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John C. Dencker

University of Illinois at Urbana-Champaign, USA

Marc Gruber

Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, marc.gruber@epfl.ch

Sonali K. Shah

University of Illinois at Urbana-Champaign, USA1

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KNOWLEDGE ACQUISITION ACTIVITIES, PRIOR KNOWLEDGE AND EXPERIENCE & THE SURVIVAL OF NEW FIRMS

John C. Dencker, University of Illinois at Urbana-Champaign, USA
Marc Gruber, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland
Sonali K. Shah, University of Illinois at Urbana-Champaign, USA¹

ABSTRACT

Knowledge acquisition activities occurring may be just as critical to firm survival as pre-existing knowledge and experience, because knowledge acquisition activities enable the augmentation of existing knowledge and the exploration and pursuit of new strategic directions. Drawing from organization theory and entrepreneurship theory, we examine two important sets of knowledge acquisition activities: knowledge acquired through planning and knowledge acquired through learning by doing. We examine the direct impact of these activities on the survival of new firms and examine the extent to which planning and learning by doing can compensate for low prior knowledge and/or management experience. We find that while learning by doing promotes firm survival and can compensate, planning deters firm survival and can not compensate.

INTRODUCTION

Entrepreneurs bring knowledge and experience from past educational, business, and hobby activities that may be valuable in spotting new business opportunities and in running firms once they are launched. As a result, de novo entrants possess prior knowledge and experience, embodied in their founding members, that is likely to influence the firm's chances of continued survival and success (Nelson and Winter 1982; Roberts 1991; Sleeper 1998; Helfat and Lieberman 2002). Most studies examining the relationship between founder characteristics and new firm survival have focused on founder characteristics that are either innate (i.e. age, personality traits, having a self-employed parent), or a stock acquired prior to entry (i.e. education; prior work, industry, management, entrepreneurial or leadership experience). However, entrepreneurs continue to acquire, change and develop their human capital and acquire knowledge necessary for their firm's survival. Existing theorizing on firm survival has yet to include this evolutionary characteristic of knowledge, despite the fact that entrepreneurs regularly engage in knowledge acquisition activities and these activities provide a means by which to explore and pursue new strategic directions.

Knowledge acquisition activities and their relationships with prior knowledge and experience are the focus of this study. There are many methods by which a firm can acquire knowledge (Malerba 1992). We focus on two methods that are the subject of particular interest and debate in the organization theory and entrepreneurship literatures: planning and learning by doing. We examine two aspects of the relationship between each of these knowledge acquisition activities and firm survival. First, we examine the direct effect of knowledge acquisition activities on firm survival. We expect this effect to be positive as current theorizing suggests that the more knowledge the firm founder holds, the better. Second, we examine the extent to which knowledge acquisition activities can compensate for low levels of prior knowledge and/or management experience. Although founders often choose to enter a specific industry because of the match between their pre-entry knowledge and experience and the requirements for competing successfully in an industry (Helfat and Lieberman 2002), founders whose prior knowledge and experience perfectly match the requirements of their new industries are rare and de novo entrants often suffer from cognitive biases limiting their ability to accurately assess this match (Kahneman and Lovallo 1993).

Our findings contribute to the theoretical discussion pertaining to the relationship between pre-entry knowledge and experience and firm survival in three ways. First, we examine how subsequent knowledge acquisition activities impact the relationship between pre-entry knowledge and experience and firm survival. Second, we discuss the extent to which knowledge acquisition activities can compensate for a lack of prior knowledge and/or experience. Third, we highlight the fact that even new firms must deal with issues of how to most effectively evolve and adapt. From a practical perspective, these findings can guide potential or existing entrepreneurs who are finding that a gap exists between the knowledge and experience they require to compete effectively in their industry and those currently at their disposal.

In the following section we review and build on work examining the impact of knowledge on the longevity of new ventures. A description of the context that we study and our data collection and analysis methods follows. We then report on and discuss our findings.

THEORY & HYPOTHESIS DEVELOPMENT

The accumulation of knowledge through learning constitutes a driving force in the development and growth of firms (Penrose 1959; Hatch and Dyer 2004). While some knowledge may be created within the firm, a great deal of knowledge is created externally by other organizations or the forces of environmental uncertainty. Firms must therefore identify and gain access to relevant knowledge that is being created externally, that is, they must engage in knowledge acquisition activities. Despite the importance and relevance of this topic to theories of strategic change, the relationship between knowledge acquisition activities and *new* firm survival has received relatively little attention; and the interaction between past knowledge and experience (stocks) and current knowledge acquisition activities (flows) has, to our knowledge, not been examined.

In the case of many newly founded firms, such as those that populate our sample, knowledge acquisition tends to be the responsibility of the firm founder, i.e. the knowledge of the new firm is equivalent to the knowledge possessed by the founder. The basic theoretical argument that has been made is that a founder's stock of knowledge improve a firm's chances of survival by allowing the founder to more efficiently organize and manage the production process and/or by allowing the founder to more easily attract customers and investment capital (Bates 1985; Brüderl, Preisendörfer and Ziegler 1992; Agarwal et al. 2004). Empirical research has generally found support for this argument using a variety of knowledge and human capital measures that are either innate (i.e. age, personality traits, having a self-employed parent), or a stock accumulated prior to entry (i.e. education; prior work, industry, management, entrepreneurial or leadership experience) Bates 1990; Roberts 1991; Brüderl et al. 1992; Sleeper 1998; Shane 2000; Burton et al. 2002; Helfat and Lieberman 2002; Agarwal et al. 2004). As mentioned, existing theoretical and empirical work provides a preliminary understanding of the impact of knowledge on firm performance, but fails to take into account the facts that knowledge can be acquired, changed, and developed; can have both positive and negative effects; that different types of knowledge can interact with one another, acting to amplify or compensate for one another; and that pre-existing knowledge stocks can influence a firm's ability to acquire new knowledge and potentially shape the direction of those knowledge acquisition activities.

In the remainder of this section, we develop a framework for understanding how knowledge obtained through two knowledge acquisition activities – planning and learning by doing - promotes or detracts from new firm survival – and how prior experience and prior knowledge affect this relationship.

Pre-entry Business Planning and Venture Survival

Nascent entrepreneurs are typically advised to develop business plans of their projected ventures (Castrogiovanni 1996). Business planning can be defined as ‘the process by which the entrepreneur, in exploiting an opportunity, creates a vision of the future and develops the necessary objectives, resources, and procedures to achieve that vision (Sexton and Bowman-Upton 1991, p. 118).’ Business plans

describe the opportunity that a venture will pursue, as well as its competition, customers, business model, and financing plans (Sahlman 1999).

While planning will allow entrepreneurs to generate new knowledge (through the gathering and analysis of information), it is unlikely that planning will be able to *compensate* for low prior knowledge of the business activity. This is because prior knowledge is needed to identify and address the most knowledgeable information sources, to ask insightful questions, to guide planning activities, to build on and challenge information that has been gathered, and to apply new information appropriately (Cooper 1986). As a result, we expect that planning be more useful for founders who have high levels of prior knowledge than for those who have low levels of prior knowledge, and that planning will be unable to substitute for prior knowledge.

Hypothesis 1a: Knowledge acquired through planning will improve the likelihood of new firm survival.

Hypothesis 1b: Knowledge acquired through planning will not compensate for low prior knowledge and/or low management experience.

Knowledge Acquired through Learning by Doing

Learning by doing is based on repetition and leads to the incremental development of expertise, which makes the individual more effective in executing tasks (Fudenberg and Tirole 1983; Adler and Clark 1991). Learning by doing is an important source of knowledge for several reasons. First and foremost, learning by doing may generate a string of subsequent improvements and new knowledge (David 1975). Second, learning by doing is a critical source of knowledge when information is “sticky”, that is costly to acquire, transfer and use (von Hippel 1994). When this is the case, learning can only take place in the context of engaging in a particular activity (von Hippel and Tyre 1995). For example, this might happen as entrepreneurs try and create a successful product line: only in the course of introducing products and seeing how customers react to them can the entrepreneur gather information about actual and/or unarticulated customer desires that is used to make additions and subtractions to the line. Third, entrepreneurial situations are characterized by newness and uncertainty. “By definition, new ventures call for a company to envision what is unknown, uncertain, and not yet obvious to the competition” (McGrath and MacMillan 1995, p.44). As a result, entrepreneurs must often plan and act, despite missing or inaccurate information and ambiguous information signals. Over time, entrepreneurs will learn about the outcomes of their early efforts, and can use this new knowledge to revise their assumptions and redirect their actions (McGrath and MacMillan 2000; Chesbrough and Rosenbloom 2002).

Hypothesis 2a: Knowledge acquired through learning by doing will improve the likelihood of new firm survival.

Knowledge acquisition through learning by doing may help an entrepreneur *compensate* for low prior knowledge of the business activity (i.e. deficits in their pre-entry stock of knowledge). There are several reasons for this. First, “doing” is likely to require that the entrepreneur gains most of the knowledge they lacked as they begin their new business venture (for example, take the case of a chef who starts a catering service. The chef may cook brilliantly, but be unfamiliar with how to transport food and reheat it at another location. The chef-turned-entrepreneur will have to learn how to handle these issues). Second, learning by doing might provide knowledge that is more useful than pre-entry knowledge, particularly in highly uncertain and dynamic entrepreneurial situations (that is to say, learning by doing may be the most direct and effective method (and in some cases even the only method) for gathering accurate, up-to-date information). Third, learning – combined with subsequent explicit actions - can also serve to transform goals, through making alterations in the way the business runs (i.e. by making changes to the technology, equipment, processes, or human capital in ways that augment capabilities) (Adler and Clark 1991).

Knowledge acquisition through learning by doing may also help an entrepreneur *compensate* for low prior management experience. Through learning by doing, and the direct feedback-loops associated with this type of knowledge acquisition activity, an entrepreneur has the opportunity to directly detect weaknesses in his management and engage in corrective actions.

Hypothesis 2b: Knowledge acquired through learning by doing will compensate for low prior knowledge and/or low management experience.

METHOD

Study Context

Our data set is derived from a sample of the 2001 cohort of entrepreneurs in the Munich, Germany region who received government assistance to support their transition from unemployment to entrepreneurship. Participants were granted “bridging allowances” of, on average, €1000/month to offset living expenses for six months. These funds do not require repayment and the funding allowance is equivalent to the unemployment allowance the individual would have received (Wiessner 2000). Thus, this type of funding is different in nature from the better known start-up investment capital supplied by banks and venture capitalists. Similar support programs exist in Australia, Belgium, Canada, Denmark, Finland, France, Greece, Great Britain, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Sweden and the US. Access to the 2001 cohort was provided through collaboration with the Federal Employment Agency of Munich.

Survey Design

After securing the cooperation of the government agency, we conducted fifteen in-depth qualitative interviews with funding recipients and start-up consultants in order to develop a deeper understanding of the challenges faced by this set of entrepreneurs, the resources to which they had access, and the process by which they created, investigated, and pursued their venture opportunities. These findings, combined with an extensive review of the literature resulted in the preparation of an eight-page survey instrument. The instrument was pre-tested with 17 entrepreneurs and four consultants. As a result, minor modifications were made to improve the clarity of some survey items.

Response Rate

In the spring of 2005 we mailed the survey to all 1892 individuals of the 2001 cohort of funding recipients, accompanied by a cover letter and return envelope. Surveys sent to 441 individuals were returned to us as these individuals could no longer be reached using the 2001 address data supplied to the funding agency. Seven weeks after the initial mailing, individually addressed reminder postcards were sent to all individuals in the population.

A total of 456 responses were received (response rate of 24.1% based on the size of the full cohort; 31.4% based on the number of individuals who received the survey). Of these, only 14 were omitted from our analyses due to missing values. We believe that our data set is representative of the population. For instance, respondents who answer only after receiving several reminders are arguably similar to non-respondents (Hendricks 1949). An analysis of early versus late respondents did not show any significant difference between these two groups.

Because we sampled the full 2001 cohort of founders, our data includes responses from individuals who were no longer self-employed (the unit of observation is the individual). This is an important property of our data set, as most studies in entrepreneurship draw on samples of surviving firms and thus may suffer from survivor bias. Twenty-two percent of respondents had ceased their self-employment activity within four years after inception, a fraction in-line with the average four year mortality rate of

new ventures formed by unemployed individuals in Germany (Wiessner 1998; Hinz and Jungbauer-Gans 1999; Institut für Mittelstandsforschung Bonn 2005).

All funding recipients founded companies based in Germany. Their business activities span a wide range of product and service types, which can be divided into three broad areas: trade and commerce (31.5% of respondents), freelance business activities such as consulting or internet services (58.5%) and craft activities (10.0%).

Operationalization of Variables

Dependent Variable

Our dependent variable of interest is the survival time (in months) of the new firm (Brüderl et al. 1992). Respondents reported whether they were still active with their self-employment activity or whether (and when) they ceased it. Continued firm survival at the time of the survey was recorded as a right-censored observation.

Independent Variables

Prior Knowledge: Because prior knowledge may have been obtained in other ways than prior work (e.g., through a hobby), we measure the degree of prior knowledge with two survey questions. These questions capture (a) the degree of overlap between the previous job and the self-employed activity, and (b) the importance of the founder's prior knowledge in the decision to pursue the business opportunity (both on five-point scales). The prior knowledge construct was created by using the highest score across both questions.

Management Experience: Founders were asked whether they possessed prior experience in management. Answers to the question were recorded on a five-point Likert-type scale ranging from "very low" to "very high."

Knowledge Created through Planning: A number of types of planning activities exist, such as strategic, operational, and financial (cf. Sahlman 1999). Following an approach used by Zahra and Covin (1993), we measure the intensity with which strategic content was analyzed and planned at founding on a five-point Likert-type scale (from "not planned at all" to "extremely"). The planning of strategic content was reflected in two items relating to (a) target market definition, and (b) the attainment of competitive advantage ($\alpha = 0.76$). In robustness tests, we consider effects of operational planning on firm survival.

Knowledge Created through Learning by Doing: We measure learning by doing through product line change. We created a dummy variable to capture the influence of change of a product line on new firm survival. Our survey question asked founders if and how they changed their product/service offering at any time between firm founding and the time of the survey (or closing of the firm). Respondents could indicate if their offering did not change (coded as "0") or if they changed it in one of the following ways (coded as "1"): extension or new addition to the product/service offering, reduction or deletion of the product/service offering, or complete replacement of the product/service offering. In robustness tests, we consider effects of changes to the customer base on firm survival.

Control Variables

Demographics of the Founder: Prior studies indicate that an individual's *sex* and *age* influence firm creation processes (Bates 1990; Sexton and Bowman-Upton 1990; Shane 1996; Lévesque and Minniti 2006). Founders were asked to indicate their sex, and to report their age in one of six age categories ranging from "below 25" to "over 60."

General Human Capital of the Founder: Following prior work (e.g. Carroll and Mosakowski 1987), we control for a founder's *years of education, years of work experience* and *area of prior employment*. Additionally, we control for a founder's *duration of unemployment*. We recorded the types of education the founders have received and calculated their total years of schooling. We also recorded how many years of work experience the founders had before they engaged in the self-employed activity. Following prior studies, an apprenticeship, which typically takes three years, was counted half as work experience and half as schooling (Brüderl et al. 1992). Following prior studies, we also control for the type of knowledge received during previous employment (Brüderl et al. 1992; Lazear 1995). Respondents could indicate in which area(s) they have gained work experience. Using a typology frequently applied in German labor market statistics, we distinguished among the following employment areas: manufacturing (without construction), construction, wholesale/retail trade, finance and consulting, restaurant and tourism, transportation, health and social service, education, other industry. Because human capital may depreciate with increasing duration of unemployment (Mincer and Ofek 1982), we also controlled for the unemployment spell prior to the self-employed activity. Founders were asked to indicate unemployment duration in one of nine categories ranging from "below one month" to "over 36 months."

Innovativeness of the Business Idea: Schumpeter (1926) was among the first scholars emphasizing the role of innovation in new firm creation. Prior studies suggest that a new firm's innovativeness impacts its survival chances (Durand and Coeurderoy 2001). We control for the innovativeness of the business idea using a five-point Likert scale ("not innovative at all" to "extremely innovative").

Initial Size of the New Firm: Prior studies have established a positive link between firm size at founding and survival (Brüderl et al. 1992). Firm size at founding is controlled by *financial capital invested in the new firm*. A host of authors discusses the importance of financial resources in new firm creation (Evans and Jovanovic 1989; Evans and Leighton 1989; Brüderl and Schüssler 1990). The amount of financial capital invested at start-up was measured on an ordinal scale with eight categories ranging from "no investment" to "> 50000 €".

Area of Business Activity: We controlled for three broad areas of business activities: trade and commerce, freelance, and craft. We created three dummy measures of each group which were coded one if the founder's business activity was in a specific area and zero otherwise.

Analytic Method

We estimate the process by which new firms either survive or fail using continuous-time event history analysis (Yamaguchi 1991; Blossfeld and Rohwer 2002). We treat a firm founded by an entrepreneur as the unit of risk, and define the probability that the firm fails as:

$$R(t) = \lim_{\Delta t \rightarrow 0} P[t < t + \Delta t | T, t] / \Delta t, \quad (1)$$

where T is a random variable for the time of event of interest, t is the time that a firm has existed, and $P(.)$ is the probability of the firm's failure over the interval $[t, t + \Delta t]$ given that the firm was alive at time t .

Although the transitions we study are duration dependent, we know little about their parametric form. Thus, instead of relying on parametric event models, we use piece-wise constant exponential models, wherein the duration of interest is broken into monthly pieces denoted as $6 \leq \tau_1 \leq \tau_2 \leq \dots \leq \tau_p$.² Splitting the time axis into time periods allows the hazard rate to vary across time periods, but specifies that covariates have the same (proportional) effects in each period (Blossfeld and Rohwer, 2002).

To estimate our model, it is important to choose time periods that are long enough to contain a meaningful number of firm failures (events). That is, in selecting periods, one must seek to improve precision, which is accomplished by specifying short time periods, yet meet the requirement that each

period is long enough to include enough events for estimation. Based on an examination of life tables and estimates from a number of different breakpoints, we decided to break the duration in scale in months at 12, 18, 30, and 48.

In order to analyze firm failure, we estimate a piece-wise exponential model of the form:

$$r(t) = \exp[\gamma p + B'X_t] \quad (2)$$

where γp includes 5 duration-period effects, X_t includes independent variables that are allowed to vary over time, and B are the parameters to be estimated. We estimated the transition rates with maximum likelihood methods found in Stata's piecewise exponential module (Sørensen 1999).

RESULTS

The descriptive statistics show that in terms of demographic composition of the sample, 60% of respondents were male, and roughly 60% of respondents were between 30 and 45 years of age. Many of the self-employed had extensive human capital. On average, respondents had roughly 15 years of education, and 15 years of work experience. In addition, roughly half of the respondents invested 5000 Euros or less in the self-employment activity. Nevertheless, a nontrivial number of respondents made significant financial commitments to their self-employment activities. For instance, more than 20% of respondents invested 25,000 Euros or more in these activities, with 7% investing more than 50,000 Euros (a table with descriptive statistics is available from the authors upon request).

Results pertaining to the failure rate analysis with respect to controls and the prior knowledge and management experience measures are provided in Table 1. Results in Model 2 show that prior knowledge significantly increases the likelihood of firm survival. However, management experience has a slight but negative effect on the likelihood of firm survival.

Models 3 and 4 of Table 2 provides evidence to assess Hypothesis 1a (planning) and Hypothesis 2a (learning by doing). Model 3 examines the effect of strategic planning on firm survival. It shows that greater intensity by respondents in strategic planning significantly reduced the chances of firm survival, a finding that is opposite what was predicted in Hypothesis 1a. Nevertheless, as we discussed in the theory section, several arguments suggest that planning may not add value (cf. Bird 1988; Bhidé 2000). Model 4 of Table 2 provides evidence regarding the effect of learning by doing on firm survival. It shows that founders who made any type of change to the firm's product line experienced a significant increase in the likelihood of firm survival, thus supporting Hypothesis 2a. In particular, results indicate that firm survival is almost 2.5 times more likely if the founder makes any type of change to the product line than is she or he made no change ($\exp(-.85)=2.34$).

Table 2 assesses whether knowledge acquisition through planning can compensate for low prior knowledge and low management experience in order to increase firm survival rates. Results in Table 2 provide the effect of each of seven combinations of knowledge, experience, and planning relative to the omitted control group (Group 8 = low prior knowledge, low management experience, high strategic planning). Overall, results are consistent with Hypothesis 1b: strategic planning does not compensate for low levels of prior knowledge and management experience. For instance, the negative effect of the coefficient for Group 1 indicates that founders with low prior knowledge and low management experience do not benefit from engaging in high levels of strategic planning. Thus, planning does not substitute for both knowledge and experience. In addition, comparing Group 4 with Group 6, we see that firms founded by individuals with high levels of prior knowledge and low levels of management experience are roughly 2.5 times more likely to fail if the founder engages in high levels of strategic planning than if she or he engages in low levels of strategic planning (absolute value of the difference between Group 4 and Group

$6=.97$; $\exp(.97)=2.64$). Thus, planning does not substitute for low management experience when the founder has high prior knowledge.

Other group comparisons in Table 2 lend support to Hypothesis 1b. Comparing Group 2 with Group 3 shows that engaging in high levels of planning is detrimental for founders with low levels of prior knowledge and high levels of management experience (absolute value of difference $=.75$; $\exp(.75)=2.12$). In other words, planning does not substitute for low prior knowledge when the founder has high levels of management experience. In addition, comparing Group 6 to Group 7 shows that the survival chances of founders with high levels of knowledge and experience are similar whether or not they engage in high levels of strategic planning (absolute value of difference $=.06$; $\exp(.06) = 1.06$). Thus, there is a six percent increase in firm survival rates if high prior knowledge and high management experience engage in low levels of strategic planning (as opposed to high levels of strategic planning). Taken together, results in Table 2 imply that the negative effect of strategic planning on firm survival is decreasing in increasing levels of knowledge and management experience.

Table 3 assesses whether learning by doing can compensate for a lack of prior knowledge and experience in order to increase firm survival rates. Results provide the effect of each of seven combinations of knowledge, experience, and learning by doing relative to the omitted control group (Group 8 = low prior knowledge, low management experience, no product line change). The results in Model 1 lend strong support to Hypothesis 2b. For example, the negative coefficient for Group 2 indicates that founders who have low prior knowledge and low management experience will increase the likelihood of their firms' survival nearly three fold if they make any change to their product lines as part of the learning by doing process ($\exp(-1.09)=.34$). Comparing Group 4 with Group 6 indicates that founders with high prior knowledge and low management experience can increase their firms' survival rates by more than half if they make any change to their product line as opposed to not making any change (absolute value of difference $=.51$; $\exp(.51)=1.67$).

A comparison of coefficients pertaining to Group 2 and Group 3 in Table 3 indicates that learning by doing can compensate for low levels of prior knowledge. In particular, founders with high levels of management experience can compensate for low levels of prior knowledge by changing their product lines (absolute value of difference $=.75$; $\exp(.75)=2.12$). In addition, learning by doing results in a nearly three-fold increase in survival chances for founders who have high levels of prior knowledge and high levels of management experience (absolute value of difference $=1.01$, with $\exp(1.01)=2.75$). Overall, learning by doing provides substantial benefits to founders regardless of their level of knowledge and experience, and can compensate for a lack of either prior knowledge or management experience.

DISCUSSION & CONCLUSION

Existing work examining the link between knowledge (human capital) and firm survival has examined factors which are either innate or a stock acquired prior to entry. Our empirical examination focus on the dynamic aspects of knowledge: knowledge can be acquired, changed and developed; knowledge can have both positive and negative effects; and different types of knowledge can interact with one another. The framework outlined in this study represents a first step towards disentangling the complex relationships between prior stocks of knowledge, knowledge acquisition activities and their effects on new firm survival.

In sum, our findings show that knowledge acquisition activities have both positive *and* negative effects of new firm survival rates. High levels of planning generally lead to higher failure rates, particularly for founders who had low levels of prior knowledge and management experience. Moreover, high planning did not compensate for low levels of prior knowledge or management experience. That is, for founders with high levels of prior knowledge, high levels of planning did not compensate for low management experience, and for founders with high levels of management experience, high levels of planning did not compensate for or low levels of prior knowledge. By contrast, learning by doing compensated for low

levels of prior knowledge and management experience to increase firm survival rates. Moreover, learning by doing compensated for low levels of management experience—in the case where the founder had high levels of prior knowledge—and compensated perhaps to an even greater extent for low levels of prior knowledge (when founders had high levels of management experience).

Speculation based on these findings paints a higher level picture about the benefits of learning by doing over planning, in that it seems that controlled learning by doing may be the most effective way to get and gather information and ultimately survive. Such activity provides information, increases the entrepreneur's knowledge of causal relationships amongst important business factors that he may or may not be able to control, and may also be more interesting for the entrepreneur and lead to multiple levels and types of insights that are remembered. Having high levels of prior knowledge and management experience is beneficial, most likely because the entrepreneur is more sensibly able to structure his learning by doing activities ("experiments").

New firms are founded by a number of different types of individuals, with extant research focusing on understanding patterns of entrepreneurial activity by academic scientists and employees of existing firms who form spin-offs, as these groups are particularly important for the creation of technologically intensive start-ups. Here we examine the importance of knowledge to a set of new firms that are neither technologically intensive nor glamorous, and find that knowledge is critical to promoting firm survival. Knowledge acquisition activities can be a great asset for a new firm, and learning by doing can compensate for low levels of prior knowledge and experience. However the extent of change created by such activities may also be constrained or facilitated by the founders' prior knowledge and experience. Given these findings, we believe that further research aimed at understanding the nuances and varieties of knowledge acquisition (and integration, in the case of larger firms) activities is crucial to understanding firm survival.

CONTACT: Marc Gruber; marc.gruber@epfl.ch; (T): +41 21 693 00 10; (F): +41 21 693 24 89; EPFL CDM ENTC Odyssea 2.02, Station 5, CH-1015 Lausanne – Switzerland.

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NOTES

1. All authors are equal contributors and are listed in alphabetical order.
2. The questionnaire asked respondents to indicate the month and year of firm failure (if the firm failed). Due to the nature of the bridge loans, there were no failures in the first six months of each firm's existence.

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Table 1: Estimated Effects of Prior Knowledge, Management Experience, Business Planning and Learning by Doing on the Hazard of Firm Failure

	Model 1		Model 2		Model 3		Model 4	
Firm Tenure								
6 < τ < 12	-6.99***	(1.06)	-5.43***	(1.16)	-5.81***	(1.23)	-5.22***	(1.08)
12 < τ < 18	-6.02***	(.99)	-4.45***	(1.09)	-4.81***	(1.17)	-4.21***	(1.02)
18 < τ < 30	-6.35***	(1.03)	-4.77***	(1.11)	-5.11***	(1.19)	-4.52***	(1.03)
30 < τ < 48	-6.25***	(1.02)	-4.66***	(1.12)	-4.98***	(1.20)	-4.39***	(1.04)
48 < τ < 60	-7.14***	(1.04)	-5.54***	(1.12)	-5.86***	(1.20)	-5.25***	(1.06)
Controls								
Male	.30	(.23)	.30	(.24)	.31	(.24)	.36	(.24)
Age	.03	(.11)	.09	(.11)	.10	(.12)	.08	(.11)
Education	-.15*	(.07)	-.17**	(.07)	-.17*	(.07)	-.17**	(.06)
Education Squared	.003*	(.002)	.004*	(.002)	.003*	(.002)	.004*	(.002)
Work Experience	.02	(.02)	.01	(.02)	.01	(.02)	.01	(.02)
Manufacturing	.45	(.33)	.30	(.34)	.24	(.33)	.28	(.34)
Construction	-.64	(.67)	-.90	(.69)	-.92	(.73)	-.84	(.64)
Wholesale/Retail	.41	(.34)	.35	(.35)	.38	(.35)	.41	(.36)
Finance	.67†	(.35)	.75*	(.36)	.75*	(.36)	.88*	(.36)
Tourism	.92	(.58)	.98†	(.55)	.93†	(.54)	1.17*	(.49)
Transportation	.68	(.71)	.55	(.73)	.78	(.70)	.60	(.74)
Health/Social	.66†	(.34)	.62†	(.34)	.79*	(.34)	.62†	(.33)
Education	-.28	(.55)	-.40	(.57)	-.33	(.59)	-.34	(.58)
Duration Unemployed	.12*	(.06)	.10†	(.06)	.10	(.06)	.11†	(.06)
Innovativeness of Idea	.27**	(.09)	.32***	(.09)	.21*	(.09)	.38***	(.09)
Investment	-.18**	(.06)	-.16*	(.06)	-.19**	(.07)	-.17**	(.07)
Freelance Area	.85	(.56)	.72	(.56)	.78	(.57)	.78	(.55)
Trade Area	.81	(.58)	.64	(.60)	.69	(.60)	.68	(.59)
Prior Knowledge & Management Experience								
Prior Knowledge			-.33**	(.11)	-.39**	(.12)	-.34**	(.11)
Management Experience			-.04	(.12)	-.15	(.13)	-.03	(.11)
Planning								
Strategic Planning					.42**	(.14)		
Learning By Doing								
Product Line Change							-.85***	(.21)
Chi-Square	2723.10		2664.50		2661.04		2589.47	
Log-Likelihood	-274.8		-270.6		-264.2		-262.8	
Number of Parameters	23		25		26		26	
Number of Obs/Founders	2019/441		2019/441		2019/441		2019/441	

Note: Standard errors are in parentheses. †p<.10; *p<.05; **p<.01; ***p<.001 two tailed tests.

Table 2: Estimated Effects of the Interaction among Prior Knowledge, Management Experience, and Business Planning On the Hazard of Firm Failure

	Model 1	
Firm Tenure		
6 < τ < 12	-4.66***	(1.20)
12 < τ < 18	-3.65***	(1.17)
18 < τ < 30	-3.95***	(1.21)
30 < τ < 48	-3.82***	(1.21)
48 < τ < 60	-4.69***	(1.23)
Controls		
Male	.26	(.25)
Age	.08	(.11)
Education	-.19*	(.07)
Education Squared	.004*	(.002)
Work Experience	.01	(.02)
Manufacturing	.31	(.35)
Construction	-.94	(.73)
Wholesale/Retail	.45	(.33)
Finance	.83*	(.35)
Tourism	.92†	(.54)
Transportation	.75	(.77)
Health/Social	.83*	(.37)
Education	-.16	(.56)
Duration Unemployed	.10	(.06)
Innovativeness of Idea	.20*	(.10)
Investment	-.22***	(.07)
Freelance Area	.75	(.54)
Trade Area	.60	(.59)
Prior Knowledge, Management Experience, and Strategic Planning Groups		
Group 1: Low Prior Knowledge, Low Management Experience, Low Strategic Planning	-.70	(.75)
Group 2: Low Prior Knowledge, High Management Experience, Low Strategic Planning	-1.84*	(.80)
Group 3: Low Prior Knowledge, High Management Experience, High Strategic Planning	-1.09	(.70)
Group 4: High Prior Knowledge, Low Management Experience, Low Strategic Planning	-2.42***	(.60)
Group 5: High Prior Knowledge, High Management Experience, Low Strategic Planning	-2.75***	(.70)
Group 6: High Prior Knowledge, Low Management Experience, High Strategic Planning	-1.45**	(.54)
Group 7: High Prior Knowledge, High Management Experience, High Strategic Planning	-1.51**	(.54)
Chi-Square	2676.83	
Log-Likelihood	-260.2	
Number of Parameters	30	
Number of Obs/Founders	2019/441	

Note: Standard errors are in parentheses. †p<.10; *p<.05; **p<.01; ***p<.001 two tailed tests. Omitted control group is group 8 (Low Prior Knowledge, Low Management Experience, High Strategic Planning).

Table 3: Estimated Effects of the Interaction among Prior Knowledge, Management Experience, and Learning by Doing on the Hazard of Firm Failure

	Model 1	
Firm Tenure		
6 < τ < 12	-5.43***	(1.01)
12 < τ < 18	-4.41***	(.96)
18 < τ < 30	-4.71***	(.98)
30 < τ < 48	-4.58***	(.98)
48 < τ < 60	-5.43***	(1.02)
Controls		
Male	.38	(.24)
Age	.05	(.11)
Education	-.18**	(.07)
Education Squared	.005**	(.002)
Work Experience	.02	(.02)
Manufacturing	.24	(.38)
Construction	-.93	(.62)
Wholesale/Retail	.54	(.34)
Finance	.96**	(.36)
Tourism	1.13*	(.46)
Transportation	.89	(.66)
Health/Social	.71*	(.35)
Education	-.20	(.58)
Duration Unemployed	.12†	(.06)
Innovativeness of Idea	.34***	(.09)
Investment	-.19**	(.07)
Freelance Area	.84	(.60)
Trade Area	.76	(.63)
Prior Knowledge, Management Experience, and Product Line Change Groups		
Group 1: Low Prior Knowledge, High Management Experience, No Product Line Change	-1.35†	(.77)
Group 2: Low Prior Knowledge, Low Management Experience, Changed the Product Line	-1.09	(.72)
Group 3: Low Prior Knowledge, High Management Experience, Changed the Product Line	-1.79**	(.66)
Group 4: High Prior Knowledge, Low Management Experience, No Product Line Change	-1.68***	(.43)
Group 5: High Prior Knowledge, High Management Experience, No Product Line Change	-1.47***	(.39)
Group 6: High Prior Knowledge, Low Management Experience, Changed the Product Line	-2.30**	(.41)
Group 7: High Prior Knowledge, High Management Experience, Changed the Product Line	-2.48**	(.42)
Chi-Square	2631.54	
Log-Likelihood	-260.2	
Number of Parameters	30	
Number of Obs/Founders	2019/441	

Note: Standard errors are in parentheses. †p<.10; *p<.05; **p<.01; ***p<.001 two tailed tests. Omitted control group is group 8 (Low Prior Knowledge, Low Management Experience, No Product Line Change).