Whom do I search for? Variances of Linkage Formation Processes of Nascent Ventures in New Product Development

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Document Identifier
D5.1

Version
1.0

Date Due
M136

Submission date
22.05.2018

WorkPackage
5

Lead Beneficiary
UU

Grant Agreement Number 649378

Change log

Version	Date	Amended by	Changes
1.0	22.05.2018	Lukas Held	-
1.1			

Content

1. Executive summary

Nascent ventures in knowledge-intensive industries establish external linkages to complement firm-level resources – a process of strategic importance because such linkages substantially contribute to the venture's performance. However, little is known about how, and under what circumstances, ventures create linkages to what kind of external partners to develop their product. Our paper aims to address this research gap by identifying patterns of when and how founders add more diversity to their ventures, and which characteristics drive this linkage formation process. Empirically, we identify distinct patterns of external linkages formation in new product development, the characteristics that drive the linkage formation process, and also identify those factors that hinder ventures to form them. Methodologically, our paper introduces the optimal matching technique to research on external linkage formation in new product development.

2. INTRODUCTION

Innovation and management scholars have emphasized that the breadth of external search substantially contributes to a firm's new product performance (Chapman, Lucena, & Afcha, 2018; Dahlander, O'Mahony, & Gann, 2016; Leiponen & Helfat, 2011; Meyskens & Carsrud, 2013). External linkages have been associated with a variety of positive outcomes, including greater product novelty and better new product performance (Hoang & Rothaermel, 2010; Nieto & Santamaría, 2007; Rothaermel, 2001), in particular for resource-scarce nascent ventures (Haeussler, Patzelt, & Zahra, 2012; Hoang & Antoncic, 2003; Meyskens & Carsrud, 2013). However, while firms increasingly rely upon external actors in their product development (Freitas, Clausen, Fontana, & Verspagen, 2011; Powell, Koput, & Smith-Doerr, 1996), we have little knowledge of how, and under what circumstances, nascent ventures create linkages to what kind of external partners. To put it differently, we do not know when and how founders or founder teams add more diversity to their ventures through external linkages. This paper aims to address this research gap.

We examine different patterns in linkage formation processes of nascent ventures in new product development. Building on the resource-based view of the firm which interprets firm behaviour as a search for competitive advantages, shaped by resource endowments and knowledge stocks (Ahuja, 2000; Alvarez & Barney, 2001; Wernerfelt, 1984), existing studies on external breadth generally suggest that broader partnerships allow ventures to access more diverse sets of knowledge and information (Ireland, Hitt, & Vaidyanath, 2002). The analysis of external partnerships, however, has been based on a somewhat coarse-grained analysis. With few notable exceptions (Fitjar & Rodríguez-Pose, 2013; Hoang & Antoncic, 2003; Hoang & Rothaermel, 2010; Meyskens & Carsrud, 2013; Rothaermel & Deeds, 2004), prior studies have not systematically distinguished between the two most important types of external linkages in new product development: External linkages that concern the (often early) research-oriented phase and the (often later) market-oriented phase. Ignoring the variance of these two very different functions of external linkages can lead to unclear results or, as Hoang et al (2010, p. 735) have put it, the risk of an "aggregation bias". We believe that a more fine-grained

understanding of linkage formation processes is important because it allows a better understanding of their variance, of their change over time, and of the characteristics explaining the formation of certain types of external linkages.

We build up our argument on March's (1991) framework on organisational learning which Rothaermel's et al (2004) have applied to external linkages in new product development. In doing so, we aim at a better understanding of why only certain external linkages are chosen (and not others). Rothaermel's et al (2004) framework recognizes that firms face two challenges in positioning themselves in a competitive environment: exploring new technological opportunities within research projects, and leveraging these opportunities by commercialising them. Building up on this framework, we argue that the selection of external linkages for new product development is based on different strategic goals (i.e. research vs. market orientation), and that it contributes to a better understanding of external linkage formation processes of nascent ventures. Doing so, we provide a new typology of how nascent ventures search for external partners over time by demonstrating a distinct variance in linkage formation patterns.

We then introduce a resource-based view perspective in order to examine the factors that drive a venture's decision to choose certain external linkages – research linkages, market linkages or a combination of both. We also make use of the resource-based view to better understand why ventures do not choose external linkages to develop a new product, even though it should improve a venture's competitiveness (Chapman et al., 2018; Dahlander et al., 2016; Leiponen & Helfat, 2011; Meyskens & Carsrud, 2013).

Taken together, we seek to address a missing perspective in the new product development and innovation literature as it applies to nascent ventures: The variance of linkage formation processes in new product development and their temporal component. We also analyse the factors driving the choice of specific linkage formations. Accordingly, our research addresses the research gap whether distinct types of external linkage formation processes of nascent ventures in new product development exist, how they differ, and which underlying factors explain their choice and combination.

We address these questions with a unique data set. To empirically derive patterns of external linkages in new product development, we use an unusually fine grained dataset documenting 402 nascent ventures in two knowledge intensive industries, the information and communication (ICT) and the renewable energy (RE) industries. Building up on intensive interviews with the ventures' founders, we construct a database covering up to 84 months of new product development and accompanying linkage formation processes. We also make use of the survey data to identify the underlying characteristics that drive linkage formation processes.

Our results show that a distinct variance in linkage formation patterns exists, both across ventures as well as across time. Ventures demonstrate very different strategies by either engaging in external research linkages, or by engaging in external market linkages, or by combining both. Further, we also identify the factors which drive the decision for the "opposite pole" in new product development, i.e. the decision to act "alone".

3. THEORY AND HYPOTHESES: WHAT DRIVES LINKAGE FORMATION OF NASCENT VENTURES IN NEW PRODUCT DEVELOPMENT?

We discuss our motivation for examining the variance of external linkages in new product development as it applies for ventures and review the literature on new product development. We then turn our attention to theorizing how the strategic search for complementary resources is likely to induce certain collaborative patterns, and how the availability of firm-level resources induce the readiness to build up external linkages. As we describe in greater detail below, these factors shape the emergence of the previously unexamined patterns of external linkages in new product development.

3.1 New product development and external linkages

New product development and innovation are important for a firm's competitiveness (Hoang & Rothaermel, 2010; Nieto & Santamaría, 2007; Rothaermel, 2001), and linkages to external actors are an important element within knowledge sourcing strategies (Carayannopoulos & Auster, 2010). Eisenhardt and Schoonhoven (1996) suggest that the resource-based view can help to better understand why linkages are formed: the access to complementary resources, in particular the access

to knowledge and information on technologies and markets (Ireland et al., 2002). Indeed, substantial empirical evidence has shown that firms, in particular resource-scarce ventures (Hoang & Antoncic, 2003), tend to establish ties to those actors that allow access to critical resources (Geletkanycz et al., 1997). This is why the ability to manage such linkages is considered to be a source of competitive advantage (Glaister, 1998; Ireland et al., 2002).

Specifying the structure and the content of external linkages, more, and above all, diverse linkages have been associated with better performance (Hoang & Antoncic, 2003). Knowledge needed for new products – which includes both, new products and new services (Easingwood, 1986) – has become increasingly complex and is increasingly distributed across various market participants, so that diverse linkages are crucial to facilitate knowledge transfer and learning, and to provide informational advantages (Chapman et al., 2018; Meyskens & Carsrud, 2013; Nieto & Santamaría, 2007). However, despite the recognition that the diversity of external linkages matter, little is known about their antecedents.

The antecedents of external linkage formation processes can be derived from the established exploration-exploitation framework of organizational learning (March, 1991) which Rothaermel et al (2004) have applied to learning in inter-firm linkages, and which also has influenced recent research on partnership diversity (Meyskens & Carsrud, 2013). According to this framework, external linkages allow ventures to mobilize resources, but depending on the resources which are needed, these linkages fulfil different functions: They may either support the *exploration* or the *exploitation* of knowledge.

Research linkages, providing access to new technologies and to innovative capabilities, are important for achieving higher degrees of novelty in the development of new products, and allow exploring *new knowledge*. These linkages include linkages to competitors, customers, suppliers or research institutes and universities. *Market linkages*, in contrast, constitute platforms to exchange information concerning potential markets, customers and suppliers, and facilitate the access to and distribution of products in particular markets. In this perspective, they allow the *new knowledge to be exploited*. They include actors like industry associations, NGOs and other social sector actors (Alvarez & Barney, 2001; Geletkanycz et al., 1997; Meyskens & Carsrud, 2013). In our analysis of external linkage formation

processes, we build up on this exploration-exploitation framework and differentiate between research and market linkages.

In a temporal view, research linkages are often built up in early stages and are combined with market linkages in later stages of the product development as the former provide new knowledge embodied in the prototype while the latter provide complementary resources like regulatory knowledge, knowledge of customers and particular markets, and distribution, transforming the new knowledge into a marketable product (Rothaermel & Deeds, 2004)[1]. As the nature of a venture's linkages has a bearing on the firm's level of product innovativeness (Rothaermel & Deeds, 2004), it is important for management and innovation scholars to better understand the underlying factors that drive the choice of these linkages over time.

3.2 Nascent ventures and complementary resources through external linkages

In the resource-based view of the firm, firm behaviour can be interpreted as a search for competitive advantages by getting access to resources not provided by the firms themselves (Ahuja, 2000). In this view, external linkages help firms to access complementary resources not available at the firm-level. As firms tend to search for complementary resources, this means that a firm's resource profile plays a decisive role in linkage formation processes (Ireland et al., 2002; Stuart, 2000). In the perspective of the resource-based view of the firm where the „coordination of resources [is] a core function" (Alvarez & Barney, 2001), an important function is attributed to the entrepreneur in searching and identifying the relevant complementary resources for her venture. Entrepreneurship means to identify lacking resources at the firm-level, and to complement them with external resources, provided by external linkages. Resource mobilisation and opportunity identification can therefore be understood as being the core elements within the entrepreneurial process or, more generally, the venture creation process (Hoang & Antoncic, 2003).

[1] (Stam, 2010) additionally has shown that ventures with central positions in industry networks positively impact new venture performance as being member in an industry association provides informational advantages.

In this context, external linkages can be understood as complementary resources provided external to the firm. These external linkages provide either technological or marketing knowledge, or a combination thereof. Obviously, the need for these external resources differs depending on the venture's characteristics: Ventures with highly innovative products will be different from less innovative ventures, and highly technically focussed ventures will be different from more ventures with more balanced skill sets. Though in both cases, external linkages provide complementary knowledge, the knowledge which is exactly needed differ dependent on the venture's characteristics.

Access to complementary technological and marketing knowledge for highly innovative new product ideas

Highly innovative products are characterised by new knowledge and new markets (Lechevalier, Nishimura, & Storz, 2014; Malerba, 2007). Ventures that aim at developing highly innovative products therefore need to solve two problems: to access complementary technological knowledge not available in the venture, and to identify potential new markets for the new product. The identification of new markets is also driven by the need to reduce the development risk associated with highly innovative products.

We therefore expect that ventures which have been founded with the strategic goal to develop a highly innovative product will, from early on, aim at a high breadth of linkages. Given that two types of linkages have been repeatedly cited in the literature for providing access to critical knowledge regarding the development of new products and their commercialisation (Meyskens & Carsrud, 2013; Rothaermel & Deeds, 2004), i.e. research linkages and market linkages, we assume this distinction to be relevant in particular for highly innovative new products. The significant challenge of ventures to develop a highly innovative new product thus lead us to posit that highly innovative ventures build up on both types of external linkages, i.e. research and market linkages:

Hypothesis 1: Ventures developing highly innovative new products are more likely to early-on focus on both, research linkages and market linkages.

Access to complementary marketing knowledge for technically focused ventures

External linkages providing complementary resources are important for ventures with a high degree of specialisation. As the founding team in nascent ventures is shaping the venture's core competences, technically focused founding teams are assumed to leave a technical "imprint" on their venture (Eesley, Hsu, & Roberts, 2014). Such a technically focussed venture has to solve the challenge that complementary resources are needed which help them to appropriate value from the innovation, but which are, at the same time, not available within the firm (Teece, 1986). Building up external market linkages is one solution to this challenge, as these allow technically focussed firms to detect new market trends and asymmetries faster than firms lacking such connections (Stam & Elfring, 2008).

Depending on the environment, different external actors provide market-relevant knowledge. While the role of incumbents in providing complementary resources like regulatory knowledge or access to markets (Eesley et al., 2014) is well researched (Powell et al., 1996; Tripsas, 1997), the entrepreneurship literature has only scarce knowledge about the antecedents of selling activities (Matthews, Chalmers, & Fraser, 2018). Recent works have shown that industry associations or service providers play an important role in ante ceding such "selling activities" by allowing knowledge exchange on particular markets and by providing contacts to prospective customers and suppliers (Dalziel, 2006; Stam, 2010; Stam & Elfring, 2008; Watkins, Papaioannou, Mugwagwa, & Kale, 2015). Besides facilitating the access and distribution of new products in particular markets, industry associations also may increase a new products' legitimacy (Meyskens & Carsrud, 2013). As there are only few and distinct industry associations which are in generally well known within the industry in which the ventures are operating, and as also liabilities of newness play less a role, industry associations have the additional advantage that they substantially reduce the search costs for ventures.

We therefore expect that ventures characterised by strong technical competences will search for market linkages to compensate for lacking internal marketing capabilities. Building up linkages to external partners providing knowledge which is relevant for market access for a venture's new prototype hence solves the problem that only certain assets have been developed internally (Ahuja,

2000). Altogether, we argue that a venture's skill composition shapes the search for complementary resources. A venture with a strong technical focus will be more likely to search for complementary linkages which provide market-related knowledge and information.

Hypothesis 2: Ventures with a technical focus are more likely to early on scale up internal product development by engaging in external market linkages.

3.3 Resource-constraint ventures and external linkage formation

If external linkages, and in particular diverse external linkages, are important in complementing a firm's resource-based, why do not all firms build up external linkages? Ahuja (2000) shows that an important antecedent of building up linkages are the existing resources at the firm-level. Hence, not only incentives to build up linkages matter like argued so far, but also the opportunities to create them. Depending on the resources available at the firm-level, opportunities for creating and entering external linkages differ substantially across firms (Ahuja, 2000; Hoang & Antoncic, 2003). Obviously, there is a trade-off between the search costs for complementary resources which are provided externally to the firm, and the resources available at the firm-level allowing for such a search. Important resource endowments that shape a venture's opportunities to establish external linkages are low levels of skill diversity and low levels of size. We focus on these resource endowments in the following.

Resource scarcity and ventures' skills uniformity

While some works have shown that the effect of diversity is not fully clear (Zhou & Rosini, 2015) as uniformity may have positive effects on common transactive memory systems (Chowdhury, 2005; Ensley, Carland, & Carland, 1998; Zheng, 2012), positive effects of diverse skill sets have been identified for research-driven firms like university-spin offs (Visintin & Pittino, 2014), for the implementation phase of innovations (Østergaard, Timmermans, & Kristinsson, 2011) and for the speed of innovation processes (Eesley et al., 2014). Also, functional diversity of management teams is linked to innovative performance (Protogerou, Caloghirou, & Vonortas, 2017). The skill diversity of the venture matters because it provides the knowledge base and the innovative capabilities of the

venture (Østergaard et al., 2011)[2]. Given the often small size of ventures, Østergaard et al (2011) have shown that employee diversity adds indeed diversity to the firm, but the overall direction does not change: a venture's skill diversity, often measured via the founding team's skill diversity, is beneficial for the venture's performance.

Diverse internal skills allow ventures to access a broader area of skills also external to the firm, and a broader variety of information and experience (Eesley et al., 2014, p. 1800). More diverse capabilities are further seen as being beneficial for a firm's absorptive capacity as they increase a firm's capability to exploit external resources (Cohen & Levinthal, 2000). This means that a venture's skill diversity also shapes the breadth of external linkages as more diverse knowledge bases allow for broader search activities (Nelson & Winter, 1982; Østergaard et al., 2011), and a broader pool of human capital to access linkages across all important phases of the innovation process (Østergaard et al., 2011).

However, restated, less diverse founding teams are constrained in their opportunities to search, and, compared to skill-diverse ventures, possess less opportunities to form external linkages (Ahuja, 2000). Combining the insight that founding team's skill diversity shapes the search for external linkages, and that scarce resources provide less opportunities to search, the interaction of the two is expected to reduce the breadth of external linkages. These arguments suggest the following hypothesis:

Hypothesis 3: Ventures with uniform skill sets are less likely to early on scale up internal product development by building up external research or market linkages.

Resource scarcity and venture size

Another important aspect of resource scarcity is a venture's size. As individual entrepreneurs cannot scale themselves up as firms can, "lone entrepreneurs" (Klotz, Hmieleski, Bradley, & Busenitz, 2014) face a finite search time (Dahlander et al., 2016). The search for external partners causes opportunity costs as external searching activities take the entrepreneur's attention away from other internal activities (Dahlander et al., 2016). When firms are small in size, and the human capital stock is low, it

[2] Starting with research on top management teams (Østergaard et al, 2011), research has focused on the role of the founding team being the first top management team of the venture.

is the entrepreneur herself who needs to carry out the search. Given that attention is a fixed resource and not infinitely elastic, small firms tend to search less for external partners. Indeed, a number of studies has shown a negative association between firm size and collaboration intensity (Chun & Mun, 2012), figuring between 10% to 60% (Czarnitzki, Ebersberger, & Fier, 2007; Howells, Ramlogan, & Cheng, 2012; Mangani & Gussoni, 2010). If small firms cooperate, then often only in later stages (Ruef, Aldrich, & Carter, 2003). As the small size does not allow entrepreneurs to scale up and to provide resources for search, it is therefore expected that firms with scarce resources in terms of firm size neither establish less external linkages, neither research nor market linkages.

Hypothesis 4 Highly constrained ventures in terms of size are less likely to early on scale up development by engaging in external research or market linkages.

4. METHODOLOGY

4.1 The Data: Sample and operationalization

To test the aforementioned hypotheses, we use a subset of the "Perfect Timing" (PT) database. Based on computer-assisted telephone interviews with founders, we collected this dataset in two waves between 2011 and 2018 with an international research team located in Utrecht (The Netherlands), New York (US), Germany (Düsseldorf and Cologne), London (UK), and Palermo (Italy). In order to capture possible variations in venture creation processes, the population interviewed includes ventures of all legal forms (excluding sole proprietorship) that were registered between 2004 and 2014 in the information technology (IT) and renewable energy (RE) industries in Germany, Italy, the US, the Netherlands and the UK. From this population, founders were randomly selected and invited to participate in an interview about the venture creation process of their company until a representative sample of 902 cases had been obtained. Out of these 902 cases we conducted all following steps in our analysis with the 402 ventures that indicated to have developed a new product as part of their venture creation process.

We collected the data with an explicit focus on the timing and sequencing of venture creation activities, which allows us to study patterns in linkage formation process in venture's new product development. Importantly, the dataset is restricted to the duration of the initial phase of the venture

creation process. This process begins with the first time a founder talked with someone else about setting up the venture in question, it ends at the moment when when the venture generated sustainable profits (defined as 3 consecutive profitable months). If a new venture never made sustainable profits, three alternative process ends can occur: namely the acquisition, merger or liquidation of the respective venture. If none of these events occurred until the date of the interview, the process of venture creation was categorized as ongoing and recorded up to a maximum duration of 84 months.

4.2 Dependent variable: The linkage formation process in new product development

For the purpose of this analysis we only consider the part of the venture creation process which is relevant for the development of a venture's main product. Accordingly, we consider the first time the venture starts developing its product as the starting point of the new product development; its end date corresponds to the end date of overall venture creation process as described above. For the purpose of the study consider the internal new product development to be completed when the first fully functional version of a product had been developed. With regard to the linkage formation activities undertaken during the venture creation process, we report which activities were undertaken to develop the product for each month.

In order to create a typology of linkage formation processes we determine the state of linkage formation for each month of venture creation. The state of linkage formation represents which constellation the venture developed its product in a particular month. We distinguish between internal new product development and new product development through external linkages. External new product development can either take the form research linkages or market oriented ones. Of course, a venture can simultaneously develop its product internally and with external linkages. Therefore we not only distinguish between the three basic ways of new product development but also account for each possible combination of them resulting in seven possible states that can occur in a venture's new product development process.

Table 1: Coding New Product Development Activities

Internal Development	External Linkages	Internal Development & External Linkages
Internal Development (ID)	Market Linkage (ML)	ID & ML
		ID & RL
	Research Linkage (RL)	ML & RL
		ID & ML & RL

The following Table 3 illustrates how we use this classification to arrive at state that depicts the linkage formation process as detailed as possible. In this hypothetic example the new product development in the venture takes place over period of 9 months. In the first two months the ventures focusses on the internal development of the product. Parallel to that it enters a research linkage with an external partner from months 3 through 5. In the following months the venture joins an association to ensure the market fit of its product through a market linkage. In month 8 it enters another research linkage to refine the product. The row "State" aggregates the linkage formation activities for every month as outlined above, thereby reporting the entire linkage formation process of our hypothetical venture.

Table 2: Example of a linkage formation process

Type	Month								
	1	2	3	4	5	6	7	8	9
Internal	ID	ID	ID	ID	ID	ID			
External			RL	RL	ML RL	ML	ML	ML RL	RL
State	**ID**	**ID**	**ID & RL**	**ID & RL**	**ID & RL &ML**	**ID & ML**	**ML**	**ML & RL**	**RL**

4.3 Independent Variables: Contextual factors

The innovativeness of a venture's business idea was determined in a three-step process. In the first step, the founder was asked what how novel product idea is.[3] In a second step, the interviewer (upon completion of the interview) cross-checked the founder's answer by comparing the venture's innovativeness with the innovativeness of the other ventures about which s/he had conducted interviews. In a third step, the person cleaning the data, again, cross-checked the degree of innovativeness indicated against the classification scheme he had developed while cleaning the entire dataset. In both step two and step three, the interviewer and the data cleaner relied on the information provided by the founder as well as on online information about the venture's business idea. This three-step process made it possible to minimize the over-estimation bias that typically occurs when founders self-report the level of their business' innovativeness. The novelty of the product idea was measured as imitation / improvement (0), or radical innovation (1).

Table 3: Dataset descriptives

Variable	Value	N	in %
Country	US	106	26.4%
	UK	59	14.7%
	Germany	154	38.3%
	Italy	46	11.4%
	Netherlands	37	9.2%
Novelty Product Idea	Not Radical	330	82.1%
	Radical	72	17.9%
Type of Good	Service	87	21.6%
	Mix	243	60.4%
	Product	72	17.9%
Number Employees	0	360	89.6%
	1	20	5.0%
	2	10	2.5%
	3	4	1.0%
	4	1	0.2%
	5+	7	1.7%

[3] Concrete question asked in the questionnaire: 'How would you describe the degree of novelty of your venture`s core business idea?'

Number of Founders	1	117	29.1%
	2	132	32.8%
	3	77	19.2%
	4	35	8.7%
	5+	41	10.2%
Industry	ICT	274	68.2%
	RE	128	31.8%
Tech Heavy	No	271	67.4%
	Yes	127	31.6%

In line with the literature we examine the effect of the composition of the founder team, both in diversity and specialization, on the approach to new product development a venture chooses. In our operationalization of these two measures we closely follow (Eesley et al., 2014). A founder (team) is characterized as technically focussed (1) if all founders indicated technical expertise as their main expertise. Teams with other expertise profiles are coded (0). The diversity of a founder team is measured by the number unique areas of expertise present in founder team divided by the number of founders.

Furthermore, we test for the effect of venture size, both in terms of number of employees a venture had hired by the time it started with its product development as well as the number of founders involved in setting up the venture. The 'Perfect Timing' dataset record only the first 5 founders and employees to be involved in the creation of the venture, hence does the category 5+ capture also ventures that potentially have more than 5 employee or founders respectively.

We control for venture characteristics that might influence the linkage formation process of a venture.Industries are structurally different and induce ventures to pursue different business models, requiring distinct organisational structures (Sine, Mitsuhashi, & Kirsch, 2006) and thus encourage different approaches to new product development. Therefore, a venture's industry was included as a control variable. It was determined in a three step process, where ventures were first sampled on the basis of NAICS industry codes and their business descriptions. In a second step, the person cleaning the samples drawn confirmed a venture's industry affiliation through online information, such as the venture's website. Finally, the founder was asked to confirm the venture's industry affiliation as part

of the interview. We group ventures into ICT (0) and Renewable Energy (1) ventures. Ventures that have an affiliation with both industries are classified as RE ventures. The second control variable included in our model is the type of good a venture produces. We assert whether a venture produces a tangible product (0), offers only services (2), or provides a mixture of both (1). This variable was recorded in the same three-step process as the ventures innovativeness.

4.4 Analyses

In line with our theoretical illustrations, we run two different types of analyses: **(1)** in a first step, we assess whether ventures follow systematically different approaches linkage formation process throughout the development of their product. If distinct linkage formation processes exist, we want to explore what they look like and differ on. To this end, we use optimal matching (OM) techniques combined with cluster analyses, whereby the linkage formation process itself constitutes the unit of analysis. The OM algorithm measures the distance between processes. If subsequently paired with cluster analyses, such sequence analyses allow us to explore and interpret patterns in longitudinal data (Halpin, 2010). We apply OM techniques because, when compared to other methods, OM has been found to deliver superior results in identifying patterns in sequence data in the context of management science (Biemann & Datta, 2014).

In the context of new venture creation, the first detailed OM application focuses on team formation process (Held, Herrmann, & van Mossel, 2018). In a more general study on venture creation processes Gordon (2012) used OM techniques to sequence gestation activities. Given that more wide-ranging developments and applications of OM algorithms only occurred after the year 2000, OM can still be considered a fairly young method. Nevertheless, a standard way of running sequence analyses, based on OM techniques, has crystallized, which we here follow (Biemann & Datta, 2014). It includes four steps:

Step 1: Coding the Data

The first step consists in reporting the linkage formation process of each venture on a monthly basis. More concretely, this means that a sequence of linkage formation states, depicting each venture's linkage formation process, needs to be created for each venture. The reported linkage formation

process can vary in length for each venture as the length is a result of time that passed between the first product development activity and the end of the venture creation process.

Step 2: Define the Substitution Costs

In order to measure the distance between two linkage formation sequences, created in Step 1, a cost needs to be assigned for replacing one state by any other state with the aim of transforming one sequence into the other. These so-called substitution costs range from 0 to an arbitrary maximum (here: 2) and are estimated on the basis of the relative frequency of transitions between two states within the entire dataset. Based on this transition frequency between any two funding states, a so-called substitution cost matrix is determined

The resulting substation cost matrix reveals that transitioning from a state featuring only one of the three basic linkage formation activities (Internal, Research Linkage and Market Linkage) is always cheapest to a state featuring the respective state in combination with another state. Not surprisingly, is transitioning to and from the state featuring all three activities cheapest vis-à-vis the three states combining two of the activities each.

Table 4: Substitution Cost Matrix

	ID	RL	ID & RL	ML	ID & ML	RL & ML	ID, RL &ML
ID	0						
RL	1.997598	0					
ID & RL	1.978305	1.965557	0				
ML	1.993012	1.996324	2.000000	0			
ID & ML	1.990971	2.000000	2.000000	1.957143	0		
RL & ML	2.000000	1.989339	2.000000	1.980757	2.000000	0	
ID, RL & ML	1.999782	2.000000	1.977779	2.000000	1.987806	1.943262	0

Step 3: Calculating Sequence Similarity

Based on these substitution costs, it is calculated (for each of the 402 sequences in our dataset) how costly it is to transform one sequence into any of the other 401 sequences. The cost of transforming one sequence into the other expresses their respective distance to one another. To determine the

distance of sequences that differ in length, we calculate their distance based on the length of the shorter of the two sequences. This reflects that the shorter of the two linkage formation processes is unknown beyond the period observed and should thus not influence the distance measure. This novel solution was introduced in Held et al. (2018) and addresses an often voiced concern of using OM for analysing sequences in social science that vary greatly in length (Aisenbrey & Fasang, 2010).

Furthermore, we normalize the respective values of sequence difference by dividing them by the length of the shorter of the two sequences in order to maintain a comparable difference measure across sequence pairs. This results in a matrix which reports the distances between each sequence pair.

Step 4: Perform a Cluster Analysis

In the concluding step, the funding acquisition processes are clustered on the basis of their respective distances to one another. Consequently, each cluster obtained encompasses those processes that are particularly similar to each other, and distant to the processes of other clusters. Accordingly, each cluster represents one of the most frequent and, thus, typical approaches to funding acquisition. We run the cluster analysis based on the Ward's minimum variance method, which has been shown to consistently produce the most accurate sequence clustering within the framework of OM analyses (Dlouhy & Biemann, 2015).

We use a combination of various partition quality measurements, namely the Weighted Average Silhouette Width (ASWw), R^2, Point Biserial Correlation (PBC), and Hubert's C (HC) to determine the optimal clustering solution amongst all solutions between one and twenty clusters. These measures indicate how similar sequences are within one cluster and how different they are between clusters. Consequently, we calculated these indicators for one, two, three, etc., up to twenty clusters in order to determine their goodness of fit. In this way, we could determine for which cluster number the goodness of fit is maximized. In doing so, we could exclude those cluster solutions which either did not yield distinct approaches, because they clustered together too different sequences, or which spread out sequences over too many similar clusters.

(2) In order to provide meaning and context to the results of an exploratory process analysis an explanatory analysis to understand *"what factors cause the different sequences observed"* is a logical

next step (Van de Ven & Engleman, 2004). Hence, in the second step, we use one-versus-rest logistic regression models to identify the conditions that influence approaches during the linkage formation process (dependent variable). In testing *Hypotheses 1-4* we research in how far innovativeness, the technological focus, diversity of the founder team as well as the number of employees and founders (independent variable) are correlated with the approach to linkage formation a venture chooses. We furthermore control for the venture's industry and whether the venture develops a service or rather a tangible good.

We fit the following model for each cluster to obtain the estimates:

$$ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 Innovativeness_i + \beta_2 TechFocus_i + \beta_2 FounderDiversity_i + \beta_3 Employees + \boldsymbol{\beta}' \boldsymbol{x}_i \quad (1)$$

where p_i denotes the probability that venture i belongs to the cluster rather than to any of the other clusters, β_0 the cluster's intercept, β_1, β_2, and β_3 the estimated coefficients for our independent variables, $\boldsymbol{\beta}$ a vector of coefficients for the control variables, and $\boldsymbol{x}_i$ a vector of control variables.

5. RESULTS

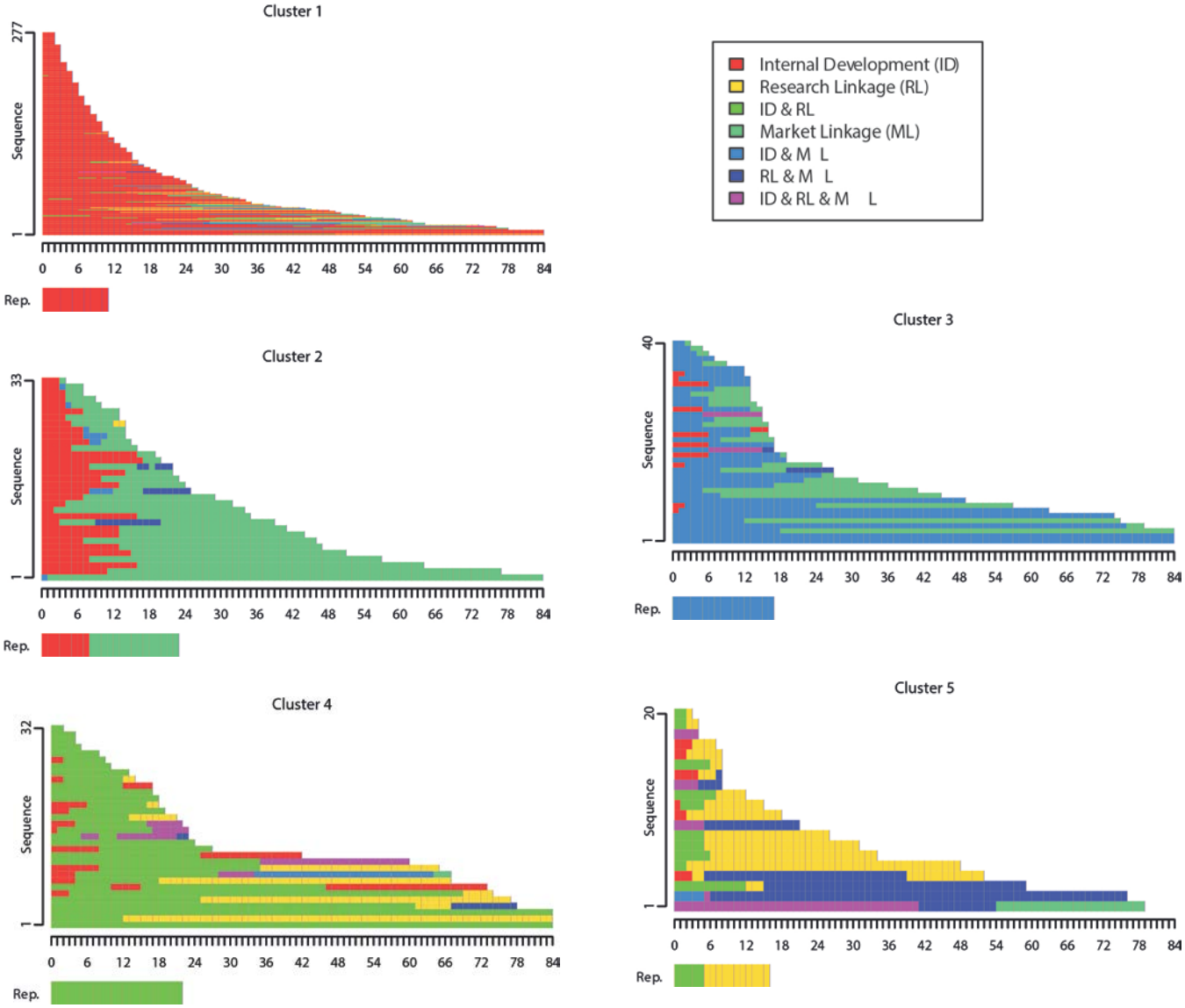
5.1 Patterns in Linkage Formation Processes

In the first part of our analysis we explore the variance in linkage formation processes in nascent ventures. More precisely, we analyse which distinct combinations and sequences of internal development, research and market linkages nascent ventures use to develop their products. The partition quality measurements point to the 5 cluster solution as the optimal solution for the linkage formation processes of nascent ventures. This solution combines the partition quality measurements better than any other considered solution (ASWw = 0.68; R^2 = 0.62; PBC = 0.78; HC = 0.07). As a result we observe 5 distinct linkage formation processes that nascent ventures engage in.

By far the most common amongst these processes is one dominated by internal product development (Cluster 1). 277 of the ventures in our sample go through this linkage formation process which is on average also a much shorter one than other linkage formation processes. The shorter processes in this cluster do not involve external linkages of either type. Only ventures in this cluster that do invest more than 12 months start creating external linkages.

Ventures in the smaller Cluster 2 (n = 33) also begin the process of developing their new product internally but start creating market linkages between months 6 and 12. Around the same time the ventures finish the internal development of the product. In other words: We observe a clear two step sequence of first developing the product and then ensuring its market fit. A different patterns emerges in Cluster 3 (n = 40). Here the ventures enter into market linkages in parallel to developing their new product internally. While the linkage formation activities are the same the clusters differ in sequence and timing of deploying them.

Graph 1: Patterns in Linkage Formation Processes



A similar phenomenon can be observed amongst ventures that pair internal development with research linkages (Cluster 4 & 5). Ventures in Cluster 4 (n = 32) run internal development in parallel to entering research linkages for the vast majority of their linkage formation process. Their counterparts in Cluster 5 (n = 20) in contrast discontinue their internal development after a brief development period at the beginning of the linkage formation process and continue the process exclusively through the means of research linkages or in some cases research and market linkages.

In general we can observe that in the sequence of linkage formation ventures have a clear preference to first develop products internally or form research linkage before they form market linkages. As shown above this can take place in distinctly different processes, but is overall in line with the expectations of the literature (Rothaermel & Deeds, 2004).

5.2 Determinants of approaches to the Link Formation Process

After exploring what different processes exist in the new product development of nascent ventures, we examine in the next steps what the drivers of the uncovered variety in these processes are. For this purpose we compare the characteristics of ventures in each cluster with those of the ventures in rest of the sample in binary logistic regressions to determine in how far cluster membership is correlated with particular venture characteristics.

In Hypothesis 1 (H1) we predicted, that ventures novel product ideas are more likely to early-on focus on both, research linkages and market linkages. We can confirm this hypothesis in so far as the one cluster in which ventures regularly form both research and market linkages (Cluster 5) is positively correlated with novel product ideas (C5; Exp $\beta = 3.339$; $p < .05$). The other cluster positively, but not significantly, correlated with novel product ideas heavily relies on the creation of research links (Cluster 4). Furthermore observe, that non-novel product ideas are correlated with market linkages. The two clusters that focus on market linkages either significantly negatively (C3; Exp $\beta = .158$; $p < .05$) or practically not correlated with novel products (Cluster 2). We thus find convincing evidence for Hypothesis 1.

Table 5: Binary Regression Analysis of Linkage Formation Clusters

	Linkage Formation Process Cluster (Exp β)				
Variable	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Industry	.433***	1.136	2.297**	2.802	1.497
Type of Good - Mix	1.054	.282***	2.128	2.439	1.087
- Product	1.203	.189**	2.524	3.272*	.22
Degree Novelty	.898	1.01	.158**	1.892	3.339**
Number Employees	.695***	1.237	1.721***	.87	.977
Number Founders	.889	1.188	.97	1.164	1.145
Tech Heavy	.822	.944	2.115*	.764	1.205
Founder Team Diversity	.43**	2.492	.761	6.568**	1.93
Intercept	8.257***	.067***	.042***	.004***	.015***
Observations in Cluster	227	33	40	32	20
R^2	.082	.081	.144	.11	.076

p-values *** < .01, ** < .05,

Our second hypothesis (H2) focuses on the role that the technical orientation of a venture might play in creating market linkages throughout the linkage formation process. The literature led us to predict that ventures with a technical focus are more likely to early on scale up internal product development by engaging in external market linkages In the light of this hypothesis we would expect those clusters which are characterized by engaging in market linkages (Cluster 2, 3) to consist of technical heavy ventures. In line with this expectation we observe that ventures in Cluster 3 are more than two times as likely as other ventures to have a tech focussed founder team, albeit at a weak significance level (C3; Exp $\beta = 2.115$; $p < .1$). In contrast, ventures in Cluster 2 are less likely than the average venture in our sample to be led by a technical heavy founder team. While this finding is not significant, we can confirm Hypothesis 2 only partially. It is noteworthy however and in line with the hypothesis that the ventures that create market linkage from the get go are the ones significantly correlated with a strong technical focus.

With regard to the effect of expertise diversity within the founder team on the linkage formation process of nascent ventures we formulated in Hypothesis 3 (H3) that ventures with uniform skill sets are less likely to early on scale up internal product development by building up external research or market linkages. Our binary regression analyses indeed reveal that the founder teams of ventures which do not at all or only late in the linkage formation process form external linkages have a

significantly less diverse expertise set (C1; Exp $\beta = .043$; $p < .05$). In addition, the ventures in three out of the four clusters that are characterized by the formation of research or market linkages are positively correlated with more diverse expertise sets. The ventures in the one cluster (Cluster 3) not in this group might be able to compensate for a lack of diversity of expertise in their founder teams through an above average number of employees (C3; Exp $\beta = 1.721$; $p < .01$).

In our fourth hypothesis (H4) we postulate that highly constrained ventures in terms of size are less likely to early on scale up development by engaging in external research or market linkages. We find support for this hypothesis in form of those ventures being made of particularly small founder and employee teams (Cluster 1) being the same one not to form external linkages as a part of their linkage formation process.

Not surprisingly the control variables in the form of industry and type of good also influence the approach of a venture to new product development. First and foremost we observe, that the type of good of ventures develops has a clear impact on some of process clusters. Ventures in Cluster 1 first develop their new product exclusively internally before forming market linkages after 6-12 months. The products these ventures develop are very likely to be services rather than tangible products (C1; Exp $\beta = .189$; $p < .01$). Since Cluster 1 is the only one with a strong and clear focus on services, this insight indicates that developing a service depends much more on ensuring market fit through the creation of market linkages rather than research links. In addition, we find that the linkage formation process of ventures varies depending on the industry it is active in. Operating in the ICT industry is clearly associated with developing ones product internally rather than through external linkages (C1; Exp $\beta = .433$; $p < .01$). In contrast, ventures in the RE industry are more likely to form either a market or research linkage at some point in their linkage formation process (Cluster 2-5).

6. DISCUSSION AND CONCLUSIONS

This study makes an empirical contribution and provides a methodological innovation. Empirically, it contributes to the sparse knowledge regarding the relationship between the formation of external linkages of nascent ventures in knowledge intensive industries for new product development and the characteristics driving it. Methodologically, it introduces the optimal matching technique to research

on external linkage formation processes in new product development. We illustrate how external linkage formation differs, both across firms and across time, in terms of external partners chosen in this process. This allows us not only to better understand differences in linkage formation patterns of nascent ventures in new product development, but also to differentiate their linkage formation processes during time.

The results presented in this paper support our prediction that entrepreneurs in nascent ventures fulfil important coordinative roles by making use of external linkages to complement firm-level resources. We showed that ventures with highly innovative product ideas, from the beginning onwards and before the first prototype has been developed, build up external breadth by combining research and market linkages. We assume that the underlying mechanism is that the combination of these linkages, in our case external research projects and membership in industry associations, allows the access to more diverse sets of knowledge and information, and reduce the market risk of the new product (Ireland et al, 2002). We also showed that ventures with a heavy technical skill composition tend to complement their knowledge stock with linkages that provide market-related knowledge.

The dataset provides also new evidence regarding the tendency to collaborate in new product development: Most surprising, though not in the focus of this paper, is the simple evidence that the large majority in our sample can be characterized as nascent ventures without any external linkages, in particular in the early stage of product development. Given the rich literature on the value that external linkages create for new ventures (Hoang & Antoncic, 2003; Hoang & Rothaermel, 2010; Nieto & Santamaría, 2007; Rothaermel, 2001), this simple descriptive finding is interesting in itself. This finding suggests that we should gain a better understanding of the factors hindering entrepreneurs to search for external linkages. This paper should be also understood as a first attempt to do so. We showed how resource constraints work as a barrier for building up external linkages, and demonstrated that constraints in terms of the ventures' skill set and of the firm size have a negative impact on the probability to engage in external linkages. Hence, though external linkages substantially increase a firm's competitiveness (Hoang & Rothaermel, 2010; Nieto & Santamaría, 2007; Rothaermel, 2001), resource constraints of nascent ventures are significant barriers to create these linkages.

Furthermore, our perspective on research and market linkages is relevant as it demonstrates the importance of different stages in new product development. Building up on the exploration–exploitation learning framework of March (1991) and Rothaermel et al (2004), we showed that ventures take different decisions regarding their choice of linkages: We find clusters of ventures which decide for research linkages, others for market linkages, and a further cluster of ventures choosing both. We explain these strategic choices with different degrees of product idea novelty and the ventures' skill composition. Nascent ventures with highly novel product ideas obviously strategically combine external knowledge and capabilities contained in research and market linkages. This is a very interesting observation, given that the literature has stressed that, vice versa, the outcome of broad linkages tends to be novel. While we cannot, given our data structure, statistically show that the causality is indeed reverse to what has been stated in the literature (Hoang & Rothaermel, 2010; Nieto & Santamaría, 2007; Rothaermel, 2001), anecdotal evidence from our interviews strongly supports our argument: Our interviewees who answered to have intended to develop a highly novel product reported, when asked about the path leading to it, that they, from the very early product idea onwards, tried to build up broad external linkages to improve access to technical knowledge stocks not available in their ventures, and, at the same time, to early on access market-relevant information to gain more fine-grained information on potential changes of the prototype, distribution channels, and marketing partners.

This paper has two implications. First, our findings indicate that that there are distinct types of temporal patterns of external linkage formation processes in new product development. Based on the exploration–exploitation framework, we have been able to identify a distinct number of approaches to engage in external linkages, varying between research linkages, market linkages or a combination of both. We also found that in many cases, ventures refrain from entering external partnerships in an early stage.

Second, our regression analyses suggest that the different approaches towards the formation of linkages are driven by the ventures' resource endowment. We identified a number of factors that

induced different approaches, namely the products' idea novelty and the venture's breadth of skills. We also identified factors that are associated with a preference of internal development, namely the scarcity of firm-level resources both in terms of size and skills. This latter observation makes an important addition to the long-held belief that the entrepreneurs' search for complementary resources is driven by incentives to complement existing resources. While this is true, obviously, it is important to take the scarcity of resources of nascent ventures into account. The opportunity costs of resource-underequipped ventures seem to be often higher than from what could gained from external linkages. This finding supports earlier work of Ahuja (2000) which is, to the best of our knowledge, the only work that has taken the role of opportunity costs in building up linkages into account.

In interpreting the results of this study, certain limitations must be kept in mind. First and most important, our data do not allow us to identify prior linkage formation experiences of the venture's founder. A number of studies has shown that prior networking experience matters (Mora-Valentin, Montoro-Sanchez, & Guerras-Martin, 2004; Okamuro, Kato, & Honjo, 2011; Paier & Scherngell, 2010) so that our study may overestimate the role of product idea novelty and breadth of skills. Further, the identification of clusters implies that we subdivide our dataset and run regression analyses on comparatively small groups of ventures. In this light an even larger n would be desirable. Nevertheless, we are confident that our results contribute significantly to the understanding of external linkage formation processes of nascent ventures.

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Submission to SBEJ

Held, L. (Lukas)
Sent: Tuesday, May 22, 2018 10:11 AM
To: Stam, F.C. (Erik)
Attachments: SBEJ_ProdDevPaper_TitlePage.pdf (17 KB) ; SBEJ_ProdDevPaper.pdf (437 KB)

Dear Erik,

please find attached our paper *'Whom do I search for? Variances of Linkage Formation Processes of Nascent Ventures in New Product Development'* to consider for publication in *Small Business Economics*. We believe the paper is well suited to the scope of your journal, because it contributes to the understanding of linkage formation in new product development in entrepreneurship by analyzing the linkage formation process of nascent ventures.

We look forward to the results of the review process, and would be delighted to see the paper eventually published in your journal.

Thank you for considering our manuscript for publication and kind regards,

Lukas Held, Andrea Herrmann and Cornelia Storz

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