest that larger firms are less like to fail in the industry, which has been a well documented relationship in the organizational ecology. Lower mortality rates for large organizations can be attributed to various reasons. From political sociology perspective, larger firms receive favorable treatment from regulators and government officials due to the welfare effects they generate because of the larger numbers of their employees (Dobrev and Carroll 2003; Hannan et al. 1998a; Hannan and Freeman 1977). Stated differently, large firms are "consequential actors" that affect policy makers, through their connections in influential positions (Barnett and McKendrick 2004). Institutional economists larger firms have a better opportunity to exploit several technical and financial advantages through the rationalization of production, innovation, and transactions (Barnett and McKendrick, 2004). Industrial firm economics associate large firms with scale economies, which provide them with structural advantages including internal efficiency and leverage in their interactions with their customers and suppliers (Dobrev and Carroll, 2003) and scale economies not only provide competitive advantage by decreasing overhead costs, but also cause horizontal expansion of firms, which in turn, enables the firms to reap the benefits of economies of scope. Moreover, large firms in an industry have the power to manipulate their environments to effect other organizations and to reduce competitive threats (Barnett and McKendrick, 2004). Milgrom and Roberts (1990) argue that large firms can attain and sustain competitive advantage by combining the separate capabilities within the firm in a way to extract more value collectively than the sum of the values of those very same capabilities used separately. Large firms have also been found to more innovative (Dobrev and Carroll, 2003) and their innovations are more likely to have an impact since these large firms are more likely to benefit from context externalities due to their positions in the industry (Sorensen and Stuart, 2000). Hannan and Freeman (1984) argue that large firms are more likely to survive with regard to their competitors with smaller size, due to the fact that structural inertia, which is positively related with firm size, renders the firms more reliable, and hence less likely fail. Therefore, large firms are expected to have survival advantages over their competitors.

Results also reveal that population level learning increases the exit rates. Firms try to benefit other firm's experiences to improve their own competitiveness and as suggested by Ingram and Baum (1997), if applied properly, the experiences of other firms in the population may really prove beneficial for a firm. The best and the worst practices of a firm in the population can be learned via different media outlets, attending trade shows, hiring employees from that firm, listening to lectures and these practices may help the firm improve its own competitiveness. Therefore any firm ever to compete in an industry, either its failure or by its survival, provides the other firms in the competition with a know-how to improve their operations. As each firm in the competition increases its efficiency, overall level competition in the population will intensify, putting more selection pressure on the remaining actors. As such, failures in an industry are one of the most powerful stimulants of firm- and population-level learning (Ingram and Baum, 1997) since they are usually paid close attention by other firms and firms that try to learn from others' failures can benefit from them (Ocasio 1997). Failures may also induce a shock to the other firms in the industry, thereby modifying the extant rules and procedures to the extent that those changes catalyze the transformations on a larger scale. While some of those changes and new *modus operandi* might prove beneficial for some organizations, they are also detrimental for some other firms, even for those that have been actively involved in the transformation process, in the population who fail to adapt to the new dynamics in the industry.

Last, but not least, it is found that firms which were exposed to competition when they were small are not only more likely to survive, but also able to exercise stronger selection pressures on their competitors, suggesting support for Red Queen competition. The widely discussed competitive advantages of large firms make them less responsive to competition, such that they invest more on keeping the *status quo* in the competition, rather than changing its dynamics (Banbury and Mitchell 1995; Christensen and Bower 1996; Christensen and Rosenbloom 1995; de Figueiredo and Kyle 2001; Henderson 1993; Henderson and Clark 1990; Tushman and Anderson 1986a) whereas according to the Red Queen competition, ceaseless improvement and continuous efforts to the changing environment are consequential for an organism just to maintain its extinction, or likelihood thereof, relative to the systems it is coevolving with (Van Valen 1973). While the results of this essay by no means suggest that large firms do not implement various practices to fit to their environment, as it is suggested by Lewitt and March (1988), they may do so via routines they have learned in the past, which may become dated and useless as the firms in the competition co-evolve over time. Therefore, it can be expected that those routines which helped those firms become strong competitors in the past, may become detrimental under new dynamics of competition a phenomenon also known as the "competence trap". This competence trap may lead the firms to disregard the probability that new routines have rendered the competition utterly different than it used to be (Barnett and Hansen 1996). The results of this essay suggest that firms are more likely to develop adaptive routines and organizational culture if they are exposed to strong selective pressures when they are small. Those routines will be ossified as the firm gets larger, and hence rendering the firm more adaptive to Red Queen competition.

ESSAY 2: PRODUCT-LEVEL DYNAMICS OF INNOVATION AND SURVIVAL: EVIDENCE FROM U.S. AUTOMOBILE INDUSTRY, 1946-2000

INTRODUCTION

Much of the management research in population ecology explicitly adopts a firm-level perspective, explaining population level change as the accumulation of foundings and failures of relatively inert firms (Baum 1996). This perspective has been criticized by management theorists who argue that significant change might also occur within firms (Barnett and Burgelman 1996). Firm-level selection is also challenged by evolutionary theorists who identify the difficulty of applying selection arguments to groups of autonomous agents (Campbell 1994). Fundamental justification for examining evolution at a "sub-firm level of analysis" is that identifiable components of firms may experience evolution independently of the firm as a whole (Ingram and Baum 1997b; Ingram and Baum 1997c). In today's business context various types of multiunit firms have become increasingly common (Baum and Singh 1994a; Baum and Singh 1994b). Large conglomerate firms buy and sell companies frequently through processes of acquisition and divestiture (e.g., acquisition of Chrysler Corporation by Daimler-Benz in 1997). International consumer goods producers create national subsidies that may then be dissolved or spun off. Large retail chains create or acquire, and then sell or close, stores or even whole divisions. Even vertically integrated firms (e.g., automobile manufacturers) close or divest components that may then be operated independently or become parts of other firms (e.g., GM's spun off its major supplier Delphi). These operations bear ramifications whose impacts reach far beyond the firm boundaries and are manifested quite dramatically at the population or industry level (Ingram and Roberts 1999). The selection forces that are observed in sub-organizational components of a nested hierarchical system, therefore, drive not only the evolution of a firm in particular, but also antecede the evolution of industries in general as well.

Ingram and Roberts (1999) provide the following example from the U.S. pharmaceutical industry (Table 2.1). They report that in the period of 1946-1991, roughly 1200 novel drugs have been introduced to the market, each of which attracted a large number of imitative offerings, rendering the total number of new products over this period a considerably higher number. Evidently, the evolution of drug products produced within this industry is a reasonable metric for the state of economic activity in the industry. Ingram and Roberts (1999) argue that the evolving portfolio of products determines the profitability of a pharmaceutical firm, with high profits associated with newer and more innovative drugs. Besides, the specific cadre of drugs offered at any point in time affects the efficacy and cost effectiveness of the state-of-the-art medical treatment (Ingram and Roberts

1999). With this particular interest in the evolution of products within this industry, the question becomes the extent to which the pattern of evolution might be captured by focusing on firm-level foundings and failures.

Table 2.1: Firm-level Origins of Product Introductions and Removals in the U.S. Pharmaceutical Industry, 1977 - 1993

	Products in 1977	**Introductions**	**Removals**	**Products in 1993**
Existing products	2894			
Product introductions by firms that existed previously		1896 (94%)		
Product introductions by new organizations		124 (6%)		
Product removals by organizations that continued to exists			710 (79%)	
Product removals by organizations that ceased to exists			147 (16%)	
Product removals by organizations with unknown fates			43 (5%)	
Totals	**2894**	**2020**	**900**	**4014**

SOURCE: IMS America. Adopted from Ingram and Roberts (1999)

Table 2.1 shows the independence of product-level incidents (i.e., the introductions and removals) from relevant critical incidents at the firm level (i.e., foundings and failures) via distinguishing between the product-level events with regard to their relationship with firm-level events. According to the table, as presented by Ingram and Roberts (1999), in the U.S. pharmaceutical industry, 2020 new products were introduced in the between 1977 and 1993. Merely 124 (6%) of these new products were introduced new firms (i.e., those founded in the same year that the product appeared) whereas the remaining 1896 were introduced by firms that have been founded before the time of introduction. Besides, of 900 products removed within the same period, only 147 (16%) co-occurred with the disbanding of their developer firms. In the remaining removals, the firm that had introduced the product continued to exist after its removal. In sum, while the U.S. pharmaceutical industry experienced 2920 product-level critical events between 1977 and 1993, only 271 (9%) co-occurred with firm-level critical events. Therefore, this table lend support to the postulation that the large majority of product-level change might be independent of firm-level change. All in all, this example indicates the extent to which significant change at the industry level is missed by analyses focusing on critical events at the firm-level.

This study builds upon the example from the U.S. pharmaceutical industry above and attempts to analyze product-level survival and competition in the U.S. automobile industry. Stated differently, this essay is an attempt to answer the question "why are some products more successful than others?" The extant marketing literature puts forth a myriad of reasons as to why some products are more profitable than others, as well as why some products that were once successful are no longer so. The first stream of literature links this co-evolution to the accelerating competition and posits that as time progresses, an increasing number of firms and products enter the market, thus stimulating competition and pushing down the profit margins. As a result, a firm that could once enjoy monopoly in a market or market niche now has to struggle with many competitors; a process which not only erodes the firm's market dominance, but also oppresses prices and profits (Carroll 1985; Stavins 1995). It is also argued that a firm's own products may cannibalize its other products. Albeit an unintended consequence, for firms offering multiple product lines it is next to impossible to optimize its product portfolio to entirely eliminate cannibalization (Greenstein and Wade 1998; Schmalensee 1978). Economies of scale and fixed costs are the main thrusts of another conceptualization of product failures. In particular, it is suggested that significant fixed costs, renders the scale of production consequential as a way of distribute fixed costs across more units, thereby reducing per unit costs. Selection pressures due to economies of scale put the products of small firms into severe survival risks (Stigler 1968). Yet another stream of extant literature posits product improvements, rather than high fixed costs, as the driver of product failures. Specifically, it is suggested that firms learn or acquire capabilities that helps them to consistently improve their products. Firms that are unable to dynamically improve their learning or capabilities over time will find their products uncompetitive (Jovanovic and Lach 1989; Jovanovic and MacDonald 1994; Klepper 1996; Klepper and Simons 2000; Levinthal 1997; Sitkin 1992; Teece 1986; Teece and Pisano 1994). This work focalizing on product innovation submits that firms have to invest in research and development activities in order to push down costs (Abernathy and Utterback 1978; Klepper 1996). On the other hand, based on Red Queen evolution, it can also be argued that if firms come up with product innovations they can enhance the quality, attributes of their products in an attempt to better meet the needs of their customers. If not, their products will be weeded out by more innovative products (Christensen 1997; Christensen and Bower 1996; de Figueiredo and Kyle 2001; Gort and Klepper 1982; Klepper 1996).

Compellingly, while various disparate streams in the extant literatures have demonstrated the relevance and significance of product level competition, there has not been an integrative study that conceptualizes these factors and analyzes product-level competition and survival. Most of the relevant studies have analyzed the dynamics of firm-level competition and survival (Barnett and McKendrick 2004; Baum and Singh 1994c; Baum and Singh 1994d; Cefis et al. 2005; Christensen 1997; Ghemawat 1991; Ghemawat and Nalebuff 1985; Hannan and Carroll 1992; Henderson 1995;

Jovanovic and Lach 1989; Jovanovic and MacDonald 1994; Klepper 1996; Schumpeter 1942; Tushman and Anderson 1986a). Nevertheless, as it evident that the processes that drive firm-level competition and survival (e.g., organizational ecology) have their micro-foundations in product-level dynamics, to better comprehend survival at firm level, we must understand what is happening at the product level, and how competition among products influence product entry, exit, and profitability outcomes.

The apathy of the scholarly inquiry on the dynamics of product level competition has also been criticized in the marketing literature (Henard and Szymanski 2001; Henderson 1983; Hoffman 2000; Milne and Mason 1990; Saunders et al. 2000; Walley 1996). While the success of any marketing strategy will depend largely on the competitive analysis on which it will be based, as Henderson (1983) argues "...present concepts of competitive analysis in marketing are almost useless. There is no logic or conceptual framework that serves as the basis for understanding the consequences of potential alternatives for intervention into a dynamic system" (p.7). Drawing exclusively on the basic principles of competition among species, he urges marketing scholars to put the coevolutionary dynamics of competition under scrutiny. With its focus on product-level competition, and emphasis on Red Queen dynamics, this study is an attempt to respond to a long-time disregarded call.

So, why are some products more successful than others? This essay attempts to answer this question by developing a model based on Red Queen evolution. Hypotheses are tested using a comprehensive dataset covering every model introduced into the U.S. automobile industry since its revival after the World War II. Using discrete-time event history methodology, this study postulates three answers to this question. First, it is suggested that innovations help products remain in the market. Second, competition diminishes the survival benefits of innovations. As such, products which fail to innovate to adapt to the dynamics of competition will be weeded out of the market by the "selection" forces of competition, which is on the most part stimulated by the innovations of other products. Besides, competition by itself is an important factor in making products more competitive, in the sense that the products that learn to cope with competitive effects in the past, are more likely to survive in the future. Third, an innovation will increase the survival chances of a product only temporarily, as the competing products, which could survive the competitive impact of that innovation, are the strong ones and they will strike back, intensifying the competition.

THEORY AND HYPOTHESES DEVELOPMENT

Extensiveness of innovation

As explained in the hypotheses development section of the Essay 1 (p. 6), product innovation helps firms obtain a closer alignment with their environment; hence it is reasonable to expect that products that are constantly innovated will have a better chance of achieving, or retaining, fitness to the continuously evolving environment than those that do not. Following Barnett (1997), it is proposed that this fit can be observed in two distinct, albeit related, product performance outcomes: improved viability and enhanced competitiveness. Specifically, products with greater innovation outcomes should survive longer, because they are better able to address the demands of environmental actors, such as consumers, suppliers, alliance partners, and governmental agencies, than those with fewer innovation outcomes (Carroll and Teo 1996; Christensen and Rosenbloom 1995; Dowell and Swaminathan 2000; Freeman and Soete 1997). Therefore, it is possible to predict the following:

H1a: A product innovation increases the chance of product survival.

H1b: The more extensive the innovation of product, the higher the chances of product's survival.

H1c: In relative terms, more extensive product innovation (i.e., relative to its competitors), the higher the chance of product's survival.

Lag load

As argued before, the outcomes of product innovation may bring significant benefits via increasing these products' viability and competitiveness. Nevertheless, it is important to point out that these benefits from innovation outcomes are usually short-lived (Carroll and Khessina 2005). Especially in technologically dynamic industries, where the technological frontier shifts quickly, what is *avant-garde* today often becomes *passé* tomorrow (Brown and Eisenhardt 1997; Carroll and Teo 1996; Christensen and Bower 1996; Eisenhardt and Tabrizi 1995; Tripsas 1997; Tushman and Anderson 1986a). Besides, even if an innovation does not become old-fashioned forthwith, its survival advantages for the firm producing it may still dissipate because of spillovers effects and imitation processes (Roberts 1999; Teece 1986). Although legal intellectual property protection measures like patent laws afford the innovators certain level of protection against spillovers and imitations, their past innovations are, nonetheless, adopted and adapted by competitors. Therefore, the competitive advantage attained through innovations rarely, if ever, remains intact and mostly is eroded by further innovations. Therefore, in an attempt to protect their intellectual property and protract their competitive superiority, innovators implement various measures to stymie imitation and/or stall the progress of counter-innovations. According to Dinopoulos and Syropoulos (2007) such measures include 1) time-pacing strategies (i.e., strategies of increasing manufacturing capacity in regular intervals independently of the pace of innovations) (Eisenhardt and Brown 1998) via strategic advertising to enhance customer loyalty, or build and expand manufacturing capacity and distribution systems especially in industries where first mover advantages and network externalities are paramount, 2) building a protective shield of patents around an innovation by registering patents in several other, but related, innovations without any intention of introducing them to the market in an attempt to frustrate the circumvention of existing patents by innovators and deter competing innovations from entering the market, and 3) enforcing a variety of confidentiality clauses with their employees in an attempt to control the flow of knowledge spillovers through the mobility of labor. As effective as they are, these measures have two major drawbacks. First, they require extensive resources. For example, the costs of direct patent litigations might be as high as 25 percent of R&D expenditures (Lerner, 1995). Second, they offer temporary solutions to the problem at hand (Teece 1986).

Therefore both, the environmental fit achieved by means of product innovation and survival advantages derived from innovations are preordained to be short-lived. Stated differently, to survive in Red Queen Competition, firms need to be at least as innovative as their competitors just to maintain their positions. Hence, it is hypothesized that:

H2: The longer since a product innovation was introduced to the market, the less likely the product will survive

Reputation

It has beeen well documented in the literature that superior reputations drive superior performance (Dierickx and Cool 1989; Rao 1994; Roberts and Dowling 2002; Rumelt 1987; Weigelt and Camerer 1988). Most of the studies examining the positive link between reputation and performance base their arguments on the resource-based view of the firm, which attributes sustainable competitive advantage to possession of assets that are not only valuable and rare but also difficult to imitate. (Barney 1991; Grant 1991). This line of reasoning ascribes particular emphasis on intangible assets which, on the most part, refer to intellectual properties including, but not limited to, trademarks and patents, brand equity, company reputation, company networks and databases (Fahy and Smithee 1999; Hall 1993; Williams

1992). Such intangible assets may lead to significant differences between the balance sheet valuation and stock market valuation of publicly traded companies (Grant 1991; Rumelt 1987). For instance, the stock market value of Amazon Inc. is 23 times more than its book value, whereas the industry average is 7.40 (Reuters), which indicates the significance of its intangible assets. Moreover, intangible assets not only have relatively unlimited capacity that enables the firms to exploit their value by utilizing them by themselves, renting them (e.g., via licensing) or selling them (e.g., by selling their brand) (Fahy and Smithee 1999; Wernerfelt 1989), but also they are relatively resistant to imitation efforts by competitors. For instance, making a hamburger identical to Big Mac with the same taste and appearance is very easy, but it would be very unlikely to have same marketing success even if there were no copyright issues. Intellectual property is afforded regulatory and legal protections (Hall 1993; Hall 1992) while databases, networks and reputation are examples of asset stocks (Dierickx and Cool 1989) and the inherent complexity and specificity of their accumulation hinders imitability and substitutability in the short run hence their benefits for sustainable competitive advantage. In sum, good reputation, which is an intangible asset, is critical due not only to its potential for value creation, but also to its intangible character, which makes it difficult to imitate (Rao 1994; Roberts and Dowling 2002).

A variety of potential benefits of good reputations explain the relationship between reputation and financial performance (Benjamin and Podolny 1999; Fombrun and Shanley 1990; Fombrun 1996; Podolny 1993). Roberts and Dowling (2002) suggest that customers value associations and transactions with high-reputation firms as well as they regard reputation as a signal of the underlying quality of a firm's products and services, hence they are willing to pay a premium for the offerings of high-reputation firms, "at least in markets characterized by high levels of uncertainty." Moreover, good reputation may not only increase the ability of a firm to recruit employees of higher caliber with a lower salary, but also retain their relatively more skilled line of employees for a longer period as the employees would be more committed to their company (Cable and Turban 2003; Davies 2003; Dowling 2001; Turban and Cable 2003). Good reputation may also decrease the contracting and monitoring costs with business partners both at the upstream and downstream supply chain, as the business partners will be less concerned about contractual hazards and uncertainties during their transactions with highly reputable (Roberts and Dowling, 2002). Good reputation facilitates communicating with customers as well. Goldberg and Hartwick (1990) argue that potential customers tend to believe in advertising claims more favorably if the reputation of the firm making those claims is more positive, even if the claims are extreme (Brown et al. 2006; Goldberg and Hartwick 1990; Goldsmith et al. 2000; Roberts and Dowling 2002). In a similar vein, Dowling (2001) suggests that good reputation helps maintain and stimulate sales force effectiveness, facilitates the introduction and penetration of new products and eases recovery during crises (e.g., during product recalls). It is also well documented that good reputation can generate a competitive advantage and superior rents as they trigger consumers' purchase decisions, improve the efficiency of marketing programs, and they enable the firms to charge more for products (Aaker 1991; Aaker 1996; Kapferer 1997; Keller 1993). As Cable and Turban (2003) argue "two brands of cars (e.g., Plymouth Laser™ and Mitsubishi Eclipse™) may offer identical product attributes, but nevertheless attract different numbers of consumers who are willing to pay different prices as a result of the reputations that are associated with the brands (Aaker, 1996)". Consequently, it is hypothesized that:

H3: As a product's reputation increases, selection pressures of competitors' innovations decreases.

Competitive history

A fundamental underpinning of the evolutionary perspective is that each entity (in our case, a product) is constrained by its history (Barnett and Hansen 1996). Following Barnett and Pontikes (2005), this essay postulates that focusing merely on the current-time dynamics of competition and ignoring its historical development may lead to inaccurate conclusions. Instead, it is suggested in the literature that history of an entity plays a significant role in determining its strengths and weaknesses which in turn, determines the future of the entity (Carroll and Harrison 1994; Dosi and Malerba 2002; Hopenhayn 1992; Jovanovic 1982; Jovanovic and Lach 1989). This essay takes the stance proposed by Barnett and Pontikes (2005) that "competition is strongly history dependent – varying as a result of the historical path that led to the current situation – and this historical effect may even exceed in magnitude the effects of current-time competition." As such, two constraints regarding the history will be taken into account in predicting the conditions under which Red Queen dynamics are likely to have maladaptive consequences (e.g., product failure).

First, all firms are shaped, and on the most part constrained, by their past experiences, the most notorious of them being the "competence trap" (Levitt and March 1988).

Firms under this condition react to changes in the environment using routines that they have learned in the days of yore, under different competitive dynamics, harming their performance by doing precisely what had worked well under different circumstances.

Based on Red Queen dynamics, this study argues that this trap will be deepened by mutual reinforcement in ecology of organizational learning. For example, Cole (1999) argues that established firms have been known to collectively deny the possibility that new practices and technologies are changing the basis of competition in an industry, preferring instead to stay with well-learned but outdated practices. Put differently, as the context changes, what was learned, and brought success, in the past might end up harming firms in the future although it had once worked to their advantage (Barnett et al. 1994).

The implication of these findings explained above, along with many others, for this essay is that historical timing of the competitive experiences will be accounted for when modeling the product-level competition. Specifically, for recent competitive experience, it will be assumed that the benefits of learning are likely to outweigh the costs, as the newly learned practices will be more relevant to the extant dynamics of competition. On the other hand, it is posited that experiences in more distant past are more likely to have taught now-outdated lessons. Therefore:

H4a: Longer mean duration of a product's recent competitive relationships increases the chances of focal product's survival

H4b: Longer mean duration of a product's past competitive relationships decreases the chances of focal product's survival

In a similar vein, strength of competitors hinges on the very same difference in historical timing. Competitors with more recent competitive experience are likely to be more potent competitors, while the others whose competitive experiences are in distant past will be less potent competitors:

H5a: Longer mean duration of rivals' recent competitive relationships decreases the chances of focal product's survival.

H5b: Longer mean duration of rivals' distant competitive relationships decreases the chances of focal product's survival.

Following Barnett and Hansen (1996), a second constraint is specified when products are engaged in more than one coevolutionary process. A product dealing with a single cohort of rivals shares with them the same timing, sequence and hence nature, of strategic interactions. But what if a product was developed within a cohort of rivals and exposed to a competition from that particular group of rivals for a certain period, but then the very same product confronted with new cohort of rivals that do not share the firm's coevolutionary history? In this case, product will have to engage in a new Red Queen competition with its new set of competitors, which is most likely to necessitate alteration of previous routines. Schumpeterian view argues that (Schumpeter 1934) previous adaptations represent constraints and will prevent various new forms of adaptations to its new rivals. In this way, each cohort of rivals begets a new challenge and incites a new Red Queen competition, but adaptations made for each cohort, as explained above, will constrain those that can be made for others (Barnett, 1996). Therefore, this study distinguishes between products according to the variance, as well as the mean, of their competitive experiences. Controlling for the number and mean duration of competitive relationships, it is expected that the variance in competitive relationships to reflect increasing constraints among multiple coevolutionary processes. Evidently, each constraint will decrease the likelihood that a product can locate and adopt an adaptive solution to any given new competitive threat. As these constraints mount, it becomes increasingly unlikely that the benefits of adaptation will be sufficient to exceed the costs. Therefore, it is hypothesized that

H6: Greater variance of focal product's competitive relationship duration lowers its chances of survival.

Market Share

Market share can be regarded as the single most important indicator of a product's competitiveness since most, if not all, of the sources of competitive advantage do co-vary with market share. Having a large market share betokens an already-established reputation, customer base, and distribution network, higher brand equity, or even competitive advantages due to "network externalities." In automobile industry, automobiles with higher market shares also have higher resale values. If not anything else, products with higher market shares enjoy the consumers' preference due to bandwagon effects. Therefore, it can be argued that as the products increase their market share, they become more capable of alleviating or even controlling "selection" pressure. Products with higher market shares have more bargaining power against wholesalers, as they are preferred more by consumers than their competitors, which provides them with competitive advantages like higher profit margins, better visibility and shelf space and etc. Therefore, it is hypothesized that:

H7a: Higher market share increases the chances of survival of the focal product.

H7b: Higher market share decreases the effects of "lag load."

DATA AND METHOD

Data

The hypotheses above are tested using data from the U.S. automotive industry for the period of 1946-2000. The research design used in the analyses of this essay is commonly referred to as a population study (Carroll and Teo, 1996). Instead using a sample, a dataset comprising all automobile manufacturers ever known to compete in the U.S. automobile market from 1946 to 2000 is examined. 1946 is the year the production, and hence the competition in the U.S. automobile industry resumed after the World War II. Immediate postwar period in the industry can be characterized as a "seller's market since the halt of production for three and a half years has created an enormous backlog of insatiable demand such that even after three years of full capacity production was far from steaming off the demand (Rae 1984). For instance, Ford Motor Company announced in April 1948 that it had a backlog of 1,575,000 orders (White 1971). Such a strong demand not only enabled the companies to delay any changes on their prewar models, but also stimulated the entries of new companies, in particular, various independent manufacturers and foreign makes entered the U.S. market (Rae, 1984). The year 2000 is the end of the observation period since it is the latest year covered by the major data sources utilized in this essay. Individual fates of all models are traced during this period to test the proposed hypotheses about the drivers of organizational mortality. Complete coverage of 55 years enables precise analysis of how Red Queen competition affects the industry in general and the competing firms in particular. Moreover, it also allows testing of hypotheses without assuming temporal equilibrium (Carrol and Teo, 1996)

Longitudinal population design is a *conditio sine qua non* for robust investigation of the dynamics of Red Queen competition since the in the core of the analyses is the competition based on innovation, which necessitates the observation of innovations for a long time to be able understand the real gains from them. Specifically, in Red Queen competition, it is postulated that any competitive move (for this essay, an innovation) will not only increase the likelihood of "death" for some actors in the population, but also will cause actual “deaths.” However, the remaining competitors (i.e., those who could survive the detrimental impact of the innovation) will react to that innovation with their own innovations and the competition will continue until there is only one firm to survive. Hence, it is only with a longitudinal population study that those dynamics, along with their impacts on organizational mortality events, can be observed.

While the data for the analyses are derived from multiple sources, the most comprehensive information is attained from a three-volume encyclopedic source that provides authoritative coverage, well-known to myriad of researches and innumerable automobile enthusiasts worldwide: the Standard Catalog of American Cars (Flammang and Kowalke 1999; Gunnell 1982). As useful as they are Standard Catalog of American Cars, by definition, do not have any information about the import cars in the U.S. automobile market. The major data source for import cars is the Standard Catalog of Imported Cars (Covello 2002). Along with these major data sources, supplementary data are derived from the New Encyclopedia of Motor Cars (Georgano and Andersen 1982), World Guide to Automobile Manufacturers, Kutner (1979) and Automotive News (1993, 1996).

Variables

Dependent Variable: Model exits from the competition

Model exits from the competition are neither uncommon, nor unexpected in the U.S. automobile industry due to the intense competition. Firms may choose to discontinue a model indicating that the model failed to compete with its rivals in the industry. When a model is withdrawn from the market, it is coded as "dead" in the dataset which includes 695 model level exits from the industry.

Independent variables

Extensiveness of innovation: The innovations applied to the product are measured using the "model specifications" tables of Automotive News Market Data Books, as well as the Standard Catalog of American Cars. Specifically, changes in the wheelbase are used to measure model-level innovations. To test H1a, a binary variable that takes the value of 1, when a change in the model occurs, is used. Absolute extensiveness of the innovation is measured by the percentage change of the wheelbase of the model, and is used to test H1b, whereas H1c is tested by the difference between the absolute extensiveness of the innovation and the mean industry-level changes. The variables I_j, AEI_j, and REI_j in the model below will be used to test the hypotheses H1a, H1b, and H1c, respectively.

Lag load: Similar to Essay 1, lag load is operationalized as the average annual innovativeness for the industry calculated by taking into account the extensiveness levels of all the innovations introduced in a given year as the first step. Then, the difference between the extensiveness of the firm's innovation and the annual industry average is calculated for the given year. Then this difference is cumulated annually over the life span of the model.

Reputation: The U.S. auto industry has many potentially fruitful measures of automaker reputation. However, this essay uses third-party ratings of reputation since they have significant effects on the quality judgments, and hence reputations, on automotive products by the consumers (Devaraj et al. 2001; Levin 2000; Podolny and Hsu 2003). Rhee and Haunschild (2006), lists Consumer Reports: Buying Guide and J. D. Power & Associates as the most important third-party car-rating sources in the United States. Both of these rating services collect quality and satisfaction data from the actual owners of new or used vehicles. Consumer Reports Buying Guides also report evaluations of the Consumer Reports as well and also has ratings of car models for all the observation period, unlike J.D. Power and Associates. Therefore, Rhee and Haunschild (2006) Mitra and Golder (2006) and many others, measurement of reputation is developed by using previous ratings of Consumer Reports.

These annual reputations for a model are represented by R_j in our model below and used to test hypothesis H3.

Competitive history: Hypotheses H4a to H6 are tested following the procedure as suggested by Barnett and Hansen (1996) , each product's relationship with each of its competitors is measured in years and denoted by τ_{jk} , the time that product *j* was exposed to competition from rival *k*. Product *j*'s experience distribution, then, is just the distribution of its τ_{jk} over all rivals denoted by the vector *k*, with a mean represented by μ_j and variance equal to $\sigma_j^2 = \sum_k \left(\tau_{jk} - \mu_j\right)^2$. The hypotheses require a differentiation between *j*'s recent and distant experiences. To accomplish this, τ_{jk} will be divided into two terms, τ_{Rjk} , representing the product's recent exposure to rival *k*, and τ_{Djk} capturing *j*'s exposure to rival *k* in the distant past. Then, means will be constructed for each product for each of these competitive experience clocks: μ_{Rj} and μ_{Dj} . The hypotheses also require the competitive experiences of the product *j*'s rivals, which are represented in the model for recent and distant experience respectively: $\sum_{k \neq j} \mu_{Rk}$ and $\sum_{k \neq j} \mu_{Dk}$. H4a will be supported when $\alpha_R < 0$. In contrast, H4b will be supported when $\alpha_D > 0$. In a similar vein, H5a will be supported if $\delta_R > 0$ and H5b will be supported if $\delta_D < 0$. Last, but not the least, $\gamma > 0$ will indicate a support for H6.

Market share: Market share will be operationalized as the ratio of the annual sales of a product to the total automobiles sales in U.S. market in that year. In the model, market share of the product *j* is denoted by *Mj*, which will be used to test the hypotheses H7a and H7b.

Model Specification and Estimation

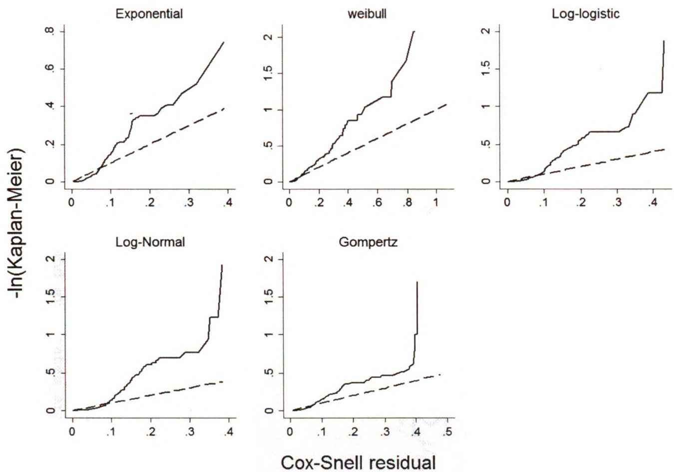
The available theory in organizational ecology literature in particular and social sciences in general do not necessarily provide guidance to choose one parametric model over another in event history analysis. Therefore, it is of crucial importance to empirically check the adequacy of the models upon which the inferences are based. While using likelihood ratio tests as a tool for comparing goodness-of-fit of alternative models is a common way of doing this, the fact that they are limited to nested models necessitates an alternative approach for the evaluation and comparison of alternative parametric assumptions. Following Blossfeld et al. (2007), pseudoresiduals (a.k.a. generalized residuals) suggested by Cox and Snell (1968) are used to evaluate distributional assumptions.

Cox-Snell residuals of the same model are generated for different distributions (i.e., Exponential, Weibull, Log-logistic, Log-Normal, and Gompertz). If a model fits the data, Cox-Snell residuals should have standard exponential distribution. To check this, an empirical estimate of cumulative hazard function via Kaplan-Meier survival estimates are calculated as the first step then plotted cumulative hazard against the Cox-Snell residuals with each distributional assumption. The plots should approximate a straight line in order to indicate a good fit of the model to the data (Figure 2.1)

As it is presented in Figure 2.1, for none of the distributions, the conditions stated above are satisfied. This was no surprise as the extant organizational ecology literature has no study that has a hazard function similar to any of those distributions stated above. Therefore, I used discrete-time event history analysis, for which postestimation analyses indicated very strong fit of the model to the data.

Figure 2.1 Graphical Check for Pseudoresiduals .

Plots of Logarithm of Survivor Functions of (of Residuals) vs. Residuals for Essay 2



The hypotheses of this essay are incorporated into the discrete-event hazard rate model presented below:

$$\log\left(\frac{\lambda_i}{1-\lambda_i}\right)=\begin{bmatrix}\beta_1 I_j + \\ \beta_2 AEI_j + \\ \beta_3 REI_j + \\ \beta_5 LL_j + \\ \beta_6 R_j + \\ \alpha_R \mu_{Rj} + \alpha_D \mu_{Dj} + \gamma\sigma_j^2 + \delta_R \sum_{k \neq j} \mu_{Rk} + \delta_D \sum_{k \neq j} \mu_{Dk} + \\ \beta_7 M_j + \\ \beta_8 LL_j * M_j\end{bmatrix}$$

RESULTS

Table 2.2 presents the descriptive statistics of the variables included in the analyses and Table 2.3 presents the results of discrete-time event history analyses. Similar to Essay 1, a model (i.e., Model 1), in which only the relationships between innovations and exit rates are analyzed, is tested as the first step. Results of the Model 1 verifies the findings in the extant literature that innovations decrease the exit rates (See results for Model 1 on Table 2.2) (Bygrave and Timmons 1992; Carroll and Teo

1996; Podolny and Stuart 1995; Schumpeter 1934). It is also found that there is a negative relationship between the extensiveness of innovation and the exit rates, suggesting radical innovations more likely to increase the survival likelihood when compared to incremental innovations. Last, but not least, the negative and statistically significant coefficient of the "relative extensiveness of innovation" variable suggests similar a similar relationship. All these findings of Model 1 confirm the ideas already established in the innovation literature and, by doing so, validate the dataset as well.

As the following step, a Model 2 is developed to incorporate the impact of both types of lag loads to the model (See results for Model 2 on Table 2.2). Model 2 reveals that both absolute and relative lag loads have significant positive impact on the exit rate, suggesting that Red Queen dynamics, just like in make-level competition, are diagnostic in model-level competition as well. Therefore, it can be argued that the advantageous position in the competition attained by an innovation is short-lived; therefore firms need to continuously innovate to be able to maintain survival and competitive advantages. Moreover, it is also found in Model 2 that when the effects of lag load are taken into account (i.e., absolute and relative lag loads), the relationships between innovation variables and the exit rates become insignificant.

Table 2.2: Descriptive Statistics for Essay 2

Variable	Minimum	Maximum	Mean	Standard Deviation
Innovation	0	1	0.132	0.339
Absolute Extensiveness	0	3.550	0.339	1.518
Relative Extensiveness	0	3.496	0.305	1.435
Absolute Lag Load	0	25	2.673	2.872
Relative Lag Load	-4.098	11.928	0.190	1.321
Reputation	23.529	100	64.642	13.554
Recent rivalry	0	5	3.321	3.171
Distant rivalry	0	55	7.213	18.566
Recent rivalry of competitors	0	121	7	15
Distant rivalry of competitors	0	228	21	44
Variance in rivalry duration	0	8651	77	342
Market Share	1.2E-05	20.891	1.151	1.769
GNP	1574.5	9817	4596.731	2348.293

Model 3 is developed to understand the role of reputation in Red Queen competition. In tandem with the previous findings in the extant literature (e.g., Aaker 1991; Aaker, 1996; Benjamin and Podolny 1999; Cable and Turban 2003; Goldsmith and Hartwick 1990; Rao 2004), results reveal that, *ceteris paribus*, firms with better reputations are less likely to exit the industry (See results for Model 3 on Table 2.2). In this model significant impacts of lag load variables persist, while the innovation-related variables remain insignificant.

Table 2.3: Estimation Results for Essay 2

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Innovation	-.291**	-.225	-.013	-.013	-.015
Abs. Extensiveness	-.013	-.019	-.142	-.188	-.187
Rel. Extensiveness	-.006	-.007	-.152	-.104	-.107
Abs. Lag Load (A-LL)		.027**	.120*	.297**	.318**
Rel. Lag Load (R-LL)		.136**	.234**	.405**	.626**
Reputation			-.077**	-.101	-.130**
Recent rivalry				-.054*	-.045*
Distant rivalry				.003	.002
Recent rivalry of competitors				.007	.019*
Distant rivalry of competitors				.001	.005
Variance in duration of rivalry				.001	.001
Market Share					-.355**
Market Share & LL					.556*
GNP	-.002**	-.002**	-.002**	-.001**	-0.001**

Following the analyses of the relationships among reputation, competition of innovativeness and the likelihood of survival in the industry, Model 4 is developed to delve further into the relationship between the competition, innovation, and exit rates (See results for Model 4 on Table 2.2). The results of the discrete-time survival analysis reveal that recent rivalry is diagnostic in determining the likelihood of survival. Considering the intense competition and the high model turnover rates in the industry, this result is not unexpected in the sense that competitiveness of any company is contingent, for the most part, upon its ability to adapt to its environment. Since rivals with more recent competitive experience will have the most current and up-to-date skills to survive in the environment, they are also more likely to generate stronger competition and hence exert more severe selection pressures on the focal firm. Other variables about rivalry (i.e., distant rivalry, recent rivalry of competitors, distant rivalry of competitors, variance in duration of rivalry) have no significant impact on the exit rates.

Model 5 shows the results of a complete model specification which tests all of the hypothesized relationships (See results for Model 5 on Table 2.2). Results indicate support for hypotheses H2, H3, H4a, H5a, H7a and H7b. Similar to the results of Essay 1, innovativeness is found to be a significant driver of survival (see also Model 1). However, when "lag loads" are taken into account, innovativeness loses its significance. Therefore, we can conclude that being innovative, in and of itself, is not sufficient to survive the competition and it is of crucial importance to keep up with the rivals, if not outrun them. Results also indicate that reputation may help companies survive longer in the competition. While this might look like a re-confirmation of an already-established hypothesis, the fact that reputation remains significant in Model 5, where we account for the lag loads, is an important finding. Recent competitive experience of a company is found to decrease the hazard rate, whereas the impact of the competitive experience in the distant past is found to be insignificant. Summary of the hypotheses testing is presented in Table 2.4.

Table 2.4: Summary of Results for Essay 2

Hypothesis	Result
H1a: A product innovation increases the chance of product survival	Not Supported
H1b: The more extensive the innovation of product, the higher the chances of product's survival	Not Supported
H1c: In relative terms, more extensive product innovation (i.e., relative to its competitors), the higher the chance of product's survival	Not Supported
H2: The longer since a product innovation was introduced to the market, the less likely the product will survive	Supported
H3: As a product's reputation increases, selection pressures of competitors' innovations decreases	Supported
H4a: Longer mean duration of a product's recent competitive relationships increases the chances of focal product's survival	Supported
H4b: Longer mean duration of a product's past competitive relationships decreases the chances of focal product's survival	Not Supported
H5a: Longer mean duration of rivals' recent competitive relationships decreases the chances of focal product's survival	Supported
H5b: Longer mean duration of rivals' distant competitive relationships decreases the chances of focal product's survival	Not Supported
H6: Greater variance of focal product's competitive relationship duration lower its chances of survival	Not Supported
H7a: Higher market share increases the chances of survival of the focal product	Supported
H7b: Higher market share decreases the effects of "lag load"	Supported

DISCUSSION

Inquiry on the benefits and drawbacks of innovations has received considerable attention in academia. Various benefits of innovation on several aspects of firm performance have been documented in the literature. For instance, innovations are shown to stimulate higher profit rates (Bayus et al. 2003; Roberts 1999), boost sales growth (Anderson and Tushman 1990; Tushman and Anderson 1986a), and increase the survival rates of the innovator companies (Banbury and Mitchell 1995; Carroll and Teo 1996; Klepper 1996; Klepper and Simons 2000). Along with the benefits, several costs and drawbacks of innovations have also been discussed. For instance it is suggested in organizational ecology literature that 1) innovations incur significant R&D costs and 2) they may necessitate various changes in the organizational structure and processes both in the idea generation and implementation phases which reduce survival chances of a firm, albeit temporarily(Barnett and McKendrick 2001; Carroll and Teo 1996; Dowell and Swaminathan 2000; Khessina 2006).

Despite their risks and costs, innovation are regarded as consequential elements of firm survival, as competing firms need to innovate ceaselessly to be able to alleviate the threat of disruption from innovations of their competitors(Cefis et al. 2005; Christensen 1997) rendering the competition among firms in the same industry and innovations are inextricably related (Hall 1994).

Therefore, using complete data on all automobile models which competed in the post-WWII U.S. automobile market, the aim of this essay is to show the relationship between competition and the survival outcomes of innovations. Based on Red Queen Competition, it is proposed that the in order to fully understand the impact of the extensiveness of an innovation on the likelihood of survival of the innovator (i.e., the automobile model for this essay), the pace of innovations on the other models should also be taken into account. As such, based on the principles of Red Queen Competition, it is empirically shown that models that cannot keep up with their competitors are more like to experience failure than those that can.

Specifically, drawing from evolutionary biology (Smith 1976; Van Valen 1973), a new construct (i.e., lag load) that measures the extent to which a model falls behind its competition is introduced and its impact on survival rates is tested. As hypothesized, the results show that the lag load increases the likelihood of failure of a model. While the results lend support to the hypotheses that more reputable models, which experienced competition in recent past, and models with higher market shares are less likely to fail, they also show that recent competitive experience of rival models increase the selection pressures on the focal model.

The firm-level lag load is shown to be diagnostic in Essay 1, the results for the Essay 2 also show that lag load is still detrimental for the likelihood of survival at the model-level competition. Therefore findings of the Essay 2 supports the main idea of the dissertation that it takes all the running a firm can do just to remain industry. In light of the results of the Essay 1, this result is not unexpected since firms and models only belong to different levels of the same nested-hierarchy, therefore, after all, they all belong in the same ecosystem and hence similar competitive dynamics. While the pace of competition at different levels of a nested hierarchy may be different, entities, albeit at a lower level, still need to competed for the same limited sources. Moreover, similar effects of lag loads at different levels incites a question of whether the dynamics of competition at different levels of the same nested-hierarchy interact with each other, hence the Essay 3 of this dissertation.

Results also suggest that models with better reputations are more likely to survive the competition in the industry. This result is not unexpected due to the well-documented benefits of reputation in the literature. Reputation, mostly regarded as an intangible resource that reflects the overall assessment of the environment about the current and future position of a competitor (Teece et al. 1997), can be a major driver of sustainable competitive advantage as it is difficult to imitate (Hall 1992). Analyzing a set of firms that are engaged in nuclear waste management or photovoltaics research, Shrum and Wuthnow (1988) suggest that "reputational status becomes a critical resource for organizational managers" (p.909) as reputation is the outcome of a set of competitive moves by means of which competitors signal their important attributes to their constituents in an attempt to maximize their financial and social status (Carmeli and Tishler 2005; Fombrun and Shanley 1990; Fombrun 1996; Sine et al. 2003). Competitive advantages driven by superior reputation are include delaying rivals' mobility in the industry, charging premium prices, attracting more qualified applications for their job postings as well as stronger investors who are more willing to invest in, or lend money to, the firm, increasing job satisfaction and commitment among employees, sustaining competitive advantage for a long time, and increasing customer loyalty (Benjamin and Podolny 1999; Carmeli and Tishler 2005; Fombrun and Shanley 1990; Fombrun 1996; Sine et al. 2003). Podolny (1993) suggest that these advantages of superior reputation are intensified when it is difficult (e.g., costly), if not impossible, for consumers to experience the actual quality of the goods or services, which increases the uncertainty about, and perceived risk of, them. Stated differently, reputation becomes a more viable signal for consumers when the information asymmetry increases.

The analyses also lend support to the hypotheses about the recent competitive advantage. While the stream of research on the relationship between survival rates and recent and distant competitive experiences of competitors and focal entities is yet to be established, and hence therefore there are not many studies to which results of this essay might be compared, this results can be attributed to the concept of "competence trap," where actors competing in an ecosystem decrease, if not cease, their endeavors to adapt to the changing conditions in their environment after being successful in a certain era. Alternatively, it can be argued that together with success, firms get larger in size, their processes become more complicated, their structures become more hierarchical, all of which stimulate organizational inertia. Considering the history of the dynamics of competition in the U.S. Auto Industry, it is possible to see evidence of competence traps. For instance, Model T was such a success for Ford that the company remained reluctant to launch new models that would fit better for customers' demands. Ford executives maintained their "one size fits all" philosophy for almost two decades and were outperformed by General Motors in the 1920s, which aimed to target different customers segments with different products. More specifically, General Motors, led by Alfred Sloan introduced annual styling changes, from which came the concept of planned obsolescence and established a pricing structure in which (from lowest to highest priced) Chevrolet, Pontiac, Oldsmobile, Buick and Cadillac did not compete with each other, so buyers could be kept in the GM "family" as their buying power and preferences changed as they aged. These concepts, along with Ford's resistance to the change in the 1920s, propelled GM to industry sales leadership by the early 1930s, a position it retained for over 70 years. Needless to say, Ford has never been No.1 in the industry again. In a similar vein, U.S. companies did not take their new competitors from Japan seriously, since the Japanese models were all small cars which were not only demanded by an unattractive segment of customers but also were less profitable to manufacture. The ramifications of this Hubris syndrome remain evident as of today.

ESSAY 3: MULTI-LEVEL DYNAMICS OF INNOVATION AND SURVIVAL: EVIDENCE FROM U.S. AUTOMOBILE INDUSTRY, 1946-2000

INTRODUCTION

Organizational ecology researchers have frequently conceptualized hierarchical models for explaining evolution of organizations since the very inception of the field. Aldrich (1979), Carroll (1984) and many others (Amburgey and Rao 1996; Baum 1999; Baum and Singh 1994a; Baum and Singh 1994b; Drazin and Schoonhoven 1996; Wu and Loucks 1995) have defined various multi-level evolutionary models where levels were nested one within the other, wholes which not only comprise other wholes at the lower levels of the firm, but also are themselves parts of other, but more extensive, wholes within the population. In a similar vein, many scholars in the larger strategic management literature have long ago come to acknowledge the hierarchical nature of various management phenomena (Andrews 1971; Campbell 1974; Cyert and March 1963; March and Simon 1958; Thompson 1967). For instance, Campbell (1974) and Baum (1999) argue that different agents at each level of hierarchy strive to optimize their own "fitness," which is determined by a complex and recursive nomology of the agent and its environment. This complexity may lead to intra-level conflicts between agents that belong to the same whole (e.g., product cannibalization) as well as inter-level conflicts where the optima of agents at different levels might be at different loci. On the other hand, a review of literature on miscellaneous applications of evolutionary theory reveals that most of the analyses have been conducted at single level, despite the well-grounded multi-level conceptualizations in the literature. For instance, while Carroll and Hannan, (1989), Hannan and Freeman (1989) have analyzed evolution at the population level, Burgelman (Burgelman 1991) and Singh and Lumdsen (Singh and Lumsden 1990) have conceptualized an evolutionary model which focuses on strategy making process within the firm (Rosenkopf and Nerkar 2001). To date, evolutionary models have been rarely, if any, analyze competitive interactions across levels, despite they have been widely used explain competition within different levels. Stated differently, burgeoning research on hierarchical structures and dynamics of co-evolution in biology (Arnold and Fristrup 1982; Buss 1987; Hogeweg 1994; Michod 1997; Okasha 2005; Wade 1978; Wilson 1997; Wu and Loucks 1995), a field which inspired Hannan and Freeman (1977) for their seminal work on the population ecology of organizations, have yet to be mirrored in organizational ecology. Thus, little is known about the interactions between competitions at different levels of a nested ecosystem of organizations.

There are various significant conceptual implications of a nested hierarchical perspective of competition (Rosenkopf and Nerkar 1999). First, two primary drivers of evolution as suggested by evolutionary biologists, selection and adaptation, can operate both simultaneously and differently at each level of a nested hierarchy (Gould 1989). Second, relationships between agents within the same whole but at different levels of the nested hierarchy may be positive or negative. Therefore, more often than not, agents within those agents at different levels compete to attain resources and to direct activities for their own interest. As suggested by Rosenkopf and Nerkar (1999) a CEO might pursue strategies to maintain her/his position in the firm (e.g., favoring short-term success and appointing people trusted for their “loyalty” at important positions in the company) at the expense of long-term advantages. Third, the relative dominance of evolutionary processes at different levels is driven by time scale and spatial variation (Rosenkopf and Nerkar, 1999). That is, evolution is faster and more effective at lower levels of the nested hierarchy as the selection and adaptation processes unfold much faster at the lower levels (Ashby 1954; Baum 1999). Last, but not least, competition among the agents at the same level of the nested hierarchy for scarce resources stimulates selection and adaptation processes. Scarcity of the resources at the higher levels of the nested hierarchy draws the boundaries for the selection and adaptation processes at the lower level.

Along with the theoretical concerns, various researchers have also mentioned the empirical problems which may be caused by a disregard for the above-mentioned nested-hierarchical relationships frequently encountered in management research. For instance, Short et al. (2007) argue that an empirical study conducted on the firm-level antecedents of performance would violate the assumption of independence of observations, which underlies traditional statistical techniques, if possible other agents in the higher- and/or lower-level of the nested hierarchy are likely to influence performance as well. Therefore, multi-level analysis of Red Queen Competition is not only beneficial, but also is necessary. Accordingly, this essay aims to unveil how much variance of failure product- and firm-level antecedents account for. Specifically, building on organizational ecology and Red Queen competition, the roles of, and ties between, various covariates are analyzed.

Using complete data of U.S. automobile industry for the years between 1946 and 2000, a multilevel model is used to assess the variance accounted for by the firm and product levels. Working on a multilevel model where products represent the lower level and firms represent the higher level in the hierarchy is suitable for various multilevel estimation models like hierarchical linear modeling (henceforth: HLM) as it nests lower-levels within higher-levels (Hofmann, 1997).

THEORY AND HYPOTHESIS DEVELOPMENT

Organizational ecology has long ago acknowledged the interactive nature evolutionary outcomes at different level and offered various conceptualizations of these relationships (Baum and Singh 1994b; Campbell 1994; Campbell 1974; Campbell 1990). Among those, notion of "downward causation," has been one of the most widely acknowledged by the scholars to explain the dynamics of technological innovation and co-evolution (Rosenkopf and Nerkar, 1999). Campbell (1990) explains downward causation as follows:

Where natural selection operates through life and death at a higher level of firm, the laws of the higher level selective system determine in part the distribution of lower level events and substances, Description of an intermediate-level phenomenon is not complete by describing its possibility and implementation in lower level terms. Its presence, prevalence, or distribution (all needed for the complete explanation of biological phenomena) will often require reference to laws at a higher level of firm as well… For biology, all processes at the lower levels of a hierarchy are restrained by, and in conformity to, the laws of higher levels. (p.4)

As shown above, Campbell (1990) defines the principle of downward causation as the converse of reductionism which is the belief that the behavior of a whole or system is completely determined by the behavior of the parts, elements or subsystems. Stated differently, reductionism postulates that if the dynamics of the behavior of the parts are known, the laws governing the behavior of the whole can also be deducted. Downward causation, along with the systems theory takes an anti-reductionist stance, arguing that the whole is more than the sum of the parts, since it has "emergent properties" which cannot be explained by the properties of, or the laws governing, the parts. Thus, downward causation can be defined as the anti-thesis of the reductionist principle as it simply suggests that the behavior of the parts at the lower level of the nested hierarchy is determined by the behavior of the parts at the higher level.

As the majority of technological innovations, which are developed in a sub-unit of a firm, not only have to conform many underlying macro-level laws that govern the research on, and development of, those innovations, but also accommodate various dynamics of firm-level competition and market demand, it can be proposed that downward causation is an important aspect of technological competition.

An example of how higher-level dynamics can shape the competition at the lower level of nested-hierarchical ecosystem is the so-called "format war" in the high definition optical disc industry to set the formatting standards of storing high definition video. A long history of research and development processes had culminated in the two competing formats: Blu-ray Disc developed by a coalition of Sony, Matsushita, Pioneer, Philips, Thomson, LG Electronics, Hitachi, Sharp, and Samsung, and HD DVD optical disc, developed by Toshiba, NEC, Sanyo, Microsoft, RCA, Kenwood, Intel, Venturer Electronics and Memory-Tech Corporation. Despite the fact that each format had its own merits and drawbacks and that neither one had absolute vantage over the other, Blu-ray technology has become the *de facto* standard in February 19, 2008 as Toshiba withdrew from the competition. According to the industry experts the format war's resolution in favor of Blu-ray was primarily decided by two factors: shifting business alliances, including decisions by major film studios and retail distributors, and Sony's decision to make Blu-ray players a part of the Sony PlayStation 3 video game console.

Rosenkopf and Nerkar (1999) suggest that another important facet of technological competition is that the dynamics of higher-level outcomes usually structure, and even reshape, subsequent competitive activities at the lower levels of the nested hierarchy. Therefore, on contrary the Darwinian evolutionary perspective, lower-level dynamics are far from being random. Rather, path-dependent higher-level processes like experience and inertia substantially drive the path of stochastic competition at the lower-levels as suggested by Lamarckian evolutionary perspective (Rosenkopf and Nerkar, 1999; Baum and Singh, 1994). Therefore it is hypothesized that:

H1: Viability outcomes of model-level innovation vary systematically with differences in make-level characteristics.

DATA AND METHOD

Data

The research design used in the analyses of this essay is commonly referred to as a population study (Carroll and Teo, 1996). Instead using a sample, a dataset comprising all automobile manufacturers ever known to compete in the U.S. automobile market from 1946 to 2000 is examined. 1946 is the year the production, and hence the competition in the U.S. automobile industry resumed after the World War II. Immediate postwar period in the industry can be characterized as a “seller’s market” since the halt of production for three and a half years due to World War II created an excessive backlog of voracious customer demand. Even three years of full capacity production after the War, failed to steam off the demand (Rae, 1984). For instance, Ford Motor Company announced in April 1948 that it had a backlog of 1,575,000 orders (White, 1971). Such a strong demand not only enabled the companies to delay any changes on their prewar models, but also stimulated the entries of new companies, in particular, various independent manufacturers and foreign makes entered the U.S. market (Rae, 1984). The year 2000 is the end of the observation period since it is the latest year covered by the major data sources utilized in this essay. Individual fates of all models are traced during this period to test the proposed hypotheses about the drivers of organizational mortality. Complete coverage of 55 years enables precise analysis of how Red Queen competition affects the industry in general and the competing firms in particular. Moreover, it also allows testing of hypotheses without assuming temporal equilibrium (Carrol and Teo, 1996)

Longitudinal population design is a *conditio sine qua non* for robust investigation of the dynamics of Red Queen competition since the in the core of the analyses is the competition based on innovation, which necessitates the observation of innovations for a long time to be able understand the real gains from them. Specifically, in Red Queen competition, it is postulated that any competitive move (for this essay, an innovation) will not only increase the likelihood of "death" for some firms in the population, but also will cause actual “deaths.” However, the remaining firms (i.e., those who could survive the detrimental impact of the innovation) will react to that innovation with their own innovations and the competition will continue until there is only one firm to survive. Hence, it is only with a longitudinal population study that those dynamics, along with their impacts on organizational mortality events, can be observed.

While the data for the analyses are derived from multiple sources, the most comprehensive information is attained from a three-volume encyclopedic source that provides authoritative coverage, well-known to myriad of researches and innumerable automobile enthusiasts worldwide: the Standard Catalog of American Cars (Flammang and Kowalke 1999; Gunnell 1982; Kimes 1996). As useful as they are Standard Catalog of American Cars, by definition, do not have any information about the import cars in the U.S. automobile market. The major data source for import cars is the Standard Catalog of Imported Cars (Covello 2002). Along with these major data sources, supplementary data are derived from the New Encyclopedia of Motor Cars (Georgano, 1982), World Guide to Automobile Manufacturers (Baldwin et al. 1987), Kutner (1979) and Automotive News (1993, 1996).

Variables

Dependent variable: Exit from the competition:

Model exits from the competition are neither uncommon, nor unexpected in the U.S. automobile industry due to the intense competition. Firms may choose to discontinue a model indicating that the model failed to compete with its rivals in the industry. When a model is withdrawn from the market, it is coded as "dead" in the dataset which includes 695 model level exits from the industry.

Make Level Independent Variables:

Lag load: For the lag load, annual innovativeness average for the industry is calculated taking into account the extensiveness levels of all the innovations introduced in a given year as the first step. Then, the difference between the extensiveness of the firm's innovation and the annual industry average is calculated for the given year. Then, this difference is cumulated annually over the lifespan of the firm.

Tenure: While calculating the tenure of a firm, its tenure in the automobile industry, rather than its organizational age is used. Stated differently, for a *de alio* firm, the age count is started when that firm extends its operations to the automobile industry, regardless of how many years that firm existed before. For *de novo* firms in the automobile industry organizational age and tenure in the industry are, by definition, equal. Tenures in the automobile industry can be calculated straightforwardly when the sources provide exact or near exact dates for the commencement of operations. Unfortunately, sources used in this study contain different degrees of precision for dates. Sometimes, exact date for initiation is available whereas, at some other times, only the month and/or the year are provided. Following Hannan et al. (1998), in this essay all of the information about timing will be converted into decimal years so that the analyses will be tractable. Dates given only at the year level will be coded as occurring at the midpoint of the year. In this case, the starting time for a firm is coded as the middle of the first year and by the end of the midpoint of the next year, firm is given a completed tenure of 1 year. These rules, which are consistent with Petersen's (1991) recommendations for dealing with the problem of time aggregation (Dobrev et al. 2002), are used to handle all of the similar cases encountered during the coding process.

Niche overlap: Operationalizing niche overlap is a two step process. First, following Dobrev et al. (2001) niche width of each firm is defined using the range of engine capacity in horsepower across all models produced by each firm at any given point in time. Second, niche overlap is for all the firms by counting the number of competitors whose niche widths intersect with the focal firm. For instance, French automaker Peugeot, offered engines with the horsepower values of 71, 80 and 97 in 1984, so its niche width is defined as 71 – 97. In the same year, Japanese automaker Mitsubishi offered engines with the horsepower values of 88, 116, and 145, which makes its niche width 88 – 145. Since the niche width values of Peugeot and Mitsubishi intersect for the year 1984, the niche overlap value for those firms is increased by 1 for that year.

Model Level Independent Variables

Extensiveness of innovation: The innovations applied to the product are measured using the "model specifications" tables of Automotive News Market Data Books, as well as the Standard Catalog of American Cars. Specifically, changes in the wheelbase are used to measure model-level innovations. Extensiveness of the innovation is measured by the percentage change of the wheelbase of the model

Lag load: Similar to Essay 1, lag load is operationalized as by annual innovativeness average for the industry is calculated taking into account the extensiveness levels of all the innovations introduced in a given year as the first step. Then, the difference between the extensiveness of the firm's innovation and the annual industry average is calculated for the given year. Then this difference is cumulated annually over the life span of the model.

Reputation: The U.S. auto industry has many potentially fruitful measures of automaker reputation. However, this essay uses third-party ratings of reputation since they have significant effects on the quality judgments, and hence reputations, on automotive products by the consumers (Levin 2000; Deveraj et al., 2001; Podolny and Hsu, 2003. Rhee and Haunschild, (2006) lists Consumer Reports: Buying Guide and J. D. Power & Associates as the most important third-party car-rating sources in the United States. Both of these rating services collect quality and satisfaction data from the actual owners of new or used vehicles. Consumer Reports Buying Guides also report evaluations of the Consumer Reports as well and also has ratings of car models for all the observation period, unlike J.D. Power and Associates. Therefore, Rhee and Haunschild (2006) Mitra and Golder (2006) and many others, measurement of reputation is developed by using previous ratings of Consumer Reports. These annual reputations for a model are represented by Rj in our model below and used to test hypothesis H3.

Tenure: While calculating the tenure of a model, its tenure in the automobile industry can be calculated straightforwardly when the sources provide exact or near exact dates for the commencement of operations. Following Hannan et al. (1998), in this essay all of the information about timing is converted into decimal years so that the analyses will be tractable. Dates given only at the year level will be coded as occurring at the midpoint of the year. In this case, the starting time for a firm is coded as the middle of the first year and by the end of the midpoint of the next year, model is given a completed tenure of 1 year. These rules, which are consistent with Petersen's (1991) recommendations for dealing with the problem of time aggregation (Dobrev et al. 2002), are used to handle all of the similar cases encountered during the coding process.

Size: Following Hannan et al (1998), the size of the model is measured as the scale of operations, specifically the annual sales of the given model in a given year. This operationalization is not only available more regularly than accounting-based performance measures (e.g., net profit, return on equity, etc) but also is more reliable in such a population study in which firms from various countries using different accounting principles, are included in the same dataset. For models for which some but not all information on capacity could be found, the missing years are be interpolated as Carroll and Teo (1996) show that interpolation does not have great effects on findings. This time-varying variable is updated annually using sources which list the annual sales figures of all competitors in the U.S. automobile industry each year.

Competition: This variable is operationalized as the number of competitors a model has any given year. Due to the fierce competition in the industry, model-level entries and exits are rather common. Therefore, the value of this variable for any model is updated annually. Number of competitors should affect the survival chances of any entity as long as the each entity is competing for the same, and limited, sources.

Model Specification and Estimation

In the model conceptualized above, automobile models are nested within automobile manufacturers (i.e., makes). It has been shown that the common procedure of ordinary least squares (OLS), which is typically applied to model-level data pooled across makes in management research, causes some statistical problems. Specifically, pooled regression on multilevel data causes biased estimates with too small standard errors (Bryk and Raudenbush 1992).

Hierarchical linear modeling (HLM) (Bryk and Raudenbush 1992) has been specifically developed to estimate models involving multilevel data (Snijders and Bosker 1999). It enables the simultaneous estimation of relationships of variables at two (or more) levels, using iterative maximum likelihood estimation (Steenkamp and Geyskens 2006).

On the other hand, since the dependent variable in this model is binary (i.e., whether the model exits the competition or not), a special version of HLM, Hierarchical Generalized Linear Modeling is used to test the hypotheses. Hierarchical generalized linear models are developed as a synthesis of generalized linear models, mixed linear models and structured dispersions (Lee and Nelder 2001). Hierarchical Generalized Linear Models (HGLMs) are flexible and efficient means for modeling non-Normal data particularly when the model may include several sources of error variation. They extend the generalized linear models (GLMs) to include additional random terms in the linear predictor (Lee and Nedler 1996). On the other hand, while HGLMs include generalized linear mixed models (GLMMs) as a special case, they do not require the additional terms to follow a Normal distribution and to have an identity link (as in the GLMM). For instance, if the basic GLM is a log-linear model (i.e., Poisson distribution and log link), an appropriate assumption for the additional random terms would be a gamma distribution and a log link. Therefore, HGLMs can handle a wide range of models simultaneously within a single framework. Each HGLM is made up from two interlinked generalized linear models, hence the opportunity to utilize a familiar repertoire of model checking techniques to help determine the appropriate error distributions and models.

Multilevel models, particularly hierarchical linear models (HLMs) were introduced to the management literature by McNamara et al. (2003) who analyzed the variance within and between strategic clusters (Short et al. 2007). As suggested by Bryk and Raudenbush (1992), multilevel models not only provide simultaneous partitioning of variance and covariance components but also, similar to other variance decomposition techniques, they also enable the estimation of multilevel influences without direct measurement of variables associated with each level via variance components analysis (Short et al., 2007). The use of multilevel models provides other advantages as well. First, multilevel models realize the possible dependence between agents at the different levels of nested hierarchy and accounts for the common variance between the agents in one level who are nested in another agent at a higher-level (Hoffman 1997).As discussed above in detail, the relationships between agents at different levels of a nested hierarchy have been of interest to organizational ecology researchers. Further, Bayesian estimation approach used in multilevel models improves the robustness of estimates compared to traditional approaches (Hoffman 1997). In this essay, the effects of firm and model level covariates on the likelihood of model survival as well as the interactions between them are modeled using a two-level HGLM. Specifically, a two-level HGLM is used to test the effects of models nested within firm. The level-1 model represents the likelihood of survival of each model as a function of extensiveness of innovation, lag load, reputation, tenure, size, and competition:

Level- 1 (Model-Level) model:

$$Prob\left(exit = \frac{1}{\beta}\right) = \varphi$$

$$Log\left[\frac{\varphi}{(1-\varphi)}\right] = \eta$$

$$\eta = \beta_0 + \beta_1(COMP) + \beta_2(INN) + \beta_3(LLM) + \beta_4(LIFE) + \beta_5(REP) + \beta_6(SIZE)$$

Level-2 (Make-Level) model:

$$\beta_0 = \gamma_{00} + \gamma_{01}(LL) + \gamma_{02}(AGE) + \gamma_{03}(NO) + u_0$$

$$\beta_1 = \gamma_{10} + \gamma_{11}(LL) + \gamma_{12}(AGE) + \gamma_{13}(NO) + u_1$$

$$\beta_2 = \gamma_{20} + \gamma_{21}(LL) + \gamma_{22}(AGE) + \gamma_{23}(NO) + u_2$$

$$\beta_3 = \gamma_{30} + \gamma_{31}(LL) + \gamma_{32}(AGE) + \gamma_{33}(NO) + u_3$$

$$\beta_4 = \gamma_{40} + \gamma_{41}(LL) + \gamma_{42}(AGE) + \gamma_{43}(NO) + u_4$$

$$\beta_5 = \gamma_{50} + \gamma_{51}(LL) + \gamma_{52}(AGE) + \gamma_{53}(NO) + u_5$$

$$\beta_6 = \gamma_{60} + \gamma_{61}(LL) + \gamma_{62}(AGE) + \gamma_{63}(NO) + u_6$$

In the Level-1 model above, COMP denotes the competition, whereas INN and LL represent the innovativeness and lag load of the model respectively. LIFE is the age of the model. REP and SIZE represent reputation and the market share of the model, respectively. For the Level-2 model, model level lag load, age and niche overlap are denoted by LL, AGE, NO, respectively. Substituting the Level-2 equations into Level-1 equation yields the following HGLM, which is used to test the hypotheses:

$$Prob\left(exit = \frac{1}{\beta}\right) = \varphi$$

$$Log\left[\frac{\varphi}{(1-\varphi)}\right] = \eta$$

$$\begin{aligned}\eta = \gamma_{oo} &+ \gamma_{01}(LL) + \gamma_{02}(AGE) + \gamma_{03}(NO) + \gamma_{10}(COMP) \\ &+ \gamma_{11}(COMP) * (LL) + \gamma_{12}(COMP) * (AGE) \\ &+ \gamma_{13}(COMP) * (NO) + \gamma_{20}(INN) + \gamma_{21}(INN) \\ &* (LL) + \gamma_{22}(INN) * (AGE) + \gamma_{23}(INN) * (NO) \\ &+ \gamma_{30}(LLM) + \gamma_{31}(LLM) * (LL) + \gamma_{32}(LLM) \\ &* (AGE) + \gamma_{33}(LLM) * (NO) + \gamma_{40}(LIFE) \\ &+ \gamma_{41}(LIFE) * (LL) + \gamma_{42}(LIFE) * (AGE) \\ &+ \gamma_{43}(LIFE) * (NO) + \gamma_{50}(REP) + \gamma_{51}(REP) \\ &* (LL) + \gamma_{52}(REP) * (AGE) + \gamma_{53}(REP) * (NO) \\ &+ \gamma_{60}(SIZE) + \gamma_{61}(SIZE) * (LL) + \gamma_{62}(SIZE) \\ &* (AGE) + \gamma_{63}(SIZE) * (NO) + error\ term\end{aligned}$$

RESULTS

Results for the HGLM analysis appear in Table 3.1. Analyses show that while the level of competition at model-level increases the exit rate; lifespan, reputation, and size are found to be increasing the likelihood of survival. While these results are in tandem with the extant literature, model-level effects of innovativeness and lag load –contrary to the expectations- are not statistically significant.

When it comes to the main effects of the make-level covariates, results indicate that make-level tenure in the industry increases the exit rates. On the other hand, the effects of lag load and niche overlap are found to be insignificant.

While the main effects of the make- and model-level covariates reveal interesting results, the main focus of this essay is on the cross-level interactions. Specifically, this essay postulates significant interactions between make- and model-level variables. It is found that the detrimental impact of model-level competition intensifies with tenure, and decreases with lag load, while make-level niche overlap has no impact on the relationship between make-level competition and the exit rates. Surprisingly, none of the make-level covariates of the model (i.e., lag load, tenure, and niche overlap) moderates the relationship between make-level innovativeness and exit rates. In tandem with the hypotheses of the previous essays, the interaction of make-level lag load and model level load is positive and significant. It is found that models that stayed in the market for a longer time (i.e., with higher lifespan) if they are produced by companies that have higher lag loads, tenures in the industry, and more competitors to compete with. Results also suggest that while more reputable models are more likely to survive the Red Queen Competition if they are produced by companies that have been competing in the industry for longer periods; lag load and niche overlap do not moderate the impact of reputation on the exit rates. The impact of model level sales on the exit rates is also found to moderated make-level covariates. Specifically, results suggest that while the beneficial effects of model-level sales decreases with the more make-level lag load decrease, they are, on the other hand, intensified with the age of the company.

More importantly, the results of the HGLM analyses show that the percentage of explained variance is 50.6% at the make-level and 13.1% at the model-level. Therefore, the hypothesis that the viability outcomes of model-level innovation vary systematically with differences in make-level characteristics is supported. Stated differently, make-level dynamics are associated with significant variance in the likelihood of survival.

Table 3.1: Estimation Results for Essay 3

Variable	γ	Significance
Intercept	**1.247**	**0.000**
Main effects: Model Level		
Competition	**0.094**	**0.000**
Innovativeness	0.023	0.333
Lag Load	-0.004	0.865
Lifespan	**-0.008**	**0.021**
Reputation	**-0.005**	**0.004**
Size	**-0.055**	**0.092**
Main effects: Make Level		
Lag Load	0.002	0.976
Tenure	**0.226**	**0.036**
Niche Overlap	-0.003	0.971
Cross-level Interactions		
Competition*Lag Load	**-0.019**	**0.031**
Competition*Tenure	**0.052**	**0.002**
Competition*Niche Overlap	0.020	0.125
Innovativeness*Lag Load	0.022	0.261
Innovativeness*Tenure	0.003	0.915
Innovativeness*Niche Overlap	0.004	0.891
Lag Load*Lag Load	**0.026**	**0.035**
Lag Load*Tenure	0.016	0.522
Lag Load*Niche Overlap	0.013	0.528
Lifespan*Lag Load	**-0.011**	**0.055**
Lifespan*Tenure	**-0.010**	**0.013**
Lifespan*Niche Overlap	**-0.006**	**0.017**
Reputation *Lag Load	0.000	0.969
Reputation *Tenure	**-0.004**	**0.013**
Reputation *Niche Overlap	0.000	0.879
Size*Lag Load	**0.013**	**0.04**
Size*Tenure	**-0.095**	**0.024**
Size*Niche Overlap	0.020	0.269
Explained Variance		
Make-level	13.100	
Model-level	50.600	

DISCUSSION

The primary objective of this essay is has been to build upon the extant literature on the co-evolution of, and competition among, multi-level, hierarchical systems. Organizational ecologists have acknowledged long ago that while separate and identifiable entities within an firm may experience competitive forces and co-evolutionary dynamics different than that of the firm they are within (Ingram and Roberts, 1999) they also argue that the painstaking study of the nested hierarchical structure of individuals within functions within organizations within populations is consequential in order to comprehend the quintessence of organizational ecology (Van de Ven and Grazman 1999). Based on these arguments, this essay attempts to unveil various issues pertaining to 1) the importance of incorporating an additional sub-organizational level as well as 2) the cross-level relationships in a nested hierarchical ecosystem. Using data on the competition in the U.S automobile industry over the 1946-2000 period in the empirical analyses it is suggested that model-level survival is appropriate unit of analysis. Due to the fact that not only do the manufacturers -in compliance with the pertinent regulations- provide complete specifications of a model, but also maintain a set of targeted consumer profiles for each model each model can be regarded as an “inert organizational artifact” (Van de Ven and Grazman 1999). In a similar vein, upstream and downstream supply chain activities, along with the marketing efforts, of an individual model is related to the overall capabilities of the firm, rendering the analyses at this sub-organizational level relevant for the organizational ecologists.

The results show that several make-level characteristics have significant effects on the survival probabilities of the models. Specifically, results show that level of competition increases the probability of failure. On the other hand, lifespan, reputation, and market share of a model are found to be negatively related to the probability of failure. Based on the reasons explained in the previous essay, (i.e., Essay 2) these effects are not only intuitive, but are also supported by the literature. The contribution of these findings particular to Essay 3 is that they serve as a signal of validity and reliability of the data and analyses.

Analyses yield an interesting result for the impact of the make-level covariates. Specifically, it is found that make-level tenure has a positive relationship with model-level exit rates. This finding is contradictory in the sense that, when analyzed at the organizational level, tenure in an industry is one of the most salient predictors of survival. This result can be attributed to the fact that organizations become more complex and more prone to inertia as they age (Hannan 1998). Specifically, the amount and perplexity of organizational routines, shaped for the most part by organizational culture, that inhibit the adaptive changes increase over time (Barron 1999; Hannan 1998; Levitt and March 1988; March 1988; March and Simon 1958). Therefore, extant literature shows that as they age firms start to suffer from "liability of senescence, and become more vulnerable to disruptions arising from changes in the firm (Amburgey and Rao 1996; Delacroix and Swaminathan 1991). Besides, when the history and evolution of the U.S. automobile industry are deliberated, it can be distinguished that the firms with higher tenures in the industry (e.g., Chrysler, Ford, General Motors, and Daimler-Benz) have exercised considerable amount of mergers and acquisitions. For instance Kaiser Motors acquired Willys-Overland in 1953, Chrysler acquired American Motors in 1987, Daimler-Benz acquired Chrysler in 1997. The acquired firms are most, if not all, of the time not strong competitors in the industry. Instead, they fail to generate strong competition, and hence they are acquired by strong competitors. After the acquisitions, some of the models of the acquired company are discontinued by the acquiring company during the post-acquisition re-structuring of the company. For instance, after the acquisition of Chrysler by Daimler-Benz, all Plymouth models, along with the brand were discontinued. Therefore, it can be argued that the higher exit rate of the models for the firms with higher tenures in the industry can also be explained by the acquisition of various companies that fail to effectively compete in the industry by other companies that could survive in the industry for a long time (i.e., higher tenure), a process which is mostly ensued by discontinuation of unsuccessful models –and sometimes brands- of the acquired company. The fact that the "Big Three" firms discontinue their models more frequently than their competitors, who are "younger," provides an affirmation for the findings as well.

Analyses also show that various cross-level interactions are significant predictors of model-level survival and that the variance of model-level survival is partly explained by make-level dynamics (i.e., make-level covariates account for 13.1% of the model-level variance). Taken together these two findings provide support to the only hypothesis of this essay. Therefore, by empirically showing that make-level attributes have an impact on model-level survival-rates, this essay reinforces the findings of Ingram and Roberts (1999), while complementing the evidence provided by Madsen et al. (1999), who show that sub-organizational dynamics affect the firm-level outcomes. Specifically significant cross-level interactions indicate a reciprocal relationship between the separate levels of the nested hierarchical system.

Despite the contributions of this essay, there are several issues which should be addressed in light of the findings outlined here. First, determination of the levels of the nested hierarchical system is context specific. In the context of automobile industry, it is reasonable to analyze the success and failure rates of models with regard to make- and model-level covariates. Nevertheless, in other studies, different outcomes and covariates might be specified. Second, while the proposed model in this essay has two levels, future research may consider adding other levels, super or subordinate levels, in order to explain more of coevolutionary dynamics in hierarchical ecosystems.

REFERENCES

Automotive News (1993), "America at the Wheel: 100 Years of the Automobile in America," Automotive News (Special Issue).

Aaker, D. A. (1991), Managing Brand Equity. New York: Free Press

---- (1996), "Measuring Brand Equity across Products and Markets," California Management Review, 38 (3), 102-20.

Abernathy, W. J., K. B. Clark, and A. M. Kantrow (1983), Industrial Renaissance: Producing a Competitive Future for America: Basic Books.

Abernathy, W. J. and J. M. Utterback (1978), "Patterns of Industrial Innovation," Technology Review, 80 (7), 40-47.

Aldrich, H. (1979), Organizations and Environments: Prentice Hall.

Aldrich, H. and M. Ruef (2006), Organizations Evolving: Sage Publications Inc.

Almeida, P. and B. Kogut (1999), "Localization of Knowledge and the Mobility of Engineers in Regional Networks," Management Science, 45 (7), 905-17.

Amburgey, T. L. and H. Rao (1996), "Organizational Ecology: Past, Present, and Future Directions," Academy of Management Journal, 39 (5), 1265-86.

Anderson, P. and M. L. Tushman (1990), "Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change," Administrative Science Quarterly, 35 (4), 604-33.

Andrews, K. R. (1971), "The Concept of Corporate Strategy," Irwin, Homewood, IL.

Arnold, A. J. and K. Fristrup (1982), "The Theory of Evolution by Natural Selection: A Hierarchical Expansion," Paleobiology, 8 (2), 113-29.

Arrow, K. J. (1974), The Limits of Organization. New York: Norton.

Ashby, W. R. (1954), Design for a Brain. New York: J. Wiley.

Baldwin, N., G. N. Georgano, S. Sedgwick, and B. Laban (1987), The World Guide to Automobile Manufacturers. New York: Facts on File.

Banbury, C. M. and W. Mitchell (1995), "The Effect of Introducing Important Incremental Innovations on Market Share and Business Survival," Strategic Management Journal, 16 (Summer Special Issue), 161-82.

Barnett, W. P. and R. A. Burgelman (1996), "Evolutionary Perspectives on Strategy," Strategic Management Journal, 17 (3), 5-19.

Barnett, W. P. and J. Freeman (2001), "Too Much of a Good Thing? Product Proliferation and Organizational Failure," Organization Science, 12 (5), 539-58.

Barnett, W. P., H. R. Greve, and D. Y. Park (1994), "An Evolutionary Model of Organizational Performance," Strategic Management Journal, 15 (Winter), 11-28.

Barnett, W. P. and M. T. Hansen (1996), "The Red Queen in Organizational Evolution," Strategic Management Journal, 17 (Summer), 139-57.

Barnett, W. P. and D. McKendrick (2004), "Why are Some Organizations More Competitive than Others? Evidence from a Changing Global Market," Administrative Science Quarterly, 49 (4), 535-71.

Barnett, W. P. and D. G. McKendrick (2001), The Organizational Evolution of Global Technological Competition: Information Storage Industry Center. Storage Industry Dynamics and Strategy.

Barnett, W. P. and E. G. Pontikes Eds. (2005), The Red Queen: History-Dependent Competition among Organizations. Greenwich, CT: JAI Press.

Barnett, William P. (1997), "The Dynamics of Competitive Intensity," Administrative Science Quarterly, 42 (1), 128-60.

Barney, J. (1991), "Firm Resources and Sustained Competitive Advantage," Journal of Management, 17 (1), 99.

Barron, D. N. (1999), "The Structuring of Organizational Populations," American Sociological Review, 64 (3), 421-45.

Baum, J. A. C. Ed. (1999), Whole-Part Coevolutionary Competition in Organizations. Thousand Oaks, CA: Sage Publications.

Baum, J. A. C. and P. Ingram (1998), "Survival-Enhancing Learning in the Manhattan Hotel Industry, 1898-1980," Management Science, 44 (7), 996-1016.

Baum, J. A. C. and J. V. Singh (1994a), Organizational Hierarchies and Evolutionary Processes: Some Reflections on a Theory of Organizational Evolution. New York: Oxford University Press.

---- Eds. (1994b), Organizational Hierarchies and Evolutionary Processes: Some Reflections on a Theory of Organizational Evolution. New York: Oxford University Press.

Baum, J.A.C. (1996), "Organizational Ecology," in Handbook of Organizational Studies, S.R. Clegg and C. Hardy and W.R. Nord, Eds. Thousand Oaks, CA: Sage.

Baum, J.A.C. and J.V. Singh (1994c), "Organizational Niche Overlap and the Dynamics of Organizational Founding," Organization Science, 5 (4), 483-501.

---- (1994d), "Organizational Niche Overlap and the Dynamics of Organizational Mortality," American Journal of Sociology, 100 (2), 346-80.

Bayus, B. L., G. Erickson, and R. Jacobson (2003), "The Financial Rewards of New Product Introductions in the Personal Computer Industry," Management Science, 49 (2), 197-210.

Bendix, R. (1974), Work and Authority in Industry: Ideologies of Management in the Course of Industrialization: University of California Press.

Benjamin, B. A. and J. M. Podolny (1999), "Status, Quality, and Social Order in the California Wine Industry," Administrative Science Quarterly, 44 (3), 563-89

Blau, P. M. (1977), Inequality and Heterogeneity: A Primitive Theory of Social Structure. New York: Free Press.

Blossfeld, H.P., K. Golsch, and G. Rohwer (2007), Event History Analysis with Stata. Mahwah, NJ: Lawrence Erlbaum Associates.

Bothner, M. S. (2003), "Competition and Social Influence: The Diffusion of the Sixth-Generation Processor in the Global Computer Industry," American Journal of Sociology, 108 (6), 1175-210.

Brown, S. L. and K. M. Eisenhardt (1997), "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations," Administrative Science Quarterly, 42 (1), 1-34.

Brown, T. J., P. A. Dacin, M. G. Pratt, and D. A. Whetten (2006), "Identity, Intended Image, Construed Image, and Reputation: An Interdisciplinary Framework and Suggested Terminology," Journal of the Academy of Marketing Science, 34 (2), 99-106.

Bryk, A. S. and S. W. Raudenbush (1992), Hierarchical Linear Models: Applications and Data Analysis Methods. Newbury Park, CA: Sage Publications.

Burgelman, R. A. (1991), "Intraorganizational Ecology of Strategy Making and Organizational Adaptation: Theory and Field Research," Organization Science, 2 (3), 239-62.

Buss, L. W. (1987), The Evolution of Individuality. Princeton, NJ: Princeton University Press.

Bygrave, W. D. and J. A. Timmons (1992), Venture Capital at the Crossroads. Boston, MA: Harvard Business School Press.

Cable, D. M. and D. B. Turban (2003), "The Value of Organizational Reputation in the Recruitment Context: A Brand-Equity Perspective," Journal of Applied Social Psychology, 33 (11), 2244-66.

Campbell, D. (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.V. Singh, Eds. New York: Oxford University Press.

Campbell, D. T. (1974), "Downward Causation" in Hierarchically Organized Biological Systems. Berkeley, CA: University of California Press.

---- Ed. (1990), Levels of Organization, Downward Causation, and the Selection-Theory Approach to Evolutionary Epistemology. Hillsdale, NJ: Lawrence Erlbaum.

Carmeli, A. and A. Tishler (2005), "Perceived Organizational Reputation and Organizational Performance: An Empirical Investigation of Industrial Enterprises'," Corporate Reputation Review, 8 (1), 13–30.

Carroll, G. and M. T. Hannan (2000), The Demography of Organizations and Industries. Princeton, NJ: Princeton University Press.

Carroll, G. R. (1985), "Concentration and Specialization: Dynamics of Niche Width in Populations of Organizations," American Journal of Sociology, 90 (6), 1262.

---- (1984), "Organizational Ecology," Annual Review of Sociology, 10, 71-93.

Carroll, G. R. and M. T. Hannan (1989), "Density Delay in the Evolution of Organizational Populations: A Model and Five Empirical Tests," Administrative Science Quarterly, 34 (3), 411-30.

Carroll, G. R. and J. R. Harrison (1994), "On the Historical Efficiency of Competition Between Organizational Populations," American Journal of Sociology, 100 (3), 720-49.

Carroll, G. R. and O. M. Khessina (2005), "The Ecology of Entrepreneurship," in Handbook of Entrepreneurship Research: Disciplinary Perspectives, Sharon A. Alvarez and Rajshree Agarwal and Olav Sorenson, Eds. New York: Springer.

Carroll, G. R. and A. Swaminathan (2000), "Why the Microbrewery Movement? Organizational Dynamics of Resource Partitioning in the US Brewing Industry," American Journal of Sociology, 106 (3), 715-62.

Carroll, G. R. and A. C. Teo (1996), "Creative Self-destruction among Organizations: An Empirical Study of Technical Innovation and Organizational Failure in the American Automobile Industry, 1885-1981," Industrial and Corporate Change, 5 (2), 619-44.

Cefis, E., O. Marsili, and O. Journals (2005), "A Matter of Life and Death: Innovation and Firm Survival," Industrial and Corporate Change, 14 (6), 1167-92.

Christensen, C. M. (1997), The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Cambridge, MA: Harvard Business School Press.

Christensen, C. M. and J. L. Bower (1996), "Customer Power, Strategic Investment, and the Failure of Leading Firms," Strategic Management Journal, 17 (3), 197-218.

Christensen, C. M. and R. S. Rosenbloom (1995), "Explaining the Attacker's Advantage: Technological Paradigms, Organizational Dynamics, and the Value Network," Research Policy, 24 (2), 233-57.

Cohen, W. M. and D. A. Levinthal (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation " Administrative Science Quarterly, 35 (1), 128-52.

Cole, R. E. (1999), Managing Quality Fads: How American Business Learned to Play the Quality Game. New York: Oxford University Press.

Covello, Mike (2002), Standard Catalog of Imported Cars 1946-2002 Iola, WI: Krause Publications.

Cox, David Roxbee and Joyce E. Snell (1968), "A General Definition of Residuals," Journal of the Royal Statistical Society B, 30 (2), 248-75.

Cyert, R. M. and J. G. March (1963), A Behavioral Theory of the Firm. Englewood Cliffs: Prentice-Hall.

Davies, G. (2003), Corporate Reputation and Competitiveness. New York: Routledge.

de Figueiredo, J. and M. Kyle (2001), "Competition, Innovation, and Product Exit," Massachusetts Institute of Technology

Delacroix, J. and A. Swaminathan (1991), "Cosmetic, Speculative, and Adaptive Organizational Change in the Wine Industry: A Longitudinal Study," Administrative Science Quarterly, 36 (4), 631-61.

Devaraj, S., K. F. Matta, and E. Conlon (2001), "Product and Service Quality: The Antecedents of Customer Loyalty in the Automotive Industry," Production and Operations Management, 10 (4), 424-39.

Dierickx, I. and K. Cool (1989), "Asset Stock Accumulation and Sustainability of Competitive Advantage," Management Science, 35 (12), 1504-11.

Dinopoulos, E. and C. Syropoulos (2007), "Rent Protection as a Barrier to Innovation and Growth," Economic Theory, 32 (2), 309-32.

Dobrev, S. D. and G. R. Carroll (2003), "Size (and Competition) among Organizations: Modeling Scale-Based Selection Among Automobile Producers in Four Major Countries, 1885-1981," Strategic Management Journal, 24 (6), 541-58.

Dobrev, S. D., T. Y. Kim, and G. R. Carroll (2002), "The Evolution of Organizational Niches: US Automobile Manufacturers, 1885-1981," Administrative Science Quarterly, 47 (2), 233-64.

---- (2003), "Shifting Gears, Shifting Niches: Organizational Inertia and Change in the Evolution of the US Automobile Industry, 1885–1981," Organization Science, 14 (3), 264-82.

Dobrev, S. D., T. Y. Kim, and M. T. Hannan (2001), "Dynamics of Niche Width and Resource Partitioning," American Journal of Sociology, 106 (5), 1299-337.

Dosi, G. and F. Malerba (2002), "Interpreting Industrial Dynamics Twenty Years after Nelson and Winter's Evolutionary Theory of Economic Change: A Preface," Industrial and Corporate Change, 11 (4), 619-22.

Dowell, G. and A. Swaminathan (2000), "Racing and Back-Pedalling into the Future: New Product Introduction and Organizational Mortality in the US Bicycle Industry, 1880-1918," Organization Studies, 21 (2), 405-31.

Dowling, G. (2001), Creating Corporate Reputations: Identity, Image, and Performance: Oxford University Press, USA.

Drazin, R. and C. B. Schoonhoven (1996), "Community, Population, and Organization Effects on Innovation: A Multilevel Perspective," Academy of Management Journal, 39 (5), 1065-83.

Drucker, P.F. (1999), Management Challanges for the 21st Century. New York: Harperbusiness.

Eisenhardt, K. M. and S. L. Brown (1998), "Time Pacing: Competing in Markets that won't Stand Still," Harvard Business Review, 76 (2), 59-69.

Eisenhardt, K. and B. N. Tabrizi (1995), "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry," Administrative Science Quarterly, 40 (1), 84-110.

Fahy, J. and A. Smithee (1999), "Strategic Marketing and the Resource Based View of the Firm," Academy of Marketing Science Review, 10 (1), 1-20.

Flammang, J.M. and R. Kowalke (1999), Standard Catalog of American Cars, 1976-1999 (3rd ed.). Ioia: Krause Publications.

Fombrun, C. J. (1996), Reputation: Realizing Value from the Corporate Image. Boston, MA: Harvard Business School Press.

Fombrun, C. and M. Shanley (1990), "What's in a Name? Reputation Building and Corporate Strategy," Academy of Management Journal, 33 (2), 233-58.

Freeman, C. and L. Soete (1997), The Economics of Industrial Innovation. Cambridge, MA: MIT Press.

Garcia, R. and R. Calantone (2002), "A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review," Journal of Product Innovation Management, 19 (2), 110-32.

Georgano, G. N. and T. R. Andersen (1982), The New Encyclopedia of Motorcars, 1885 to the Present: EP Dutton.

Ghemawat, P. (1991), Commitment: The dynamic of Strategy. New York: Free Press.

Ghemawat, P. and B. Nalebuff (1985), "Exit," The RAND Journal of Economics, 16 (2), 184-94.

Goldberg, M. E. and J. Hartwick (1990), "The Effects of Advertiser Reputation and Extremity of Advertising Claim on Advertising Effectiveness," Journal of Consumer Research, 17 (2), 172.

Golder, P. N. and G. J. Tellis (1993), "Pioneer Advantage: Marketing Logic or Marketing Legend?," Journal of Marketing Research, 30 (2), 158-70.

Goldsmith, R. E., B. A. Lafferty, and S. J. Newell (2000), "The Influence of Corporate Credibility on Consumer Attitudes and Purchase Intent," Corporate Reputation Review, 3 (4), 304–18.

Gort, M. and S. Klepper (1982), "Time Paths in the Diffusion of Product Innovations," The Economic Journal, 92 (367), 630-53.

Gould, S. J. (1989), "Punctuated Equilibrium in Fact and Theory," Journal of Social Biological Structure, 12, 117-36.

Grant, R. M. (1996), "Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration," Organization Science, 7 (4), 375-87.

---- (1991), "The Resource-based Theory of Competitive Advantage: Implications for Strategy Formulation," California Management Review, 33 (3), 114-35.

Greenstein, S. M. and J. B. Wade (1998), "The Product Life Cycle in the Commercial Mainframe Computer Market, 1968-1982," The RAND Journal of Economics, 29 (4), 772-89.

Greve, H. R. (2003), Organizational Learning from Performance Feedback: A Behavioral Perspective on Innovation and Change. Cambridge: Cambridge University Press

---- (1996), "Patterns of Competition: The Diffusion of a Market Position in Radio Broadcasting," Administrative Science Quarterly, 41 (March), 29-61.

Gunnell, J. (1982), Standard Catalog of American Cars, 1946-1975: Krause Publications.

Gusfield, J. R. (1957), "The Problem of Generations in an Organizational Structure," Social Forces, 35 (4), 323-30.

Hall, P. (1994), Innovation, Economics and Evolution. London: Harvester Wheatsheaf.

Hall, R. (1993), "A Framework Linking Intangible Resources and Capabilities to Sustainable Competitive Advantage," Strategic Management Journal, 14 (Novermber), 607-18.

---- (1992), "The Strategic Analysis of Intangible Resources," Strategic Management Journal, 13 (2), 135-44.

Han, J. K., N. Kim, and H. B. Kim (2001), "Entry Barriers: A Dull-, One-, or Two-Edged Sword for Incumbents? Unraveling the Paradox from a Contingency Perspective," Journal of Marketing, 65 (1), 1-14.

Hannan, M. T. (1997), "Inertia, Density and the Structure of Organizational Populations: Entries in European Automobile Industries, 1886-1981," Organization Studies, 18 (2), 193-228.

---- (1998), "Rethinking Age Dependence in Organizational Mortality: Logical Formalizations " American Journal of Sociology, 104 (1), 126-64

Hannan, M. T. and G. R. Carroll (1992), Dynamics of Organizational Populations: Density, Legitimation and Competition. New York: Oxford University Press.

Hannan, M. T., G. R. Carroll, S. D. Dobrev, and J. Han (1998a), "Organizational Mortality in European and American Automobile Industries. Part I: Revisiting the Effects of Age and Size," European Sociological Review, 14 (3), 279-302.

Hannan, M. T., G. R. Carroll, S. D. Dobrev, J. Han, and J. C. Torres (1998b), "Organizational Mortality in European and American Automobile Industries Part II: Coupled Clocks," European Sociological Review, 14 (3), 303-13.

Hannan, M. T., G. R. Carroll, and E. Dundon (1995), "Organizational evolution in a multinational context: entries of automobile manufacturers in Belgium, Britain, France, Germany, and Italy," American Sociological Review, 60 (4), 509-44.

Hannan, M. T. and J. Freeman (1989), Organization Ecology. Cambridge: Cambridge University Press.

---- (1977), "The Population Ecology of Organizations," American Journal of Sociology, 82 (5), 929-64.

---- (1984), "Structural Inertia and Organizational Change," American Sociological Review, 49 (2), 149-64.

Hannan, M. T., L. Polos, and G. R. Carroll (2003a), "Cascading Organizational Change," Organization Science, 14 (5), 463-82.

---- (2003b), "The Fog of Change: Opacity and Asperity in Organizations," Administrative Science Quarterly, 48 (3), 399-432.

Haunschild, P. R. and B. N. Sullivan (2002), "Learning from Complexity: Effects of Prior Accidents and Incidents on Airlines' Learning," Administrative Science Quarterly, 47 (4), 609-46.

Haveman, H. A. (1993), "Organizational Size and Change: Diversification in the Savings and Loan Industry after Deregulation," Administrative Science Quarterly, 38 (1), 20-50.

Henard, D. H. and D. M. Szymanski (2001), "Why Some New Products are More Successful than Others," Journal of Marketing Research, 38 (3), 362-75.

Henderson, B. D. (1983), "The Anatomy of Competition," Journal of Marketing, 47 (2), 7-11.

Henderson, R. (1995), "Of Life Cycles Real and Imaginary: The Unexpectedly Long Old Age of Optical Lithography," Research Policy, 24 (4), 631-43.

---- (1993), "Underinvestment and Incompetence as Responses to Radical Innovation: Evidence from the Photolithographic Alignment Equipment Industry," The RAND Journal of Economics, 24 (2), 248-70.

Henderson, Rebecca M. and Kim B. Clark (1990), "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," Administrative Science Quarterly, 35 (1), 9-30.

Hickson, D. J., D. S. Pugh, and D. C. Pheysey (1969), "Operations Technology and Organization Structure: An Empirical Reappraisal," Administrative Science Quarterly, 14 (3), 378-97.

Hoffman, D. A. (1997), "An Overview of the Logic and Rationale of Hierarchical Linear Models," Journal of Management, 23 (6), 723-44.

Hoffman, N. P. (2000), "An Examination of the "Sustainable Competitive Advantage" Concept: Past, Present, and Future," Academy of Marketing Science Review, 4, 1-16.

Hogeweg, P. (1994), "Multilevel Evolution: Replicators and the Evolution of Diversity," Physica D, 75 (1-3), 275-91.

Hopenhayn, H. (1992), "Entry, Exit, and Firm Dynamics in Long Run Equilibrium," Econometrica, 60 (5), 1127-50.

Hutchins, E. (1995), Cognition in the Wild. Cambridge, MA: MIT Press.

Iansiti, M. (1995), "Technology Integration: Managing Technological Evolution in a Complex Environment," Research Policy, 24 (4), 521-42.

Ingram, P. and J. A. C. Baum (1997a), "Chain Affiliation and the Failure of Manhattan Hotels, 1898-1980," Administrative Science Quarterly, 42 (1).

---- (1997b), "Chain Affiliation and the Failure of Manhattan Hotels, 1898-1980," Administrative Science Quarterly, 42 (1), 68-102

---- (1997c), "Opportunity and Constraint: Organizations' Learning from the Operating and Competitive Experience of Industries," Strategic Management Journal, 18 (Summer Special Issue), 75-98.

Ingram, P. and P. W. Roberts (1999), Suborganizational Evolution in the US Pharmaceutical Industry. Thousand Oaks: Sage Publications.

Jovanovic, B. (1982), "Selection and the Evolution of Industry," Econometrica, 50 (3), 649-70.

Jovanovic, B. and S. Lach (1989), "Entry, Exit, and Diffusion with Learning by Doing," American Economic Review, 79 (4), 690-99.

Jovanovic, B. and G. M. MacDonald (1994), "Competitive Diffusion," Journal of Political Economy, 102 (1), 24-52.

Kapferer, J. N. (1997), Strategic Brand Management: Creating and Sustaining Brand Equity Long Term. London: Kogan Page Ltd.

Keller, K. L. (1993), "Conceptualizing, Measuring, and Managing Customer-Based Brand Equity," Journal of Marketing, 57 (1), 1-22.

Khessina, O.M. (2006), "Hidden Costs of Technological Innovation: Effects of Product Innovation on Firm Survival in the Worldwide Optical Disk Drive Industry, 1983-1999," Working Paper.

Kimes, B. R. (1996), Standard Catalog of American Cars, 1805-1942. Ioia: Krause Publications.

Klepper, S. (2002), "The Capabilities of New Firms and the Evolution of the U.S. Automobile Industry," Industrial and Corporate Change, 11 (4), 645-66.

---- (1996), "Entry, Exit, Growth, and Innovation over the Product Life Cycle," American Economic Review, 86 (3), 562-83.

Klepper, S. and K. L. Simons (2000), "The Making of an Oligopoly: Firm Survival and Technological Change in the Evolution of the US Tire Industry," Journal of Political Economy, 108 (4), 728-60.

Kline, S. J. and N. Rosenberg Eds. (1986), An Overview of Innovation. Washongton D.C.: National Academy Press.

Kogut, B. (1988), "Joint Ventures: Theoretical and Empirical Perspectives," Strategic Management Journal, 9 (4), 319-32.

Kono, C., D. Palmer, R. Friedland, and M. Zafonte (1998), "Lost in Space: The Geography of Corporate Interlocking Directorates," American Journal of Sociology, 103 (4), 863-911.

Lane, P. J. and M. Lubatkin (1998), "Relative Absorptive Capacity and Interorganizational Learning," Strategic Management Journal, 19 (5), 461-77.

Lee, Y. and J. A. Nelder (2001), "Hierarchical Generalised Linear Models: A Synthesis of Generalised Linear Models, Random-Effect Models and Structured Dispersions," Biometrika, 88 (4), 987-1006.

Leonard-Barton, D. (1992), "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development," Strategic Management Journal, 13 (5), 111-25.

Levin, D. Z. (2000), "Organizational Learning and the Transfer of Knowledge: An Investigation of Quality Improvement," Organization Science, 11 (6), 630-47.

Levinthal, D. A. (1997), "Adaptation on Rugged Landscapes," Management Science, 43 (7), 934-50.

Levitt, B. and J. G. March (1988), "Organizational Learning," Annual Review of Sociology, 14 (1), 319-38.

Lippman, S. A. and R. P. Rumelt (1982), "Uncertain Imitability: An Analysis of Interfirm Differences in Efficiency under Competition," The Bell Journal of Economics, 13 (2), 418-38.

Madsen, T. L., E. Mosakowski, and S. Zaheer Eds. (1999), Static and Dynamic Variation and Firm Outcomes.

March, J. G. (1988), Decisions and Organizations. New York: Blackwell.

March, J. G. and H. A. Simon (1958), Organizations. New York: Wiley

McKendrick, D. G., J. Jaffee, G. R. Carroll, and O. M. Khessina (2003), "In the Bud? Disk Array Producers as a (Possibly) Emergent Organizational Form," Administrative Science Quarterly, 48 (1), 60-97.

McNamara, G., D. L. Deephouse, and R. A. Luce (2003), "Competitive Positioning within and Across a Strategic Group Structure: The Performance of Core, Secondary, and Solitary Firms," Strategic Management Journal, 24 (2), 161-81.

Meyer, J. W. and B. Rowan (1977), "Institutionalized Organizations: Formal Structure as Myth and Ceremony," American Journal of Sociology, 83 (2), 340-63.

Mezias, S. J. and T. K. Lant Eds. (1994), Mimetic Learning and the Evolution of Organizational Populations. New York: Oxford University Press.

Michod, R. E. (1997), "Cooperation and Conflict in the Evolution of Individuality. I. Multilevel Selection of the Organism," American Naturalist, 149 (4), 607-45.

Milgrom, P. and J. Roberts (1990), "The Economics of Modern Manufacturing: Technology, Strategy, and Organization," American Economic Review, 80 (3), 511-28.

Milne, G. R. and C. H. Mason (1990), "An Ecological Niche Theory Approach to the Measurement of Brand Competition," Marketing Letters, 1 (3), 267-81.

Mitra, D. and P. N. Golder (2006), "How Does Objective Quality Affect Perceived Quality? Short-Term Effects, Long-Term Effects, and Asymmetries," Marketing Science, 25 (3), 230-47.

Mowery, D. C., J. E. Oxley, and B. S. Silverman (1998), "Technological Overlap and Interfirm Cooperation: Implications for the Resource-Based View of the Firm," Research Policy, 27 (5), 507-23.

Nelson, R. R. (1995), "Recent Evolutionary Theorizing about Economic Change," Journal of Economic Literature, 33 (1), 48-90.

Nelson, R. R. and S. G. Winter (2002), "Evolutionary Theorizing in Economics," Journal of Economic Perspectives, 16 (2), 23-46.

---- (1982), An Evolutionary Theory of Economic Change: Harvard University Press.

Ocasio, W. (1997), "Towards an Attention-Based View of the Firm," Strategic Management Journal, 18 (Summer Special Issue), 187-206.

Okasha, S. (2005), "Multilevel Selection and the Major Transitions in Evolution," Philosophy of Science, 72 (5), 1013-25.

Pamela J Derfus, Patrick G. Maggitti, Curt Grimm, and Ken G. Smith (2008), "The Red Queen Effect: Competitive Actions and Firm Performance," The Academy of Management Journal, 51 (1), 61-80.

Petersen, T. (1991), Time-Aggregation Bias in Continuous-Time Hazard-Rate Models. Cambridge, MA: Basil Blackwell.

Pfeffer, J. and G. R. Salancik (1978), The External Control of Organizations: A Resource Dependence Perspective. New York: Harper & Row.

Podolny, J. M. (1993), "A Status-Based Model of Market Competition," American Journal of Sociology, 98 (4), 829-72.

Podolny, J. M. and G. Hsu (2003), Quality, exchange, and Knightian uncertainty.

Podolny, J. M. and T. E. Stuart (1995), "A Role-Based Ecology of Technological Change," American Journal of Sociology, 100 (5), 1224-60.

Podolny, J. M., T. E. Stuart, and M. T. Hannan (1996), "Networks, Knowledge, and Niches: Competition in the Worldwide Semiconductor Industry, 1984-1991," American Journal of Sociology, 102 (3), 659-89.

Porter, M. E. (1980), Competitive Strategy: Techniques for Analyzing Industries and Competitors New York: Free Press.

Rae, J. B. (1984), The American Automobile Industry. Boston, MA: Twayne Publishers.

Rao, H. (1994), "The Social Construction of Reputation: Certification Contests, Legitimation, and the Survival of Organizations in the American Automobile Industry: 1895-1912," Strategic Management Journal, 15 (Winter), 29-44.

Rhee, M. and P.R. Haunschild (2006), "The Liability of Good Reputation: A Study of Product Recalls in the U.S. Automobile Industry," Organization Science, 17 (1), 101-17.

Rindova, V. P. and S. Kotha (2001), "Continuous 'Morphing': Competing through Dynamic Capabilities, Form, and Function," Academy of Management Journal, 44 (6), 1263-80.

Roberts, P. W. (1999), "Product Innovation, Product-Market Competition and Persistent Profitability in the US Pharmaceutical Industry," Strategic Management Journal, 20 (7), 655-70.

Roberts, P. W. and G. R. Dowling (2002), "Corporate Reputation and Sustained Superior Financial Performance," Strategic Management Journal, 23 (12), 1077-93.

Rogers, E. M. (1995), Diffusion of Innovations. New York: The Free Press.

Rosenkopf, L. and A. Nerkar (2001), "Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disk Industry," Strategic Management Journal, 22 (4), 287-306.

---- Eds. (1999), On the Complexity of Technological Evolution: Exploring Coevolution within and across Hierarchical Levels in Optical Disc Technology. Thousand Oaks, CA: Sage Publications.

Ruef, M. (2000), "The Emergence of Organizational Forms: A Community Ecology Approach," American Journal of Sociology, 106 (3), 658-714.

Rumelt, R. P. Ed. (1987), Theory, Strategy, and Entrepreneurship. Cambridge, MA: Ballinger.

Saunders, J., P. Stern, R. Wensley, and R. Forrester (2000), "In Search of the Lemmus Lemmus: An Investigation into Convergent Competition," British Journal of Management, 11 (1), S81-S94.

Saxenian, A. L. (1994), Regional Advantage: Culture and Competition in Silicon Valley and Route 128. Cambridge, MA: Harvard University Press.

Schmalensee, R. (1978), "Entry Deterrence in the Ready-to-Eat Breakfast Cereal Industry," The Bell Journal of Economics, 9 (2), 305-27.

Schumpeter, J.A. (1942), Capitalism, Socialism and Democracy. New York: Harper and Brothers.

---- (1934), The Theory of Economic Development. Cambridge, MA: Harvard University Press.

Selznick, Philip (1949), TVA and the Grass Roots: A Study in the Sociology of Formal Organization. Berkeley, CA: University of California Press.

Shankar, V., G. S. Carpenter, and L. Krishnamurthi (1998), "Late Mover Advantage: How Innovative Late Entrants Outsell Pioneers," Journal of Marketing Research, 35 (1), 54-70.

Short, J. C., D. J. Ketchen, T. B. Palmer, and T. Hult (2007), "Firm, Strategic Group, and Industry Influences on Performance," Strategic Management Journal, 28 (2), 147-67.

Shrum, W. and R. Wuthnow (1988), "Reputational Status of Organizations in Technical Systems," American Journal of Sociology, 93 (4), 882-912.

Sine, W. D., S. Shane, and D. D. Gregorio (2003), "The Halo Effect and Technology Licensing: The Influence of Institutional Prestige on the Licensing of University Inventions," Management Science, 49 (4), 478-96.

Singh, J. V. and C. J. Lumsden (1990), "Theory and Research in Organizational Ecology," Annual Reviews in Sociology, 16 (1), 161-95.

Sitkin, S. B. (1992), Learning through Failure: The Strategy of Small Losses. Greenwich. CT: JAI Press.

Smith, M.J. (1976), "A Comment on the Red Queen," The American Naturalist, 110 (973), 325-30.

Snijders, T. A. B. and R. J. Bosker (1999), Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling: Sage Publications Inc.

Sorensen, J. B. and T. E. Stuart (2000), "Aging, Obsolescence, and Organizational Innovation," Administrative Science Quarterly, 45 (1), 81-112.

Starbuck, W. H. (1983), "Organizations as Action Generators," American Sociological Review, 48 (1), 91-102.

Stavins, J. (1995), "Model Entry and Exit in a Differentiated-Product Industry: The Personal Computer Market," The Review of Economics and Statistics, 77 (4), 571-84.

Steenkamp, J.B. and I. Geyskens (2006), "How Country Characteristics Affect the Perceived Value of Web Sites," Journal of Marketing, 70 (3), 136-50.

Stigler, G. J. (1968), The Organization of Industry. Homewood, IL: Irwin.

Stuart, T. E. (1998), "Network Positions and Propensities to Collaborate: An Investigation of Strategic Alliance Formation in a High-Technology Industry," Administrative Science Quarterly, 43 (3), 668-98.

Teece, D. J., G. Pisano, and A. M. Y. Shuen (1997), "Dynamic Capabilities and Strategic Management," Strategic Management Journal, 18 (7), 509-33.

Teece, D.J. (1986), "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy," Research Policy, 15 (6), 285-305.

Teece, D.J. and G. Pisano (1994), "The Dynamic Capabilities of Firms: An Introduction," Industrial and Corporate Change, 3 (3), 537-56.

Thompson, J. D. (1967), Organizations in Action: Social Science Bases in Administrative Behavior. New York: McGraw-Hill.

Tripsas, M. (1997), "Unraveling the Process of Creative Destruction: Complementary Assets and Incumbent Survival in the Typesetter Industry," Strategic Management Journal, 18 (Summer Special Issue), 119-42.

Tripsas, M. and G. Gavetti (2000), "Capabilities, Cognition, and Inertia: Evidence from Digital Imaging," Strategic Management Journal, 21 (10-11), 1147-61.

Turban, D. B. and D. M. Cable (2003), "Firm Reputation and Applicant Pool Characteristics," Journal of Organizational Behavior, 24 (6), 733-51.

Tushman, M. L. and P. Anderson (1986a), "Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change," Administrative Science Quarterly, 35 (4), 604-33.

---- (1986b), "Technological Discontinuities and Organizational Environments," Administrative Science Quarterly, 31 (3), 439-65.

Tushman, M. L. and J. P. Murmann (1998), "Dominant Designs, Technology Cycles, and Organizational Outcomes," Research in Organizational Behavior, 20, 231-66.

Utterback, J. M. (1996), Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change. Cambridge, MA: Harvard Business School Press.

Van de Ven, A. H. and D. N. Grazman (1999), "Evolution in a nested hierarchy: a genealogy of twin cities health care organizations, 1853-1995'," Variations in Organization Science: In Honor of Donald T. Campbell, London.

Van Valen, L. (1973), "A New Evolutionary Law," Evolutionary Theory, 1 (1), 1–30.

Wade, M. J. (1978), "A Critical Review of the Models of Group Selection," The Quarterly Review of Biology, 53 (2), 101-14.

Walley, K. (1996), "A Review, Synthesis and Interpretation of the Literature on Competitive Advantage," Journal of Strategic Marketing, 4 (3), 163-79.

Weber, M., H. H. Gerth, and C. W. Mills (1958), From Max Weber: Essays in Sociology: Oxford University Press.

Weigelt, K. and C. Camerer (1988), "Reputation and Corporate Strategy: A Review of Recent Theory and Applications," Strategic Management Journal, 9 (5), 443-54.

Wernerfelt, B. (1989), "From Critical Resources to Cororate Strategy," Journal of General Management, 14 (Spring), 4-12.

White, H. C. (1981), "Where Do Markets Come From?," The American Journal of Sociology, 87 (3), 517-47.

White, L. J. (1971), The Automobile Industry Since 1945: Harvard University Press.

Williams, J.R. (1992), "How Sustainable is Your Competitive Advantage," California Management Review, 34 (Spring), 29-51.

Williamson, O.E. (1985), "The Economic Institutions of Capitalism," New York: Free Press.

Wilson, D. S. (1997), "Altruism And Organism: Disentangling The Themes Of Multilevel Selection Theory," The American Naturalist, 150 (July), S122-S34.

Wu, J. and O. L. Loucks (1995), "From Balance of Nature to Hierarchical Patch Dynamics: A Paradigm Shift in Ecology," Quarterly Review of Biology, 70 (4), 439-66.

Zuckerman, E. W. and T. Y. Kim (2003), "The Critical Trade-off: Identity Assignment and Box-Office Success in the Feature Film Industry," Industrial and Corporate Change, 12, 27-67.