Do intangible assets and pre-founding R&D efforts matter for innovation speed in start-ups?

Vlerick Leuven Gent Working Paper Series 2004/04

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ANS HEIRMAN
Ans.Heirman@vlerick.be
BART CLARYSSE
Bart.Clarysse@vlerick.be

D/2004/6482/04

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ANS HEIRMAN

Vlerick Leuven Gent Management School

Ghent University

BART CLARYSSE

Vlerick Leuven Gent Management School

Ghent University

Contact:

Ans Heirman

Vlerick Leuven Gent Management School

Tel: +32 09 210 98 88

Fax: +32 09 210 99 22

Email: Ans.Heirman@vlerick.be

ABSTRACT

The launch of the first product is an important event for start-ups, because it takes the new venture closer to growth, profitability and financial independence. However, entrepreneurship literature lacks theory and data on new product development and innovation speed. Integrating insights form new product development literature with resource-based theory, we construct a conceptual framework concerning the antecedents of innovation speed in start-ups. In particular, we argue that pre-founding R&D efforts and intangible assets such as team tenure, experience of founders, and collaborations with third parties are important for innovation speed. We collected a unique dataset on 99 research-based start-ups (RBSUs) and use an event-history approach to test our model. We find that RBSUs differ significantly in their starting conditions and that these differences have a significant effect on the time it takes to launch the first product. The impact of starting conditions on innovation speed differs however between software, medical-related, telecom and other technologies. Although intuition suggests that start-ups that are further in the product development cycle at founding launch their first product faster, we find that software firms starting with a beta-version experience slower product launch. Next, it is shown that team tenure and experience of founders leads to faster product launch. Contrary to expectations, alliances with other firms do not significantly affect innovation speed and collaborations with universities lead to longer development times. The insights of this study enhance our understanding of product development processes in start-ups and the differences between slow growers and fast growers.

Keywords: Intangible assets, New Product Development and Start-Ups

INTRODUCTION

Research-based start-ups (RBSUs), defined here as new business start-ups which develop and market new products or services based upon a proprietary technology or skill, have received a great deal of attention from academics in the last two decades (e.g.; Roberts, 1991; Shane, 2001; Utterback et al., 1988; Woo et al., 1994; Bower, 2003; Kaulio, 2003). This is no surprise because RBSUs have been found to contribute to an economy in terms of exports, employment, taxes paid, research and development, and innovations (Utterback et al., 1988) and play an important role in bringing new technologies to the market (Schumpeter, 1934; Henderson, 1993; Christensen, 1997; Hiltzik, 1999). The supporters of entrepreneurial development argue that in the long-run the formation of RBSUs can have an appreciable effect on regional job creation, technological change and innovation, and economic renewal (Acs and Audretsch, 1990). However, the significance of start-ups for innovation, economic growth and renewal is still debated among researchers and policy makers. Some researchers argue that most RBSUs do not grow to any size (Storey and Tether, 1998) and many fail to bring new products to market and get stuck in a consulting mode (Roberts, 1991, pp. 166 - 170). Clearly, there is still much discussion and uncertainty about the early growth of RBSUs and their innovation speed.

Nelson (1991) argues that new product development (NPD-) processes are probably the most important dynamic capabilities for firms. This may be especially true for RBSUs, which by definition need a set of core capabilities in R&D in order to develop new proprietary products. Therefore, a better understanding of NPD in RBSUs is particularly critical to enhance our insights in the early growth path of these companies. Especially, a better understanding of the antecedents of innovation speed, (i.e. time it takes to introduce the first new product to the market) might be important to get insights in the differences between slow growers and fast growers.

Until today, the entrepreneurship as well as the product innovation literature overlooked NPD-processes in start-ups. The entrepreneurship scholars focus their attention on studying the resources, strategy and industry environment of new firms (e.g. Roberts, 1991; Feeser & Willard, 1990; Utterback et al. 1988). However, few studies linked the starting conditions to new product development processes in RBSUs. The NPD-literature mainly studies product development projects in large established firms (Cooper, 1979; Cooper, R.G. & Kleinschmidt, 1987, 1993; Clark & Fujimoto, 1991; Clark & Wheelwright, 1992; Brown & Eisenhardt, 1995; Krishnan &

Ulrich, 2001). A few noticeable exceptions are Meyer & Roberts (1986), Schoonhoven et al. (1990), Pavia (1991), Deeds et al. (1999). Our main aim is to translate the insights of the product innovation and entrepreneurship literature into a conceptual NPD-model appropriate for RBSUs.

The paper is organized as follows. We start with arguing that the time it takes to develop the first product is an important milestone for RBSUs and we develop a conceptual model regarding the antecedents of innovation speed in new ventures. Next, we translate this model into testable hypotheses using insights from the entrepreneurship and product innovation literature. Next, we describe the sampling design, data collection, variables and econometric analysis we apply in this research. The discussion of the most important results follows. We end with conclusions, limitations and directions for future research.

THE CONCEPTUAL MODEL

Importance of innovation speed for RBSUs

The emphasis on accelerating the product innovation process is not new but is one of the least studied NPD performance metrics (Clark & Fujimoto, 1991; Iansiti, 1995; Meyer et al., 1997; Kessler & Chakrabarti, 1996). Lately, however, it has acquired greater importance due to increasing cost of slow product development (Gupta & Wilemon, 1990). Also for new ventures, time to market is a crucial factor. For these companies, Schoonhoven et al. (1990) defined the 'Time-to-First-Product-Shipment' as a major milestone for four reasons: (1) to gain early cash-flow for greater financial independence, (2) to gain external visibility and legitimacy as soon as possible, (3) to gain early market share, and (4) to increase the likelihood of survival. In addition, NPD-capabilities improve a firm's ability to raise money through an initial public offering (Deeds et al., 1997). Thus, it seems that the ability to develop the first product in a timely manner enables RBSUs to overcome the liability of newness (Stinchcombe, 1965) and enter a new stage in their growth trajectory towards financial independency, profitability and growth. Hence, innovation speed and first product launch are crucial for the growth and prosperity of RBSUs (Kaulio, 2003) and insights in the antecedents of innovation speed are useful to help firms apply appropriate intervention(s) to pursue it.

The antecedents of innovation speed

To get insights in what factors differentiate fast innovation efforts from their slower counterparts we review the new product development literature. This literature defines innovation speed as the time elapsed between (a) initial development, including the conception and definition of an innovation, and (b) ultimate commercialization, which is the introduction of a new product into the marketplace (Mansfield, 1988; Murmann, 1994; Vesey, 1991). The project is the unit of analysis to study innovation speed. This makes sense because the NPD-literature mainly focuses on large organizations, which conduct several development efforts simultaneously. In this context it are indeed projects that are accelerated and not individuals or organizations. Hence, the NPD-literature studies the attributes of specific projects to explain innovation speed. Start-ups on the contrary mostly focus all their development activities on one core project. In this context, the project level of analysis corresponds to the firm level. Our research question can therefore be formulated at an organizational and project level: "how can RBSUs speed innovation?" or "which factors explain time-to-market of the first product?"

In start-ups, the attributes of the whole organization are directly relevant to study NPD-processes and antecedents of innovation speed. To build a conceptual framework about the antecedents of innovation speed in start-ups, we therefore position our study within the resource-based and dynamic capabilities view of the firm (e.g. Wernerfelt, 1984; Barney, 1991, 2001ab; Teece et al., 1997). Resources are tangible or intangible assets that are tied semi-permanently to the firm (Maijoor & Witteloostuijn, 1996). Capabilities, on the other hand, refer to the ability to exploit and combine resources, through organizational routines in order to accomplish its targets (Amit & Schoemaker, 1993). NPD processes can be seen as one specific type of dynamic capabilities, by which RBSUs exploit, combine and manipulate resources in order to develop a product ready for sales (Eisenhardt & Martin, 2000).

The RBV explicitly recognizes that a firm's history is an important antecedent to current capabilities and opportunities (e.g. Barney, 1991). This thinking is in line with Stinchcombe's (1965) and Boeker's (1989) arguments that conditions and events surrounding the creation and infancy of new ventures affect their exposure to liabilities of newness and smallness, and moreover can have long-lasting effects on their future development. Given the potentially powerful initial and historical effects, we argue that the start-up's initial NPD-capabilities may be an important antecedent of its innovation speed. We build on the extensive empirical research on

NPD processes in large firms to get insights in the key success factors for innovation speed. This literature found that so-called “intangible assets” such as routines, experience of project members and leaders, collaboration agreements etc. are important antecedents of innovation speed. Thus, our conceptual model focuses on the relationship between intangible assets at founding and innovation speed.

Studying NPD-processes in start-ups faces a unique challenge compared to NPD-studies in larger firms. That challenge is that the new product development not necessarily begins when the company is founded. It is probable that start-ups differ significantly in their pre-founding NPD-efforts. That is, firms may start at different points in the new product development cycle. In contrast, the bulk of the NPD literature studies projects in large established firms, which tend to follow a well-defined and structured path, and starts at the same milestone, namely the conception of the innovation. Clearly, to study NPD-process in start-ups we need to control for the differences in starting point in the NPD-cycle at founding. This will improve our ability to evaluate the influence of intangible assets on innovation speed. In addition we also control for differences between technological domains because the nature of the product development tasks – and by consequence the time it takes to complete the development – may differ between technologies. Figure 1 depicts the theoretical model. In the next section we translate this model into testable hypotheses. We begin our discussion with the influence of differences in stage of new product development at founding. Next, we elaborate on the role of intangible assets for innovation speed in start-ups.

Insert Figure 1 About Here

HYPOTHESES

Stage of product technology at founding

Most researchers take the legal founding date (data of incorporation) or the date of hiring the first employees as the start date of a new company. They mostly neglect the events, which took place before the new company was legally founded. Previous research indicates, however, that founding a company is not a single moment in time but is rather a process in which its existence become progressively more established (Versper, 1990, p. 97; Clarysse & Moray, 2004). Consequently, the degree of pre-organizational efforts is also likely to vary considerably among start-ups and we expect that RBSUs are not in the same stage of product development at legal founding. Some firms start with just a product idea, other start-ups have a proof of concept, a working prototype or even a completed product. It is so obvious that the stage in the new product development cycle at founding is an important ingredient in the NPD process for start-ups but it tends to be overlooked in prior research. For example, the only two studies that studied innovation speed in RBSUs we could identify – namely Schoonhoven et al., 1990 and Hellman & Puri, 2000 - do not take into account this important difference in founding condition. We start our analysis with studying how RBSUs differ in their pre-founding R&D efforts and how different starting points at founding – alpha- or beta-prototype or market ready product – relate to the time it takes to develop the first product after legal founding. Our first hypothesis is:

H1: **"The further the firm is in the product development process at founding, the shorter the time it takes to develop the first market-ready product after founding."**

Intangible assets

The NPD-literature identifies the following key success factors for the new product development process: (1) team tenure and routines, (2) experienced and cross-functional teams, and (3) alliances or collaborations with other organizations (Wheelwright & Clark, 1992; Brown & Eisenhardt, 1995; Eisenhardt & Martin, 2000). In the following paragraphs we briefly discuss these key success factors for innovation speed and translate them into testable hypotheses for RBSUs.

Founding teams and routines

Speeding up innovation requires superior coordination both within and between relevant parties involved in the process (Keller, 1986; Takeuchi & Nonaka, 1986). Team tenure and routines in the team are therefore identified as important factors to speed up NPD. Teams with a short history together tend to lack effective patterns of information sharing and working together which results in time efficiencies (Brown & Eisenhardt, 1995). It is well know that RBSUs are mostly founded by entrepreneurial teams instead of by single entrepreneurs (Roberts, 1991).

Team tenure and routines among team members might therefore be especially critical for NPD-processes in RBSUs. To work-out routines and team tenure in RBSUs, we study the size of entrepreneurial teams and the portion of the founders that previously worked together, the number of years of their joint working experience, and whether other people - such as technicians and programmers - with joint work experience joined the start-up. This is in line with Stinchcombe's (1965:148) thinking on the liability of newness. He argues that in new ventures the learning of new roles and the learning to work together results in time inefficiencies. However, if the start-up is founded by entrepreneurs and/or employs people who previously worked together, these people will import organizational and managerial processes, organizational culture and structure, coordinative mechanisms and several working procedures from their previous working experience into the new company. Therefore, such a start-up can start with a broader and deeper array of organizational resources and routines (Brush et al., 2001; Teece et al., 1997). Joint work experience prior to start-up could minimize several of the liabilities of newness that Stinchcombe (1965) mentions. Hence, our second hypothesis can be formulated as follows:

H2: "Founding team tenure will lead to shorter times-to-first-product"

Experience and cross-functionality of founding team

Maidique and Zirger (1985) argue that project teams with long-term experience in the technology and market do better at new product development than teams that lack this experience because experienced teams have a higher understanding of customer needs and the technological know-how to fulfill them. Therefore, we hypothesize that founding teams with more experience in R&D, marketing and other functional areas have shorter product development times. Next to the amount of experience, also the balance between different forms of functional expertise is important for NPD success (Ancona & Candwell, 1990). That is because cross-functional teams can adequately fill the many, often diverse roles required in product development processes. Hence, the third set of hypotheses is:

<u>H3a</u>: "More experience of founding teams in R&D, marketing and other functional domains will lead to shorter times-to-first-product"

<u>H3b</u>: "Balanced, multifunctional founding teams will lead to shorter times-to-first-product"

NPD-collaborations with third parties

Corporate social capital can be defined as "the set of resources, tangible or virtual, that accrue to a corporate player through the player's social relationships, facilitating the attainment of goals" (Gabbay and Leenders, 1999:3). Most prior studies investigate the concept, attributes, and function of social capital, but have not articulated its nature in the context of start-ups and their value creation (Lee et al., 2001). In this paper, we look at one specific type of corporate social capital, namely the alliances and partnership for new product development. Schoonhoven et al. (1990) argue that partnerships may be important to fasten the product development process for resource-constrained start-ups. Alliances are especially important for development activities, which are highly uncertain and require specialized knowledge and are difficult to outsource (e.g. Robertson & Gatignon, 1998; Deeds et al., 1999). For new ventures, partnerships with other firms can supplement complementary resources on a timely basis (Baum et al. 2000), which can be a determining factor for effective product development. Greater use of external sources is likely to be associated with relatively faster product development because time can be saved if organizations consciously limit internal tasks required and seek out external components (Gold, 1987). We distinguish between collaboration agreements with private companies and collaborations with universities and research institutes. Our fourth set of hypotheses can be formulated as follows:

<u>H4:</u> "Collaboration agreements with third parties will reduce the time-to-first-product"

METHODOLOGY

Population of RBSUs

We define "Research-Based Start-Ups" (RBSUs) as new business start-ups, which develop and market new products or services. "Start-up" points to the fact that firms under study are new ventures, i.e. they are 'young'. Start-ups need time to mature and to overcome the liability of newness (Stinchcombe, 1965). Previous research indicates that the earliest this might occur would be 3 to 5 years after creation, and more usually, not until the venture is 8 to 12 years old (Quinn & Cameron, 1983; Kananjian & Drazin, 1990). "Research-based" refers to firms that have their own R&D and develop their own products.

We study RBSUs in a homogeneous region in order to reduce the non-measured variance resulting from environmental conditions. We choose Flanders, which is a small, export-intensive economy, located in the Northern part of Belgium. Flanders is considered as an emerging high tech region, experiencing a fast process of convergence between old and new technologies and thereby improving its competitive position (Cantwell & Iammarino, 2001). Next, we focus on RBSUs founded between 1991 and 1997. These firms are between 5 and 12 years old at time of survey. Younger companies are excluded because the track record of the company is too short to draw any conclusions on innovation speed. Further, reliability of the answers of respondents probably decreases with the time elapsed between the surveyed period and the moment at which the survey is conducted. Since we study the influence of intangible assets at founding on innovation speed, companies older than 12 years are excluded.

Sampling

To identify a unique set of Research Based Start-Ups (RBSUs), we took the listing of high tech sectors as defined by the OECD and Eurostat as a point of departure (DSTI 1997/2). Between 1991 and 1997, 7775 firms were started in medium and high tech sectors Flanders, of which 5914 in service sectors and 1861 in manufacturing industries. To identify the RBSUs in the broader population of high and medium tech companies, we first randomly sampled 720 firms. We performed a phone survey of all these companies to discern to what extent these firms are active in developing and commercializing technological products and / or services. Only 27 (3.75%) of these firms are in effect RBSUs. The majority of the start-ups in high and medium tech sectors has no own R&D activities and no intentions to commercialize a proprietary new technology, product or service. Most firms are engaged in other activities such as distribution, software vending, building of web sites, specialized advice, etc. To get a sample of about 100 RBSUs, it would be necessary to draw a random sample of about 2670 companies. We found, however, that about half of the 27 RBSUs identified by random sampling could also be identified by three other listings of high tech companies: (1) academic spin outs, (2) portfolios of Venture Capitalists (VCs) investing in early stage technology firms and (3) a database of SMEs requesting government support. This venue for constructing our database seems to be a more efficient way of identifying the population of interest than purely relying on random sampling. What makes our database unique is that we performed a phone survey to each company in these listings to discern if they are in effect an RBSU.

Based on the phone surveys, we identified a sample of 123 RBSUs, of which 27 were drawn from the random sampling and 96 from the three alternative listings. We have a response of 90% on average, ending up with 111 firms willing to cooperate in our research. Twelve of these companies appeared in more than one listing. After removing the doubles from the sample, we ended with 99 unique cases for our analysis (of a total estimated population of 300 RBSUs founded in Flanders between 1991 and 1997).

At time of the data collection (2002 – 2003), the surviving RBSUs are between 5 and 12 years old. On average the RBSUs in our sample are 7 years old. Most of the 99 firms, namely 87 survived as independent entities. From the 12 RBSUs that dissolved by 2003, 5 went bankrupt and 7 were acquired. Only 3 RBSUs went public. During their first year of operations (the period we cover in this paper) the number of employees ranged between 1 and 25, with an average of 3. In 2002, the number of employees ranged between 1 and 520, with an average of 31.

Technology Representation

To classify RBSUs according to their technological base, we follow the International Patent Classification System (IPC), which classifies patents in eight technical areas, namely (A) Human Necessities, (B) Performing Operations, Transporting, (C) Chemistry, Metallurgy, (D) Textiles, Paper, (E) Fixed Constructions, (F) Mechanical Engineering, Lighting, Heating, Weapons, Blasting, (G) Physics, (H) Electricity. As a group the RBSUs span a broad number of IPC classes. For analytical purposes, we choose to aggregate the firms into four classes. The first class, labeled as “software”, consists of the firms classified in the G06F code of the IPC system. The second group represents the “telecom” firms, classified in the H class of the IPC system. The third group are the “medical-related” companies and correspond to firms in the A class of the IPC-system. This groups includes medical device companies as well as biotechnology firms. Finally, the fourth group consists of firms in the B, C, F and G (except for G06F) class of the IPC-system. This last group is labeled as “other”.

Data Collection, Measures and Descriptive Statistics

The primary data source is a structured questionnaire which is conducted during face-to-face interviews with the founder of the company. The founders or CEO’s were targeted because they typically possess the most comprehensive knowledge on the organization’s history, the firm’s strategy, its processes and performance (Carter et al., 1994). The data give us detailed insights in the firm’s resources and NPD-processes and enable us to observe a timeline of events for each company, including if and when it completed its first product. The interviews typically have duration of one to two hours and are conducted by two researchers. One of the interviewers asks the questions and the other person fills in the questionnaire and takes notes. Immediately after the interview, the researchers crosscheck facts and impressions.

In the theoretical section we built a conceptual framework concerning the antecedents of innovation speed in RBSUs. Table I describes how the variables are measured. All variables are based on specific questions in the questionnaire and are thus rated by the interviewee. Table II gives an overview of the descriptive statistics.

Insert Table I About Here

Insert Table II About Here

Cox Proportional Hazard Analysis

To study how intangible assets influence the time it takes to develop a first product that is ready for sales, we use an event-history approach (Lee, 1980; Allison, 1984; Tuma & Hannan, 1984; Blossfeld et al., 1989; Smith, 2002). The advantage of event-history analysis is that it takes into account both the occurrence and timing of an event while estimating the effects of exogenous variables. The event that we study in this paper is whether or not the firm developed a first product. There are two situations in which a firm may fail to show an event during the period of study. Firstly, the firm may fail before it developed its first product. For the purposes of this study, we consider a firm as failed when it goes bankrupt or when it is acquired by another firm and ceases to exist as an independent entity before it developed a product. Secondly, a firm may also fail to have an event before the end of the observation (year 2002). These cases are right-censored.

The time-to-first-product is measured as the number of months elapsed between the founding of the firm and time at which the product was ready for sales. For both the right-censored cases and the failed firms there is no event, but we record a waiting period, namely the company age until the end of observation. This period is the minimum time we know during which no event occurred. The dependent variable in this study then becomes the waiting time qualified by the dummy variable, which indicates whether or not the firm experienced an event (the censor variable).

One of the most often used models suggests that the covariates have a multiplicative effect on a basic hazard function called the baseline hazard. Let Yx denote the response depending on an observed vector of covariates x. By a proportional hazard model for Yx, we mean the model $h_x(y) = h_0(y)\ g_1(x)$, where g is equal to $e^{\beta Tx}$ and is a positive function of x, and $h_0(y)$ is called the baseline hazard, representing the hazard function for a firm having $g_1(x) = 1$. The Cox proportional hazard model is the most common distribution-free regression model used for the analysis of censored data. This model allows to first estimate β in $h_x\ (y) = h_0(y)\ e^{\beta Tx}$ and then the baseline hazard in data that are possible right-censored. We estimate several Cox duration regression models with months-to-product as the dependent variable and controlling in each model for technology effects. We report the hazard ratios or the relative risks and the standard errors are between parentheses. A hazard ratio greater than one implies that a higher x is linked to a higher hazard rate and hence a lower expected duration. More specifically, the hazard ratio tells us how much the hazard (i.e. the instantaneous risk) of the event increases for a unit change in the explanatory variables. In the case of a dummy variable, this is equal to the ratio of the instantaneous probabilities of the two possible states.

RESULTS AND DISCUSSION

Technological domain and stage of product technology at founding

Most start-ups in our sample (71%) succeed to launch their first product and did this on average 3 years (35 months) after founding. Although we do not find differences in the probability of developing a product between firms active in software, telecom, medical-related and other technologies (Pearson chi-square = 0.522, p = 0.914), the time it takes to launch the first product differs significantly between the four technological domains (Kruskal-Wallis = 10.398, p = 0.0152). Descriptive analyses (box plots) revealed that those companies that did bring a product on the market in medical related technologies, did so in a much shorter time frame than their equivalents in other technological domains. This is counter-intuitive because most people argue that development cycles in software are much shorter than in medical-related technologies. In the descriptive analyses we only compared those companies that *did* bring a product on the market. When we use hazard analysis to take into account both occurrence of the event (product launch) and timing, we observe no significant effects of medical-related or other technologies on innovation speed (Model 1a, Table III). This is due to the three biopharmaceutical start-ups among the medical-related firms in our sample, which have significantly longer development cycles and *did not* bring a product on the market before the end of our observation period. When we exclude the biopharmaceutical start-ups, we do find that medical-related firms are significantly faster in launching their first product compared to start-ups in other technologies (Model 1b, Table III). Because only three firms in our sample are bio-pharmaceutical start-ups, we can not form a separate group. Therefore, we chose to test all our models with and without the biopharmaceutical start-ups. Since we found no difference in interpretation of the coefficients, we only report the results for our full sample including the biopharmaceutical start-ups.

In model 2 and 3 (table II), we test our first hypothesis. Our data show that pre-founding R&D efforts and the resulting differences in starting point for product development explain for innovation speed in start-ups. However, this effect differs between technological domains. Below we discuss these effects in detail and provide explanations based on the qualitative insights from the interviews.

RBSUs differ considerably in the number of years of R&D that preceded the founding of the firm. On average, RBSUs build on 3 years of R&D (Table II). These pre-founding R&D

activities take place while the entrepreneurs are working for the parent company (with or without formal support) or during their leisure time. The pre-founding R&D efforts do not significantly differ between technological domains (K-wallis, Chi-Square = 1.645; p = 0.649). However, these differences in starting conditions have different effects on innovation speed. Model 2 in table III shows that the years of pre-founding has no significant effect on innovation speed for software firms. For firms in telecom and especially in medical-related technologies, on the other hand, the years of pre-founding R&D have a significantly positive effect on innovation speed. The more R&D activities before the company was founded the faster the launch of the first product[1].

The heterogeneity in pre-founding R&D efforts results in differences in the starting point of product development at founding. Table II shows that almost 20 percent of the firms start with a market-ready product, 12 percent has a beta-prototype at founding and 25 percent starts with a proof of concept (alfa-prototype). The remainder of the RBSUs (43%) starts from scratch, that is, based on a vague product idea. Model 3 (Table III) shows that RBSUs, which start with a more or less market-ready product launch their first product faster than firms, which start at an earlier time in the product development cycle. This is not surprising, but the effect is much larger for firms in medical-related technologies (shown by the high and very significant interaction term). Next, model 3 (Table III) shows that starting with a beta-prototype significantly reduces the time to first product launch for firms in medical-related, telecom and other technologies. However, for software firms the interaction term with beta-prototype offsets the direct effect of starting with a prototype (the interaction term is much smaller than 1 and very significant). Software firms starting with a beta-prototype are actually slower in launching their first product. This is a at first sight a counter-intuitive result.

Insert Table III About Here

Our interview notes suggest several explanations. Firstly, several software firms, which start with a prototype, receive negative customer feedback once the company is founded. As a result, these prototypes need considerable redesign efforts, which cause serious delays in the development process. Thus, having a prototype at founding is no guarantee for faster product

[1] We also calculated the univariate cox models with years of pre-founding R&D as dependent variable for each technological domain separately and came to the same conclusions (Results can be obtained from the authors upon request).

launch if this prototype does not meet customer expectations. Hauser and Clausing (1988) argue that involving customers early in the product development and frequently checking with them as the process proceeds prevents costly and time-consuming redesign. Our interview notes indicate that the pre-founding product development work of software start-ups often suffers from a lack of market involvement. The technical entrepreneurs develop the software behind the thick walls of their research labs in universities, other firms or their homes. The prototypes are developed far away from the market and come out of the 'lab' when the new company is founded - often to find out that customers want something else. The software firms, which started from scratch on the other hand, developed the first product in close interaction with customers. The entrepreneurs mostly started with offering customized software services. They developed a standardized product, while working with different clients with similar problems. Concept testing with customers seems to be key for fast product development. The medical-related firms involved customers (doctors and patients) almost naturally in the product development process. These firms gradually tested prototypes on larger groups of patients. This explains why these firms suffered less from re-engineering problems. For software firms the concept testing tends to be overlooked by some technical entrepreneurs who waste precious time developing "bells and whistles" that customers don't care about. The fastest software firm in our sample did the exact opposite. The quote of the leading entrepreneur illustrates vividly the importance of customer involvement for innovation speed.

"*My fellow entrepreneurs (2) and I had been working in the graphical sector for a number of years. Two of us worked several years as software developers and the other one had many years of experience as sales representative. We worked for a company developing workflow automation systems for the graphical industry. When this firm was acquired, we felt unhappy with the new strategy and we talked about starting our own company. We brainstormed about potential business ideas for a couple of months. Our gut feeling was that printers needed software to automate their pre-press activities. We visited several printers and found out that they indeed were looking for tools to automate their pre-press activities and that none of the big players was focusing on this niche at the time. During these first meetings we let the customers explain what they exactly needed and how they wanted the product to look like. We said that we had a product on the shelf that could do about half of that. With hindsight we took big risks, because we actually sold our first product before we developed it. We were not even sure that we* *could do it. We also promised that we would work on the other features they wanted if other companies had similar requests. We worked very hard to develop the software system that did the 50% job. We implemented this product with several customers. Later, we developed new versions including more features on customer's request. "*

A second explanation for the negative effect of starting with a beta-prototype on innovation speed in software is that several firms start with consulting activities for which they use their prototype as a back-office tool. So, although these firms have a prototype at founding, they focus initially on services instead of completing product development. This service orientation slows down the launch of the first product. The reasons to adopt a consulting-based business model in the first years are twofold. Firstly, the firm might suffer from a lack of starting capital and the need for cash forces it into consulting activities. Another reason is related to the market. The market might not be ready yet for standardized product sales and needs considerable customer services and education. The firm develops the product while serving and getting to know the market while delivering services. The goal is to have a standardized product ready when the market window opens.

To conclude, hypothesis 1 is only supported for start-ups in medical related sectors and telecom. Having a prototype or a beta-version in these sectors really matters. The years of pre-founding R&D speeds first product launch for medical-related and telecom start-ups. However, there is no significant positive effect of pre-founding R&D efforts for software firms. In line with this, having a beta-prototype at founding does not increase innovation speed for software firms. Software entrepreneurs that start with a prototype seem to develop this without sufficient customer involvement. Once the prototype is ready, they start the new venture and get market feedback. At that point, it becomes clear that the prototype does not fulfill customer expectations, which results in serious development delays. Re-engineering a beta-prototype often takes longer than developing a software product from scratch but "right" from the start.

Intangible Assets

To test our hypotheses regarding the influence of intangible assets at start-up on innovation speed, we test several models (Table IV). In the previous section we found that there are significant interaction effects between technology and stage in product development at founding on innovation speed. Therefore, we include the stage in NPD at founding as well as the significant interaction terms with technology as control variables in our models. First, we estimate a model for all firms with all the measures for intangible assets as explanatory variables (first model in Table IV). Next, we test whether the effect of intangible assets differs between technological domains. To do this, we test separate models for software and other technologies (Model 2 and 3 in Table IV). The limited number of medical-related (14) and telecom (11) firms in our sample does not allow us to estimate separate multivariate models for these technologies. To test the interaction effects between intangible assets and these technological domains we therefore used a blocked approach. This means that we constructed separated models for each hypothesis, which include all possible interaction terms with the technological domain[2]. We report and discuss the significant findings below.

Insert Table IV About Here

Founding teams and routines

The number of founders that previously worked together has no significant effect on innovation speed. However, the average number of years of the joint work experience significantly fastens the launch of the first product (Table IV). This positive effect of the years of joint work experience is significantly larger for software firms. In software, we also observe that larger entrepreneurial teams are significantly faster in launching the first product than smaller teams. Recruitment of employees such as researchers, programmers, and technicians from the prior employer has a different effect on innovation speed in software and other technologies. In software, we observe that recruitment of employees with joint work-experience leads to significantly longer times to first product launch. In other technologies, on the other hand, employees from the parent company lead to significantly faster product launch. The interaction effect with telecom and medical-related technologies does not significantly differ from other technologies (not shown). These results are consistent with our discussion on the effect of prototypes on innovation speed. In software, prototypes at founding slow down first product launch while in other technologies, prototypes fasten product launch. As discussed earlier, several software firms find that their beta-versions need considerable adaptation to meet customer

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[2] We do not include the separate hazard models for each hypothesis because this would make the paper too long. These models can be obtained from the others upon request. In the text, we report the significant interaction effects.

expectations, which delays the launch of the first product. Our data suggest that changing a product concept might be more difficult and take longer when employees who designed the first prototype join the start-up. When the prototypes face serious redesign issues, joining of employees might be rather a liability than an asset. It is well known that "inventors" often refuse to see the shortcomings in their work and find it difficult to make changes. Programmers who developed the prototype might be unwilling to change it or at least delay the redesign. In other technological domains, prototypes at founding lead to faster product launch and are less confronted with serious redesign issues. In such instances, employees coming from the prior employer are a clear asset because they bring valuable knowledge as well as working procedures to the start-up, which speeds the launch of the first product.

Several scholars argue that team tenure might give the start-up more teamwork related competencies and superior coordination processes (Stinchcombe, 1965). Our data show that founding team tenure and recruitment of employees from the parent company is especially relevant for NPD-processes in start-ups. We find support for hypothesis 2. Team tenure and more specifically the number of years founders have previously worked together speeds the launch of the first product in all technologies. Joining of employees who were involved in NPD before founding the new venture leads to faster product launch except in software. In software, we find support for the opposite hypothesis. We argue that this might be due to redesign issues.

Experience and cross-functionality of founding teams

The importance of the founders' experience to speed the launch of the first product differs between technological domains. The model including firms of the four technological domains (Table IV) shows that especially experience in functional domains other than R&D and marketing is important. For software start-ups, however, neither experience in R&D, marketing nor other functional domains seems to have a significant effect on innovation speed. For firms in other technologies, experience in these different functional domains all have a significant positive effect on innovation speed.

Table V shows in more detail the type of experience that matters most to speed first product launch in the four technological domains. Experience of founders in marketing and other functional domains such as financing and manufacturing is significantly more important for medical-related firms. R&D experience, on the other hand, is most important for firms in other technologies and significantly less important for medical-related start-ups.

Manufacturing and selling medical-instruments is subject to more stringent rules than products in other technologies. To be successful at fast product launch in the complex and highly regulated medical environment, experience in manufacturing and marketing seems to be more important than for other firms. This is in line with Mitchell's findings (1994) on medical equipment start-ups. He concluded that commercial routines are especially critical for medical equipment start-ups to overcome the liability of newness. Hence, our data support hypothesis 3a: more experience of founders leads to shorter times-to-first-product. The functional experience (R&D, marketing or other) which is most important to speed innovation depends on the nature of the product development tasks at hand and therefore differs between technologies and the stage of the development process.

Next, we use a cross-functionality index[3] to study whether balanced, multifunctional teams increase innovation speed. We find no significant effect of cross-functionality on innovation speed. Hence, our data do not support hypothesis 3b. Tuning the experience of the founding team to the needs determined by nature of the development tasks seems to be more important for innovation speed than having a founding team in which different functional domains are balanced.

Insert Table V About Here

NPD-collaborations with third parties

Finally, we study the relationship between alliances or R&D collaborations with other organizations and innovation speed. We find that collaborations with private firms have no significant effect on innovation speed for all technological domains. Collaborations with universities are associated with significantly longer times-to-first product for medical-related,

[3] The cross-functionality index measures the degree to which different functional expertise is represented in the founding team. The cross-functionality index is calculated as the sum of squared number of years of R&D, marketing and other experiences divided by total years of experience. This index ranges from 0 to 1. The closer to 1, the more homogeneous the founding teams. Closer to 0 means that founding teams are more heterogeneous and have experience spread over different functional domains.

telecom and other technologies. For software firms, the effect of working with universities seems to be in the opposite direction but is not significant.

There is a strong correlation between being an academic spinout and collaborations with universities after start-up (Pearson chi-square = 11.491; P=0.001). Academic spinouts are based on knowledge and technologies developed within the university and the collaborations evolve naturally. Hite & Hesterly's (1999) analysis also suggests that the prior social and work-related ties of the entrepreneurs determine the alliances they create at founding. In many cases, the continued collaborations with the departments from which they spun out are necessary because at time of spinning-out, the technology is in such an embryonic state that further development requires faculty participation (Thursby et al., 2001; Heirman et al., 2003). Hence, the finding that collaboration with universities is associated with slower innovation speed should be interpreted with care. This result does not mean that working with universities slows down the innovation process. It rather indicates that the firms' technology is in an early stage of development and requires the specialized scientific knowledge of university faculty. Our results suggest that collaborations with universities mostly serve to stay at the cutting edge of new technologies. Collaborations with other firms, on the other hand, are often set up to get access to complementary resources and capabilities, which are difficult or time-consuming to build internally (Baum et al., 2000).

CONCLUSIONS AND RECOMMENDATIONS

For new ventures, the launch of the first product is a crucial milestone in their evolution towards growth and financial independence (Schoonhoven et al., 1990; Deeds et al., 1997). Innovation speed in start-ups, however, has not been the subject of many studies in the entrepreneurship and NPD-literature. The NPD-literature offers valuable insights in the antecedents of innovation speed at the project level in large organizations. The purpose of this study is to test these insights in the context of new ventures. To do so, we position this study within the resource-based view of the firm, which argues that assets at founding can have a long-lasting influence on success of new ventures. Hence, our conceptual framework focuses on the impact of initial conditions on innovation speed in start-ups. More specifically, we study the impact of team tenure, experience of founding teams, and NPD-collaborations with third parties and control for differences in technology and maturity of the product at founding.

We found that the stage in the NPD-process and intangible assets at founding explain for innovation speed in RBSUs. More importantly, this study shows that the impact of these assets differs considerably between technological domains. Especially the product development process in software firms seem to differ significantly from that in telecom and medical-related or other technologies. Among the medical-related firms, we found that the biopharmaceutical start-ups experience much longer development processes and did not launch their first product before the end of our observation period. However, the number of biopharmaceutical start-ups in our sample was too low to study them as a separate group.

A first important insight is that start-ups differ considerably in their pre-founding R&D efforts and in the maturity of their product technology at founding. Clearly, RBSUs start at different stages in the NPD-process and these differences in starting point have a significant impact on innovation speed. RBSUs starting with an almost market-ready product, launch their first product significantly faster than firms starting at an earlier point in the development cycle. This is indeed an endogenous finding. We want to stress it however because when studying NPD-processes in new ventures it is important to acknowledge that the start of the NPD-project is not the same as the founding date of the firm. These differences in starting conditions explain much of the differences in innovation speed.

Contrary to expectations, we find that starting with a beta-version leads to significantly longer development efforts for software start-ups. For new ventures in other technologies, beta-prototypes at founding significantly increase innovation speed. Our qualitative data show that software firms starting with a beta-version often face considerable re-engineering issues which delay the launch of the first product. These software entrepreneurs developed their prototypes in the absence of (or at least a lack of) market information and lost precious time developing bells and whistles that customers don't want. Software entrepreneurs who founded the firm earlier in the product development cycle, on the other hand, develop their products in close interaction with customers, suffer less from re-engineering delays and are able to launch their first product faster. Assuring that the product is "right" for the customer's needs is important in avoiding redesign delays (Gupta & Willemon, 1990). Several scholars found that in order to overcome serious delays, concept testing with customers should start early in the product development cycle (e.g. Urban & Hauser, 1993; Cooper, & Kleinschmidt, 1987; Maidique & Zirger, 1985).

The novel insight from this study is that entrepreneurs in different technological domains should take different actions to get early (and accurate) customer feedback and overcome redesign delays. More specifically, our data suggests that the optimal time of founding the new venture in order to increase innovation speed differs between technologies. Moenaert et al. (1994) argue that formalization of NPD projects in larger firms leads to increased communication flows between marketing and R&D, which in turn has a significant effect on project success. In line with this, we argue that formalizing the new venture increases the quality and the frequency of the customer feedback, which might have a significant effect on project success. Our data suggest however that formalization of the firm early in the product development cycle is especially critical for software start-ups in order to ensure timely customer involvement and speed the first product to market. However, pre-founding R&D and beta-prototypes at founding increase innovation speed for firms in medical-related and other technologies. Hence, our data suggest that early formalization is not critical for innovation speed in other technologies. Our data suggest that firms in medical-related and other technologies are able to get sufficient customer feedback early in the development cycle even when the new venture is not formalized yet. Software start-ups, on the other hand, need to be formalized to get sufficient/ accurate customer feedback. We offer two complementary/ alternative explanations.

Firstly, software development may involve a higher amount of sticky information compared to developments in medical-related and other technologies. Sticky information is information on customer needs which is difficult and costly to transfer to the manufacturer (Von Hippel, 1998; 2001). Indeed, most (industrial) software products are designed to automate specific processes and/or analyze data, which involve a great deal of sticky customer-specific information. In such instances, close involvement of customers in product development is necessary to increase efficiency.

Another complementary/ alternative explanation is that software faces shorter development cycles and more rapidly changing environments. Iansiti (1995) showed that flexibility and responsiveness are the key success factors for product development in such turbulent environments. He argues that companies in turbulent, fast changing environments should focus on gathering and rapidly responding to new market and technical information and that the point of concept freezing should be moved as close to market introduction as possible. Our results show that software entrepreneurs better start their ventures early in the product development cycle, which enables them to “freeze” the concept in close interaction with market. Software entrepreneurs starting with a beta-version froze their product concept in the absence (or at least a lack) of market information and as a result suffered from poor design and delays. In software, a flexible approach is needed and fast product launch is dependent on rapid and flexible iterations with customers. Our data show that the best way to do this is to found the new venture early in the development cycle. In other technologies (e.g. developing a new machine to sort fruits or medical equipment), product development seems to be a more structured process consisting of clearly defined and sequential phases. The user needs are easier to understand, less sticky and require less frequent customer involvement. This adds clarity and stability to the development project, which might be conducted before the new venture is formalized.

This discussion is important for entrepreneurs and managers of RBSUs pursuing fast product and for venture capitalists, which often set the availability of a prototype as a requisite to invest. launch because one of the first key decisions an entrepreneur faces is when to found the firm. This study indicates that this decision should be informed by the need for customer involvement in the product development process. The results are also relevant for investors. Venture capitalists prefer to invest in firms, which have a product that is close to market or at least in a prototype phase. Our results show that starting with a beta-prototype is not always beneficial especially for software start-ups.

Next, we find that the experiential background of founders influences innovation speed. Again, we find that the importance of different types of experience vary between technological domains. Medical-related start-ups launch a product faster when the founders have experience in marketing and other functional domains such as manufacturing and financing. Several medical-related firms start with a product that is almost market-ready. Moreover, these firms face more stringent manufacturing and sales procedures than firms in other technologies. This might explain why marketing and other functional experience beyond R&D are more important for medical-related firms. In other technologies, R&D experience is more important to increase innovation speed. Next, in line with the findings in large organizations (Brown & Eisenhardt, 1995), we find that team tenure in start-ups leads to better coordination processes and teamwork related competences and faster innovation speed. Entrepreneurs, managers and investors should be aware that it is not only the experience of individuals that matters to be successful at fast product launch. When time is crucial, working with existing teams and employees from the prior employer might be more effective than adding experienced but unrelated individuals to the NPD-team. Software start-ups seems to be an exception. Employees coming from the parent company slow down innovation speed. We argue that this might be linked to the fact that software products often need redesign and customization. For those who built that first version, the temptation to preserve it can slow down the commercial launch.

Finally, we find that alliances with other companies do not significantly influence the time it takes to develop the first product. Collaborating with universities on the other hand is associated with longer development efforts, except in software. The firms working with universities are mostly developing products based on technologies that are so new they need faculty (and basic science) involvement. Joint development efforts with universities should therefore be motivated by an urge to stay on the cutting edge of changing technologies and not to speed innovation.

LIMITATIONS

The returns generated by firm assets depend on conditions in a firm's environment. We deliberately choose a small geographic coverage, i.e. Flanders, in order to reduce the influence of non-measured variance in our study. The trade-off, however, is that one might question the external validity. Future research in other regions is needed to test whether our findings hold. However, we strongly believe that the Flemish region is very comparable to most emerging and developing high tech regions. A second limitation is that our study relies on retrospective data. Several scholars argue that such data can impose bias because the respondents' lack of trust-worthiness especially when the time lags between date of interview and the questioned period increases. This type of bias is one of the most difficult to overcome in entrepreneurship research. The dependent variable (time-to-first-product) and most of the explanatory variables in our study are based on facts such as number of founders, years of experience, etc. We believe that these variables are less sensitive to bias than subjective measures in other studies. Next, we try to deal with survival bias by including survivors as well as dissolved firms in the sample and by studying firms that are between 5 and 12 years old, which is a much earlier stage than do most other databases. Finally, we only controlled for technology-specific differences in NPD-processes with a broad classification of technological domains. More fine-grained measures are needed to control for differences in the task complexity of product development processes between different technologies.

DIRECTIONS FOR FUTURE RESEARCH

This study has a static character. The main aim was to examine the effects of intangible assets at founding in the context of NPD-processes. Our results show that the firms' intangible assets at founding are important antecedents for innovation speed. This study should be seen as a first step towards a better understanding of NPD in start-ups. Intangible assets are not static, but evolve during the early growth path of RBSUs. Experience, skills and organizational links with other firms and universities, may perish or wear out over time. Further theoretical and empirical work is needed to examine the dynamics of the processes by which firms build their assets and competencies and how these dynamics influence NPD-processes. A detailed inventory of a firm's resources over time could shed light on how resources contribute to firm performance over time. A challenge for future research is therefore to introduce the temporal component in the analysis.

This paper focuses on the question "how can RBSUs speed up innovation?" It is important to acknowledge that speed affects other important outcomes such as cost, quality and ultimately success in a variety of ways. Further research should take into account when innovation speed is appropriate and what happens when innovation is speed up.

ACKNOWLEDGEMENTS

We thank the participants of the research seminars at MIT Sloan School of Management, Ghent University and Vlerick Leuven Gent Management School for their helpful comments on earlier drafts of this paper. All errors are our own. Financial support of the Flemish government (Steunpunt Ondernemerschap, Ondernemingen en Innovatie) is gratefully acknowledged.

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FIGURE 1

Conceptual Model: Antecedents of Innovation Speed in RBSUs

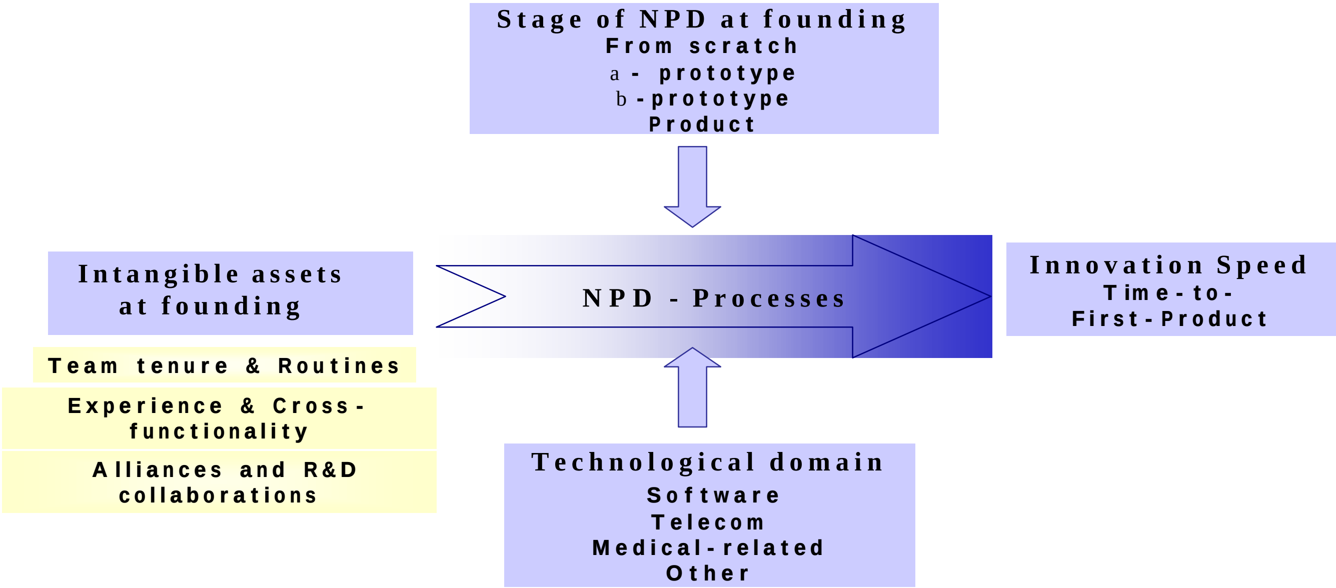

TABLE I

Description of Variables

Category	Name of variable	Description/ Interpretation
Technological Domain	Technological segment in which the firm is active	Following the International Patent Classification System and aggregating firms into 4 main classes: Software, Telecom, Medical-related and Others*
Characteristics of Product Technology	Alfa-prototype at founding	Measures whether the firm started with a alfa-prototype (1 = yes; 0 = no)
	Beta-prototype at founding	Measures whether the firm started with a beta-prototype (1 = yes; 0 = no)
	Product at founding	Measures whether the firm started with a market-ready product (1 = yes; 0 = no)
	Pre-founding R&D efforts	Years of research before incorporation of the firm
Founding Team	Size founding team	Number of founders
	% joint work Experience	Percentage of the founders that worked together before starting the focal firm (Ranging from 0 to 1)
	Years joint work experience	Average number of years of the joint work experience of the founders
	Other employees	Measures whether other people such as technicians, scientists, etc. who previously worked on the project on which the start-up is based, joined the company (1 = yes; 0 = no)
Experience	Total years of experience	Sum of number of years of total work experience of all the founders
	Years R&D experience	Sum of number of years of R&D experience of all the founders
	Years Marketing experience	Sum of number of years of marketing experience of all the founders
	Years Other experience	Sum of number of years of experience in manufacturing, financing, legal functions. etc. of all the founders
	Cross functionality	$\Sigma\ (Fi/\ T)^2$ with Fi = Total years of R&D, Marketing and other experience and T = Total years of experience
Organizational Links	Collaboration with private firms	Measures whether the company has formal collaboration agreements with other companies in order to develop or market products (1 = yes; 0 = no)
	Collaboration with universities and research institutes	Measures whether the company has formal collaboration agreements with universities and/ or research institutes (1 = yes; 0 = no)

* A detailed description of the classification procedure can be obtained from the first author upon request.

TABLE II

Descriptive Statistics for All Variables

Variables	N	Mean	Median	Minimum	Maximum	SD
Dependent Variable						
Event Product	99	0.717	1	0	1	0.453
Months-to-Product – All	99	49.121	48	1	139	36.291
- Event Product = 0	28	84.679	83	24	139	25.373
- Event Product = 1	71	35.099	30	1	127	29.839
Control variables						
Software	99	0.394	0	0	1	0.491
Telecom	99	0.111	0	0	1	0.316
Medical-related	99	0.141	0	0	1	0.350
Other	99	0.354	0	0	1	0.481
Alfa-prototype	99	0.252	0	0	1	0.437
Beta-prototype	99	0.121	0	0	1	0.328
Product	99	0.192	0	0	1	0.396
Years of pre-founding R&D efforts	99	3.020	1	0	35	5.059
Explanatory variables						
Size founding team	99	2.040	2	1	7	1.355
% joint work exp.	99	0.365	1	0	1	0.502
Years joint work exp.	99	1.970	0	0	20	3.609
Other employees	99	0.313	0	0	1	0.466
Total years of exp.	99	19.75	16	0	78	17.112
Years R&D exp.	99	11.641	9	0	60.5	13.332
Years marketing exp.	99	4.932	0	0	47	9.318
Years other exp.	99	3.177	0	0	39	6.856
Cross-functionality index	99	0.835	1	0.333	1	0.238
Collaboration with private firms	99	0.172	0	0	1	0.379
Collaboration with universities and research institutes	99	0.212	0	0	1	0.411

TABLE III

Cox Proportional Hazard Models: Intangible assets and Time-To-First-Product : Pre-founding NPD efforts

Variable	Model 1a: Different effects by technology domain	Model 1b: Different effects by technology domain excluding biopharma	Model 2: Pre-founding R&D	Model 3: Stage NPD at founding
Years of pre-founding R&D			1.027 (0.026)	
Product at founding				4.958*** (2.738)
Beta-prototype at founding				10.580*** (8.687)
Alfa-prototype at founding.				1.155 (0.552)
Software	0.935 (0.256)	0.988 (0.273)	1.198 (0.372)	1.186 (0.524)
Telecom	1.191 (0.485)	1.261 (0.408)	0.962 (0.457)	1.651 (0.943)
Medical	0.986 (0.388)	2.488** (0.398)	0.318* (0.198)	0.487 (0.377)
Years of pre-founding R&D * Software			0.885 (0.071)	
Years of pre-founding R&D * Telecom			1.086* (0.051)	
Years of pre-founding R&D * Medical-related			1.970**** (0.232)	
Alfa-prototype * software				1.270 (0.870)
Alfa-prototype * telecom				0.426 (0.510)
Beta-prototype * software				0.056*** (0.057)
Beta-prototype * Medical- related				0.074* (0.109)
Product * Software				1.368 (1.044)
Product * Telecom				4.490 (4.804)
Product * Medical–related				10.58** (10.713)
N	99	96	99	99
Log Likelihood	-283.103		-273.005	-258.390
LR-Chi2	0.35	5.165	20.55	49.78
d.f.	3	3	7	13
Prob. Model	0.9495	0.1601	0.0045	P < 0.0001

*p < .10; ** p < .05; *** p < .01; **** p < .001; Hazard Ratios are reported; standard errors are in parentheses

TABLE IV

Cox Proportional Hazard Models: Determinants of Innovation Speed: Intangible assets[4]

Variable	All	Software	Other
Size Founding Team	1.160	2.003**	0.380
	(0.189)	(0.691)	(0.293)
% Joint Work Experience* Size Team	0.937	0.664	1.780
	(0.157)	(0.207)	(1.190)
Years Joint Work Experience	1.471***	1.484	0.603
	(0.199)	(0.795)	(0.202)
Years Joint Work Experience*2	0.970***	1.014	1.007
	(0.010)	(0.064)	(0.018)
Other Employees	0.893	0.148**	9.906***
	(0.308)	(0.125)	(8.603)
Cross-functional founding team	2.291	1.391	13.390
	(1.893)	(2.144)	(30.036)
Years R&D Experience	1.011	0.961	1.039*
	(0.015)	(0.050)	(0.026)
Years Marketing Experience	1.014	1.017	1.081*
	(0.018)	(0.035)	(0.052)
Years Other Experience	1.091***	1.101	1.157*
	(0.034)	(0.068)	(0.095)
Collaboration with private firms	1.533	9.005	0.851
	(0.570)	(12.396)	(0.690)
Collaboration with universities and research institutes	0.330***	10.010	0.050***
	(0.135)	(17.698)	(0.062)
Product at founding	4.541***	27.168****	16.173***
	(2.321)	(24.469)	(15.509)
Beta-prototype at founding	13.386****	0.143**	51.410***
	(10.865)	(0.144)	(67.221)
Beta-prototype * Software	0.037****		
	(0.037)		
Beta-prototype * Medical-related	0.028***		
	(0.037)		
Product * Software	1.757		
	(1.237)		
Product * Telecom	14.568***		
	(15.113)		
Product * Medical- related	7.624***		
	(6.182)		
N	99	39	35
Loglikelihood	-244.625	-65.356	-59.726
LR-Chi2	77.31	43.07	27.88
d.f.	18	13	13
Prob. Model	P < 0.0001	P < 0.0001	0.0094

* p < .10; ** p < .05; *** p < .01; **** p < .001; Hazard Ratios are reported; standard errors are in parentheses

[4] When these models are tested with logistic regression (dummy dependent variable = product today or not), the results are qualitatively the same. Also with Huber white correction for standard errors the results remain robust.

TABLE V

Determinants of Innovation Speed: Experience and interaction effects with technology[5]

Variable	Experience
Years R&D Experience	1.041**
	(0.021)
Years R&D Experience * Software	0.995
	(0.029)
Years R&D Experience * Telecom	0.997
	(0.045)
Years R&D Experience * Medical	0.940**
	(0.0297)
Years Marketing Experience	1.011
	(0.031)
Years Marketing Experience * Software	0.998
	(0.037)
Years Marketing Experience * Telecom	1.044
	(0.049)
Years Marketing Experience * Medical	1.373**
	(0.195)
Years Other Experience	1.006
	(0.035)
Years Other Experience * Software	1.033
	(0.055)
Years Other Experience * Telecom	0.916
	(0.104)
Years Other Experience * Medical	3.505****
	(0.272)
Cross-functional founding team	0.652
	(0.612)
Cross-functional founding team * Software	1.841
	(0.894)
Cross-functional founding team * Telecom	0.865
	(0.993)
Cross-functional founding team * Medical	0.984
	(1.054)
Product at founding	5.792***
	(2.960)
Beta-prototype at founding	21.590****
	(18.399)
Beta-prototype * Software	0.013****
	(0.015)
Beta-prototype * Medical-related	1.43
Product * Software	1.151
	(0.847)
Product * Telecom	12.362**
	(14.528)
Product * Medical- related	14.885***
	(16.096)
N	99
Loglikelihood	-248.119
LR-Chi2	70.32
d.f.	23
Prob. Model	P < 0.0001

* p < .10; ** p < .05; *** p < .01; **** p < .001; Hazard Ratios are reported; standard errors are in parentheses

[5] When similar models are tested with logistic regression (with and without correction for Huber white noise), the results are qualitatively the same.