Entry Timing and the Survival of Startup and Incumbent Firms in New Industries

Raj Echambadi
Department of Business Administration
University of Illinois
Champaign, IL 61821
217.244.4189
rechamba@illinois.edu

Barry Bayus
Kenan-Flagler Business School
University of North Carolina
Chapel Hill, NC 27599
919.962.3210
Barry_Bayus@UNC.edu

Rajshree Agrawal
Robert H. Smith School of Business
University of Maryland
College Park, MD 20742
301.405.2250.
rajshree@rhsmith.umd.edu

Abstract

Using a unique firm-level longitudinal data set of twenty-two diverse consumer and industrial industries started over the past century, we empirically consider whether firm and industry characteristics affect the relationship between firm survival and entry timing. While we find no survival advantage of being the first (or second) entrant into a new industry, we do find a "window of survival advantage." Being first in a new industry is less important to long-term survival than being among the first. Early entering large incumbents have relatively high survival rates, especially in less innovative industries. While they tend to survive longer in new industries that are highly innovative, small startups typically do better by following later. Large startups do well by entering less innovative new industries after the industry has been established. In contrast to popular wisdom, we conclude that large incumbents should not shy away from creating new industries.

1. Introduction

Entry timing is one of the most important decisions a firm makes when contemplating the opportunities associated with a new industry. Yet, empirical results regarding the performance implications of these early entry decisions remains equivocal (Suarez and Lanzolla 2007; Markides and Sosa 2013). A potential reason for the conflicting empirical evidence may be that early mover advantage is contingent on both entrant characteristics and the industry environment within which they enter. Indeed, the vast majority of entry timing research assumes that any early entrant advantages (or disadvantages) apply equally to all early entrants (e.g., Lieberman and Montgomery 1998). Thus, firm heterogeneity among early entrants is ignored—entry timing recommendations are the same no matter if the firm is a small startup or a large incumbent.

Yet, there is good reason to believe that early entrants are not a homogeneous pool—numerous studies have consistently documented that new industries are pioneered by both small startups as well as large incumbent firms (e.g., Pavitt, et al. 1987; Acs and Audretsch 1990; Methe, et al. 1996; Chandy and Tellis 2000; Robinson and Min 2002; Srinivasan, et al. 2004; Acs 2005; Min, et al. 2006; Mitchell and Skrzypacz 2015). For example, the sample of consumer durables and office product pioneers assembled by Chandy and Tellis (2000) was composed of 42% small startups and 30% large incumbents. And, many of the studies represent single industry analysis, thus masking the potential effects of differences in industry characteristics on the relationship between timing of entry and firm performance. Indeed, the theoretical factors relating to early entry (dis)advantage that are identified by Lieberman and Montgomery (1988; 1998)—such as preemption of resources, network effects, and buyer switching costs—may be different across industry environments.

In this paper, we consider whether differences in firm and industry characteristics act as contingency factors that impact the performance consequences of early entry decisions. Following extant literature, we pay particular attention to entrant heterogeneity as measured by prior experience and size, and industry differences in innovativeness (e.g., Klepper and Simons 2000; Sarkar, et al. 2006; Bayus and Agarwal 2007; Chen, Williams, and Agarwal 2012). Specifically, we seek to empirically explore the following questions:

- Do early entrants into a new industry have survival advantages over later entrants?
- Should small startups enter early and help create the new industry?
- Should large incumbents wait to enter until after the new industry has taken off?
- How do the answers to these questions vary by industry innovativeness?

Our focus on firm survival as a performance outcome is consistent with existing marketing and strategy research. While it has been suggested that the correlation between survival and profitability is weak under some conditions (e.g., Shaffer 1989), it is clear that long term survival is a fundamental business objective that is of interest to shareholders, employees, the community in which the firm is based, and competitors (Mitchell 1991; McGahan 2004).

This set of research questions has not been addressed by the prior literature. While studies do consider the relative performance of pioneers either across industries (e.g., Boulding and Christen 2003; Srinivasan, et al. 2004) or as compared to first followers (e.g., Robinson and Min 2002; Min, et al. 2006; Zhu and Xu 2011), insights from this line of research is limited since the performance outcomes of pioneers are not compared to other later entrants in the same industry. More closely related to our research is Mitchell (1991) who separately examines the relationship between entry timing and survival for newcomers and incumbents, but only in technical subfields within the diagnostic imaging industry. We move beyond these studies by analyzing objective and detailed information on all the firms entering and exiting a diverse sample of twenty-two new industries over the past century, i.e., we study a longitudinal panel of over twenty-seven hundred firms and over twenty-five thousand firm-year observations. Unlike prior research on this topic, our study is not hampered by survival bias or conclusions limited to a single industry.

Answers to these questions are important for managers and policy makers responsible for encouraging innovation as an engine of economic growth (e.g., Baumol 2002). For example, if the early entrants into a new industry do not survive long enough to reap sufficient market rewards, other non-market incentives will be necessary to entice entrepreneurs and firms into these important founding roles. Moreover, answers to these questions are not intuitively obvious—even Schumpeter, the father of innovation as "creative destruction," changed his beliefs on which firms should be the source of major innovations from small entrepreneurs (Schumpeter 1934) to large established firms (Schumpeter 1942). Further, conventional wisdom based solely on industry anecdotes may be too dogmatic. In their popular book for example, Markides and Geroski (2005) take the position that the early entrants are not the long run survivors—they recommend that large experienced firms should *never* attempt to create a new market. They make three strong claims: (a) early entrants into a new industry are small startups that do not survive very long, (b) large incumbent firms are the industry consolidators that scale up a new market and thus are the long run winners, and (c) successful consolidators enter after the industry is established. Our study provides an empirical test of this claim.

In the next section, we discuss the conceptual framework underlying our study the related literature. We then turn to our empirical study, including the data we use, measures, estimation approach, and results. Finally, we discuss the implications of our findings and limitations of this research.

2. The Conceptual Framework

In this section, we discuss the conceptual framework underlying our research. Because we are interested in examining the contingency effects of firm and industry characteristics on the performance of early entrants, we briefly review each of these factors. We refrain from developing explicit hypotheses regarding these relationships, primarily because the extant theoretical and empirical literature does not provide a clear consensus on the possible contingency effects. Accordingly, the following review of the related literature should be viewed as background that guides our in-depth empirical study.

2.1 Entry Timing

The classic literature on entry timing distinguishes between pioneers and first followers based on a strict chronological timing of entry: pioneers are *the* first firm to enter the industry, while first followers are the firms that are second to enter the industry (e.g. Golder and Tellis 1993; Robinson and Min 2002). In parallel to studies that relate an industry's evolution based on chronological entry time, researchers have also identified distinct stages in an industry life-cycle that may serve as a basis for classification of cohorts of entrants. We elaborate briefly below.

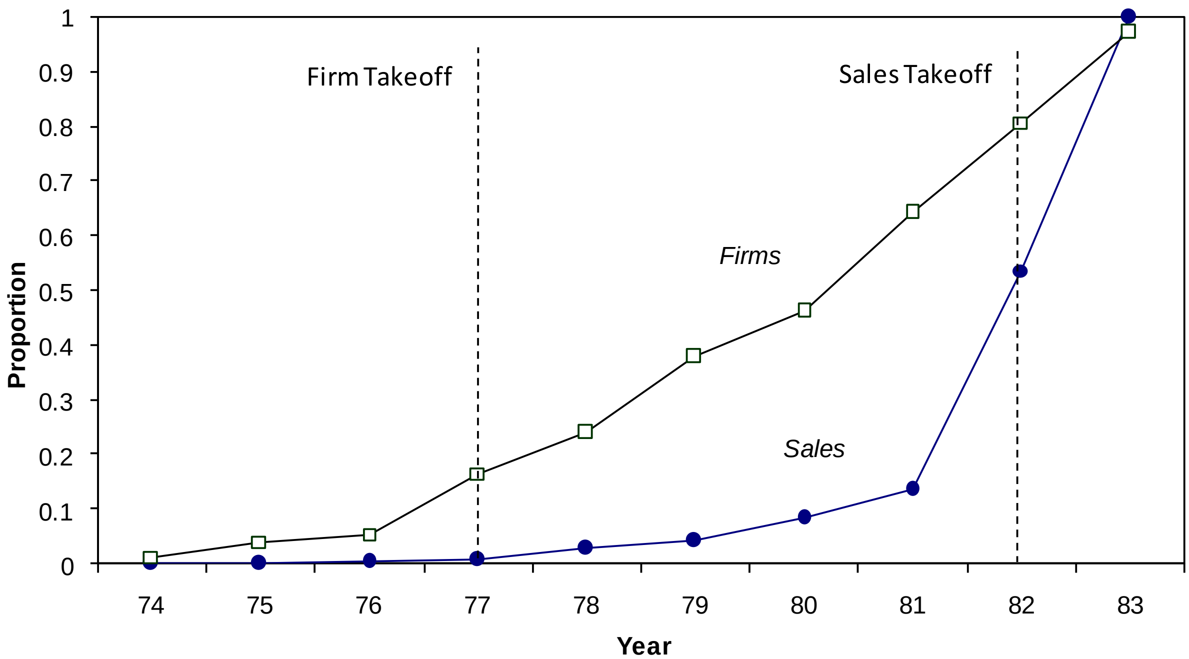
New industries are characterized by a period of slow growth immediately after commercialization that eventually turns into a sharp increase or "takeoff" in industry sales (Gort and Klepper 1982; Golder and Tellis 1997; Klepper 1997; Agarwal and Bayus 2002; Golder, Shacham, and Mitra 2009). The sales takeoff point represents the transition between the introductory and growth periods of the product life cycle. As shown in Figure 1 for example, sales growth in the personal computer industry was low for the first few years after commercialization (e.g., there was a little over 20,000 total units sold in 1976); unit sales of personal computers did not explode until 1982 (over 3 million units were sold in 1982, a 291% increase over the previous year).

Before sales take off, a nascent industry is fraught with product, technical, and market uncertainty. The first commercialized forms of an innovation are usually very primitive, and industry creation often requires significant additional product improvements. Before an industry standard is established[1], many firms introduce differentiated products based on newly available

[1]While not all industries exhibit a dominant design (Srinivasan, et al. 2006), when a new industry does have a dominant design it generally occurs after the sales takeoff (Utterback 1994; Suarez and Utterback 1995).

Figure 1

The Evolution of the Personal Computer Industry



technology as well as the successful design elements of early competitors (Utterback 1994; Agarwal and Bayus 2002; Geroski 2003; Grodal, Gotsopoulos, and Suarez 2015).

Research in economics, marketing, and technology management also confirms three further empirical regularities of new industries (Gort and Klepper 1982; Klepper 1997; Agarwal and Gort 2001; Agarwal and Bayus 2002): (1) the number of firms competing in a new industry is low at the beginning, and then dramatically increases over time, (2) any monopoly period that exists is short-lived, and (3) a takeoff in the number of firms systematically occurs before sales take off. As shown in Figure 1, there were few firms in the personal computer industry in its early years (e.g., in each year there were multiple competitors; in 1976 there were only eight competitors) and firm entry accelerated after 1977 (sixteen new competitors entered this year).

These observations highlight the fact that a single pioneering firm is rarely (if ever) wholly responsible for the success of a new industry. Early entrants *together* establish the legitimacy of a new industry via advertising and promotion activities, setting up new distribution channels and pricing arrangements, and developing a market infrastructure of complementary products and services (e.g., Brown 1981). Thus, in addition to the distinction between pioneers and first followers, we follow the evolutionary literature by studying cohorts of early entrants (e.g., Gort and Klepper 1982; Suarez and Utterback 1995; Klepper and Simons 2000; Suarez, Grodal, and Gotsopoulos 2015). Based on the general pattern in Figure 1, we define *creators* to be firms entering the new industry before the firm takeoff and *anticipators* to be entrants between the firm and sales takeoff.

We expect that the survival chances of creators and anticipators will be very different due to the dynamics associated with industry evolution and their timing of entry. Theoretically, the existence of early mover survival advantages hinges on the relative importance of preemption (e.g., whether entering early affords superior access to geographic, technological, or consumer mind-space) versus uncertainty reduction (e.g., Lieberman and Montgomery 1988; Suarez and Lanzolla 2007; Hawk, Pacheco De-Almeida and Yeung 2013). Clearly, the uncertainty facing these firms is very different—since creators represent the early cohort of the few firms that enter prior to firm take-off, they face the highest level of risk and uncertainty, while anticipators have more information based on the observed successes and failures of the creators that preceded them. In the personal computer industry for example, creators had to navigate the many different 8-bit microprocessors that were available from a very diverse set of suppliers, whereas anticipators made their selection based on the more popular 8-bit Intel microprocessors (already being used by creators) or the newest available second generation 16-bit technology (Polsson 2007a). Before the firm takeoff, personal computer manufacturers generated awareness and interest for their products through classified advertising, distributed their devices through the mail, and only arranged for the availability of rudimentary programming languages like BASIC (Polsson 2007b). After firm takeoff, several magazines touting the uses and benefits of a personal computer sprang up, distribution through independent retailers was the norm, and a more extensive set of complementary products and services were available from third parties (Polsson 2007b).

2.2 Firm Characteristics

A large body of research documents the importance of firm heterogeneity in new industries. Two firm-level characteristics that have been identified as being particularly important are pre-entry experience and size. We briefly review this literature.

Pre-entry experience is an important firm-level characteristic since founding conditions imprinted on an organization can have long-lasting effects (Stinchcombe 1965). As reviewed by Helfat and Lieberman (2002), Sosa (2006), and Sarangee and Echambadi (2014), there are several theoretical arguments associated with the advantages (competency re-use and development) and disadvantages (organizational inertia) of incumbency. Incumbents generally possess a wide range of competencies favorable to the creation of, and survival in, new industries—including capital, organizational structure, technical and market knowledge, as well as other specialized skills necessary to develop a market infrastructure. However, incumbents may also be reluctant to cannibalize their existing markets, particularly if the new product is a close substitute to their earlier offering (e.g., Chandy and Tellis 1998), and be stuck in organizational routines that hinder their decision to innovate or adapt to changing industry conditions (e.g., Leonard-Barton 1992). This suggests that startups—firms that previously never existed—may be the primary source of major innovations. Empirical studies present conflicting results: some studies contend that small startups are the primary source of really new products (e.g., Pavitt, et al. 1987; Acs and Audretsch 1990; Christensen 1997; Acs 2005), while others argue that large incumbents play a more important role in fostering innovations that lead to new industries (e.g., Methe, et al. 1996; Chandy and Tellis 2000). In terms of failure risks, empirical research consistently finds that incumbents have a survival advantage over startups in the early stages of a new industry (e.g., Klepper 1997; 2002; Min, et al. 2006).

Not surprisingly, firm size is the other dimension that has been extensively studied (e.g., Cohen and Levin 1989; Acs and Audretsch 1990; Chandy and Tellis 2000; Camison-Zornoza, et al. 2004; Acs 2005). In general, the effects of size and incumbency are intertwined—firms with prior experience also tend to be large. Consequently, the theoretical arguments for and against incumbents have been applied to large firms (e.g., large firms have substantial resource endowments to draw upon but can also be encumbered by organizational inertia; Chandy and Tellis 2000). The organizational ecology literature consistently finds that size is positively related to firm survival (e.g., Carroll and Hannan 2000). This liability of smallness stems from multiple sources: selection processes that favor the structural inertia of large organizations (Hannan and Freeman 1984), access that large firms have to capital and trained manpower (Baum and Oliver 1991), inefficiencies of small firms resulting from not being at the minimum efficient scale, and a lack of production and procurement economies (Audretsch and Mahmood 1995).

2.3 Industry Innovativeness

We also consider how differences in industry innovativeness help us better understand the entry timing and survival of startup and incumbent firms. Our notion of industry innovativeness relates to innovation opportunities made possible by knowledge investments in an industry (Romer 1986). Highly innovative industries are characterized by rapid and frequent product and process technology introductions, as well as high levels of R&D expenditures (Zahra 1996; Sarkar, et al. 2006). As noted by John, et al. (1999), R&D know-how represents a greater portion of investments in high-tech industries. Empirical research demonstrates that new industries vary widely in their underlying technological innovativeness (Schmookler 1966; Mansfield 1968; Klevorick, et al. 1995). These differences stem from firm investments in knowledge-generating activities like R&D (e.g., Klevorick, et al. 1995). Arrow (1962) first drew attention to the non-excludable and non-rival nature of technological developments, and many researchers have since highlighted the role of knowledge spillovers in enabling further technology development, often by new entrants (Klevorick et al. 1995; Rosenkopf and Almeida 2003; Agarwal, et al. 2004; Sarkar, et al. 2006; Chen, Williams, and Agarwal 2012). Moreover, the non-excludable nature of technological change implies that firms cannot easily block rivals from developing and commercializing their own products in highly innovative industries (Levin, et al. 1987). In industries flush with innovative opportunities, entrants can differentiate their products in a number of ways and can target niche market segments (Comanor 1967; Baldwin, et al. 2002). Highly innovative industries are also conducive to inter-firm product and technical experimentation—thus permitting key product specifications and technical issues to be worked out quickly (e.g., Greve and Taylor 2000).

Industry innovativeness is strongly related to firm entry and survival (Audretsch 1995; Audretsch and Mahmood 1995; Sarkar, et al. 2006). Highly innovative industries tend to have high entry rates (Gort and Klepper 1982; Acs and Audretsch 1990; Audretsch 1995; Bayus, et al. 2007), but the elevated turbulence and uncertainty in these environments also results in higher failure rates (Audretsch 1995; Audretsch and Mahmood 1995). Thus, the existing literature provides strong evidence that industry innovativeness will significantly impact firm entry and survival.

2.4 Summary

In summary, our literature review suggests a need to examine the relationship between entry timing and firm survival while taking into account how firm and industry level characteristics such as pre-entry experience, size and industry innovativeness may affect this relationship. While each factor has been identified as being important to firm performance, there is little guidance offered by the extant literature that enables the development of specific hypotheses. Importantly, the underlying theoretical rationale for any potential advantages may have offsetting effects. Among early entrants, advantages of startup flexibility may be tempered by incumbent possession of relevant related knowledge. Similarly, the ability of small creators to grow with the industry may be countered by the ability of large anticipators to consolidate the market to their advantage. Industry innovativeness may likewise help or hinder creators and anticipators possessing different firm-level characteristics. For example, highly innovative industries simultaneously present small startup *creators* the opportunity to create new markets and appropriate the value from their innovation, but, at the same time, the uncertainty and risk of the competitive landscape that they confront is high in such industries. Accordingly, to shed light on our research questions we turn to a systematic analysis of comprehensive data on entrants (creators, anticipators, and later followers) across multiple industries that vary in their level of innovativeness.

3. Data and Variable Definitions

To identify an appropriate sample of new industries to study, we build on the work of Golder and Tellis (1997) and Agarwal and Bayus (2002) that report firm and sales takeoff times for several consumer and industrial innovations. Following other researchers (Gort and Klepper 1982; Agarwal and Bayus 2002; Robinson and Min 2002; Min, et al. 2006; Sarkar, et al. 2006; Wu 2013), we rely on the *Thomas Register of American Manufacturers* for detailed information on firm entry and exit within an industry. The *Thomas Register* is a national buying guide to the full range of products manufactured in the United States that strives to achieve complete representation of domestic manufacturers (Lavin 1992). To ensure inclusion of all firms producing a particular product, the *Thomas Register* looks for startup ventures in university incubators and subscribes to a broad range of industry newsletters (see also Gort and Klepper 1982). Inclusion in the *Thomas Register* is free; as such, the *Thomas Register* obtains an unbiased census of firms in an industry. Important for our purposes is that the *Thomas Register* includes both public and private firms, as well as provides a consistent and systematic definition of an industry and the relevant competing firms.

Matching the innovations considered by Golder and Tellis (1997) and Agarwal and Bayus (2002) with the data available from the *Thomas Register* resulted in twenty-two new industries for

Table 1
Key Dates for Our Sample of New Industries
(from Golder and Tellis 1997; Agarwal and Bayus 2002)

New Industry	**Commercialization Year**	**Firm Take-Off Year**	**Sales Take-Off Year**
Phonograph Record	1897	1917	1919
Outboard Engine	1913	1916	1936
Electric Blanket	1915	1923	1952
Dishwasher	1915	1951	1955
Clothes Washer	1921	1923	1933
Freon Compressor	1935	1938	1964
Cathode Ray Tube	1935	1943	1949
Clothes Dryer	1935	1946	1950
Electric Razor	1937	1938	1943
Styrene	1938	1943	1946
Piezoelectric Crystals	1941	1944	1973
Home Freezer	1946	1947	1950
Antibiotics	1948	1950	1956
Turbojet Engine	1948	1949	1951
Ball-Point Pen	1948	1957	1958
Garbage Disposer	1949	1953	1955
Magnetic Recording Tape	1952	1953	1968
Heat Pump	1954	1960	1976
Home Microwave Oven	1970	1974	1976
Microcomputer	1974	1977	1982
Home VCR	1974	1975	1980
Compact Disc Player	1983	1984	1985

which appropriate firm-level data could be assembled (see Table 1). These twenty-two industries include a diverse mix of important consumer and industrial innovations introduced in the United States during the past century. Many of these innovations were introduced between 1905 and 1966, which is generally believed to be the most technologically progressive period in US economic history (e.g., Field 2003). These data are objective and hence do not suffer from self-report biases that one typically encounters in survey research, or survival biases that typically plagues studies using retrospective information.

Year of firm entry and exit (if observed) were constructed by manually examining annual issues of the *Thomas Register* for at least ten years after each innovation was commercialized. Checks were made to confirm that actual entry occurred and care was taken to ensure that existing firms that had been renamed or relocated were not added as additional entries. As is common practice with these data (Mansfield 1962; Robinson and Min 2002), mergers between firms were treated as the continuance of the larger firm and exit of the smaller firm[2]. Our final longitudinal panel database includes a total of 2,746 firms and 25,618 firm-year observations.

3.1 Firm-Level Variables

Using the information in Table 1, we classify firms entering before the firm takeoff as *creators* and firms entering between the firm and sales takeoff as *anticipators* (the baseline cohort is firms that enter after the sales takeoff). We also identify market pioneers for the twenty-two industries in order to contrast our results with exiting research. Recognizing the inherent problems in identifying true market pioneers, we follow Robinson and Min (2002) and Min, et al. (2006) by defining *pioneers* to be firms entering during the commercialization year and *first followers* to be second entrants (i.e., first entrants after the entry of the market pioneers)[3]. Since our emphasis is on the early entrants into new industries, firms that follow after sales take off serve as the baseline for our survival analyses.

Incumbency is determined based on information in the *Thomas Register*. If a firm was listed in the index volumes of the *Thomas Register* for the year preceding its entry into the focal industry, it was classified as an *incumbent* firm (otherwise it was classified as a *startup*). The resulting classifications were also confirmed using other data sources such as Lexis/Nexis.

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[2]In our data, mergers accounted for less than three percent of exits. Estimation results excluding the merged firms do not change our substantive conclusions.

[3]Because we only have annual data, the industries we study can have multiple *pioneers* and *first followers*.

Prior studies have measured firm size in terms of the number of employees, sales volume, or assets; these operationalizations give very similar empirical results (Chandy and Tellis 2000). In our study, firms are considered to be *large* or *small* based on categories of current dollar assets in the year of entry as listed in the *Thomas Register*. *Large* firms are defined to be those with assets greater than 1.4M (in 1982 dollars) at the turn of the century, and over time, consecutive asset categories were added to the *large* firm definition to appropriately adjust for inflation[4].

Descriptive statistics on our sample of firms is in Table 2. In line with the prior literature, we find that early entrants include both *small startups* and *large incumbents* (as well as *small incumbents* and *large startups*). Across all twenty-two industries, there are significantly fewer *large incumbent creators* than *small startup creators*. This significant difference is also evident in industries with higher innovativeness. For the less innovative industries however, the *large incumbents* tend to outnumber the *small startups*.

Finally, because firm tenure in a new industry has been found to be an important explanatory variable (Carroll and Hannan 2000), we include *firm age* (measured as the number of years the firm participated in this industry) and its square (to capture any non-linear effects) as control variables.

3.2 Industry-Level Variables

Following prior research (e.g., Sarkar, et al. 2006), information on total (company, federal, other) industry R&D expenditures (as a percentage of sales) at the three-digit SIC level is used to quantify *industry innovativeness*. Our measure is derived from statistics published in the Survey of Industrial Research and Development over the 1987-1997 period. As such, this measure reflects a "steady-state" level of innovativeness since this period is after the sales takeoff for all our industries.

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[4]We note that our substantive conclusions are robust to an alternative operationalization used by Robinson and Min (2002), i.e., firms are considered to be small if their size is less than the 60th percentile of the size distribution for all firms entering in a given decade.

Table 2

Descriptive Statistics of Entrant Cohorts

	Small Startups	***Small Incumbents***	***Large Startups***	***Large Incumbents***
All Industries				
Pioneers (n=63)	38%	14%[a]	25%	22%[b]
First Followers (n=53)	38%	19%[a]	15%[a]	28%
Other Creators (n=123)	37%	18%[a]	18%[a]	27%[b]
Creators (n=239)	38%	19%[a]	17%[a]	26%[a]
Anticipators (n=521)	35%	17%[a]	15%[a]	33%
More Innovative Industries[1]				
Pioneers (n=51)	43%	16%[a]	24%[a]	18%[a]
First Followers (n=38)	45%	11%[a]	18%[a]	26%[b]
Other Creators (n=78)	44%	14%[a]	18%[a]	24%[a]
Creators (n=167)	44%	14%[a]	20%[a]	23%[a]
Anticipators (n=364)	40%	16%[a]	16%[a]	29%[a]
Less Innovative Industries[1]				
Pioneers (n=12)	17%	8%	33%	42%
First Followers (n=15)	20%	40%	7%	33%
Other Creators (n=45)	27%	24%	18%	31%
Creators (n=72)	24%	25%	18%	33%
Anticipators (n=157)	24%	19%	13%[a]	44%[a]

[a]significantly different from the *Small Startup* percentage at the 0.05 level
[b]significantly different from the *Small Startup* percentage at the 0.10 level
[1]Based on a median split

Moreover, this measure varies across industries but is time-invariant. Even though industries may exhibit ups and downs in R&D allocations, cross-industry variation is relatively robust. As Klevorick, et al. (1995; 188) note, "[A] striking characteristic of industries that are commonly thought to be rich in technological opportunities is that high R&D intensities and high rates of technical advance tend to be sustained over time." As a result, industries like clothes washer, ball-point pen, and heat pump have relatively low industry innovativeness, whereas other industries like cathode ray tube, turbojet engines, and microcomputers are considered to be more innovative. The median value of *industry innovativeness* for our sample is 2.9 (minimum=2.2; maximum=13)[5].

The theory of density dependence, based on the contrasting effects of legitimization and competition, postulates a U-shaped survival relationship to firm density: initial increases in the number of firms and the associated rise in legitimacy results in a decline of exit rates for all firms, but at higher levels of firm density competitive effects intensify and exit hazard rates increase (Carroll and Hannan 2000). Because there is wide variation in the peak number of firms across the industries we study, we include a relative measure of time-varying *density* (computed as the contemporaneous number of firms divided by the observed peak number of firms in the industry) and its square as control variables (see also Agarwal, et al. 2002). We also include a measure of *founding density* (*density* in the entry year) as the prior literature suggests that higher competitive intensity at entry is related to lower survival rates (Carroll and Hannan 2000). As with density, the measure of founding density is scaled by the peak number of firms in order to enable comparisons across industries. Finally, we include twenty-one industry dummy variables in all our survival estimations to control for any cross-sectional industry effects (e.g., due to different commercialization dates) and *year* to control for any temporal trends.

4. Estimation Model

To study firm survival, we examine firm-level hazard rates $h_i(t, X)$. By definition, $h_i(t, X)$ is the probability that firm *i* will exit in interval $t + \Delta t$, conditional on it having survived up to *t*. Here, X is a vector of explanatory variables. We make the standard assumption that the hazard rate

[5]We obtain similar results using the alternative measure used in the literature (Robinson and Min 2002) is based on R&D intensity operationalized as the ratio of R&D employees to total employees developed by the Bureau of Labor Statistics (see Hadlock, et al. 1991). Further, sensitivity checks involving alternative classifications of the borderline cases of industry innovativeness did not change our substantive conclusions.

satisfies the proportional hazard specification $h_i(t,X) = h_0(t)e^{\beta X}$ where β is the vector of parameters to be estimated.

Because our data are longitudinal, it is possible that the within-firm information is correlated. Moreover, clustering (wherein data are pooled across firms that share a common characteristic) may lead to correlated data. Failure to incorporate these correlations can lead to biased coefficient estimates and incorrect statistical inferences (Diggle, et al. 2002). Consequently, we use generalized estimating equations (GEE) developed by Liang and Zeger (1986) that allow the data to be modeled as a general linear model while enabling correlated within-firm observations, and are also flexible enough to accommodate categorical dependent variables.

Our GEE model is developed as follows. First, the expected value of the marginal response is specified as a linear combination of explanatory variables, $\eta_{it} = X_{it}\beta$. We specify a complementary log-log link function $\log(-\log(\mu_{it}))$ which relates the expected value of the dependent variable y_{it} ($\mu_{it} = E[y_{it}]$) to the linear predictor η_{it}: $\log(-\log(\mu_{it})) = \eta_{it}$. We specify an exchangeable structure for the working covariance matrix of y_{it}, $V(\alpha) = \varphi A_i^{0.5} \mathrm{R}_i(\alpha) A_i^{0.5}$ where φ is a constant, A_i is the n ×n diagonal matrix with $V(\mu_{it})$ as the jth diagonal element. With this GEE specification, we estimate the regression coefficients β by solving the estimating equation

$$U(\beta) = \sum_i \frac{\partial \mu_i}{\partial \beta} (V(\alpha))^{-1} (y_i - \mu_i) = 0 .$$

Because GEE model parameters are estimated using quasi-likelihood procedures, there is no associated likelihood underlying the model. Thus, the usual likelihood-ratio tests cannot be applied. To statistically compare GEE models and coefficient estimates, however, one can construct a multi-parameter Wald test to test the joint null hypothesis that a set of βs equal 0 (e.g., Hedeker 2005). The multi-parameter, or generalized, Wald test is given by $\chi^2 = \hat{\beta}^1 C^1 \left(CV(\hat{\beta})C^1 \right)^{-1} C\hat{\beta} \Big)$ which is distributed as χ^2 with q degrees of freedom under the null hypothesis. C is a q×p indicator matrix of ones and zeros to select the parameters of interest for the multi-parameter test. Here, p equals the number of regressors in the full model (including the intercept) and q equals the number of parameters in the multi-parameter test (i.e., the difference in regressors between the full and reduced models).

5. Empirical Results

Estimation results for the separate effects of entrant cohort, size, and incumbency are in Table 3 and the detailed results for the various entrant cohorts by industry innovativeness are in Table 4. Across all our analyses, we obtain similar results for the control variables. The significant coefficient estimates for the linear and quadratic *firm age* terms imply that firms are subject to a liability of obsolescence, i.e., firms' initially successful alignment with its founding environment erodes over time due to structural inertia and an inability to make necessary adjustments (Carroll and Hannan 2000). The significant estimates for the linear and quadratic *density* terms are consistent with the U-shaped theory of density dependence, and the positive effect of *founding density* on firm exit is as expected. The significant and negative coefficient estimates for *year* imply that firm survival rates are generally higher in the more recent years.

Table 3 presents the main effect models for our key variables of interest. From Model 1, both *creators* and *anticipators* have a lower probability of exit than the follower base line group of firms that enter after the sales takeoff. *Incumbents,* regardless of whether they are small or large, have lower probabilities of exit than *startups* (here, *large startups* are the baseline comparison). Notably, while size does not matter among *startups*, *large incumbents* have marginally higher survival rates than *small incumbents* (Wald coefficient test: χ^2=2.59; p<0.11). Consistent with the notion that higher levels of

Table 3
GEE Estimation Results* of Firm Exit
(standard errors in parentheses)

	Model 1	Model 2	Model 3
Entry Timing			
Pioneer		-0.02 (0.10)	
First Follower		-0.11 (0.11)	
Other Creator		-0.16 (0.05)[a]	
Creator	-0.13 (0.05)[a]		-0.49 (0.06)[a]
Anticipator	-0.08 (0.03)[a]	-0.08 (0.03)[a]	-0.30 (0.05)[a]
Entry Timing			-1.06 (0.05)[a]
Creator × Entry Timing			0.15 (0.13)
Anticipator × Entry Timing			0.01 (0.09)
Firm Characteristics			
Small Startup	-0.02 (0.02)	-0.02 (0.02)	-0.02 (0.01)
Large Incumbent	-0.18 (0.03)[a]	-0.18 (0.03)[a]	-0.18 (0.03)[a]
Small Incumbent	-0.12 (0.03)[a]	-0.12 (0.03)[a]	-0.11 (0.03)[a]
Industry Innovativeness	0.18 (0.03) [a]	0.25 (0.04) [a]	0.19 (0.03) [a]
Controls			
Firm Age	0.04(0.00)[a]	0.04 (0.00)[a]	0.05(0.00)[a]
Firm Age^2 (x10^{-2})	-0.04 (0.00)[a]	-0.05 (0.00)[a]	-0.08 (0.00)[a]
Density	-1.13 (0.11)[a]	-1.13 (0.11)[a]	-0.62 (0.10)[a]
Density^2	0.77 (0.09)[a]	0.77 (0.09)[a]	0.48 (0.08)[a]
Founding Density	0.09 (0.04)[b]	0.09 (0.04)[b]	0.04 (0.04)
Year (x10^{-2})	-0.42 (0.16)[b]	-0.41 (0.16)[b]	na[1]
Constant	6.25 (3.18)[b]	5.27 (3.20)[c]	1.78 (0.27)[a]
Wald χ^2	2644.91[a]	2643.46[a]	2429.01[a]
N	25618	25618	25618

*21 industry dummy variables included in estimations but not reported
[1]Because *Firm Age*, *Entry Timing* and *Year* together form a mathematical identity, we must exclude one of these variables from our model.
[a]significant at 0.01 level ; [b]significant at 0.05 level

technological change imply a more challenging environment for survival, the coefficient estimate for *industry innovativeness* is positive and significant.

In Model 2 (Table 3), we consider whether *pioneers* and *first followers* have survival advantages over other entrants. Interestingly, neither *pioneers* nor *first followers* have coefficients that are statistically significant, indicating that there are no survival advantages for these firms. In agreement with our results in Model 1 however, the negative and significant coefficient estimate for *other creators* suggests that *creators* as a group have lower mortality rates (or higher survival rates) than followers entering after the sales takeoff. We further confirm that chronological entry time within the *creator* and *anticipator* cohorts does not matter in Model 3 (Table 3). Defining *entry timing* for each firm as the difference between its year of entry and the initial year of industry commercialization (see Table 1), we find that the interaction terms involving entrant cohort are not signficant (the coefficient estimates of *creator* and *anticipator* are statistically different according to a Wald coefficient test: χ^2=9.67; p<0.01). From these results, a "window of survival advantage" based on entrant cohort (rather than a specific chronological time or order of entry) captures the relationship between survival and entry timing.

We now turn to our results that illuminate the differences in survival rates among entrant cohort and industry innovativeness. Given the structural collinearity issues that three and four-way interaction models may introduce that make it difficult to obtain significant lower order interaction terms (Echambadi and Hess 2007), we employ a variant of a technique proposed by Gruber (1994). We define a set of eight mutually exclusive firm categories based on entry cohort (*creator*, *anticipator*) [6], size (*large*, *small*), and incumbency (*startup*, *incumbent*)—here, the baseline includes all firms entering after the sales takeoff. As noted by Sarkar, et al. (2006), this approach is

[6]In line with our findings from Table 3, we focus on entry cohorts defined by *creators* and *anticipators* and do not include the additional distinction of *pioneer* and *first followers*. The results from an analysis of entry cohorts including *pioneers* and *first followers* are substantially similar, and available from the authors upon request.

Table 4
GEE Estimation Results* of Firm Exit by Entrant Cohort
(standard errors in parentheses)

	Model 1	**Model 2**
Creators		
Small Startup	0.02 (0.09)	0.37 (0.16)[a]
Large Incumbent	-0.25 (0.09)[a]	-0.46 (0.15)[a]
Large Startup	0.07 (0.11)	-0.33 (0.20)
Small Incumbent	-0.07 (0.13)	0.21 (0.23)
Small Startup × Industry Innovativeness		-0.06 (0.02)[a]
Large Incumbent × Industry Innovativeness		0.05 (0.03)[b]
Large Startup × Industry Innovativeness		0.07 (0.03)[b]
Small Incumbent × Industry Innovativeness		-0.07 (0.04)
Anticipators		
Small Startup	-0.02 (0.07)	0.33 (0.13)[a]
Large Incumbent	-0.11 (0.06)[b]	-0.38 (0.11)[a]
Large Startup	0.17 (0.08)[b]	-0.61 (0.16)[a]
Small Incumbent	-0.06 (0.08)	-0.15 (0.17)
Small Startup × Industry Innovativeness		-0.05 (0.02)[a]
Large Incumbent × Industry Innovativeness		0.06 (0.02)[b]
Large Startup × Industry Innovativeness		0.13 (0.03)[a]
Small Incumbent × Industry Innovativeness		0.02 (0.02)
Industry Innovativeness	0.28 (0.02)[a]	0.28 (0.02)[a]
Controls		
Firm Age	0.04 (0.00)[a]	0.03 (0.00)[a]
Firm Age^2 (x10^{-2})	-0.04 (0.00)[a]	-0.04 (0.00)[a]
Density	-1.26 (0.17)[a]	-1.25 (0.17)[a]
Density^2	0.93 (0.14)[a]	0.93 (0.14)[a]
Founding Density	0.14 (0.06)[b]	0.16 (0.06)[b]
Year (x10^{-2})	-0.30 (0.15)[b]	-0.27 (0.15)[b]
Constant	4.44 (2.90)	3.81 (2.94)
Wald χ^2	3755.35[a]	3984.13[a]
N	25618	25618

*21 industry dummy variables included in estimations but not reported
[a]significant at 0.01 level ; [b]significant at 0.05 level

mathematically equivalent to a fully specified, multiplicative interaction model and enjoys two major advantages. First, this approach allows the investigation of firm survival across different groups, and hence permits an immediate comparison of the survival rates of each group relative to the baseline. Second, this approach provides an easy way to test the invariance of survival probabilities across any two groups through the use of multivariate Wald tests[7].

Model 1 in Table 4 provides estimates of the effects of firm characteristics on mortality rates. *Large incumbents* that are *creators* as well as *anticipators* have relatively high survival rates whereas *large startup anticipators* have high mortality rates. The results reported for the full model in Model 2 (Table 4) reveal clear evidence of contingency effects. The negative and significant coefficient estimates indicate that *large incumbents* and *large startups* have higher survival rates than other entrants. At the same time, the positive and significant coefficient estimates imply that *small startups* generally have the lowest survival rates of all entrants. Interestingly, entry timing matters for *large* but not *small* firms (the coefficient estimates for *small incumbents* are insignificant and the coefficient estimate for *small startup creators* is not significantly different than that for *small startup anticipators*). *Large incumbent creators* have higher survival rates than *large incumbent anticipators* (Wald coefficient test: $\chi^2=17.63$; $p<0.01$), while *large startup anticipators* have higher survival rates than *large startup creators* (Wald coefficient test: $\chi^2=16.82$; $p<0.01$). These findings suggest that *small startups* should enter after the sales takeoff, while *large incumbents* should enter in the early stages of a new industry before the firm takeoff (and *large startups* should enter after the firm takeoff but before the sales takeoff).

[7]As suggested by Echambadi and Hess (2007), we randomly partitioned the data into multiple subsets and estimated several three-way interaction models. The estimated coefficients were stable across the various datasets, indicating no serious collinearity problems.

The significant coefficient estimates for the interaction terms in Table 4 also indicate that there are contingency effects with respect to *industry innovativeness*[8]. The negative and significant interaction terms imply that *small startups* in more innovative industries have higher survival rates than *small startups* in less innovative industries. The positive and significant interaction terms indicate that *large incumbents* and *large startups* in more innovative industries have lower survival rates than similar firms in less innovative industries.

Together, these results imply that *large incumbents* generally fare well by entering early and helping to create the new industry, particularly in less innovative industries. While they tend to survive longer in new industries that are highly innovative, *small startups* typically do better by waiting until the product, technical and market uncertainty has been resolved and entering after sales have taken off. Finally, *large startups* seem to thrive by entering less innovative new industries after the *creators* have established a foothold but before there is a general sales takeoff.

6. Discussion and Implications

Marketing strategies typically involve the interaction of two processes—value creation and value appropriation—in creating sustained competitive advantage (Mizik and Jacobson 2003). Conventional wisdom and popular press accounts suggest that the value creators may not be the same as the value appropriators. For example, Markides and Geroski (2005) contend that the early entrants into a new industry do not survive long enough to reap the rewards associated with long run survival. Consequently, they recommend that large incumbents only enter after the industry is established. In contrast to this popular viewpoint, our results provide greater optimism for creators: we find that creators have the highest probability of survival, and thus they are also the ones poised to reap a sufficient share of the market rewards associated with the new industry. This finding is

[8]Although it is not recommended (e.g., Irwin and McClelland 2003), we also examined the robustness of these results by estimating a model in which *industry innovativeness* was dichotomized (mean and median split). Our general results are robust to this alternative formulation.

also intuitively appealing as it confirms that there are inherent advantages associated with the decision to create a new industry. Further, we find that rather than a "one size fits all" strategy, firms need to pay close attention to how their characteristics match the industry environment that they are entering (Helfat and Lieberman 2002).

6.1 Do early entrants into a new industry have survival advantages over later entrants?

Consistent with other studies (Golder and Tellis 1993; Min, et al. 2006), we find no survival advantage of being the first (or second) entrant in a new industry. However, the results in Table 3 do indicate that there is a survival advantage for firms entering before the firm takeoff (i.e., creators). This more general "early-entrant" advantage is consistent with existing research (e.g., Lieberman and Montgomery 1988; Suarez and Lanzolla 2007; Suarez et al. 2015). Importantly, we extend this literature by demonstrating that entering prior to the firm takeoff provides a survival advantage rather than whether a firm is first or second, per se. This "window of survival advantage" is related to whether the firm is part of the crucial formative years before the spike in competitive entry, *not* to a specific chronological time or order of entry.

The implication of this finding is clear—firms don't need to worry if they miss the chance to be first or second in a new industry. At the same time however, firms should not wait too long on the sidelines as a new industry develops since that is detrimental to their long run prospects. Rather, firms should monitor the evolution of competition in new industries so that they do not miss the early window of opportunity. Entering prior to firm takeoff enables participation in the exploration, creation, and development of the new industry. The survival advantages that accrue to firms entering during this window may stem from their ability to a shape the new industry towards their own resources and strengths. Importantly, the activities of the (few) firms that enter prior to the firm takeoff may be synergistic rather than deleterious—their collective actions may raise consumer awareness about the new industry and thus increase industry demand more than the efforts of any individual firm.

6.2 Should small startups enter early and help create the new industry?

Our results in Table 4 suggest that small startup creators and anticipators generally have relatively high mortality rates as compared to later followers. Although this finding is consistent with separate strands of empirical literature, this result may seem somewhat surprising given that the majority of creators are small startups (e.g., Markides and Geroski 2005). Table 5 summarizes some survival statistics for the various creator cohorts in our sample. Size, more so than prior experience, is positively related to long run survival. Why do so many small startups enter during the formative years of a new industry when so few of them survive in the long run? As demonstrated by Stiglitz and Weiss (1981), limited liability laws may encourage entrepreneurs to take greater risks than large, established firms[9]. With few assets to protect and outside investors having a relatively large share of the capital at risk if the venture fails, small startups may be inclined to "swing for the fences." While the chances of long run survival are typically low for small startup creators, the few survivors can obtain high rewards. Using the results reported in Table 4, the estimated mortality rate of small startup creators sharply declines over time as compared to the relatively flat mortality rate of large incumbents (see Figure 2). This implies that the survival chances of small startups that enter early and survive the initial years improve dramatically. Together, these results emphasize the high risk versus high reward strategy that many small startups follow in new industries.

6.3 Should large incumbents wait to enter until after the new industry has taken off?

In direct contrast to the recommendations of Markides and Geroski (2005), our empirical results strongly suggest that large incumbent firms should participate in the creation of new industries (see Table 4). Large incumbent creators are able to engage in both value creation and appropriation, and

[9]Shane (2008) discusses other reasons, including personal psychic rewards, why entrepreneurs start new businesses despite the fact that hardly any survive more than a few years.

thus likely to do well. Large incumbent firms not only have scale related advantages to experiment with various product technologies, but they are more likely to enjoy strong institutional support (Baum and Oliver 1991). Also, early entry by large incumbent firms in industries that are relatively stable and have low technological change may lead to advantages associated with quickly moving up the experience curve and down the production cost curve. It is interesting to note that unlike large incumbent creators firms, we find that large startup creators do not enjoy lower mortality rates than large startup anticipators. This suggests that pre-entry experience is a critical determinant of the successful creation and development of new industries for large firms.

6.4 How do the answers to these questions vary by industry innovativeness?

Although the fundamental thrust of our answers to the above three research questions does not vary by industry innovativeness, we do find several interesting contingency effects.

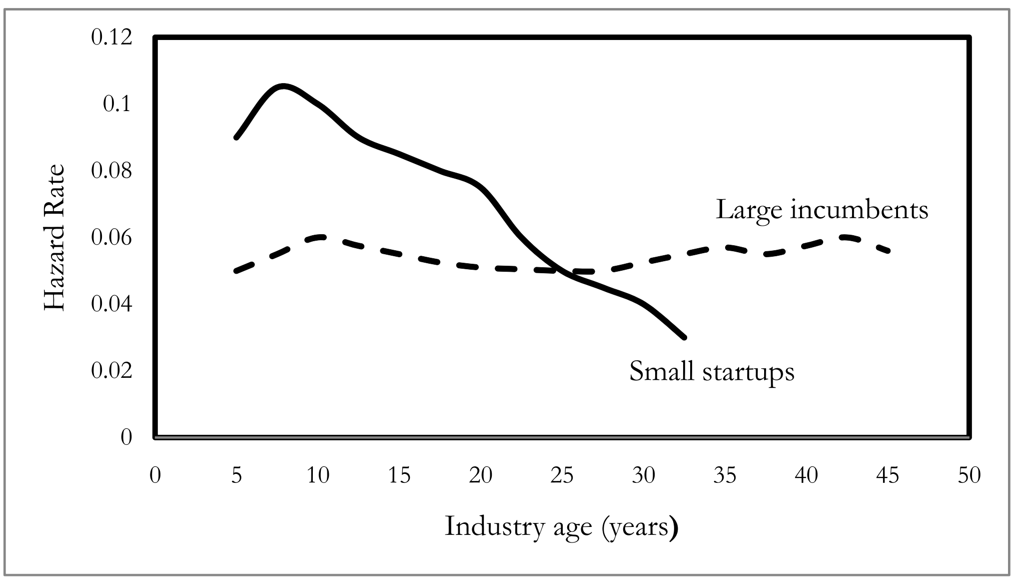
Small startups have relatively high survival rates in highly innovative industries. Highly innovative environments offer high levels of technological opportunities (Zahra 1996), and hence the assortment of available new technologies increases greatly (John, et al. 1999). As a result, small startups are likely to find more opportunities to capitalize on, and survive in, highly innovative environments as compared to less innovative environments. Further, the ability of small startups to grow with the industry is enhanced in highly innovative environments since they can more easily offset any scale disadvantages by providing differentiated products (Sarkar, et al. 2006).

Large incumbent creators and anticipators have relatively high survival rates in less innovative industries. Less innovative environments may be most suitable to the large incumbent firms because they can leverage their related resources (including brand recognition and distribution channels in related industries) and scale advantages in an environment that is less differentiated. Consequently, these firms have the opportunity to enter and grow rapidly.

Table 5
Survival Statistics for Creators

Creator Cohort	Number	Exit Before Firm Takeoff	Exit Before Sales Takeoff
Small Startups	90 (38%)	47%	71%
Small Incumbents	41 (19%)	32%	59%
Large Startups	46 (19%)	24%	50%
Large Incumbents	62 (26%)	13%	44%

Figure 2
Smoothed Hazard Estimates by Creator Cohort



Large startup anticipators have relatively high survival rates in less innovative industries. Firms that have the advantage of size, but lack the advantage of prior experience benefit by waiting to enter a less innovative industry till after firm take-off. Doing so may allow them to leverage size to ramp up and take advantage of their scale, while at the same time learning from the experience of the firms that entered prior to firm take off. As a result, they offset the experience disadvantage, and build on the benefits of size.

7. Limitations and Future Research

Like all empirical research, our study has several limitations that should be carefully considered before generalizing the results to other industries and settings. Although it is a widely used source of firm-level information in new industries, our list of creators, anticipators, pioneers, and first followers is constrained to the *Thomas Register*. The detailed data requirements for our study also restrict our analysis to twenty-two industries. While the industries included in our study span most of the 20^{th} century, they only involve US markets. As industries become global in both production and demand, additional research that examines the generalizability of our results in other geographic markets would add immense value.

Also, due to data limitations, we could not account for the product market strategies of individual firms. Additionally, our key firm related characteristics are measured at the time of entry, not over time as the firm matures. Thus, a firm's long run survival chances may not only be a function of who they are at the time of entry, but also who they subsequently become after entry (e.g., Bayus and Agarwal 2007). These limitations highlight the need for further research on this general topic.

Our results suggest that early entrants surviving past the firm takeoff have greater survival rates. An interesting question emerges from this finding: what are the factors that distinguish these firms from other creators? These factors may include variables such as technological and marketing capabilities at time of entry, access to venture capital, and access to important networks. Additionally, the background and prior experience of the founders and CEOs may also be a promising avenue of study (e.g., Burton, et al. 2002; Phillips 2002; Agarwal, et al. 2004; Klepper and Sleeper 2005; Yadev, et al. 2007; Campbell et al. 2012). While our measure of experience was at the *firm* level, founders bring with them valuable experience that may enable startups to enter and compete effectively vis-à-vis more experienced firms. Studies of spinouts—or employee entrepreneurs—typically examine later entrants and their performance advantages over the industry life cycle, but have not focused on whether such startups can also create really new industries with breakthrough innovations. There is value in future research that examines both the fraction of *creator* startups that have related industry experience, and also whether there is a systematic difference in their incidence and survival across innovative environments. In particular, if individuals serve as an important conduit for knowledge spillovers across organizations (Agarwal, et al. 2007), then future research that examines the role of entrepreneurial individuals in creating *both* new firms and new industries will shed light on the value created for society, particularly if their firms live on to become successful.

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