Product Strategies and Survival in Schumpeterian Environments:

Evidence from the Security Software Industry

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ABSTRACT

This paper seeks to explore the drivers of survival in environments characterized by high rates of entry and exit, fragmented market shares, rapid pace of product innovation and proliferation of young ventures. Specifically, the paper aims to underscore the role played by post-entry product strategies, along with their interaction, after carefully controlling for "at entry" factors and demographic conditions. Based on a population of 270 firms that entered the Security Software Industry from 1989 till 1998, we find evidence that surviving entities are those that more aggressively adopt versioning and product portfolio broadening strategies. Particularly, focusing on one of the two product strategies commands a higher survival probability than adopting a mixed strategy.

Keywords: Survival, Versioning, Product Portfolio, New and Young Ventures, Software

JEL: L86, O32, M13

INTRODUCTION

It is well known that success factors in a stable consolidated industry, for instance cars, tires or computer hardware, are rather distinct than those observed in a more uncertain and dynamic industry, like biotechnology (Ilinitch et al. 1996). While in the former scale economies are a necessary, albeit not sufficient, condition to achieve competitive advantages, in the latter firm size is a relatively less important success factor. Indeed, it could not be otherwise in an industry – biotechnology - that in 2003 hosted more than 600 publicly traded companies (Ernst & Young 2004). What are then the drivers of success in such turbulent and constantly morphing environments?

This paper addresses this research question by empirically examining the drivers of firm survival in a Schumpeterian environment, viz. an environment where entry and exit barriers are small, economies of scale play a marginal role, product innovation paces fast, and firms' competences and strategies are placed under a fierce process of selection (Covin and Slevin 1989; Schmalensee 2000). Typically, one can observe such conditions in the early stages of the evolutionary development of an industry (Klepper and Graddy 1990). For instance, the car industry in the 1920s was much more dynamic and uncertain than it is nowadays (Dobrev et al. 2002). However, Schumpeterian environments might sometimes constitute the DNA code of some specific industries. Examples in this respect include laser, software, semiconductors and biotechnology (Barnett and Freeman 2001; McKendrick et al. 2003), which have shown little sign of consolidation across time.

Specifically, the contribution of this research is to underscore the impact of post-entry product strategies on firm survival beyond "at entry" factors and initial conditions, which have been identified as determinants of survival by the industrial organization literature (Audretsch 1991; Klepper 2002), and after carefully controlling for environmental and demographic conditions (Hannan 1997). The focus on post-entry product strategies becomes relatively more important in Schumpeterian environments where firms that rest on their laurels, i.e. entry factors and initial conditions, are condemned to a premature exit. Indeed, due to greater dynamism and uncertainty, initial conditions are exposed to a higher degree of obsolescence than in more stable environments. Moreover, due the rapid pace of product innovation, product strategies become critical to guarantee the survival of the venture.

In order to assess how much post-entry product strategies matter for firm survival in Schumpeterian environments, we draw on a population of 270 firms that have entered our reference industry, the Security Software Industry (SSI), since its inception in 1989 till 1998. SSI is a relatively recent segment of the software industry, which constitutes a quintessential example of a Schumpeterian environment. Indeed, SSI is an interesting test-bed for several reasons: i) it is a technology-based industry where product innovation plays a major role; ii) since its inception, it has displayed an important level of entry and exit, with little sign of consolidation around a few large players; iii) entry and exit barriers as well as scale economies are rather low; iv) competition takes place mostly among young ventures, whereas mature *de alio* entrants are marginal players. A distinguished feature of our research setting compared to the industries on which the literature has traditionally focused, i.e. computer hardware (Sorenson 2000), cars and tires (Carroll et al. 1996; Dobrev et al. 2002; Klepper 2002), is the peculiar nature of the products. Software products tend to depreciate in value over time much faster than physical products. Additionally, software manufacturers typically have far fewer horizontally differentiated offerings within a product category because of the low marginal cost of increasing scope (Gandal 2001). In turn, these features make our focus on product strategies even more interesting.

We find evidence that surviving entities are those that more aggressively adopt versioning and product portfolio broadening strategies. By versioning, we mean a strategy that implies the generation of multiple versions (or releases) of a product within one niche, whereas product portfolio broadening occurs when the firm product strategy covers several industry niches. Moreover, we show that focusing on one of the two product strategies commands a higher survival probability than adopting a mixed strategy, which involves both a versioning and a portfolio broadening strategy. So, a unique strategic orientation helps young ventures (the average age of our firm population is less than three years) increase their survival probability. We find this result consistent with the organization learning and market-orientation literature (Kuwada 1998; Slater and Narver 1990). Interestingly enough, other things being equal, pioneers do not command a significantly higher likelihood of surviving, whereas technological capabilities play an important role.

This paper is related to several streams of literature. From the industrial organization tradition, while several investigations have already studied industry-level determinants of survival, such as sector characteristics, IPRs regimes, availability of venture capital, etc. (Gans and Stern 2003), much less is known about firm-specific drivers of survival. The finding on which the literature agrees is that survival is directly influenced by firm age and size (Audretsch 1991; Wagner 1994; Gerosky 1995). However, in Schumpeterian environments the dominant organizational form is the new or very young venture, while larger established corporation have well-known difficulties to successfully compete (Tushman and Anderson 1986; Tripsas and Gavetti 2000). Hence, dealing with young firms, size and age represent far too a grainy lens. Recently, some authors have highlighted the role of initial capabilities (differently measured) and entry timing as the two most important determinants of new ventures' survival (Klepper 2002). However, little attention has been devoted to the analysis of post-entry strategies, our main concern here.

From a different tradition, population ecologists have also analyzed the determinants of firm survival (Freeman and Hannan 1989; Carroll and Hannan 1989). Firm age and density are repeatedly reported as the two major drivers of death rates (Hannan et al. 1998a; Hannan et al. 1998b). Product strategies have received attention only recently. Using data on the US automobile industry, Carroll et al. (1996) show that survival rates are smaller in periods of product differentiation, although such variable is not firm-specific. Sorenson (2000) analyze the effect of the number of products on market exit in the computer workstation industry. He shows that product breadth (i.e. a larger number of products) has a negative impact on the likelihood of exit, although such effect tends to decline as the number of rivals' offerings increases. Dobrev et al. (2002) argue that the degree of niche width has a positive effect on survival in turbulent and uncertain environments; however, its effect on more stable concentrated markets is reversed. All these papers have used a one-dimensional measure of product strategy. Firms have either a broad product line or focus their activity in a specific product niche. We expand the product strategy space by introducing the versioning dimension. Versioning measures the extent to which the firm introduces new versions of the same product on the market, which is theoretically different from horizontal differentiation through the broadening of the product scope (a strategy that we label product portfolio broadening). Versioning is especially important in the software industry (Shapiro and Varian 1998), but more in general in all Schumpeterian environments where the degree of product obsolescence is extremely high. In addition, rather than looking at the interaction between product strategies and the evolution of the industry, which would be unviable since we focus on the early years after inception, we try to underscore the interaction between our two product strategies. Interestingly enough, and possible due to the fact that most of our sample firms are rather young and small, we find that pursuing both strategies at the same time might reduce survival rates.

The remainder of the paper is organized as follows. The next section builds the theoretical background and derives our hypotheses. Section 3 takes a brief detour into the salient traits of SSI, whereas section 4 describes the sample and the methodology. Section 5 discusses our findings and section 6 concludes the paper.

THEORETICAL BACKGROUND AND HYPOTHESES

Following the seminal work of William J. Abernathy and James M. Utterback (1978), several scholars have focused their attention on the way industries evolve and its implications for strategy. Most industries are believed to follow an evolutionary pattern known as the “industry life cycle”. A salient characteristic of this pattern is that after an initial period of very intensive entry and exit, and highly fragmented market shares, the industry is subject to a “shake-out” phase, which leads to higher concentration, fewer opportunities to improve the products and the emergence of a dominant design (Geroski 1995; Klepper 2002). Organizational ecologists have also analyzed the processes related to evolving market and social structure over time (Hannan 1997). However, the consolidation level of a population has been considered as part of the broader environment because it is assumed to be relatively immutable with respect to short-term firm movements and strategic action (Dobrev et al. 2002).

Schumpeterian environments, which we define as environments where entry and exit barriers are small, economies of scale play a marginal role, product innovation paces fast, and firms’ competences and strategies are placed under a fierce process of selection, tend to characterize the early phases of development of the industry. Indeed, such salient traits could be found in the fifteen years after the inception of the automobile industry, although nowadays the industry is extremely concentrated with almost no entry (Dobrev et al. 2002). In Schumpeterian environments, product innovation plays a crucial role: New versions and product categories proliferate rapidly making obsolete established product generations. Since there is little investment in capital-intensive methods of production, the minimum efficient size of the firm can be small. As a consequence, entry and exit costs are limited, and firms can try and experiment with little penalization (i.e. the costs associated with failure and exit) (Geroski 1995).

While the evolution of an industry is not a static process and, by definition, must unfold over time, the opposite is not necessarily true: time can pass but the industry might not show up any "shake-out" phase (Dobrev et al. 2002: page 236). Indeed, some recent evidence has highlighted that industry consolidation is not as ubiquitous as it has been initially suggested. The laser industry, semiconductors and biotechnology offer good examples of how entry and exit rates remain intense during the whole industry life (McKendrick et al. 2003; Barnett and Freeman 2001). In addition, in recent years, some industries have evolved from oligopolistic stable environments to Schumpeterian ones due to exogenous shocks, like for instance deregulation. In other words, Schumpeterian environments are not an exclusive feature of the early phases of the industry life cycle.

Whereas in more stable and consolidated environments, superior performances are most likely to be driven by cost advantages based on the exploitation of scale economies, in Schumpeterian environments, there is "a fundamental shift in the rules of competition and the way the game of competition is played" (Ilinitch et al. 1996). Successful firms need to continuously renew their competitive advantage and rely on dynamic capabilities (Teece et al. 1997). By creating a constantly changing series of small, temporary competitive advantages, firms manage to keep competitors off balance by forcing them to respond (Makadok 1998).

Post-entry strategies are therefore particularly important in Schumpeterian environments where firms that rest on their laurels are condemned to a premature exit. In this paper, we aim at quantifying the impact of post-entry strategies beyond that of “at entry” factors and other possible determinants of survival.

We will focus on the post-entry strategies pursued in the product space, and their interaction. Our decision to choose product strategies is twofold. First, product introduction represents a measurable and visible (especially for competitors) realization of the firm’s strategy, and so it takes a primary position inside the range of potential strategic moves (Siggelkow 2003). Second, product strategies are extremely important for new and young ventures that usually build their reputation on the type of products they introduce (Kazanjian and Rao 1999; Debruyne et al. 2002). For example, Meyer and Roberts (1986) have found product strategies to be key for the success of small technology-based firms. In addition, Schumpeterian environments are characterized by substantial rates of product innovation, and firms that are not proactive in the product space tend to face serious difficulties in their struggle to survive.

Specifically, we distinguish between two product strategies: Versioning and product portfolio broadening. By versioning, we mean a strategy that implies the generation of multiple versions (or releases) of a product within one niche, whereas product portfolio broadening occurs when the firm product strategy covers several industry niches. Most of the literature has focused on the difference between broad product line and niche specialization, using a one-dimensional measure to capture such product strategy (Kekre and Srinivasan 1990; Sorenson 2000; Dobrev et al. 2002). We expand the product strategy space by introducing the versioning dimension, which should capture the extent to which a firm introduces up-dated versions of the same product in the market.

Versioning is an important strategy in Schumpeterian environments. First, given the usually low entry barriers, incumbents are often threatened in their core product niches by new entrants endowed with innovative products. By keeping its core products always updated and at the technological frontier, the firm can signal its intention and ability to disrupt the market periodically, implying that eventually a new breakthrough product will replace the actual standard (Smith et al. 1997). Competitors are forced to play continuous catch-up, and invest heavily to improve product quality.

Second, when consumer preferences are fragmented, versioning represents a way to segment customers without cannibalizing the existing product (Shapiro and Varian 1998). For instance, early versions commanding high prices can be commercialized to costumers who quickly need the products, whereas later versions with decreasing prices are meant to attract a broader base of customers.

Finally, in Schumpeterian industries, product innovation has usually a strong customer-driven component (Schmalensee 2000). To create and sustain product success, firms should be highly responsive to consumers' feedbacks and needs (Von Hippel 1986; Torrisi 1998; Gandal 2001). Versioning signals a proactive market orientation with continual and quick firm responses to customers' suggestions and critics. This line of reasoning fits quite well in the population ecology tradition where versioning could help legitimate the product and strengthen firm reputation (Carroll et al. 1996; Hannan et al. 1998a). Hence, we posit:

H1. In Schumpeterian environments, firms that adopt an aggressive strategy of product versioning exhibit a higher survival rate.

Product portfolio broadening implies offering a large menu of products from different sub-segments of the product space. Especially in highly dynamic industries, firms might signal an aggressive behavior by entering a large number of product niches. Moreover, product portfolio broadening could be used to raise entry barriers (Lancaster 1990), an important strategic move when there are no initial sunk costs. By saturating the product space, the firm makes more difficult for de-novo competitors to enter in niches already populated.

A broad product portfolio is particularly important when environmental uncertainly is high and boundedly rational managers do not know ex ante the distribution of consumer preferences and the rivals' product offerings. Product variety allows managers to hedge their bets (Sorenson 2000). Similarly, Dobrev et al. (2002) argue that the benefit of product portfolio broadening is larger in more unstable environments.

Portfolio broadening could also be the necessary condition to pursue a bundling strategy. According to Gandal et al. (2002), product bundling leads to superior performance either when consumer preferences for different products are positively correlated, or if the main customers are organizations that average multiple agent preferences. Bundling could also be used to extract rents from low quality products that are shadowed by high quality ones inside product packages (Kenney and Klein 1983).

Needless to say, the benefits of product variety must be traded off with increasing production, coordination and inventory costs. However, the empirical evidence so far has remained inconclusive about the magnitude of such costs. For instance, Kekre and Srinivasan (1990) find no evidence that broad lines increase either inventories or the direct costs of production once firm scale effects are controlled for. A significant positive relationship between product variety and costs is even more debatable in information-based industries like software where inventory costs tend to zero (Shapiro and Varian 1998).

H2. In Schumpeterian environments, firms that adopt an aggressive strategy of product portfolio broadening exhibit a higher survival rate.

At this point, some interesting and unanswered questions naturally arise: How do the strategies of versioning and product portfolio broadening interact with each other? Are there synergies in pursuing both strategies at the same time? Or do the firms that focus on any of the two strategies end up enjoying a competitive advantage?

There are two lines of reasoning that lead us to suspect that strategic focus pays off in Schumpeterian environments. First of all, since Schumpeterian environments are most likely to be populated by relatively small and young firms with limited resources and no organizational experience, the direction of their strategic orientation, i.e. a selected strategy *vis-à-vis* a mix of different strategies, should play a crucial role on the likelihood of survival. To surmise the potential interaction between the two strategies, we resort to the literature on organizational learning (Kuwada 1998). Organizational learning generates knowledge in support of future strategic initiatives that will, in turn, produce differences in organizational performances. Organizational learning becomes even more important for new and young ventures that have to create their organizational blueprints *ex nihilo*. Organizational learning tends to increase through a continuous process of information accumulation. A critical component of this process is strategy repetition (Kuwada 1998). Repetition is intended as the stable and frequent use of the same strategy. Since learning shows usually increasing returns phenomena (March 1991), our assumption is that learning returns diminish if firms disperse their "learning investments" along different strategic trajectories. Therefore, the returns from organizational learning could be poor if a firm fragments its available resources, typically scarce for a new or young venture, through a variety of strategic trajectories.

Second, product strategy coherence could be easily interpreted as a stable market orientation, viz. discover, select and serve a particular type of customers. Marketing scholars have highlighted how a focused customers' orientation increases firm performance (Slater and Narver 1994). By maintaining continuous interactions with the target customers the firm increases its opportunity to learn from users (Von Hippel 1986). In Schumpeterian environments, where product innovation drives competitive advantages and consumer preferences are emergent and volatile, a stable customer orientation fosters the fruitful co-evolution of firm supply and customer demand. This is especially important in environments where product innovation is mostly user-driven (Von Hippel and Katz 2002).

Indeed, Pelham (1999) finds that generic strategy selection for small firms produces weaker competitive advantages, given the resource limitations of these organizations. Similarly, Covin and Slevin (1989) suggest that a clear definition of strategic postures produces the internal cohesiveness necessary to sustain the performance of small firms.

This line of reasoning leads to our last hypothesis:

H3. In Schumpeterian environments, focusing on one type of strategy (either versioning or product portfolio broadening) exhibits a higher survival rate compared to adopting a mixed strategy.

RESEARCH SETTING

The Security Software Industry (SSI) provides the test bed for our hypotheses. SSI is a recent niche of the software industry, a quintessential example of Schumpeterian environments (Giarratana 2004). SSI has experienced an unprecedented growth in recent years. The world market of SSI reached 4.4 billon dollars in 1999 from 3.2 billion dollars in 1998 and 2.2 billion dollars in 1997 (International Data Corporation 1999).

The technological foundation of the industry date back to the late 70s, when the US government directed important investments in military projects linked to the security of data transmission. However, it was not until the late 80s that commercial software security products were released to the civilian market. The inception of the industry has therefore coincided with the rising market of home personal computers and the development of the Internet, which created a growing civilian demand with different needs, increasing the spectrum and the complexity of different products and services required. Specifically, the first software security product we are aware of was released by McAfee in 1989.

Figure 1 shows the number of firms that entered and exited SSI and the observed hazard rates. This graph highlights the high industry turbulence, given the steady increase in the rates of entry and exit all over the period. In part this can be explained by the relatively small sunk costs needed to start a SSI venture; for example, the initial amount invested to set up Check Point, the fourth largest firm in SSI at 1998, was only $300,000.

[FIGURE 1 ABOUT HERE]

To date, SSI includes a wide range of products: from the basic security software, such as Virtual Private Networks, Firewall and Virus Scanning to advanced security services like Public Key Infrastructures, Security Certification and Penetration Testing. Table 2 shows the major product niches in SSI according to a six digit SIC code classification.

[TABLE 1 ABOUT HERE]

The design of the general security protection of an information system is a complex project and it incorporates solutions of problems originated from different technological fields such as mathematics, software, hardware and network design. The technological core of the product is the "crypto algorithm", which specifies the mathematical transformations that are performed on data. A crypto algorithm is a procedure that takes the plain text data and transforms it into cipher text. The process could be reversed with a usual password. Speed of mathematical calculations and security level are the two main features on which SSI products are evaluated, because the time consumed by encrypting and decrypting processes depends on the length of mathematical algorithm and on the power of computing machines (Giarratana 2004). The crypto algorithm is the principal object of a firm's patent under the technological patent class "cryptology". The main buyers of SSI products are large hardware and software producers, telecommunication companies, credit card administrators, banks, financial institutions and on-line resellers.

DATA AND METHODOLOGY

Population sample, entry and exit

Our population sample is composed by all firms that have introduced at least one product in SSI. Product introduction data were taken from Infotrac's General Business File ASAP and PROMT database that, from a large set of trade journals, magazines and other specialized press, reports several categories of "events" like product introductions classified by industrial sectors. This database is the new version of the old Predicast database that has been used extensively in the literature. We searched for all press articles that reported a "Product announcement", a "New software release" and a "Software evaluation" in SSI (SIC Code 73726) from 1980 to 1998. Then, from each of these articles, we extracted the name of the company, the date of product introduction and the precise SIC code of the product (six digit SIC code). We found that the first product was introduced in 1989. From 1989 to 1998, we registered 270 different entrants that have introduced 1,125 different products. All the products were classified in 6 different niches according to their SIC code classification (see Table 1). We also cleaned for eventual product double-counting (i.e. articles that cite the same event).

We triangulated different databases to obtain the exit information. Precisely, we checked: i) in the US (www.uspto.gov) Trademark Databases looking for firms' "live" security software trademarks. Trademarks granted are withdrawn if the firm is not actually using them in the market. As a matter of fact, since the US represents the most important market for software products, firms that want to operate in such a market should own at least a “live” trademark there, regardless of their nationality; ii) in some financial databases – Hoover’s (www.hoovers.com), Mergent on Line (www.mergentonline.com), Bureau Van Djik’s Orbis (www.bvdep.com) – for any firm’s balance sheets; iii) in Infotrac Company Resource Data Center and in Infotrac PROMT for any press article that included news of firms (acquisition, bankruptcy, shutdowns and so on). Since we have searched for firm information until the year 2000, we have not a right censoring problem at 1998. The final sample is formed by 604 company-year observations with 162 exit events.

Independent variables of interest

Versioning. This time variant variable (VERSIONING) is equal to the cumulative number of new versions of the entry product, i.e. the product that has spurt firm entry in SSI. The variable is calculated for each year of firm permanence in the market. This means that if CheckPoint entered in SSI in 1994 introducing a Firewall, we computed the cumulative number of new versions of this product CheckPoint has released each year till its exit (or till 1998 if the firm still “lives”). The entry product niche turns out to be particularly important for young ventures because it usually creates a strong reputation effect and sustains the competitive advantage in the preliminary phases of competition (Kazanjian and Rao 1999). Moreover, subsequent niche specialization strategy is usually pursued in the niche that characterized entry (Debruyne et al. 2002). At the same time, our direct interviews with some managers of SSI companies confirm the importance of building up the firm reputation around the product that has spurt entry.

Product portfolio broadening. This variable (BERRY) is again time variant and measures for each year the Berry index of dispersion of the cumulative number of products the firm has released in SSI. Specifically, the Berry index equals to

$$B_t=1-?^{n}_{i=1} X^2_t$$

where X_t is the share of products in niche i over the total number of products at time t. As discussed above, there are 6 major niches in SSI. We multiplied this value by 100 so that BERRY goes theoretically from 100 (maximum differentiation) to 0 (no differentiation). The Berry index is a quite precise and standard measure of dispersion. Other proxies used in the literature are the following:

Carroll et al. (1996) employ a year dummy to capture an overall industry differentiation effect; Dobrev et al. (2002) use the Min-Max difference in the engine power to measure niche-width in the automobile industry; Sorenson (2000) measures differentiation in the computer workstation industry by counting the cumulative number of products a firm offers.

Mixed strategy. Our aim is to test if the strategies of versioning and product portfolio broadening show any interaction with each other. Empirically we can address this issue simply by constructing a new covariate equal to the product (VERSIONING* BERRY) of the VERSIONING and BERRY variables.

Control variables

We introduce several time variant and time invariant control variables following the standard practice in the literature (Sorenson 2000). Time invariant control variables capture for the effects of pre-entry conditions, and are frequently used proxies in the industrial organization tradition (Audretsch 1991; Klepper 2002). First of all, we introduce firm age and size at market entry to proxy scale and experience effects. Age (ENTRY AGE) at entry is calculated as the difference between the entry year and the year of firm foundation. We proxy size at entry by the stock of trademarks the firm has registered at the US Patent and Trademark Office (ENTRY TRADEMARKS). When dealing with small-to-medium sized, non-listed firms entered in a new industry, time series on sales, employees or assets are very difficult to obtain. This is a classical problem in most studies of young ventures. In this respect, trademarks are a very useful proxy since they are freely available for all firms, and earlier studies (Seethamraju 2003) have found significant correlation between firm sales and the stock of firm trademarks. We introduce it in the log specification to smooth no-Gaussian size distribution effects.

In Shumpeterian environments firms endowed with "dynamic capabilities", i.e. firms able to continuously achieve new forms of competitive advantage, have an edge over competitors in the fight to survive (Teece et al. 1997). In SSI, due to its science-based nature, one of the leading dynamic capabilities is technological soundness. A deep technological background and innovative capability is therefore a necessary condition to short-term survival and long-run performance. This is why we insert as a control the stock of firm patents granted at the US Patent Office at the year of entry (ENTRY

PATENTS). Patent stocks have been used to proxy technological capabilities in the literature (Henderson and Cockburn 1994). Patent data were downloaded from the US Patent Office web site. We considered all patents granted in the US class 380 (Cryptography) that is the fundamental technological class in SSI (Giarratana 2004).

To control for different industry conditions at the time of entry we employed the industry density at the time the firm enters the market (DENSITY DELAY). This is a standard control in survival studies (Carroll et al. 1996; Sorenson 2000) that assume that initial competition conditions influence the future exit hazard of firms.

Moreover, a large body of the literature has analyzed and measured the magnitude and sustainability of first-mover and early-mover advantages (Lieberman and Montgomery 1988 and 1998). In SSI, where entry and exit barriers are low, and scale economies are less important, the sustainability paradigm of the first-mover advantage is under the most severe test (Gandal 2001; Lieberman 2003). Nonetheless, early movers in SSI might benefit from the existence of the same users' switching costs that characterize the software industry as a whole (Torrisi 1998). Users who want to move to a different software provider might need to learn how the new supplier's product works, an investment that is already sunk with the software product in use. Early-movers might also benefit from a reputation effect. Established firms that offer a solution that works have an advantage over new competitors whose product offer is characterized by higher uncertainty. In some niches of SSI, for instance antivirus, not only it is important to offer a high quality product, suppliers might have also to convince prospective buyers that they will be able to update their products in the incoming future. Established firms with a built reputation might be more trustworthy. To test for the presence of first-mover advantages we create a dummy (PIONEERS). Since we have a total of 10 years of industry life, this variable takes the value 1 if a firm has entered in the period 1989-1991, the first 3 years, and 0 otherwise.

Finally, we insert a dummy variable that takes the value of 1 if the organization is a US firm, and 0 otherwise (US FIRM). This is meant to smooth the possible distortion effect for non US firms in the US

Patent and Trademark database. Moreover, the US SSI market is the largest in the world, giving to local firms a potential advantage.

We move now to time-variant controls largely derived from the organizational ecology literature (Caroll et al. 1996; Sorenson 2000; Dobrev et al. 2002). To capture the effect of the U-shaped relationship between population density and firm exit probability, we include for each year the number of firms operating in SSI and the square term. Following Carroll et al. (1996) we use the one year lagged value (DENSITY and DENSITY^2). Experience in the market is captured by the number of years the firm is competing in SSI (AGE IN MARKET). This variable is the difference between the firm entry year and the current year. Size effects are controlled through the stock of trademarks registered at the US Patent and Trademark Office at every year of firm market presence in SSI. We use the log specification to smooth no-Gaussian size distribution effects (TRADEMARKS).

Table 2 displays the basic statistics for the variables used. In particular, it is worth noticing that the average firm age at entry is only 2.66 year, confirming that in this initial phase of the industry the young venture is the dominant organizational form. Table 3 provides covariates correlations.

[TABLE 2 AND 3 ABOUT HERE]

Methodology

To test our hypotheses, we use a hazard model, which estimates the hazard rate, namely the probability of exit from the market in year t conditional on being in the market at time t. Hazard models draw on hazard functions, which are distribution functions of the duration or spell length for an individual $F(t)= Pr(T<t)$, where T is the duration. Hazard rates are estimated from hazard functions. They are the rates at which spells are completed at duration t, given that they have lasted until t,

$$?(t)= f(t)/S(t)$$

where $f(t)=dF(t)/dt$ is the number of firms who exits the market at time t while $S(t)=1-F(t)=Pr(T= t)$, the set of individuals whose duration is at least t, is the number of individuals still at risk at time t, i.e. the risk set (Kiefer 1988).

Following earlier works (Sorenson 2000; Dobrev et al. 2002) on firm survival in industry population, we opted for the piece-wise exponential model specification that does not make any strong assumption on time dependence. Given the time periods, this model could be expressed as:

$$?_{jt} = exp\ (a_t + X_{jt} ?_j)$$

where *X* is the covariate vector, ? is the vector of coefficients assumed not to vary across time and *a* is a constant coefficient associated with the *t* time period (see Blossfeld and Rohwer 2002: 120).

RESULTS AND DISCUSSION

Table 4 provides the estimation results. Model 1 omits the core covariates, showing only the baseline model with the control variables. Model 2, 3, 4 and 5 progressively add our covariates of interest. Variable addition increases the fit of the model, as shown by the Chi-square test of significance. Indeed, Model 5 appears the best suited ($?^2$= 66.36 *vs* Model 1, 34.2 *vs* Model 2, 48.96 *vs* Model 3, 20 *vs* Model 4). Our two first hypotheses gain support from the data since firms that introduce a larger number of versions of their original "entry" product or have a higher level of product differentiation command a higher probability to survive. In unreported regressions, we also perform some robustness checks using different measures for portfolio broadening like, for instance, the cumulative number of niches in which the firm operates. We also control for heterogeneity in the survival rates across different niches through a set of dummy variables. Results are confirmed.

[TABLE 4 ABOUT HERE]

The coefficient on VERSIONING*BERRY defines how one product strategy attenuates or strengthens the effects of the other. Our estimation shows that the interaction covariate has a significant negative impact on the survival probability confirming our last hypothesis.

To better interpret our findings, we report in Table 5 the estimates of the multiplier rate of firm exit conditional on different values of VERSIONING and BERRY. A multiplier rate of one means that a variable has no effect on the exit rate. A multiplier rate smaller than one implies that a particular level of a variable increases the chance of survival. Table 5 explores the change in exit rate due to a more aggressive product portfolio broadening strategy for given levels of the versioning strategy and viceversa. Multiplier rates are computed with a baseline model of a one product firm: M = exp (-.389* VERSIONING -0.097*BERRY + .016*VERSIONING*BERRY) / exp(-.389). First, notice that for low levels of product versioning increasing the degree of product portfolio broadening decreases the exit rate. This finding supports our second hypothesis. However, for sufficiently high level of VERSIONING, an effort to broaden the product offering might have a negative effect on the survival rate according to the third hypothesis. A firm would be better off by focusing as much as possible. Specifically, the advantage shifts from being multi-niche to being single-niche when product versioning is above 7. We turn now to the second part of Table 5 where we analyze the change in exit rate due to a more aggressive versioning strategy for given levels of the product portfolio broadening strategy. Again, we observe that versioning produces an advantage when the firm has a quite concentrated product portfolio (according to hypothesis 1); however, pursuing an aggressive versioning strategy when the firm has a broad product portfolio has a negative effect on the survival rate. The switching occurs when BERRY takes the value of 25.

[TABLE 5 ABOUT HERE]

In sum, the results suggest two possible routes for survival in SSI: a) a niche product leadership, i.e. specializing with aggressive versioning in a particular niche and keeping the product at the technological frontier; b) a one-stop-shop strategy, i.e. offering a complete security package to customers, which may include also consultancy services. The most famous firms that pursue niche product leadership are Checkpoint Software (Firewall), Aladdin (Data protection), Symantec (Antivirus) and Trend-Micro (Antivirus). Firms that have championed the second strategy are Verisign, Security Dynamics and Network Associates that supply a large set of products from consultancy to the integration of applications. This vision is clearly expressed by the words of Zach Nelson, chief strategy officer at Network Associates, one of the SSI market leaders: “We went aggressively after the one-stop-shop strategy five years ago, and we were way ahead of the market in terms of the customers’ willingness to accept all of those products from one vendor” (Eweek 2000). Our results are also consistent with a large stream of marketing research focused on consumers’ orientation and demand segmentation (Slater and Narver 1994). It is interesting to note that the two business models replicate quite well the particular structure of the SSI demand in our sample period. From one side, there are large ICT firms that represent technological-skilled, high-selective customers that tend to choose the best products on the market (hardware and semiconductors producers, telecommunication companies…); on the other side, we have less "techy" consumers that demand broad security packages like banks, financial institutions and credit cards (Giarratana 2004).

As far as it concerns our control variables, the dummy for early industry entrants (PIONEERS) is not significant at all, suggesting that firms that have entered SSI in its early days do not show a higher probability to survive. This result seems quite robust. Indeed, we have experimented with different time windows for early entrants and with a time trend (= year of firm entry - 1989), obtaining always insignificant coefficients. After all, it is not surprising that the first cohort of entrants does not show lower hazards of exit. First of all, the high degree of uncertainty in the initial stages of a new industry could moderate the benefits of first mover advantages. Second, the evidence concerning first-mover advantages comes typically from more stable and concentrated industries where pioneers end up enjoying larger scale economies, lead time and network effects. Indeed, only weak evidence of first-mover advantages has shown up in the really few studies focused on Schumpeterian environments (Makadok 1998; Gandal 2001; Lieberman 2003). The high degree of turbulence of the environment might also explain the insignificant effect of firm size and age at the entry.

As expected, pre-entry technological capabilities play an important role in shaping the survival rate. If all other variables are held at their mean values, entrants endowed with, for example, 6 patents are 88.8% more likely to survive than entrants with only one patent (Exp[-0.439*(6-1)], using estimates from Model 5). Industry density shows an effect completely in line with the population ecology tradition (Carroll et al. 1996; Dobrev et al. 2002): Positive for the DENSITY term, negative for the square, negative for the density at the entry.

Finally, by comparing firm experience on the market with firm size, one reaches the conclusion that, in SSI, experience has a more robust effect than size. Indeed, the TRADEMARKS variable (our proxy for size) loses significance when we account for firm product strategies, while AGE IN MARKET remains always significant. This effect could be due to some idiosyncratic features of the software industry: Scarce scale economies, crucial role of learning from users, and importance of product reputation (Shapiro and Varian 1998; Torrisi 1998; Gandal 2001; Von Hippel and Kats 2002).

CONCLUSION

In this paper we have empirically investigated the determinants of firm survival in the Security Software Industry, a prototypical example of a Schumpeterian environment, where the young venture is the dominant organizational form.

Our findings suggest that post-entry strategies of versioning and product portfolio broadening are important in explaining survival rates even after controlling for the standard drivers of survival highlighted by the industrial organization (Klepper and Graddy 1990; Audretsch 1991; Gerosky 1995; Klepper 2002) and the population ecology traditions (Hannan and Freeman 1989; Carroll et al. 1996; Sorenson 2000; Dobrev et al. 2002). This significant effect of post-entry product strategies fits perfectly in a framework where dynamic capabilities (Teece et al. 1997) and hyper-competition (Ilinitch et al. 1996) play a major role.

Moreover, we show that coherence and focus in post-entry product strategies improve firm performance. Indeed, firms attempting to achieve high levels of both versioning and product portfolio broadening display lower survival rates. These findings, in addition to be interesting *per se*, are consistent with both the organizational learning and the marketing orientation literature. First, organizational learning has been shown to be important for firms in general, and particularly for young ventures with scarce resources. The dispersion of the firm's resources along a variety of different strategies could decrease the returns from learning and undermine firm performance and stability (Kuwada 1998). According to this view, a coherent strategy approach in SSI means to exploit the scarce resources for either achieving niche leadership through an aggressive versioning strategy or expanding horizontally the product offer to supply the market as a one-stop-shop provider. By contrast, pursuing both strategies might be deleterious for survival. Second, marketing scholars highlight how a focused customers' orientation increases firm performance (Slater and Narver 1994). Given that the demand for security software products is segmented in high-tech customers (who demand the best product on the market) and low-tech customers (who need a comprehensive security package), the negative effect of the interaction of our two product strategies could be explained as the result of a poor customers' orientation by the company.

As secondary findings, we show that firm age and size at entry are not significant, whereas we confirm the important role played by pre-entry technological capabilities and post-entry market experience. We relate these stylized facts to the particular features of SSI, where entry and exit barriers are low, scale economies scarce, but market experience, learning from users, technological competences and reputation are key to achieve success (Torrisi 1998; Von Hippel and Kats 2002). Moreover, in line with previous empirical studies on Schumpeterian environments (Gandal 2001), pioneer firms do not command higher survival rates than later entrants.

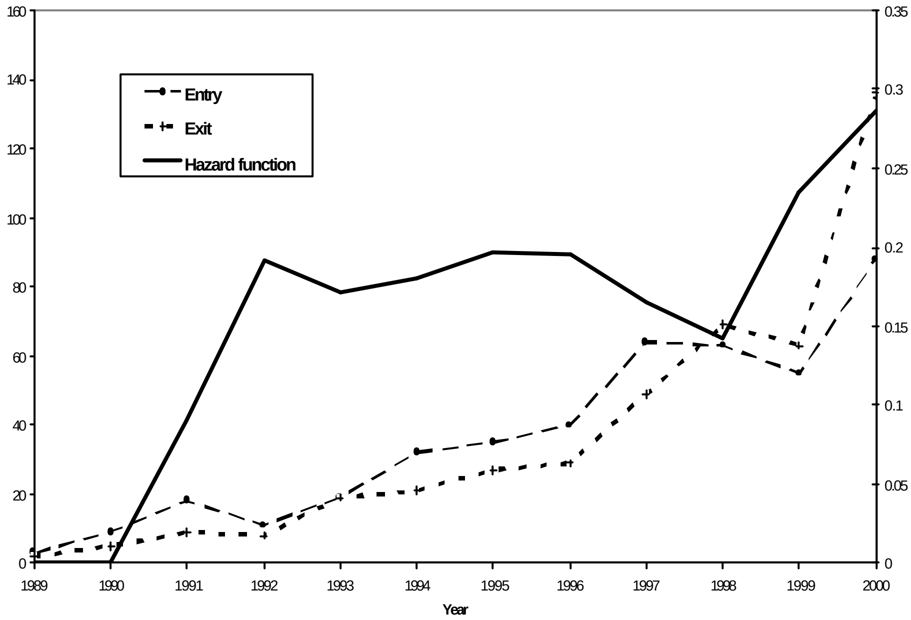
There are several lines of research that might be inspired by this work. For instance, technological capabilities and post-entry strategies could indeed be proxies of the same unobserved entrepreneurs' ability. As a matter of fact, the two product strategies could depict two different initial entrepreneurial blueprints (Baron and Hannan 2002) that could echo the population ecology distinction between generalist and specialist organizations (Dobrev et al. 2002). In this respect, we are referring to: i) A product-oriented firm that bases its competitive advantages on the technological quality of one product; ii) a service-oriented organization that exploits the richness of intra-industry product variety to build up a one-stop-shop offer. Indeed, this confirms that direct, extensive surveys to firms could provide information that with great difficulty one can extract from secondary data.

Second, it could be interesting to deepen our knowledge of how firms in SSI use technology licensing complementarily or alternatively to product strategies. This line of research would follow the footsteps of a recent stream of literature (Anand and Khanna 2000; Gans and Stern 2003) that sees technology contracts pivotal to increase the profitability of young firms with scarce downstream assets but high-value innovations. Data on technology contracts could be assembled using the same sources we have employed to identify our product strategies.

Finally, we depart a little from the on-going research on firm survival, which has mainly focused on industries with large sunk costs, high entry barriers and scale economies – i.e. computer hardware

(Sorenson 2000), cars and tires (Carroll et al. 1996; Dobrev et al. 2002; Klepper 2002). Compared to these industries, SSI elevates to the central stage the crucial role of product strategies, market orientation, technological competences and learning. By focusing on a different research setting we are aware of the costs: we loose some of the advantages of cumulativeness of knowledge in Social Sciences. However, we believe that the benefits, i.e. a better understanding of product strategies and industry dynamics in turbulent environments, overweight the costs. Needless to say, further research on other Schumpeterian environments is needed to assess the generalization of our findings.

Figure 1: *Entry, exit and hazard function, 1989-2000*



Notes: X axis years, Y_1 axis (left) number of firms, Y_2 axis (right) hazard.

Table 1: *Product niches in SSI*

Niche	Description
Authentication-Digital Signature	Products for the authentication of digital documents with a copyrighted mark
Antivirus	Programs that detect and clean viruses from computers
Data and Hardware Protection	Products aimed to secure the integrity of sensible data stored in hard drivers
Firewalls	A sort of checking door between different networks
Utility Software	Utility software programs that assure the protection and proper execution of the operating system and applications, giving the possibility to recreate the content of some data packages lost
Network Security and Management	Network security management packages that guarantee the high performing functioning of different networks

Source: Our elaboration from Infotrac according to a six digit SIC code classification.

Table 2: *Descriptive statistics*

Variable	Mean	Std. Dev.	Min	Max
Time variant controls				
1.DENSITY	72.478	33.992	0	116
2.AGE IN MARKET	1.023	1.439	0	9
3.TRADEMARKS	1.568	1.380	0	210
Time invariant controls				
4.ENTRY TRADEMARKS	8.673	19.253	0	186
5.ENTRY PATENTS	0.251	0.678	0	6
6.ENTRY AGE	2.668	2.483	0	27
7.DENSITY DELAY	75.5	41.519	3	152
8.PIONEERS	0.304	0.460	0	1
9.US FIRMS	0.766	0.423	0	1
Variables of theoretical interest				
10.VERSIONING	1.799	1.934	1	22
11.BERRY	2.021	9.817	0	64
12.VERSIONING*BERRY	6.314	41.422	0	500

Table 3: *Correlation matrix*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1.00											
2	0.11	1.00										
3	0.03	0.32	1.00									
4	0.03	0.02	0.66	1.00								
5	0.19	0.06	0.21	0.12	1.00							
6	-0.06	0.06	0.20	0.15	0.13	1.00						
7	0.82	-0.45	-0.16	0.01	0.13	-0.09	1.00					
8	-0.68	0.37	0.12	-0.02	-0.08	0.07	-0.79	1.00				
9	-0.07	0.07	0.18	0.13	0.10	0.12	-0.11	0.11	1.00			
10	0.21	0.33	0.07	-0.05	-0.01	-0.06	-0.03	-0.04	0.05	1.00		
11	0.01	0.55	0.30	0.07	0.10	0.14	-0.26	0.29	0.05	0.14	1.00	
12	0.00	0.37	0.18	0.03	-0.01	0.05	-0.18	0.21	0.04	0.41	0.65	1.00

Table 4: *Hazard Rates for piecewise exponential model for SSI market exit, 1989-98*

Independent variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Time variant controls					
DENSITY	-4.423**	-4.510**	-4.605**	-4.343**	-4.711**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
DENSITY^2	0.019**	0.019**	0.019**	0.018**	0.020**
	(0.000)	(0.001)	(0.001)	(0.000)	(0.002)
AGE IN MARKET	-0.646**	-0.726**	-0.416**	-0.462**	-0.454**
	(0.100)	(0.107)	(0.132)	(0.129)	(0.131)
TRADEMARKS	-0.142*	-0.127*	-0.103	-0.088	-0.087
	(0.065)	(0.065)	(0.070)	(0.076)	(0.076)
Time invariant controls					
ENTRY TRADEMARKS	0.004	0.003	0.002	0.000	0.000
	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
ENTRY PATENTS	-0.506**	-0.528**	-0.449**	-0.443**	-0.439**
	(0.122)	(0.120)	(0.132)	(0.131)	(0.131)
ENTRY AGE	0.010	-0.003	0.020	0.013	0.013
	(0.020)	(0.024)	(0.015)	(0.016)	(0.016)
DENSITY DELAY	-0.051**	-0.064**	-0.046**	-0.056**	-0.056**
	(0.009)	(0.011)	(0.009)	(0.010)	(0.010)
PIONEERS	-0.054	-0.360	-0.236	-0.491	-0.501
	(0.342)	(0.307)	(0.310)	(0.285)	(0.283)
US FIRMS	-0.045	0.029	-0.140	-0.024	-0.022
	(0.143)	(0.144)	(0.125)	(0.135)	(0.135)
Variables of theoretical interest					
VERSIONING	-	-0.377**	-	-0.370**	-0.389**
		(0.060)		(0.064)	(0.062)
BERRY	-	-	-0.051**	-0.051**	-0.097**
			(0.026)	(0.024)	(0.023)
VERSIONING* BERRY	-	-	-	-	0.016**
					(0.003)
LogL	913.33	903.33	888.85	896.23	880.15

Notes: 162 exits, 604 organizations-years. * indicates p<0.10, ** indicates p<0.05. Heteroskedastic consistent standard errors in parenthesis.

Table 5: *Multiplier rates of exit.*

	VERSIONING				
BERRY	**1**	**2**	**5**	**10**	**20**
1	0.923	0.635	0.208	0.032	0.001
5	0.668	0.490	0.194	0.041	0.002
10	0.446	0.355	0.178	0.056	0.006
20	0.199	0.186	0.150	0.105	0.052
30	0.089	0.097	0.126	0.196	0.470
44	0.040	0.051	0.106	0.365	4.283

	BERRY					
VERSIONING	**0**	**5**	**10**	**20**	**30**	**40**
1	1.000	0.668	0.446	0.199	0.089	0.040
3	0.678	0.490	0.355	0.186	0.097	0.051
6	0.211	0.194	0.178	0.150	0.126	0.106
11	0.030	0.041	0.056	0.105	0.196	0.365
21	0.001	0.002	0.006	0.052	0.470	4.283

Notes: Changes in the variable in rows for a given level of the variable in columns

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