Journal of Business Venturing 30 (2015) 564–581

Contents lists available at ScienceDirect

Journal of Business Venturing

Does innovativeness reduce startup survival rates?

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ARTICLE INFO

Article history:
Received 8 October 2013
Received in revised form 14 October 2014
Accepted 15 October 2014
Available online 4 November 2014

Field Editor: P. Davidsson

Keywords:
Entrepreneurship
Innovativeness
Startups
Survival

ABSTRACT

There are two competing hypotheses explaining how innovativeness influences the survival of startups: On the one hand, innovativeness is argued to foster survival-enhancing attributes (e.g., market power and cost efficiency) and capabilities (e.g., absorptive capacity). On the other hand, an innovative startup faces (and bears the associated risks of) liabilities of newness and smallness that exceed those of its non-innovative counterparts. The available empirical literature addressing this theoretical tension mostly supports the former hypothesis; we suggest that this finding is, in part, driven by the common practice of employing an ex post measure that already embodies a degree of success in innovativeness. We use an ex ante measure and find that a startup's innovativeness is negatively associated with its subsequent survival. We also find that entrepreneurs' greater appetite for risk magnifies this negative association. These findings imply that pursuing innovations is not necessarily associated with survival during the early stages of firm development and entails a more complicated start-up process.

1. Executive summary

The link between innovativeness and firm survival has been studied extensively in previous research. Theoretical considerations suggest that innovativeness might have either a positive or a negative effect on firms' survival prospects, whereas the previous empirical literature mostly suggests that the association is positive.

However, we find a negative association between innovativeness and subsequent firm survival, which we attribute to two factors. First, we employ an ex ante measure that mirrors the inherent uncertainty of innovativeness and mixes successful and unsuccessful innovative efforts. Second, we study the association between innovativeness and survival using data on startups, i.e., firms that are in the early stages of their development.

We suggest that future analyses of the innovativeness–survival nexus pay careful attention to two types of survivorship biases. First, there is a survivorship bias of ideas, when the empirical measures of innovativeness refer to ex post indicators that tend to capture successful innovations and innovators. For example, although patents and other intermediate innovation outcomes do not guarantee success in the marketplace, they do indicate a level of success with prior innovative effort. Second, there is a survivorship bias for firms, when the study sample consists of incumbent firms that are a selected subset of firms that originally entered the market. In such a selected sample, there is a risk that a spurious positive correlation will be found between innovativeness and survival.

Our data refer to two cohorts of 1165 Finnish startups surveyed shortly after their entry into the market. The data allow us to measure innovativeness by the startups' ex ante plans to employ innovations and to actively pursue innovations, which may (or may not) lead to desired outcomes.

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http://dx.doi.org/10.1016/j.jbusvent.2014.10.001
0883-9026/

We contribute to the sparse but growing literature that suggests that a startup's innovativeness may in fact hurt its survival prospects. Our baseline estimations suggest that the survival rate for innovative startups is approximately 6–7 percentage points lower than that of non-innovators. This negative association is consistent with the view that pursuing innovations appears to lead to a more complicated start-up process that may be disproportionately hindered by the liability of newness. We also find that the interaction of innovativeness and entrepreneurs' greater appetite for risk further reduces the prospects for survival, which is consistent with a trait–task dependency.

Our findings have important practical implications. On the one hand, they suggest that entrepreneurs should not regard innovativeness as a form of insurance against failure in the startup phase. On the other hand, our analysis casts doubt on the policy premise that innovating ventures should be supported because they are more likely than other startups to survive and create stable jobs. Of course, our findings by themselves do not undermine other policy reasons to support innovation in new ventures.

2. Introduction

Does innovativeness have a positive or negative effect on firms' survival prospects? We study these two competing perspectives empirically by focusing on the innovativeness–survival link during the early stages of firm development. Our motivation to examine the innovativeness–survival link in this particular context is that the theoretical literature suggests that the effect can be either positive or negative, whereas the empirical literature—with a few notable exceptions—suggests a positive relation.

A number of *theoretical* arguments suggest a positive link between innovativeness and subsequent survival: In addition to making entry possible, innovativeness enhances firms' market power (Schumpeter, 1934), improve their ability to escape competition (Porter, 1980), reduce their production costs (Cohen and Klepper, 1996a, 1996b), improve dynamic capabilities (Teece et al., 1997), and lead to enhanced absorptive capacity (Zahra and George, 2002). However, another set of theoretical arguments suggest that the link may also be negative: Pursuing innovations leads to riskier, more complicated, and less linear start-up processes (Samuelsson and Davidsson, 2009) and (potentially) to more skewed returns (Scherer and Harhoff, 2000). An innovative startup may face a greater liability of novelty than its non-innovative counterparts (see, e.g., Amason et al., 2006). Other scholars argue that such firms suffer from having few collateralizable assets and long and uncertain payback times (Brown et al., 2012; Minetti, 2011). Therefore, innovative startups have more limited access to external financing, which leads to a greater likelihood of failure (Berger and Udell, 2006). Moreover, entrepreneurs who believe that they are exceptionally innovative may have a particular exit strategy in mind (e.g., DeTienne et al., 2015) and may, as a result, seek to increase the firm's risk profile to achieve the desired exit.

The prevailing view in the *empirical* literature appears to be that there is a positive association between the innovativeness of firms and their subsequent survival (Arrighetti and Vivarelli, 1999; Audretsch, 1995; Calvo, 2006; Cefis and Marsili, 2005, 2006, 2011, 2012; Colombelli et al., 2013; Helmers and Rogers, 2010; Sarkar et al., 2006; Wagner and Cockburn, 2010). Nevertheless, there is emerging empirical evidence suggesting that these results may be context-dependent and not necessarily applicable to younger firms (Boyer and Blazy, 2013; see also Cader and Leatherman, 2011; Reid and Smith, 2000).

We contribute to this emerging empirical literature and argue that the widely documented positive association between innovativeness and survival does not necessarily apply to the youngest firms, particularly after two interrelated but separate selection biases are accounted for. *First*, there is a survivorship bias of ideas. As Buddelmeyer et al. (2010) note, the empirical measures of innovativeness are frequently ex post indicators that tend to capture successful innovations and innovators (Artz et al., 2010; Mairesse and Mohnen, 2002; Pandit et al., 2011; Santarelli and Vivarelli, 2007). Although patents, for example, in no way guarantee success in the market place, they do indicate a certain level of success regarding innovativeness. Because such success rarely decreases profits, innovative firms flagged by ex post indicators are more likely to survive than otherwise similar but not (yet) successfully innovating firms. In the context of patents, an unsuccessful innovation might be represented by a rejected application; a preferred ex ante indicator of innovativeness would capture both patent approvals and rejections, in addition to situations in which the innovator did not seek patent protection. *Second*, there is a survivorship bias with respect to firms that have successfully traded in the marketplace as independent businesses (Becchetti and Trovato, 2002; Kannebley et al., 2010). In other words, incumbent businesses are a selected subset of firms that originally entered the market (Cader and Leatherman, 2011). As we explain later, a typical survival regression may yield a spurious positive correlation between early-stage innovativeness and survival, if this type of selected sample is employed.

This paper examines whether innovativeness enhances or reduces startups' survival prospects. By considering these two competing perspectives, we shed new light on the theoretical tension discussed above in the specific context of young firms. Our contribution to the empirical literature is, first of all, that we address the two interrelated selection biases simultaneously. We measure innovativeness by firms' ex ante plans to employ new-to-the-market processes or products/services in the next three years and by firms' active engagement in such innovativeness. Compared with most of the firm-level measures used in the prior empirical literature, this measure better mirrors the uncertainty that characterizes (only potentially successful) innovativeness of a firm from an ex ante perspective. In this regard, we also differ from those prior papers that focus on the effects of the overall innovativeness of the industry (the technological environment) on firm survival. Moreover, our estimating sample consists of startups surveyed in the first few months after entering the market, which considerably reduces the survivorship bias of firms. We evaluate how innovativeness is associated with firm survival in this empirical setting. Second, we take a step further by empirically studying how the relation between innovativeness and firm survival is moderated by the risk appetite of the startups' founder-entrepreneurs. Our motivation to do so is that this interaction is one of the most salient trait–task dependencies that we can imagine in light of the received literature (Rauch and Frese, 2007; see also Caggese, 2012; Cucculelli and Ermini, 2013; Kessler et al., 2012): more risk-tolerant entrepreneurs are more likely to pursue innovations that are risky ex ante. The consequences of this extra risk clearly depend on the nature of the innovativeness–survival link in the first place.

We wish to note at the outset that our study does not explicitly focus on determining the private or social returns generated by innovative startups. This stance means that our findings do not rule out the possibility that either the expected private or social returns are greater for those startups that pursue innovativeness than for those that adopt more imitative business models.

3. Previous empirical literature

The prevailing view in the empirical literature appears to be that there is a positive association between innovativeness and firm performance. For example, Rosenbusch et al. (2011) perform a detailed meta-analysis of the innovation–performance relationship among small and medium-sized enterprises (SMEs) and find that innovation is positively associated with SMEs' performance. Echoing this finding, Song et al. (2008) report that a positive innovativeness–performance link is found in over two-thirds of the empirical studies they review. Both of these meta-analyses also find that the results may be context-dependent and heterogeneous; in addition, when measures of innovation inputs (as opposed to ex post outcomes) are used in the analysis, the empirical association between firms' innovativeness and their performance becomes weaker.

Turning more specifically to the relationship between innovativeness and firm survival, Table 1 summarizes a large grouping of the available empirical analyses. As shown in the upper part of Table 1, a number of prior studies report a positive association. In a series of recent papers, Cefis and Marsili (2005, 2006, 2011, 2012) use Dutch Community Innovation Survey data to study the link between innovativeness and survival. In general, these authors find that success in nurturing product or process innovations is positively correlated with established firms' subsequent business survival. Colombelli et al. (2013) employ a sample of French manufacturing firms to study how aspects of firms' patent stocks affect survival. They find that innovation enhances survival prospects. Esteve-Perez and Manez-Castillejo (2008) use a representative sample of Spanish manufacturing firms to test a set of hypotheses derived from the resource-based theory of the firm; these authors find that development of firm-specific assets via R&D improves survival prospects. Helmers and Rogers (2010) study a cohort of UK-based limited liability companies established in 2001 and find that owning intellectual property is positively associated with survival. Wagner and Cockburn (2010) study the survival prospects of Internet companies after an initial public offering on the NASDAQ and find that patenting is positively associated with firm survival. Coad and Guenther (2013) study German machine tool manufacturers in the post-war era and examine degrees of diversification among such manufacturers, which is related to product innovation. Among other things, they find that survival prospects are enhanced by innovativeness, "if not undertaken too hastily" (p. 634).

Table 1
Previous empirical research.

Article	Sample	Innovation measure	Link to survival?	Comment
Cefis and Marsili (2005)	Sample of mostly established Dutch manufacturing firms	CIS: Successful innovativeness; innovation types	Positive	Particularly for process innovation
Cefis and Marsili (2006)	Sample of mostly established Dutch manufacturing firms	CIS: Introduction of either process or product innovation(s)	Positive	
Cefis and Marsili (2012)	Sample of mostly established Dutch manufacturing firms	CIS: Successful innovativeness; innovation types	Positive	
Coad and Guenther (2013)	Population of post-war German machine tool manufacturers	Product portfolios compiled from trade journals	Positive	
Colombelli et al. (2013)	Sample of established French manufacturing firms	Measures based on EPO patent filings	Positive	
Helmers and Rogers (2010)	Cohort of UK limited liability companies established in 2001	EPO and UK patents and trademarks	Positive	
Wagner and Cockburn (2010)	Sample of Internet-related firms that made an IPO in NASDAQ	USPTO filings for business method and other patents	Positive	
Esteve-Perez and Manez-Castillejo (2008)	Sample of established Spanish manufacturing firms	R&D expenditure	Positive	Evidence of heterogeneity
Cefis and Marsili (2011)	Sample of mostly established Dutch manufacturing firms	CIS: Introductions of process and product innovations	Positive, Negative	Negative in high-tech ind.
Audretsch and Mahmood (1995)	Cohort of US manufacturing establishments	Trade journal announcements (industry-level)	Negative	Note: Industry-level measure
Cader and Leatherman (2011)	Sample of US establishments with over 100 employees	Industrial classification (SIC, industry-level)	Negative	Note: Industry-level measure
Buddelmeyer et al. (2010)	Large sample of Australian old and new businesses	Measures based on patent, trademark, and design applic./grants	Positive/ Negative	Negative, when radical innovation used
Boyer and Blazy (2013)	Cohort of French startups initially having under 10 employees	Innovativeness	Negative	

Notes: CIS = Eurostat's Community Innovation Survey. USPTO: The United States Patent and Trademark Office. EPO = European Patent Office. SIC = Standard Industrial Classification (US).

The lower part of Table 1 shows that a number of qualifications are warranted: the general positive association appears to be at least somewhat context-dependent (it is conditioned on the level and type of innovation measure) and may not apply to all firms.

First, there is some evidence of heterogeneity in the innovativeness–survival link, both across firms (e.g., Esteve-Perez and Manez-Castillejo, 2008) and across industries (e.g., Cefis and Marsili, 2011; see also Bayus and Agarwal, 2007). Second, there are studies that use industry-level measures of innovativeness or the technological environment and find a negative association between these measures and firm survival. For example, in their seminal paper, Audretsch and Mahmood (1995) study over 12,000 US manufacturing establishments entering the marketplace in 1976 and find that operating in a highly innovative environment hurts survival prospects (see also Audretsch, 1991). More recently, Cader and Leatherman (2011) have analyzed the survival of new US establishments entering the marketplace from 1990 to 1998. Echoing Audretsch and Mahmood (1995), they find that new establishments are less likely to survive in technology-intensive industries.

Buddelmeyer et al. (2010) study firm survival using a large panel of Australian firms. To differentiate between legal and market uncertainty and between incremental and radical innovations, these authors use both patent and trademark applications and grants to derive measures of flows and stocks of innovativeness. Buddelmeyer et al. (2010) find that past success in radical innovation—as captured by the stock of granted patents—enhances survival prospects; however, these authors also find that firms are more likely to fail immediately after investing in radical innovation, as measured by submitted patent applications. These findings point to a selection problem because submitted patent applications are less likely to indicate success regarding innovativeness and are thus less likely to refer to ex post outcomes. The authors' analysis does not, however, explicitly address the survivorship bias of firms because their data consist mostly of incumbent firms.

In summary, the prior empirical literature suggests a positive association between innovativeness and firm survival, with some qualifications. In many cases, the measures of innovativeness employed embody some degree of (firm-level) success and thus refer, at least in part, to ex post outcomes. Furthermore, the data sets previously employed frequently consist of firms that have previously had some success in the marketplace.

As a matter of fact, the most recent studies using data on young firms suggest a reason to reassess whether the association between innovativeness and firm survival is indeed positive in the early stages of firm development. Boyer and Blazy (2013) study the survival determinants of innovative and non-innovative micro-enterprises established in France in 1998. These authors explore a variety of survival determinants, but a key finding of their study—particularly from our perspective—is that the likelihood of survival of innovative enterprises is 10% lower than that of non-innovators. However, Boyer and Blazy (2013) do not link their findings to the two selection biases or, e.g., to the liabilities of newness and smallness that we emphasize. Moreover, these authors do not condition their analysis on the size of the startup at the time of market entry, which is potentially problematic because it is well-established that size at entry is an important predictor of subsequent survival (e.g., Reid, 1995). Not controlling for it in the survival model may lead to a negative bias in the coefficient for the innovativeness measure, particular if entry size is negatively correlated with the likelihood of pursuing innovations in the startup phase.

4. Theory and hypotheses

The available literature sets forth a number of theoretical arguments explaining why the relation between SMEs' innovativeness and their subsequent performance, including longer-term survival, might be either positive or negative.

The arguments pointing to a positive innovativeness–performance relation include, but are not limited to, the following: Innovativeness (i) enhances SMEs' market power (at least temporarily; Schumpeter, 1934) and their ability to escape competition (Nelson and Winter, 1982; Porter, 1980); (ii) reduces the costs of production (Cohen and Klepper, 1996a, 1996b; Nelson and Winter, 1982); (iii) creates dynamic capabilities for the SMEs (Eisenhardt and Martin, 2000; Teece et al., 1997); and (iv) improves their absorptive capacity (Zahra and George, 2002).

There are, however, a number of mechanisms that may moderate the association between innovativeness and firm performance (many of these are carefully described and reviewed by Rosenbusch et al., 2011) and even reverse its sign to make it negative. In the following, we focus on the mechanisms that are particularly salient and relevant for understanding the association between innovativeness and startup survival: (1) the stage of firm development, and (2) attitudes toward risk (i.e., entrepreneurial risk-taking).

4.1. Stage of firm development

The process of new venture creation is at the core of entrepreneurship research (Casson, 2005; Samuelsson and Davidsson, 2009; Shane and Venkataraman, 2000). A large segment of this literature builds on the notion that the venture creation process is based on a novel business idea (such as an innovative product) that a new venture explores and experiments with and that may eventually allow the new venture to outperform its competitors (Dahlqvist and Wiklund, 2012; Schumpeter, 1934).

Younger firms may benefit *more* from innovativeness because they have less rigid routines (e.g., Brüderl and Schüssler, 1990; Freeman et al., 1983), can adapt more quickly to changes in their operating environment (Klepper and Simons, 1997) and are more likely to be entrepreneurially alert and oriented (Lumpkin and Dess, 1996). They are also more open to the possibilities that technologically driven discontinuities can create (Christensen and Bower, 1996; Hill and Rothaermel, 2003). Based on these arguments, Rosenbusch et al. (2011) hypothesize that the positive association between innovativeness and small business performance is stronger for younger firms. Their empirical findings support this view. This finding, however, is not universal.[3] The direction of the association may also be questioned on theoretical grounds.

4.1.1. Liabilities: newness, smallness, and novelty

Stinchcombe (1965) suggests that an entrant organization suffers from a liability of newness, which manifests itself in lower survival probability compared with a similar incumbent organization. He attributes this liability to having both less experience in cooperating with other organizations and less legitimacy in the eyes of potential financiers and other stakeholders (see also Baum and Oliver, 1996). A related but distinct argument is the liability of smallness (Freeman et al., 1983), which refers to size-driven problems that are related to being able to attract human capital (e.g., recruiting and retaining skilled and educated employees), raising sufficient external financing, having legitimacy issues with outside stakeholders, and facing relatively high organizational and administrative costs (Aldrich and Auster, 1986). The liabilities of newness and smallness suggest that startups may benefit *less* from innovativeness. The youngest and smallest firms are also more exposed to the failure of a research or development project than larger and more mature firms because such failure is more likely to endanger the entire existence of the firm (Nohria and Gulati, 1996).

As Samuelsson and Davidsson (2009) note, the process of new venture creation differs between innovative and imitative new ventures. Pursuing innovativeness appears to lead to riskier, more complicated, and less linear start-up processes. Amason et al. (2006) further note that a novel entrant must contend with being both new and different. Such an entrant must be managed without the benefit of precedent. These characteristics of a new venture increase the skills, abilities, and the quality of composition required of its top management. Thus, pursuing innovations at the startup phase, i.e., launching an innovative and novel venture, involves greater uncertainty and complexity, both of which point toward a lower probability of survival. Saemundsson and Dahlstrand (2005) lend support to this observation by showing that firms that seek to exploit new, as opposed to existing, market knowledge are less likely to grow.

4.1.2. Innovativeness and the overall risk profile of startups

There are a number of additional theoretical reasons why innovativeness of startups may inflate their risk profile and reduce the likelihood of their survival.

First, innovating startups accumulate fewer tangible assets and thus have limited collateral to pledge as part of a lending process (Brown et al., 2012; Minetti, 2011). This lack of collateral restricts their access to external financing and impacts their ability to withstand negative revenue shocks, as a consequence. Second, innovativeness changes the overall risk profile of a new venture by making the distribution of revenue streams more variable and skewed (Scherer and Harhoff, 2000). Third, the R&D portfolios of new ventures are typically undiversified (i.e., they run a limited number of costly projects at any given time; see Caggese, 2012; García-Quevedo et al., 2014). Thus, the innovative new ventures may carry a non-negligible amount of idiosyncratic risks such that the failure of a single project can threaten the existence of the entire venture. Fourth, innovativeness may also alter the intertemporal patterns of cash flows. Investments in innovativeness are frequently associated with long and uncertain payback times (Brown et al., 2012; Minetti, 2011), which further reduces the likelihood of the firm being able to meet its debt and other payment obligations. Finally, entrepreneurs who believe that they are exceptionally innovative may have a particular exit strategy in mind (e.g., DeTienne et al., 2015) and can, as a result, seek to increase their firm's risk profile to achieve the desired exit and associated rewards (conditioned on survival, of course).

On the basis of the foregoing theoretical arguments, we set forth two competing hypotheses:

Hypothesis 1a. Innovativeness is negatively correlated with the survival probability of firms in the early phases of their development.

Hypothesis 1b. Innovativeness is positively correlated with the survival probability of firms in the early phases of their development.

It is important to note that Hypothesis 1a is fully consistent with rational investment behavior and, in particular, with the standard view in finance (Brealey et al., 2013) that investing in a high-risk activity goes hand-in-hand with higher expected returns. The standard risk-return tradeoff is in line with a negative association between innovativeness and startup survival, if the expected profitability of the investments in innovativeness is sufficiently high, *conditional on firm survival*.

4.2. The riskiness of innovativeness and entrepreneurial risk-taking

Utilizing entrepreneurs' personality traits as predictors for and determinants of entrepreneurial activity and success has long been controversial in entrepreneurship research. Using this observation as their starting point, Rauch and Frese (2007) perform a meta-analysis of how entrepreneurs' personality traits are associated with venture creation and success. Although the sizes of the effects vary, these authors find that some of the personality traits are significantly correlated with successful entrepreneurial outcomes and conclude that "…entrepreneurship research cannot develop a consistent theory about entrepreneurship if it does not take personality variables into account…" (p. 375). More specifically, Rauch and Frese (2007) argue for theory-driven matching of personality traits with specific entrepreneurial tasks and suggest that the importance of an entrepreneurial trait is task dependent.

[3] For example, Reid and Smith (2000) find that innovativeness does not improve performance in their sample of Scottish startups. The startups in this study were, on average, 20 months old and had 6.4 employees immediately after market entry. Reid and Smith's measure of innovation is based on a question that asks the respondent to rate his/her firm's innovativeness by the following scale: "Not applicable", "Could be better", "Fair", and "Good".

Building on a long tradition in the literature (Caggese, 2012; Cucculelli and Ermini, 2013; Ekelund et al., 2005; Kessler et al., 2012; Kihlström and Roth, 1982; Knight, 1921), we argue that an entrepreneur's willingness to take and tolerate risk and uncertainty is a particularly relevant and salient trait for understanding how the pursuit of innovations is related to firm survival during the early phases of firm development. Entrepreneurs with a greater appetite for risk are more likely to pursue innovations that are risky ex ante (Forlani and Mullins, 2000). It is unclear, however, whether pursuing riskier innovations make the relation between innovativeness and firm survival more positive or more negative. On the one hand, the recent literature suggests, at least indirectly, that the probability of firm survival decreases with the riskiness of the innovations pursued (Buddelmeyer et al., 2010). This prediction suggests that if innovativeness is, on average, negatively associated with survival, the risk tolerance trait may further magnify the negative association, which is consistent with "innovative strategy bets" not paying off in an uncertain environment. On the other hand, Pérez-Luño et al. (2011) argue that the ventures of more risk-taking entrepreneurs are likely to generate more numerous and novel innovations. If the innovativeness–survival link is positive on average to begin with, risk tolerance may strengthen this association.

We summarize the above considerations as follows:

Hypothesis 2. The association between the innovativeness of startups and their probability of survival is more pronounced for more risk-tolerant entrepreneurs.

5. Data and descriptive statistics

5.1. Data sources

Our data combine two random samples of new Finnish startups. The samples come from two surveys; at the time of the surveys, the firms had only recently begun operations. The surveys were based on computer-aided telephone interviews of the startups' owner-managers.

The first survey targeted firms established in October 2003 and yielded 385 usable observations with a response rate of 45% (documented in detail by Rouvinen and Ylä-Anttila, 2004). In this survey, approximately four months had elapsed since the startups had become active. The second survey targeted firms that were established in the first half of 2005 and yielded 780 usable observations, with a response rate of 41% (documented in detail by Pajarinen et al., 2006). In this survey, approximately six months had passed since the startups had become active. The stratification in the second survey oversampled limited liability companies, but this oversampling is taken into account in our analysis. We also control for differences in macroeconomic conditions at the times of the two surveys.

In both surveys, the most commonly reported reason for declining the request to be interviewed was lack of time. These non-responses do not appear to be correlated with observable individual and firm characteristics. [4]

In total, we have data on 1165 startups. The two surveys allow us to observe a number of characteristics of both entrepreneurs and their firms (startups) at the time of market entry and to study how they are related to the subsequent survival of the startups.

The startups in our sample had survived their first few months of active operation before they were surveyed. The subsequent survival of the sample firms is determined on the basis of the official business register of Statistics Finland (the central statistical agency), which covers all active enterprises, corporations, and self-employed persons in Finland. Because Statistics Finland tracks business establishments separately from the business entities they belong to at any given point in time, we can quite conclusively exclude business exits that result from mergers and acquisitions (i.e., the disappearance of a startup from our data due to a merger or an acquisition; for the importance of taking such mergers and acquisitions activity into account, see Cefis and Marsili, 2012; Wennberg et al., 2010). That is, we can use establishment level data to check whether the establishments of the startups (that appear to have exited) have, for example, been acquired by another firm. This check revealed that in our data, only nine business exits are associated with mergers and acquisitions. Our results are unaffected, if we remove these potentially positive exits (e.g., harvest sales; see Wennberg et al., 2010) from the data. Furthermore, as Coad (2014) notes, most exits indicate that the business in question was unsuccessful.

5.2. Variables

Our dependent variable, the three-year survival rate of a startup (Firm: Survives), takes on the value of one if the startup remains in business three years after its entry and is zero otherwise (cf. Table 2).

Our key independent variable, Firm: Innovates, takes the value of one (and zero otherwise), if *any* of the following conditions are true about the firm in question at the time of market entry: (i) it *plans to employ* new-to-the-market processes in the next three years; (ii) it *plans to introduce* new-to-the-market products/services in the next three years; and/or (iii) it is *actively pursuing* innovations.

[4] In the combined sample, the survey response rate is slightly over 40%. Although comparatively high, this response rate might lead to the concern of a selection bias related to startup survival. We cannot completely rule out such selection, but we note the following. First, in the descriptive statistics section, we show that the key properties of our sample closely correspond to the relevant population, particular in terms of survival. Second, since the startups were surveyed when they were only a few months old, this bias should not be large when compared with many existing data sets, which mostly include mature and old firms. Moreover, if there is such selection, it biases the analysis in a particular way: if innovativeness actually reduces the survival of firms and therefore decreases the likelihood that a firm is observed in our estimating sample, an indicator of innovativeness, which is a key explanatory variable in our regression model, is positively correlated with the error term in the sample. The estimated effect of innovativeness on survival thus has a positive bias.

Table 2
Construction of the variables.

Variable		Unit/range/values
Firm: Survives	Remains in business three years after entry	{0, 1}
Firm: Innovates	Plans to become or is innovative (see text)	{0, 1}
Basic: 1st survey	The observation comes from the first survey (see text)	{0, 1}
Basic: Ltd	A limited liability company (cf. stratification; see text)	{0, 1}
Firm: Entry size	Headcount of initial employment (in tens of persons)	Count
Firm: Team	More than one founder/entrepreneur involved	{0, 1}
Firm: B-to-B	Targets business-to-business markets	{0, 1}
Firm: Not local	Plans to earn revenues outside 50 km radius	{0, 1}
Firm: Network	Networking intensity (0, 0.25, 0.50, 0.75, 1)	[0–1][a]
Firm: Growth intent	Is actively seeking opportunities to grow	{0, 1}[b]
Firm: Entry support	Received public subsidies for establishing the firm	{0, 1}
Firm: Other support	Received public subsidies for running the firm	{0, 1}
Firm: Region	5 categories: (omitted category: Helsinki region)	{0, 1}[c]
Firm: Industry	8 categories: (omitted category: other services)	{0, 1}[d]
Person: Age	Age of the entrepreneur (in tens of years)	Count
Person: Female	The entrepreneur is a female	{0, 1}
Person: Income	Prior monthly gross income (in thousands of euros)	Euros
Person: Higher ed.	Has a higher education degree	{0, 1}
Person: Industry exp.	Has prior experience in the startup's industry	{0, 1}
Person: Mgmt exp.	Has prior management experience	{0, 1}
Person: Spin-off	Business idea relates to previous (paid) employment	{0, 1}
Risk: Subjective exit	Self-assessed subjective failure rate at the time of entry	[0–1][e]
Risk: Industry exit	3-year failure rate of young firms (the same 3-digit ind.)	[0–1][f]
Risk: Risk preference	Has a preference for taking risks (0, 0.33, 0.67, 1)	[0–1][g]

[a] Count of third-party cooperation agreements in the following domains: production, sales and marketing, logistics, and R&D (divided by four).
[b] An affirmative answer to a series of questions regarding growth prospects.
[c] South (excluding the Helsinki metropolitan region, the reference), West, East, and North.
[d] Industries (with NACE Rev. 1 codes): primary production (01–14, 40–41), technology industries (29–34, 352, 353), other manufacturing (15–37, excluding technology industries), construction (45), trade (50–52), accommodation and restaurants (55), transport (60–63), other services (64–99).
[e] Self-assessment of the startup's three-year exit rate.
[f] Actual three-year exit rate in the firm's three-digit industry.
[g] Survey question: "I am willing to take a lot of risk to get large revenue or income" with responses on a four-point scale from "totally disagree" to "totally agree". Rescaled to 0–1.

Three aspects of Firm: Innovates are worth stressing. First, Cronbach's alpha for the three measures of innovativeness is 0.721, which indicates that this set captures an underlying one-dimensional latent construct rather well. Second, our measure necessarily departs from much of the previous literature, because we want to use an ex ante measure of heterogeneous innovativeness that is capable of capturing the uncertain nature of innovativeness (and not the ex post outcomes associated with it; see also the discussion in the next section) and that also might not be associated with formal R&D.[5] Third, to the extent that startups' plans are not fully followed, our measure errs on the conservative side because it is not likely to predict exits.

As Table 2 shows, our control variables are grouped in four blocks. The first block, Basic, consists of one binary indicator for limited liability companies (Basic: Ltd) and of another binary indicator that identifies the observations that come from the first survey (Basic: 1st survey). The limited liability company indicator is a control for the organizational form of firms and also for oversampling in the second survey. The latter indicator is a control for the differences in the two surveys and for the general macroeconomic conditions between the two startup cohorts.

The next two blocks, Firm and Person, refer to the characteristics of the startups and their entrepreneurs (owner-managers). The variables in these two blocks are mostly drawn from the prior literature; see, e.g., Parker (2009, Table 14.1), Song et al. (2008), and Boyer and Blazy (2013). The overviews of these authors are not in complete concordance in all dimensions, but they suggest that i) venture's survival prospects are enhanced by the entrepreneur's age (Person: Age) and education (Person: Higher Ed.) in addition to his/her prior experience in the industry (Person: Industry exp., Person: Spin-off) and in management (Person: Mgmt exp.); that ii) the gender of an entrepreneur matters for survival prospects (Person: Female); and iii) that the survival prospects of a venture are enhanced by its entry size (Firm: Entry size), founding team size (Firm: Team), early growth (Firm: Growth intent), target market size (Firm: Not local), and when it operates in service industries (Firm: Industry). Our review of the prior empirical literature (e.g., Boyer and Blazy, 2013; Parker, 2009) also suggests that one should have controls for the geographical location (Firm: Region) and for the degree of engagement in external networking (Firm: Network). Moreover, since any subsidized transfer eases a firm's financial position and thus its survival prospects, we control for receiving public support upon entry (Firm: Entry support) and when running the business (Firm: Other support).

[5] Most small startups do not engage in formal R&D, so even this widely used measure would be deficient for our purposes. The innovativeness measure of Boyer and Blazy (2013) is similar in spirit to ours, but we cannot determine from their wording whether it is more of an ex ante than an ex post measure. It, too, appears to consist of three parts.

Table 3
Descriptive statistics.

Variable	Obs.	Mean	St. dev.	Min.	Max.
Firm: Survives	1165	.61	.49	0	1
Firm: Innovates	1165	.34	.47	0	1
Basic: 1st survey	1165	.33	.47	0	1
Basic: Ltd	1165	.29	.45	0	1
Firm: Entry size	1165	.22	.40	0	9
Firm: Team	1165	.21	.41	0	1
Firm: B-to-B	1165	.46	.50	0	1
Firm: Not local	1165	.57	.50	0	1
Firm: Network	1165	.28	.31	0	1
Firm: Growth intent	1165	.38	.49	0	1
Firm: Entry support	1165	.24	.43	0	1
Firm: Other support	1165	.24	.43	0	1
Firm: Region: South	1165	.22	.41	0	1
Firm: Region: West	1165	.35	.48	0	1
Firm: Region: East	1165	.09	.29	0	1
Firm: Region: North	1165	.12	.33	0	1
Firm: Ind. Primary	1165	.04	.19	0	1
Firm: Ind. Engineering	1165	.01	.11	0	1
Firm: Ind. Other manuf.	1165	.05	.23	0	1
Firm: Ind. KIBS	1165	.18	.38	0	1
Firm: Ind. Constr.	1165	.15	.35	0	1
Firm: Ind. Trade	1165	.24	.43	0	1
Firm: Ind. Rest. & Hotels	1165	.04	.20	0	1
Firm: Ind. Transport	1165	.05	.21	0	1
Person: Age	1165	3.69	1.03	1.80	6.90
Person: Female	1165	.34	.47	0	1
Person: Income	1165	2.21	1.71	0	25.00
Person: Higher ed.	1165	.46	.50	0	1
Person: Industry exp.	1165	.76	.43	0	1
Person: Mgmt exp.	1165	.48	.50	0	1
Person: Spin-off	1165	.12	.33	0	1
Risk: Subjective exit	1165	.11	.16	0	1
Risk: Industry exit	1165	.35	.09	0	1
Risk: Risk preference	1165	.47	.31	0	1

The remaining block, Risk, at the bottom of Table 2 refers to various risk measures (Risk: Subjective exit; Risk: Industry exit, calculated on the basis of Statistics Finland's business registry; Risk: Risk preference). Based on the prior work (e.g., Caggese, 2012; Cucculelli and Ermini, 2013; Forlani and Mullins, 2000; Kessler et al., 2012; Kihlström and Roth, 1982), we argue that not controlling for the basic level of the startup's (Risk: Subjective exit) and its industry's risk (Risk: Industry exit) might lead to a biased effect of innovativeness on survival. The reason is that pursuing innovations may be positively correlated with the overall (baseline) risk profile of the startup and that riskier ventures may be more likely to fail. In addition to controlling for the risk profile of the startups, these variables (Risk: Subjective exit; Risk: Industry exit) also (indirectly) control for entrepreneurial over-optimism (for a recent summary of this behavioral bias, see Åstebro et al., 2014): A linear combination of the industry failure rate and an entrepreneur's self-assessment of his venture's failure likelihood can be considered a measure of entrepreneurial optimism (Landier and Thesmar, 2009). A control for "self-report bias" is required, if the entrepreneurs who are overly optimistic are more likely to report that their firms are engaged in pursuing innovations: In particular, if the entrepreneurs who are overly optimistic are actually more likely to fail, a negative (downwards) bias might follow.[6]

5.3. Descriptive statistics

Table 3 reports a set of basic descriptive statistics for our sample. The first line of the table shows that the three-year survival rate of the sample firms is 61% (Firm: Survives). Eurostat's Business Demography by Size Class statistics states that the EU-15 average percentage of enterprises that were newly born in 2005 and survived to 2008 is 63%; the figure for Finland is also 63%. Our sample is thus representative of the survival pattern of a typical startup cohort.

The second line in Table 3 suggests that 34% of the sample firms are engaged in innovativeness (Firm: Innovates). According to the Community Innovation Survey (CIS) conducted by Statistics Finland, 48% of all Finnish firms with at least ten employees innovated in 2006–2008 (http://v.gd/jdpTS5). The difference in the corresponding share in our sample is attributable to two factors. First, CIS refers

[6] More generally, the direction of the ensuing bias is ambiguous: If the entrepreneurs who are overly optimistic are willing to invest more resources and put more effort into their firms, it is plausible that their firms are actually less likely to fail, which would result in an upward bias and reduce the chances that we would obtain a negative coefficient.

to (much) older and larger firms: the firms in the CIS sample in 2008 employ 169 employees and are 25 years old, on average. Because a large firm is more likely to have more divisions and establishments than a startup, it is more likely to report being engaged in (at least one type of) innovativeness. Second, the basic definition of the CIS considers new-to-the-firm innovations. Because the firms in our sample have recently been established, everything they do is new-to-the-firm and fulfils the basic definition of innovation employed in the CIS. Thus, we necessarily employ a somewhat stricter new-to-the-market definition of innovation.

Table 3 also shows that one quarter of the startups received some form of public support upon entry (Firm: Entry support) and that approximately the same share, albeit not necessarily the same firms, received public support when the business was already running (Firm: Other support). Moreover, a typical startup in the sample is engaged in one type of external networking (Firm: Network). The startups are small at the time of market entry, at which point they have 2.2 employees on average (Firm: Entry size, measured in tens of persons). Obviously, many of these firms grew larger over time.

The average age of the entrepreneur is 36.9 years (Person: Age, measured in tens of years in the table), but it varies substantially between 18 and 69. The average monthly income in prior employment was 2211 euros (Person: Income), which corresponds almost exactly to the average income of Finns in the labor force.

On average, the observed three-year exit rate in the population of young firms in the same three-digit industries of the sample firms is 35% (Risk: Industry exit). Upon entry, entrepreneurs are optimistic with respect to their own prospects: the average self-assessed survival rate of one's own startup is 89% (Risk: Subjective exit). The entrepreneurs are, on average, almost risk neutral when measured by our indicator for their risk appetite (Risk: Preference).

6. Method

6.1. Empirical approach

Our dependent variable, Firm: Survives, is binary and refers to the three-year survival of the startups. We therefore study the survival likelihood using a standard probit model (see, e.g., Cameron and Trivedi, 2005).

The metric of main interest to us is the economic and statistical significance of the average marginal effect of the Firm: Innovates variable on the probability of startup survival. We add our control variables block-by-block (as defined in Table 2) to show that our estimates are not sensitive to how the control variables are entered into the model. These baseline models allow us to explore whether Hypothesis 1a or 1b is supported by the data. To test Hypothesis 2, we augment our baseline model with an interaction term of Risk: Risk Preference and Firm: Innovates. The coefficient of this variable describes how the effect of innovativeness on startup survival varies with entrepreneurs' risk tolerance.

6.2. Measurement issues

As we argued already earlier, it is important that the empirical approach used to study the relation between innovativeness and firm survival takes into account two interrelated but separate selection biases. We discuss each of them in turn:

6.2.1. Survivorship bias of firms

There is a survivorship bias with respect to firms if the estimating sample only includes incumbent businesses that are a selected subset of firms that originally entered the market.

The following hypothetical example illustrates how and why the survivorship bias of firms may lead to a spurious positive relation between innovativeness and survival: *First*, assume that innovativeness *reduces* survival and that firms may have a set of *other* strengths that enhance their survival. For simplicity, the strengths are by assumption uncorrelated with innovation activity in the *population* of new firms. *Second*, note that to be included in the (selected) sample of surviving firms, a surviving innovative firm is more likely to have higher levels of these sets of strengths than its non-innovative counterparts. *Third*, the strengths are likely to be partly unobserved by an empirical researcher and therefore show up in the error term of a typical survival regression. *Fourth*, because the error term and innovativeness are positively correlated when the regression is fitted to the sample of surviving firms, there is a positive bias (see the formula for omitted variable bias in, e.g., Cameron and Trivedi, 2005, p. 93).[7] If the bias is large enough, the estimated regression coefficient may be positive, although innovativeness is assumed to reduce survival prospects.

In sum, the foregoing discussion suggests that there is a statistical reason to focus on a startup sample, like we do, when studying the association between innovativeness and survival.

6.2.2. Survivorship bias of ideas

The survivorship bias of ideas emerges because developing a commercially successful innovation is best understood as a selection process in which the choice to continue (or discontinue) is made at each step. Being engaged in innovativeness or investing more inputs into the innovation process does not ensure that a commercially successful innovation will ultimately result (e.g., Buddelmeyer

[7] This conclusion follows because the correlation between the included variable and the omitted variable is positive and because we have assumed, for purposes of our hypothetical example, that the (unobserved) strengths increase the survival rate of firms. More generally, if a survival regression is fitted on a selected sample, the coefficient of the variable that measures innovativeness may be biased upward or downward, depending on how it is correlated with the attrition mechanism that determines which firms get selected into the sample.

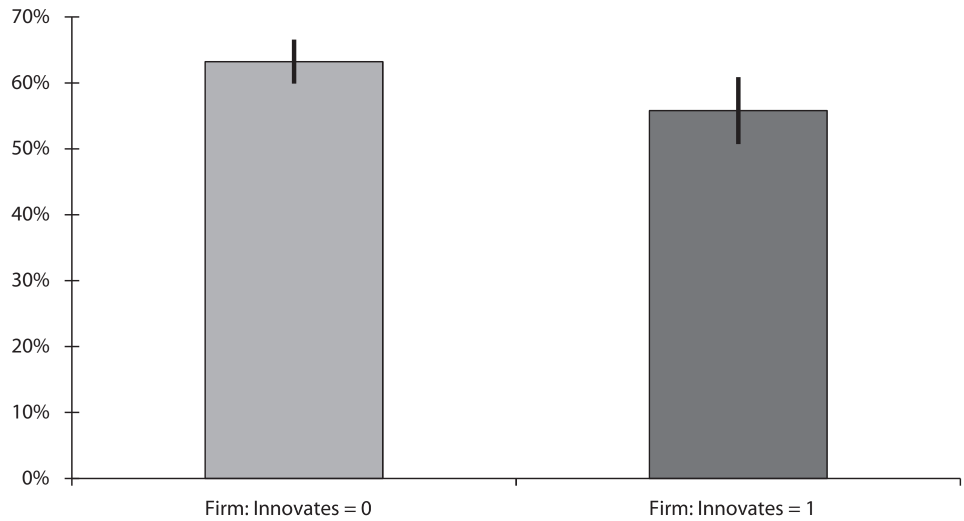

Fig. 1. Three-year survival rate by innovativeness. Notes: The vertical bars display the mean of Firm: Survives, conditional on whether they are (right, Firm: Innovates = 1) or they are not (left, Firm: Innovates = 0) pursuing innovations. The vertical lines on the top of each bar represent the 95% confidence intervals of the means.

et al., 2010; Rosenbusch et al., 2011). In addition to the quality of the underlying (initial) idea, the outcome of the process depends on how skillfully the process is executed and how technological, legal, and market uncertainties are managed and resolved during the process (Buddelmeyer et al., 2010; Howell et al., 2005).

If an empirical measure of innovativeness is an ex post indicator, it tends to be biased toward innovators that are more likely to be successful (Buddelmeyer et al., 2010). For example, owning a patent or a trademark does not guarantee success in the market place, but it does indicate some level of success in past innovativeness. This reasoning indicates that the subset of firms with innovations that are identified by ex post indicators is more likely to survive than other firms.

In sum, the survival of ideas biases the assessment of how the decision to pursue innovativeness is related to firms' subsequent survival. To capture the uncertainty of innovativeness and to allow for the more complex process of creating innovative ventures (Samuelsson and Davidsson, 2009), one has to use a proper ex ante measure of innovativeness, such as our Firm: Innovates variable, in the empirical analysis.

7. Results

7.1. Main results

Fig. 1 takes a first look at the association between the innovativeness of startups and their subsequent survival. The height of the two vertical bars corresponds to the mean survival rates of startups, conditional on whether they are (right) or they are not (left) engaged in innovativeness. A comparison of the two bars suggests that the mean survival rate of startups engaged in innovativeness is 7–8 percentage points lower (mean: 56%) than the mean survival rate of startups not engaged in innovativeness (mean: 63%).

Table 4
Estimation results of the baseline probit models.

	(1)	(2)	(3)	(4)
Firm: Innovates	−0.074 **	−0.064 *	−0.065 **	−0.068 **
	(0.031)	(0.033)	(0.033)	(0.033)
Basic: Included?	Yes **	Yes *	Yes *	Yes **
Firm: Included?		Yes ***	Yes ***	Yes **
Person: Included?			Yes ***	Yes ***
Risk: Included?				Yes ***
Observations	1165	1165	1165	1165
Pseudo R-squared	.108	.149	.164	.186

Notes: The dependent variable is Firm: Survives. The reported numbers are the marginal effects of the probit estimates and their standard errors (in parentheses). The control variable blocks included are indicated by "Yes", and their joint significance is illustrated by asterisks. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively. Table A1 in the Appendix A reports the complete estimation results.

Table 5
Interaction of innovativeness (Firm: Innovates) with risk preference (Risk: Preference).

	(1)	(2)	(3)	(4)
Firm: Innovates	0.036	0.048	0.044	0.043
	(0.055)	(0.055)	(0.055)	(0.054)
Innovates × Risk pref.	−0.238 **	−0.240 **	−0.235 **	−0.238 ***
	(0.096)	(0.094)	(0.093)	(0.091)
Risk: Risk preference	0.104 **	0.093 *	0.098 **	0.086 *
	(0.051)	(0.049)	(0.049)	(0.049)
Basic: Included?	Yes ***	Yes **	Yes **	Yes **
Firm: Included?		Yes ***	Yes ***	Yes **
Person: Included?			Yes ***	Yes ***
Risk: Included?				Yes ***
Observations	1165	1165	1165	1165
Pseudo R-squared	0.112	0.153	0.168	0.190

Notes: The dependent variable is Firm: Survives. The reported numbers are the marginal effects of the probit estimates and their standard errors (in parentheses). The included control variable blocks are indicated by "Yes" and their joint significance is illustrated by asterisks. ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively. Table A2 in the Appendix A reports complete estimation results.

This difference provides the first evidence in support of Hypothesis 1a and is close to, but slightly lower than, what Boyer and Blazy (2013) report for the survival difference among innovative and non-innovative French startups.

Table 4 reports the marginal effects from our baseline probit models (the dependent variable is Firm: Survives). The first row in the table reports the marginal effect of Firm: Innovates and shows that the survival probability of firms pursuing innovations is 6–7 percentage points lower than that of other firms. The effect is statistically significant at the 5% level in three cases (and at the 10% level in column 2) and is not sensitive to changing the set of control variables. These findings thus support Hypothesis 1a.

The signs of the coefficients of the control variables, which are not discussed in detail here (see the Appendix A for full results), are consistent with the prior literature. They are also jointly significant when tested block-by-block (Table 4).

In Table 5, we study Hypothesis 2 by adding the interaction of Risk: Risk Preference with Firm: innovates into our models. With the exception of the interaction term, Table 5 is identical to Table 4.

As Table 5 shows, the interaction term obtains a negative and statistically significant coefficient. The interaction term is also jointly significant with Firm: innovates (see the Appendix A), which provides support for Hypothesis 2 and implies that the higher the entrepreneur's appetite for risk, the more negative the association is between innovativeness and survival. This is consistent with the prior view that there is task dependence, i.e., that there is a matching of the risk-tolerant personality trait with the specific entrepreneurial task of running an innovative venture.

Fig. 2 depicts how an entrepreneur's risk appetite moderates the effect of innovativeness on the probability of survival. The vertical axis displays the estimated survival probability and the horizontal axis measures the risk appetite, moving from completely risk averse

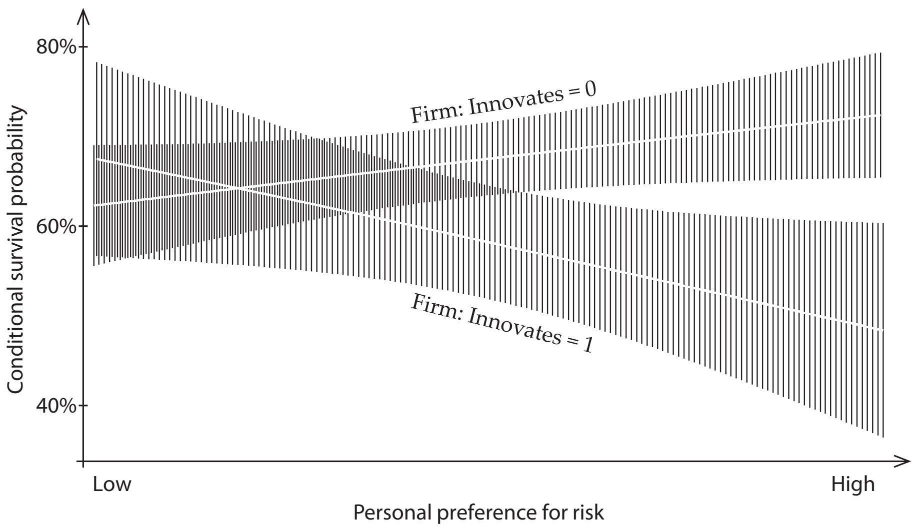

Fig. 2. Conditional survival probabilities. Notes: The figure is simulated using the estimation results reported in Table 5. The vertical lines indicate 95% confidence intervals and the white (horizontal) lines represent the mean estimates.

(left) to completely risk tolerant (right). The figure uses the estimates of Table 5; when drawing the graph, the values of the control variables are set to their mean values. The vertical lines indicate 95% confidence intervals and the white solid line represents the mean predictions. The purpose of Fig. 2 is to illustrate the joint effect of the first three coefficients in Column 4 of Table 5 (when accounting for the presence of all the other variables).

Fig. 2 shows that the survival probability of firms pursuing innovations is much lower than that of other firms, particular when the entrepreneur has an appetite for risk. Thus, consistent with Hypothesis 2, it appears that the interaction of innovativeness and the risk appetite of a startup reduces the probability of survival. This finding suggests that there is a matching of the personality trait of being risk tolerant with the specific entrepreneurial task of running a highly innovative venture. This matching seems to lead to exit-proneness: when evaluated at the highest risk preference, the difference in the survival probability between the innovative and non-innovative startups is as high as 24 percentage points.

7.2. Robustness tests and auxiliary analyses

We start by demonstrating that the survivorship of ideas is an important ingredient in our results by using an ex post measure of innovativeness instead of our preferred ex ante measure. The ex post measure is defined as a binary indicator that is equal to one if the startup owns patents, trademarks, or intangible assets and equal to zero otherwise. A startup reporting that it owns intellectual assets of this type indicates that it has enjoyed at least some prior success in innovativeness. When we replace our preferred measure with the ex post measure and re-estimate the probit models of Table 4, we obtain a *positive* but statistically insignificant coefficient. This finding is consistent with the view that when the measure of innovativeness is biased toward successful innovators, a spurious positive association may be found.

Notably, when we add the two measures *simultaneously* into the probit models of Table 4, we obtain a negative (−0.071) and statistically significant (p-value = 0.029) marginal effect for our preferred ex ante measure. The ex post measure obtains, again, a positive and insignificant coefficient. These differences between the ex ante and ex post measures lend additional support to our argument that properly accounting for the uncertainty in pursuing innovations is important.

We have explored the robustness of our baseline results also in the following ways: First, it might be argued that our focus on survival probability is inadequate. We can, however, show that this is not the case. We use the employment of startups three years after entry as an alternative outcome variable. For those firms that have exited, employment is set to zero. The tobit estimations of the specifications that match those of Tables 4 and 5 confirm our basic findings. For example, we find that in the model using the longest control vector (cf. the far right column in Table 4), the marginal effect of the innovativeness on the probability of the firm having positive employment is −0.054, which is just shy of being statistically significant at the 5% level (p-value = 0.053).

Second, our baseline estimations employ a three-year survival rate as the dependent variable. The use of this particular time window is consistent with the time frame of our ex ante innovation measure. However, at the suggestion of an anonymous referee, we also consider the two-, four-, and five-year survival rates as the dependent variable. Our results in Table 4 are robust to using the two-year survival rate as the dependent variable. In particular, we found that the coefficient of Firm: Innovates is −0.086 (p-value = 0.006) in the estimation, which is similar to Table 4, Column 4. For the longer survival rates, the coefficients of Firm: Innovates are also negative, but the effects are not statistically significant at conventional levels. For instance, when using the four-year survival period, the coefficient of Firm: Innovates is −0.048 (p-value = 0.150) in the specification similar to Table 4, Column 4. It thus seems that uncertainty regarding innovativeness is mostly resolved by the third year. After that, a startup's engagement in innovativeness appears to be less informative of its likelihood to survive. The results of Table 5 are *not* affected, if the time window for survival is changed: in all cases, the interaction term between a startup's innovativeness and an entrepreneur's risk preference is negative and statistically significant. The interaction term is also jointly significant with Firm: Innovates in all the estimations. For example, when using the five-year survival rate as the dependent variable (similar to Table 5 column 4), the coefficient of the interaction term is −0.296 (p-value 0.002). A χ^2 test for the joint significance of the interaction term and Firm: Innovates obtains the value of 11.001 (p-value 0.004).

Third, we re-ran the models reported in Tables 4 and 5 as a logit model and as a linear probability model (OLS). The results echo our baseline findings. For example, using the model that is reported in Column 4 of Table 4, the marginal effect of Firm: Innovates in a logit model is negative and significant (−0.066, p-value 0.046), and in an OLS model, negative and almost significant at the 5% level (−0.065, p-value 0.053). Using the model that is reported in Column 4 of Table 5, the marginal effect of the interaction term is −0.250 (p-value 0.008) in a logit model and −0.248 (p-value 0.007) in an OLS model.

Fourth, the potential endogeneity of innovativeness ought to be considered. To this end, we need a valid instrumental variable (Cameron and Trivedi, 2005) that is not directly related to firm survival and that explains why certain startups are engaged in innovativeness. Unfortunately, there are no perfect instruments in our data. To address the endogeneity concern, we use travel distance to the nearest Centre for Economic Development, Transport and the Environment as an instrument in an exploratory fashion. There are 15 such centers in Finland. These centers provide public support to Finnish small and medium-sized firms (e.g., to their various development projects). They also act as local outlets for the services of the Finnish Funding Agency for Technology and Innovation (Tekes), which provides public subsidies for pursuing innovations. Our motivation to use the travel distance as an instrument is that the closer to a center a firm is located, the more likely it is to seek and/or to obtain public support for pursuing innovations. The instrument satisfies the exclusion restriction if, conditional on the startups' industry and region (and our other controls), the distance to a center has no direct effect on their survival. The first stage results suggest that the instrument has some predictive power.[8] When we use the standard 2SLS estimation and the distance as an instrument, we obtain a (large) negative but insignificant coefficient for Firm: Innovates. This result is qualitatively consistent with our basic findings: the coefficient is not estimated accurately, which is not surprising because the instrument is far from perfect. Our experiments with other instruments, such as the squared travel distance as an additional instrument or the travel time to the nearest center as the sole instrument, yielded similar results.

8. Discussion and conclusions

8.1. Summary and discussion

There are a number of competing theoretical arguments that explain why the relation between startups' innovativeness and their subsequent survival might be either positive or negative. On the one hand, innovativeness can increase the likelihood of survival if it enhances startups' market power, reduces the costs of production, or allows the creation of dynamic capabilities and absorptive capacity (Teece et al., 1997; Zahra and George, 2002). Younger firms may benefit disproportionately from the opportunities created by innovativeness due to their less rigid routines and greater flexibility (e.g., Brüderl and Schüssler, 1990; Christensen and Bower, 1996; Freeman et al., 1983; Hill and Rothaermel, 2003; Klepper and Simons, 1997; Lumpkin and Dess, 1996). On the other hand, we have argued that the stage of firm development and the stage and nature of innovativeness may moderate the association between innovativeness and firm survival adversely and can even turn it negative. An innovative startup is laden with excess liability of novelty and smallness, which reduce its chances of survival relative to its non-innovative counterparts. Startups' innovativeness may also limit their access to external finance (due to lack of collateral) and change their overall risk profile by making the distribution of revenue streams more variable and skewed (Scherer and Harhoff, 2000) and by delaying them in time.

Whereas the available empirical literature mostly suggests that the relation between firms' innovativeness and their subsequent survival is positive, we find a negative association between innovativeness and survival. Our baseline estimations suggest that the survival probability of startups engaged in innovativeness is approximately 6–7 percentage points lower than that of other startups. This finding reinforces the result of Boyer and Blazy (2013), who documented that innovative French micro-enterprises established in 1998 were more likely to fail than their non-innovative counterparts.

In our view, two aspects of our empirical approach are important for these findings: First, we employ an ex ante measure of innovativeness to account for the associated uncertainties and to avoid the survivorship bias of ideas (i.e., the consequences of focusing on a selected subset of firms that have previously innovated successfully). Second, we study the association between innovativeness and firm survival using a sample of startups, which allows us to account for the survivorship bias of firms (i.e., the consequences of market selection) to a reasonable extent.

We also find that the interaction of innovativeness and entrepreneurs' higher appetite for risk further reduces the survival prospects of their startups. This finding is consistent with Buddelmeyer et al. (2010), who suggest that the probability of survival may vary with the riskiness of innovations. It is also consistent with Forlani and Mullins (2000), who argue that more risk-tolerant entrepreneurs are more likely to engage their startups in riskier innovative efforts. Taken together, these findings suggest that the effect of entrepreneurial risk-taking is task dependent and that it matters in particular for innovativeness. This finding is consistent with the broader conclusions of Rauch and Frese (2007), who stress that it is important to link entrepreneurs' traits to particular entrepreneurial tasks.

8.2. Limitations and further research

A limitation of our study is that we cannot explicitly address the various modes of exits and their potentially different determinants (Bates, 2005). Exits via mergers and acquisitions, including what Wennberg et al. (2010) call harvest and distress sales, appear to be rare in our data during the time horizon that it covers. Therefore, we could not analyze them statistically. However, analyzing how (ex ante) innovativeness is associated with various forms of exit, such as in a competing risks framework, would certainly be valuable because it might reveal further heterogeneity in how engaging in innovativeness is associated with longer-term survival. Our analysis does not rule out the possibility that innovativeness will be positively associated with, for example, the likelihood of trade sales over the longer term.

Another limitation is the flipside of our strength: our data are not informative regarding incumbents' innovativeness and regarding how associated, frequently incremental, improvements shape incumbents' subsequent survival (Banbury and Mitchell, 1995). Our study highlights the importance of (a) allowing for selection among and within the various cohorts of firms (Cader and Leatherman, 2011; Coad et al., 2013), and (b) distinguishing ex ante activity from ex post outcomes, such as patents and market introductions of new processes or products.

[8] The coefficient of travel distance (measured in kilometers) in the first-stage regression was −0.0007 (p-value 0.075). The sign is as expected, but the statistical significance is relatively weak. The adjusted R^2 of the first-stage regression was 0.303 and partial R^2 of travel distance was 0.003.

Although we believe that our measure of innovativeness is an improvement over those used in the previous literature, our measure still leaves something to be desired: we could not directly observe the nature and riskiness of startups' innovations. Measuring innovativeness in general (Buddelmeyer et al., 2010) and, e.g., the potential market newness of entering firms (Dahlqvist and Wiklund, 2012) is difficult. This proposition indicates that our measure is likely to hide much interesting heterogeneity. The effect of innovativeness on startup survival may also depend on industry characteristics, such as the technological and market environment (we do control for industry but do not explicitly study industry characteristics). Whether different types of innovativeness among startups are differentially associated with subsequent survival—and how those effects are context dependent—remain open questions that future research might fruitfully address.

Three final limitations are worth mentioning. First, the firms in our sample were surveyed when they were a few months old. The survivorship bias of firms should therefore be reasonably small, but clearly it is not eliminated altogether. Second, although we have controlled for the industry failure rate and an entrepreneur's self-assessment of his venture's likelihood of failure, we cannot completely dismiss a type of self-report bias due to more optimistic entrepreneurs being more likely to report that their firms are pursuing innovations.[9] Finally, it is important to acknowledge that innovativeness, even if measured ex ante and studied using a random sample of startups, is not randomly allocated. Our analysis might suffer from a negative bias (i.e., we might obtain too negative of a coefficient) if, for example, the startups of technologically oriented and technically skilled entrepreneurs are more likely to pursue innovations *and* if such orientations and skills have a negative effect on the likelihood of startup survival. We are the first to admit that our data do not allow us to conclusively rule out such self-selection, although our extensive set of control variables alleviates this concern.

8.3. Managerial and policy implications

An obvious managerial implication of our findings is that innovativeness should not be considered a form of inexpensive insurance against failure during the early phases of firm development: if survival is one of the primary objectives of an entrepreneur and, in particular, if entrepreneurs have overly concentrated portfolios (i.e., if they carry significant idiosyncratic business risk; Heaton and Lucas, 2000; Moskowitz and Vissing-Jorgensen, 2002), it may be best not to try to be innovative or to engage in only modestly risky forms of such activity. Successful radical innovation may still be rewarded handsomely; seeking such rewards, however, comes with a cost.

Our findings also have implications from a wider public policy perspective. First, besides its primary productivity, spillover, and competitiveness motives, public support for innovativeness is sometimes based on the premise that innovating firms are more likely to survive and are thus more likely to create stable jobs. Our analysis casts doubt on this particular premise, even if the other motives for public support remain intact. Second, discontinuing a business does not necessarily indicate that all fruits of its innovative efforts are wasted. On the one hand, innovativeness may generate local knowledge spillovers (see, e.g., Gilbert et al., 2004, and the references therein), regardless of whether such activities are ultimately successful. The knowledge spillover theory of entrepreneurship predicts, for example, that new knowledge created by incumbent firms leads to new market entry (Acs et al., 2009; Plummer and Acs, 2014). On the other hand, exits of startups that have pursued innovations release resources (e.g., employees with enhanced human capital and specialized assets) that may stimulate future entry (Pe'er and Vertinsky, 2008). Viewed from this perspective, the most important argument for subsidizing startups' innovativeness is that they produce positive intertemporal and spatial externalities.

We conclude with two reminders. First, the documented negative association between startups' innovativeness and the probability of survival does *not* imply that the survival rate of innovative startups is sub-optimal; our findings say nothing about the socially optimal survival rate of innovative startups. Second, our findings do not exclude the possibility that either the expected private or social returns are greater for innovative startups than for their non-innovative counterparts.

Acknowledgments

This paper has been written in the context of the *Finnish Innovative Entrepreneurship* project (*FinnEntre*) of *VTT, Technical Research Centre of Finland*. The authors wish to acknowledge the kind support of *Tekes, the Finnish Funding Agency for Innovation* in Finland (grant number 702/31/09). The authors also wish to thank the stakeholders of the *FinnEntre* project as well as the participants of its final seminar (held on 6 May 2013 at Aalto Startup Sauna in Espoo, Finland) for comments and suggestions.

[9] We thank an anonymous reviewer for noting this potential problem. If, on the one hand, the entrepreneurs who are overly optimistic are both more likely to report that their firms are pursuing innovations and more willing to invest resources in their firms (and to put in more effort), an upward bias, working against our main findings, would result because the firms of such optimistic entrepreneurs would in fact be less likely to fail. On the other hand, if the entrepreneurs who are overly optimistic are actually more likely to fail, our estimates might be downwards biased.

Appendix A

Table A1
Complete estimation results of the baseline probit model.

	(1)	(2)	(3)	(4)
Firm: Innovates	−0.074 **	−0.064 *	−0.065 **	−0.068 **
	(0.031)	(0.033)	(0.033)	(0.033)
Basic: 1st survey	−0.168 ***	−0.100 ***	−0.136 ***	−0.133 ***
	(0.032)	(0.034)	(0.039)	(0.039)
Basic: Ltd	0.326 ***	0.313 ***	0.290 ***	0.271 ***
	(0.028)	(0.033)	(0.036)	(0.036)
Firm: Entry size		0.137	0.125	0.115
		(0.085)	(0.081)	(0.074)
Firm: Team		−0.019	−0.015	−0.010
		(0.042)	(0.041)	(0.040)
Firm: B-to-B		0.061 **	0.046	0.049 *
		(0.029)	(0.029)	(0.029)
Firm: Not local		−0.009	−0.011	−0.007
		(0.029)	(0.029)	(0.029)
Firm: Network		−0.001	−0.011	−0.009
		(0.048)	(0.047)	(0.048)
Firm: Growth intent		0.009	0.007	0.006
		(0.033)	(0.033)	(0.033)
Firm: Entry support		0.062	0.068 *	0.055
		(0.040)	(0.040)	(0.039)
Firm: Other support		0.104 ***	0.097 ***	0.099 ***
		(0.037)	(0.037)	(0.036)
Firm: Region: South		0.019	0.026	0.009
		(0.040)	(0.040)	(0.040)
Firm: Region West		0.019	0.024	0.007
		(0.037)	(0.037)	(0.036)
Firm: Region: East		0.022	0.030	0.016
		(0.052)	(0.051)	(0.050)
Firm: Region: North		0.072	0.087 *	0.078 *
		(0.045)	(0.045)	(0.045)
Firm: Ind. Primary		−0.014	−0.016	−0.059
		(0.073)	(0.070)	(0.073)
Firm: Ind. Engineering		0.188 *	0.182	0.171
		(0.110)	(0.113)	(0.104)
Firm: Ind. Other manuf.		−0.100	−0.092	−0.082
		(0.064)	(0.064)	(0.062)
Firm: Ind. KIBS		−0.009	−0.026	0.007
		(0.042)	(0.043)	(0.042)
Firm: Ind. Constr.		0.160 ***	0.139 ***	0.112 **
		(0.041)	(0.044)	(0.045)
Firm: Ind. Trade		−0.015	0.001	0.052
		(0.037)	(0.037)	(0.037)
Firm: Ind. Rest. & Hotels		0.038	0.007	0.064
		(0.069)	(0.069)	(0.066)
Firm: Ind. Transport		0.164 ***	0.159 ***	0.062
		(0.061)	(0.061)	(0.072)
Person: Age			0.009	0.005
			(0.014)	(0.014)
Person: Female			0.012	0.011
			(0.031)	(0.031)
Person: Income			0.013	0.012
			(0.010)	(0.010)
Person: Higher ed.			0.006	0.013
			(0.029)	(0.028)
Person: Industry exp.			0.094 ***	0.079 **
			(0.033)	(0.032)
Person: Mgmt exp.			0.016	0.009
			(0.031)	(0.030)
Person: Spin-off			0.105 **	0.099 **
			(0.041)	(0.041)
Risk: Subjective exit				−0.350 ***
				(0.080)
Risk: Industry exit				−0.669 ***
				(0.175)
Risk: Risk preference				0.017
				(0.042)

Table A1 *(continued)*

	(1)	(2)	(3)	(4)
Wald test for rhs set 1 (χ^2)	5.606 **	3.571 *	3.791 *	4.261 **
Wald test for rhs set 2 (χ^2)		51.772 ***	43.934 ***	35.883 **
Wald test for rhs set 3 (χ^2)			23.754 ***	18.892 ***
Wald test for rhs set 4 (χ^2)				35.65 ***
Pseudo R-squared	0.108	0.149	0.164	0.186
Log pseudolikelihood	−695.350	−663.637	−651.840	−634.616
Wald (χ^2)	143.585 ***	165.781 ***	191.037 ***	232.437 ***
Observations	1165	1165	1165	1165

Notes: The dependent variable is Firm: Survives. The reported numbers are the marginal effects of the probit estimates and their standard errors (in parentheses). ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

Table A2
Complete estimation results: Interaction of innovativeness and risk preference included.

	(1)	(2)	(3)	(4)
Firm: Innovates	0.036	0.048	0.044	0.043
	(0.055)	(0.055)	(0.055)	(0.054)
Innovates × Risk pref.	−0.238 **	−0.240 **	−0.235 **	−0.238 ***
	(0.096)	(0.094)	(0.093)	(0.091)
Risk: Risk preference	0.104 **	0.093 *	0.098 **	0.086 *
	(0.051)	(0.049)	(0.049)	(0.049)
Basic: 1st survey	−0.171 ***	−0.101 ***	−0.137 ***	−0.132 ***
	(0.032)	(0.034)	(0.040)	(0.039)
Basic: Ltd	0.329 ***	0.317 ***	0.293 ***	0.277 ***
	(0.028)	(0.033)	(0.035)	(0.035)
Firm: Entry size		0.128	0.118	0.108
		(0.084)	(0.081)	(0.075)
Firm: Team		−0.016	−0.012	−0.010
		(0.041)	(0.041)	(0.040)
Firm: B-to-B		0.063 **	0.047	0.050 *
		(0.029)	(0.029)	(0.029)
Firm: Not local		−0.009	−0.011	−0.005
		(0.029)	(0.029)	(0.028)
Firm: Network		−0.008	−0.018	−0.014
		(0.048)	(0.048)	(0.047)
Firm: Growth intent		0.012	0.009	0.010
		(0.033)	(0.033)	(0.033)
Firm: Entry support		0.063	0.068 *	0.054
		(0.039)	(0.039)	(0.039)
Firm: Other support		0.103 ***	0.095 ***	0.099 ***
		(0.037)	(0.037)	(0.036)
Firm: Region: South		0.019	0.025	0.010
		(0.040)	(0.040)	(0.039)
Firm: Region West		0.016	0.021	0.004
		(0.037)	(0.036)	(0.036)
Firm: Region: East		0.018	0.027	0.013
		(0.052)	(0.051)	(0.049)
Firm: Region: North		0.071	0.087 *	0.079 *
		(0.045)	(0.045)	(0.045)
Firm: Ind. Primary		−0.018	−0.020	−0.065
		(0.073)	(0.071)	(0.073)
Firm: Ind. Engineering		0.199 *	0.193 *	0.182 *
		(0.108)	(0.111)	(0.103)
Firm: Ind. Other manuf.		−0.101	−0.093	−0.084
		(0.063)	(0.063)	(0.061)
Firm: Ind. KIBS		−0.006	−0.024	0.010
		(0.042)	(0.043)	(0.042)
Firm: Ind. Constr.		0.158 ***	0.137 ***	0.109 **
		(0.041)	(0.044)	(0.045)
Firm: Ind. Trade		−0.017	−0.002	0.051
		(0.037)	(0.037)	(0.037)
Firm: Ind. Rest. & Hotels		0.035	0.003	0.063
		(0.070)	(0.070)	(0.067)
Firm: Ind. Transport		0.162 ***	0.158 **	0.060
		(0.061)	(0.061)	(0.073)
Person: Age			0.008	0.002
			(0.015)	(0.014)

(*continued on next page*)

Table A2 *(continued)*

	(1)	(2)	(3)	(4)
Person: Female			0.011	0.010
			(0.031)	(0.031)
Person: Income			0.013	0.012
			(0.010)	(0.010)
Person: Higher ed.			0.010	0.016
			(0.029)	(0.028)
Person: Industry exp.			0.095 ***	0.082 **
			(0.033)	(0.032)
Person: Mgmt exp.			0.015	0.009
			(0.031)	(0.030)
Person: Spin-off			0.104 **	0.098 **
			(0.041)	(0.041)
Risk: Subjective exit				−0.350 ***
				(0.078)
Risk: Industry exit				−0.684 ***
				(0.176)
Wald test for rhs set 1 (χ^2)	11.977 ***	10.286 **	10.524 **	11.180 **
Wald test for rhs set 2 (χ^2)		51.508 ***	43.475 ***	35.921 **
Wald test for rhs set 3 (χ^2)			23.714 ***	18.828 ***
Wald test for rhs set 4 (χ^2)				35.961 ***
Wald test for Firm: Innovates and Innovates × Risk pref. (χ^2)	11.610 ***	10.010 ***	10.000 ***	11.030 ***
Pseudo R-squared	0.112	0.153	0.168	0.190
Log pseudolikelihood	−691.865	−660.163	−648.346	−631.154
Wald (χ^2)	145.335 ***	169.162 ***	194.701 ***	235.159 ***
Observations	1165	1165	1165	1165

Notes: The dependent variable is Firm: Survives. The reported numbers are the marginal effects of the probit estimates and their standard errors (in parentheses). ***, **, and * indicate statistical significance at 1, 5, and 10% levels, respectively.

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