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User-Industry Spinouts: Downstream Industry Knowledge as a Source of New Firm Entry and Survival

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Recent scholarship on entrepreneurship suggests that the pre-entry know-how of start-ups, embodied in their founders, affects not only entry, but also performance. Although prior work focuses on new entrants from the focal industry (i.e., employee spinouts) and academic organizations (i.e., university spinoffs), this study identifies and examines a hybrid category of start-ups from downstream user-industries, which we call "user-industry spinouts." We draw from the literature on evolutionary theory, user innovation, and industrial dynamics to propose that, given the unique combination of knowledge inherited by these entrants, their choices at entry and their ability to survive in the focal industry will differ with respect to other start-ups. We do this by extending existing work on new firm creation to investigate entry and performance in different product markets. Our findings, based on a dataset of start-ups in the semiconductor industry over a 10-year period (1997–2007), show that user-industry spinouts are more likely both to enter and to survive in market-specific product categories. We suggest that the pre-entry knowledge resources of spinouts may support entry and survival across industry boundaries. However, the specific nature of these resources will influence which product markets they choose to enter. Our results have theoretical implications for the literatures on entrepreneurship, industrial dynamics, and strategy.

Keywords: entrepreneurship; evolutionary approaches; strategy and firm performance; user innovation, spinouts
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1. Introduction

Recent scholarship on entrepreneurship suggests that the pre-entry knowledge resources of new entrants, embodied in their founders, affects not only their entry strategy, but also their long-term performance and ability to survive (Agarwal et al. 2004, Bruderl et al. 1992, Chatterji 2009, Klepper and Simons 2000). Pre-entry know-how and experience may be sourced from different "knowledge contexts" (Agarwal and Shah 2014). In a value-chain perspective, such contexts include the focal industry as well as "upstream" suppliers and "downstream" users or customers. Although much of the research in this area focuses on entrants from the focal industry (i.e., employee spinouts), recent work has explored entry from both upstream (i.e., university spin-offs; Shane 2004) and downstream contexts (i.e., user entrepreneurs; Shah and Tripsas 2016, 2007). This study focuses on a hybrid category of entrants: start-ups in the focal industry that were founded by the ex-employees of firms in downstream industries that use the focal industry's products in their final products. We call these entrants "user-industry spinouts." Because the founders of user-industry spinouts were formerly employed in incumbent firms in an industry, the knowledge context from which they originate resembles that of employee spinouts. The fact that their founders enter the focal industry with experience from user industries, however, means that user-industry spinouts also inherit many of the characteristics of user entrepreneurs. How this combination of knowledge resources affects the entry choices and survival rates of such spinouts is the focus of this research.

User-industry spinouts are new and independent ventures founded by entrepreneurs that cross industry boundaries from a downstream, user industry into a focal industry. The technological knowledge that such entrants inherit, therefore, refers to the use of products of the focal industry in downstream applications. Similarly, the market knowledge that they inherit refers to their experience with distribution channels, industry associations, and marketing networks in the downstream industry. We develop and test a theoretical framework that links this knowledge inheritance to specific entry strategies and performance as measured by survival. We consider two different product market strategies: entry into generic or market-specific product categories. Our central claim is that the know-how and experience gained within the

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context of downstream, user industries do not provide new firms with the resources necessary to enter and survive equally well in all product markets of the focal industry. Rather, spinouts from user-industries are more likely to enter and succeed in product markets that require technological, organizational, or market knowledge related to user contexts. These markets provide a better match with the pre-entry resources of such new entrants.

We test our predictions in the context of a high-technology industry, semiconductors, over a 10-year period (1997–2007) characterized by rapid growth and development. This industry is at an advanced stage of its life cycle, with differentiated final markets (Klepper 2001). In some cases, firms compete more on technology and volume, with generic products targeted to multiple markets. In other cases, firms seek to differentiate their products from their rivals' by tailoring them closer to the needs and characteristics of specific markets. Focusing on these differences in strategy gives us insight into the choices new firms confront when entering an industry. Our data set consists of 936 new entrants. We start from the finding that a significant share of semiconductor start-ups were founded by entrepreneurs who were previously employed in downstream, user industries (Adams et al. 2013). We find that these "user-industry spinouts" were more likely than other start-ups to enter and survive in market-specific product categories of the semiconductor industry.

Our study focuses on a phenomenon as yet unstudied in the literature. By investigating the performance of a hybrid category of employee spinouts whose founders cross industry boundaries, we contribute to scholarship in entrepreneurship, industrial dynamics, and strategy (Agarwal et al. 2004, Agarwal and Shah 2014, Klepper 2007). By suggesting that pre-entry experience influences the strategic choices of spinouts concerning both entry and survival in different product markets within an industry, we also contribute to the literature on evolutionary theory and industry dynamics (Helfat and Lieberman 2002, Klepper 2001, Nelson and Winter 1982). Finally, by providing large-sample evidence of the effect of pre-entry experience from different knowledge contexts on the strategies and performance of independent start-ups across different types of product markets, our study advances empirical research on entry and survival.

This paper is organized as follows: In the next section, we generate testable hypotheses concerning the entry strategies and performance of user-industry spinouts based on our theoretical framework concerning pre-entry knowledge contexts. We then provide a brief overview of the semiconductor industry and explain why it is an appropriate setting for the study. The subsequent section describes the data set and the methodology used for the analysis. We then present the major results. The final sections discuss the empirical and theoretical implications of this research.

2. Theoretical Framework and Hypotheses

2.1. Knowledge Contexts and Start-Up Survival

The early literature in management provides little support for the idea that pre-entry knowledge determines the entry choices of firms in an industry. Rather, this literature focuses on factors such as barriers to entry, profit objectives (Geroski 1995), competitive strategy and market opportunities (Porter 1998), and entrepreneurial spirit (Knight 1989, Shrader and Simon 1997) as the drivers of entry. More recent empirical work paints a different picture. Research over a broad range of industries shows that the pre-entry experience and know-how inherited by independent start-ups through their founders plays a significant role in determining both the strategic choices and the success rates of new entrants (Agarwal et al. 2004, Chatterji 2009, Klepper and Sleeper 2005). This work is largely based on evolutionary theory that suggests that firms' pre-entry resources and capabilities affect both the likelihood and the success of entry.

Consistent with this theory, research also shows that the pre-entry resources and capabilities of start-ups may be drawn from different "knowledge contexts" related to the origins of their founders (Agarwal and Shah 2014, Chatterjee and Wernerfelt 1991, Frischmann et al. 2014, Helfat and Lieberman 2002). In a value-chain perspective, these contexts include not only the focal industry, but also upstream suppliers and downstream user/consumer markets. New ventures created by the ex-employees of incumbent firms in the same industry are widely referred to as "spinouts" (Agarwal et al. 2004, Klepper 2009). This category has received extensive attention by scholars seeking to understand how knowledge is passed from parent to spinout and what impact this knowledge has on entry and survival rates. Upstream sources of knowledge, by contrast, include suppliers of products and services as well as universities and research organizations. Most of the empirical work on upstream contexts focuses on academic entrepreneurship (Berkovitz and Feldman 2008, Lockett et al. 2005, Shane 2004), whereas much less has been done to understand entry by supplier firms (Carroll et al. 1996). Finally, the downstream context refers to demand as a source of knowledge (Adams et al. 2013, von Hippel 1988). Most of the research on downstream contexts examines user entrepreneurs that start new ventures based on innovations they have developed to satisfy their own needs for improved products or services (Baldwin et al. 2006, Shah and Tripsas 2007). Together, these different research streams provide a significant base of evidence to show not only that start-ups originate from different knowledge contexts, but that such differences influence entry strategy and performance.

This study builds on existing research by examining a hybrid category of employee entrepreneurship, which we call "user-industry spinouts." User-industry spinouts are created when the employees of downstream industries

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leave their prior employment to create new and independent firms in the focal industry. They are considered spinouts to the extent that they are entrepreneurial ventures founded by ex-employees of an incumbent firm (Agarwal et al. 2004, Klepper 2001). Their industry of origin, however, is not the focal industry, but a downstream, user industry. Such spinouts enter the focal industry with knowledge from the demand side about how the focal industry's products are used and integrated by downstream firms in their final products. User-industry spinouts, therefore, represent a hybrid category of spinouts that draws on a unique combination of knowledge resources.

To understand how the pre-entry knowledge resources of user-industry spinouts may affect their strategies and performance over time, we begin by examining the implications of their classification as "spinouts." It is argued that spinouts differ from other start-ups because their founders inherit knowledge from previous employment in firms in an industrial context (Chen et al. 2012, Helfat and Lieberman 2002, Klepper and Sleeper 2005). This inheritance may include managerial skills (Moore and Davis 2004); technological knowledge (Teece 1986); market knowledge related to customer needs or market opportunities (Buenstorf 2007, Sleeper 1998, Tripsas 2007); industry knowledge concerning regulations, practices, and marketing networks (Chatterji 2009); knowledge related to operations or organizational procedures; or some combination of marketing and technological knowledge (Agarwal et al. 2004, Franco et al. 2009). It is also argued that spinouts benefit as much from "what they know" as from "who they know." They may have established networks within the industry (Higgins and Gulati 2003), social connections (Sorenson and Audia 2000), or contacts with important suppliers and other actors in the industry's ecosystem.

Like other spinouts, user-industry spinouts are founded by individuals who were previously employed in incumbent firms. Their founders may include managers, engineers, or other professionals employed within these firms. What is critical is that they have pre-entry experience in a downstream firm in which the products of the focal industry are used or integrated into other final products. The technological knowledge that such entrants inherit, therefore, regards the use by firms of products from the focal industry. Similarly, the market knowledge that they inherit refers to their knowledge of, and experience with, distribution networks, industry associations, and marketing networks in the downstream industry. Although such knowledge resources may be more limited in scope than the knowledge resources inherited by spinouts from the focal industry, they constitute "relevant" resources for entry into the focal industry.

Neither academic nor user entrepreneurs possess the same type of pre-entry resources as either focal spinouts or user-industry spinouts. The highly scientific or technological backgrounds of university researchers may provide aspiring entrepreneurs with scientific and technological knowledge that acts as a base for new business ventures (Clarysse et al. 2011, Hsu et al. 2007, Jong 2006), but such founders often lack experience in firms in an industry setting in which technologies or components are used. They may also have less knowledge than spinouts about the organizational routines, marketing activities, or production processes required to bring a technology to market (Feldman et al. 2002, Shane 2004, Wennberg et al. 2011). Finally, it is more likely that university spinoffs will lack links to customers or industry affiliations, which may be critical for commercial success (Vohora et al. 2004). Along similar lines, user entrepreneurs who seek to commercialize product innovations they have developed for their own personal use may not have the more broad-based technological and marketing knowledge possessed by founders whose experience is related to the firm-level use of an intermediate product in final products. Such user entrepreneurs may also lack knowledge of, or access to, operations and organizational routines for manufacturing and distribution. Although user entrepreneurs may be able to activate user communities for support in both the product development and diffusion stages of the venture (Jeppesen and Frederiksen 2006), they may not receive the same structural benefits from such communities that spinouts receive from relevant industry networks.

But do such differences matter? Can we expect that the pre-entry industry knowledge resources possessed by user-industry spinouts will affect their performance with respect to other start-ups? The extant literature on spinouts indicates they will. Empirical research suggests, in fact, that prior industry experience has a positive impact on firm survival (Bruderl et al. 1992, Dencker et al. 2009, Gimeno et al. 1997). This work covers a broad range of industries including lasers (Buenstorf 2007, Sleeper 1998), automobiles (Klepper 2002, 2007), disk drives (Agarwal et al. 2004, Franco and Filson 2006), and medical devices (Chatterji 2009). These studies show that new entrants founded by the ex-employees of firms in the focal industry are more likely to survive than other start-ups. They attribute this outcome to spinout founders' core technological knowledge and to complementary assets in the form of management and production experience, distribution networks, marketing experience, and customer relationships. They suggest that pre-entry resources help entrants to identify, analyze, and assess information related to changing customer preferences, market trends, and industry practices (Feeser and Willard 1990). This research also supports the suggestion that a firm's initial resources and capabilities affect its ability to enact and adapt to changes in an industry environment subsequent to entry (Dencker et al. 2009). More specifically, technological know-how increases a firm's ability to generate innovations and technological change, whereas marketing know-how increases the ability to understand the evolving needs of

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customers and to commercialize new products better and quicker than competitors (Agarwal et al. 2004).

Although these arguments are drawn from empirical research on focal spinouts, we propose that they may be extended to user-industry spinouts as well. Like focal spinouts, and unlike other start-ups whose founders lack pre-entry firm-level experience, user-industry spinouts inherit managerial and organizational know-how that will help them run a business. From their experience of working with the focal industry's products in downstream products and processes, user-industry spinouts also have a solid knowledge base for the development of product innovations and for adapting technologies to the needs of customers. Finally, their marketing knowledge from a downstream perspective will enhance their ability to work with customers and to identify the appropriate activities and channels needed to access downstream markets. Such knowledge should also allow user-industry spinouts to recognize opportunities and to respond to customer needs more effectively and quicker than other start-ups. As a result of their pre-entry experience in firms in downstream industries, therefore, the chances for user-industry spinouts to survive in the focal industry are closer to those of focal spinouts than to those of other start-ups. We therefore propose the following:

Hypothesis 1 (H1). *User-industry spinouts, like focal spinouts, will have a higher likelihood of survival in the focal industry than other start-ups.*

2.2. User-Industry Spinouts: Entry and Survival in Product Markets

Although user-industry spinouts belong to the spinout category (i.e., independent ventures founded by ex-employees of incumbent firms), the specific knowledge context from which they originate differs significantly from that of spinouts from the focal industry. In terms of technological and operational knowledge, user-industry spinouts may inherit knowledge about their suppliers' products and processes through learning by using (Rosenberg 1982); however, this knowledge is likely to be of a "local" nature (von Hippel 2005) and limited to a specific context of use. The distinctive knowledge inherited by user-industry spinouts through their founders is more likely to come from a deep, contextual experience with products and processes in firms in the downstream industry. We may call this knowledge "application specific." The more such knowledge is tacit, and the more it concerns complex systems and processes, the more likely it is to be "sticky" to the individuals that work in user firms (von Hippel 1998). In terms of marketing knowledge, entrepreneurs from user firms may draw on direct experience as former customers of the focal industry. This type of pre-entry experience may provide user-industry spinouts with knowledge about other firms (former competitors) in the downstream industry, as well as about sales and distribution networks, regulatory practices, and required standards in that industry.

Although our category of spinouts regards the use of products by firms, rather than by individuals, many of the elements that characterize the knowledge context from which user entrepreneurs emerge are applicable here as well (Bogers et al. 2010, Shah and Tripsas 2007, von Hippel 2005). Firms in user-industries are immersed in problem contexts that, in terms of the focal industry, are concerned with the use of an intermediate product rather than the production or commercialization of that product (Chatterji et al. 2008, Shah et al. 2012). They therefore experience the functionality, as well as the shortcomings, of the focal industry's products firsthand within their own application contexts (Chatterji and Fabrizio 2013, Winston Smith and Shah 2013). Other firms may obtain some of this knowledge by working closely with their customers on specific applications and by integrating user knowledge into the product development processes of their organizations. However, with respect to employees from firms in the focal industry, employees from user industries are more likely to benefit from a continuous and direct experience with products or processes within their own organizations (Chatterji and Fabrizio 2012, 2013; Tripsas 2007; von Hippel 1998). The limit of such knowledge is that it is restricted to a specific application area and may not extend across heterogeneous applications or downstream uses.

But again, do these differences in knowledge resources matter? If, as in most of the extant literature on spinouts, our focus remains at the industry level without regard to product markets, the effect of such differences may not emerge: as in H1, user-industry spinouts would appear similar to other spinouts and different from other start-ups. We propose, however, that by digging deeper to explore the specific product market choices made by start-ups, including diverse types of spinouts, differences in knowledge resources will matter. We predict, in fact, that user-industry spinouts will make different product market choices at entry than other types of start-ups, including focal spinouts, and that these choices will affect their performance.

A relevant distinction between different types of product market strategies is that between generic and market-specific products. Generic products refer to products that may be sold into multiple markets with no need for customization or adaptation. Such products in these markets respond to generic needs across a wide range of customer categories. Market-specific products, by contrast, are tailored to the distinct needs of defined customer categories that may stem from either system-level requirements, standards in an application area, or customer strategies to differentiate a final product through the use of components or technologies.

We first examine entry. We propose that user-industry spinouts are more likely to enter market-specific product

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categories in the focal industry. Initial support for this proposition may be found in the entry literature that shows that new entrants tend to enter niche markets close to their pre-entry experience. Kim and Kogut (1996) find that the previous experience of semiconductor firms in platform technologies is highly correlated with their subsequent entry into related subfields. Other studies show that focal spinouts tend to enter niche market segments that are close to those targeted by their parent companies (Agarwal et al. 2004, Klepper and Sleeper 2005) or that rely on the specific prior experience of the founders (Chatterji 2009, Christensen 1993). Finally, research on user entrepreneurship shows that start-ups founded by user entrepreneurs tend to serve niche markets based on customer needs that are left unmet by established firms (Agarwal and Shah 2014, Baldwin et al. 2006, Shah 2005, Haefliger et al. 2010).

Building on this work, we suggest that the knowledge resources inherited by user-industry spinouts provide a better match with market-specific product categories than the knowledge resources inherited by other start-ups, including focal spinouts. The technology and operational knowledge inherited by user-industry spinouts is related to the use of the focal industry's products in specific applications rather than to basic technological knowledge and broad solutions that cut across heterogeneous product areas in the focal industry. Their marketing knowledge is also linked to specific customer segments and downstream industry networks and environments. User-industry spinouts, therefore, have higher levels of both technological and marketing know-how related to downstream markets than other start-ups, including focal spinouts (Agarwal et al. 2004).

Such differences in knowledge are likely to affect the way different start-ups identify and frame entrepreneurial opportunities with respect to the needs of the industry (Shane 2000). Founders that originate from the focal industry will have developments in that industry as their major frame of reference. Similarly, entrepreneurs from research contexts such as universities are more likely to define their contribution in terms of broad technologies or product innovations that may interest a wide set of application areas (Shane 2004). Research shows, in fact, that entrepreneurs from universities not only possess less marketing knowledge than other founders, but they also have less interest in how their inventions may be used in particular applications (Mody 2006). In particular, universities tend to invest in knowledge related to core technological and scientific advances, and to have little experience with the industry context outside of the research domain. Their work is also concentrated at the "proof of concept" phases of development, rather than at later stages related to the relevance of a technology for specific applications (Clarysse et al. 2011).

User-industry spinouts, on the other hand, are better positioned to recognize unmet needs in downstream product markets and to develop solutions to meet these needs (Chatterji and Fabrizio 2012, Lüthje et al. 2005, Riggs and von Hippel 1994, Winston Smith and Shah 2013). Although their ideas may not be relevant for wider markets in the focal industry, they may be relevant for user firms in application areas with similar needs (Shah and Mody 2009). In short, they are more likely to frame opportunities with respect to downstream user segments that draw on application-specific knowledge than with respect to generic needs within the focal industry. We therefore propose the following:

Hypothesis 2 (H2). *User-industry spinouts are more likely to enter into market-specific product categories in the focal industry than other start-ups, including focal spinouts.*

We next examine survival. Again, evolutionary theory would suggest that user-industry spinouts have pre-entry know-how and experience that will allow them to learn about and adapt quicker to changes in industry contexts that are closest to their existing resources. Previous studies suggest that entrants whose pre-entry knowledge is more closely related to the market of entry will have a higher probability of success in that market (Helfat and Lieberman 2002). Yet, the studies supporting this observation generally focus on entry into industries without regard to specific product markets (Klepper 2009). We extend this work by examining the degree of match between pre-entry knowledge and market strategy as defined by entry into generic or market-specific product categories. We argue that the general relationship and mechanisms identified for the survival of spinouts at the industry level (H1) will hold for survival of user-industry spinouts in market-specific product categories of the focal industry.

The reasoning behind this argument relates back to differences in the pre-entry knowledge context of user-industry spinouts with respect to both focal spinouts and other start-ups. User-industry spinouts have inside knowledge of downstream industries, including professional contacts and network ties, that will help them to overcome the liabilities of newness (Agarwal et al. 2004, Phillips 2002) and to find the information and resources necessary for survival in dynamic environments. As industry insiders they may also be able to get feedback and technical inputs about products from other user firms in their application areas in ways that other start-ups, including focal spinouts, are unable to do. Furthermore, recognizing evolving needs in rapidly changing markets often involves tacit knowledge that user-industry spinouts are more likely to possess in market-specific product categories due to their pre-entry experience in downstream industries (von Hippel 1994). Finally, because the social capital of user-industry spinouts is more related to downstream markets than to the wider focal industry, their knowledge resources will be more valuable for survival in such segments than the resources of focal spinouts and

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other start-ups that originate from different knowledge contexts. We therefore propose the following:

Hypothesis 3 (H3). *User-industry spinouts are more likely to survive in market-specific product categories in the focal industry than other start-ups, including focal spinouts.*

3. The Semiconductor Industry

The semiconductor industry is an appropriate setting to study the importance of downstream knowledge for new firm entry and survival. The evolution of the industry has been characterized by high levels of technological change and entrepreneurship since its birth in the 1950s (Brittan and Freeman 1986, Holbrook et al. 2000). The early part of the industry's history was dominated by spinouts from the focal industry. The famous spinouts from Fairchild, the so-called Fairchildren, are cases in point. In more recent periods, however, entrepreneurship in semiconductors (Saxenian 1990) has also involved innovative start-ups from more diverse knowledge contexts. Whereas some of these new entrants are the spawns of vertically integrated system firms that decided to spin out their chip divisions (e.g., Hewlett Packard spun out Agilent, Siemens spun out Infineon), others were founded by entrepreneurs coming directly from user-industries or academia who were attracted by the rapid growth in the semiconductor market and the availability of venture capital (VC) (Fairlie and Chatterji 2013). This variation in prior employment is critical for our empirical analysis.

Additionally, developments in the industry lowered the barriers to entry in many product categories in semiconductors and opened up the range of potential entry strategies for new start-ups. The diffusion of complementary metal oxide semiconductor production processes, in fact, made it easier for new firms to enter into the design phase of semiconductor devices while outsourcing production to independent foundries (Braun and MacDonald 1982, Brown and Linden 2009, Malerba 1985). The creation of standardized interfaces between components and electronic design automation (EDA) tools also fostered the development of modular systems in which blocks of intellectual property ("design blocks") could be exchanged and licensed across products and companies. Finally, developments in CAD (computer-aided design) software and in communications networks made it possible for companies to exchange huge amounts of data and design specifications.

Alongside of these technological changes, developments on the demand side meant that entrepreneurs with downstream application knowledge, often "sticky" in nature, had potential information advantages to recognize the needs arising in new market segments. The chip market became increasingly fragmented by growing demand from both consumer and industrial product categories such as cameras, televisions, mobile communications, and data storage. These emerging markets opened new design spaces for customization that often required a deep understanding of the systems in which the devices would be used and integrated (Brown and Linden 2009).

4. Methodology

4.1. Data Sources

The data in this study are drawn from several sources. The list of entrants into the industry was obtained from *Semiconductor Times*, a magazine published monthly by Pinestream Communications, a private consultancy company specialized in the semiconductor industry. The magazine records new start-ups in the industry each month and provides a profile of each company, including a description of their product offerings and activities. The company profiles also contain information regarding the founders of each start-up and their backgrounds. These data were collected in an online database with restricted access. We consider Pinestream's list a large-scale and reliable sample of new entrants into the industry for two reasons. First, given that Pinestream Communications traces the history of new entrants into the industry as a central part of its business and public relations activities, accuracy is critical for them. Second, Pinestream provides consulting services to semiconductor firms irrespective of their category, age, or type of activity. There is therefore no reason to expect any particular bias in their list.

The list of new semiconductor firms obtained from Pinestream was cross-checked with other lists provided by the EE Times magazine (http://www.eetimes.com) and IC Insight, a market research firm. Information collected from Pinestream on founder backgrounds was also checked and enriched with information drawn from the Hoover database, ZoomInfo (http://www.zoominfo.com), InsideChips (http://www.insidechips.com), and ABI/INFORM. Through ABI/INFORM we also scanned the specialized trade press for information on the activities and careers of the founders of the firms in our list. A further source of information on the background of founders was the personal profiles of these individuals as published on LinkedIn (https://www.linkedin.com). Information on funding and VC support was collected from Link Silicon Valley (http://www.linksv.com), a specialized website that provides information on people who build and fund the technology companies of Silicon Valley. Information on acquisitions was collected from LexisNexis. Finally, further information on firms that ceased to exist was extracted from company websites using Google archives (https://news.google.com/archivesearch) and the Internet archive (https://archive.org).

4.2. The Data Set

Using the above information, we constructed a database of start-ups in the semiconductor industry between 1997 and 2007. The data set includes 936 independent start-ups.

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For each firm in the data set, we codified the following information: company name, geographic location at entry, year founded, (eventual) year of exit (by failure or by acquisition), product category and submarket at entry, name, education, and background of the founders.

4.3. Constructing Measures

4.3.1. Pre-entry Experience. Our first task was to distinguish between different types of start-ups. We used the industry origin of the founders to classify the firms in our data set into three groups. The industry of origin refers to the industry in which the founder(s) was last employed. Our first group includes firms founded by entrepreneurs whose last employment was in a semiconductor firm (Standard Industrial Classification (SIC) 367). These firms are classified as "focal spinouts." Firms that were founded by entrepreneurs with a background in semiconductor software and/or in semiconductor design and production (e.g., electronic design automation) are also classified as focal spinouts. In total, the database identifies 429 focal spinouts.

The second group contains firms founded by entrepreneurs who were previously employed in downstream industries that use semiconductors as components in their final products (e.g., manufacturers of computers and office equipment, consumer electronics, communication equipment, automobiles). We define firms in this category as "user-industry spinouts."[1] In total, 280 firms belong to this group. It should be noted that some producers of computers and office equipment (SIC 357), consumer electronics (SIC 36, except 366 and 367), and communication equipment (SIC 366) may be considered "vertically integrated" producers (i.e., they possess a semiconductor-related division and/or a semiconductor R&D laboratory). Entrants with at least two founders who worked for these semiconductor-related divisions in their previous employment are classified in the focal spinout category; otherwise, they are considered user-industry spinouts.

The third category is a residual group of 227 firms whose founders come from either universities or research institutes or who were previously employed in areas such as finance, venture capital, business software, business and/or engineering consultancy. We refer to this category as "other start-ups."

The classification of firms with a single founder (418 firms) was relatively straightforward. To classify start-ups founded by a team of entrepreneurs (518 firms), on the other hand, it was necessary to examine each founder's background. When at least two founders were previously employed by a semiconductor firm, a downstream user firm, or a university or other organization, the firm was placed, respectively, in those categories. This "majority rule" was used for 350 of the multiple-founder firms in our database. The remaining cases (168 firms) have founders from different backgrounds. To classify these firms, we used the principle of the most influential founder (i.e., a founder with previous entrepreneurial experience and/or previous innovative experience) as proposed in previous studies (Arora and Nandkumar 2011, Klepper 2007).

It is interesting to note that although focal spinouts represent the largest share of entrants in our data set (45.8%), entrants from downstream industries also represent a substantial group. Thirty percent of total entrants during this period, in fact, are user-industry spinouts. This indicates that such firms are more than just marginal cases in the industry's dynamics; they represent a significant category for analysis.

4.3.2. Entry by Product Category. For our analysis of entry, we identify the main product market of activity from company profiles reported in *Semiconductor Times* for all firms in our data set. The profiles include not only the general product description of the activity, but a closer reading of the target market identified for such products. Given their young age and lack of resources, firms tend to enter just one product market at birth.

A list of products in the semiconductor industry was obtained from an industry report (IC Insights 2007) on the semiconductor industry. The products were then divided into three major categories: generic semiconductors, market-specific semiconductors, and other semiconductors. *Generic semiconductors* refers to devices that are not targeted at any specific market. They may be used in a wide range of systems or product applications with little or no need for customization or adaptation by suppliers. These devices normally serve specific functions such as memory or logic processing and are not designed with any specific application or system in mind. This category includes the majority of devices in submarkets such as memories (including DRAM, Flash, SRAM, and other memories) and processors (including microprocessors, microcontrollers, and digital signal processors). The category definitions and lists of products within each category were cross-checked with industry experts from both semiconductor firms and research institutes specialized in semiconductor technology.

Market-specific semiconductors refers to chips that are targeted at specific application markets. The design of such devices requires some degree of knowledge and understanding of the applications or systems in which they are integrated. Chip solutions may involve a complete platform that would include the diagram for the circuit layout, software applications, and software development kits. Such solutions would normally be tailored by suppliers to the needs of a specific submarket or a specific user firm. In our analysis, the market-specific category is further divided into five major submarkets: communications (wired or wireless communications), consumer products (audio, visual, personal electronics, appliances), computation and storage (computers, printers, storage applications), industrial, and other.[2]

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Table 1 Entry by Firm Type and Product Category

	Generic	Market specific	Other	Total
Focal spinout	148	192	89	429
User-industry spinout	62	171	47	280
Other start-ups	77	91	59	227
Total	287	454	195	936

Other semiconductors represents a residual category including customized application-specific integrated circuit design services and EDA tools. In these cases, firms normally assist clients in designing customized chips rather than provide them with generic or market-specific devices.

Table 1 reports entry by firm type and product category. *Market-specific products* accounted for the largest share of entrants (48.5%), driven by an increasing demand for specialized chips for telecommunications, computers, and consumer products. The next largest share of entrants occurred in the *generic products* category (30.7%), whereas a smaller share entered in the *other semiconductors* category (20.8%).

4.3.3. Firm Performance. Most of the previous empirical work on pre-entry experience measures performance in terms of the survival of new ventures. Consistent with this literature, we use survival as our measure of success and treat firms that exit the industry as unsuccessful new ventures. Although we treat both exit by acquisition and exit by failure as cases of "nonsurvival," we capture these differences in our data. Table 2 reports the number of firms in our data set that survive and exit by category.[3] In general, spinouts have a higher survival rate (78.7%) than other new start-ups (63.8%) at the end of the period. Approximately 25% of the firms in our data set exited the industry at the end of our observation period. Most exits (75.1%) occurred by acquisition rather than failure. It may be noted, however, that the majority of firms that exit by failure are in the category "other start-ups" (44.8%), followed by "focal spinouts" (31%) and "user-industry spinouts" (24%).

4.3.4. Control Variables. To our measures of pre-entry experience we add a series of controls related to both firm and founder characteristics. We first control for the size of the firm. *Firm size* is constructed as the total number of employees at the time of entry. Initial size is a good indicator of the quality of the start-up: previous contributions have found a positive correlation between size and performance as measured by survival (Agarwal and Audretsch 2001, Dunne et al. 1988, Evans 1987, Mata et al. 1995, Phillips and Kirchhoff 1989). Another indicator of firm quality is patenting activity (Hsu and Ziedonis 2013), since it has been found that firms holding patents are more likely to enter specific markets and less likely to exit those markets after entry (Cockburn and McGarvie 2011). In the current study, the variable *patent at entry* is equal to one if, at entry, the start-up had filed at least one patent with the U.S. Patent and Trademark Office and zero otherwise. We also control for the source of capital for start-ups. Prior literature suggests that different types of start-ups experience different levels of ease in accessing VC funding and that this may be a critical factor for success in entrepreneurship (Burton et al. 2002, Chatterji 2009, Hsu et al. 2007). *VC support* is equal to one if, at entry, the firm had received venture capital support and zero otherwise. Next, we control for the status of the semiconductor firm in terms of whether it has manufacturing facilities or not (*fabless firm*). The variable *fabless firm* is equal to one if the firm is a fabless and zero otherwise. Finally, we control for the effect of the characteristics of the founder(s) on firm performance. *Serial entrepreneur* is equal to one if the founder, or a member of the founding team, had previously founded another firm (Gompers et al. 2010). Similarly, the variable *founding team* is equal to one if the firm was founded by a team of employees, and zero otherwise (Burton et al. 2002).

In all of our specifications, we include a vector of entry time and country dummies. Although the majority of the firms in our data set (76.1%) are located in North America (United States or Canada), some firms are located in Europe (14.1%), and others are located in Israel (6.1%) and Asia (3.7%).

Table 2 Firm Category and Mode of Exit

	Survived	Failed	Acquired	Total
Focal spinout	342	18	69	429
User-industry spinout	216	14	50	280
Other start-ups	145	26	56	227
Total	703	58	175	936

Note. Chi-square statistics = 24.7284***.
***Signficant at 1%.

5. Results

Our predictions concerning start-ups regard both entry and survival. For this reason, we use two separate models for our analysis. First, we examine how the industry of origin of new firms affects entry into semiconductor product categories. We carry out this analysis by estimating a multinomial probit model in which the dependent variable is the probability to enter into one of the product categories defined above (i.e., generic semiconductors, market-specific semiconductors, other semiconductors). Industry origin is captured by the focal spinout and user-industry spinout dummies. Several other variables are used as controls as specified above. Second, we analyze the relationship between industry of origin and firm survival by performing a discrete time-duration analysis using a complementary log-logistic function to model the hazard of exit (Bayus and Agarwal 2007). Although survival, as opposed to exit, is our main measure of

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success, to account for the disproportionate number of exits by acquisition, we also apply a competing risk model (CRM). The CRM is estimated as an extension of the discrete time model in which the case of multiple modes of exit (i.e., firm failure or acquisition) is considered explicitly. The CRM allows us to treat the modes of exit as independent events, and it is modeled using a multinomial logit function (Jenkins 2004). Finally, we test whether differences exist in the correlation between pre-entry experience and the hazard of exit by failure and/or acquisition depending on the specific product category a firm enters.

Table 3 summarizes the descriptive statistics and the correlation coefficients for all of the variables in our analysis. Coefficients in the correlation matrix do not seem to suggest that colinearity is a problem in our data. This observation is confirmed by the variance inflation factor of 1.38, which is far below the recommended threshold (Belsley et al. 1980).

In the subsequent sections we present the results for entry followed by the results for survival. This allows us to follow a logic in which we first examine the entry strategies of firms and then test for performance. Consequently, in §6.1 we present our results concerning entry into specific product/market categories (H2), whereas in §6.2 we show our findings related to survival in the focal industry in general (H1) and to survival in specific product/market categories (H3).

5.1. Results for Entry

In Table 4 we report the results of our entry analysis carried out using multinomial probit estimation. Columns (1) and (2) report the regression coefficients for entry into market-specific semiconductors and other semiconductors, respectively. The reference category is generic semiconductors. Column (3) reports the coefficients for entry into other semiconductors as contrasted with entry into market-specific semiconductors.

Our results provide evidence that the choice of entry varies by entrant type. In column (1), the coefficient of user-industry spinouts is positive and significant, suggesting that they are more likely than the base category (i.e., other start-ups) to enter into market-specific semiconductors. This result supports H2. The coefficient for focal spinouts is not significant. Our control variables behave as expected, with firm size positively correlated with the probability to enter market-specific products and with fabless firms more likely to enter market-specific products than generic products. Receiving support from venture capital does not seem to impact the results in terms of entry, whereas having a patent at entry is negatively associated with entry into market-specific products compared to generic products.[4]

A closer examination of the data reveals some further insights into how the knowledge context from which the founders of user-industry spinouts are drawn may influence their choice of entry strategy. To understand how closely the pre-entry experience of founders matches the product market strategies of user-industry spinouts at entry, we examine the subset of these spinouts founded by single founders. This subset provides a clean and direct link between pre-entry experience and entry strategy. Table 5 summarizes the results for the 24 user-industry spinouts with single founders in our data set. Eighteen of these 24 firms went into the same submarket in which their founders had been previously employed. These results, albeit from a small sample of firms, indicate that not only are user-industry spinouts more likely to enter into market-specific product categories in general, but that they are more likely to enter into those specific submarkets linked to the pre-entry experience of their founders.

5.2. Results for Survival

Table 6 reports the results of our survival estimations considering exit by failure (Model (1)), by acquisition (Model (2)), and by either failure or acquisition (Model (3)).

Model (1) accounts for exit by failure against survival and acquisition. The coefficients for both focal spinouts and user-industry spinouts are negative and significant, suggesting that these two groups have relatively lower hazard rates with respect to the base category (i.e., other start-ups). Similar, significant, and stronger correlations are found for the probability of being acquired (Model (2)) and for the probability of exiting by failure or acquisition (Model (3)). This evidence suggests that, relative to other start-ups, both types of firms have a lower probability of exiting the industry by failure. In each of the three models, the null hypothesis of equality of coefficients for the two variables, focal spinouts and user-industry spinouts, could not be rejected. This suggests that user-industry spinouts perform just about the same as focal spinouts in terms of survival. Overall, these results are consistent with H1. For the remaining controls, relatively larger firms and firms that receive VC support at entry have a higher hazard of exit by acquisition, whereas firms founded by serial entrepreneurs have a lower hazard of exit by acquisition or failure.

Although these results highlight the presence of differences between exit by failure and exit by acquisition, the methodology used above combines distinct modes of exit. However, firms exit in either one mode or another, not in multiple modes. To account for this distinction, a multinomial logistic CRM is used. The results of this model are presented in Table 7.

The estimates from this analysis are again consistent with H1: relative to other start-ups, both focal spinouts and user-industry spinouts have a lower probability of exiting the industry by both failure (column (1)) and acquisition (column (2)). In addition, we compare the two modes of exit: exit by acquisition and exit by failure (column (3)).

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Table 3 Descriptive Statistics and Correlation Coefficients

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0.236	0.425	0	1	1																
2	0.057	0.233	0	1	0.445	1															
3	0.178	0.383	0	1	0.839	−0.115	1														
4	0.902	0.711	0	2	0.031	0.004	0.032	1													
5	0.297	0.457	0	1	−0.029	−0.03	−0.014	0.041	1												
6	0.449	0.498	0	1	−0.083	−0.069	−0.051	−0.051	−0.586	1											
7	0.254	0.436	0	1	0.126	0.11	0.072	0.015	−0.38	−0.527	1										
8	32.526	14.818	1	95	0.145	0.089	0.106	−0.066	0.049	0.003	−0.055	1									
9	0.422	0.494	0	1	0.074	0.022	0.069	−0.149	−0.016	0.096	−0.094	0.181	1								
10	0.239	0.426	0	1	−0.054	0.022	−0.073	−0.012	0.007	0.051	−0.066	0.038	0.068	1							
11	0.281	0.45	0	1	0.089	0.063	0.06	0.008	−0.031	0.025	0.004	0.135	0.095	0.105	1						
12	0.358	0.48	0	1	−0.031	−0.051	−0.003	−0.055	−0.016	−0.002	0.018	−0.034	−0.032	−0.041	0.001	1					
13	0.547	0.498	0	1	0.065	0.02	0.06	0.051	−0.048	0.054	−0.011	0.083	0.101	0.113	0.149	−0.049	1				
14	0.307	0.461	0	1	−0.061	−0.017	−0.057	−0.844	−0.121	0.077	0.04	−0.014	0.013	0.04	−0.002	0.078	−0.078	1			
15	0.485	0.5	0	1	0.069	0.025	0.061	0.134	0.164	−0.069	−0.095	0.119	0.188	−0.057	−0.007	−0.067	0.072	−0.645	1		
16	0.208	0.406	0	1	−0.015	−0.012	−0.01	0.793	−0.065	−0.002	0.072	−0.131	−0.246	0.025	0.011	−0.006	0	−0.341	−0.498	1	
17	0.066	0.249	0	1	−0.054	0.021	−0.073	−0.338	0.408	−0.245	−0.151	−0.007	−0.039	0.068	0.021	0	−0.063	0.401	−0.258	−0.137	1
18	0.183	0.387	0	1	0.016	−0.064	0.057	0.065	0.724	−0.435	−0.268	0.015	0.034	−0.026	−0.013	−0.01	0.008	−0.314	0.487	−0.243	−0.126
19	0.05	0.219	0	1	−0.031	0.022	−0.048	0.355	0.352	−0.212	−0.13	0.059	−0.087	−0.029	−0.07	−0.007	−0.059	−0.153	−0.223	0.448	−0.061
20	0.158	0.365	0	1	−0.06	−0.075	−0.02	−0.55	−0.283	0.471	−0.245	−0.052	0.049	0.038	−0.003	0.077	−0.029	0.652	−0.421	−0.222	−0.115
21	0.205	0.404	0	1	0.007	0.012	0.001	0.07	−0.332	0.552	−0.287	0.136	0.186	−0.007	0.011	−0.061	0.078	−0.338	0.523	−0.261	−0.135
22	0.095	0.293	0	1	−0.102	−0.053	−0.081	0.501	−0.212	0.352	−0.183	−0.12	−0.157	0.035	0.028	−0.012	0.02	−0.216	−0.315	0.632	−0.086
23	0.082	0.275	0	1	0.025	0.052	−0.004	−0.38	−0.196	−0.275	0.529	0.052	−0.009	−0.044	−0.018	0.03	−0.036	0.45	−0.291	−0.154	−0.08
24	0.097	0.296	0	1	0.086	0.11	0.028	0.045	−0.214	−0.302	0.58	−0.005	0.019	−0.053	−0.009	−0.017	0.005	−0.218	0.338	−0.168	−0.087
25	0.063	0.243	0	1	0.125	0.025	0.124	0.401	−0.169	−0.239	0.458	−0.127	−0.143	0.026	0.049	0.01	0.03	−0.172	−0.252	0.506	−0.069

	18	19	20	21	22	23	24
18	1						
19	−0.109	1					
20	−0.205	−0.1	1				
21	−0.24	−0.117	−0.22	1			
22	−0.153	−0.075	−0.14	−0.165	1		
23	−0.142	−0.069	−0.13	−0.152	−0.097	1	
24	−0.155	−0.075	−0.142	−0.167	−0.106	−0.098	1
25	−0.123	−0.06	−0.112	−0.132	−0.084	−0.078	−0.085

Notes. 1, *Exit*; 2, *failed*; 3, *acquired*; 4, *type of products*; 5, *user-industry spinouts*; 6, *focal spinout*; 7, *other start-ups*; 8, *firm size*; 9, *fabless firms*; 10, *serial entrepreneur*; 11, *VC support*; 12, *patent at entry*; 13, *founding team*; 14, *generic semiconductors*; 15, *market-specific semiconductors*; 16, *other semiconductor*; 17, *user-industry spinouts entering generic semiconductors*; 18, *user-industry spinouts entering market specific semiconductors*; 19, *user-industry spinout entering other semiconductors*; 20, *focal spinouts entering generic semiconductors*; 21, *focal spinouts entering market-specific semiconductors*; 22, *focal spinouts entering other semiconductors*; 23, *other start-ups entering generic semiconductors*; 24, *other start-ups entering market-specific semiconductors*; 25, *other de novo entrants entering other semiconductors.*

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Table 4 Multinomial Probit Regression—Entry in Semiconductor Product Categories

	Coefficients		
Variables	(1)	(2)	(3)
Focal spinout	0.0732	−0.1258	−0.1991
	[0.16221]	[0.1742]	[0.1728]
User-industry spinout	0.7154	0.0892	−0.6262
	[0.1799]***	[0.2009]	[0.1936]***
Firm size	0.0095	−0.0040	−0.0135
	[0.0049]*	[0.0060]	[0.0059]**
Fabless firm	0.2922	−0.7854	−1.0776
	[0.1313]**	[0.1563]***	[0.1523]***
Serial entrepreneur	−0.3268	−0.0567	0.2701
	[0.1509]**	[0.1670]	[0.1655]*
Founding team	0.4062	0.1933	−0.2129
	[0.1349]***	[0.1516]	[0.1464]
VC support	−0.0741	−0.0149	0.0591
	[0.1536]	[0.1726]	[0.1655]
Patent at entry	−0.3028	−0.2516	0.0511
	[0.1330]	[0.1496]*	[0.1465]
Constant	−0.4866	0.5929	1.0795
	[0.3253]	[0.3439]*	[0.3578]***
Observations		936	
Log Likelihood		-879.6853	
Chi-square		7,393.28***	

Notes. Standard errors are adjusted for clustering at the firm level. All specifications include a full vector of country and entry year dummies. Column (1), market specific versus generic; column (2), other versus generic; column (3), other versus market specific.
*Significant at 10%; **significant at 5%; ***significant at 1%.

In this case, the positive coefficient suggests that focal spinouts show a higher probability of being acquired than of exiting by failure. The above results highlight the presence of systematic differences in the mode of exit between firms with previous experience (i.e., focal spinouts and user-industry spinouts) and other start-ups. However, as in Table 6, the null hypothesis of equality of coefficients for the two variables, focal spinouts and user-industry spinouts, could not be rejected, indicating that we do not find statistically significant differences between focal spinouts and user-industry spinouts.

Our next step is to investigate survival in the different product categories. We examine whether the mode of exit systematically differs across entry origin and type of market in Table 8. Here we construct a set of mutually exclusive dummy variables involving entry origin and type of market to test directly for differences between focal spinouts, user-industry spinouts, and other start-ups, as well as for differences between focal spinouts and user-industry spinouts in each product category.

In column (1) we look at failures. The negative and significant estimate for user-industry spinouts entering into market-specific semiconductors indicates that these firms have a lower exit hazard than other start-ups in generic semiconductors (the reference category). In addition, the test of coefficient equality indicates that the coefficient estimates for focal spinouts entering into market-specific semiconductors and user-industry spinouts entering into market-specific semiconductors are significantly different. This evidence provides support for H3.

It is interesting to note that the results in column (1) for generic products also provide further, albeit indirect, support for our framework that suggests that the survival rates of user-industry spinouts in different product markets will differ from those of focal spinouts. Focal spinouts entering into generic semiconductors have a lower exit hazard than other start-ups in generic semiconductors, and the test of coefficient equality indicates there is a significant difference between the coefficient estimates for focal spinouts entering into generic semiconductors and for user-industry spinouts entering into generic products.

In column (2) we look at acquisitions. In this case, the only positive and significant coefficient is for other start-ups entering into other semiconductors. This result indicates that these firms have a higher probability of being acquired than the reference category. Our final estimates in column (3) contrast acquisitions with failures. In this case, both the estimate for user-industry spinouts entering into market-specific semiconductors and the estimate for focal spinouts entering into generic semiconductors are positive and significant. These results suggest that both of these categories have higher exit hazards than the reference category. Once again, in both cases the

Table 5 Entry of User-Industry Spinouts in Market-Specific Semiconductors by Submarket and Industry of Origin Industry of Origin

	Industry of origin				
	Communications	Computing and storage	Consumer products	Industrial and other	Total
Submarket of entry					
Communications	9	0	0	1	10
Computing and storage	1	1	0	1	3
Consumer products	2	0	4	1	7
Industrial and other	0	0	0	4	4
Total	12	1	4	7	24

Note. Restricted data set of single-founder firms.

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Table 6 Complementary Log-Logistic Regressions for the Hazard of Exit: Base Model

	Failed (1)	Acquired (2)	Either 1 or 2 (3)
Focal spinout	−1.0703	−0.6365	−0.8523
	[0.3630]***	[0.2182]***	[0.1971]***
User-industry spinout	−0.7189	−0.4630	−0.6166
	[0.4002]*	[0.2277]**	[0.2045]***
Controls			
Time (Log)	−0.7995	−0.7891	−0.8514
	[0.0879]*	[0.0402]***	[0.0340]***
Firm size	0.0137	0.0117	0.0144
	[0.0118]	[0.0059]**	[0.0054]***
Fabless firm	0.0627	0.2894	0.2529
	[0.3458]	[0.1928]	[0.1738]
Serial entrepreneur	0.0089	−0.6630	−0.4821
	[0.3670]	[0.2368]***	[0.2027]**
Founding team	0.0096	0.1277	0.1343
	[0.3277]	[0.1942]	[0.1750]
VC support	0.4800	0.4536	0.5317
	[0.3269]	[0.2041]**	[0.1833]***
Patent at entry	−0.4041	−0.1414	−0.2150
	[0.3516]	[0.1888]	[0.1726]
Constant	−2.6520	−0.3411	−0.1174
	[0.7365]***	[0.4257]	[0.3782]
Observations[a]	5,561 (794)	6,289 (931)	6,299 (936)
Number of firm exits	58	175	233
log likelihood	−772.446	−1,839.719	−2,043.202
Chi-square	335.52***	740.69***	1,110.45***

Notes. Standard errors are adjusted for clustering at the firm level. All specifications include a full vector of country and entry year dummies.

[a]The number of firms is in parenthesis.

*Significant at 10%; **significant at 5%; ***significant at 1%.

tests of coefficient equality rejects the null hypothesis of equivalence. Firm type seems to explain most of the variance in the dependent variables in these specifications. For the most part, the control variables are not significant.

Cumulatively, the evidence in Table 8 points to the important role of the pre-entry knowledge context for firms' performance in specific product categories. Both focal and user-industry spinouts still perform better than other start-ups. However, contrary to the evidence presented in Table 7 (when the focus was at the industry level, without regard to product categories), the performance of user-industry spinouts differs from the performance of focal spinouts depending on the specific product market choices made by different types of firms. Other things being equal, user-industry spinouts are more likely to survive in market-specific product categories in the focal industry. The effect of differences in the pre-entry knowledge context of user-industry spinouts has now become fully evident.[5]

Alternative explanations could be advanced for our finding that spinouts from downstream industries are more likely to enter and survive in market-specific product categories. These may include the ability of such entrepreneurs to obtain financing (Shane and Khurana 2003) and their ability to innovate. Success may also be determined by more advanced human capital in the form of senior management experience (Burton et al. 2002). Although we do not exclude the effect of such factors for both entry and survival in general terms, they do not seem to influence our results concerning specific entry decisions or survival rates. Our control variables for financing (venture capital), innovation (patents), and management experience (serial entrepreneur), in fact, were not significant.

6. Discussion

This research investigates entry and survival for a hybrid category of independent start-ups that we call "user-industry spinouts.'' This category consists of start-ups

Table 7 Competing Hazard Regressions of Failure and Acquisition for Entry Type

	(1)		(2)		(3)	
Focal spinout	−1.0928	[0.3269]***	−0.4318	[0.1936]**	0.6610	[0.3743]*
User-industry spinout	−0.9945	[0.3355]***	−0.4225	[0.1992]**	0.5720	[0.3867]
Test of coefficient equality						
Focal spinout = user-industry spinout	0.1672		0.0832		-0.0840	
Controls						
Time (Log)	−0.2777	[0.1490]*	−0.0832	[0.0881]	0.1944	[0.1678]
Firm size	0.0134	[0.0086]	0.0884	[0.0048]*	−0.0049	[0.0101]
Fabless firm	−0.0775	[0.2917]	0.1745	[0.1610]	0.2520	[0.3308]
Serial entrepreneur	0.1030	[0.3106]	−0.4633	[0.2086]**	−0.5663	[0.3711]
Founding team	−0.2074	[0.2800]	0.1236	[0.1705]	0.3310	[0.3190]
VC support	0.2055	[0.2884]	0.1563	[0.1772]	−0.0491	[0.3372]
Patent at entry	−0.3333	[0.3120]	0.0751	[0.1666]	0.4084	[0.3500]
Constant	−5.0150	[0.6914]***	−3.4476	[0.3457]***	1.5764	[0.7706]**
Observations[a]			6,299 (936)			
Number of firm exits			233			
Log likelihood			−1,061.249			
Chi-square			3,085.01***			

Notes. Standard errors are adjusted for clustering at the firm level. All specifications include a full vector of country and entry cohort dummies. Column (1) shows failure versus survival, column (2) shows acquisition versus survival, and column (3) shows acquisition versus failure.

[a]The number of firms is in parenthesis.

*Significant at 10%; **significant at 5%; ***significant at 1%.

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Table 8 Competing Hazard Regressions of Failure and Acquisition for Entry Type and Type of Market with Interactions

	(1)		(2)		(3)	
Focal spinout entering in generic	−1.8077	[0.7077]**	−0.0819	[0.3500]	1.7258	[0.7789]**
Focal spinout entering in market- specific	−0.5414	[0.4904]	0.1231	[0.3251]	0.6645	[0.5841]
Focal spinout entering in other	−1.7640	[0.8212]**	−0.6570	[0.4561]	1.1069	[0.9299]
User-industry spinout entering in generic	−0.4155	[0.5907]	−0.7202	[0.5514]	−0.3047	[0.7945]
User-industry spinout entering in market-specific	−1.5443	[0.5859]***	0.1361	[0.3152]	1.6804	[0.6611]**
User-industry spinout entering in other	−0.3204	[0.6134]	−0.5332	[0.5420]	−0.2128	[0.8234]
Other start-up entering in market-specific	0.0763	[0.4814]	0.0909	[0.3622]	0.0145	[0.5992]
Other start-up entering in other	−0.0181	[0.6021]	1.1196	[0.3656]***	1.1377	[0.7191]
Test of coefficient equality						
Entering in generic (*focal spinout= user-industry spinout*)	1.3922*		−0.6383		−2.0305**	
Entering in market-specific (*focal spinout = user-industry spinout*)	−1.0028*		0.0130		1.0158*	
Controls						
Time (log)	−0.2703	[0.1506]*	−0.0647	[0.0892]	0.2056	[0.1699]
Firm size	0.0111	[0.0091]	0.0097	[0.0049]**	−0.0013	[0.0106]
Fabless firm	−0.0675	[0.3002]	0.1410	[0.1633]	0.2076	[0.3366]
Serial entrepreneur	0.0950	[0.3222]	−0.4985	[0.2161]**	−0.5936	[0.3848]
Founding team	−0.2168	[0.2781]	0.1271	[0.1750]	0.3439	[0.3205]
VC support	0.1903	[0.2886]	0.1058	[0.1793]	−0.0844	[0.3378]
Patent at entry	−0.2726	[0.3145]	0.0938	[0.1705]	0.3665	[0.3567]
Constant	−5.0913	[0.8531]***	−3.8902	[0.4728]***	1.2009	[0.9750]
Observations[a]			6,299 (936)			
Number of firm exits			233			
Log likelihood			−1,044.606			
Chi-square			2,960.90***			

Notes. Standard errors are adjusted for clustering at the firm level. All specifications include a full vector country and entry cohort dummies. Column (1) shows failure versus survival, column (2) shows acquisition versus survival, and column (3) shows acquisition versus failure.
[a]The number of firms is in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1%.

in a focal industry founded by ex-employees of firms in downstream, user industries. We find empirical support for our hypotheses that such entrants are more likely to both enter and survive in market-specific product categories in the focal industry. Below we discuss the theoretical and empirical implications of our findings, the limitations of this study, and directions for future research.

6.1. Theoretical Implications

Scholarship in entrepreneurship, innovation, and strategy has advanced our understanding of how the knowledge context from which entrepreneurs emerge shapes the character of the new firms they create (Agarwal and Shah 2014). Three main sources of innovative new ventures have been the focus of most of the research in this area: employee entrepreneurship (i.e., spinouts), academic entrepreneurship (i.e., spinoffs), and user entrepreneurship. Our study advances this research by investigating start-ups that enter the focal industry from a different industry. In narrow terms, our results show that entrepreneurs that spinout from firms in downstream industries may enter and survive in upstream industry contexts. Whereas industrial demand as an incentive for entry and as a source of innovation is a topic that has received extensive attention in the literature, knowledge from downstream industries as a source of entrepreneurship in an upstream industry has been largely ignored. We provide evidence that this may be a relevant phenomenon in high-technology industries. In broader terms, we show that the knowledge resources gained by entrepreneurs through their pre-entry experience in an incumbent firm may support entry and survival across industry boundaries. Whereas other studies on entry have noted the presence of new firms with a clear heritage in industries other than the focal industry (Klepper 2007), little attempt has been made to analyze how the specific knowledge context from which such firms emerge affects their performance in the new industry. Our findings therefore suggest that scholars of entrepreneurship should develop a more nuanced approach to knowledge contexts to include start-ups originating from intermediate positions along the value chain and founders with careers and experience in industries other than the focal industry. Further work in this direction may provide researchers with a deeper understanding of how the initial endowments that founders inherit through their pre-entry experience affect both entry and survival across industry boundaries.

Our study also contributes to the broader literature on evolutionary theory, entrepreneurship, and industry dynamics that examines the impact of heritage on the performance of new firms in an industry (Dencker et al. 2009, Helfat and Lieberman 2002, Khessina and Carroll

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2008, Klepper and Sleeper 2005). Previous work on entry argues that spinouts have a higher likelihood of survival than other start-ups in the industry from which they originate. While this research recognizes that spinouts tend to enter unoccupied product niches or market segments near to those of their parent firms, survival is normally measured without regard to specific product categories or submarkets. Recent scholarship, however, has begun to place more attention on the specific technology and submarket strategies adopted by spinouts (Berchicci et al. 2011, Bhaskarabhatla and Klepper 2014). Our study adds to this research by showing that not all spinouts have the same likelihood of surviving in all product markets of an industry. Our findings suggest, in fact, that the knowledge resources inherited by spinouts through their founders work to both define and constrain the strategies most suitable for their new ventures in terms of the type of product market they choose to target at entry. Consistent with evolutionary theory, our results also indicate that new firms are more likely to enter and survive in product markets that represent a better match with their existing resources and in which they have deeper and more contextual knowledge. Future studies will therefore need to explore how the specific knowledge contexts from which entrants originate may affect their survival rates across different product markets. This appears to be an important distinction as yet understudied in the literature.

Finally, our work provides a new link between the literature on user innovation and user entrepreneurship (Shah and Tripsas 2007; von Hippel 1988, 2005) and research on industry dynamics. Our study suggests that many of the elements that characterize the knowledge context from which user entrepreneurs emerge also characterize the knowledge context of entrepreneurship originating from firms in industries where intermediate products are used in downstream products and processes (Shah and Tripsas 2007, Winston Smith and Shah 2013). Pre-entry experience in a user-industry, in fact, provides the founders of spinouts with deep and contextual knowledge with which to understand how intermediate products are used and integrated by firms into downstream applications, what improvements are needed in such products, and how downstream use might evolve over time (Baldwin and von Hippel 2011, von Hippel 1988). To the extent that the knowledge gained from such experience is tacit and linked to organizational routines and capabilities, it will be difficult for suppliers to access and transfer through formal or codified mechanisms (Nelson and Winter 1982, Nonaka 1994, Winter 1987). As a result, it may represent a source of advantage for entrepreneurs with experience in intermediate user industries and thus affect the roster of new entrants and the growth and selection of different types of firms over time.

6.2. Empirical Implications

Although not the focus of our study, our results suggest that focal spinouts may be at a serious disadvantage with respect to user-industry spinouts in product categories that require significant market- or application-specific knowledge. As noted above, such knowledge is often highly tacit in nature and may be resident in individuals or embedded in routines and teams (Nelson and Winter 1982). It may defy articulation and be more "sticky" to those individuals involved in a product application (von Hippel 1994). This central proposition in the literature on user innovation (Baldwin and von Hippel 2011) is utilized to explain why the locus of innovation for the application-specific part of product innovations is often shifted to users. Transferring this type of knowledge from one context to another may therefore require more than external contacts and relations with customers, markets, and industry experts. Our results indicate that the likelihood of enduring success in market-specific product categories may be enhanced by direct and contextual experience that is more easily transferred through personnel mobility (e.g., founders from firms in downstream industries; Almeida et al. 2003, Franco and Filson 2006). Although the knowledge gained by managers in focal industries with downstream customers and contexts might be sufficient for entry in market-specific product categories, it might not provide the in-depth contextual knowledge necessary for longer-term survival in such categories. This seems to be particularly true in markets in which technologies and customer requirements are evolving rapidly. How formal and informal cooperation between focal spinouts and user firms in product development and innovation may compensate for this apparent weakness is thus an interesting area for future research.

6.3. Limitations and Future Research

Although the semiconductor industry provides a rich environment in which to study the importance of downstream knowledge for new firm entry, our focus on a single, high-technology industry in a specific time period may limit the generalizability of our findings. We suspect, however, that similar patterns will occur in other industries that have submarkets related to heterogeneous demand segments and complex user applications, and where technological knowledge is partly codified and accessible through markets for technology. Future research on these topics may therefore focus on industries such as lasers, robotics, hard disk drives, and software.

Our study focuses on the submarket of activity at the time of entry. We do not investigate the extent to which user-industry spinouts were constrained by their initial knowledge to continue to focus on the same market-specific products or were able to modify and extend their product offering to other categories over time. In other words, it is important to ask to what extent deep and situated downstream knowledge limits product development choices over time, and to what extent the dynamics of knowledge is constrained by the initial choices of product specialization. Such questions may

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be investigated in future studies by examining in greater detail the product offerings of user-industry spinouts over time.

The issue of what happens over time in such cases also opens another area for future research related to the social identity of user-industry spinouts (Whetten and Godfrey 1998). The literature on user entrepreneurship underscores the importance of social interactions and experience in framing opportunities and shaping the decisions made by new firms (Fauchart and Gruber 2011, Shah and Tripsas 2007). The identity of user-industry spinouts originates from both their prior experience in a downstream industry and their use of an intermediate product from the focal industry. As they enter the focal industry with this experience from the downstream industry, they are, to a certain extent, crossing domains (Haefliger et al. 2010). The question remains, then, to what degree their social identity will remain tied to the downstream industry context or will move closer to the focal industry. Furthermore, how might a shift in identity away from the downstream industry and toward the focal industry impact the strategic vision of these firms over time? Although this study does not address social identity directly, our results highlight the importance of exploring such issues in organizations that fall between "pure market makers" and "pure community players" (Fauchart and Gruber 2011), or that apply knowledge across industry domains.

Finally, a further limitation of our study is the classification of entrepreneurs by their most recent job previous to the start-up. Although this method may not capture the full breadth and depth of the founders' pre-entry experience, it is the most reliable method for understanding the direct knowledge context from which they originate. Subsequent studies, however, may consider more complex indicators that include analyses of the career paths of such founders or indicators that are able to weigh the length of time a founder was employed in his/her previous position.

7. Conclusions

Our results suggest that downstream firms may be an important source of entry in high-technology industries. They further suggest that the downstream knowledge context from which user-industry spinouts emerge affects both their specific entry choices and their ability to survive in the new industry. Pre-entry knowledge provides a valuable resource when it is best matched with a product strategy that exploits the specific nature of this knowledge.

Our research has important implications for researchers and managers interested in high-technology industries. It underscores the importance of downstream knowledge as a source of entrepreneurship. This implies that changes in industry structure and in the population of firms may come from industrial customers and intermediate users as well as from existing competitors or incumbent firms. It also underlines that analyses of ecosystems should include demand-side as well as supply-side considerations (Adner 2006, De Figueiredo and Silverman 2012). This research also provides useful suggestions to venture capitalists exploring the market for interesting investment opportunities. Our results indicate that their search should reach beyond work being done in research labs and universities, and beyond contacts within the incumbent industry, to include promising ideas and entrepreneurs from downstream user industries. Especially in specific product niches, experience in such industries may provide significant knowledge for the formation of new firms.

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Endnotes

[1]Notable examples in this category include the following: (1) Anchor Bay Technologies, Inc. (2001) was founded by an ex-employee of DVDO Inc., a producer of video connectivity solutions for professional installers and end users. Anchor Bay Technologies designs and manufactures digital semiconductors and system-level solutions for digital TV and high-definition products. (2) SiByte Inc. (1998) was founded by three ex-employees of Digital Equipment Corporation, a computer producer. SiByte makes specialized chips for large network systems. (3) Sequans Communications SA was founded in 2003 by an ex-employee of Jupiter Networks, a company that develops and markets network products. Sequans is a fabless 4G chip company that produces specialized chips for the wireless communications market.

[2]To identify the submarkets, we adopted the classification provided by IC Insights (2007) and employed by Corsino and Gabriele (2011).

[3]The chi-square test statistically rejects the null hypothesis of independence between firm entry origin and mode of exit.

[4]We also calculated the predicted probability of each entry choice and the marginal effects for the industry origin dummies. These probabilities were computed using the median values of the continuous variables (*size*) and the mean values of the dichotomous variables (*focal spinouts*, *user-industry spinouts*, *fabless firm*, *serial entrepreneur*, *founding team*, *VC support*, *patent at entry*). The marginal effects were computed as discrete change, holding all other independent variables constant at their mean or median values. With regard to the marginal effects for our entry origin dummies, we computed the discrete change from belonging to the residual category of "other start-ups" to being a focal spinout or a user-industry spinout, respectively. Our results confirm that the choice of entry is systematically

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different between user-industry spinouts and other start-ups, and that the magnitude of the effect is quite high. In particular, the probability of entry into market-specific products is 44% higher for user-industry spinouts.

[5]These findings are confirmed when we split the data set by product category and rerun three separate models: one for generic semiconductors, one for market-specific semiconductors, and one for other semiconductors. In the generic products category, focal spinouts show a significantly lower hazard than other start-ups, whereas user-industry spinouts do not seem to perform differently from the base category. In the case of market-specific products, user-industry spinouts show a significantly lower hazard than other start-ups, whereas focal spinouts do not seem to perform differently from the base category. Finally, in the "other semiconductors" category, both types of spinouts survive more than other start-ups.

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