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Article abstract

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ABSTRACT

Several articles call for more integrative models dealing with the identification of ACAP antecedents. Along with this idea, there is a growing need for further investigation to better approach the triggering of a knowledge absorption sequence. The objective is to highlight the impact of different organizational mechanisms as well as the knowledge broker role of SME CEOs in triggering and developing absorptive capacity. This study reveals on one hand the critical role of SME CEOs in triggering a knowledge absorption sequence. On the other hand, results underline that knowledge formalization and the codification of behaviors are effective mechanisms for the development of absorptive capacity.

Key words: absorptive capacity, knowledge broker role, high-tech SMEs

Résumé

Plusieurs articles sur la CAPacité d'Absorption (ACAP) appellent à des modèles intégratifs traitant de l'identification d'antécédents de l'ACAP. Il existe également un besoin croissant d'approfondir les investigations sur le déclenchement d'une séquence d'absorption. L'objectif est de mettre en évidence l'impact de quatre mécanismes organisationnels ainsi que le rôle de « *knowledge broker* » des dirigeants de PME. Cette recherche révèle le rôle critique des dirigeants de PME dans le déclenchement d'une séquence d'absorption des connaissances. Les résultats soulignent aussi le fait que la formalisation des connaissances et la codification des comportements sont des mécanismes efficaces pour le développement de la capacité d'absorption.

Mots-Clés : capacité d'absorption, rôle de *knowledge broker*, PME de haute technologie

Resumen

Varios artículos reclaman modelos integradores que aborden la identificación de los antecedentes de la capacidad de absorción. Existe también una necesidad de seguir investigando para enfocar mejor el desencadenamiento de una secuencia de absorción de conocimientos. El objetivo es poner de relieve el impacto de mecanismos organizativos, así como el papel de “*knowledge broker*” de los directores generales de las PYME. Este estudio revela el papel fundamental de los directores generales de las PYME en el desencadenamiento de una secuencia de absorción de conocimientos. Los resultados subrayan también que la formalización de los conocimientos y la codificación de los comportamientos son mecanismos eficaces para el desarrollo de la capacidad de absorción.

Palabras Claves: capacidad de absorción, papel de *knowledge broker*, PYMES de alta tecnología



A wealth of research has investigated the concept of absorptive capacity (ACAP) in the past two decades. In their landmark article, Cohen and Levinthal (1990) defined ACAP as a firm's ability to recognize and acquire new external knowledge, assimilate it, and apply it to commercial ends. Subsequently, Zahra and George (2002) reconceptualized ACAP and integrated another dimension—transformation—between the assimilation and exploitation stages. Other more recent works (Lane, Koka, and Pathak, 2006; Todorova and Durisin, 2007; Volberda, Foss, and Lyles, 2010) have proposed reifications and reconceptualizations of the concept, arguing that most studies do not take into account prior work in considering and mobilizing ACAP in different ways.

This situation underscores the need for a deep exploration of ACAP, especially its antecedents that have been understudied (Nahapiet and Ghoshal, 1998; Lane *et al.*, 2006; Volberda *et al.*, 2010; Bjorvatn and Wald, 2018), from both a conceptual and an empirical perspective. Jansen, Van Den Bosch, and Volberda (2005) shed new insights into ACAP antecedents, but these pertain only to organizational variables, which prevents capturing the multilevel nature of ACAP. “The AC construct is still surrounded by considerable ambiguity with respect to its meaning and nature; the domain(s) in which it exists; and its implications and antecedents, including its microfoundations in individual action and interaction” (Volberda *et al.*, 2010, p. 943). Given these shortcomings, the goal of the current study is to better understand the triggering and development of an absorption sequence at the individual and organizational levels of analysis. Drawing from Walsh and Ungson (1991), “triggering” is defined as the decision to start a knowledge absorption sequence primarily at the individual level. First, we follow Jansen *et al.*'s (2005) and Volberda *et al.*'s (2010) stated directions for future research by incorporating new antecedents of ACAP. The issue is not to discover a collection of ACAP antecedents but rather to introduce some key variables that may refine scholarly knowledge on ACAP triggering and functioning. In contrast with Jansen *et al.* (2005), we consider each ACAP dimension separately, as it may offer more precise results on the role of different antecedents over knowledge processes that could occur at different levels of analysis (i.e., individual, unit, and/or organization). Second, we also pursue a managerial view of ACAP in terms of how managers of high-tech small and medium-sized enterprises (SMEs) can influence the different ACAP processes (Zahra and George, 2002; Volberda *et al.*, 2010; Flatten, Adams, and Brettel, 2015). Research has not sufficiently explored the

role of managers in ACAP development (Lenox and King, 2004), though it acknowledges their importance in knowledge acquisition. Indeed, different streams of research (e.g., organizational learning, social network, new product development, top management team) have highlighted managers' role as brokers and/or gatekeepers. In a more classic part of management literature, Mintzberg (1973, 1975) underscores the informational and interpersonal role of managers. Given these elements, it is surprising that few studies have examined the influence of managers on ACAP triggering and development. Thus, we create specific individual and organizational variables that represent knowledge mechanisms that can have an impact on the development of ACAP.

Some theoretical thoughts about ACAP

Adopting multiple level of analysis

“Future research opportunities exist for applying the notion of ACAP to the individual actor, and also to the group, and assessing what characteristics of individual cognition, leadership, or motivation influence ACAP or knowledge flow and utilization” (Volberda *et al.*, 2010, p. 944). In this research, we follow a multilevel approach of ACAP. The basic idea is to conceptualize ACAP in a more operational way, highlighting knowledge processes used daily in managerial work. This perspective is in line with Lane *et al.* (2006, p. 853), who argue: “The lack of attention to the process aspects of absorptive capacity has also led researchers to overlook the role of individuals in developing, deploying, and maintaining”. Rather surprisingly, although many studies in the organizational learning field have examined the mechanisms of learning at an individual level of analysis, they have had a negligible influence on ACAP research (Lane and Lubatkin, 1998; Minbaeva and Michailova, 2004; Lane *et al.*, 2006; Volberda *et al.*, 2010). Indeed, seminal works on cognitive structures and problem solving (Ellis, 1965; Estes, 1970) have paved the way for organizational learning conceived as being dependent on the individual learning of an organization's employees, which was the basis of Cohen and Levinthal's (1990) original argumentation. These individual learning mechanisms appear fundamental in organizational learning literature and have been highlighted in different works (Crossan, Lane, and White, 1999; Brown and Starkey, 2000).

Moreover, as ACAP is an important driver of innovation, individuals' creativity is likely the first pillar of this outcome, so focusing only on an organizational level does not allow precise understanding of its development. The capacity of individuals

to recognize and acquire valuable external knowledge, to assimilate it, to transform, and to exploit it may be the basis of innovation practices in firms (Wang, Zhao, and Zhou, 2018). Such capacity is particularly important when identifying ACAP antecedents because it may help unpack precise knowledge mechanisms.

This multilevel perspective of ACAP is reinforced when taking into account that ACAP has mostly been considered an organizational-level construct that resides in firms and organizational units (Cohen and Levinthal, 1990). Indeed, most studies have explored ACAP at an organizational level of analysis; few studies consider the country and interorganizational levels. Consequently, these works did not account for the content or relationships between the different dimensions of ACAP (Zhao and Anand, 2009). This failure has resulted in perceptions of ACAP as a kind of supra-concept, apart from learning practices in firms (Yoo, Sawyerr, and Tan, 2016). Moreover, prior works on ACAP do not identify precise mechanisms and/or individual roles related to the first, second, third, or fourth dimension. A multilevel and “deconstructed” approach of ACAP can bring some connections between different levels of analysis and the four dimensions of this concept. It may help deepen the practical knowledge of ACAP and the underlying learning practices of the individual and/or team. Globally, this perspective may offer a more dynamic view of ACAP antecedents in opposition to prior research that identifies more “static” variables.

From a general static view of ACAP antecedents to a dynamic approach

This section addresses the main ACAP models and focuses more precisely on the mechanisms facilitating the beginning of a knowledge absorption sequence. Both Jansen *et al.* (2005) and Lane *et al.* (2006) differentiate two main categories of ACAP antecedents: those related to organizational characteristics as firm structure (Van Den Bosch, Volberda, and De Boer, 1999), organizational routines, and practices (Lane and Lubatkin, 1998; Lane *et al.*, 2006) and those related to knowledge characteristics as the level of contingent knowledge (Cohen and Levinthal, 1990) and the similarity of knowledge bases (Zahra and George, 2002). Much of this line of research adopts a static perspective of ACAP, without considering the role of antecedents or even whether ACAP's development is only internal (Zahra and George, 2002; Todorova and Durisin, 2007).

The adoption of a multilevel approach allows combining different approaches of ACAP research. Beyond the debates on the conceptualization of this concept in one dimension or two supra-dimensions, an approach based on dynamic capabilities is used by considering each dimension individually, covering a set of processes and

routines on its own. This perspective led us to adopt a dynamic approach to select ACAP antecedents, based on organizational processes related to knowledge management, from their acquisition to their exploitation. This is in line with more recent studies that highlight the role of external knowledge sources in ACAP development (the concept of “desorptive” capacity [Lichtenthaler and Lichtenthaler, 2010]; the concept of collective ACAP [Spithoven, Clarysse, and Knockaert, 2010]). We partly follow Jansen *et al.* (2005), who stress the influence of individual and organizational capabilities on ACAP development, capabilities that accelerate knowledge flow and ease the triggering of an absorption sequence. These capabilities depict relational capacities of knowledge sharing. This perspective is supposed to be complementary to the main one treating knowledge sources as static recipients of new knowledge for firms. Indeed, when working to acquire new knowledge outside the firm, it is unrealistic to consider that individuals or teams just absorb knowledge without the participation of other actors. This is one aspect that led Volberda *et al.* (2010, p. 946) to call for research “to build on prior work addressing the nature of ACAP and inter-organizational antecedents so that there is an accumulation of knowledge about ACAP.” This consideration is in line with our dynamic approach of ACAP, which argues that the triggering of a knowledge absorption sequence occurs in a context of interactions between individuals belonging to different organizations. When not considering ACAP a linear concept, it is clear that the triggering of a knowledge absorption sequence comes from the identification and acquisition of new external knowledge based on exchanges with actors in the company's environment. From this perspective, ACAP remains partly an interorganizational concept. Instead of identifying external knowledge sources that may be industry specific, we try to uncover different antecedents and to specify their impact on the dimensions of ACAP. Along this line, we consider with our different antecedents (which remain knowledge mechanisms) the compulsory role of inside practices but also that of outside learning practices, which has been overlooked (Chang, Chen, and Lin, 2014). This idea means that knowledge acquisition depends not only on the ACAP of the recipient but also “on the knowledge sender's attitudes and behavior” (Minbaeva and Michailova, 2004, p. 666). Apart from a specific consideration of ACAP antecedents, some research (Den Hertog, 2000; Bettencourt, Ostrom, Brown, and Roundtree, 2002; Bjorvatn and Wald, 2018) assumes that the development of ACAP relies not simply on internal efforts but more on intensive interactions with other individuals, teams, and/or organizations (Yoo *et al.*, 2016). This perspective highlights a nascent dynamic approach of ACAP antecedents that we call “triggers,” depicting a more active role of these variables.

Antecedents of ACAP in this research

The process of identifying ACAP antecedents is based on the idea that prior possession of relevant knowledge supports the acquisition of new external knowledge by allowing some associations and linkages that may give rise to creativity. This idea finds support in research on ACAP (Henderson and Clark, 1990; Lane and Lubatkin, 1998; Reagans and McEvily, 2003; Lane *et al.*, 2006). Therefore, we consider antecedents that ease the process of association between different knowledge blocks following Haller, Amabile, Meissonier and Boudrandi (2013, p. 134): “The level of information and knowledge absorption (...) is maybe based on the capacity of the receiver to combine them, and to enhance the interpretations which can be made.” These antecedents clearly refer to some social mechanisms of integration, such as processes or routines of knowledge sharing/transfer, communication processes in the organization, networks of relationships, cross-functional interfaces, and broker or gatekeeper role (Lane and Lubatkin, 1998; Van den Bosch *et al.*, 1999).

Individual mechanisms associated with knowledge sharing

At the individual level of analysis, coordination capabilities can be associated with knowledge sharing capabilities. “Coordination capabilities are cross-functional interfaces” [...] “that bring together different sources of expertise and increase lateral interaction” (Jansen *et al.*, 2005, p. 1000–1001). These mechanisms allow strengthening knowledge exchanges in an intraorganizational context between employees and teams and in an interorganizational context among different individuals in an industry. Therefore, we highlight the potential of individuals to share or transfer knowledge. From this perspective, we can identify three forms of interaction that condition the content of exchanged ACAP dimensions. We first consider informal ways of transfer that promote coordination between employees (“free” discussions). Knowledge transfer, without considering any organizational incentives, deals with the capacity of employees to share ideas and problems (Haller *et al.*, 2013; Wang *et al.*, 2018). According to Haller *et al.* (2013), some social integration mechanisms consist of informal processes of business intelligence and are positively related to knowledge absorption from different actors (e.g., customers, competitors, suppliers). This ability should enhance cross-coordination and promote knowledge understanding and integration in the firm (Daft and Lengel, 1986). Therefore, these social integration mechanisms can have an influence on every dimension of absorptive capacity.

Hypothesis 1: The use of informal knowledge sharing mechanisms is positively related to acquisition, assimilation, transformation, and exploitation of new external knowledge.

Formal knowledge sharing that eases integration and institutionalization of new external knowledge can be approached in terms of organizational practices and routines that create favorable conditions for knowledge exchange between individuals and/or groups. Internal (meetings, teamwork) and external (participation in conferences/trade shows, industrial tracks) practices constitute key opportunities to accelerate knowledge identification and acquisition and potentially to trigger a knowledge absorption sequence. In the wine industry, Haller *et al.* (2013) found that professional organisms promote knowledge absorption through the use of formal social integration mechanisms such as conferences, newsletters, and meetings. Thus, we posit the following:

Hypothesis 2: The use of formal knowledge sharing mechanisms is positively related to acquisition, assimilation, transformation, and exploitation of new external knowledge.

Organizational mechanisms associated with system capabilities

System capabilities promote the coordination of employees’ behaviors and supply a kind of memory for routine situations (Van Den Bosch *et al.*, 1999). This “proxy” variable takes into consideration interorganizational practices that influence individual and/or group information sharing. Formalization is a common feature enhancing unity in individual behaviors through established and well-known practices and procedures (Duchek, 2015). Whereas it may prevent some deviant behaviors in supplying a frame of reference, it also makes the exploration and assimilation of new external knowledge noncompulsory.

Hypothesis 3a: System capabilities are negatively linked to acquisition and assimilation of new external knowledge.

Alternatively, system capabilities automate knowledge retrieval because of the use of familiar organization tools and procedures (Gupta and Govindarajan, 2000). Therefore, these mechanisms act as memory systems that make the knowledge available to the whole organization. From this perspective, formalization should entail the creation of a continuous rejuvenating knowledge base that allows individuals and/or groups to identify opportunities for the

transformation and exploitation of new external knowledge (Zollo and Winter, 2002; Miroshnychenko, Strobl, Matzler, and De Massis, 2021). Although these capabilities can exert a negative influence on the first two dimensions, they may have a positive impact on transformation and exploitation, helping to draw relationships between old and new knowledge and thus facilitating the institutionalization of new external knowledge (Todorova and Durisin, 2007).

Hypothesis 3b: System capabilities are positively linked to transformation and exploitation of new external knowledge.

Organizational mechanisms associated with coordination capabilities

“Coordination capabilities enhance knowledge exchange across disciplinary and hierarchical boundaries” (Jansen *et al.*, 2005, p. 1000). Therefore, examining the intensity of interorganizational and intraorganizational knowledge exchanges through different mechanisms seems relevant to assess coordination capabilities (Van Wijk, Jansen, and Lyles, 2008). Instead of considering participation in decision-making or job rotation that constitutes organizational mechanisms (Jansen *et al.*, 2005), we assess the influence of social integration mechanisms in firms. This “proxy” variable takes into account the specificities of our sample-high-tech SMEs. Therefore, we explore knowledge absorption opportunities through relationships with customers, competitors, meetings, and projects with partners or the participation in external project gathering of different firms, which is frequently the case for high-tech SMEs (Gupta and Govindarajan, 2000; Snyder and Wenger, 2000; Bjorvatn and Wald, 2018). Jansen *et al.* (2005) suggest that external relationships and cross-functional teams positively influence the acquisition and assimilation of new external knowledge through greater coordination between actors. Indeed, the potential absorption of knowledge by a company’s employees depends on the intensity of exchanges with similar economic external actors (Haller *et al.*, 2013). These exchanges foster knowledge sharing with external actors and also result in lateral forms of exchanges between individuals in the firm (Jansen *et al.*, 2005). In the same vein, Verona (1999) proposed that social exchanges foster coordination between actors and are directly linked to the capabilities of external knowledge absorption.

This variable aims to measure individual and team behaviors regarding knowledge absorption practices, both inside and outside the firm, that enhance coordination capabilities (Wang *et al.*, 2018). These individual and organizational

working practices can trigger a knowledge absorption sequence through greater motivation of both insiders and outsiders (Cohen and Levinthal, 1990; Minbaeva *et al.*, 2003; Lichtenthaler and Lichtenthaler, 2009, 2010).

Hypothesis 4a: Coordination capabilities are positively linked to acquisition and assimilation of new external knowledge.

In addition, these opportunities and practices stimulate the integration of new knowledge through the support of individuals and/or teams that revisit ways of doing in the firm. They ease commitment to a collective common goal. Thus:

Hypothesis 4b: Coordination capabilities are positively linked to transformation and exploitation of new external knowledge.

Knowledge broker role of SME CEOs

This study investigates French high-tech SMEs. In these organizations, the role of the CEOs in organizational learning is broader than in large firms, because they are in charge of both operational and strategic activities (Garcia-Morales, Llorens-Montes, and Verdu-Jover, 2008; Broersma, Van Gils, and De Grip, 2016). Consequently, assessing the “broker” role of the CEO is relevant to determine whether it has an impact on the different dimensions of ACAP. In this research, we focus on the role of knowledge brokers, who we define as actors who serve as intermediaries within the knowledge transfer process between disconnected parties (Hargadon and Sutton, 1997; Haas, 2015). In a slightly different context of cooptation, this role of knowledge brokers is realized through the initiation of new projects, the promotion of coordination and knowledge sharing between actors, and the strengthening of “awareness of and trust in innovative solutions by centralizing knowledge diffusion” (Chiambaretto, Massé, and Mirc, 2019, p. 587). This role seems to be critical in SMEs in triggering a knowledge absorption sequence.

Whereas some studies have tried to identify the multiple variables that can influence ACAP, in general the role of the CEO in ACAP has been poorly studied. This situation remains a paradox when taking into account all the managerial studies on network and leadership issues, in particular those related to the CEO’s central position at the crossroads of internal and external contexts. However, some studies provide some cues on how to consider the role of SME CEOs in our research. Eggers and Kaplan (2009) note that cognitive processes related to project

management strongly influence ACAP. In this respect, the knowledge broker role of the CEO, oriented toward knowledge acquisition and diffusion, project initiation, and support aspects, can be considered an antecedent of ACAP (Haas, 2015; Broersma *et al.*, 2016). This idea is in line with several related studies on organizational learning (e.g., Naqshbandi and Tabche, 2018) and social network issues that clearly stress the role of leaders in acquiring knowledge through their network of relationships (Carroll and Teo, 1996; Tortoriello, McEvily, and Krackhardt, 2014; Kraft and Bausch, 2018). In particular social networks, studies highlight the role of CEOs in developing informal exchanges with various actors of the industry, notably their peers, to gain access to specific, “private” knowledge that fosters innovation perspectives (Haller *et al.*, 2013; Kraft and Bausch, 2018). The position of SME CEOs allows them to “learn about and link a wide range of existing problems and solutions, creating innovative solutions in the form of new combinations of these existing ideas” (Hargadon, 1998, p. 210). Although some of these studies did not specifically focus on CEOs but more on managers at different levels within a hierarchy, they took place in large firms to a great extent. These different contexts, however, do not detract from the use of these studies to assess the role of CEOs in triggering a sequence of knowledge absorption.

First, Verona (1999) argued that capabilities for absorbing new external knowledge are directly linked to managerial structures, systems, and social relations. Second, Floyd and Lane (2000) and Lenox and King (2004) highlighted the potential of managerial action in ACAP development, though they did not test this perspective from an empirical standpoint. Third, the current study took place in high-tech SMEs, and in this specific environment, the CEO plays a critical knowledge-brokering role (Li, Sun, and Dong, 2018) in charge of the firm’s information systems (Haller *et al.*, 2013). Thus, we argue that SME CEOs can act first as brokers in ACAP triggering and, second, as initiators and developers along this knowledge absorption sequence. The CEOs of these small firms, as knowledge brokers, hold a specific position that eases knowledge acquisition, and their specific expertise allows them to address existing problems and solutions and also to create new ideas from existing ones (Hargadon, 1998).

Drawing from extent literature and observations from participation in SMEs’ internal and external business meetings, we use four items to assess the role of CEOs. The first highlights the CEO’s project initiator and resources diffusion role. The second and third items assess the CEO’s role in terms of knowledge sharing,

diffusion, and transfer outside and inside the company (Clement, 1994; Flatten *et al.*, 2015). The last item involves the CEO’s incentive to foster teamwork, coordination, and participation in industrial meetings, which is an important step in knowledge absorption (Liedtka, Haskins, Rosembaum, and Weber, 1997; Lenox and King, 2004; Jansen *et al.*, 2005). These items highlight CEOs’ role in acquiring new external knowledge, in promoting its diffusion and the use of social integration and sharing mechanisms, and in initiating and supporting projects that contribute to the development of ACAP.

Hypothesis 5: The knowledge broker role of SME CEOs is positively linked to acquisition, assimilation, transformation, and exploitation of new external knowledge.

Methods

Sampling and data collection

This research took place in 11 French high-tech SMEs belonging to different industries, including robotics, home automation, artificial intelligence, telecommunication protocols, electronics, metrology, medical electronics, and computer science. The size of these companies ranges from 24 to 232 employees, with a large majority having between 60 and 80 employees. The sample chosen was based more on technological than economic criteria. We used Organization for Economic Co-operation and Development criteria to determine the “degree” of technology—that is, these firms perform technologically. We use the following five criteria: employee turnover, growth in turnover, R&D investment, number of patents per year, and R&D intensity. These technology SMEs form a homogeneous population with several points of similarity, particularly in terms of industries, knowledge bases, background, and the career path of the CEOs.

We chose to work with a sample of high-tech SMEs for several reasons. First, the SMEs are naturally oriented toward innovation projects, whether in terms of products and services or production processes and techniques. Several of the companies were born out of innovations. They thus show a clear need for acquiring and developing new knowledge. Second, the manager’s role as a broker is more critical in this type of company than, for example, in a company that carries out subcontracting for another. Third, the open structure of these organizations, which are part of corporate clubs, work with universities and research centers, and respond to calls for tenders, was a particularly suitable context for our study topic.

We administered the questionnaire to a specified number of employees in each firm, in an effort to reduce a possible effect of firm size. After been introduced by a business club to the CEOs of these SMEs, we maintained relatively frequent contact with them. We were thus able to distribute and collect most of the questionnaires. A small number of questionnaires were returned directly to us by mail; this approach ensured the confidentiality of the answers. In the end, we collected 231 questionnaires, 15 of which were incomplete and therefore discarded, leaving 216 questionnaires for analysis.

The profiles of the employees of these SMEs are similar, with almost the same proportion in production and administration in each firm and with relatively similar levels of education overall. Their background is also almost identical, with a strong orientation toward technical study. In detail, nearly 75% of the respondents are men, and the average age is 37 years. More than 57% of the respondents have pursued higher education up to a level equal to or greater than a master's degree. Nearly 10% have between three and four years of university study, and 25% have a baccalaureate plus a diploma of two years of university mainly in the form of a BTS or a DEUG. Only 8% have not completed university studies and have a baccalaureate or technical diploma such as CAP or BEP.

In addition, in terms of seniority in the position, 33% of employees have up to two years of experience, more than 37% between two and five years of experience, and 29% more than five years of experience. In terms of seniority in the same company, more than 32% of respondents have two years or less seniority, 27% between two and five years, and more than 40% over five years.

Measurement and validation of constructs

This research used existing measurement scales for several variables. For each ACAP dimension, we take advantage of the research proposing a multilevel measure of ACAP (Chauvet, 2014). We provide statistical results of these ACAP metrics in the Appendix (Tables A1, A2, and A3) and in Table 1. We do not use the classic differentiation between potential absorptive capacity (PACAP) and realized absorptive capacity (RACAP) in our main analysis for two reasons. First, statistical results for these two supra-dimensions are poor. Second, we adopt a multilevel perspective of the concept, so this dividing approach is not relevant. Thus, we consider each dimension separately. It is important to note that tests confirm this theoretical orientation (see Table A3).

TABLE 1
Statistical results for ACAP antecedents and dimensions

Variables	Number of items	KMO	Alpha	% explained variance	Rh�
ACAP antecedents					
Knowledge sharing mechanisms					
- Informal	3	0.69	0.87	79%	0.87
- External	3	0.67	0.77	69%	0.78
Knowledge broker role of SME CEO	4	0.74	0.78	60%	0.85
System capabilities	10	/	/	/	/
Coordination capabilities	7	/	/	/	/
ACAP dimensions					
Acquisition	6	0.84	0.87	62%	0.87
Assimilation	6	0.87	0.85	58%	0.86
Transformation	4	0.75	0.84	68%	0.86
Exploitation	3	0.74	0.85	78%	0.86

Note: KMO = Kaiser-Meyer-Olkin

Appropriate measurement scales for other variables in the specific context of high-tech SMEs were not directly available. Thus, we took three steps to develop adequate measures of the constructs. First, we reviewed the literature and proposed a pool of items related to each scale. Second, we organized specific sessions to work on the building of these scales. The goal of these sessions, which comprised several university professors and doctoral students, was to select some items from the initial pool for each variable and to remove any ambiguity in the formulation of the questionnaire. Some of the proposed improvements suggested to others for approval were related to a more direct focus on the context of the SME and/or to the phrasing of some items. Third, these measures were presented to each CEO of the participating SMEs to uncover any misunderstanding or ambiguity. A final version of the questionnaire resulted from these steps.

To measure “organizational mechanisms associated with system capabilities” and “organizational mechanisms associated with coordination capabilities,” we took inspiration from the scales of Jansen *et al.* (2005) and Flatten, Engelen, Zahra, and Brettel (2011). For “knowledge broker role of SME CEOs,” we constructed a measurement scale based on the work of Clement (1994). For the variable “individual mechanisms associated to knowledge sharing,” we took inspiration from Hansen (1999), Tsai (2002), and Gure and Sharma (2019).

ACAP antecedents

Antecedents were measured on a seven-point scale ranging from strongly disagree (1) to totally agree (7), except “organizational mechanisms associated with system and coordination capabilities,” which are proxies. Scales for the ACAP antecedents and dimensions are reliable. Table 1 and 2 summarize the characteristics of these metrics.

Statistical results for the ACAP construct led us to specify that the four dimensions are distinguishable from both a theoretical and statistical standpoint. As a consequence, we ran our regression analyses considering only the ACAP dimensions, not the one-factor (ACAP) or two-factor (PACAP and RACAP) models. Last, confirmatory factor analyses show that the scales for the ACAP antecedents are highly reliable (see Table 2).

ACAP antecedents			
Indices	Informal KSM	Formal KSM	CEO role
χ^2/df	0.956	0.204	0.837
GFI	0.997	0.999	0.998
SRMR	0.007	0.007	0.009
RMSEA	0.000	0.000	0.000
P	0.447	0.729	0.478
CFI	1.000	1.000	1.000

Note: KSM = Knowledge Sharing Mechanisms

Results

Table 3 presents the results of the linear regression analyses for individual, organizational, and managerial mechanisms associated with each ACAP dimension. We examined multicollinearity by calculating variance inflation factor values. The value in each model is below the accepted cutoff of 10 (Jansen *et al.*, 2005), which indicates that the variables in the model are weakly correlated. Unstandardized coefficients appear in Table 3 with standard errors in parentheses, as well as standardized coefficients for each dimension. The adjusted R-square appears for each dimension of ACAP. We discuss only the significant results for ease of understanding.

First, as expected, the mechanisms associated with formal knowledge sharing capabilities are critical antecedents of ACAP. They exert positive and significant effects on assimilation, transformation, and exploitation. Thus, hypothesis 2 is validated. By contrast, the mechanisms associated with informal knowledge sharing capabilities have no impact. Thus, hypothesis 1 is not confirmed.

TABLE 3
Results of linear regression analyses

	Acquisition		Assimilation		Transformation		Exploitation	
	t (sig)	β	t (sig)	β	t (sig)	β	t (sig)	β
KSM - Informal - Formal			2.6 (.010)	.175*	5.02 (.000)	.321**	5.19 (.000)	.247**
Knowledge broker role of SME CEO	13.22 (.000)	.648**					4.56 (.000)	.311**
Coordination capabilities	4.1 (.000)	.200**			3.39 (.001)	.217**		
System capabilities							0.31 (.000)	.267**
Adjusted R ²	0.546**		0.026*		0.178**		0.325**	

Note: KSM = Knowledge Sharing Mechanisms. A stepwise method was used. * $p < .01$. ** $p < .001$.

Second, the results of our analyses indicate that organizational mechanisms associated with system and coordination capabilities have contrasting roles. On the one hand, and contrary to our prediction, organizational mechanisms associated with system capabilities have no effect on acquisition and assimilation. Thus, hypothesis 3a is not confirmed. This result is in line with that of Jansen *et al.* (2005), who also found that formalization has no effect or a negative effect on the first two dimensions of ACAP. On the other hand, system capabilities positively influence exploitation but have no effect on transformation, in partial support of hypothesis 3b.

Third, organizational mechanisms associated with coordination capabilities have a positive influence on acquisition and transformation but no effect on assimilation and exploitation. Thus, hypotheses 4a and 4b are partially supported, with coordination capabilities displaying a positive impact on the two ACAP dimensions, which is in line with Jansen *et al.*'s (2005) overall results.

Finally, the knowledge broker role of the CEO has a positive impact on acquisition and exploitation of new external knowledge; it has no effect on assimilation and transformation activities. Therefore, hypothesis 5 is partially supported. As our results show, the role of the CEO is critical in triggering a knowledge absorption sequence. Indeed, the knowledge broker role of the CEO explains 52% of the variance of the acquisition of new external knowledge. This result is promising because it underscores the managerial influence on triggering and developing ACAP, which, to our knowledge, has not been assessed before. Moreover, taken together, the role of the CEO, knowledge sharing mechanisms, and system capabilities explain 33% of the variance of the activities of knowledge exploitation. Last, the results for assimilation are practically nonexistent, with an adjusted R-square of 0.026. Transformation is explained only to a certain degree (adjusted $R^2 = 0.178$) by the use of formal knowledge sharing and coordination capabilities.

Discussion

Theoretical contributions

The goal of this research was to explore the impacts of individual, organizational, and managerial antecedents of ACAP, using a multilevel perspective. The results contribute to ACAP literature in several ways. First, while research has identified

the competitive benefits of ACAP, few studies have tried to identify its antecedents. It is from this perspective that the current research significantly advances understanding of absorptive capacity functioning. Second, because previous research has not taken into account the effect of managerial actions on ACAP, our findings provide compelling evidence for the knowledge broker role of high-tech SME CEOs, who are partly responsible for ACAP triggering and development (Flatten *et al.*, 2015). This result is in line with research on the role of the CEO in knowledge activities related to innovation (e.g., Broersma *et al.*, 2016). To some extent, the results indicate that SME CEOs are able to acquire new external knowledge, to diffuse it, and to initiate and supply firms' ACAP (Li *et al.*, 2018). Third, we contribute to the leadership and entrepreneurship literatures by showing that SME CEOs participate in the triggering of a knowledge absorption sequence, thereby participating in the strategic development and orientation of their firm (Volberda *et al.*, 2010; Ramachandran, 2018). Finally, this study feeds the debate on the conceptualization of ACAP by showing that the ACAP dimensions do not react to the same organizational and knowledge mechanisms. We find that these dimensions, while forming a global sequence, cover very different activities and can be approached partly individually.

In addition, this research reveals that informal knowledge sharing mechanisms do not contribute to enhance ACAP while formal mechanisms exert a positive impact on three of the four dimensions (assimilation, transformation, and exploitation). These results are notable for two reasons. First, they highlight the necessity of creating formal opportunities of knowledge exchange whether in the firm or with external actors. Second, they question the role of informal knowledge sharing mechanisms in ACAP development, which echoes in some way the transfer of tacit knowledge between individuals (Garcia-Morales *et al.*, 2008), which helps solidify the relationship between the different ACAP dimensions. The results also question the role of employees in two activities: "free" participation in problem solving and in the initiation of projects. This outcome can be compared, to a certain extent and by taking into account the different levels of analysis, with that of Jansen *et al.* (2005), who specify that connectedness and socialization tactics have no effect on acquisition and assimilation. Of note, we do not view connectedness and socialization tactics as informal knowledge sharing mechanisms. However, we believe that the results of the two studies point in the same direction by showing that certain mechanisms supposed to

facilitate knowledge exchange between individuals do not influence acquisition and assimilation. These results further highlight the need to develop formal mechanisms that help control certain phases of the development of ACAP. This idea of controlling ACAP development is particularly related to the knowledge broker role of the CEO in the SME context, which we regard partly as an organizational control mechanism in the initiation and development of ACAP (Broersma *et al.*, 2016).

Thus, we highlight the usefulness of the knowledge broker role of the CEO in driving ACAP triggering and development and particularly in easing individuals' actions when going from a specific knowledge activity to a new one. From this perspective, our study reveals that the role of SME CEOs is related to new external knowledge acquisition and exploitation, which are the first and last sequence of ACAP, respectively. This position could help high-tech SME CEOs exert a certain control over ACAP development, in terms of bringing new knowledge into the firm and in participating in exploitation activities (Naqshbandi and Tabche, 2018). This result also echoes that of Broersma *et al.* (2016), who highlight the operational and strategic roles of SME CEOs in overseeing the development of ACAP from its triggering to the formal exploitation of activities characterized by the launch of a new product/service. Future research might investigate to what extent and how CEOs should control ACAP triggering and development.

Our study also reveals that organizational mechanisms associated with system capabilities are related to the exploitation of new external knowledge. This outcome indicates a need for the exploitation of knowledge formalization, which is a critical issue considering the prevalence given to tacit knowledge in the organizational learning literature (Miroshnychenko *et al.*, 2021). This result shows that knowledge capitalization and behavior codification stimulate exploitation, suggesting that some effective behaviors should not remain tacit (Zollo and Winter, 2002; Wang *et al.*, 2018). Formal knowledge sharing mechanisms indicate the existence of well-design procedures and behaviors that stimulate knowledge understanding and recombination, supporting the development of new competences and capabilities (Zollo and Winter, 2002; Jansen *et al.*, 2005). This result confirms that knowledge formalization and the codification of behaviors are efficient mechanisms for ACAP development.

The results also show that ACAP antecedents are often linked to just two of the four dimensions. Thus, considering each dimension separately is more relevant to identify ACAP antecedents. More specifically, three of the four antecedents used in this research are related to dimensions pertaining to the PACAP and RACAP supra-dimensions. This calls into question the conceptualization of the two ACAP dimensions, while contributing to the literature on ambidexterity in identifying antecedents (Broersma *et al.*, 2016).

The "individual" approach of the ACAP dimensions allows us to determine precisely the role of different factors in the global sequence of knowledge absorption. Given that the four dimensions imply very different learning activities, analyzing each dimension separately provides more accurate results in explaining success levels of knowledge management. For example, different employees can intercede along different stages of the process (e.g., an employee might only participate in knowledge transformation). This result shows that in high-tech SMEs, the broker role of the CEO is critical in the acquisition of new external knowledge but not in its assimilation. On this specific point, we imagine that to a certain degree, high-tech SME CEOs feed their organization with new external knowledge. A possible explanation is that they are at the frontier of their firm and thus have relationships with many stakeholders. This aspect is in line with the results of Chang and Hughes (2012), which show that CEOs in technological SMEs have appropriate leadership styles and the cognitive ability to process and deal with all external information. Indeed, the SME CEOs scan and identify critical knowledge for the development of their firms, thus helping to reduce uncertainty in these high-tech environments. The same argument is also valuable for knowledge exploitation.

Finally, the results show a poor impact of the antecedents used in this research on assimilation. A possible explanation is that assimilation is partly an individual activity, designed for the internalization of new external knowledge. This point reinforces the idea that including acquisition and assimilation in one PACAP supra-dimension is not relevant. Instead, ACAP represents a global knowledge absorption sequence consisting of four dynamic knowledge capabilities that could be compared with systematic routines of knowledge treatment at different stages of development. Thus, we suggest that ACAP should be approached in terms of four different but combinative sets of dynamic capabilities, to ease

understanding of this concept in accurately defining the scope of each dimension and its relationships and also in identifying specific antecedents for each stage (Broersma *et al.*, 2016).

Managerial implications

The results of this study also have managerial implications. First, this research highlights the critical role of high-tech SME CEOs in the acquisition of new external knowledge. It puts into perspective the strategic role of this activity, which partly determines the medium—and long-term orientation of organizations in the development of innovation projects. The role of high-tech SME CEOs has a clear impact on strategic decisions and resource allocations and gives legitimacy to them in these strategic and operational activities. Second, the scales used in this research proved to be highly relevant evaluation tools for the 11 SMEs participating in this project. In particular, they revealed the importance of two organizational mechanisms. On the one hand, the implementation of formal knowledge sharing processes, often set aside in the SME context because of a strong proximity between actors, appears critical. On the other hand, it highlights the importance of evaluation and control processes to ensure good performance in the internalization of new external knowledge.

Limitations and future research directions

This study has limitations in terms of the research design, generalization, and theorization. First, as few studies have operationalized ACAP with metrics, we needed to develop difficult-to-measure constructs that could be discussed. In this sense, this study, though confirming some results of Jansen *et al.* (2005) and Flatten *et al.* (2011), remains somewhat exploratory. Indeed, the new set of scales developed for ACAP antecedents could be improved. For example, the acquisition dimension does not take into account enough external characteristics of knowledge acquisition. Similarly, the scale reflecting the knowledge broker role of the CEO could be enlarged to offer a more detailed view of all the activities underlying this specific role. As we suggested previously, some items of control should be included in this scale to strengthen the understanding of the influence of the role of the CEO on ACAP development. Second, generalization of the findings is limited by the specificities of our sample. Indeed, high-tech SMEs possess some distinctive characteristics that may have strongly influenced our results, such as the

importance of the CEOs' broker role. Indeed, the majority of CEOs have an engineering degree and related experience, so they are clearly able to identify relevant knowledge in their environment, which is likely not the case in other settings. Moreover, small and large firms display different organizational structures that deal with different problems and resource constraints that could influence ACAP triggering and development. Finally, the characteristics of high-tech SME CEOs give form to their firms. This idea is reinforced by their critical role in external knowledge acquisition, which determines part of their strategic decisions and orientation (Hambrick and Mason, 1984; Eggers and Kaplan, 2009).

Our research also opens avenues for future research, especially on the role of managers in ACAP development. First, research could test the managerial role of ACAP in different settings. Second, analysis of high-tech SME managers' social networks could reveal the extent to which they acquire new external knowledge and succeed in disseminating it in their firm (Imbert and Chauvet, 2012). Last, to shed further light on our results that suggest that some control is useful to ease ACAP development, research could assess whether managers mobilize specific control mechanisms along the different phases.

In conclusion, ACAP offers many opportunities for future research because its content and development remain difficult to define precisely. A deeper perspective on this concept, incorporating external aspects related to the different stages of this knowledge absorption sequence, might provide new insights to better understand how firms trigger, develop, and accelerate knowledge absorption activities.

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APPENDIX

Table A1: Results of the principal component and reliability analyses for ACAP

ACAP	M	SD	Factor loadings*				Cronbach's alphas			
			1	2	3	4	a	b	c	
<Recipient> is informed about changes in products and services.	4.91	1.64	0.74				0.87	0.77	0.83	
<Recipient> is informed about new strategic orientations.	4.44	1.87	0.77							
<Recipient> is informed about technological transformations and innovations.	4.94	1.75	0.72							
<Recipient> is informed about changes of partners.	5.20	1.47	0.85							
<Recipient> is informed about changes of suppliers or distributors.	4.47	1.83	0.77							
<Recipient> is informed about staff changes.	4.26	1.86	0.73							
When meeting external actors: <Recipient> learns new management methods and processes.	3.66	1.77		0.65			0.85			
<Recipient> discovers new suppliers and distributors.	4.13	1.88		0.85						
<Recipient> acquires knowledge about external technical processes and technological innovations.	4.84	1.73		0.85						
<Recipient> discovers new products and services.	4.68	1.72		0.81						
<Recipient> has new ideas.	4.57	1.59		0.78						
<Recipient> improves current methods and practices by proposing new solutions.	4.65	1.55			0.79		0.84			0.80
<Recipient> improves current methods and practices by finding ways to go faster.	4.62	1.61			0.84					
<Recipient> improves current methods and practices by changing old processes.	4.91	1.69			0.77					
<Recipient> improves current methods and practices by using new tools.	4.99	1.65			0.79					
We have a strong reputation for technological excellence.	5.36	1.60				0.91	0.85			
Knowledge intensity is characteristic of our business.	5.70	1.13				0.77				
There is a strong knowledge component in our products and services.	5.82	1.27				0.79				

Note: 1 = acquisition; 2 = assimilation; 3 = transformation; 4 = exploitation; a = 4 dimensions; b = PACAP/RACAP; c = ACAP.

* Only factor loadings greater than 0.3 are shown



APPENDIX

Table A2: Results of the confirmatory factor analyses for ACAP dimensions

Indicators	ACAP dimensions			
	Acquisition	Assimilation	Transformation	Exploitation
χ^2/df	1.312	0.906	2.855	2.086
GFI	0.983	0.985	0.993	0.994
AGFI	0.86	0.93	0.93	0.96
SRMR	0.040	0.029	0.018	0.013
RMSEA	0.038	0.000	0.093	0.071
P	0.543	0.785	0.177	0.253
CFI	0.989	1.000	0.995	0.996
Reliability Jöreskog's ρ	0.866	0.872	0.862	0.864
Average variance extracted	0.52	0.54	0.61	0.68

APPENDIX

Table A3: Results of the confirmatory factor analyses for the global ACAP and the PACAP/RACAP models

Indicators	ACAP	PACAP	RACAP
χ^2/df	8.146	2.836	1.174
GFI	0.909	0.879	0.982
AGFI	0.815	0.787	0.902
SRMR	0.326	0.106	0.037
RMSEA	0.182	0.092	0.028
P	0.000	0.000	0.707
CFI	0.485	0.691	0.997
Reliability Jöreskog's ρ	0.849	0.096	0.498
Average variance extracted	0.59	0.05	0.33