Opportunity Spin-offs and Necessity Spin-offs

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Abstract:
This paper proposes a new distinction between two types of spin-offs, which is based on the events triggering spin-off formation. Spin-offs induced by newly discovered opportunities are distinguished from necessity spin-offs organized by to escape deteriorating job conditions. An empirical analysis of spin-offs in the German laser industry traces differences in the performance and determinants of the two spin-off types. Necessity spin-offs are important to limit the devaluation of individual human capital by the competitive market process.

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1. Introduction

In 1972 five employees of IBM Germany quit their jobs to start a new venture called SAP. Their idea was to develop and market business software. Their business model challenged established industry practices in several ways: SAP pursued standardization instead of customer-specific programming, it offered integrated modules addressing and linking the multiple data needs of business firms, and used real-time instead of batch computing (Meissner, 1997). 35 years later, SAP had grown into a global leader in business software with 40,000 employees and more than US$ 10 billion in annual revenues (SAP, 2007).

The SAP history is far from unique. Corporate spin-offs like SAP have been identified as drivers of innovation and industry evolution in a number of markets. Probably the most well-known ones, including Fairchild and Intel, have been spawned in Silicon Valley's semiconductor industry, and Klepper (2007a) shows that they were often triggered by the parent firms' reluctance to pursue employee ideas for new products or processes. Evidence on the U.S. automobile (Klepper, 2002a, 2007b), laser (Klepper and Sleeper, 2005; Klepper and Thompson, 2006), and disk drive (Christensen, 1993) industries likewise indicates how frustrated attempts to pursue innovative opportunities within the parent firm are a major force underlying spin-off activities. As is evidenced by household names such as Ford, Intel, SAP, and Adobe (Chesbrough, 2003), the spin-off process frequently leads to great firms that change the history of their industries and sometimes home regions. This shows that spin-offs based on the pursuit of perceived new business opportunities – termed "opportunity spin-offs" in the following – play a crucial role in market economies: they commercialize ideas that would otherwise be shelved by the parent firm (Klepper and Thompson, 2008).

The importance of opportunity-induced spin-offs has increasingly been realized in recent years. However, not all employee startups are triggered by the discovery of a promising new business opportunity. A second type of triggering events is related to adverse developments that render future employment at the parent firm less attractive or even impossible. A variety of events can trigger the emergence of these "necessity spin-offs," including changes in management, relocation of activities, takeovers, crises in profitability, or even bankruptcy of the parent firm.

Adverse developments at the parent firm have been recognized as drivers of spin-off events before, and there is some evidence suggesting that spin-offs induced by "push factors"

are less distinctive performers than those driven by employee innovations (Brittain and Freeman, 1986; Eriksson and Kuhn, 2006; Dahl and Reichstein, 2007). Against this backdrop, the objective of the present paper is twofold. First, theoretical considerations and empirical evidence on the different types of spin-offs are integrated into a common conceptual framework of the spin-off process. Second, differences and commonalities between opportunity spin-offs and necessity spin-offs are further explored in the context of the German laser industry, which is characterized by sustained entrepreneurial activities over a 40-year period of time (Buenstorf, 2007a). Not only did necessity spin-offs account for a substantial share of the spin-off dynamics in this industry, the analysis also suggests they built on knowledge bases comparable to those of opportunity spin-offs. And even though their performance was not as distinguished as that of opportunity spin-offs, on average they did not perform less well than other types of entrants, including startups spawned by universities and public research organizations.

The remainder of the paper proceeds as follows. In the next section, opportunity and necessity spin-offs are defined and related to the prior research on the spin-off process. Hypotheses regarding differences in their performance and driving forces are derived in section 3. Section 4 analyzes the two kinds of spin-offs in the evolution of the German laser industry. Section 5 looks at some implications of necessity spin-offs for entrepreneurs, incumbent firms, and the market process. Section 6 offers concluding remarks.

2. Opportunity and necessity in the spin-off process

2.1 Defining opportunity and necessity spin-offs

The distinction between opportunity and necessity entrepreneurship is well-established in entrepreneurship research. Its origins can be traced back to the Global Entrepreneurship Monitor (GEM) studying the extent and nature of entrepreneurial activities on a global scale. Opportunity and necessity entrepreneurship are defined in the 2001 edition of the GEM (Reynolds et al., 2002). The GEM authors characterize opportunity entrepreneurship as new firm formation to take advantage of a unique business opportunity, while necessity entrepreneurship reflects new firm formation induced by a lack of alternative employment options. Classifying respondents on the basis of self-reported motivations, the GEM project found substantial differences in the prevalence and drivers of the two kinds of entrepreneurship. For example, while national rates of opportunity entrepreneurship were

related to economic growth, rates of necessity entrepreneurship varied with the extent of social welfare programs.

The distinction between opportunity and necessity entrepreneurship has also been made at the national level. For Germany, Wagner (2006) found necessity entrepreneurs to be more risk averse than opportunity entrepreneurs. Defining necessity entrepreneurs as individuals who lost their job through being laid off or because of their employer's exit, Block and Wagner (2006) showed that opportunity and necessity entrepreneurs differed in their personal characteristics as well as the levels and determinants of their earnings.

It is straightforward to extend the distinction to spin-off entrepreneurship. In what follows, opportunity and necessity spin-offs will be characterized in terms of how the triggering events underlying their formation affected the opportunity costs faced by their founders. Thus, similar to the approach of Block and Wagner (2006), types of spin-off entrepreneurship are derived from observable information.

Specifically, *opportunity spin-offs* are defined as spin-offs triggered by an increase in the expected future benefits of spin-off formation caused by the new discovery of a promising entrepreneurial opportunity. In contrast, *necessity spin-offs* are defined as spin-offs triggered by a decrease in the expected future benefits of further employment at the parent firm, which is driven by events that adversely affect the parent firm and/or decrease the subjective attractiveness of further employment at that firm for the spin-off founder. Note that the distinction between opportunity and necessity spin-offs is solely based on the triggering event driving the actual decision to start the new firm. This does not rule out that the founder of a necessity spin-off had identified an entrepreneurial opportunity at some previous time of her tenure at the parent firm – provided, however, that this discovery alone was not sufficient to induce actual spin-off formation before the triggering event occurred.

2.2 The spin-off process: learning, triggering events, and knowledge transfer

The above definition of opportunity and necessity spin-offs highlights the different kinds of events triggering spin-off formation. At the same time, existing evidence on spin-off performance is suggestive of substantial employee learning and knowledge transfer operating through the mobility of (teams of) individual spin-off entrepreneurs. These different aspects of the spin-off dynamics can be integrated into a common conceptual framework distinguishing three phases of spin-off emergence: employee leaning, triggering event, and the formation of capabilities in the new firm (cf. Table 1). In the remainder of this subsection, the three phases are discussed in more detail.

– Table 1 about here –

Employee learning in the existing organization: Firms are loci of unique capabilities that give rise to heterogeneity in the products, processes, and strategies within the population of competing firms. Capabilities are reflected by the firm's capacity to deploy its resource base toward desirable ends (Amit and Shoemaker, 1993). They are ultimately based on the firm's knowledge base, which is in part tacit (Nelson and Winter, 1982; Kogut and Zander, 1992; Langlois, 1992). For the individual firm, capabilities, including the dynamic capabilities to adapt to a changing environment (Teece et al., 1997), provide the foundation of competitiveness. At the same time, limited adaptability of capabilities results in the continuity of practices within the firm, as the set of existing capabilities possessed by the firm conditions its ability to develop and utilize new ones (Cohen and Levinthal, 1990).

Prospective spin-off founders acquire various kinds of useful knowledge during their employment in existing firms, including knowledge about technologies and markets, knowledge about organizational processes, as well as personal skills based on learning from others and from their own experience.

Learning about technologies and markets is an oft-noted dimension of the spin-off process (cf., e.g., Christensen, 1993; Agarwal et al., 2004). In high-technology industries, spin-off activities are frequently initiated by R&D specialists with in-depth knowledge about the parent firm's technology base. Employees working in the marketing and sales departments of incumbent firms make up another prominent group of spin-off founders. They are well-positioned to gain insights into customer needs and market niches that are currently not satisfied by the producers in the industry. Existing evidence indicates that this kind of knowledge matters for spin-off performance. For example, Sleeper (1998) shows that U.S. laser spin-offs with founders from marketing and sales positions tended to be more successful than those whose founders had an R&D background.

Spin-off performance and parent firm performance have been found to be directly correlated (Helfat and Lieberman, 2002). One interpretation of this finding is that employees learn more than just knowledge about technologies and/or markets, the acquisition of which may owe more to an individual's specific position in the firm than to the firm's overall quality. Almost by necessity, employees also develop increasing familiarity with the organizational processes they are involved in; i.e., they increasingly get to know relevant aspects about how the firm operates. Theoretical and empirical contributions indicate that this

learning operates at different degrees of deliberation, and that the ensuing knowledge differs in its degree of tacitness (Cohen and Bacdayan, 1994; Zollo and Winter, 2000; Cohen, 2006; Jensen and Szulanski, 2007).

The firm organization structures the interactions between individuals within its boundaries. It establishes patterns of repeated interaction allowing for interpersonal learning. This learning may be based on the explicit communication of knowledge and strategies, but it may also involve less deliberate, nonverbal learning processes based on the observation of role models (Bandura, 1986; Witt, 1998). Personal on-the-job experience further shapes the level and nature of the employee's knowledge and skills. For example, on-the-job learning allows employees to acquire specific expertise and engage in intuitive problem-solving, which has been shown to be based on domain-specific and largely tacit heuristics (Anderson, 2000). There is also evidence suggesting that exposure to demanding field assignments involving high degrees of autonomy and outcome responsibility may instill entrepreneurial attitudes in junior employees and prepare them to take over leadership positions (Higgins, 2005).

Triggering events: A key insight into the spin-off process is that spin-offs do not "emerge" automatically whenever employees acquire valuable knowledge. It has often been observed that employees generally try hard to apply their knowledge and skills in the parent firm, resorting to spin-off activities only when they find that this is not, or no longer, feasible or supported by the firm's management (Garvin, 1983; Klepper. 2007a).[1] Spin-offs tend to be triggered by specific events that alter the opportunity cost of spin-off formation. This subsection will first discuss the two triggering events that inform our distinction between opportunity and necessity spin-offs: opportunity discovery and adverse events at the parent firm. The discussion then turns to how these relate to strategy conflicts, which are at the core of the spin-off model proposed by Klepper and Thompson (2008).

Opportunity spin-offs are triggered by a newly discovered[2] entrepreneurial opportunity. The ability of employees to identify and pursue such opportunities – as well as precisely how they frame them – is intimately linked to their prior acquisition of technological knowledge and/or knowledge about markets and customer needs (Shane, 2000). As

[1] Based on this observation, it appears questionable to explain spin-off activities in terms of a principal-agent framework, with employees pursuing illegitimate learning activities hidden from the firm's management and defecting if arriving at successful solutions (e.g., Anton and Yao, 1995). See also Klepper (2001) for a more thorough discussion.

[2] The use of this terminology does not reflect a commitment to the view that opportunities are necessarily discovered rather than created (cf. Sarasvathy et al., 2003, for a discussion). As argued elsewhere, a case can be made that, in the final analysis, all opportunities are created, but they are not always created by the same individual who subsequently pursues them (Buenstorf, 2007b).

opportunity discovery is part of the tasks of R&D and sales staff, it does not normally lead to spin-off formation. To the contrary, exploitation of new opportunities by the existing firm would generally seem advantageous, as incumbents have established capabilities and control complementary assets (Teece, 1986) that lower their cost of exploitation as compared to stand-alone exploitation in spin-offs.

However, in some situations, the existing firm is unwilling or unable to exploit all opportunities identified by its employees. In this situation, spin-off formation may be the only channel of commercialization available to employees, as other incumbents are unlikely to take up ideas developed but rejected by a competitor (Garvin, 1983). Unwillingness to exploit may result from the management's inability to appreciate the value of a particular opportunity (Agarwal et al., 2004). This inability may be due to the technological nature of the opportunity (Henderson and Clark, 1990) or the fact that it addresses demand segments outside the firm's current customer base (Christensen and Rosenbloom, 1995). Yet the refusal to pursue opportunities discovered by employees need not be pathological. If some of the demand raised by introducing a new product would reduce sales of existing products, the opportunity may not have a positive net value for the incumbent firm (Klepper and Sleeper, 2005). Also, in highly dynamic industries, established firms may simply face more opportunities than they can exploit (Moore and Davis, 2004).

The definition of necessity spin-offs is informed by substantial evidence showing that spin-off emergence is not always triggered by employees' opportunity discovery. Rates of spin-offs out of existing firms are also influenced by developments affecting the firm and its employees, particularly by adverse shocks. This suggests that employees may be "pushed" rather than "pulled" into spin-off entrepreneurship (Eriksson and Kuhn, 2006).

The most negative event that may affect an existing business is involuntary exit, which has been identified as a significant driver of spin-off activities in a broad sample of Danish firms (Eriksson and Kuhn, 2006). In an industry context, spin-off rates have increased during the time of the parent firm's exit from the industry in both the U.S. and German laser industries (Klepper and Sleeper, 2005; Buenstorf, 2007a). Other events may have adverse consequences for individual employees or departments, even though they are not necessarily adverse to the entire firm. Notably, acquisition by a competitor tends to help strengthen the acquired firm's market position and cost structure. But acquisitions are often accompanied by the discontinuation of specific activities because of their redundancy or lacking fit with the new company's overall strategy. They therefore endanger the jobs of some employees and induce spin-off activities by those affected. A similar argument holds for changes at the top

management level, which have also been shown to increase spin-off rates (Brittain and Freeman, 1986), as well as for other events that shift the future prospects of employees in the firm (e.g., changes in location).

Klepper and Thompson (2008) highlight strategic disagreement as triggers of spin-off activities. They document numerous instances of spin-offs originating from disagreements between an employee and the incumbent firm's management. They also develop a formal model of the spin-off process driven by these disagreements that can account for an impressive number of empirical findings (ibid.). The distinction between opportunity spin-offs and necessity spin-offs is not inconsistent with the theory of Klepper and Thompson (2008). Both opportunity discovery and adverse events at the parent firms may give rise to strategic disagreements that then lead to spin-off activities. The discovery of opportunities that are then rejected by the firm's management is a well-established cause of conflicts that have resulted in spin-off formation (cf., e.g., Garvin, 1983; Christensen 1993; Agarwal et al., 2004, as well as the evidence presented in Klepper and Thompson, 2008). Disagreements may also result from adverse events such as firm exit, withdrawal from specific market segments, or relocation decisions. Distinguishing these deeper causes of disagreements leading to spin-off activities helps predict spin-off performance as well as the determinants of spin-off rates.

However, in our conceptualization of the spin-off process, strategic disagreements are not *necessary* as triggers of spin-offs. Not all unexploited opportunities result in strategic disagreements. There may well be consensus among all firm members that a viable opportunity does exist but is not suitable for exploitation by the existing firm. In this situation, spin-off activities often are actively supported by the parent firm's management. In the case of adverse developments, the existing firm's management and the prospective founders may likewise agree that spin-off entrepreneurship is an option to create employment and possibly secure some of the existing firm's capabilities and assets.

Development of spin-off capabilities: In the final phase of the spin-off process, the fledgling spin-off develops capabilities based on the transfer and utilization of its founders' knowledge. The various kinds of knowledge acquired by the founders in their prior employment can be expected to differ in how easily they can be transferred to the new venture, because, as was argued above, they differ both in their explicitness and context-dependence.

As it defines the strategy of opportunity spin-offs, founders' opportunity-related knowledge about technologies or markets will be deliberately and explicitly disseminated in these spin-offs. Reproducing other elements of the parent firm's knowledge about

technologies and markets may be more problematic, as this knowledge tends to be distributed among many employees and will often not have been readily observable for the spin-off founders during their tenure at the parent firm. Being less central to the spin-off strategy, it may also be less explicit in character, complicating efforts to communicate it in the new firm.

Knowledge about organizational processes may be transferred to spin-offs in tacit or explicit form. It is plausible to expect that spin-off founders naturally resort to behavior they internalized during their participation in the organizational routines of the parent firm (Cohen, 2006). However, since tacit organizational routines operate through interaction with other firm members, the knowledge they embody cannot be transferred easily to the new organization (Nelson and Winter, 1982). In recreating the underlying interaction patterns and adapting them to the new context, spin-off founders will frequently modify the working of the routine. Deliberate, template-based transfer of organizational knowledge involves the conscious imitation of the parent's organizational processes (Jensen and Szulanski, 2007). Again, except for processes they aim to modify relative to the parent firm, resorting to template imitation is a straightforward default solution in setting up the new organization. It is facilitated if the parent firm has codified templates to safeguard the continuity of its own organizational processes (Kogut and Zander, 1992; Zollo and Winter, 2000).

Finally, personal skills of its founder(s) are of particular importance to spin-off capabilities. Founders have a "holistic picture" (Agarwal et al., 2004, p. 506) of the fledgling venture. They also provide natural role models for newly hired employees. Accordingly, one determinant of the spin-off's performance is the founders' ability to communicate the business model and strategy to the employees, which helps to coordinate the firm members' activities (Witt, 1998). This ability is particularly important for those elements of the spin-off's strategy that depart from the parent firm's practices and possibly also challenge established industry practices. As business conceptions are often not fully verbalized, successfully communicating them to employees requires personal interaction and observational learning (ibid.). The same holds for the transfer of personal expertise and intuitive problem-solving skills that spin-off founders have acquired in prior employment.

3. How do opportunity and necessity spin-offs differ?

This section develops hypotheses on the performance and determinants of opportunity and necessity spin-offs. In the next section these hypotheses will be tested using data for the German laser industry.

3.1 Performance of opportunity and necessity spin-offs

Founders of both types of spin-offs start their new firms on the basis of prior industry experience. Based on the considerations on knowledge transfer in the spin-off process, as well as the prior empirical evidence on spin-off performance (e.g., Sleeper, 1998; Agarwal et al., 2004; cf. also the evidence reported in Helfat and Lieberman, 2002), spin-offs are expected to be among the more successful firms in an industry, with a performance comparable to diversifiers and outperforming *de novo* entrants whose founders come from outside the industry.

It is also well-established that superior incumbents tend to have the best spin-offs (Klepper, 2002a; Buenstorf and Klepper, 2008). Both opportunity and necessity spin-offs can include entrants coming from the industry's top performers, reflecting that the events underlying necessity spin-offs are not always averse from the firm perspective, but may only be adverse for some of its employees. However, opportunity spin-offs have two key additional benefits over necessity spin-offs: they are by definition based on a unique, newly discovered business opportunity, and their timing of entry is more controlled. Both factors are expected to lead to a more distinctive performance of opportunity spin-offs relative to necessity spin-offs. The following results are predicted:

Hypothesis 1 (spin-off performance): Opportunity spin-offs outperform necessity spin-offs, which in turn outperform inexperienced entrants.

3.2 Determinants of opportunity and necessity spin-offs

As was noted above, prior analyses of the spin-off process in the laser and other industries have found higher spin-off rates at times of firm-specific events such as exit or management changes (Brittain and Freeman, 1986; Klepper and Sleeper, 2005). A necessary condition for the conceptual distinction between opportunity and necessity spin-offs to be valid is that adverse effects only predict the rates of necessity spin-offs, but not the rates of opportunity spin-offs. The following is therefore predicted:

Hypothesis 2 (adverse events at parent firm): Events lowering the expected future benefits from continued employment at a firm only increase the firm's likelihood of spawning necessity spin-offs. The likelihood of opportunity spin-offs is unaffected.

Better-performing incumbents have been found to be more fertile "breeding grounds" for spin-offs, leading to a higher likelihood of spin-offs to emerge from these firms (Klepper, 2002a; Buenstorf and Klepper, 2008). This finding, which extends to the laser industries in both the U.S. and Germany (Klepper and Sleeper, 2005; Buenstorf, 2007a), suggests that employees in better performing firms had better chances to acquire knowledge enabling them to start firms. Controlling for the occurrence of adverse events, a positive relationship between incumbent firm performance and spin-off rates is expected for both types of spin-offs, because all potential spin-off founders benefit from the better learning environments provided by superior firms.

Hypothesis 3a (industry performance of parent firm): More successful firms spawn spin-offs of either type at a higher rate.

In earlier studies of spin-off rates in the laser industry, firm performance in specific markets (defined by laser types) was found to be a better predictor of spin-offs entering this market than performance in the aggregate industry (Klepper and Sleeper, 2005; Buenstorf, 2007a). This is consistent with the above considerations suggesting that learning about specific technologies and markets is a key element in the on-the-job learning by prospective spin-off founders. As these kinds of knowledge are beneficial for both types of spin-offs, incumbent performance in specific markets should predict rates of both types of spin-offs (in the respective markets). However, knowledge about technologies and markets is essential for the identification of new entrepreneurial opportunities on which opportunity spin-offs are based. The effect of specific knowledge is therefore expected to be stronger for opportunity spin-offs than for necessity spin-offs.

Hypothesis 3b (market performance): Performance in specific markets favors the emergence of both opportunity spin-offs and necessity spin-offs.
Hypothesis 3c (market performance): The effect of market performance on spin-off emergence is stronger for opportunity spin-offs than for necessity spin-offs.

4. Opportunity and necessity spin-offs in the German laser industry

4.1 Empirical Setting: The German laser industry, 1960-2003

The empirical context of this study is the German laser industry, which is characterized by the absence of two key features that are generally found in the evolution of industries (Buenstorf, 2007a). One is that no shakeout in the number of active firms has been observed in this industry, but there has been sustained entry into the industry over 40 years of evolution. The other is that no first-mover advantages in favor of early entrants are observable. Both these characteristics are similar to the U.S. laser market and can be attributed to the prominent role of heterogeneous and changing laser (sub)markets (Klepper and Thompson, 2006).

Given the sustained potential for successful entry into the laser industry, spin-off emergence and performance can be traced and analyzed over the industry's history from its inception. For the period 1960-2003, the pre-entry backgrounds of all 143 German producers of laser sources have been identified using buyers' guides and various trade publications (cf. Buenstorf (2007a) for a detailed discussion of sources). Spin-offs accounted for 48 of the 143 entrants (34%) in Germany, which compares to 79 out of 486 entrants (16%) in the U.S. laser industry (Buenstorf, 2007a, Klepper and Sleeper, 2005). Accordingly, there were almost as many spin-offs in this industry as there were pre-existing firms from other industries that diversified into laser manufacturing. Including prior laser importers and distribution firms, diversifiers accounted for 56 of the 143 entrants (39%). With a total number of 28 (20%), entrepreneurs coming directly out of public research account for most remaining entrants.

For the present study, all 48 spin-off entrants have been classified into opportunity and necessity spin-offs. The categorization is based on information provided by the firms themselves about their founding context and/or coverage in the trade press discussing the firms' origins and strategy. Firms were categorized as necessity spin-offs whenever there was substantial evidence that the impetus for their organization was based on events at the parent firm (13 cases in total). Among these, four spin-offs were started after the parent firm had gone bankrupt. In a fifth case, bankruptcy was eventually avoided by partial acquisition, but spin-off formation had already been initiated, and the spin-off took over some of the parent firm's previous activities. Seven spin-offs were started by employees because the parent firm abandoned the laser industry or a specific laser market, in part due to post-acquisition strategic refocusing. Also, one spin-off was started by a leading R&D employee of a successful West German laser producer when it was acquired and relocated to Eastern Germany following Germany's reunification.

Twenty-eight entrants are classified as opportunity spin-offs based on the available information about their initial strategy in terms of product innovation and targeted market segments. This information indicates that the founders had discovered new opportunities on which they based their business models, while no evidence suggested that the organization of these firms was primarily due to adverse developments at the parent firm. The group of opportunity spin-offs includes three cases of serial entrepreneurs reentering the industry after successfully selling an earlier laser business. Among the other opportunity spin-offs, opportunities were in some instances evaluated differently by the founder and the prior employer. In yet other cases, the founding impetus was exclusively attributable to entrepreneurial aspirations. For example, one spin-off entrepreneur suggested he had entertained plans to start a firm already while being a university student, and had joined the parent firm only to learn. Finally, several of the opportunity spin-offs were "parent spin-offs" in the sense of Helfat and Lieberman (2002); they were initiated by the parent firm's management to pursue new activities in different segments of the laser industry.

Overall, there was explicit information allowing for a classification of 41 of the 48 spin-offs. In the remaining seven cases, no explicit information was available on which a classification could be based. For these firms it was checked whether adverse developments occurred at the parent firm at the time of spin-off formation. This check identified two cases in which the spin-off organization coincided with the parent firm's exit from the industry, suggesting that these two firms also were necessity-based. No such evidence was found in the remaining five cases. In total, we thus found that 33 out of the 48 spin-offs (69%) were opportunity-based versus 15 (31%) that were necessity based.[3]

4.2. Measures and empirical approach

In line with earlier studies on industry evolution, we adopt longevity in the laser industry as a measure of spin-off performance. Hazard rate models are utilized to analyze how firm characteristics affected longevity, which ranged between one and 37 years. (The average firm remained in the industry for seven years.) We estimate semi-parametric Cox regressions. They are attractive because no assumptions on the time-dependence of the hazard need to be made. Adequacy of the proportionality assumption underlying the Cox model was established using specification tests based on Schoenfeld residuals (Grambsch and Therneau, 1994).

[3] As a robustness check, the econometric analyses were alternatively performed classifying as opportunity spin-offs all seven firms for which no explicit information was available, i.e., with a smaller set of only 13 necessity spin-offs. This had no appreciable effect on the estimates.

Hazard rate models allow for controlling differences in the type of exit. Specifically, exits through acquisition by a competitor, which is often not an indication of poor performance (but possibly the opposite), are treated as right-censored observations (cf. Klepper, 2002b). In alternative specifications, being acquired is interpreted as a second risk competing with the hazard of failure (i.e., exit by bankruptcy or voluntary withdrawal from the laser industry). In this way, it can be probed whether the results of the hazard rate analysis are driven by differences in the acquisition likelihood of both spin-off types. The effects of entrants' backgrounds on the acquisition hazard are estimated as interaction effects, which indicate whether the effect of the respective background differed between the two hazards (Lunn and McNeil, 1995). Since firm age has different effects on the competing risks, a stratified specification is adopted.

The influence of the hypothesized factors on the emergence of opportunity and necessity spin-offs is studied using multinomial logits. Specifically, the annual likelihood of spin-off emergence out of existing German laser firms is estimated separately for the two spin-off types. The emergence of all 43 spin-offs spawned by German laser firms between 1960 and 2003 is analyzed, while the five spin-offs that had foreign parents are disregarded. For each industry year after a firm's entry into the laser industry and for each of seven laser types,[4] the firm can either spawn no spin-offs, one or several opportunity spin-offs, or one or several necessity spin-offs. There is no case in which both opportunity and necessity spin-offs emerged from the same firm in the same year and laser type. In two cases, two spin-offs of the same kind were spawned by the same firm in the same year. A few spin-offs entered in more than a single laser type in their first year. In these cases, the spin-off event is taken into consideration for all respective laser types.

Exit of the parent firm is used as a proxy for adverse events underlying necessity spin-offs. To this purpose, a dummy variable is constructed that for each firm assumes the value one in the five-year period around its exit year and is zero otherwise. Analogous to the hazard rate analysis, longevity in the laser industry or a specific laser market is used as the primary measure of performance. Firm longevity is measured by the firm's *total* years of survival in the industry (market). This number is known only *ex post*; in the econometric analysis it is constant over the firm's entire lifetime, irrespective of the time a spin-off is actually formed. As an alternative performance-related measure, a firm's *current* industry and market experience is also employed in the multinomial logit. The underlying reasoning is that the

[4] Laser types are defined by the laser's active medium The following laser types are distinguished: solid-state, semiconductor, dye, CO_2, helium-neon, ion, and excimer. The number of markets served by individual producers ranges between one and six, the mean is 1.58.

more knowledge the parent firm has built up over time, the more there is for potential spin-off founders in the firm to draw upon. A positive dependence of the spin-off likelihood on the firm's accumulated experience would thus provide further evidence for the importance of employee learning. Current experience is measured by counting the number of years that the firm had been active in the industry or the specific market at the time when the respective spin-off was organized. Thus, the experience indicator varies over an incumbent's lifetime. It is smaller for spin-offs spawned when the firm is young and higher for spin-offs spawned at a later stage. Since prior studies have consistently found annual spin-off rates to be highest at intermediate firm ages (Klepper, 2002a; Klepper and Sleeper, 2005; Buenstorf, 2007a), suggesting non-monotonous effects of experience on the spin-off likelihood, the experience variable is included in the analysis in both linear and quadratic terms.

4.3. Results

Our sample size severely limits the complexity of the models that can be analyzed. The initial model specification (Model 1 in Table 2) therefore only includes three dummy variables denoting three kinds of experienced entrants into the German laser industry: opportunity spin-offs, necessity spin-offs, and diversifiers from other industries. Thus, the model studies whether the average longevity of these entrants, which either were experienced organizations or had founders experienced in the laser industry, was significantly different from that of less experienced entrants, which make up the control group.[5]

– Table 2 about here –

Negative coefficient estimates are obtained for all three firm type indicators, which implies that their hazard of exit was lower than that of firms in the control group. Only the coefficient estimates for the diversifiers and the opportunity spin-offs are significantly different from zero. Accordingly, opportunity spin-offs but not necessity spin-offs had a systematically higher longevity than firms in the control group. The ranking of coefficients is consistent with the predictions of Hypothesis 1. However, even though the difference between the coefficient estimates obtained for the two spin-off types is substantial, it is not statistically significant ($p > .22$). Accordingly, Hypothesis 1 is only partially supported by the evidence.

Two additional model specifications are utilized to check the robustness of the findings. In Model 2, the number of laser types currently produced by the firm (defined by

[5] Controlling for diversifiers among the non-spin-off entrants is important in light of substantial prior evidence that diversifiers tend to outperform most entrepreneurial entrants (cf. Helfat and Lieberman, 2002).

active laser medium) is included to control for the scope of the firm's laser activities, using annual observations. This variable does not improve the explanatory power of the model, while the effects of the firm type indicators are almost unaffected. In Model 3, the alternative interpretation of acquisitions as a competing risk (see above) is utilized. Compared to the earlier models, smaller effects on the hazard of failure are obtained for the diversifier and opportunity spin-off variables. Only the failure hazard of opportunity spin-offs remains significant. At the same time, the dummy variable identifying opportunity spin-offs has a positive effect on the hazard of being acquired, with the interaction term indicating that the two kinds of hazards are affected in significantly different ways. No such difference in the effect on the different hazards is found for the diversifiers. (The interaction term is not estimated for the necessity spin-offs because none of them exited by acquisition.) These results suggest that spin-offs that were started to pursue a distinctive opportunity, but not those that were started out of necessity, developed into attractive candidates for takeovers.

– Tables 3 and 4 about here –

Determinants of annual spin-off rates out of existing laser producers are analyzed next. Descriptive statistics of the explanatory variables used in this analysis are provided in Table 3. The initial model specification (Model 4 in Table 4) studies whether the spin-off likelihood out of incumbent firms went up in the 5-year period around the firms' exit from the laser industry, as well as the effect of incumbent firm longevity on spin-off rates. In line with Hypothesis 2, a strong and statistically significant increase in the likelihood of necessity spin-offs is found around firm exit, while the rate of opportunity spin-offs does not increase significantly. The difference between the coefficient estimates for the two spin-off type dummies is marginally significant ($p < .07$). In line with Hypothesis 3a, the annual likelihood of both kinds of spin-offs is higher in longer-lived firms. The coefficient estimate for the effect of industry longevity on the rate of opportunity spin-offs is slightly larger than that for necessity spin-offs, but both estimates are similar and statistically indistinguishable.

Next, a second performance variable is included in the model, which measures the number of years a firm survived in the specific laser market that a spin-off initially entered (Model 5). In line with expectations (Hypothesis 3b), this new variable is positive and significant for both types of spin-offs. Its inclusion strongly reduces the effect of the industry-level longevity measure, which loses its significance. Contrary to the prediction of Hypothesis 3c, the effect of the new, "narrow" longevity measure is similarly strong for both types of

spin-offs. The effect of the dummy variable measuring spin-off activities around the time of the firm's exit year is hardly affected by the changes in model specification. Finally, Model 6 uses a similar specification as Model 5, but replaces the two longevity measures by measures of current experience in the industry as well as its specific markets, for which linear and quadratic terms are entered to allow for non-monotonous effects. The results are very similar to those obtained in Model 5. Only experience in specific markets increases the spin-off likelihood (at young ages), and it does so for both types of spin-offs.[6]

5. Implications: why necessity spin-offs matter

The scholarly discussion of spin-offs has mostly concentrated on opportunity spin-offs. Their importance in breaking up organizational inertia and bringing fresh ideas to the market has often been emphasized, and our findings just add to the favorable light in which they are normally portrayed. In contrast, necessity spin-offs have not received the attention they deserve. Necessity spin-offs accounted for about a third of all spin-off entries into the German laser industry. They were not as distinctive in their performance as opportunity spin-offs were (on average). But they were no underachievers, either. Specifically, they did not perform worse than other *de novo* entrants, notably those formed out of public research.

Our findings furthermore suggest that necessity spin-offs are based on comparable degrees of employee learning as opportunity spin-offs. In the analysis of spin-off emergence, both proxies for learning opportunities in incumbent firms – incumbent longevity and incumbent experience – affected the likelihood of both kinds of spin-offs in the same way. This indicates that while necessity spin-offs were triggered by adverse events, they were not the result of a haphazard process of firm formation, with the spin-off entering the market without appropriate capabilities or prematurely. Rather, it seems that founders of necessity spin-offs had the competence and skills needed to start new businesses but – perhaps for personality reasons, perhaps for reasons related to the strategy of the prospective business – required some additional "push" to actually go ahead and do so.

What can we learn from these findings on opportunity and necessity spin-offs? First, when researchers have previously distinguished between entrepreneurial activities induced by "push" versus "pull" factors, the relative inferiority of ventures whose founders were "pushed" into entrepreneurship has been in the focus of attention (Eriksson and Kuhn, 2006;

[6] The coefficient estimates imply that the effect of experience in specific markets reaches a maximum at about age 15 and remains positive at least through age 24 of a firm. The coefficient estimates obtained for industry experience differ in sign, but are not significantly different from zero or from each other.

Dahl and Reichstein, 2007). Our analysis suggests a similar performance ranking. It also shows, however, that spin-off entrepreneurship induced by adverse triggering events can lead to viable new ventures in a high-tech industry such as lasers. Accordingly, the industry experience that necessity spin-offs are based upon appears to be as valuable for the venture's future prospects as other, non-industry backgrounds such as research. This result also puts into perspective the widespread emphasis on academic entrepreneurship in science-based industries. In the industry analyzed here, a background in public research clearly did not lead to the best-performing firms.

A second implication relates to the effect of spin-off activities on the spin-offs' parent firms. Managers of existing firms are often wary about their employees starting potential competitors. For instance, Intel is well known for its hostile stance vis-à-vis (potential) spin-offs. Based on their experience at Fairchild, Intel's founder-managers adopted this position to limit what they perceived as a dangerous outflow of technological knowledge through spin-off activities (Moore and Davis, 2004). It is far from established that these reservations vis-à-vis spin-offs are justified in general, as there is hardly any supportive evidence at least for manufacturing industries. Conceptually, spin-offs based on opportunities that remain unexploited at the parent firm (for whatever reason) will often engage in activities that are not directly competing with those of the parent firm.

In any case, the potential concerns vis-à-vis spin-offs are less relevant for necessity spin-offs. If the parent firm exits from the industry or a specific activity or market segment, spin-offs taking over its activities do not become its competitors. Even without parent firm exit, support of spin-off activities under adverse conditions may have long-run benefits for the parent firm. A case in point has been explored by Buenstorf and Fornahl (2008) who trace the spin-off activities that followed the downsizing of a prominent German e-commerce software developer after the end of the dot-com bubble. They find that employees of the firm started a large number of spin-offs, mostly in markets that were related but not identical to the parent firm's activities. These spin-off activities helped to retain substantial software-specific human capital in the home region of the parent firm, and induced substantial cluster dynamics. This has also generated benefits for the parent firm.

Finally, from a policy perspective, necessity spin-offs can be argued to play an important role in the dynamics of competitive markets: they limit the devaluation of human capital brought about by adverse shocks to individual firms. As the empirical analysis has shown, necessity as a spin-off trigger accounts for a substantial share of entry even under "normal" market conditions. However, the relevance of spin-offs as vehicles to reuse

knowledge acquired on the job appears even more relevant in special situations such as macroeconomic crises such as the liberalization of formerly protected industries or the transition from centrally planned to market economies. For example, after German reunification, former employees of state-owned East German firms organized substantial numbers of necessity-based spin-offs. To illustrate, it has been estimated that some 80 spin-offs emerged from Carl Zeiss Jena, an optics and precision mechanics company (Plattner, 1997). Survey results indicate that the founders of these spin-offs were able to benefit from substantial transfers of technology- and customer-related knowledge (Habekost, 2007). This suggests that necessity spin-offs are a suitable instrument to foster structural change through entrepreneurship.

6. Conclusions

This paper has focused on the drivers of spin-off formation. It has suggested that, building on employee learning, spin-off formation is triggered by specific events. Two kinds of events have been highlighted: discovery of opportunities that increase the attractiveness of spin-off formation, and adverse events that decrease the attractiveness of continued employment in the parent firm. In analogy to the entrepreneurship literature, the spin-offs corresponding to the two types of events have been referred to as opportunity spin-offs and necessity spin-offs, respectively.

The empirical analysis traced opportunity and necessity spin-offs in the German laser industry. The empirical findings provide substantial support to the proposed conceptual distinction. About one-third of all German laser spin-offs were necessity-based. On average, their performance was similar to that of entrepreneurial entrants from other backgrounds. Their emergence was affected by incumbent performance in the same way as those of opportunity spin-offs.

Necessity spin-offs allow for the continued application of knowledge and skills acquired during prior employment. Thus, necessity spin-offs are suitable vehicles for the reutilization of individual competences, limiting the devaluation of human capital through the competitive market process. Although the above findings and interpretation need to be corroborated for other industries and contexts, they call for adopting a fuller perspective on spin-offs that does not only focus on the Intels and SAPs of this world. Necessity spin-offs are a relevant type of entrepreneurial activities, with a substantial role to play in the dynamics of industries and economies.

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Table 1: Phases and determinants of the spin-off process

Phase	***Employee learning***	***Triggering event***	***Formation of spin-off capabilities***
Consequence	***Spin-off potential***	***Spin-off formation***	***Spin-off performance***
Underlying factors	• Learning about technologies and markets • Learning about organizational processes • Acquisition of personal skills	• Opportunity discovery • Adverse events at parent firm • Strategic disagreement (poss. due to opportunity discovery or adverse events)	• Transfer of technological and market knowledge • Transfer of organizational processes • Use of personal skills

Table 2: Longevity of spin-offs

Method	*Cox proportional hazards*		*Competing risks Cox regression (stratified)*
	Model 1	*Model 2*	*Model 3*
Opportunity spin-off	-.1.115** (.448)	-1.096** (.452)	-.926** (.449)
Opportunity spin-off*acquisition			1.797** (.780)
Necessity spin-off	-.477 (.408)	-.406 (.401)	-.461 (.409)
Diversifier	-.707** (.309)	-.699** (.310)	-.419 (.316)
Diversifier *acquisition			.089 (.655)
Number of active submarkets		-.201 (.206)	
No. of observations (events)	143 (49)	143 (49)	143 (66)
Log-likelihood ($p > chi^2$)	-203.367 (.032)	-202.847 (.055)	-262.374 (.077)

Note: Standard errors (adjusted for clustering by firm) in parentheses; *, **, and *** denote significance at the .10, .05, and .01 levels, respectively.

Table 3: Descriptive statistics of the analysis of spin-off determinants

Variable	*Mean*	*Std. Dev.*	*Min*	*Max*
Parent firm exit +/- 2 years	.176	.381	0	1
Parent firm survival in industry (years)	11.091	8.382	1	37
Parent firm survival in submarket (years)	3.236	5.273	1	32
Parent firm experience in industry (years)	6.434	6.209	0	36
Parent firm experience in submarket (years)	1.313	3.580	0	32

Table 4: Determinants of spin-off activities by year and product type (multinomial logit)

	Model 4		*Model 5*		*Model 6*	
Spin-off type	*Opportunity*	*Necessity*	*Opportunity*	*Necessity*	*Opportunity*	*Necessity*
Parent firm exit +/- 2 years	.634 (.485)	2.051*** (.527)	.620 (.488)	2.037*** (.533)	.269 (.527)	1.804*** (.578)
Parent firm survival in industry (years)	.068*** (.019)	.057** (.025)	.030 (.026)	.007 (.037)		
Parent firm survival in submarket (years)			.077*** (.029)	.097*** (.025)		
Parent firm experience in industry (years)					.086 (.089)	-.052 (.099)
Square of parent firm experience in industry					-.002 (.002)	.002 (.003)
Parent firm experience in submarket (years)					.370*** (.081)	.391*** (.087)
Square of parent firm experience in submarket					-.016** (.007)	-.012** (.005)
Constant	-6.921*** (.436)	-7.511*** (.621)	-6.810*** (.424)	-7.385*** (.632)	-6.974*** (.470)	-7.461*** (.438)
Number of observations	11956		11956		11956	
Log-likelihood (p > chi^2)	-408.220 (.0000)		-397.122 (.0000)		-380.157 (.0000)	

Note: Standard errors (adjusted for clustering by firm) in parentheses; *, **, and *** denote significance at the .10, .05, and .01 levels, respectively.