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Entrepreneurship and prior experience as antecedents of absorptive capacity of high-tech academic spin-offs

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RESEARCH ARTICLE

Abstract

We investigate the influence of entrepreneurial orientation and team efficacy, in addition to the impact of domain-specific industry and research experience of spin-off management teams, on absorptive capacity, both potential and realised. A multiple regression analysis in 95 Dutch high-tech academic spin-offs indicates that entrepreneurial orientation and domain-specific research experience are positively related to potential absorptive capacity while entrepreneurial orientation, team efficacy and domain-specific industry experience are positively related to realised absorptive capacity. Analyses of the explained variance show that entrepreneurial orientation and team efficacy provide a higher contribution to absorptive capacity than domain-specific experience, which contributes to recent debates on antecedents of absorptive capacity for academic spin-offs.

Keywords: absorptive capacity, entrepreneurial team efficacy, entrepreneurial orientation, domain-specific experience, academic spin-offs

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1. Introduction

Entrepreneurship scholars have studied the role of absorptive capacity to explain the innovation capability and value creation process of new ventures (McKelvie and Davidsson, 2009; Sapienza *et al.*, 2006; Zahra *et al.*, 2006) and the growth of new ventures (Fosfuri and Tribó, 2008; Gray, 2006; Hayton and Zahra, 2005; Larraneta *et al.*, 2007; Rothaermel and Thursby, 2005; Zahra *et al.*, 2009). Absorptive capacity is defined as 'a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability' (Zahra and George, 2002: 186). Firm absorptive capacity is given specific attention because it reflects the dynamic capabilities that enable a business to deploy and coordinate different resources (e.g. Von Hippel, 1994) and to reconfigure its existing resource and capability base (Teece *et al.*, 1997). This is especially important for academic spin-offs, which are new start-ups founded by academics who commercialise scientific findings (Pirnay *et al.*, 2003; Siegel *et al.*, 2007; Steffensen *et al.*, 2000). They originate from an academic environment, and in order to develop business opportunities they need absorptive capacity to evaluate external knowledge and combine it with their scientific findings (Vohora *et al.*, 2004; Walter *et al.*, 2006). Absorptive capacity plays a critical role in fostering their growth and helping them face their growth challenges through the acquisition and exploitation of knowledge and resources (Bollingtoft and Ulhoi, 2005; Holcomb *et al.*, 2009; Lockett *et al.*, 2005; Sirmon *et al.*, 2007; Wright *et al.*, 2007; Zahra *et al.*, 2009). It will help such firms with constant access to new knowledge and information about opportunities (Engelen *et al.*, 2014; Rothaermel and Alexandre, 2009).

The literature has thoroughly investigated the consequences of absorptive capacity for firm performance (Lane *et al.*, 2006; Van Den Bosch *et al.*, 1999; Zahra and George, 2002; Zahra *et al.*, 2009), but so far relatively limited research has been conducted on the antecedents of absorptive capacity, especially within new ventures (Hayton and Zahra, 2005; Zahra *et al.*, 2009). Previous studies focused on prior experience as an antecedent of absorptive capacity (Argote *et al.*, 2003; Cohen and Levinthal, 1990; Van den Bosch *et al.*,

1999) with a focus on prior related experience (Cohen and Levinthal, 1990; Lane *et al.*, 2006; Zahra and George, 2002). In entrepreneurship literature, the success of such new ventures is typically explained by prior related knowledge. However, the effect of prior experience in previous research is inconclusive with various indicators for prior experience having both positive and negative effects (Scholten *et al.*, 2015; Walter *et al.*, 2006). We focus on domain-specific research and industry experience which are considered more relevant for academic spin-offs (Agarwal *et al.*, 2004; Kor, 2003; Shane and Venkataraman, 2000).

Other studies argue that the extent to which new ventures are successful at exploiting new opportunities and new innovations is dependent on the management team's entrepreneurial orientation (Clarysse *et al.*, 2011b; Keh *et al.*, 2007; Walter *et al.*, 2006) and entrepreneurial team efficacy (Arnold *et al.*, 2001; Baum and Bird, 2010; Drnovajek *et al.*, 2010). Therefore we complement the team experience with the team entrepreneurial orientation and team efficacy to reflect their attitude towards receiving and evaluating new information. Academic spin-offs might face difficulties in translating their initial idea into sustainable business due to the lack of entrepreneurial orientation (Iacobucci *et al.*, 2011). Entrepreneurial orientation leads to better identification of opportunities that might lead to new venture ideas (Clarysse *et al.*, 2011b). It is argued that new ventures with founders who are more creative, proactive and risk-taking seek more novel information and are better at exploiting the acquired information (Keh *et al.*, 2007; Walter *et al.*, 2006). Hence, entrepreneurial orientation is thought to improve firm performance by intensifying the acquisition of information and its exploitation efforts (Keh *et al.*, 2007), thereby advancing the knowledge creation processes (Li *et al.*, 2009).

Entrepreneurial team-efficacy is the extent of team members' motivation and confidence in their ability to successfully perform the various roles and tasks of entrepreneurship (Hmieleski and Baron, 2008) leading to start-up performance (Bandura, 1997; Durham *et al.*, 1997; Hmieleski and Baron, 2008; McGee *et al.*, 2009). Several conceptions of individual differences, other than self-efficacy, also reflect confidence (e.g. locus of control, self-esteem); however, they are applied in a more general context (Bandura, 1997). To concentrate on high-growth entrepreneurs such as high-tech academic spin-offs, we apply entrepreneurial self-efficacy at the team level, known as entrepreneurial team-efficacy since in these typical start-ups the founding of a company is a joint effort. In summary, in the present study, we investigate both domain-specific experience (Agarwal *et al.*, 2004; Kor, 2003; Shane and Venkataraman, 2000), the role of team entrepreneurial orientation (Covin and Slevin, 1990), and entrepreneurial team-efficacy (Arnold *et al.*, 2001; Baum and Bird, 2010; Drnovajek *et al.*, 2010), as antecedents of the absorptive capacity of high-tech academic spin-offs.

This paper aims to study the effect of domain-specific experience, entrepreneurial orientation, and team-efficacy on the absorptive capacity of the spin-off's management team. This paper contributes to absorptive capacity and entrepreneurship literature in three ways. First, by investigating how entrepreneurial orientation and entrepreneurial team-efficacy relate to different dimensions of absorptive capacity. We study the antecedents of both dimensions of absorptive capacity (Greve, 2008; Jansen *et al.*, 2005; Salvato *et al.*, 2009; Volberda *et al.*, 2010; Zahra and George, 2002), in particular potential absorptive capacity and realised absorptive capacity. Zahra and George (2002) distinguished between potential absorptive capacity and realised absorptive capacity. Potential absorptive capacity is based on knowledge acquisition and assimilation and is the ability to identify, acquire, and assimilate new external knowledge. Realised absorptive capacity is based on knowledge transformation and exploitation, and is the ability to arrive at new insights from the combination of existing and newly-acquired knowledge (Zahra and George, 2002). It has been recognised that different antecedents may have different effects on the dimensions of potential and realised absorptive capacity (Fosfuri, and Tribó, 2008; Jansen *et al.*, 2005; Todorova and Durisin, 2007; Zahra and George 2002).

Second, following suggestions to broaden the search for antecedents of absorptive capacity and to investigate how capacity is built at the team level (Volberda *et al.*, 2010), we study absorptive capacity antecedents at the level of the high-tech academic spin-off team. Since new venture teams are themselves responsible for building such capabilities (Holcomb *et al.*, 2009; Sirmon *et al.*, 2007), we study how the spin-off teams can be organised to seek and perceive external knowledge as opportunities. Besides the team's domain-specific experience, this paper also contributes to the debate in literature about a team's micro-level antecedents such as willingness and motivation, which are notably absent in the literature (Minbaeva *et al.*, 2003; Volberda *et al.*, 2010).

Finally, academic spin-offs provide a unique context for expanding our current knowledge in the absorptive capacity, entrepreneurial orientation and team-efficacy literature. The Dutch sample provides an opportunity to test these relationships in a non-USA setting, where a majority of previous research has occurred.

The following section presents the theoretical basis and hypotheses for our conceptual framework that depicts the relationships between management team characteristics, potential and realised absorptive capacity (Figure 1). It unfolds along the following lines. Section 2 reviews the relevant literature to derive hypotheses on the determinants of absorptive capacity. Sections 3 and 4 present the methods of empirical data collection and the operational measures, respectively the results and discussion on the tested hypotheses. Finally, Section 5 presents the conclusions and implications.

2. Theoretical background and hypotheses

Absorptive capacity, conceptualised by Cohen and Levinthal (1989), has attracted considerable interest in organisational research (Lane *et al.*, 2006). Absorptive capacity comprises routines to acquire, assimilate, transform and exploit new external knowledge, in order to build, maintain or renew other capabilities (Cohen and Levinthal, 1990; Todorova and Durisin, 2007; Zahra and George, 2002). The prior possession of knowledge and skills is considered important to the development of learning when new knowledge is combined with existing knowledge. However, Covin and Levinthal (1990) argue that for an effective absorptive capability capacity, the intensity of effort is crucial. Thus effort and purposeful action is needed to make novel associations and linkages. Fabrizio (2009) found that biotechnology and pharmaceutical firms that invest more in their internal basic research and engage in collaborations with university scientists do in fact experience additional search benefits, thereby supporting his argument that 'effort, experience, expertise, and purposeful action among members are required to identify, assimilate, and exploit this external knowledge' (Fabrizio, 2009: 257).

However, most studies on absorptive capacity have investigated the role of required skills and experience of firm members, and neglected studying the micro-level antecedents of absorptive capacity such as motivation that members may have (Minbaeva *et al.*, 2003; Volberda *et al.*, 2010). In this section we develop hypotheses investigating teams' domain-specific experience in addition to entrepreneurial antecedents of academic spin-off teams as antecedents of the two dimensions of absorptive capacity.

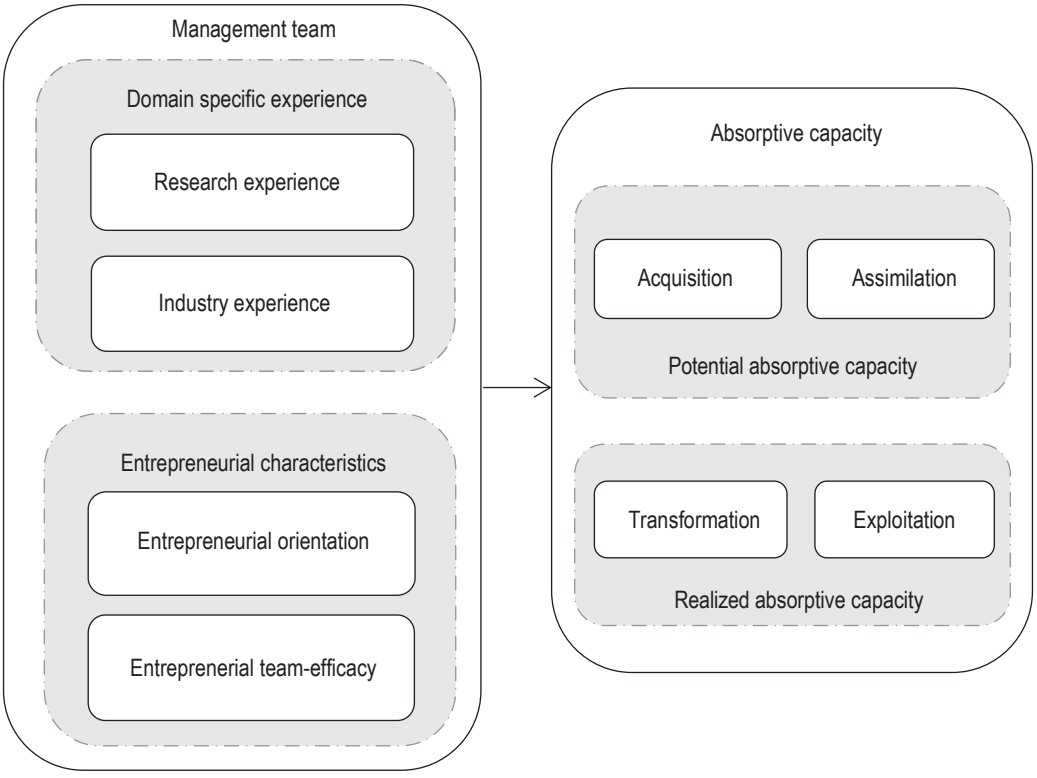

Figure 1. Theoretical model.

Domain-specific research and industry experience

Previous literature indicates that the employment history and experiences of the entrepreneur are crucial for entrepreneurial success (Sandberg and Hofer, 1988; Starr and MacMillan, 1990; Wright *et al.*, 2007). Entrepreneurship literature has focused on domain-specific experience in terms of domain-specific research and domain-specific industry experience (Agarwal *et al.*, 2004; Kor, 2003; Shane and Venkataraman, 2000).

Domain-specific research experience

Academic scientists need different sets of skills and expertise to pool technological opportunities and exploit entrepreneurial opportunities (D'Este *et al.*, 2012). In fact they need to conduct further research before they can exploit their scientific findings (Clarysse *et al.*, 2005).

Knowledge acquisition capacity refers to identifying value and acquiring externally generated knowledge that is critical to firm operations (Zahra and George, 2002). Spin-off teams that have been involved in a scientific discovery possess a great deal of non-codified knowledge that can be useful to identify and evaluate external knowledge, which is needed for the further development and implementation in practice (Clarysse and Moray, 2004). Indeed, domain-specific research experience affects the team's access to scientific experience and expertise in other research areas (Corolleur *et al.*, 2004; Murray, 2004; Shane and Stuart, 2002) and advances the discovery of opportunities (Shane, 2000).

Domain-specific research experience facilitates the search for new innovations by suggesting possible solutions and allowing researchers to focus their search in the most likely areas of opportunity while eliminating areas of search that would have proved fruitless (Fabrizio, 2009; Sorenson and Fleming, 2004). This will eventually result in a higher knowledge acquisition capacity.

Assimilation refers to analysing, interpreting and understanding the information obtained from external sources (Szulanski, 1996). During assimilation, new external knowledge is connected to existing knowledge within the firm, which requires the identification of similarities. Firms need prior related knowledge to assimilate new knowledge (Cohen and Levinthal, 1999). A management team with high research experience will be more efficient in combining and assimilating diverse externally sourced knowledge to its internal knowledge base (Sapienza *et al.*, 2004). The dimensions of knowledge acquisition and assimilation together define potential absorptive capacity (Jansen *et al.*, 2005; Zahra and George, 2002). In conclusion, we postulate that spin-off teams with a higher level of domain-specific research experience will exhibit a higher level of potential absorptive capacity, acquisition and assimilation capacity, which leads to our first hypothesis:

Hypothesis 1: Spin-off teams with an overall higher level of domain-specific research experience will show a higher acquisition and assimilation capacity (that is, higher potential absorptive capacity).

Transformation refers to developing and refining routines that facilitate the recognition of opportunities and consequences of new external knowledge for existing operations, structures, and strategies (Jansen *et al.*, 2005; Zahra and George, 2002). It refers to maintaining and subsequently reactivating knowledge (Walsh, 1991). The more prior knowledge a firm has in a given field, the easier it is to maintain and reactivate additional knowledge (Garud *et al.*, 1998). Knowledge transformation covers the efforts to arrive at new insights from the combination of existing and newly acquired knowledge (Zahra and George, 2002). The benefits of prior knowledge indicate path-dependencies in knowledge retention (McGaughey, 2002; Pandza and Holt, 2007). Domain-specific research experience is particularly critical to the translation of research into commercial opportunities. Especially when it concerns complex or non-codified knowledge components, the translation requires common language and frequent face-to-face interaction to understand the opportunity and implement the scientific finding in practice (Agrawal, 2006).

The exploitation process refers to refining, extending and elaborating existing competencies or creating new ones by incorporating acquired and transformed knowledge into firm operations (Zahra and George, 2002). It is most efficient when individuals integrate highly specialised knowledge (Grant, 1996) in the firm's primary operations (Zahra and George, 2002). The dimensions of knowledge transformation and exploitation together define realised absorptive capacity (Jansen *et al.*, 2005; Zahra and George, 2002). Thus, we postulate that spin-off teams with a higher level of domain-specific research experience will exhibit a higher level of realised absorptive capacity, transformation and exploitation capacity, which leads to our second hypothesis:

Hypothesis 2: Spin-off teams with an overall higher level of domain-specific research experience will show a higher transformation and exploitation capacity (realised absorptive capacity).

Domain-specific industry experience

The prior related knowledge comprises not only domain-specific research experience but also the accumulation of domain-specific industry experience (Kor, 2003; Shane and Venkataraman, 2000). Industry-specific experience may impact both knowledge acquisition and knowledge assimilation (Romijn and Albaladejo, 2002). The knowledge acquisition capacity depends on the extent to which a management team pays attention to new knowledge and recognises opportunities. Prior knowledge of a specific industry has an effect on opportunity recognition, as it influences the locus of search (Shane, 2000; Zahra and George, 2002). Entrepreneurs tend to search in areas that they already know, where they had their earlier successes (Zahra and George, 2002). This kind of knowledge established through learning by doing may be measured by job experience of the managers (Vinding, 2004). Academic spin-off management teams with specific industry experience are endowed with market-pioneering know-how, that will help them to better seize market opportunities in high-tech markets (Agarwal *et al.*, 2004), leading to higher acquisition capacity.

Assimilation capacity refers to the extent to which firms are able to analyse and understand new external knowledge (Jansen *et al.*, 2005; Zahra and George, 2002). Entrepreneurs with domain-specific industry experience can adapt more easily to the habits of that industry (Chandler, 1996). Entrepreneurs that are experts in a very specialised knowledge field tend to search in-depth for new knowledge that is related to their existing knowledge base (Chandler, 1996; Laursen and Salter, 2006), which leads to higher assimilation capacity. Accordingly, we postulate that spin-off management teams with a higher level of domain-specific industry experience will exhibit a higher level of acquisition and assimilation capacity, which leads to our third hypothesis:

Hypothesis 3: Spin-off teams with an overall higher level of domain-specific industry experience will show a higher acquisition and assimilation capacity (potential absorptive capacity).

Domain-specific industry experience is critical for academic spin-offs to overcome the difficulties of commercialising academic output (Wright *et al.*, 2006). More complex innovations involve more specialised knowledge. The integration and transformation of knowledge from these specialists requires a certain degree of common language (Cohen and Levinthal, 1990; Grant, 1996; Hargadon and Sutton, 1997). In turn this common language requires a certain level of prior related knowledge in a given field. In summary, domain-specific knowledge improves the efficiency of knowledge transfer (Lane and Lubatkin, 1998).

Furthermore, when the current industry of the spin-off firm is closely related to that of the entrepreneurs' previous employment, the entrepreneurs are better placed than others to exploit market knowledge and benefit from their previous contacts with potential customers and suppliers (Shepherd, 2000). It is generally believed that entrepreneurs with related industry sector experience will have a better understanding of any underdeveloped technological and marketing opportunities in that specific sector (Shane, 2000). Such entrepreneurs are able to seize market opportunities and to position their new products (Colombo and Grilli, 2005). Moreover, experience in similar markets benefits a firm through the presence of past relationships with suppliers/customers, and a familiarity with the appropriate sales techniques and capital requirements (Marvel, 2007). It was verified that industry-specific experience has a positive effect on performance: companies whose current products, technologies and markets are related to the entrepreneurs' previous companies show higher rates of growth (Bruderl and Preisendorfer, 2000; Feeser, 1990). Consequently, domain-specific industry experience could provide a management team with a higher exploitation capacity. Thus, we postulate that spin-off management teams with a higher level of domain-specific industry experience will exhibit a higher level of transformation and exploitation capacity, which leads to our next hypothesis:

Hypothesis 4: Spin-off teams with an overall higher level of domain-specific industry experience will show a higher transformation and exploitation capacity (realised absorptive capacity).

Entrepreneurial orientation and entrepreneurial team-efficacy

Previous literature on entrepreneurship has made great strides in defining essential parameters or roles of entrepreneurs in performing entrepreneurial endeavours (Sardeshmukh and Corbett, 2011). For example, entrepreneurs have to detect and exploit opportunities, be proactive and make rapid decisions in uncertain conditions and a resource-limited environment; they have to be willing to work harder than most employees, and thus they have to possess a wide variety of skills, knowledge, and abilities (Shane, 2003). Essential parameters or characteristics of entrepreneurs in successful entrepreneurial endeavours can be gauged by entrepreneurial orientation (Covin and Slevin, 1990; Naman, 1993), and entrepreneurial team-efficacy (Baum and Bird, 2010; Drnovajek *et al.*, 2010).

Entrepreneurial orientation

Many firms attribute their success and performance to entrepreneurial orientation (Dess and Lumpkin, 2005). At the core of the general notion of entrepreneurial orientation is that such firms are more likely to embrace the creation and pursuit of new entries (Lumpkin and Dess, 1996). Regarding academic spin-offs, it has been verified that entrepreneurial orientation has a highly significant effect on their ability to access external knowledge and realise competitive advantages (Walter *et al.*, 2006). Entrepreneurial orientation is defined as a firm's strategic orientation and willingness in capturing specific entrepreneurial antecedents of decision-making styles, methods, and practices (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003). Wiklund and Shepherd (2003), stated that 'entrepreneurial orientation can enhance the performance of a firm's knowledge-based resources by focusing attention on the utilization of these resources to discover and exploit opportunities' (Wiklund and Shepherd, 2003: 1308).

Acquisition processes refer to the collection of primary or secondary information (Moorman, 1995) which involves environmental scanning, intelligence activities and the integration of that information for the firm (Keh *et al.*, 2007). Higher levels of entrepreneurial orientation help management teams to scan and monitor their environment in order to find new opportunities and strengthen their competitive positions (Keh *et al.*, 2007) and identify trends and opportunities and deploy knowledge-based resources earlier than competitors (Wales *et al.*, 2012). A management team with a more proactive orientation is expected to be more responsive to externally acquired knowledge (Liao *et al.*, 2003). During assimilation new external knowledge is connected to existing knowledge within the firm. Entrepreneurial oriented teams have higher levels of proactivity and creativity (Unsworth, 2001), identify opportunities, and act on them, until meaningful change occurs, which may lead to higher assimilation capacity. Therefore, the entrepreneurial orientation of a team may contribute to higher performance levels by strengthening a team's capacity to identify innovative opportunities and gain first mover advantages (Stam and Elfring, 2008; Wiklund and Shepherd, 2003). In summary, we argue that spin-off management teams with substantial entrepreneurial orientation will do better in acquisition and assimilation. This expectation is captured in the following hypothesis:

Hypothesis 5: Spin-off teams with an overall higher level of entrepreneurial orientation will show a higher acquisition and assimilation capacity (potential absorptive capacity).

In addition to their impact on potential absorptive capacity, entrepreneurial orientation motivates and supports firm efforts to leverage absorbed knowledge into so-called value-creating resource bundles (Griffith *et al.*, 2006; Wiklund and Shepherd, 2003). It helps combine new knowledge with existing knowledge to generate new ideas (Zahra and George, 2002), leading to higher transformation capacity. Moreover, entrepreneurial orientation in terms of proactive behaviour is important for exploitative learning routines, to utilise knowledge in ways that will meet future requirements (Gilstrap and Hart, 2012). With higher levels of entrepreneurial orientation, firms may improve their performance by intensifying their information exploitation efforts (Keh *et al.*, 2007). As such, entrepreneurial orientation enhances the commercialisation of firm knowledge that is the exploitation dimension in a firm's absorptive capacity (Wales *et al.*, 2012). To conclude, an entrepreneurially oriented spin-off management team is expected to have a higher transformation and exploitation capacity. Accordingly, we posit the following hypothesis:

Hypothesis 6: Spin-off teams with an overall higher level of entrepreneurial orientation will show a higher transformation and exploitation capacity (realised absorptive capacity).

Entrepreneurial team-efficacy

Entrepreneurial team-efficacy is the extent to which team members have motivation and are confident in their ability to produce consistently high levels of performance in entrepreneurship specific tasks (Chen *et al.*, 1998). The knowledge acquisition and assimilation capacity depends on how a management team pays attention to new knowledge and recognises opportunities. It refers to the collection of primary or secondary information (Moorman, 1995) which involves environmental scanning, intelligence activities and the integration of the resulting information into the firm (Keh *et al.*, 2007). As Chen *et al.* (1998: 301) stated, 'the same entrepreneurial environment could be assessed as replete with opportunities by people with high entrepreneurial self-efficacy but fraught with costs and risks by people with low entrepreneurial self-efficacy.' Since opportunity recognition depends on self-efficacy (Krueger and Dickson, 1994), teams with greater belief in their ability to undertake entrepreneurial activities will be more likely to engage in entrepreneurial endeavours and perceive new opportunities (Sardeshmukh and Corbett, 2011). Barbosa, Gerhardt, and Kickul (2007) also observed a connection between entrepreneurial self-efficacy and opportunity identification (Barbosa *et al.*, 2007).

Hence, scholars have shown that self-efficacy leads to a higher propensity to scan their environment and evaluate new information about valuable opportunities (Krueger and Dickson, 1994; Neck and Manz, 1992). Therefore, we argue that a spin-off management team with higher entrepreneurial team-efficacy will have a better acquisition and assimilation capacity.

Hypothesis 7: Spin-off teams with an overall higher level of entrepreneurial team-efficacy will show a higher acquisition and assimilation capacity (potential absorptive capacity).

Transformation and exploitation capacity is expected to be related to the level of motivation of employees (Liao *et al.*, 2007). Shane (2003) considered entrepreneurial team-efficacy as the entrepreneurial motivation and confidence for entrepreneurial endeavours in new ventures. Self-efficacy has been considered as an effective predictor of teams' motivation and learning (Zimmerman, 2002). Entrepreneurial team-efficacy reflects team members' confidence in their ability to successfully accomplish the different roles and tasks of entrepreneurship (Hmieleski and Corbett, 2008) and teams' beliefs about innovation and marketing (Baum and Bird, 2010; Hmieleski and Baron, 2008; McGee *et al.*, 2009) and ability to visualise success (Shepherd and Krueger, 2002). Team members with high levels of entrepreneurial self-efficacy are more likely to exhibit high levels of persistence and concentration, which enhances start-up performance (Forbes, 2005; Hmieleski and Baron, 2008; Prodan and Drnovsek, 2010). Thus it improves the transformation and opportunity exploitation capacity, critical to successfully commercialising an entrepreneurial idea. Therefore, we postulate that management teams with higher entrepreneurial team-efficacy will do better in transformation and exploitation, which leads to our last hypothesis:

Hypothesis 8: Spin-off teams with an overall higher level of entrepreneurial team-efficacy will show a higher transformation and exploitation capacity (realised absorptive capacity).

3. Methods

Sample and data collection

For this research we developed a list of spin-offs, which was provided mainly by university facilitators, such as university incubators. We delineated the population of spin-offs on the basis of three criteria, namely: location on or near the campus of universities of technology; spin-offs that are younger than 10 years old (Pirolo and Presutti, 2010); and spin-offs that are connected to a university program or incubators and use at least one type of support from the university. In total, 205 spin-offs were identified. First, we targeted 10 potential spin-offs in our pilot study, recommended by university incubators, to pre-test our questionnaire. The firm's founder filled out the questionnaire in the presence of one of the researchers, which led to final adjustments of the semi-structured questionnaire. Second, between December 2011 and March 2012 we sent the final questionnaire to 205 academic spin-offs from three prominent technical universities in the Netherlands: Delft University of Technology, Wageningen University and Research centre and Eindhoven University of Technology. Of the 105 surveys that were returned, ten incomplete questionnaires were rejected and we ended up with 95 useable questionnaires of academic spin-offs, yielding a response rate of 46%, which is quite acceptable for this type of survey (Baruch, 1999).

To assess the quality of the data, we tested for various potential biases, but found no anomalies. For example, we tested for non-response effects by comparing the group of early respondents to the group of late respondents (Armstrong and Overton, 1977) and we found no significant differences between the two groups. One other potential source of bias resides in the fact that our findings are derived from spin-offs that survived to the time of the survey. Spin-offs that had failed to survive fell outside our ability to observe. This is a common problem in studies on young firms. However, failure among academic spin-offs from technical universities is generally low. For example, the incubator in Delft witnesses 90% survival after six years of existence (Van Geenhuizen and Soetanto, 2009). This is slightly higher than the average in the EU at large which is 75% after six years of founding (Clarysse *et al.*, 2007), indicating a rather small potential bias in the results due to excluding non-survivors.

Table 1 provides descriptive information on the dataset regarding company age and size, management team age and size, research experience and industry experience. The average company age was 3.3 years, with the distribution skewed towards younger spin-offs (63.2% of spin offs under three years). The average age in management teams was 34.5 years. The average number of employees was six, which fit into the general slow growth in the European Union. In the European Union, most spin-offs are not larger than 10 employees after 6 years of existence (Mustar *et al.*, 2008). The average number of years of industry experience among team members before starting the spin-off was just over four, which is consistent with other literature on spin-offs (Clarysse *et al.*, 2011a; Ensley and Hmieleski, 2005). Finally, with regard to sectors, the spin-off firms were mainly active in

Table 1. Descriptive statistics and correlations (n=95).[1]

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Potential absorptive capacity	5.23	1.01	1.00										
2. Realised absorptive capacity	5.41	0.82	0.62**	1.00									
3. Domain-specific research experience (years)	6.40	0.78	0.13	0.28**	1.00								
4. Domain-specific industry experience (years)	4.68	1.66	-0.09	0.23*	0.49**	1.00							
5. Entrepreneurial orientation	4.89	1.09	0.28**	0.45**	0.09	-0.06	1.00						
6. Entrepreneurial team-efficacy	4.74	5.64	0.21*	0.52**	0.09	0.02	0.19	1.00					
7. Environmental turbulence	5.71	6.10	0.26*	0.07	-0.08	-0.05	0.09	0.07	1.00				
8. Academic spin-off size (FTE)	5.9	10.0	0.05	0.08	0.06	-0.18	0.04	0.11	-0.06	1.00			
9. Academic spin-off age (years)	3.3	2.0	-0.20	-0.01	0.37**	0.49**	-0.14	-0.02	-0.08	-0.01	1.00		
10. Management team size (FTE)	2.7	1.2	0.04	0.04	-0.03	-0.11	0.01	0.18	-0.03	0.11	0.05	1.00	
11. Average age of management team (years)	34.5	8.1	-0.12	-0.17	-0.08	-0.08	-0.11	-0.01	-0.04	0.02	0.11	0.41**	1.00

[1] * $P<0.05$; ** $P<0.01$.

information technology (31%), medical technology (26%) clean technology (27%), and agribusiness and food (16%).

Although the data was self-reported, previous studies show that founder-reported responses to questions about start-up team members can be considered reliable (Brush and Vanderwerf, 1992). This procedure is considered adequate when collecting detailed information regarding prior experience of start-up team members (Davidsson and Wiklund, 2006), is less suitable for questions on past opinions or beliefs, but is especially suited to data-gathering on simple facts and events, as is the case in our study (Golden, 1992). Furthermore, the use of retrospective reporting is a viable research method when the measures used are reliable and valid (Miller *et al.*, 1997). Complementary data on past experiences regarding the questions on domain research and industry experience (Appendix 1) was gathered from secondary sources, such as LinkedIn and Facebook to reduce the potential of single source bias.

Data analysis

The data analysis follows a two-step procedure: assessing measures (using exploratory factor analysis), followed by multi-hierarchical regression. We performed a multi-hierarchical regression analysis, in STATA, to assess the effects of the various antecedents on absorptive capacity. The hierarchical approach is appropriate when the focus is on theory-based decisions to investigate the change in variations as a result of entering independent variables in the analysis over and above that contributed by independent variables entered initially in the analysis (Cohen, 1983). The analysis takes potential and realised absorptive capacity as dependent variables. In each step of the hierarchical analysis the two factors for prior related knowledge and two factors for entrepreneurial antecedents as entrepreneurial orientation and team-efficacy are added, to the six control variables.

Measures

We measured the relevant constructs (Appendix 1) using multi-item scales, based on existing literature, with their reliability and validity being assessed through various analyses.

Dependent variables

We used existing literature on the dependent variables of potential and realised absorptive capacity to develop measurements for each of the four constructs on or dimensions of absorptive capacity – acquisition, assimilation, transformation and exploitation (Appendix 1). Measurements were partially based on existing items and measures of related constructs, using seven-point Likert scales (Jansen *et al.*, 2005; Schleimer and Pedersen, 2013; Zahra *et al.*, 2007). Since relevant previous research was mainly directed at large companies, we adapted the measures to the academic spin-offs. For example, we replaced the term 'units of organisation' by 'management team'.

The results of the exploratory factor analysis are presented in Table 2. The table presents three items from Schleimer and Pedersen (2013), four items from Zahra *et al.* (2007) and nine items from Jansen *et al.* (2005). The exploratory factor analysis with varimax rotation and Kaiser Normalisation (Hair and Black, 2006) resulted in a four-factor solution with clean loadings for the items on their respective constructs. The initial results led to the elimination of one item. The dependent variable potential absorptive capacity comprises the acquisition and the assimilation of external knowledge. Three items loaded on knowledge acquisition (α=0.82). In addition, five items measured the assimilation of external knowledge (α=0.82). The dependent variable realised absorptive capacity comprises the transformation and exploitation of external knowledge. Three items loaded on knowledge transformation (α=0.66), and four items together measure knowledge exploitation, or the ability of spin-offs to incorporate new external knowledge into their operations (α=0.75). The respective Cronbach alpha shows that each of the four constructs of the dependent variables performed satisfactorily (Table 2).

Independent variables

The antecedents of absorptive capacity consist of the management teams' prior related knowledge and entrepreneurial orientation and team-efficacy. To measure prior related knowledge, in terms of domain-specific research and industry experience, we asked the main founder to provide information on the team members' experience (Appendix 1). We also used secondary sources, such as LinkedIn and Facebook for the respondents who did not completely fill out this part and we also used it to validate the data that the respondents gave to reduce the potential of single source bias.

We adapted respectively the average number of years of doing research and work experience of the management team in the specific field or technology of the start-up (Florin *et al.*, 2003; Scholten, 2006; Shane and Stuart, 2002; Westhead *et al.*, 2001). To obtain normally distributed variables we used square root transformation for the domain-specific experience.

The measurement for entrepreneurial orientation was based on the Covin and Slevin (1989) scale (Covin and Slevin, 1989). The analysis leads us to exclude one item of proactiveness, so the scale examines innovativeness (three items), risk taking (three items), and proactiveness (two items), resulting in a reliable scale (α=0.67). Since these three subscales are manifestations of entrepreneurial orientation, we use the measure for the combined construct instead of individual subscales (Keh *et al.*, 2007), since the subscales are highly correlated (Wiklund and Shepherd, 2005). To measure team-efficacy we deployed a used scale (Kickul *et al.*, 2009; McGee *et al.*, 2009). The scale uses 7 items or statements to measure ability of the start-up team to perform the instrumental functions in the entrepreneurial process. For each statement, the respondents rated the extent to which they felt confident that their team could successfully complete tasks, actions and processes that contribute to successful performance. To reduce the dimension based on common variance we used explorative factor analysis that extracted one factor, and the loadings for indicators ranged from 0.73 to 0.82, suggesting construct validity. The performance scale has a Cronbach's alpha of 0.91, which indicates a good level of reliability.

Control variables

The research included six control variables, namely spin-off size, spin-off age, start-up team age, start-up team size, environmental turbulence and sector. First, larger spin-offs may have more resources, yet they may lack the flexibility to acquire and assimilate new external knowledge. To obtain normally distributed variables we included the natural log for spin-off size and age and for management team size and age (Jansen *et al.*, 2005). Second, one would expect older firms, with their accumulated experience, to be better at exploitation (Acs and Audretsch, 1988; Brouwer and Kleinknecht, 1999). Third, spin-off team age is a control variable because age and capabilities might be correlated (Hambrick and Mason, 1984; Kor, 2003). Fourth, in line with

Table 2. Results of the exploratory factor analysis for absorptive capacity (n=95).

Variables	Mean	SD	Potential absorptive capacity		Realised absorptive capacity	
			Acquisition	Assimilation	Transformation	Exploitation
1. We frequently scan the environment for new technologies	5.11	1.621	0.783	0.171	0.333	-0.007
2. We thoroughly observe technological trends	5.37	1.360	0.848	0.270	0.055	0.153
3. We observe in detail external sources of new technologies	5.04	1.436	0.752	0.179	-0.107	0.318
4. We thoroughly collect industry information	5.32	1.273	0.490	0.538	0.146	0.238
5. We can quickly interpret changing market demands	5.31	1.272	0.326	0.727	0.311	0.025
6. New opportunities to serve our clients are quickly understood	5.14	1.411	0.087	0.714	0.247	0.116
7. We analyse various combinations of attributes for our products	5.30	1.295	0.186	0.771	-0.041	0.253
8. We analyse different sequences for new product development	5.31	1.305	0.176	0.634	0.180	0.382
9. We record and store newly acquired knowledge for future reference	5.10	1.422	-0.109	0.261	0.688	0.089
10. We determine how customers will use our technologies	5.44	1.373	0.295	-0.014	0.686	0.201
11. We identify different customer groups that might have an interest in our products	5.29	1.304	0.176	0.405	0.583	0.046
12. We have a clear division of roles and responsibilities	5.46	1.285	-0.068	0.105	0.491	0.657
13. We easily implement technologies in new products	5.43	1.267	0.131	0.170	0.008	0.715
14. We have a common language regarding our products and services	5.61	1.132	0.110	0.220	0.377	0.754
15. We constantly consider how to better exploit knowledge	5.69	0.968	0.291	0.146	-0.023	0.628
Eigenvalue			6.13	1.66	1.33	1.04
Variance explained			38.34	10.93	8.71	6.92
∑ Variance explained			38.34	49.13	57.95	64.85
Cronbach α			0.82	0.82	0.66	0.75

previous studies (Mihalache, 2012), we control for spin-off team size by including the natural log of the number of start-up team members. Fifth, environmental turbulence is also claimed to influence potential absorptive capacity (Jansen *et al.*, 2005; Zahra and George, 2002). The related construct consists of four items (α=0.83); it is based on Jaworski and Kohli (1993) and was used in many other studies (Sethi and Iqbal, 2008). Sixth and finally, considering prior studies that have reported different knowledge strategies in different industries (Salavisa *et al.*, 2012), we controlled for industry effects. We included industry dummies for spin-offs focused on medical technology (used as the base group), clean technology, information technology, or agriculture and food.

4. Results

Table 1 provides the descriptive statistics and zero order correlations among the variables used in the regression analyses. We examined multicollinearity between the predictors, by calculating the variance inflation factor (VIF) index and tolerance statistics. The VIF indices varied between 1.09 and 2.18, far below the VIF index threshold value of 10 (Field, 2009). The tolerance statistics showed values between 0.45 and 0.89, all well above 0.20. Finally, the maximum correlation value of 0.62 also indicates absence of serious threats to multicollinearity (Field, 2009).

The results of the hierarchical multiple regression analyses are reported in Table 3. To distinguish between the relative effects of different antecedents of prior knowledge and entrepreneurial antecedents on potential and realised absorptive capacity, we determined the relative importance of each set of antecedents, performing F-tests involving both the full and restricted models (Kotha and Nair, 1995).

For both potential and realised absorptive capacity we examined a base model and main effects models. We regressed the dependent variable on the control variables to create a baseline model (Model A1 and Model B1 in Table 3), then entered the direct effects to test Hypotheses 1, 2, 3 and 4 about domain-specific experience (Model A2 and Model B2 in Table 3), and finally entered entrepreneurial orientation and team-efficacy to test Hypotheses 5, 6, 7 and 8 (Models A3 and B3 in Table 3).

Table 3. Potential and realised absorptive capacity: prior knowledge and entrepreneurship (STATA).[1]

	Potential absorptive capacity						Realised absorptive capacity					
Model	A 1		A2		A3		B1		B2		B3	
	Beta	S.E.	Beta	S.E.	Beta	S.E.	Beta	S.E.	Beta	S.E.	Beta	S.E.
Domain-specific experience												
Domain-specific research experience			0.25**	0.10	0.17*	0.10			0.25*	0.11	0.07	0.06
Domain-specific industry experience			-0.11	0.09	-0.08	0.10			0.09	0.08	0.15*	0.07
Entrepreneurial antecedents												
Entrepreneurial orientation					0.31*	0.14					0.37**	0.08
Entrepreneurial team-efficacy					0.11	0.10					0.39**	0.07
Controls												
Environmental turbulence	0.31**	0.10	0.32**	0.10	0.29**	0.11	0.06	0.08	0.08	0.07	0.01	0.06
Management team size	0.11	0.20	0.05	0.19	0.01	0.17	0.25	0.21	0.27*	0.16	0.13	0.12
Management team age	-0.72*	0.37	-0.96*	0.42	-0.69	0.45	-0.05	0.41	-0.77*	0.38	-0.20	0.29
Spin-off size	-0.08	0.15	-0.08	0.15	-0.12	0.13	0.04	0.11	0.06	0.11	-0.03	0.08
Spin-off age	-0.10	0.15	-0.08	0.15	-0.03	0.14	-0.16	0.15	-0.11	0.13	-0.07	0.10
Constant	7.87**	1.30	8.35**	1.38	6.37**	1.62	5.47**	1.37	7.17**	1.24	3.85**	1.03
Model F-statistic	4.09**		4.57**		5.55**		1.24		4.57**		18.15**	
R2	0.16		0.21		0.27		0.05		0.19		0.51	
Adjusted R2	0.12		0.14		0.20		0.001		0.13		0.46	
R2 change			0.05*		0.06*				0.14**		0.32**	

[1] n=5; robust standard errors, * $P<0.05$, ** $P<0.01$; Sectors (IT, clean technology, medical technology and agriculture have also been controlled).

The control variables of management size and age, spin-off size and age and environmental turbulence explain 16% of the variation in potential absorptive capacity but only 5% of the variation in realised absorptive capacity. The next step of analysis includes the two variables for prior related knowledge as displayed in Models A2 and B2. These two variables account for an additional 5% of the variation in potential absorptive capacity and 14% of variation in realised absorptive capacity. Domain-specific research experience has a statistically significant positive relationship with both potential absorptive capacity (α=0.25; P<0.01) and with realised absorptive capacity (α=0.25; P<0.05). The results in Models A2 and B2 support both Hypothesis 1 and Hypothesis 2. A higher level of domain-specific research experience of management team members has a significant and positive effect on potential absorptive capacity and realised absorptive capacity However, for the domain-specific industry experience we did not find significant statistical relationships, thus neither Hypothesis 3 nor Hypothesis 4 is supported by the data.

Models A3 and B3, the full models, introduce the variables of entrepreneurial orientation and team-efficacy, and significantly increase the amount of explained variance. The increase in variation for potential absorptive capacity is 6%, whereas for the realised absorptive capacity the increase is 32%. After adding the entrepreneurial aspect variables, the effect of domain-specific research experience became less significant in Model A3 and disappears in Model B3. Domain-specific industry experience is not statistically significant in Model B3, and only has a statistically significant effect on realised absorptive capacity (α=0.15; P<0.05) in Model B3. Models A3 and B3 reveal that entrepreneurial orientation has a statistically significant positive relationship with both potential absorptive capacity (α=0.31; P<0.05) and realised absorptive capacity (α=0.37; P<0.001) supporting both Hypothesis 5 and Hypothesis 6. Finally, in contrast to Hypothesis 7, Hypothesis 8 received substantial significant statistical support (α=0.39; P<0.001), indicating a strong positive effect of team-efficacy on realised absorptive capacity. Figure 2 presents the significant relationships.

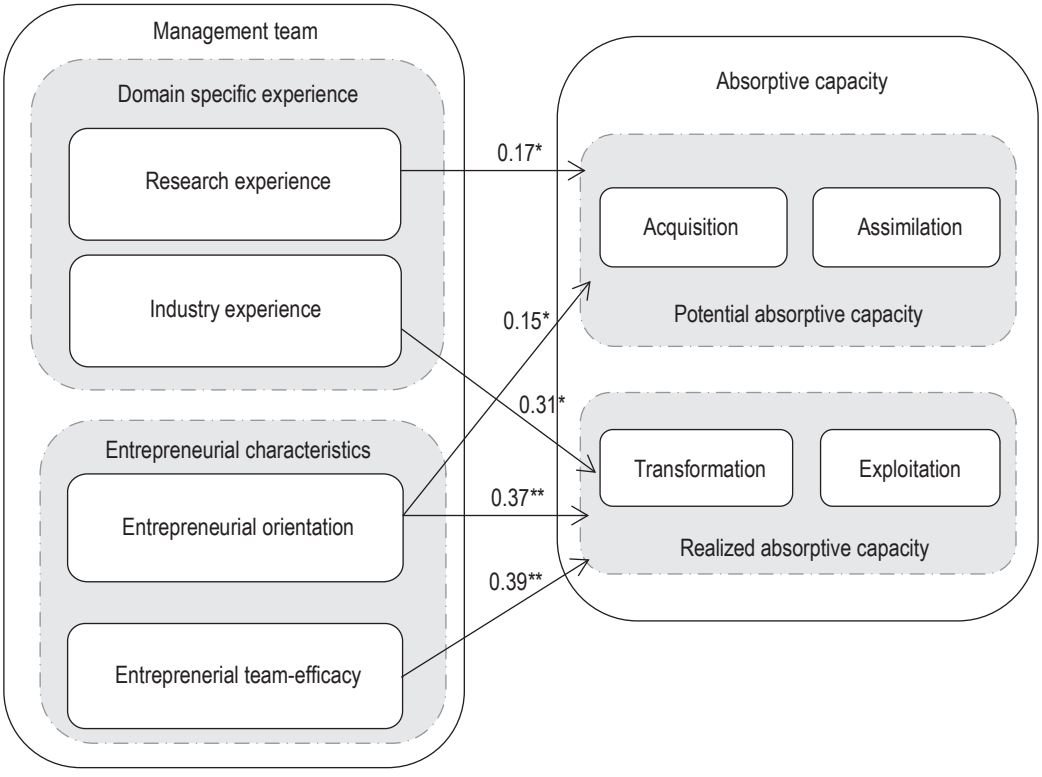

Figure 2. Statistically significant model paths. Only the significant paths are shown. * significant path at P<0.05; ** significant path at P<0.01

5. Discussion and conclusions

Academic spin-offs are known to differ from other ventures with respect to their academic origin, human capital and resource demands (Patzelt and Shepherd, 2009; Shane, 2004; Wright *et al.*, 2007). Absorptive capacity plays a critical role in fostering academic spin-off growth and helping them face their growth challenges through the acquisition and exploitation of knowledge and resources (Bollingtoft and Ulhoi, 2005; Holcomb *et al.*, 2009; Lockett *et al.*, 2005; Sirmon *et al.*, 2007; Wright *et al.*, 2007; Zahra *et al.*, 2009). This study investigates how the prior experience of academic spin-off teams, and their entrepreneurial orientation and entrepreneurial team-efficacy, relate to different dimensions of potential absorptive capacity and realised absorptive capacity. This corresponds to studies among other types of organisations showing that different antecedents may have different effects on both dimensions of potential and realised absorptive capacity (Fosfuri and Tribó, 2008; Jansen *et al.*, 2005; Todorova and Durisin, 2007; Zahra and George 2002).

In light of the scant evidence on the factors that shape academic spin-off absorptive capacity, the present study investigated how absorptive capacity in high-tech academic spin-offs is influenced by the spin-off teams' domain-specific industry and research experience and team entrepreneurial orientation and team-efficacy. In line with the literature on studying the importance of management team ability in start-ups (Holcomb *et al.*, 2009), we show that academic spin-off management team characteristics play a critical role in building absorptive capacity. We provide evidence of the importance of entrepreneurial orientation (Walter *et al.*, 2006) and entrepreneurial team-efficacy (Arnold *et al.*, 2001) in developing spin-offs' absorptive capacity.

Our findings expand previous studies on prior experience as an antecedent of absorptive capacity (Argote *et al.*, 2003; Cohen and Levinthal, 1990; Van Den Bosch *et al.*, 1999). We specified the effects of both domain-specific research and industry experience on both potential and realised absorptive capacity. The finding shows that domain-specific research experience is a predictor for both potential and realised absorptive capacity while domain-specific industry experience is only a predictor for realised absorptive capacity. This result can be explained by the notion of Lazaric *et al.* (2008) that the passage from potential absorptive capacity to realised absorptive capacity is not only a period that goes beyond a simple discovery of knowledge base, but is also a stage where the management team can gain competencies regarding their work experience in that specific industry (Lazaric *et al.*, 2008). In other words, while specific research experience is relevant for opportunity discovery and the exploration aspects of entrepreneurial opportunities, something more than excellent science is needed for exploitation (D'Este *et al.*, 2012).

The present study provides evidence that next to prior experience, team entrepreneurial orientation and team-efficacy are key in shaping absorptive capacity in high-tech academic spin-off teams. Our results suggest strong support for the effects of domain-specific experience and team entrepreneurial antecedents on both dimensions of potential and realised absorptive capacity. More specifically, the domain-specific research experience of academic spin-off teams and willingness to take risks or entrepreneurial orientation (Covin and Slevin, 1990) are positively related to potential absorptive capacity and domain-specific industry experience; while the confidence, motivation or entrepreneurial team-efficacy (Hmieleski and Corbett, 2008) are positively related to realised absorptive capacity. Our findings show significant effects of team entrepreneurial antecedents on potential and realised absorptive capacity. The findings indicate that a team with high levels of entrepreneurial orientation enhances a spin-off's potential absorptive capacity as well as its realised absorptive capacity. However, managers also need high levels of entrepreneurial team-efficacy to enhance their realised absorptive capacity. This confirms studies that recognise the role of team motivation and confidence on realised absorptive capacity (Liao *et al.*, 2007). Finally, our results reveal the importance of environmental dynamics in relation to potential absorptive capacity. In line with other scholars (e.g. Jansen *et al.*, 2005), we show that in turbulent environments potential absorptive capacity was higher.

Implications

Our study contributes to research on absorptive capacity and entrepreneurship and has various important implications for high-tech academic spin-off management teams.

The present study contributes to scholars' understanding as to how spin-off management teams are able to acquire and assimilate new external knowledge, and also how they transform and exploit it successfully, since absorptive capacity antecedents may follow different developmental paths (Jansen *et al.*, 2005).

Academic spin-off management teams may face particular barriers during their growth related to their university origins and lack of experience and entrepreneurial characteristics. The results of this study indicate that management teams benefit the most from having members with both research

and industry experience. The findings show that next to research experience, the management team should seek and acquire new knowledge, while industry experience is needed for selecting the idea with commercial potential and transferring the technology and knowledge to commercial ends. Therefore it is recommended that at least one member of a management team has industry experience in order to better absorb and utilise the external knowledge.

In addition, our findings indicate that academic entrepreneurs can benefit from having an entrepreneurial orientation; e.g. to be more willing to support creativity and introduce new knowledge, to have a tendency to take action more quickly when entering unknown and new markets and committing a larger proportion of resources to activities for which the outcomes are more uncertain (Lumpkin and Dess, 2001). Therefore, proactive, innovative, and risk-seeking behaviours are significant internal determinants of their firms' dynamic capabilities. This is in line with Keh *et al.* (2007). It seems that a creative, proactive and risk-taking posture is important for start-up teams when they seek and utilise information. Furthermore, the findings suggest that teams with higher levels of entrepreneurial orientation have more potential absorptive capacity. However, to increase their realised absorptive capacity, they need an effective entrepreneurial team-efficacy. Entrepreneurial team-efficacy is more critical in realised absorptive capacity relating more to the implementation and exploitation of the technology or product. Management teams must be confident in performing entrepreneurial activities in particular when related to product commercialisation such as writing a formal business plan and raising money to start a business. Therefore, in order to have both potential and realised absorptive capacity, management teams should balance between the dimensions of absorptive capacity (Todorova and Durisin, 2007). Zahra and George (2002: 191) argue that 'firms can acquire and assimilate knowledge but might not have the capability to transform and exploit the knowledge'. In other words, potential absorptive capacity and realised absorptive capacity are distinct dimensions, with complementary roles that should be balanced. A better understanding of the role of entrepreneurial orientation and team self-efficacy may help founders of spin-off teams to recruit and add new members to their team in order to reach higher absorptive capacity. Venture capitalists and other investors can be advised to analyse not only the experience of teams, but also their team entrepreneurial antecedents such as entrepreneurial orientation and team-efficacy before making an investment decision.

Limitations and implications for future research

Although the study provides some interesting findings, several limitations should be noted. Our study used a single key informant approach, which is a common practice in entrepreneurial research in start-up teams (Walter *et al.*, 2006). We have chosen the academic founders as key informants: people we assume are well informed about their start-up management team. We are also aware of using measures based on subjective perceptual data. These measures are associated with a number of limitations such as social desirability due to respondents' willingness to create a positive image of themselves or of their firm (Podsakoff *et al.*, 2012). Future research may benefit from conducting interviews with more than one informant in each spin-off (Pettersen and Tobiassen, 2012) and using other objective indicators to measure potential and realised absorptive capacity. However, such objective data such as R&D intensity, expertise of employees, or number of patents have drawbacks. These proxies are also disputed because of ignorance of absorptive capacity multidimensionality. Several productive avenues for future research exist. The discrepancies in past research may have partly arisen from failure to distinguish between different types of domain-specific experience. For instance, some knowledge sources and experience might be more easily shared among the start-up team than others, e.g. the codifiability of knowledge. Therefore, further theory development should focus on which types of knowledge and experience are best suited for developing absorptive capacity in the context of high-tech academic spin-offs. As our study was cross-sectional in nature, it would be worthwhile investigating the long-term effects of absorptive capacity on performance, which calls for a longitudinal study complete with more control variables. Fine-grained, qualitative approaches may be needed to discover what factors may foster or inhibit potential and realised absorptive capacity in spin-offs. Future research can study different antecedents of absorptive capacity which are relevant for the context of academic spin-offs, for instance the network of advisors, coaches and facilitators that may help them to better understand and absorb external knowledge.

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Appendix 1. Questionnaire items.

Domain-specific experience

Please provide us with information about the members of the management team.					
Who are the management team?	Name	.....	.....	.....	.....
Age at founding	Year	... year	... year	... year	... year
Highest education	PhD				
	MSc				
	BSc				
	MBA				
Before joining the start-up, how many years of experience does this person have in	the same industry as the start-up?				
	doing research in the same technology as the start-up?				

Domain-specific research experience: Management team members' average number of years of doing research in the same industry as the spin-off
Domain-specific industry experience: Management team members' average number of years of experience in the same field as the spin-off

Absorptive capacity (Jansen et al. 2005, Schleimer and Pedersen, 2013; Zahra et al. 2007)

To what extent do you agree or disagree with the following statements about your management team (circle 1 = completely disagree, 7 = completely agree).

Potential absorptive capacity (Acquisition and assimilation)	
We frequently scan the environment for new technologies	1 2 3 4 5 6 7
We thoroughly observe technological trends	1 2 3 4 5 6 7
We observe in detail external sources of new technologies	1 2 3 4 5 6 7
We thoroughly collect industry information	1 2 3 4 5 6 7
We can quickly interpret changing market demands	1 2 3 4 5 6 7
New opportunities to serve our clients are quickly understood	1 2 3 4 5 6 7
We analyse various combinations of attributes for your products	1 2 3 4 5 6 7
We analyse different sequences for new product development and introduction	1 2 3 4 5 6 7
Realised absorptive capacity (Transformation and exploitation)	
We regularly consider the consequences of changing market demands in terms of new product and services.	1 2 3 4 5 6 7
We record and store newly acquired knowledge for future reference	1 2 3 4 5 6 7
We determine how customers will use our technologies	1 2 3 4 5 6 7
We identify different customer groups that might have an interest in our products	1 2 3 4 5 6 7
We have a clear division of roles and responsibilities	1 2 3 4 5 6 7
We easily implement technologies in new products	1 2 3 4 5 6 7
We have a common language regarding our products and services	1 2 3 4 5 6 7
We constantly consider how to better exploit knowledge	1 2 3 4 5 6 7

Entrepreneurial antecedent's entrepreneurial orientation (Covin and Slevin, 1989)

To what extent do you agree or disagree with the following statements (circle 1 = completely disagree, 7 = completely agree).

Innovativeness		
In general we favour a strong emphasis on the marketing of tried and true products and services	1 2 3 4 5 6 7	In general we favour a strong emphasis on R&D, technological leadership, and innovations
Over the last years we had few new lines of products or services	1 2 3 4 5 6 7	Over the last years we had many new lines of products and services
Changes in product or service lines have been mostly of a minor nature	1 2 3 4 5 6 7	Changes in product or service lines have usually been quite dramatic
Proactiveness		
In dealing with competitors, we typically respond to actions which competitors initiate	1 2 3 4 5 6 7	In dealing with competitors, we typically initiate actions
It is very seldom that we are the first to introduce new products/services, operating technologies	1 2 3 4 5 6 7	In general we favour a strong emphasis on the marketing of tried and true products and services
We typically seek to avoid competitive clashes, preferring a 'live-and-let-live' attitude	1 2 3 4 5 6 7	We typically adopt a very competitive, 'undo-the-competitor' attitude
Risk taking		
In general we have a strong proclivity for low risk projects (with normal and guaranteed rates of return)	1 2 3 4 5 6 7	In general we have a strong proclivity for high risk projects (with chances of very high returns)
We believe that owing to the nature of the environment, it is best to explore it gradually via careful, incremental behaviour	1 2 3 4 5 6 7	We believe that owing to the nature of the environment, bold, wide-ranging measures are necessary to achieve the firm's objectives
We typically adopt a 'wait-and-see' attitude in order to minimise the probability of making costly decisions	1 2 3 4 5 6 7	We typically adopt a bold, aggressive attitude in order to maximise the probability of exploiting potential opportunities

Entrepreneurial team-efficacy (Kickul et al., 2009, McGee et al., 2009)

How confident are you that the team members can execute the following activities? (1 = not confident, 7 = very confident)

Conceive a unique idea for a business	1 2 3 4 5 6 7
Identify market opportunities for a new business	1 2 3 4 5 6 7
Write a formal business plan	1 2 3 4 5 6 7
Raise money to start a business	1 2 3 4 5 6 7
Convince others to work for you in your new business	1 2 3 4 5 6 7
Manage a small business	1 2 3 4 5 6 7
Grow a successful business	1 2 3 4 5 6 7

Environmental turbulence (Jaworski and Kohli, 1993)

To what extent do you agree or disagree with the following statements (circle 1 = completely disagree, 7 = completely agree).

The technology in our markets is changing rapidly	1 2 3 4 5 6 7
Technological changes provide big opportunities in our market	1 2 3 4 5 6 7
In our industry customers' needs change rapidly	1 2 3 4 5 6 7
In our industry market conditions change frequently	1 2 3 4 5 6 7