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EXPLAINING GROWTH PATHS OF YOUNG TECHNOLOGY-BASED FIRMS: STRUCTURING RESOURCE PORTFOLIOS IN DIFFERENT COMPETITIVE ENVIRONMENTS

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We explore how environmental contingencies determine the way resources are accumulated in young technology-based firms and argue that growth paths are critically shaped at the nexus between resource management and the competitive environment, defined along its most important dimensions, 'stability' and 'complexity.' We also build propositions about the way environmental conditions affect resource portfolio development or acquisition. We show how particular high-growth paths result from structuring resource portfolios in accordance with environmental demands and provide insights into why, based on six case studies of young technology-based high-growth firms, involving 27 interviews, 121 press releases, 605 press articles, and archival data. Copyright © 2011 Strategic Management Society.

INTRODUCTION

Entrepreneurship research has tended to privilege growth as the primary indicator of business success (Davidsson, Steffens, and Fitzsimmons, 2009) and several studies have examined the determinants of venture growth (see Davidsson, Delmar, and Wiklund, 2006; Gilbert, McDougall, and Audretsch, 2006; MacPherson and Holt, 2007; Coad, 2009 for recent reviews). Increasingly, however, academics argue that growth has been overemphasized as a simple indicator of successful performance. Markman and Gartner (2002), for instance, show that high growth rates in different cohorts of the Inc. 500 companies do not match the profitability of these companies. Davidsson *et al*. (2009) extend this finding to companies with average rather than high growth rates. They show that companies that increase sales revenues without focusing on profitability experience unstable growth, while only profitable growth characterizes star companies that realize sustainable growth. McKelvie and Wiklund (2010) argue that previous research has placed too much emphasis on the question of 'how much' companies grow, while the question of 'how' they grow is ignored. They point out that many studies have assumed growth to be realized organically (internal), whereas further research shows that acquisitions (external) are an important growth mechanism (e.g., Hambrick and Crozier, 1985). Gaining insights into the mode of growth is important because growth resulting from either internal or external mechanisms likely has a differential influence on growth outcomes (Gilbert *et al*., 2006). McKelvie and Wiklund (2010) further suggest that focusing on modes of growth may provide better insights into the causal mechanisms behind growth.

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Many studies of growth drivers adopt a resource-based perspective, following Penrose's (1959) seminal work. In these studies, the availability of human (Feeser and Willard, 1990; Ensley, Pearson, and Amason, 2002), financial (Heirman and Clarysse, 2004; Lee, Lee, and Pennings, 2001), technological (Hindle and Yencken, 2004, Delapierre, Madeuf, and Savoy, 1998; Clarysse, Wright, and Van de Velde, 2011), and social resources (Khaire, 2010) is related to venture growth. These studies have several major shortcomings, which do not allow them to go beyond the mere establishment of an empirical link between resources and level of growth. First, they look at resources independently, while ignoring the potential of 'resource configurations' to reflect differences in growth patterns. Second, they study resources at start-up and their imprinting impact on growth later in the company's life cycle, ignoring how these bundles of resources develop over time and the way they are deployed (Gilbert *et al*., 2006; Sirmon, Hitt, and Ireland, 2007). Third, they overlook the characteristics of the competitive environment in which a venture operates, in spite of evidence that environment matters. For instance, Delmar, Davisson, and Gartner (2003) show that the growth paths of clusters of high-growth firms differ according to their industry affiliations. Romanelli (1989) argued that industry-specific studies on growth need to keep the influence of the environment constant. None of these studies, however, developed a theoretical explanation of *how* the environment shapes different modes of growth. This is surprising, as the environment construct has been studied in-depth since at least the seminal paper by Dess and Beard (1984).

Taken together, previous studies suggest that: (1) the growth literature has predominantly focused on explaining levels of growth, ignoring *how* these firms grow and *why* different growth patterns exist; (2) the structuring of resources into specific configurations can provide insights into different growth patterns; and (3) the environment plays a role in explaining different growth patterns. The ways ventures manage resources according to the specific demands of the competitive environment, which in turn results in a given growth path, is neither well understood theoretically nor empirically tested. Our study addresses this research gap by asking how the development of resource configurations and the competitive environment provide insight into different growth patterns.

Extant theory on firm growth is not sufficiently developed to allow us to propose hypotheses that test the relationship between resource portfolio structuring, the environment, and different growth patterns. Therefore, we conducted a multiple-case inductive study (Eisenhardt, 1989a). Using rich data based on 27 interviews, 121 press releases, 605 press articles, patent data, and data from financial databases, we analyze how six young, technology-based firms that achieved different high-growth trajectories have structured and deployed their resource portfolios. The companies selected operate in different industries, thus optimizing environmental heterogeneity in the design.

Our study makes theoretical contributions to the literature on firm growth and on resource-based theory in particular. First, we extend theoretical understanding of firm growth by showing that the differences in the relationship between the competitive environment in which ventures operate and the way they manage resource portfolio development lead to totally different modes of growth. Our model indicates how resource configurations are adjusted to the competitive environment and how this leads to very different modes of growth. Second, we demonstrate how resource portfolios develop over time in six young technology-based firms competing in three different environments, in order to provide better understanding of the way resources are adjusted to environmental conditions to create growth (Sirmon *et al*., 2007). This extends prior conceptual insights by showing that ventures may achieve profitable growth based on revenue from products or growth in employment through organic or acquisitive modes, depending on the nature of the competitive environment.

THEORETICAL BACKGROUND

Building on McKelvie and Wiklund's (2010) insight regarding the need to examine how ventures grow, we focus on the relationships between resources and growth and between environmental contingencies and resources.

Resources and growth

Much of the growth literature is rooted in resource-based traditions, typically linking resources to venture growth paths. The resources described in this literature comprise human, financial, social, and technological resources.

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Firm-specific *human resources* in new firms include management know-how and entrepreneurial experience of the founder and/or founding team (Welbourne and Andrews, 1996; Mosakowski, 1998). Larger founding teams, heterogeneity of industry experience, and past joint working experience are important determinants of new venture growth (Eisenhardt and Schoonhoven, 1990; Amason, 1996; Baum and Wally, 2003; Macpherson and Holt, 2007; Mustar, Wright, and Clarysse, 2009).

Financial resources represent a second key resource linked to levels of new venture growth. Attraction of venture capital (VC) is positively related to new venture survival and success (Hellmann and Puri, 2002; Davila, Foster, and Gupta, 2003). VCs select high-growth potential firms and add post-investment benefits (Baum and Silverman, 2003). Besides providing money, VCs play an important role in professionalizing the new business (Hellmann and Puri, 2002), therefore substantially influencing its growth prospects (Lee *et al*., 2001).

Social resources provide important sources for knowledge acquisition and learning, leading to growth (Yli-Renko *et al*., 2001). Knowledge acquisition and learning from partners allow the venture to climb the learning curve more rapidly than through learning-by-doing (Bruneel, Yli-Renko, and Clarysse, 2010). Further, through partnerships, new ventures can mobilize resources which would otherwise be beyond their reach. This option provides greater flexibility than acquiring resources on the market or accumulating them internally (Zhao and Aram, 1995).

Finally, *technological* resources are an important resource bundle. Ventures whose main purpose is to translate technologies into products develop their own manufacturing and marketing capabilities, thus enjoying faster growth (Delapierre *et al*., 1998). Pervasive or broad technologies enable the same platform technology to be used as a base architecture for derivative products (Meyer, 1997), thus offering the most opportunities for growth (Hicks and Hegde, 2005; Avenel *et al*., 2007).

Within the resource-based tradition, the dominant view is that more and/or better resources lead to higher levels of growth. However, several scholars question this simplistic relationship. For instance, Baker and Nelson (2005) show that resource constrained firms may achieve superior growth. Mishina, Pollock, and Porac (2004) suggest that in different environmental circumstances, the level of financial and human resources has a differential impact on sales growth. Along the same lines, Katila and Shane (2005) suggest that the environment might moderate the impact of resources on performance. Youndt, Subramaniam, and Snell (2004) extend the configuration approach toward resources to capabilities using an intellectual capital approach. They emphasize that not only is the stock of knowledge embodied in human, social and organizational resources interrelated, but also the way this stock is turned into competitive advantage results from the interplay between the different resources. Sirmon *et al*. (2007) disentangle the process through which resources are turned into portfolios by describing the intermediate step of resource bundling. Following this logic, different resource configurations can be bundled into different capability configurations which then in turn explain differences in competitive advantage. Gruber *et al*. (2010) confirm this configuration view in an exploratory study of how resources are linked to capabilities and performance.

In summary, resource-based research concludes that: (1) a lower level of available resources may have a positive impact on growth; (2) the environment plays a moderating role; and (3) resources tend to be interrelated and act as bundles or configurations rather than individual subcomponents. However, theoretical and empirical analysis of how environmental subdimensions interact with bundles of resources to create different growth paths is lacking. In the next paragraph, we discuss research on environmental contingencies.

Environmental contingencies and resources

To understand the different growth patterns of entrepreneurial ventures, it is important to understand the environmental circumstances in which they operate. The environment construct has been defined along dimensions such as dynamism, complexity, and munificence (Rajagopalan, Rasheed, and Datta, 1993). Dess and Beard (1984) conceptualize dynamism as the rate of change and the degree of instability. Rate of change refers to the speed at which the industrial context in which the firms operate can change. Eisenhardt (1989b) refers to this part of dynamism as 'velocity' and shows that high-tech environments are typically 'high-velocity' environments. With respect to instability, a key source of stability for a young, high-growth technology-based firm is its ability to appropriate rents from its own technological development, without having to create

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the market. With enforceable intellectual property rights, high-tech firms can either protect themselves from direct imitation and realize rents through a temporary monopoly position in the product market (Anton and Yao, 1994) or enter the market for technology (Arora, Fosfori, and Gambardella, 2001). Efficacy of legal protection mechanisms, therefore, represents the level of environmental stability, even in inherently dynamic environments like high-tech. Even if the environment changes in terms of industry structure, due to new firm entry or changing market demand, a well-functioning market for technology provides the venture with a stable exit option. Environmental stability is, consequently, a subcomponent of environmental dynamism.

Second, environments differ in terms of complexity (Rajagopalan *et al*., 1993; Dess and Beard, 1984). Complexity concerns the heterogeneity and range of factors which the venture has to take into account. Teece (1986) operationalized environmental complexity as the degree of 'importance' and the 'difficulty' faced by new ventures in obtaining the complementary assets to enable them to build the value chain to reach the end user. When complementary assets are tightly held by incumbents, industry inputs (and/or outputs) are concentrated, and new ventures face great difficulty in accessing or controlling the necessary complementary assets to compete. Environmental complexity has an important influence on the amount of resources needed for success and the quantity of information to be processed (Chandler and Hanks, 1994). Successful innovators in environments where technologies and markets are emerging need substantial resources to invest in building customer relationships (Meyers and Athaide, 1991) which, in turn, depend on the number of units with which the firm has to interact and the complexity of the sales process. Thus, complexity implies imperfect competition (Simsek, Veiga, and Lubatkin, 2007). More complex environments are difficult to enter, thereby limiting the option to compete in the market.

Finally, environmental munificence is the degree of resource abundance and richness of investment opportunities in the firm's environment. Simsek *et al*. (2007) suggest that munificent environments support expansion and can enable slack resources in support of growth. However, resource munificence is also related to geographical regions (Wan and Hoskisson, 2003). Hence, this third dimension is difficult to operationalize for groups of companies such as technology firms in one region. Therefore, we focus on environmental complexity and stability. The extensive literature on environmental contingencies offers little insight into how they determine the structuring of resources and, subsequently, the growth path of entrepreneurial start-ups.

Taken together, the existing literature: (1) describes a wide range of resources that might impact the different growth rates companies display after start-up, while largely ignoring *how* these resources interact and *why*; and (2) suggests that environmental contingencies might play a role in explaining the value of these resources and how these resources deploy over time, ignoring *how* different environmental characteristics impact resource configurations. Theoretical insight into how environmental dimensions *and* bundles of resources interact to create different growth paths is lacking.

We extend the resource-based theory on growth by explicitly focusing on how different growth patterns result from interplay between the competitive environment and the way resource bundles are structured and deployed over time.

METHODS

As the growth literature is insufficiently developed to formulate hypotheses that test the relationship between deployment of resource configurations, the environment, and growth paths of firms, we conducted an inductive, multiple case study design (Eisenhardt, 1989a). Pratt (2009) suggests also that qualitative research is best suited for addressing 'how' as opposed to 'how much' questions. Therefore, we analyze six specific cases of young technology-based firms that have realized quite different growth paths. Multiple cases facilitate collection of comparable data and the likely creation of more robust theory, as the propositions are more deeply grounded in varied empirical evidence (Eisenhardt and Graebner, 2007).

Our starting point was a unique, hand-collected database of young technology-based firms in the Flemish region of Belgium.[1] Young technology-

[1] We define 'young technology-based firms' as companies founded from 1991 to 2002, which develop and commercialize new product/services based on proprietary technology or skills and of which the founder or the different founders declared that they wanted to grow. These companies were identified by using four different secondary databases: (1) a list of academic spin-offs from Flemish universities and public research organizations; (2) the portfolio companies of Flemish venture capital firms; (3) a list of companies that received R&D grants from

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Table 1. Summary description of the six cases

	BEST	Artwork Systems	CropDesign	Ablynx	Keyware	Clear2Pay
Founding date	1996	1992	1998	2002	1996	2001
Description of activity	Development of sorting technology	Development of prepress software solutions	Development of a functional genomics technology platform	Development of a nanobodies technology platform	Development of biometric verification technology platform	Development of a generic payments processing platform
Sector (Nace code)	31.6	72.2	73.1	73.1	72.2	72.2
Number of acquisitions	0	0	0	0	4	5
Exit status or status today	Independent	IPO (1996)	Trade sale (2006)	Independent	IPO (2000)	Independent
AAGE[a]	13.6	3.75	9.0	20.0	35.0	45.6
(start-up until exit)	(24.8)	(2.3)	(10.1)	(13.5)	(30.0)	(57.4)
AAGR[b]	4,372	3,096	803	1,074	3,074	4,438
(start-up until exit)	(5,637)	(2,213)	(1,223)	(1,347)	(4,010)	(2,986)

Notes: [a]AAGE: average annual growth in employees, expressed in full-time equivalents.
[b]AAGR: average annual growth in revenues, expressed in 000 Euros.

based firms are significant for our research question, as each has a concrete entrepreneurial intent to grow. From the database, we identified a subpopulation of firms showing exceptional rates of growth in employment and revenues—the two most common indicators of growth in the entrepreneurship literature (Wiklund and Shepherd, 2003)—during five years after start-up. Five years is a reasonable time horizon, indicating a degree of sustainability in the growth pattern. Consistent with Delmar *et al*. (2003), we identify two rates of growth as the top 10 percent of high-growth companies in both employees (at least four FTE per year) and/or revenues (at least €500,000 per year). This reduces our sample to 24 companies. As we are interested in detecting maximal potential differences in the resource deployment strategies and the environmental contingencies in which these companies operate, we selected the six most extreme cases in terms of employment and/or revenue growth for further investigation (Eisenhardt, 1989a; Diesing, 1971).

Two companies, CropDesign and Ablynx, grew specifically in employees but experienced almost no growth in revenues (their growth is not profitable), while two companies, BEST and Artwork Systems, grew exceptionally fast in revenues with hardly any growth in employees (their growth is profitable). The remaining two companies, Clear2Pay and Keyware, have grown rapidly in both revenues and employees, but differed from the four previous ones, as they grew mainly through acquisitions (whereas the others grew mainly organically). Table 1 provides a summary description of the six cases. For a more detailed history of the six cases, see Appendix.

Data sources

We use primary data and secondary data sources. Primary data was collected through face-to-face interviews with persons who were founders/CEOs during the period from 2002 to 2008. For initial interviews, we developed a semistructured questionnaire that captures information about the firm's history, products and services, markets, and other background information. In follow-up interviews, we collected information about company development in terms of: top management team, financial

the Flemish government; and (4) a database of Flemish companies founded from 1991 to 2002 active in high-tech and medium high-tech sectors. Included in the database are 210 young technology-based firms.

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resources, growth in employment and revenues, and growth mode (i.e., organic versus acquisitive growth). For example, longitudinal data on top management team changes (i.e., entrants and exits) were gathered. To increase construct validity, we used previously validated measures for the different theoretical constructs (Spector, 1987). We performed 27 interviews with 15 members of the firms' top management teams, ranging from 45 to 120 minutes.

To complement the primary data, we used six public data sources for triangulation. First, we consulted BEL-FIRST (Bureau van Dijk, 2007) to cross-check information about growth in employees and revenues. BEL-FIRST is a financial database containing detailed financial information (annual financial accounts) on more than 320,000 Belgian companies. Second, we used ESPACENET to collect information about the number of patent applications. ESPACENET is an online, worldwide database containing information about patent applications, such as application number, application data, and patent applicant. Third, we collected information about the intellectual property right regime at sector level using data from the CIS4 survey (2002 to 2004). Fourth, we used Factiva Companies and Executives (Dow Jones Factiva, 2007), which holds detailed information on more than 30 million corporations and organizations, to collect information about the firms' customers. Fifth, we made extensive use of press releases from the companies' web sites. The number of press releases per company ranges from zero (Artwork Systems) to 41 (Keyware). Finally, we studied the press coverage of the companies by scanning the public press using Mediargus, a digital press database developed by a consortium of Flemish and Dutch newspapers that contains each article published by the consortium members since 1988 (Vlaamse Dagbladpers 2007). Using the firm name as a keyword, we retrieved from 12 to 211 articles per firm. The extent of interviews and other data sources are summarized in Table 2.

Data analysis

Following Eisenhardt (1989a), we compiled individual case histories including the interview, observational, and archival data. We triangulated the data to detect patterns of resource deployment that were confirmed during interviews and by different data sources. Interview transcripts, archival evidence, and our notes of potential causality were read and reread as data was collected, enabling emerging themes to be refined as this process progressed. We followed up several times through phone calls and emails to clarify points. The cases ranged from 20 pages (BEST) to 150 pages (Clear2Pay). Validity of emerging insights was checked throughout the process by discussion with key actors (Yin, 1993). We synthesized the material and discussed it with other academics in the research project within which this data was collected. Their views were integrated into our analysis. To avoid confirmatory biases, one of the researchers was kept at a distance during the data collection and examination process.

Our analysis is presented in two ordered steps (Taylor and Bogdan, 1984). Initially, we conducted a first-order analysis of how the six cases structured and deployed resources during the first five years after founding. In this within-case analysis, we analyzed how the human, financial, social, and technological resources evolved over time, and made a distinction between accumulating these resources versus acquiring them. We did this analysis *after* most of the data was collected to preserve the integrity of the replication logic (Ozcan and Eisenhardt, 2009). We then compared differences between companies by performing an in-depth between-case analysis to develop propositions through analytical generalization (Yin, 1993). In this second-order analysis, we introduce a contingency perspective to analyze how different environmental conditions influence the management of resources. To guide our between-case analysis, we identified environmental

Table 2. Overview of data sources

	BEST	Artwork Systems	CropDesign	Ablynx	Keyware	Clear2Pay
Number of interviews	3	4	6	3	5	6
Number of members of top team interviewed	3	1	4	1	3	3
Number of press releases	1	0	19	24	41	36
Number of articles in public press	23	12	211	127	111	121

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dynamism and complexity as the two main determinants of heterogeneity. Environmental dynamism embodies both the volatility and the stability of the environment. As we focus on young technology-based firms that commercialize products that are new to the market using emergent technology, the environment in which they operate is, by definition, volatile. Hence, we focus on the stability component. We operationalize environmental stability as the degree to which a market for the technology (and products) already exists, using the appropriability regime of the technology on which the venture is based as a proxy. Building on Gans, Hsu, and Stern (2002), we use the number of EPO and USPTO patent applications per company and the strength of the intellectual property regime at the sector level (i.e., the percentage of firms in a specific sector that has patent activity) as measures of the strength of the appropriability regime. Second, we used value chain complexity, access to upstream and downstream complementary assets, complexity of the sales process, and average size of customers as proxies for environmental complexity. We briefly discuss the within-case analysis before addressing the core between-case analysis.

DESCRIPTION OF RESOURCE PORTFOLIOS—WITHIN-CASE ANALYSIS

Human resources

Only BEST and Artwork Systems, the two companies that show an organic, profitable growth path, fit the conceptualization of strong teams suggested by Eisenhardt and Schoonhoven (1990): relatively large, heterogeneous, and complementary teams at start-up that stayed the same over time (Table 3a and Table 3b). This contrasts with the four other companies. For instance, CropDesign and Ablynx (the employment growers) started with high involvement of the technology transfer organization of the public research institute from which they were spun-off. Experienced management was attracted and put in place *after* the initial round of capital had been completed. Clear2Pay and Keyware, which grew both in revenues and employment (mainly through acquisitions), also had relatively small founding teams. Top management skills were attracted in the most important countries where they were active by keeping the top managers in place in the companies acquired. In short, we conclude that human resources can be strong or weak at start-up. Strong teams are able to realize profitable growth immediately, while weaker teams can evolve into strong teams and are found in companies with organic and acquisitive growth paths.

Financial resources

Financial resources can be generated by the firm itself, borrowed from banks or, more likely in the case of high-growth, obtained from external investors such as venture capitalists. BEST and Artwork, the two revenue growers, did not raise venture capital and used only the minimum capital needed to start a firm. BEST invested €62,500 of personal capital and secured a bank loan of €125,000 to

Table 3a. Resources at start-up

Resources	BEST	Artwork	CropDesign	Ablynx	Keyware	Clear2Pay
Human						
• # of founders	4	3	N/A	N/A	2	2
• External	1	0	N/A	N/A	0	1
• Different experience	Yes	Yes	N/A	N/A	No	Yes
• Joint working experience (years)	4	10	N/A	N/A	12	0
Financial						
• External financing	No	No	Yes	Yes	Yes	Yes
• # of investors	n/a	n/a	3	3	2	1
• Capital at start-up (in 1,000 Euro)	62.5	74.4	4,300	5,060	3,000	1,985
Technology						
• Stage of development	4	4	1	1	1	1
• Broadness	2	1	4	5	5	5

Notes: Stage of development is measured on a four-point scale ranging from 1 = idea phase to 4 = market ready product; breadth of technology is based on a five-point scale ranging from 1 = a specific product to 5 = very broad technology with different applications.

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Table 3b. Resource evolution during the first five years after founding (age at which change of resources occurred is indicated by 1 to 5)

Resources	BEST	Artwork	CropDesign	Ablynx	Keyware	Clear2Pay
Human	No changes	No changes	1: Two additions (VP technology/business alliances; director R&D) 3: One addition (director research & technology alliance) 4: One addition (R&D director) 5: One addition (CEO)	1: Two additions (director therapeutic development, director of business development) 3: One addition (CSO) 4: Two additions (CEO, CBO)	1: One addition (CFO) 4: One addition (CFO)	1: Five additions (product marketing, business development, COO, sales, product development) 2: One addition (country manager Netherlands) 4: Four additions (VP S&M, VP R&D, GM C2P Belgium, GM C2PAustralia) 5: Five additions (VP &CTO, VP & MD C2P EMEA, VP & MD C2P Americas)
Financial	5: +€25,000, personal funds	No changes	2: +€25.7 million	2: +€25 million 4: +€40 million	1: +€2.5 million 2: +€2.5 million 3: +€6.25 million 4: +€33 million	2: +€6.5 million 3: +€6.1 million 5: +€17.7 million
Social	N/A	N/A	2: 1 TA[a] 3: 1 TA 4: 2 TA 5: 1 KCR[b], 1 TA	2: 2 KCR 3: 1 TA 4: 3 KCR, 2 TA	2: 6 KCR, 4 TA 3: 7 KCR, 3 TA 4: 5 KCR, 2 TA	1: 1 KCR 3: 5 KCR 4: 3 KCR 5: 2 KCR
Technology	Start-up: First sale 3: Two types of sorting machines on the market 4: Market intro of machine with larger capacity	1: First product ready	1: Traitmill platform technology at least eight years before market introduction 2: Alliance with GBA—start of wheat product development program 5: First results of Traitmill platform technology—commercialization expected in five to seven years	2: Nanobody leads against 16 human disease targets, two leads in preclinical trials 4: First human studies, first milestone reached for treatment in the musculoskeletal category, start of Alzheimer's program	3: Biometrics technology platform ready for 20% 4: Acquisitions of applications companies in the three domains: physical access environment, e-business, and mobile telephone	1: First sale—VISA deal 2: Platform technology is ready, start development of new generation of core products 3: Global rollout of product strategy, extending product offerings with 3-D secure certified payments solutions, announcement of next generation platform technology 5: Expand product range and development of new products

[a]Technology alliance, [b]Key Customer Relationship.

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finance development of its first sorting machine. In contrast, the four companies showing high employment growth were created with significant amounts of venture capital, ranging from almost €2 to €5 million at start-up, totaling from €25 million to €50 million five years after founding. In sum, we observe that the two companies that grew in revenues but not in employment financed their growth via internally generated cash flows, while the other four companies used significant amounts of external financial resources provided by specialized venture capitalists.

Social resources

We focus on announcements of marketing and technology alliances and of key customer relationships made by the six firms as indicators of *social resources* (Park and Mezias, 2005; Yli-Renko *et al*., 2001). The two companies that grow only in revenues (the organic, profitable growers)—BEST and Artwork—do not make any announcements about alliances or key customer relationships. In contrast, CropDesign, Ablynx, Keyware, and Clear2Pay show intensive use of social resources, with the number of alliances and key customer relationships ranging from four to 27. The employment growers, CropDesign and Ablynx, make announcements about technological partnerships. The purpose of the alliances announced by CropDesign and Ablynx is to provide evidence of the technology's progression and acceptance. The acquisitive growers, Keyware and Clear2Pay, also make similar announcements, but put more emphasis on marketing alliances and key customer relationships.

Technology resources

We also analyze the characteristics of the technology resources, focusing on the technology's stage of development at founding and the 'breadth' or 'pervasiveness' of the technology as measures of the extent to which a stream of different products to serve multiple markets can be developed (Meyer, 1997). BEST and Artwork were founded with narrow, focused technologies embedded in a single product market combination that was market ready at founding, while CropDesign, Ablynx, Keyware, and Clear2Pay started with broad technology platforms in the idea phase. The focused technologies broadened over time, while the pervasive ones tended to become more focused.

Overall, the within-case analysis shows that resource levels can be very high or low at founding and evolve in different ways. Those companies that have an organic, profitable growth path have high levels of human resources at start-up, but low levels of financial, social, and technological resources. They build up financial and technological resources over time internally. The companies that grow only in employment start with high levels of technological resources and attract financial resources to build up human and social resources over time. Finally, the companies that follow an acquisitive growth path have considerable human, technological, and financial resources at start-up, but further leverage these resources and build social resources over time. We will further explore these initial findings in the between-case analysis in the next section.

BUILDING PROPOSITIONS: BETWEEN-CASE ANALYSIS

The within-case analysis, which we have described, shows significant differences between the three groups of companies in how they structure and deploy resources. Table 4 shows the environmental variables for each case and is the basis for our between-case analysis covering three contexts. The theoretical framework we develop next is summarized in Figure 1.

Quadrant 1: high stability and low complexity environments

The founders of Artwork Systems and BEST—the two revenue growers—knew there was a clear demand for their product/solution when they started the company. Artwork Systems and BEST operate in environments characterized by high stability and low complexity. Their customers are quite small (ranging from $29.7 million to $35.7 million) and easy to identify. Unlike in complex environments, where huge investments in complementary assets are needed to reach the end customer, the printers in the case of Artwork Systems and the fruit distributors in the case of BEST are easy to approach. The relatively small size of these customers also means that BEST and Artwork Systems do not need to build up sufficient legitimacy to become credible suppliers.

Ventures that target the same product/market combination as the parent organizations from which they

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Table 4. Environment: stability and complexity

Environment	BEST	Artwork	CropDesign	Ablynx	Keyware	Clear2Pay
Stability: IPR regime						
# EPO and USPTO patent applications	0	0	51	16	0	1
CIS data on IPR (2002 to 2004)	33.3	3.3	61.8	61.8	3.3	3.3
Complexity: complementary assets						
Complexity of the value chain	3	2	5	5	3	2
• Access to suppliers	2	1	3	2	2	1
• Access to distribution channels	3	3	5	5	2	2
• Access to customers	2	2	5	5	3	3
Complexity of the sales process	1	2	5	5	5	5
• Average size of customers ($ millions)	35.7	29.7	78.0	248.9	109.5	103.5

Notes: Complexity of the value chain is measured on a five-point Likert scale ranging from 1 = 'completely independent of others' to 5 = 'strong dependence of others; access to suppliers is measured on a five-point scale ranging from 1 = 'the bargaining power of the suppliers is very weak' to 5 = 'the bargaining power of suppliers is very strong.' Access to distribution channels is measured on a five-point scale range from 1 = ' the intensity of competition your firm is facing with respect to access to distribution channels is very weak' to 5 = 'the intensity of competition your firm is facing with respect to access to distribution channels is very fierce.' Complexity of sales process is measured on a five-point scale ranging from 1 = 'not complex' to 3 = 'complex but clear identification of key decision maker is still possible' to 5 = 'very complex.'

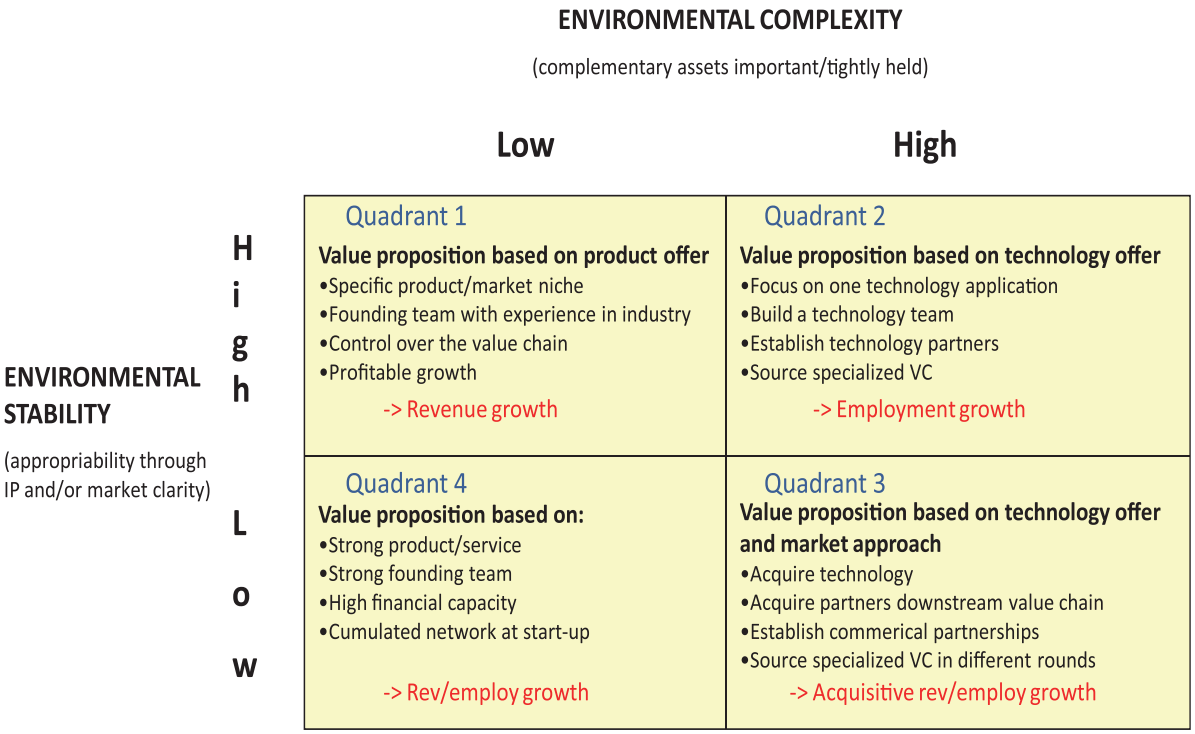

Figure 1. Hypothetical framework

are (formally or informally) spun out, grow significantly faster than those that do not (Feeser and Willard, 1990). This also links into the idea that new ventures should first target niche markets below the radar screen of large incumbents (Carter *et al*., 1994) and that if entrepreneurs already have experience in these markets, the probability of growth becomes very high (McGee, Thomas, and Pruett, 1995).

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The resource portfolios of both companies (see Tables 3 and 4) did not include venture capital, but classic financial instruments such as bank loans. Financial data showed that both companies' growth is mainly financed through internally generated means and both stayed profitable throughout the growth phase. The average annual cash flow generated by BEST and Artwork is around €2 million.[2] These high, positive cash flows provided sufficient financial resources to both companies, facilitating growth without the need to raise external financing. Interestingly, there were no top management team changes in the first five years after start-up. Both companies had an experienced top management team that represented all the competences needed to become successful on the product market. The founders felt they were sufficiently in control of difficulties, so there was no need to enlarge the team. The development of human resources and knowledge was mostly through gaining insights into new (international) markets. In an interview, the CEO of BEST declared to us:

> There is no separation between R&D, engineering, and services. All employees are trained in the three activities. All employees spend at least 35 nights per year abroad, travelling to different customers and providing them services and after-sales support. In a way, all our employees are salesmen.

This illustrates that the human resources accumulated over time reside in knowledge about customers and contacts with these customers. Neither BEST nor Artwork announced any strategic partnerships. Instead, social resources are situated at the individual level within the companies. Finally, technology is not developed as a separate platform of knowledge, but embedded within the commercial and production knowledge of the employees. This brings us to the following proposition:

> *Proposition 1: In stable, low complexity environments, young technology-based firms will realize an organic, profitable path of revenue growth in the first five years (while employment remains stable) by (1) keeping a specific product focus; (2) starting with an experienced team that remains stable; (3) keeping control over the value chain (minimal partnerships); and (4) using its accounting profit to finance growth.*

Quadrant 2: high stability and high complexity environments

CropDesign and Ablynx, the two employment growers, are active in an environment characterized by relatively high stability, measured by strength of IPR regime and a clear market focus. Although the environment tends to have high stability, both in perception (market focus) and facts (IPR), CropDesign and Ablynx face complex value chains. In these value chains, large incumbents, such as seed companies (CropDesign) and pharmaceutical companies (Ablynx) control downstream complementary assets (i.e., distribution channels). In CropDesign the founders wanted to avoid this complex value chain by focusing on rice instead of corn as a downstream market. Unlike corn, the value chain of rice is fragmented and there are thousands of varieties. However, subsequently they realized that the business model in corn seemed to be much clearer. There *was* a market for genetically manipulated corn, so they did not have to create one as they had to do with rice. There were large players already distributing corn, so they did not have to acquire small seed companies to enter the market as they did with rice. If they could show that their genetic variety had a crop yield that was X percent higher and that this crop yield was stable over generations, this would be sufficient. Thus, value chain complexity forced their business model to concentrate on technological development, but also made the business model quite clear.

To be successful in such a complex, though relatively stable, environment, Ablynx and CropDesign have structured their resource portfolios as follows: first, both companies are venture capital backed and, in their first five years, raised from €50 to €65 million from syndicates of international venture capitalists specialized in their respective technology domains. In both cases, the prestige of the research institute from which they were spinning out was extremely important in attracting venture capital from *specialized* VCs. The interview notes revealed that in both cases, it was extremely important that investors understood the business model of the business they invested in. For instance the CEO of CropDesign told us:

[2] In contrast, the annual average cash flows of CropDesign, Ablynx, Keyware, and Clear2Pay are highly negative, ranging from –€1.5 million to more than –€4 million.

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> In our sector, companies get sold for €80 to €120 million if they can show a substantial improvement in crop yield that was stable in field tests. This was the target for our investors, and we did not try to get into the market for seeds any more ourselves.

Also, Ablynx used the various rounds of financing to speed up development of their technology platform by investing in new laboratory equipment and recruiting R&D staff. For example, the CropDesign CEO declared that the money from a €16 million capital round would be used to finance large field experiments (*De Tijd*, 2004). These financial resources were used to build a management team from the ground up. Both Ablynx and CropDesign recruited top management team members with business and technological profiles during the first five years. Ablynx hired three executives with business profiles and two executives with technological profiles. The resources they recruited were meant to bring technical professionalism. It was important that the pharma and seed companies trusted the companies' management capabilities to overcome complex technical hurdles. The CEO of Ablynx told us:

> In large pharmaceuticals, they typically do not want to take the technical risks of a small biopharma company because they have so many other leads they can focus upon. However, once you enter into clinical trials, you have to know the language they talk and organize it in an acceptable way.

In addition to investment in human resources and R&D facilities, significant amounts were invested to build a patent portfolio to protect the technology and create legitimacy toward potential investors and acquirers. Despite the large patent portfolios and the multipurpose nature of the underlying technology, both companies decided early on to focus on one application and accumulate resources in that specific domain rather than spreading resources over several applications. For instance, CropDesign focused first on rice and then on corn because of the potential opportunities downstream the value chain. This focus allowed them to build a network of technology partnerships and a critical mass of expertise. Although this focus made them vulnerable, they argued that large incumbents would never look for the same technical solutions or finance the same product development internally because it was too risky. Hence, business model uncertainty was limited to the technical uncertainty of being able to realize the crop improvement or being able to develop a drug into clinical phases. The technological partnerships of CropDesign and Ablynx are, therefore, carefully selected and broadly announced to raise interest in the downstream market. As both operate in environments where complementary assets are tightly held by a few companies, information about this kind of partnership spreads very easily and indicates a high level of technological competence. Thus, we propose:

> *Proposition 2: In stable, though complex environments, young technology-based firms will follow an organic growth path of employment growth during the first five years (while revenues lag behind) through building a strong technology proposition characterized by: (1) a specific technology-application focus; (2) a critical mass of technical experts; (3) a number of technological partnerships; and (4) a significant financial base collected from specialized investors.*

Quadrant 3: Low stability and high complexity environments

The environments in which Clear2Pay and Keyware operate are unstable and complex. These companies face very weak appropriability regimes. Keyware has no patent applications, while Clear2Pay filed one application at the USPTO, which the company later dropped. The founder of Clear2Pay explained why patenting is not very useful in their environment:

> It was purely defensive . . . You can get a patent granted, but the legal insecurity remains very high . . . The cost of the application ranges from €150,000 to €200,000. But this doesn't reflect the real costs. A patent application is very demanding for people who are creative and technical. I do not know if we will go through this (patenting) again with our future innovations.

Both Keyware and Clear2Pay entered the market with revolutionary ideas for which customer demand was, at first, unclear. While working at a large bank, one of Clear2Pay's founders observed that the handling of international payments was very time and cost inefficient. He wondered how the internet might be used to simplify the process. He knew, however,

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that banks are reluctant to adopt new technologies. High environmental instability is exacerbated by the environmental complexity faced by Keyware and Clear2Pay. Customers are relatively large (typically greater than $100 million in revenues) and tend to buy from only established, legitimate suppliers. The difficulty and intensity of the resulting sales process is illustrated in the following extract from a public press article about Clear2Pay (*Australian Financial Review*, 2004):

> The complexity of payment solutions results in both a long sales cycle and a need for a product specialist . . . It can take Clear2Pay up to three years to clinch a sale with a customer (financial institutions).

The environmental instability and complexity faced by both companies is reflected in the way the resource portfolio is structured. First, both Clear2Pay and Keyware raised significant amounts of venture capital (up to €45 million) from syndicates of international investors during the first five years. It was clear from start-up that both companies would target an exit to generate returns for investors. Financial resource deployment decisions should be seen in the light of such an exit. The first financial resources were set up to develop a team as quickly as possible, as indicated by the founder of Clear2Pay:

> Akkermans joined Clear2Pay as founder, business angel, and CEO upon my request. Together with him, 50 people from S1 (the company Akkermans had founded before and sold) joined us. These people were vital to the existence of Clear2Pay. They had the knowledge to build the PayPark platform. Without them, it would have been impossible to do so. Recruiting such a team takes years, and time is extremely important in the fast-changing world of e-financing.

Once the company was set up, the strategy of acquiring rather than accumulating resources remained in place. Clear2Pay made five acquisitions during the first five years after founding, while Keyware undertook four. Each acquisition was downstream the value chain, both to buy into customers and to build international presence. Time to market and accelerating internationalization seem to be crucial factors in motivating this acquisitive strategy. For instance in a 2004 press release, Clear2Pay announced:

> . . . this third-round financing will enable us to implement our growth strategy. Our previous acquisitions have not only allowed us to increase our international presence, but the subsequent integration also enabled us to accelerate the roll-out of our product strategy.

These acquisitions are very important to get timely access to customers. Due to the long sales process, it is often cheaper to buy into a customer by taking over an existing supplier than to start a sales process from scratch. However, both companies reported that it is extremely important that acquisitions are profitable, otherwise cash burn in the holding company goes out of control at a time when the holding company is not profitable at all. This results in a complex organizational structure where executives from the acquired companies tend to be included in the top management team of the original company. Clear2Pay added 13 new members to its management team during the first five years. The reason Clear2Pay gave for this approach is that the founders wanted to keep close control of the cash flow in each acquired company. Keyware did not, but reported after the collapse of the company (10 years after founding) that this was one of the main mistakes made during the first five years. Instead of integrating the executive team of the acquired companies into the top management team of Keyware, they fired them and, thus, lost the benefits of their knowledge. During our interviews, the CEO of Keyware said:

> The CEO of the acquired firm leaves within less than three years . . . this makes sense; you cannot stay an entrepreneur in a company that is no longer yours . . . Once acquired, we become the new 'boss' and he can no longer do whatever he wants . . . We decided not to integrate them into our management team as these guys are entrepreneurs, not managers.

In addition to acquisitions, each customer deal is widely communicated to the press by both Clear2Pay and Keyware as a 'strategic commercial partnership' or a 'key customer relation,' depending on deal size. In total, Keyware reported 19 such partnerships, while Clear2Pay had strategic partnerships and key customer relationships with nine companies. These companies placed considerable importance on signaling the commercial partnerships they had already achieved to other potential customers.

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In sum, young technology-based firms in these environments acquire, rather than accumulate, a resource portfolio. This acquisition strategy is high risk, as it is financed by risk capital; however, acquired companies should not add to the company's burn rate if they are acquisitions downstream the value chain. To raise the interest of end customers, commercial partnerships are announced widely. Hence:

Proposition 3: In unstable and complex environments, young technology-based firms will follow an acquisitive growth path of revenue and employment within the first five years through building up a strong customer proposition characterized by: (1) a novel technology customized to specific market needs; (2) a team of managers with in-depth market knowledge and technical expertise; (3) a legitimate amount of commercial partnerships; and (4) a significant financial base collected from a variety of specialized investors.

Quadrant 4: low stability and low complexity environments

We found no cases showing extreme growth patterns in highly unstable but simple environments. Low-complexity environments imply that new entrants can easily reach the end customer. However, when the environment is unstable, it is difficult to protect knowledge or technology from being copied by competitors or to sell knowledge on the market for technology or ideas. The unstable environment suggests there is no market for technology, so companies need to grow fast to guarantee a place in the product market. We did not observe any cases in this quadrant; this may be due to our focus on young *technology-based* firms. In less technology-based contexts, such as Web 2.0 services, the environment is inherently unstable. The market often has to be created, and no market for technology exists, nor is protection possible. At the same time, these markets tend to be simple. For instance, in a survey of mobile web services, Powers and Walters (2009) find that more than 5,000 companies entered this space in the last three years. The ones that realized growth tended to be those who were able to secure enough capital at founding, had an experienced team, had a network of customers at start-up, and offered a unique value proposition. This suggests that in this quadrant, the key to success is the availability of resources at founding. This leads us to the following proposition:

Proposition 4: In unstable, though simple environments, young (technology-based) firms will follow an acquisitive growth path during the first five years based on: (1) a strong financial base at founding; (2) an experienced founding team; (3) an available network at founding; and (4) a distinct technological proposition.

DISCUSSION AND CONCLUSION

The resource-based growth literature falls short in explaining: (1) *why* technology-based companies might show different patterns of growth; (2) how resources interact with each other and evolve over time into different resource configurations that are indirectly related to growth; and (3) how the interplay between the competitive environment and the structuring of the resource portfolio over time shape different modes of growth. We address these gaps in the literature and summarize our findings in Figure 1.

We extend resource-based theory explaining growth by showing that the intersection between the venture's competitive environment and the way bundles of resources evolve into configurations over time explains why young technology-based firms exhibit different patterns of growth. These growth patterns differ in terms of mode (organic versus acquisitive growth, McKelvie and Wiklund, 2010) and nature (profitable versus nonprofitable growth, Davidsson *et al*., 2009). Although the growth literature has suggested these growth paths exist, it has not provided a clear explanation of *why* they exist.

If the competitive environment was relatively stable, resource accumulation that results in an organic growth path was the main mechanism, while resource acquisition associated with acquisitive growth was the main mechanism to build a resource portfolio if the environment was relatively instable. In stable environments, young technology-based firms with successful growth paths tend to accumulate resources over time, whereas in unstable environments, there is less time to build resources gradually. Lack of protection mechanisms in an unstable environment and absence of a market for technology as an alternative exit mechanism mean that building market share and legitimacy quickly through acquisitions is the only possible route to market.

To explain whether growth will be fueled by internal cash flow from profits or will depend on external

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financing, we need to look at the complexity of the environment. If the environment is simple, the customer is easy to reach and resource accumulation will be financed with internal cash flow. In contrast, in a more complex environment where the customer is more difficult to reach, resource accumulation is financed by external capital from specialized venture capitalists. This form of resource accumulation results in a nonprofitable growth path, at least during the first years after start-up. In a complex environment, the nonprofitable growth is intentional, as the venture benefits in the longer term more from developing a stronger technology base (in a stable environment) or from investing in human, technological, and social resources (in an unstable environment) than from focusing on profitability. The profits that can be realized after developing these resources, or the value that can be obtained through selling the newly built resource configuration, are expected to more than offset the losses from the initial years. These findings clearly show how the environment influences how resource bundles evolve over time and result in different growth paths.

Our empirically grounded model further extends the resource-based explanation of growth by showing how abundance of certain resources substitutes for lack of others at founding and how these different levels of resources develop into resource portfolios optimally adjusted to the competitive environment.

For instance, in highly stable and low complex environments (Quadrant 1), relevant experience of the founding team at start-up compensates for a lack of financial resources, which helps a venture realize a 'profitable growth' path. As the environment is simple, cash flow can be generated relatively quickly if there is a market for the product. There is no need to look for substantial external capital. If the environment is also stable, the venture likely does not have to move quickly, so it can grow organically, at least if the experienced founding team remains stable and no external expertise has to be hired. When the environment is stable but complex, however (Quadrant 2), there is no easy way to reach the end customer. Hence, substantial financial resources and a strong value proposition are needed at start-up to be successful; entrepreneurial human capital is less important. Availability of venture capital makes it possible to attract experienced managers externally. Thus, low levels of certain resources (e.g., entrepreneurial human capital) can be substituted by higher levels of other resources (e.g., strong technology and financial basis) in complex environments. However, if the environment is not stable (Quadrant 3), experienced management has to be attracted quickly and their level of experience will need to be much greater than if the environment is stable. This facilitates both the functioning of the market for technology and protection of the value proposition from easy imitation.

Thus, we extend resource-based theory by showing how the development of resources into resource configurations happens and by indicating that the appropriate resource configurations will differ across the different types of competitive environments. Our analysis repositions the findings of Baker and Nelson (2005), Katila and Shane (2005), and Sarasvathy (2001) who each, in different ways, argue that lack of resources does not necessarily prevent a new venture from being successful. We extend their findings by showing how the competitive environment determines what managerial agency is left to operate with limited resources. These findings are also in line with those of Sirmon and Hitt (2009), who show in a sample of banks that different levels of investments in human and physical resources will lead to higher performance levels if these different resource bundles are deployed in market segments where the degree of environmental complexity matches the resource bundles. We also analyzed how resources are accumulated or acquired over time. By doing so, we add to understanding of the process of resource deployment and the structuring of resource portfolios. Our cases take concerted decisions matched with the environment in which they operate. For instance, start-ups in highly stable and low complexity environments (Quadrant 1) bootstrap. In this environment, financial slack is not necessary, as the company has time to develop (Katila and Shane, 2005). We also show that the availability of a market for technology in stable environments allows new ventures to build a resource portfolio concentrated on the technological value proposition. In other words, growth in a market for technology is concentrated around capacity, while successful companies are not profitable, as they do not generate revenues. The four resources develop in a concerted way. A specific application is chosen to prove the superior value of the technological resource, a team of technical experts is built around this technological value propositions, the legitimacy of the value proposition is ensured by signaling technological partnerships with large incumbents, and specialized technology-specific venture capitalists are attracted to finance the development. This evolu-

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tion results in a bundle or configuration of resources that cannot be disentangled to explain the actions or performance of these companies. The same happens if the environment is not stable and complex; in this case, 'speed to market' seems to play a major role (Quadrant 4). Accumulation of resources might take too long, so technological and human resources are preferably acquired. For such an acquisitive strategy, there is a need for significant venture capital to identify and fund acquisition targets. A heterogeneous management team is built by integrating management of the acquired firms into the holding company, and technological companies are purchased to fill the gap in the value proposition. In addition, an extensive network of business partnerships is elaborated to gain legitimacy on the market.

In sum, as far as we are aware, this is the first study to operationalize the development of resource configurations in relation to environmental context with respect to new ventures. We add to understanding of *how* resources are adjusted to environmental conditions to create value (Sirmon *et al*., 2007; Sirmon, Gove, and Hitt, 2008; Sirmon and Hitt, 2009). We also add to resource-based theory by showing how slack in certain resources impacts constraints in other resources (Gruber *et al*., 2010). We explain how the interaction between the environment, starting resources at founding, and their development over time shape modes of growth. We confirm that resource-constrained companies can be successful, as suggested by Baker and Nelson (2005) among others, but we extend that perspective by demonstrating that constraints in certain resources will need to be compensated by resource abundance in others (Gruber *et al*., 2010). Again, the competitive environment in which these companies are active influences which resources can be constrained and which ones are needed to successfully start the company. Our findings that resource constrained companies can be successful if the constraints in some resources are compensated by strengths in other resources is consistent with Sirmon *et al*. (2010). They show that resource weaknesses are not always negative, because this may be necessary in order to make the necessary investments to develop strong resources in specific areas that allow the firm to compete effectively.

Finally, we show how suboptimal resource configurations at start-up evolve into optimal configurations adjusted to the competitive environment. This means that knowing how to manage the resource portfolio is more important than having resources in place at founding.

Implications for further research

Like all articles, this one has a number of limitations that provide opportunities for further research. Our analysis is based on a sample of six firms, albeit drawn from a larger focused population. Future research needs to test the propositions developed in this article using large-scale quantitative longitudinal studies. The focused population in one region provided a consistent institutional context suitable for initial theory building. Further research is needed in different institutional and sectoral environments, especially with different environmental munificence, in order to establish the generalizability of the propositions developed. For example, we developed proposition 4 relating to low-stability, low-complexity environments, but in the context studied here, we were unable to identify any cases that fit this configuration. Additional studies in different sectors could help establish the generalizability of this proposed relationship.

We have shown that development of the resource portfolio in a certain environmental context leads to perceived success in that context. Perceived success further enables the development of the resource portfolio, but causes and consequences might be extremely difficult to disentangle. Further research might seek to more carefully explore these relationships using alternative research designs and data sets to understand growth. For example, research might take a cohort of new high-tech firms at start-up and follow them over time to compare the resource portfolio accumulations of those that subsequently experience high-growth with those that do not. Large-scale and longitudinal quantitative studies enable the application of well-established techniques to deal with endogeneity. Although we have identified environmental contexts where acquisition of resources is preferred to organic accumulation, it was beyond our scope to examine the process by which suitable acquisition targets (or, indeed, partnerships) are identified and assimilated. Further research is needed to address this important issue, since the challenges involved are well known from the wider acquisition and alliance literature. However, new high-growth start-ups may be distinctive in their lack of capabilities to search for appropriate acquisition and alliance partners.

A further issue concerns the different life cycles experienced by the companies and their relationship with the nature of growth trajectories. First, further work is needed on the sustainability of growth tra-

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jectories beyond our window of study. Research might usefully consider issues such as whether sale- or employment-oriented growth is more sustainable, the conditions and periods under which employment growth can be sustained until sales revenue can be generated or further rounds of venture capital obtained, etc. There is also a need to consider whether firms remain independent or exit to a different ownership structure, as well as the nature of growth that accompanies these strategies. Three of the companies remain independent, two have experienced IPOs, and one experienced a strategic sale. While there has been considerable focus on IPOs as an exit route for VC firms, strategic sales are also an important exit route (Cumming and MacIntosh, 2003; Murray, 1994). Among our sample, we find that revenue-oriented companies focus on growth through attracting customers, while exit-oriented companies grow in employees (not revenues) and build legitimacy in the market for investors and acquirers. Young technology firms that show both high-growth in revenues and employees create legitimacy through acquisitions of complementary assets downstream the value chain; these companies face a weak appropriability regime and a market that has to be created. The boundaries of our focus are on building on the work of Delmar *et al*. (2003) and others who also examine the different trajectories of high-growth firms, to explain how resources, environmental conditions, and resource development strategies interact to generate different high-growth strategies. It was not our purpose to examine whether these differences existed between high-, low-, no-, or average-growth high-tech firms (Denrell, 2003) or, indeed, in relation to surviving or nonsurviving firms (Aldrich, 1999). Further research might pursue these avenues.

CONCLUSION

Although there is emerging recognition that new ventures may pursue different growth paths, how and why they achieve these different growth paths has remained something of a theoretical black box. By opening this black box, our study ties into recent work on how resources are structured and turned into value creating capabilities (Sirmon *et al*., 2007; Holcomb, Holmes, and Connelly, 2009). We show how the competitive environment determines both how resource configurations evolve over time and the modes adopted to structure resources: organic accumulation (internally) or acquisition (externally). As such, we extend resource-based theory on growth by showing that different growth paths result from an interplay between resource management and the competitive context in which young technology-based firms operate. Our study serves as a departure point for large-scale longitudinal studies of different growth trajectories that can further explore the configurational and contingency approach with regard to resource management. Researchers examining the relationship between resource management and different growth patterns can build on our insights regarding the role of environmental contingencies.

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APPENDIX

Belgian Electronic Sorting Technology (BEST)

The idea to create Belgian Electronic Sorting Technology (BEST) resulted from market pull. Two engineers, while working at a company that developed and commercialized inspection machines for the food industry, noticed that customers, especially in the raisin industry, showed more and more interest in sorting machines. Since their employer showed little interest in this type of machine, the two engineers wrote a business plan together with a business manager and established the company BEST in the spring of 1996. To strengthen the team, the three entrepreneurs attracted a person with extensive commercial experience in the industry. The company sold its first raisin sorting machine within six months after start-up. Four years later, the company has a whole range of machines for sorting shrimps, peanuts, walnuts, etc., and it sells products in 28 different countries through an extensive network of local sales agents. In 2000, the company also established a subsidiary to serve the large U.S. market (25% of total turnover is realized in U.S.). Three years later, the company made its sole acquisition: Barco Machine Vision. Through this acquisition, BEST extended its product range with sorting machines based on camera, infrared, and X-ray technologies, adding a new important selling area to BEST's existing markets. The company, which started with four people and a turnover of less than €100,000, grew to more than 100 people realizing a consolidated turnover of more than €30 million at the end of 2004. This considerable growth positions BEST among the top three in the world in the development and commercialization of sorting machines.

Clear2Pay (C2P)

Clear2Pay (C2P) is a niche company with a single-minded focus on providing payment and payment-related solutions for financial institutions and their clients. Using its electronic payments processing platform, C2P leverages the existing financial institution's infrastructure to integrate it with the client's financial value chain. While working as an investment banker, the founder of the company realized that international payments are executed in several steps, resulting in considerable costs and a relatively long handling time. Contrary to this 'corresponding banking system,' he shaped the concept of performing international payments using the Internet. Given his lack of entrepreneurial experience, he attracted a very successful entrepreneur with substantial experience in the financial payments industry. The company started to translate the concept into a technology platform: the core payment-processing engine PayPark Bank Payment Hub (finished by the end of 2004). To speed up developments, C2P acquired Tectrade in 2002, which designed and built transaction platforms. Since 2002, the company has experienced accelerating growth through a series of acquisitions in every continent. To sustain the technological developments (R&D expense in 2006 was €7 million) and to expand the marketing and sales efforts, the company raised external financing in several rounds totaling €33.2 million. Both the number of employees and revenues generated soared since start-up: an annual absolute growth in employees of 45.6 FTE and €4.44 million in revenues.

CropDesign

In 1998, the biotechnology company CropDesign emerged as a spin-off company from the Flemish Institute for Biotechnology (VIB). The technology transferred to the spin-off stems from research started in 1989 at the Department of Plant Genetics of Ghent University and further developed within VIB. The research group developed knowledge/technology in cell division and cell cycle technology, which creates the possibility of producing novel, transgenic varieties with increased yield, improved resistance against various diseases and adverse environmental conditions, etc. The initial results of the technology were so promising and the variety of applications so high that the idea grew to develop a technology platform. So in 1998, the underlying IP (eight patents) of the technology platform was transferred to CropDesign. The company started with five employees working on the development of a genomics platform called Traitmill®, which is a plant evaluation factory. To accelerate technological developments, CropDesign built up critical mass relatively rapidly by hiring additional researchers; the company had 72 people on the payroll in 2002. Although initially focused on rice with breakthrough results at the end of 2003, the company shifted attention to the more financially attractive crops (i.e., maize). This new

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research direction attracted the attention of several large maize companies, including BASF Plant Science. This company signed a broad license and research cooperation agreement which turned into the acquisition of the biotechnology company by BASF in mid-2006.

Keyware Technologies (KT)

In the period 1980 to 1985, a research group at a company called Excalibur started experimenting with adaptive pattern recognition processes and neural networks to identify persons by their face. Although the technical results were spectacular, the company had no clear idea about possible applications. Just 10 years later, two employees (among which was Excalibur's CEO) started to explore market opportunities for the technology and concluded that there was a need for verification processes in several large markets. So in 1996, Keyware Technologies (KT) was created with the mission to build a technology platform that combines different biometric technologies, such as voice, face, and fingerprint verification. Within 12 months, the company turned the proof of concept into a technology platform, and they sold the first products in 1998. To strengthen the company's commercialization process, KT acquired a number of companies developing and selling applications that could be integrated into the technology platform. As a result, KT sales jumped from less than €200,000 in the first three years to almost €4 million in 1999. Profiting from the economic climate characterized by soaring stock prices of young, technology-based companies, KT developed plans to go public. The company contracted a consortium of investment banks to manage the market introduction, and KT was listed on EASDAQ stock exchange on June 22, 2000. The money raised via the IPO was to be used to support the acquisition strategy of product-oriented companies active in network security, access control, and smart cards.

Artwork Systems

In 1989, DISC, a company that developed prepress software, was taken over by Barco, a world leader in display and visualization solutions. After the acquisition, Barco integrated DISC within the existing structures and also transferred its business culture. The three founders of Artwork Systems worked at DISC and experienced difficulties adapting to the new situation. In the beginning of the 1990s, they saw a market opportunity that couldn't be exploited within the boundaries of their employer's business. The takeover of DISC and the identification of the market opportunity triggered the founding of Artwork Systems. Artwork Systems, created in mid-1992, develops complete and integrated software solutions for the preparation of professional color printing, i.e., prepress software. The company signed its first deal within six months after founding. Targeting a very specific niche, Artwork Systems faced little to no competition. As a result, the company sold its products worldwide and realized double-digit sales growth. Since the founders decided not to attract venture capital, profits were reinvested to support the company's growth. EASDAQ was created in late-1996 following the successful American Stock Exchange NASDAQ, to offer high-growth technology firms the possibility to go public. Artwork Systems grabbed this opportunity, realized an IPO at EASDAQ, and used the capital raised to spur growth.

Ablynx

Biotechnology company Ablynx is a spin-off from the Flemish Biotechnology Institute (VIB) and the Vrije Universiteit Brussel (VUB). In 1993, a research group at VUB discovered a unique type of antibody that occurs in certain animals belonging to the Camelidae family (e.g., camels and llamas). Later findings showed that these antibodies offer several advantages over conventional antibodies: they have a much simpler structure, are easier to isolate, and lend themselves feasibly to small-scale production. By 2000, the research group, in collaboration with a multidisciplinary team at VIB, had created a technology platform that could be used for the discovery and development of therapeutic drugs. Subsequently, a business plan was developed and Ablynx was founded administratively at the end of 2001 (and became operational in early-2002). Ablynx started with 10 employees, including five former VUB researchers. This structure was crucial to transfer the technology from the VUB group to the newly founded company. The VIB appointed a professional headhunting company to form an experienced management team, which enabled the company to raise start-up capital of €5 million from an international consortium of venture capitalists specializing in biotechnology. By mid-2004, Ablynx entered into its first collaboration agreement for discovery and development with a leading pharmaceutical company—Procter and Gamble Pharmaceuticals—to develop Nanabody®-based drug candidates. Other collaboration agreements were signed with companies such as Johnson & Johnson and Novartis. In addition to collaboration agreements, the company also signed (commercial) research and licensing agreements with Wyeth and Boehringer Ingelheim, worth $212.5 million and $265 million respectively.

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