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DOES THE STOCK OF INTANGIBLE ASSETS AT START-UP MATTER TO SPEED THE FIRST PRODUCT TO THE MARKET?[1]

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ABSTRACT

We adopt the resource-based and dynamic capabilities view of the firm to study new product development processes of research-based start-ups (RBSUs). RBSUs are new ventures, which develop and market new products or services based upon a proprietary technology or skill. We study how RBSUs differ at founding in their core capabilities in R&D and which intangible assets matter for the time it takes to launch the first product. Specific hypotheses about their effect on the time it takes to develop a first product are derived. To test the hypotheses, we use a unique hand-collected dataset of RBSUs in Flanders (Belgium). We found that RBSUs differ considerably in their pre-organizational development efforts and that controlling for stage in the product development process at founding is necessary. Next, our empirical findings suggest that joint work experience of founders prior to starting the focal company is important to get the first product out fast. We also found that the total years of experience of the founders and especially the experience in R&D and marketing are important determinants of time-to-first product launch. Experience in other functional domains such as finance, manufacturing or legal issues, on the other hand, does not significantly affect time-to-first-product. Development time of the first product reduces also if an experience project manager is present at founding. Finally, our results show that collaborations with other companies reduce the time it takes to develop the first product. Collaborations with universities and research institutes, on the contrary, seem to prolong the product development process.

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

1. INTRODUCTION

This article is concerned with studying how intangible assets matter for product development processes in research-based start-ups. Research-based start-ups (RBSUs hereafter) are new business start-ups, which develop and market new products or services based upon a proprietary technology or skill. Schumpeter (1934) identified start-ups and entrepreneurs as key innovative actors. Henderson (1993), Bower & Christensen (1995), Christensen (1997), Hiltzik (1999) and others later confirmed the importance of start-ups for innovation. Despite the importance of RBSUs for developing and introducing new products in the market place, we know little about the new product development (NPD) processes of these companies. Indeed, the bulk of the NPD literature focuses on large established firms (see Wheelwright & Clark, 1992; Brown & Eisenhardt, 1995 and Krishnan & Ulrich, 2001 for reviews of the literature); small companies and start-ups are mainly overlooked in this literature.

Entrepreneurship scholars, on the other hand, did pay a great deal of attention to RBSUs in the last two decades (e.g. Bollinger et al., 1983; Utterback et al., 1988; Roberts, 1991; Storey & Tether, 1998; Shane, 2001; Bower, 2003; Kaulio, 2003). These studies reveal that RBSUs, or New Technology-Based Firms (NTBFs) in more general, contribute significantly to an economy in terms of exports, employment, taxes paid, research and development, and innovations (Bollinger et al., 1983; Utterback et al., 1988). Most of the studies aim to describe and characterize promising start-ups by studying their initial resources, environmental conditions and strategy. However, few studies linked the starting conditions to new product development processes in these companies. Nelson (1991) argues that 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. Hence, a better understanding of the factors that influence NPD in RBSUs is particularly critical to enhance our understanding of the early growth path of these companies.

NPD-processes can be studied from different theoretical angles. The industrial organization framework focuses on the analysis of the effect of external or environmental factors such as the characteristics of the industry in which the firm competes. In this paper, we study NPD-processes from a resource-based and dynamic capabilities perspective. We do control for different technological domains but our primary objective is to identify key internal or organizational factors that may play an important role for NPD-processes in RBSUs. Resource-based scholars study financial, physical, technological, human, and organizational assets used by the firm to develop, manufacture and deliver products to its customers (Barney, 1991). In this paper we are particularly concerned with the internal assets that are identified in the NPD-literature as key success factors for NPD-processes. Reading the NPD-literature from a resource-based perspective, we found that the key success factors for NPD-processes can be classified as intangible assets (e.g. routines, knowledge, experience and skills embodied in the people, organizational procedures). However, with few exceptions (e.g. Meyer & Roberts, 1986, Schoonhoven et al., 1990, Pavia, 1991, Deeds et al., 1999), the NPD-literature focuses on large established firms. We translate the insights of this literature to the context of RBSU. Hence, our aim is to examine the impact of intangible assets on NPD-process in RBSUs. More specifically, we evaluate the effect of intangible assets at founding on the time it takes to develop the first product. Figure 1 depicts the theoretical model which guides this study and which is the object of the empirical test carried out in this paper.

The paper is organized as follows. In the next section we argue that the launch of the first product is an important entrepreneurial event and that the time it takes to develop the first product is an appropriate performance measure for this study. Next, we position this study in the resource-based and dynamic capabilities view of the firm. In this section, we translate the key success factors for NPD identified in the literature to the context of RBSUs. This allows us to identify intangible assets that may play an important role in the NPD-processes of RBSUs and we derive specific hypotheses regarding their influence on time-to-first-product. Next, we describe the sampling design, the data collection, the variables and the econometric analysis we apply in this research. Next, we discuss the results. We end with conclusions and directions for future research.

2. IMPORTANCE OF TIME-TO-FIRST-PRODUCT FOR RBSUS

Meyer et al. (1997) gives a detailed overview of the numerous measures of R&D effectiveness that have been proposed in the literature. For the purpose of our study, we need a NPD performance metric that is appropriate in the context of new ventures. Financial-based measures such as returns or profits generated by product sales are not appropriate in the context of start-ups since many of these firms are not profitable and most firms cannot provide sales figures yet (e.g. Roberts, 1991; Hart, 1995; Lee et al. 2001; Shane & Stuart, 2002). A commonly used R&D metric on the individual project level is “slip”, i.e. the gap between expected and actual project time and budget (Moser, 1985). However, Meyer et al. (1997) and Utterback et al. (1992) argue that this only measures the quality of the manager’s predictions and cannot be seen as a metric for NPD-success. Another commonly used R&D performance metric is time to market of individual products (Meyer et al., 1997). Especially for start-ups, the launch of the first standardized product is a key milestone (Kaulio, 2003). Schoonhoven et al. (1990) argue that 'Time-to-First-Product-Shipment' is a major milestone for a RBSU for 4 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, Deeds et al. (1997) found that new product development (NPD) improves a firm's ability to raise money through an initial public offering. Hence, we believe that rapid development of the first product is a key determinant of the success of NPD-processes for RBSUs and "time-to-first-product" is therefore an appropriate performance metric for this study.

3. PRE-FOUNDING R&D EFFORTS

Most researchers take the legal founding date (data of incorporation) or the date of hiring of 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 of a company is not a single moment in time but is rather a process with durations that vary considerably between firms (Clarysse et al., 2001; Clarysse & Morray, 2003). Consequently, the degree of pre-organizational efforts is also likely to vary considerably among start-ups and we might expect that RBSUs are not in the same stage of product development at founding (legal incorporation). Some firms start with just a product idea, other start-ups have a proof of concept, a working prototype or even a completed product. One would expect that the companies that are further in the development cycle at founding will have shorter times to market than ventures that start from scratch. It is therefore surprising that prior research on time to first product does not control for this important difference in founding condition (Schoonhoven & Eisenhardt, 1990; Hellman & Puri, 2001). We start our analysis with studying how different starting points – alfa- or beta-prototype or market ready product – relate to the time it takes to develop the first product. 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.

4. THE ROLE OF INTANGIBLE ASSETS IN THE DEVELOPMENT PROCESS OF THE FIRST PRODUCT

We position this study in 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). The most comprehensive definition is probably the one of Teece, Pisano & Shuen (1997): *"Dynamic capabilities reflect a firm's ability to achieve new and innovative forms of competitive advantage. These encompass organizational and managerial processes (i.e. coordination/ integration, learning and reconfiguration), specific asset positions (i.e. technological, financial, reputational etc. assets) and path dependencies (i.e. the firm's history)" (Teece, Pisano & Shuen, 1997).* Eisenhardt & Martin's (2000) define dynamic capabilities as "identifiable, specific strategic and organizational processes like product development, alliancing and strategic decision making that create value for firms within dynamic markets by manipulating resources into new value-creating strategies." Following these definitions, we study NPD processes as one specific type of dynamic capabilities, by which RBSUs exploit, combine and manipulate resources in order to develop a product ready for sales. Defining dynamic capabilities as specific processes implies that one can build on the extensive empirical research on the process, in this case the NPD literature. Moreover, by defining dynamic capabilities in terms of their functional relationship to resource manipulation, their value is defined independent of firm performance. This enables empirical falsification (Eisenhardt & Martin, 2000).

The potential for long-term competitive advantage lies in using dynamic capabilities sooner, more astutely, or more fortuitously than the competition to create resource configurations that have that advantage (Eisenhardt & Martin, 2000). Hence, the NPD capabilities of RBSUs will be defined and constrained by the firm's assets at start-up. Therefore, we study how the firm's assets at founding influence the time it takes to develop the first product. Studies on product development processes in start-ups are very scarce. Some noticeable exceptions are Meyer and Roberts (1986), Schoonhoven et al. (1990), Pavia (1991) and Deeds et al. (1999). However, the bulk of the NPD-literature focuses on large organizations. This literature identifies the following key success factors for the new product development process: (1) routines, (2) experienced and cross-functional teams, (3) heavy-weight team leaders, and (4) common customer visits and feedback (Wheelwright & Clark, 1992; Brown & Eisenhardt, 1995; Eisenhardt & Martin, 2000). In the following paragraphs we briefly discuss these key success factors in the NPD-process and translate them into testable hypotheses for RBSUs.

a. *Founding teams and routines*

Team tenure and routines in the team are identified as important success factors for NPD. Teams with a short history together tend to lack effective patterns of information sharing and working together (Brown & Eisenhardt, 1995). To work-out routines and team tenure in RBSUs, we look at 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: Starting routines, measured as portion and number of years of founding team tenure and joining of other employees, will lead to shorter times-to-first-product.

b. *Experience of founders*

Maidique and Zirger (1985) argue that companies that have a higher understanding of customer needs because the managers, engineers and marketing people associated with the product are people with long-term experience in the technology and/or market do better at new product development than companies that lack this experience. The NPD literature also indicates that cross-functional teams are an important success factor in new product development projects. Cross-functional teams are project groups that comprise members from more than one functional area such as engineering, manufacturing, or marketing. Such project teams are often found in larger, more mature firms in which people are grouped together principally by discipline (Wheelwright & Clark, 1992, p. 191). Most new ventures, on the other hand, are not organized in separate functional areas. In essence, the entire organization mostly focuses on a single development project. However, we think that experience of the founders in different functional areas (research and development, marketing, and other functional areas) might be important determinants of time-to-first-product. Therefore, we study the influences of the total number of years of experience as well as the number of years of experience in different functional domains. The third hypothesis is therefore:

H3: More experience of founding teams in R&D, marketing and other functional domains will lead to shorter times-to-first-product

c. Corporate social capital

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 alliances and partnership, which may be important to fasten the product development process for resource-constrained start-ups (Eisenhardt & Schoonhoven, 1996). Alliances are especially important for development activities, which are highly uncertain and require specialized knowledge and are difficult to outsource (e.g. Deeds et al., 1999). For new ventures, partnerships with other firms can supplement complementary resources on a timely basis, which can be a determining factor for effective product development. We distinguish between collaboration agreements with private companies and collaborations with universities and research institutes. Our fourth hypothesis can be formulated as follows:

H4a: Collaboration agreements with private firms will reduce the time-to-first-product.

H4b: Collaboration agreements with universities and/or research institutes will reduce the time-to-first-product.

d. Experience of NPD Project Leaders

The NPD-literature argues that the presence of a heavyweight project leader has an influence on the success of the new product development process (Wheelwright & Clark, 1992; Brown & Eisenhardt, 1995). Heavyweight team leaders are senior managers who coordinate the activities of the product-development team and have a primary influence over the project members. They are powerful linking pins, who obtain external information and share it within the project team. The heavyweight project manager is important in large organizations as a champion of the project, i.e. as someone with experience and authority to lead the project and to attract company resources to the project. In this sense, heavyweight managers are not meaningful for small companies and start-ups since mostly there is no competition for company resources between different projects (although overall resources are often very low in start-ups). The interviews revealed that the NPD-leader is sometimes one of the founders, who mostly also has a lot of other duties during the start-up process and might not have experience in managing NPD-processes or in the sector, in other cases the company attracted an experienced NPD-leader to lead the project. Therefore, we think that the experience of the NPD-leader in the sector and in managing NPD-processes is an important intangible asset.

H5: NPD-leaders with more sector and NPD-experience will reduce the time-to-first-product.

e. Customer Involvement

With regard to external relationships, von Hippel (1988) has shown the importance for innovation of close relationships with potential customers. Involvement of customers in product design can cut the complexity of the project, which in turn creates a faster and more productive product-development process (Brown & Eisenhardt, 1995), especially in turbulent environments (Iansiti, 1995). Also Maidique and Zirger (1985) found that the frequency and quality of customers' communications are important success factors for new products. Hence, we hypothesize that the frequency of contacts with customers might influence the waiting to first product. Our sixth hypothesis is:

H6: More frequent contacts with potential customers will reduce the time-to-first-product

5. METHODOLOGY

a. 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 ‘young’. We focus on RBSUs that are between five and eleven years old, which is presumably the time it takes for a new venture to mature and to overcome its liability of newness (Stinchcombe, 1965). Previous research indicates that the earliest this might occur would be three to five years after its creation, and more usually, not until the venture is eight to twelve years old (Biggadike, 1979; Quinn & Cameron, 1983; Kananjian & Drazin, 1990). “Research-based” refers to firms that have their own R&D and/or develop their own products (Utterback and Reitberger, 1982).

b. Sample Frame and Sample

We adopt a guided sampling technique to construct the sample frame of RBSUs in Flanders, founded between 1991 and 1997. Three specific subgroups of the RBSU population are identified to construct the sample frame. It is important to highlight that the subgroups are not mutually exclusive, i.e. a firm can belong to one or more subgroups. We first select the subgroup of academic spin-offs. In previous research, Clarysse et al. (2001) identified all academic spin-offs in Belgium. Twenty-five companies in the sample frame are academic spin-offs, which all met the profile of RBSUs. Secondly, we select the subpopulation of start-ups that have received risk capital from Venture Capitalists and Business Angel Funds located in Flanders. Fifty-seven firms in these-portfolios were founded between 1991 and 1997, and 18 of them met the definition of RBSUs. Only 8 of these were “new” RBSUs that did not appear as academic spin-offs. Thirdly, we identify the group of RBSUs that have received innovation or R&D grants from the Flemish government. One hundred eighty-two (182) start-ups in the period 1991-1997 had received such grants. Forty-seven (47) firms met the profile of RBSUs and 4 of these companies were already identified via other ways. Finally, we complemented the three groups with a random sample of 480 firms, drawn from the entire population of companies that were founded in Flanders between 1991 and 1997 and have a NACE-code that is classified in high-tech and medium-high-tech industries according to the OECD classification (DSTI 1997/2). This population comprises 7775 companies in total, of which 1861 are classified in manufacturing industries and 5914 in service sectors. Only seven new RBSUs could by identified using this random sampling. This confirms our intuition that the three subgroups, which we identified before represent a large part of the total population of RBSUs and that purely relying on random sampling would be a slow and cumbersome process to identify RBSUs.

Eighty-three (83) RBSUs[2] participated in our study. At time of the data collection (2002), the surviving RBSUs are between 5 and 11 years old. On average the RBSUs in our sample are 7 years old. Most of the 83 firms, namely 86%, survived as independent entities. The other 12 RBSUs (14%) dissolved, i.e. failed to exist as independent entities, by 2002. Half of these are acquired by other firms and the other 7% went bankrupt. During the first year after founding the number of employees (in full time equivalents) ranged between 0 and 305, with an average of 8 employees during the first year. In 2002, the number of full time employees ranged between 1 and 520, with an average of 33 employees.

[2] The descriptive statistics are based on data for 82 firms because the data for one firm were not coded yet when we started the analysis.

c. Technology Representation

The nature of the product development tasks – and by consequence the time it takes to complete the development - differs largely between different technologies. Therefore, we control for the technological domain in which the firms is active. To classify RBSUs according to their technological base, i.e. the technology that underpins their business activities, we followed the International Patent Classification System (IPC). The IPC is a hierarchical classification system routinely applied to published patent documents. It 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[3]. 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 consists of the firms classified in the G06F code of the IPC system. We label this group of firms as SOFTWARE firms. The second group consists of the companies in the H class of the IPC system, which we label as the TELECOM firms. The third group are the companies in the A class of the IPC-system and are labeled as the MEDICAL-RELATED companies. 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 firms. Table 1 gives on overview of RBSUs in different technological domains.

Data Collection, Measures and Descriptive Statistics

The primary data source is a structured questionnaire with mainly closed questions. This questionnaire 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 when it developed a first product. The interviews typically have duration of one hour to one hour and a half 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 elaborated the resource-based view of the firm in the context of NPD-processes of RBSUs. We built specific hypotheses regarding the influence of intangible assets at founding on the time it takes to develop the first product. We argued that routines, experience of founders in different functional domains, experience of the project leader, organizational links, and customer contacts are important determinants of time-to-first-product. We also control for different technological domains and the stage of the product in the development cycle at founding. Table 2 describes how the variables are measured. All variables are based on specific questions in the questionnaire and are thus rated by the interviewee. Table 3 and 4 give an overview of the descriptive statistics and the pairwise correlations respectively.

d. 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, Hamerle, and Mayer, 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

[3] A detailed description of the classification procedure can be obtained from the author upon request.

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. However, when a firm is acquired or merged with another firm but continued to operate as a relatively independent subsidiary, we consider this firm as surviving. 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 $e^{\beta T x}$ and is a positive function of x, and $h_0(y)$ is called the baseline hazard, representing the hazard function for a firm having g1(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 $h_x(y) = h_0(y)\, e^{\beta T x}$ 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 industry 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.

6. RESULTS AND DISCUSSION

Figure 2 shows the Kaplan-Meier survival function of the time it takes to develop the first product. We observe a steep decline in the survival function in the first month because 9 firms started with a market ready product. Over the first 60 months, the survival function shows a rather steep decline, indicating that approximately every 1 to 2 months, 1 or 2 firms had their first product ready for sales. After 5 years, the slope of the survival function becomes less steep. This indicates that RBSUs tend to develop a first product within the first 5 years after founding; later the likelihood of developing a first product seriously declines. Hence, it seems that the first 5 years are crucial for the development of the first product in RBSUs. Due to the small sample size and the limited geographic coverage of the study, this result remains a hypothesis which needs further testing in a larger sample and older RBUS. However, our finding is in line with

Roberts' (1991, pp. 161 – 170). He reports that in a sample of 5 to 7 years old firms, a large number of firms (16%) still not qualify as companies with tangible products. He also points to the fact that some high tech start-ups that start with consulting activities get stuck and never evolve into product manufacturing and sales.

The descriptive statistics (table 3) show that RBSUs differ with regard to the stage of development of the first product at founding. Almost 20 percent of the firms start with a market-ready product, 11 percent has a beta-prototype at founding and 24 percent starts with a proof of concept (alfa-prototype). The remainder of the RBSUs (45%) starts from scratch, that is, based on nothing more than a vague product idea. The maturity of the product-technology (stage in NPD-process) at founding is a reflection of the pre-organizational development efforts. In the first step of the hazard analyses, we investigate whether the stage in the NPD-process at founding significantly influences the time it takes to develop the first product and whether and how we should control for these differences in pre-organizational efforts in studying the critical success factors for NPD-processes. In Model 1 (Table 5) we include three dummy variables, which measure whether the firm started with a alfa-, or beta-prototype or with a market-ready product. The hazard ratios show that RBSUs which start with a market-ready product are about 10 times faster to launch a product than firms that start from scratch ($p<0.001$). Firms starting with a alfa- or beta-prototype are not significantly faster in developing the first product than firms that start from scratch. Next, we estimated the hazard model with the product dummy but without the alfa and beta-prototype dummies (Model 2 in table 5). We found that the effect of having a product at founding on time-to-first product remains robust ($p<0.001$). Based on the log likelihood of these two models, we used the c-statistic to test the null hypotheses that the coefficients of alfa- and beta-prototypes are zero.

$C = -2(\log L2 - \log L1) = -2(-193.085 - (-192.621)) = 0.928 < \text{Chi-square}_{cr}$ (2df, 5%) = 5.99

Hence, we fail to reject the null hypothesis and assume that the coefficients on alfa- and beta-prototype are indeed not significantly different from zero. For further hypotheses testing, we will therefore control for the presence of a market-ready product at founding (and not for alfa- or beta-prototype). The availability of a more or less market-ready product at start-up is a reflection of the maturity of the technology and the amount of pre-founding product development efforts. Controlling for this important metric seems almost self-evident. However, two prior studies on time to first product we could identify, namely Schoonhoven et al. (1990) and Hellmann & Puri (2001) did not control for this important factor. Maybe this could be an explanation of the seemingly contradictory results of the studies. Hellmann & Puri found that venture capital reduces the time to market, while Schoonhoven et al. found that greater capital expenditures lead to longer time to market.

Next, we introduce several measures of intangible assets in the regression models. To do so, we used a blocked approach (table 6). Here we report the most interesting findings. Firstly, we estimate a Cox proportional hazard model with factors related to the tenure among the founders and the first employees. We find a significant positive effect of the percentage of the founders that previously worked together before founding the company. The number of years of the founders' joint work experience and the joining of other employees such as technicians who previously worked together have no significant effect on time-to-first-product. Hence, we find partial support for the hypothesis that team tenure reduces time-to-first product.

Secondly, we study how the experience of the founders before starting the firm influences time-to-first-product. We find that founding teams with more years of experience are significantly faster in developing the first product (model 2). Model 3 shows that especially the number of years of experience in R&D and is important for the rapid development of the first product. Marketing experience of the founding team is also marginally significant. The number of years of experience in other functional areas such as financing, manufacturing and legal has no significant effect on time-to-first-product. Our results indicate that teams, which have experience in R&D and marketing, have shorter times-to-first-product than founding teams with less experience in these functional domains. This is in line with Schoonhoven et al. (1990), who found that start-ups whose founding structures included both a manufacturing and marketing position shipped their first product significantly faster than new ventures without these positions.

Thirdly, we look at the influence of alliances with other organizations on time-to-first-product. Model 4 shows that collaborations with private firms lead to shorter time-to-first product. Collaborations with universities, on the contrary, lead to a longer time-to-first product.

Finally, model 5 studies the importance of the experience of the NPD-leaders and the frequency of their contacts with (potential) customers on the time-to-first-product. We find that start-ups with project leaders who have more experience in new product development are faster to develop their first product. This result is significant at the 10% level. The experience of the project leader in the sector of the firm is not significant. We also find no significant effect of the frequency of customer contacts on the time it takes to develop the first product. This is, however, not an indication that customer involvement is not important for NPD-processes in RBSUs.

Involvement of the customers in the development process may be important to increase the value of the first product for the customer (Von Hippel, 1998, 2001). Our analysis only indicates that customer involvement does not significantly influence the development time.

The overall Cox proportional hazard model is significant (LR Chi-square (16 df) is 46.18, p=0.0001). More specifically, we found that routines (measured as the percentage joint-working experience of the founding team) and NDP-experience of the project leader significantly reduce the time-to-first product. Collaboration agreements with universities and research institutes seem to significantly prolong the time it takes to develop the first product.

7. CONCLUSIONS, LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Conclusions

Intangible assets and time-to-first-product have not been the object of many studies neither in entrepreneurship nor in R&D and innovation management. The relationship between them has neither been a focus of serious conceptual discussion nor tested with robust methodology and data. There exist, however, a large literature on management of R&D and new product development. Reading this literature from a resource-based and dynamic capabilities perspective reveals that the several of the key success factors for NPD can be classified as intangible assets. The bulk of the NPD-literature is concerned with large and established firms. Until today, we know very little about NPD-processes in start-ups. The general contribution, which this study sets out to make to the R&D and Innovation management literature, is to provide insights with respect to the role of intangible resources in NPD processes of research-based start-ups (RBSUs).

To test the influence of intangible assets on time-to-first-product we collected a unique dataset of RBSUs in Flanders (Belgium). Our results show that managerial experience and the related 'team capital' (Penrose, 1959), and idiosyncratic firm history (Teece et al., 1997) influence the new product development processes in RBSUs. More specifically, we found that joint work experience of founders prior to starting the focal company is important to get the first product out fast. Next, the experience of the founders in R&D and marketing are important determinants of time-to-first product launch. Experience in other functional domains such as finance, manufacturing or legal issues, on the other hand, does not significantly affect time-to-first-product. We also found that the presence of an experienced NPD-project leader reduced the development time for the first product. Finally, our results show that collaborations with other companies reduce the time it takes to develop the first product. Collaborations with universities and research institutes, on the contrary, seem to prolong the product development process.

Hence, our study shows that intangible assets play an important role for the time it takes to develop the first product. First-product-launch is an important entrepreneurial event, which takes the new venture closer to growth, profitability and financial independence. Teece (1998) stressed the importance of complementary assets next to valuable technological assets to commercialize a new product. He argued that possessing superior technology is rarely enough to build up competitive advantage of a firm. The competitive advantage of firms depends on the ownership of and capability to manage intangible assets additional to R&D such as skills, marketing, firm's organization and entrepreneurial know-how embodied in the people (Dosi et al., 1993; Teece/ Pisano, 1994; Teece 1998; Eliasson, 1998). Yet, also tangible complementary assets to an innovation are necessary and comprise such factors as competitive manufacturing, distribution facilities and complementary technologies, along with many types of services (Teece, 1986, p. 288). These studies stressed the importance of complementary tangible and intangible assets to commercialize a new product. Our study expands this view to the new product development process itself. Intangible complementary assets are not only necessary to commercialize the first product but also to develop it in a timely manner. Given the importance of intangible assets, managers, investors and policy makers should focus sufficient attention to acquiring and building them. O'Gorman (2003) argues that policy instruments designed to support RBSUs should be learning-oriented. Policy makers should take into account the importance of experience, learning, routines and organizational links in order to support RBSUs in their early growth path. The results of our study support this view.

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 think the Flemish region is very comparable to most emerging and developing high tech regions. Therefore, we believe that the external validity of this study is probably higher than studies focusing on highly developed and unique high tech environments such as Silicon Valley and Boston. 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. 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,… We believe that these variables are less sensitive to bias than our subjective measures such rating of experience of the NPD-leader. This type of bias is, however, one of the most difficult to overcome in entrepreneurship research. 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 11 years old, which is a much earlier stage than do most other databases. Finally, we only controlled for technology-specific differences in R&D 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 emphasis was to examine the effects of intangible assets at founding in the context of NPD-processes. We showed that the state of the firms intangible assets at founding is an important antecedent for the firms ability to develop the first product in a timely manner and hence to enter a new resource configuration and a new stage in its growth path with new opportunities and challenges. We did not study the dynamics of the processes by which intangible assets evolve during the early growth path of RBSUs. Both tangible and intangible assets, such as experience and skills and organizational links with other firms and universities, may perish or wear out over time. Alternatively, a firm's early source of competitive advantages may grow over time, such that a small lead may escalate into an advantage that proves to be insurmountable (Lippman & McCardle, 1987). Further theoretical and empirical work is needed to examine the dynamics of the processes by which firms build their assets and competencies. 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.

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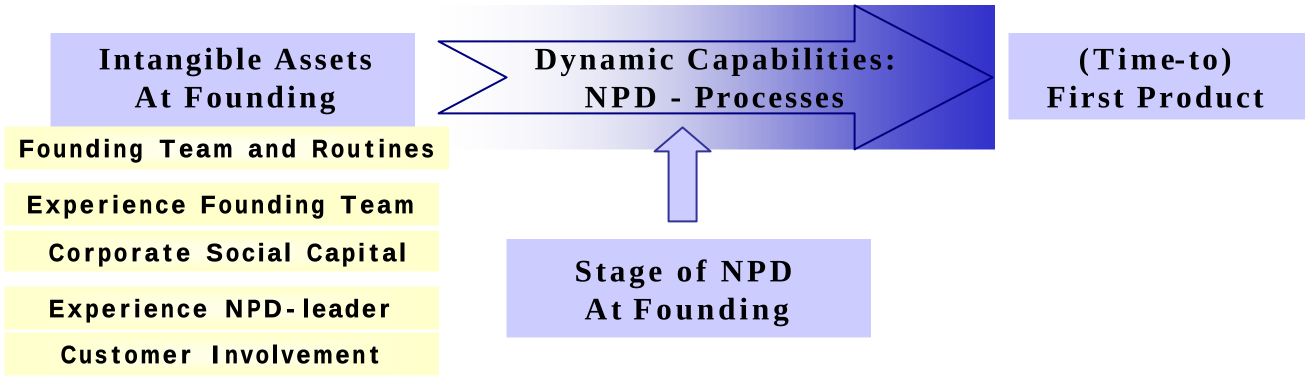

Figure 1: Intangible assets determining time-to-first-product

Table 1: RBSUs by Technological Domain

IPC Class	Technology Label	Number of Firms	Percentage of Firms
A	Medical-related	10	12
G06F	Software	40	49
H	Telecom	12	16
B,C,F,G	Other	20	23
TOTAL		82	100

Table 2: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*
Stage NPD at founding	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)
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
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)

Project leader	NPD experience of project leader	Experience of the project leader in managing new product development projects (Scaled 1 to 5, with 1 = low and 5 = high)
	Sector experience of project leader	Experience of the project leader in the sector of the firm (Scaled 1 to 5, with 1 = low and 5 = high)
Customer Involvement	Customer contact	Frequency of contact between the project leader and (potential) customers during the development period of the first product (Scaled 1 to 6 with 1= never; 2 = irregular, now and then; 3 = monthly; 4 = weekly; 5 = several times per week; 6 = daily)

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

Table 3: Descriptive Statistics for All Variables

Variables	**N**	**Mean**	**Median**	**Minimum**	**Maximum**	**SD**
Dependent Variable						
Event Product	82	0.695	1	0	1	0.463
Months-to-Product – All	82	50.902	52.5	0	127	35.544
- Event Product = 0	27	81.333	82	24	127	23.378
- Event Product = 1	55	35.963	31	0	127	30.686
Explanatory variables						
Alfa-prototype	82	0.244	0	0	1	0.432
Beta-prototype	82	0.110	0	0	1	0.315
Product	82	0.195	0	0	1	0.399
Size founding team	82	2.146	2	0	7	1.458
% joint work exp.	82	0.388	0	0	1	0.480
Years joint work exp.	82	1.988	0	0	20	3.556
Other employees	81	0.395	0	0	1	0.492
Total years of exp.	80	20.169	17	0	78	17.526
Years R&D exp.	80	12.244	7	0	60.5	14.167
Years marketing exp.	80	5.250	0	0	47	9.890
Years other exp.	80	2.675	0	0	39	6.878
Collaboration with private firms	82	0.195	0	0	1	0.399
Collaboration with universities and research institutes	82	0.207	0	0	1	0.408
NPD experience of project leader	64	2.984	3	1	5	1.453
Sector experience of project leader	64	3.297	3.5	1	5	1.433
Customer contact	74	4.405	5	1	6	1.655

Table 4: Pairwise Correlation Table

		v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16
V1	Alfa	1.000															
V2	Beta	0.601	1.000														
V3	Product	0.446	0.743	1.000													
V4	Size team	-0.128	-0.067	-0.135	1.000												
V5	%joint work exp	-0.085	0.000	-0.033	0.493	1.000											
V6	Years joint work exp	-0.079	-0.095	-0.129	0.330	0.625	1.000										
V7	Other employees	-0.141	-0.048	-0.020	0.053	0.257	0.231	1.000									
V8	Total year exp	0.026	0.002	-0.038	0.272	0.508	0.443	0.287	1.000								
V9	Years R&D exp	0.069	0.158	0.092	0.214	0.436	0.022	0.177	0.678	1.000							
V10	Years marketing exp	-0.118	-0.196	-0.127	0.095	0.277	0.558	0.229	0.509	-0.162	1.000						
V11	Years other exp	0.093	-0.039	-0.104	0.114	-0.003	0.283	0.034	0.420	-0.100	0.192	1.000					
V12	Coll. private firms	-0.020	0.119	0.128	0.239	0.322	0.146	0.297	0.227	0.361	-0.013	-0.145	1.000				
V13	Coll. Univ/ Res. Inst.	-0.048	0.008	0.068	0.226	0.309	0.015	0.170	0.167	0.282	-0.058	-0.071	0.280	1.000			
V14	NPD exp. Project leader	0.120	0.083	0.129	-0.136	0.043	0.257	0.097	0.248	-0.141	0.341	0.316	-0.152	0.032	1.000		
V15	Sector exp. Project leader	0.004	0.066	0.010	-0.273	0.075	0.044	0.148	0.117	0.036	0.136	0.003	-0.243	-0.167	0.582	1.000	
V16	Customers	-0.046	-0.021	-0.049	-0.226	-0.420	-0.312	-0.254	-0.285	-0.275	-0.150	0.068	-0.247	-0.288	0.061	0.174	1.000

Figure 2: Survival function of time-to-first-product

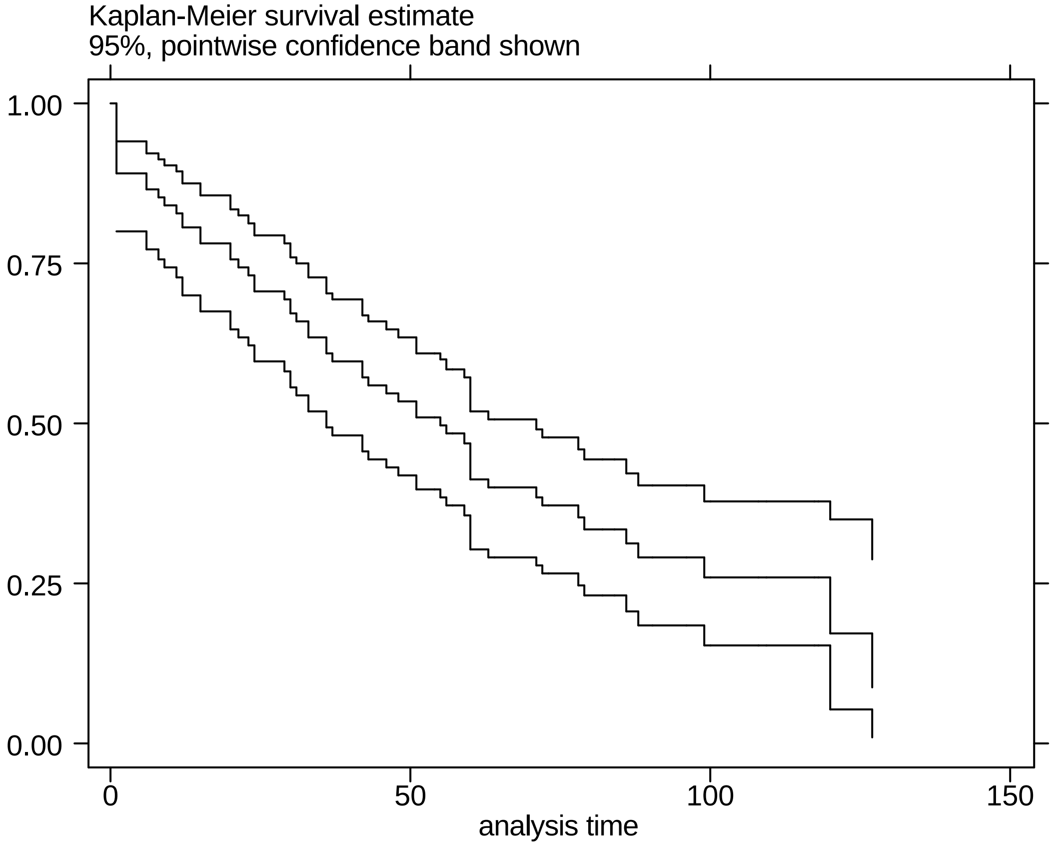

Table5: Cox Proportional Hazard Models: Determinants of Time-To-First-Product : STAGE IN NPD AT FOUNDING

Variable	Model 1	Model 2
Software	1.161 (0.426)	1.123 (0.408)
Telecom	1.797 (0.847)	1.786 (0.827)
Medical	0.656 (0.339)	0.626 (0.317)
Product at founding	10.394**** (4.141)	9.716**** (3.607)
Beta-prototype at founding	0.853 (0.444)	
Alfa-prototype at founding.	1.351 (0.498)	
N	82	82
Log Likelihood	-192.621	-193.085
LR-Chi2	33.40	32.47
d.f.	6	4
Prob. Model	P < 0.0001	P < 0.0001

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

Table 6: Cox Proportional Hazard Models: Determinants of Time-To-First-Product

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Size Founding Team	1.086 (0.128)					1.180 (0.172)
% Joint Work Experience	2.321** (0.890)					6.437*** (4.353)
Years Joint Work Experience	0.997 (0.047)					0.878 (0.078)
Other Employees	0.705 (0.212)					1.072 (0.460)
Total Years of Experience		1.019** (0.008)				
Years R&D Experience			1.025** (0.011)			1.015 (0.022)
Years Marketing Exp.			1.026* (0.015)			1.003 (0.023)
Years Other Experience			0.995 (0.024)			0.983 (0.029)
Collaboration with private firms				1.938* (0.774)		0.706 (0.414)
Collaboration with universities and research institutes				0.397* (0.190)		0.184** (0.130)
NPD experience of project leader					1.334* (0.208)	1.682** (0.381)
Sector experience of project leader					1.087 (0.143)	0.767 (0.183)
Customer contact					0.901 (0.100)	1.014 (0.134)
Product at founding	11.973**** (4.845)	11.251**** (4.324)	10.813**** (4.194)	9.981**** (3.733)	6.288**** (3.281)	8.045**** (4.990)
Software	1.034 (0.387)	1.240 (0.456)	1.153 (0.421)	0.818 (0.322)	1.378 (0.614)	0.488 (0.258)
Telecom	1.714 (0.814)	1.574 (0.744)	1.440 (0.684)	1.262 (0.599)	2.474 (1.491)	1.468 (1.002)
Medical	0.661 (0.359)	0.546 (0.276)	0.474 (0.254)	0.520 (0.267)	3.254* (2.225)	3.068 (2.170)
N	81	80	80	82	63	62
LR-Chi2	40.10	37.36	38.98	37.42	29.94	46.18
d.f.	8	5	7	6	7	16
Prob. Model	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001	0.0001	0.0001

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