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Building absorptive capacity through firm openness in the context of a less-open country

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Abstract: We explore the roles that potential and realized absorptive capacity play in enhancing firm performance, and examine external knowledge search strategies as antecedents of absorptive capacity. In this way, we endeavor to open the black box that sits between external knowledge search and performance, and suggest that the establishment of deep and broad relationships with external sources has differing impacts on potential and realized absorptive capacity for the firm. We argue that distinguishing clearly between potential and realized absorptive capacity may provide new insights into understanding why some companies are more successful than others at benefiting from external knowledge. A sample of 171 suppliers operating in the Iranian automotive industry is used to test the proposed theoretical model, through a two-stage least squares approach. Surprisingly, our results indicate that only the firm's capability to acquire and assimilate new ideas from the external environment (potential absorptive capacity) is related to performance for these firms operating in Iran, which been isolated from global markets due to international sanctions. Our findings emphasize the notion that potential and realized absorptive capacity represent distinct capabilities, with different antecedents and different impacts on firm performance.

Keywords: absorptive capacity, potential, realized, depth, breadth, performance

1. Introduction

Understanding why some firms are successful at gaining from external knowledge sources – while others are not – has long grabbed the attention of both academics and managers (e.g, Ferreras-Méndez, Fernández-Mesa, & Alegre, 2016; Zahra & George, 2002). One possible explanation may be that, while external knowledge acquisition is important, mere exposure to external sources is not enough to create performance benefits (Voudouris, Lioukas, Iatrelli, & Caloghirou, 2012); as Escribano, Fosfuri, & Tribó (2009, p. 97) note, "firms exposed to the same amount of external knowledge flows might not derive equal benefits". When external knowledge is acquired by the company, gaining real benefit requires that the new knowledge is both understood deeply and combined with the firm's existing stock of knowledge (Todorova & Durisin, 2007). As Chen, Lin, and Chang (2009) argue, in addition to external learning, a firm's absorptive capacity has a critical role in its performance.

Since Cohen and Levinthal (1990, p. 128) define absorptive capacity (AC) as "the ability of firms to recognize the value of new, external information, assimilate it, and apply it to commercial ends", many scholars from different fields have identified various aspects of this concept. However, researchers tended, for quite some time, to treat AC as a unidimensional concept, measured using R&D intensity (e.g., Chen, Chen, & Vanhaverbeke, 2011; Laursen & Salter, 2006).

Zahra and George (2002) and Lane, Koka, and Pathak (2006) highlight the importance of different dimensions of absorptive capacity, noting that each dimension has a distinct impact on performance; this has led researchers in the management literature to consider AC as a multidimensional construct (Ferreras-Méndez, Newell, Fernández-Mesa, & Alegre, 2015; Volberda, Foss, & Lyles, 2010; Zobel, 2017). Zahra and George (2002) define absorptive capacity as a dynamic capability – "a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge" (p. 186) – and discuss two aspects: potential absorptive capacity (PAC), which encompasses the obtaining and interpretation of exogenous knowledge, and realized absorptive capacity (RAC), which focuses on the transformation and implementation of knowledge. Zahra and George (2002) assert that the quest for performance demands that both dimensions of AC be managed successfully. While a company concentrating solely on the acquisition and assimilation of external

knowledge (i.e., potential absorptive capacity) may be able to renew its knowledge base on a continuous basis, it is unlikely to gain full benefit of the knowledge, due to underdeveloped capabilities related to transformation and exploitation (Jansen, Van Den Bosch, & Volberda, 2005). On the other hand, while companies concentrating on transformation and exploitation capabilities (i.e., realized absorptive capacity) may benefit from short-term outcomes through exploitation, they risk falling into a familiarity trap, which is the result of overemphasizing the exploitation of current knowledge and thus restricting the firm from investing in unfamiliar technologies (Ahuja & Lampert, 2001; Zahra & George, 2002).

Our focus is on examining the as-yet-understudied process associated with developing absorptive capacity, particularly in terms of how organizations can develop different dimensions of absorptive capacity through searching for new knowledge from the external environment. Differentiating more clearly between potential and realized absorptive capacity may yield a deeper understanding of why some firms are particularly successful at benefiting from openness to external knowledge. As Zahra and George (2002, P. 189) argue, "while these capabilities have some commonalities across different firms and attain equifinality, they are idiosyncratic in the specific ways firms pursue, develop, and employ them". In other words, these two components of AC affect firms' performance differently, as exogenous and endogenous forces, affect PAC and RAC in different ways (e.g., Zahra & George, 2002). As previous studies have indicated, while some firms are particularly capable of interpreting and understanding complex technical issues, they are not as effective at leveraging new knowledge in order to generate profits (Zahra & George, 2002; Baker, Miner, and Eesley, 2003). This highlights the importance of differentiating between these two aspects of AC, and their effects on firm performance.

In addition, the concept of absorptive capacity has generally been addressed in the context of large, R&D-intensive companies, with a few exceptions (e.g., Grimpe & Sofka, 2009; Spithoven, Clarysse, & Knockaert, 2011). However, firms in more traditional sectors also build AC by tapping into outside sources of knowledge (e.g., Spithoven, Clarysse, & Knockaert, 2011). We add to the body of knowledge by studying AC in the context of such a traditional industry in an emerging economy, with

a focus on small and medium size enterprises (SMEs). Specifically, our research context is suppliers to automotive manufacturers in Iran, which is a sector that is dominated by SMEs.

This paper makes two main contributions. First, we focus on the multidimensional nature of absorptive capacity, distinguishing between potential and realized AC. This responds to calls for more research into AC's inter-organizational antecedents (Berghman, Matthyssens, & Vandenbempt, 2012; Volberda et al., 2010), on the basis that characteristics such as the type of search strategy may affect the both transfer of knowledge and the development of AC (Murovec & Prodan, 2009). Since the development of AC does not rely solely on the firm's own R&D activities, there is value in understanding more about the internal processes that allow firms to acquire, assimilate, transform, and exploit external knowledge that may enhance performance (Volberda et al., 2010; Zahra & George, 2002; Zobel, 2017). Following this logic, we explore how the *depth* and *breadth* of external knowledge search are related to the development of firms' potential and realized absorptive capacity, and how PAC and RAC are related to performance. Distinguishing between PAC and RAC emphasizes the multidimensional nature of AC, while also highlighting the different ways in which organizational antecedents may affect AC (Vega-Jurado, Gutiérrez-Gracia, & Fernández-de-Lucio, 2008). In this way, we also respond to the call by Ferreras-Méndez et al. (2015) to investigate the impacts of different dimensions of AC on the relationship between search strategies and performance.

Second, we consider these issues in the context of an understudied market: Iran. To date, most empirical studies of AC consider firms from either North America or Europe. Such contexts tend to be dynamic markets that are home to firms with rather well-developed absorptive capacity. While the Iranian context is distinct, due to international sanctions that have led to decades-long near-isolation from global markets, the findings of this study have relevance for other countries, such as Russia, Cuba, Belarus, Iraq, Lebanon, and some African countries (e.g., Egypt, Libya, and Sudan), where firms have also dealt with the effects of partial or full international sanctions. Our findings may also add to the general understanding of knowledge search in firms that operate in geographically isolated environments (e.g., New Zealand). Notwithstanding the importance of external knowledge, there are

still limited studies about how firms operating under constraints manage to tap into outside sources of knowledge.

The structure of this paper is as follows. First, we review the literature and propose four hypotheses. Then, we discuss the sampling frame, the data, and the research method, and present the results obtained through two-stage least squares modeling. Finally, we present the conclusion and contributions.

2. Literature review and development of hypotheses

Although Kedia and Bhagat (1988) mentioned the term "absorptive capacity", Cohen and Levinthal (1990) is regarded as the seminal paper in this field. Cohen and Levinthal (1990) argue that the concept of absorptive capacity is critical for understanding successful innovation activities; the firm's absorptive capacity relies heavily on its prior R&D investment, which occurs as a by-product of production and manufacturing operations. While Cohen and Levinthal (1990) consider AC as a unidimensional concept, measured using R&D intensity, more recent work (e.g., Sun & Anderson, 2010) has noted that this does not fully capture the dynamic nature of the complex concept. AC can be viewed as a dynamic capability that creates the ability to modify, expand, and leverage current competencies, or to generate new ones, by integrating newly-acquired knowledge into the firm's manufacturing processes, ultimately helping the organization to react more effectively to strategic changes (e.g., Teece, Pisano, & Shuen, 1997). In the Cohen and Levinthal definition (1990), AC relies primarily on the firm's existing knowledge and skills, which determine firm's capability to value, assimilate, and apply knowledge, emphasizing the "unidirectional and patterned developmental path" of AC (Zahra & George, 2002, p. 198).

Another important conceptualization of AC is that of Zahra and George (2002), who stress the processes, mechanisms, routines, and structures within firms that let them recognize, assimilate, transform, and apply exogenously-generated knowledge. The Zahra and George (2002) reconceptualization is one of the first to highlight the multidimensional nature of AC, suggesting that the complex concept relies on several factors, such as the firm's knowledge base, knowledge

complementarity, and variety of knowledge resources. In contrast to the definition of Cohen and Levinthal, Zahra and George argue that AC "follows a multidirectional and fluid path, rather than a patterned trajectory of knowledge acquisition and exploitation" (p. 198). They also note that AC is a dynamic capability that has two stages: potential (PAC, which involves acquisition and assimilation) and realized (RAC, which involves transformation and exploitation). Acquisition is the firm's ability to recognize and obtain external knowledge. Assimilation is the process of analyzing, interpreting, identifying, and understanding the knowledge. Transformation refers to the activities that facilitate the combining of knowledge transferred from the external environment with that already resident in the firm. Finally, exploitation is the ability to use, expand, and apply externally-generated knowledge in order to generate new ideas through the combination of transferred and existing knowledge into the firm's operations (Zahra & George, 2002). In this paper, we focus on these two dimensions of AC – potential and realized – and explore how external search strategies affect the firm's internal capabilities, following Zahra and George (2002), and investigate the distinct contributions of PAC and RAC to firm performance. Our premise is that the antecedents of AC (e.g., search strategies) may affect PAC and RAC in different ways, and that managers thus may need different mechanisms to nurture and harvest these two dimensions of AC in their firms, in order to generate stronger performance benefits.

2.1. The role of breadth for potential and realized absorptive capacity

Operating in a competitive environment, characterized by rapid technological changes and evolving customer preferences, makes the creation of new ideas extremely important; however, this can also be difficult, risky, and costly (Griffin, 1997). Engaging with external sources may provide an efficient means for organizations to acquire capabilities that facilitate the creation of new ideas (Adams, Day, & Dougherty, 1998; Rampersad, Quester, & Troshani, 2010).

Von Hippel (1988) suggests four exogenous knowledge sources for collaboration: suppliers, customers, competitors, and universities. Since then, some scholars have addressed these sources (e.g., Leiponen & Helfat, 2010). Laursen and Salter (2014) add consultants, private R&D institutes, and public research institutes as other important sources of external knowledge. While previous studies have highlighted the role of external sources for performance, the empirical results have been inconsistent

(Cruz-González, López-Sáez, Navas-López, & Delgado-Verde, 2015). One possible explanation for the contradictory results is that simply searching for new knowledge is not sufficient for enhancing performance (Voudouris et al., 2012); rather, firms need to develop capabilities that allow them to acquire, assimilate, transform, and exploit the new knowledge into their products and services (Todorova & Durisin, 2007). On this basis, we consider how external knowledge search assists firms to not only acquire and assimilate new knowledge (i.e., develop PAC), but also to integrate and exploit previously-acquired knowledge within the organization (i.e., develop RAC).

Laursen and Salter (2006, p. 134) note that search strategies have two components. The first is external search breadth, which is defined as the diversity of outside sources or search channels that the firm accesses in order to improve its knowledge activities. The second is external search depth, which is "the extent to which firms draw deeply from different external sources or search channels". Previous studies have shown that pursuing both depth and breadth search strategies puts firms in a better position to benefit from external knowledge sources (e.g., Laursen & Salter, 2006; Laursen & Salter, 2014). However, it is not yet clear how these search strategies are related to the different dimensions of AC. Considering the multi-dimensional nature of AC may assist in developing an understanding of why some firms are able to benefit from external knowledge sources, while others are not (Zahra & George, 2002).

Considering breadth, previous studies have argued for a positive association between PAC and the number of external sources with which the firm has relationships (Ahuja & Lampert, 2001; Laursen & Salter, 2014). More specifically, collaborations with partners operating in different lines of business may facilitate the generation of new ideas by creating easier access to a variety of knowledge stocks (Daghfous, 2004; Granovetter, 1973). For example, Asakawa, Nakamura, and Sawada (2010) assert that developing relationships with universities and suppliers can create opportunities for laboratories to access a wider range of knowledge sources, which can help them to develop their acquisition and assimilation capabilities (PAC). Lööf and Heshmati (2006) suggest that collaboration with different external knowledge sources can expand the firm's knowledge base and increase its capabilities, thus improving its performance. In a case study of SMEs, Jones and Craven (2001) find that using a diversity

of sources, such as customer contact, competitor monitoring, customer and supplier input, and trade shows, help to develop firms' knowledge stocks. Thus, the literature provides evidence that having broader relationships with external knowledge sources can offer access to a greater variety of knowledge that differs from that already in the firm's possession, thereby expanding its knowledge base and its capabilities for acquiring and assimilating new knowledge (PAC).

While external search breadth is likely to have a positive impact on PAC, it may not be as effective for RAC. Searching for knowledge from the external environment is costly, and requires the investment time and effort to identify the proper mechanisms, routines, and norms of each of the different external knowledge sources. Todorova and Durisin (2007) note that the main challenge associated with acquiring external knowledge is transforming the new knowledge so it works in harmony with the firm's existing knowledge. Seeking knowledge from a large number of relationships, without creating, in advance, the mechanisms and routines necessary to support such openness in the knowledge search may lead to confusion and challenges for managers, who need to focus on recognizing the potential value of the external knowledge as well as integrating it with the current stock (see, for example, Ferreras-Méndez et al., 2016; Laursen & Salter, 2014). The acquisition of too many ideas and solutions from different external sources may create difficulties for managers with respect to allocating sufficient attention and resources to each solution. This may mean that the newly-generated knowledge will not be transformed and exploited within the organization (RAC) (Koput, 1997; Laursen & Salter, 2006). On this basis, we hypothesize:

Hypothesis 1a-b: The breadth of the firm's external knowledge search is positively related to its development of (a) PAC and (b) RAC.

Hypothesis 1c: Breadth of external knowledge search is related more strongly to PAC than to RAC.

2.2. The role of depth for potential and realized absorptive capacity

Another approach that companies can use to search for new ideas is to create deep relationships with a limited number of external partners (Laursen & Salter, 2006). Deeper relationships may help partner

firms to establish effective patterns of communication over time and build shared mechanisms and routines (e.g., Laursen & Salter, 2006). These types of interactions, therefore, may even allow parties to share tacit knowledge, as they develop relationships based on trust and consistency (Jack, 2005). Previous work on inter-organizational collaboration has suggested that strong ties and active collaboration are necessary preconditions for sharing knowledge within a network (Reagans & McEvily, 2003; Van Wijk, Jansen, & Lyles, 2008), and that these attributes also play critical roles in the successful transformation and exploitation of external knowledge (Kohlbacher, Weitlaner, Hollosi, Grünwald, & Grahsl, 2013; Laursen & Salter, 2006).

Studying value creation in business-to-business (B2B) marketing, Komulainen (2014) found that service providers need to learn what motivates customers, in order to become fully involved in value co-creation. Nurturing deep relationships with customers may allow firms to overcome obstacles that they face in terms of applying technology; suppliers may also make use of this knowledge to update their technologies in a more affordable manner. Relationships with customers are especially critical, given that customers who are not successful in using a technology-related service may replace the service with another one (Komulainen, 2014). In addition, manufacturers benefit from deep and trusting relationships with suppliers, in order to reduce conflicts and increase access to valuable knowledge (Dyer & Hatch, 2006; Vazquez-Casielles et al., 2013). Therefore, deep relationships can be viewed as facilitating the transformation and exploitation of newly acquired knowledge (RAC).

On the other hand, close relations with external sources require more time and the allocation of more resources, compared to weak ties, on the basis that "an adherence to a norm of reciprocity implies that the focal actor forgoes the immediate pursuit of his or her own objectives in order to assist others in the pursuit of their objectives (Hansen, Podolny, & Pfeffer, 2001, p. 28). In addition, having close relations with different external actors may limit a firm's ability to develop its own business and restrict organizations to the skills and knowledge that are already present in the network. Therefore, even if close relations with external partners have the potential to assist the focal firm to acquire new and useful knowledge (PAC), trying to maintain deep relationships with many partners may be costly, especially in terms of resources (Ferreras-Méndez et al., 2016). On this basis, we hypothesize:

Hypothesis 2a-b: The depth of the firm's external knowledge search is positively related to its development of (a) RAC and (b) PAC.

Hypothesis 2c: Depth of external knowledge search is related more strongly to RAC than to PAC.

2.3. The roles of potential and realized absorptive capacity for firm performance

While a growing body of literature has investigated the role of absorptive capacity in developing performance (e.g., Lewin, Massini, & Peeters, 2011; Patterson & Ambrosini, 2015), few studies have addressed the differential effects of PAC and RAC in shaping performance outcomes. Making this distinction may help to explain why some companies are more effective than others, in terms of utilizing external knowledge sources.

Scholars have noted that the acquisition and assimilation of externally-sourced knowledge (PAC) have positive impacts on cost reduction and performance (Ahuja & Katila, 2001; Caloghirou et al., 2004; Sisodiya, Johnson, & Grégoire, 2013). PAC also has strategic benefits, such as helping firms to avoid the risk and cost associated with internal R&D (Noori, 1990), attaining rapid improvement (Granstrand, Bohlin, Oskarsson, & Sjöberg, 1992), and also accessing state-of-the-art knowledge (Jones, Lanctot & Teegen, 2001). In addition, the acquisition and assimilation of external knowledge can reduce product development cycles and facilitate larger numbers of new product introductions (Yli-Renko, Autio, & Sapienza, 2001) through expanding the firm's knowledge base. Fiol (1996) notes that the accumulation of newly-generated knowledge has a critical role in performance. Firms with stronger capacity to acquire and assimilate external knowledge are more capable of lowering both unit and overhead costs, thereby increasing profits (e.g., Lyles and Salk, 1996). As Zahra and George (2002, p. 196) note, "firms with well-developed capabilities of knowledge acquisition and assimilation (PAC) are more likely to sustain a competitive advantage because of greater flexibility in reconfiguring their resource bases and in effectively timing capability deployment at lower costs than those with less developed capabilities". Further, PAC can help a firm to extend its knowledge boundaries, allowing

sharpening of its skills and the extension of its competitive advantage (Mowery, Oxley, & Silverman, 1996; Teece, 1992). Therefore, we hypothesize:

Hypothesis 3: PAC will be positively related to the firm's performance.

A firm's capability for combining externally-sourced knowledge with its current knowledge is a crucial aspect of developing sustainable competitive advantage (e.g., Cohen & Levinthal, 1990; Rosenkopf & Nerkar, 2001). Transformation and exploitation capabilities (RAC) can help firms not only to reconfigure and recombine knowledge, but also to reinterpret currently-held knowledge and let go of outdated knowledge (Cegarra-Navarro, Eldridge, & Wensley, 2014). In this way, firms that can apply external knowledge effectively should be better able to increase their performance (Araujo, Dubois, & Gadde, 2003; Ettlie & Subramaniam, 2004). Teece (2006) asserts that the firm's capability for integrating external knowledge with existing stocks has a critical role in improving its performance. Transformation and exploitation capabilities develop firm performance via product and process innovation (Zahra & George, 2002). For instance, Kazanjian, Drazin, and Glynn (2002) indicate that, pursuing product line extension or new product development means that new knowledge and skills need to be leveraged and recombined. Well-developed capabilities for knowledge transformation and exploitation (RAC) can put a firm in a better position to achieve stronger performance through decreased costs and more effective new product development (Zahra & George, 2002; Teece, 2006).

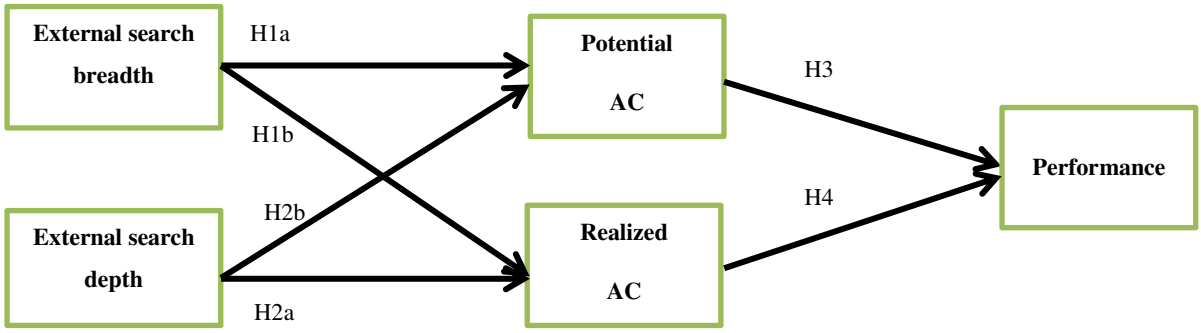
Previous scholars have argued that RAC can expand a firm's capacity for understanding new ideas and developing innovation-related activities, while strengthening its ability to recognize new opportunities (García-Morales, Lloréns-Montes, & Verdú-Jover, 2008; Gray, 2006). Therefore, RAC can develop a firm's performance through the transformation of newly-acquired knowledge from external sources and the integration of that knowledge with the firm's existing supply (Kotabe, Jiang, & Murray, 2011). Accordingly, we hypothesize:

Hypothesis 4: RAC will be positively related to the firm's performance.

Figure 1 shows the proposed model.

FIGURE 1

The research model



3. Research method

3.1. Sample and data collection

We test our hypotheses using survey data obtained from supplier firms in the Iranian automotive industry. We selected this context for multiple reasons. First, operating in an emerging economy, Iranian firms have strong motivation to acquire knowledge from external sources, in order to develop their own performance, and gain the capabilities necessary to compete in the global market (Ghazinoory, Riahi, Azar, & Miremadi, 2014). While the funding allocated by the Iranian government has yielded an increase from 82 researchers per million residents to 1500 researchers per million during the past three decades (Soofi & Ghazinoory, 2011), this support has not been enough to change the traditional Iranian economy into a knowledge-based one (Scaringella & Burtschell, 2015). In addition, the Iranian government has put pressure on manufacturers to produce vehicles that meet high environmental standards, in order to increase exports. While the automotive industry is a critical sector for Iranian policy makers who aim to be able to export cars to neighboring countries, the budget allocated for internal R&D has proven insufficient for the Iranian suppliers in this industry; therefore, these firms tend to interact with external sources in order to develop their capabilities and their performance. Third, apart from oil, the automotive industry is the most important in Iran, with a turnover around 12 billion USD; the country's leading vehicle assembler, Iran-Khodro, is the largest automotive manufacturer in the Middle East and North Africa (MENA) region (Business Monitor International, 2015). Therefore,

this industry provides a useful context in which to examine the process of learning from external partners (Dyer & Nobeoka, 2000).

The survey instrument was developed based on the existing literature, and refined following interviews with 16 senior managers in the Iranian automotive supplier sector[1]. Designed in English, the questionnaire was translated into Persian, and then back-translated, to ensure conceptual equivalence (Douglas & Craig, 2007). We then conducted a pilot survey, with a panel of R&D, technology, and performance managers, and the head of a material research center; this led to minor changes that introduced terms that would be more familiar to the target audience of Iranian managers. The questionnaire items used seven-point Likert scales.

According to the interviews, some 250 suppliers play key roles in this sector, in terms of collaborating with external sources. We focused on this group of suppliers that have exhibited open behavior, and contacted the firms via email and telephone, to set appointments with senior managers, in order to ask them to complete the questionnaire during personal meetings. A total of 200 firms agreed to take part in this study. Finally, we obtained 171 completed questionnaires, representing a 68% response rate.

3.2. Measurement

3.2.1. Dependent variable – performance: A firm's performance is related to the efficiency and effectiveness of the actions that it takes (Neely, Gregory, & Platts, 1995). Since performance is a multidimensional construct (Murphy, Trailer, & Hill, 1996), we operationalize it based on financial performance and growth (Wiklund & Shepherd, 2005). Respondents were asked to assess their firms' performance over the past year, relative to their competitors, with respect to five aspects: profit growth, return on assets, sales growth, market share growth, and cash flow (Jaworski & Kohli, 1993; Reinartz, Krafft, & Hoyer, 2004; Venkatraman, 1989; Wiklund & Shepherd, 2005). The five items combined to form a reliable measure, with α=0.90 (see Appendix A).

[1] Each interview lasted for approximately 30-60 minutes. Semi-structured interviews were employed, to provide better comparison across the firms and ensure that the data from the interviews are analyzed consistently (Morse, 2005). These interviews helped us to confirm, expand, and modify the set of variables stemming from the literature.

3.2.2. Intermediate variables – absorptive capacity: Previous studies have tended to use R&D intensity as a proxy for AC (Laursen & Salter, 2006). However, this approach of considering AC as a single factor and operationalizing it in this manner has been questioned (Sun & Anderson, 2010; Zahra & George, 2002). In this study, we considered potential and realized absorptive capacity (PAC and RAC, respectively) separately.

We measured PAC using a 12-item scale (α=0.95), based on the Zahra and George (2002) process-based definition of AC. The items, measured using seven-point Likert scales, with 1 and 7 representing "strongly disagree" and "strongly agree", respectively, aim to capture the extent to which the firm has the ability to scan the environment, and acquire and assimilate new knowledge from external sources (Jansen et al., 2005; Szulanski, 1996). RAC was operationalized using an eight-item factor (α=0.91), aimed at assessing the firm's ability to combine its newly-acquired knowledge with its existing knowledge, in order to commercialize new products and processes (Jansen et al., 2005; Smith & Tushman, 2005; Szulanski, 1996; Zahra & George, 2002)[2] (see Appendix D).

3.2.3. Explanatory variables – external search breadth and depth: Breadth refers to the different types of sources with which a firm links in order to develop innovation activities (Chen et al., 2011; Laursen & Salter, 2006). Following prior research (e.g., Laursen & Salter, 2006), we operationalized the external search breadth as the number of different types of external sources with which the firm has a relationship. We identified 11 types of potential external sources, including organizations within the business group, competitors and other enterprises from the same industry, universities, and laboratories or R&D companies (see Appendix B). The breadth measure ranges from 0 (representing collaboration with none of these potential partner types) and 11 (when the firm has used all of the named sources).

Depth pertains to the extent to which firms draw intensively from different external partners (Laursen & Salter, 2006). Following Laursen & Salter (2006), our measure of external search depth is based on responses to the question: "What is the importance of co-operation with the following external

[2] Exploratory factor analysis undertaken with the full set of applicable items yielded the two factors representing PAC and RAC.

partners in your firm's innovation activities?", listing the same potential external partners as those used to measure breadth, where 1 represented low importance and 7 high importance. In order to differentiate between "the cases which have a very deep linkage with one or two specific external sources from companies whose relationships are not so deep but are sustained with more external sources" (Ferreras-Méndez et al., 2015, p. 5), we opted not to create a measure based on factor scores or mean responses. Rather, we considered that responses of 1-4 represent a relationship with an external source that is not very deep, while responses of 5-7 reflect a deep relationship. Summing the resulting binary measures (1 for deep, 0 for not), a depth score of 0 means that the firm has no deep relationships and 11 represents deep relationships with all of the named external sources.

3.2.4. Control variables: In line with previous research (e.g., Laursen & Salter, 2006), we include five control variables. Many studies have shown a relationship between firm size and innovative performance; we operationalized firm size using the number of the employees, collected via the questionnaire. We also controlled for the firm's age, since older firms have had more time to develop capabilities and gain experiences that affect their absorptive capacity. We also distinguish between privately- and publicly-owned companies, given government support for the latter. In addition, the level of the investment in R&D may influence the success of the firm's innovation activities through the development of AC (Cohen & Levinthal, 1990). Therefore, we included R&D intensity, measured as the ratio of the number of employees involved in R&D to the number of total employees, in the models. Moreover, the ability to benefit from learning may be related to the level of environmental change (Lane et al., 2006). When competition in the market is strong, managers may try to expand their capabilities, to respond to exogenous changes and develop performance (Jansen, Van Den Bosch, & Volberda, 2006). We operationalized the competitive environment using three items (Birkinshaw, Hood, & Jonsson, 1998; Jaworski & Kohli, 1993), measured using seven-point Likert scales.

Table 1 reports the correlation matrix and descriptive statistics for all of the variables used in the models.

Table 1

Correlations, means, and standard deviations

	Mean	s.d	1	2	3	4	5	6	7	8	9
1.Performance	**4.01**	**1.30**	**0.85**								
2.Potential absorptive capacity	**0.00**	**1.00**	0.58**	**0.80**							
3.Realized absorptive capacity	**0.00**	**1.00**	0.08	0	**0.80**						
4.Breadth	**9.07**	**2.24**	0.23**	0.37**	0.01	1.00					
5.Depth	**3.02**	**3.05**	0.08	0.10	0.34**	0.40**	1.00				
6.Competetive environment	**4.70**	**1.18**	0.17*	0.12	0.21**	0.03	0.13	**0.84**			
7.Age of the company	**21.20**	**10.57**	-0.26**	-0.32**	0.07	-0.19*	0.09	-0.01	1.00		
8.Employees 2016	**3.32**	**1.63**	-0.10	-0.23**	0.04	0.08	0.24**	0.11	0.31**	1.00	
9.R&D intensity	**1.79**	**1.30**	0.09	0.06	0.20*	0.10	0.21**	0.18*	-0.09	0.15*	1.00
10.Ownership	**0.90**	**0.29**	0.04	-0.01	-0.04	-0.01	-0.02	-0.07	-0.08	-0.01	0.07

Note: Diagonal elements are the square root of the average variance extracted (AVE).

n=171**.**

** $p < 0.01$

* $p < 0.05$

3.3. Reliability and validity

Before testing the hypotheses, we assessed the reliability and validity of the constructs. First, we undertook exploratory factor analysis, using varimax rotation, to develop the multi-item constructs, followed by reliability analysis based on Cronbach's α values. Table 2 shows factor loadings, reliability, and details of the items and constructs. The uniformly high α values suggest acceptable reliability. In addition, the constructs' composite reliability (CR) values, ranging from 0.87 to 0.95, are satisfactory (Fornell & Larcker, 1981). Through these results, the reliability of the main constructs is viewed as acceptable. The average variance extracted (AVE) values are all higher than 0.50, providing evidence of the convergent validity of constructs (Fornell & Larcker, 1981). To address discriminant validity, we compared the AVE of each latent variable to the squared correlation between the constructs (Fornell & Larker, 1981); the fact that each of the AVEs is higher provides support for the assessment that the measures have adequate discriminant validity.

Table 2 Factor loadings, Cronbach's α, and validity assessment	Factor Loading	α
Potential absorptive capacity (CR=0.95, AVE=0.64)		**0.95**
Our company observes external sources of new products and technologies in detail.	0.71	
Our company frequently scans the environment for new technologies.	0.80	
Our company thoroughly observes technological trends.	0.82	
Our company has information on the state-of-the-art of external technologies within our industry.	0.81	
Our company regularly utilizes new opportunities in the new market.	0.82	
Our company collects industry information (e.g., potential competitors, customer needs, etc.).	0.73	
Our employees regularly approach the external environment (e.g., universities, research institutes, government, etc.) to acquire technological knowledge.	0.76	
Our company periodically organizes special meetings with external partners to acquire new technologies.	0.79	
Our company quickly understands new opportunities in our market (e.g., emerging customer needs).	0.77	
Our company quickly analyses and interprets changing market demands (e.g., shifting structure of competition).	0.76	
Our company quickly analyses and interprets new technology trends.	0.78	
Our employees store technological knowledge for future reference.	0.73	
Realized absorptive capacity (CR=0.93, AVE=0.64)		**0.91**
Our company communicates relevant knowledge across the units of our firm.	0.67	
New opportunities to serve our customers with existing technologies are quickly understood.	0.82	
Our company regularly matches new technologies with ideas for new products.	0.80	
Employees share practical experiences.	0.84	
We grasp the opportunities for our firm from new external knowledge.	0.73	
Our company regularly applies technologies in new products.	0.80	
Our company considers how to better exploit technologies.	0.73	
Our employees have a common language regarding our products and services.	0.74	
Performance (CR=0.93, AVE=0.71)		**0.90**
Profit growth	0.84	
Return on assets	0.86	
Sales growth	0.85	
Market share growth	0.86	
Cash flow	0.86	
Competitive environment (CR=0.87, AVE=0.71)		**0.80**
Our firm has relatively strong competitors.	0.85	
Competition in our local market is extremely high.	0.89	
Price competition is a hallmark of our local market.	0.80	

4. Analysis

We employed a two-stage least squares (2SLS) approach to evaluate the relationships and test the hypotheses. Employing 2SLS not only offers sequential estimation of the full model, but also provides the benefit of estimators that are consistent and robust (e.g., Kennedy, 2003), while accounting for potential problems of endogeneity in the complex relationship among external knowledge search, AC, and performance. The 2SLS approach treats AC, knowledge, and performance as a system; given the potential endogeneity, failure to do so could result in biased and inconsistent estimates (Shaver, 2005).

The first step of the 2SLS approach generated two instrumental variables, representing PAC and RAC. Hypotheses 1 and 2 were tested during this stage. These instrumental variables then became explanatory variables in the second-stage performance model, used to test Hypotheses 3 and 4. All of the estimation was undertaken using ordinary least squares (OLS). Variance inflation factors (VIFs) indicated no evidence of problem multicollinearity, and residual analysis showed no deviation from the key OLS assumptions.

Because the dependent and explanatory variables were derived from the same survey instrument, our analysis is subject to common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). We have used several approaches to mitigate this risk. First, we designed the survey instrument so that the items used for the dependent and explanatory variables were separated from each other. Second, an extensive pilot study ensured that items in the questionnaire were expressed in an understandable manner. Third, we also assured respondents about the confidentiality of their responses. Fourth, the majority of the firms in our study are SMEs (72% with fewer than 200 full-time equivalent employees) and the respondents mainly (87%) top managers, offering further protection against the effect of common method bias (Gerschewski, Rose, & Lindsay, 2015). Fifth, our in-depth interviews with a sub-sample of 16 firms provided information that was fully consistent with the results of the corresponding survey. Finally, Harman's single-factor test revealed that no single factor accounted for more than 23.45% of the applicable total variance, providing further evidence that common method bias is not a serious issue (Podsakoff et al., 2003).

5. Results

Table 3 contains the results of the first and second stages of the 2SLS estimation used to test Hypotheses 1 and 2 and Hypotheses 3 and 4, respectively.

Table 3

The results of first and second stages of the 2SLS estimation

Stage 1 results: PAC and RAC			**Stage 2 results: Performance**			
Variables	Potential absorptive capacity	Realized absorptive capacity	Variables			
Intercept	-1.26(0.61)	-0.70(0.63)	**Intercept**	3.92(0.64)	4.04(0.81)	4.09(0.80)
Key predictors			*Key predictors*			
Search breadth	0.32** (0.04)	-0.16† (0.04)	**Potential absorptive capacity**	0.31** (0.32)		0.31**(0.33)
Search depth	0.01 (0.03)	0.31** (0.03)	**Realized absorptive capacity**		-0.01 (0.38)	0.05(0.38)
Control variables						
Competitive environment	0.14† (0.07)	0.17* (0.70)	**Competitive environment**	0.02 (0.10)	0.11 (0.11)	0.01(0.12)
Age of the company	-0.18* (0.01)	0.07 (0.01)	**Age of the company**	-0.06 (0.01)	-0.21*(0.01)	-0.07(0.01)
R&D intensity	0.03 (0.06)	0.17* (0.06)	**R&D intensity**	0.01 (0.08)	0.05 (0.10)	-0.01(0.10)
Employees 2016	-0.24** (0.05)	-0.06 (0.05)	**Employees 2016**	0.01 (0.07)	-0.12 (0.07)	0.01(0.08)
Ownership	0.04(0.31)	0.01(0.32)	**Ownership**	0.01(0.40)	0.03(0.41)	0.01(0.40)
n	134	134	***n***	134	134	134
R^2	0.24	0.18	R^2	0.12	0.08	0.12
Max VIF	1.37	1.37	**Max VIF**	2.19	2.12	2.26

Note: Standard errors in parentheses.

† $p<0.10$

* $p<0.05$

** $p<0.01$

Hypothesis 1 pertains to the relationship between external knowledge search breadth and both potential and realized absorptive capacity. Hypothesis 1a is supported, as the coefficient associated with breadth is positive and significant (p<0.01), while Hypothesis 1b is contradicted, as the coefficient associated with breadth is significantly negative (p<0.10). Hypothesis 1c is supported, based on non-overlapping 95% confidence intervals for the two estimated coefficients.

We explore the relationships between external search depth and absorptive capacity in Hypothesis 2. Search depth has a significant and positive marginal relationship with RAC (p<0.01), providing support for Hypothesis 2a. In contrast, Hypothesis 2b is not supported, as the estimated coefficient associated with the depth of external knowledge search in the model of PAC is not significant (p>0.10). Comparison of 95% confidence intervals for the estimated coefficients provides support for Hypothesis 2c. Together, the results of the first stages of the 2SLS modeling suggest that external search breadth is important for developing PAC, but that establishing deeper relationships may not expand a firm's acquisition and assimilation capabilities. In contrast, while external search depth has a key role for developing RAC, search breadth may not develop a firm's transformation and exploitation capabilities.

The second stage of the 2SLS modeling examines the relationship between the two dimensions of AC and firm performance. The results in Table 3 show that PAC is significantly associated with performance (p<0.01), marginal to the other variables in the models, but that the estimated coefficient associated with RAC is not significantly different from zero (p>0.10). Thus, Hypothesis 3 is supported, but Hypothesis 4 is not.

5.1. Post-hoc analyses

In order to investigate the potential for problems due to endogeneity and reverse causation, we undertook additional analysis of our data. Specifically, we have estimated two models using structural equation modelling (SEM). Model 1 represents the original model in our paper, with the sequential relationship between search depth and breadth and PAC and RAC. Model 2 represents the reverse direction for the relationship. Table 4 shows the fit indices for the two models, which provide evidence

that the theoretical model in our paper can be assessed as representing an excellent fit, far superior to the reverse-causality version. While we cannot claim an absolute lack of endogeneity in our data, the 2SLS approach that we have employed allows for consistent estimation in the face of this possibility.

Table 4: Fit indices for original and reverse-causality models

Fit Summary	Model 1 (original)	Model 2 (reversed)
Root mean square error of approximation (RMSEA)	0.0000	0.425
Goodness-of-fit statistic (GFI)	0.995	0.835
Normed-fit index (NFI)	0.987	0.378
Comparative fit index (CFI)	1.000	0.351

To further assess the robustness of our results, we replaced performance with two other dependent variables, in order to better understand the lack of relationship between RAC and performance. We estimated the relationship between the two aspects of absorptive capacity and both new and incremental innovation. We find that RAC is not related to the development of new innovation (p>0.10), marginal to the other variables in the model, but the coefficient associated with PAC is positive and significant (p<0.01). In contrast to new innovation, RAC has a positive and significant relationship with incremental innovation (p<0.05).[3] A potential explanation for these results is related to the fact that Iranian suppliers may be able to acquire and assimilate new knowledge from external sources, but that they lack the capabilities necessary to transform and exploit newly-generated knowledge into their manufacturing operations. Therefore, these firms may fall into the three types of competence traps (i.e., familiarity, maturity, and propinquity) introduced by Ahuja and Lampert (2001), which hinder firms from implementing radical changes in their manufacturing processes and operations (Zahra & George, 2002).

In contrast, when it comes to incremental changes in manufacturing processes, Iranian suppliers seem to have sufficient capabilities to transform and exploit familiar knowledge in order to modify and

[3] Details are available from the authors upon request.

improve their current knowledge to develop their operations. These additional results provide us with some further insight into our finding that RAC is not related to performance.

6. Discussion

While it is widely accepted that making use of external knowledge sources is critical to developing a firm's performance, relatively little attention has been paid to the role that potential and realized absorptive capacity play in enhancing firm-level performance. Making a clear distinction between potential and realized absorptive capacity may help to develop a deeper understanding of why some firms are particularly successful at benefiting from openness to external knowledge. In addition, most previous studies of AC have focused on developed countries (e.g., Ferreras-Méndez et al., 2016), which present extremely different institutional environments, compared to emerging and less-open markets such as Iran. Furthermore, researchers have tended to study these issues in the context of knowledge-intensive industries (e.g., Huang, Lin, Wu, & Yu, 2015); operating successfully in such industries requires the implementation of higher-level technologies and more-developed external knowledge strategies (Bee, 2003; Grindley & Teece, 1998). However, the question still remains of the extent to which firms, especially SMEs, operating in a less-open environment benefit from external knowledge (Pervan, Al-Ansaari, & Xu, 2015). In this study, responding to the call by Karna, Richter, and Riesenkampff (2016) for more context-specific studies of firm-level capability and performance, we investigate the effects of potential and realized absorptive capacity on performance, along with AC's inter-organizational antecedents, in the context of Iran, an economic setting that has received scarce academic attention in this field.

Our study thus contributes to the literature on absorptive capacity, by theoretically illustrating and empirically testing the relationship between external knowledge search and internal capabilities, along with the relationship between the internal capabilities and performance. Our findings suggest that, while PAC contributes to performance, RAC does not have significant impact, after accounting for other factors.

One explanation for this unexpected finding may pertain to the strong path dependency of PAC, which is affected by the firm's prior experience with developing its knowledge stock by being able to spot new opportunities in the external environment. As the firm gains experience, over time, and manages its search processes more effectively, it should face lower costs associated with changing its resource position and operational procedures. Increased flexibility and capability with respect to renewing its knowledge stock should mean that the firm is in a better position to "reconfigure their resource bases to capitalize upon emerging strategic opportunities" (Zahra & George, 2002, p. 196). The literature suggests that this can eventually help them to gain and sustain superior performance through reducing unit and overhead cost, and increasing profits (Raff, 2000; Lyles and Salk, 1996). This can occur due to improved customer responsiveness (Matusik & Hill, 1998) and first mover advantage (Ferrier, Smith, & Grimm, 1999); firms that acquire and assimilate important knowledge or technology that is scarce may be able to impede others from acquiring the same information, and thus gain competitive advantage (e.g., Schulze, 1994). In this way, well-developed PAC "helps firms track changes in their industries more effectively and therefore facilitates the deployment of necessary capabilities, such as production and technological competencies" (Zahra & George, 2002, p. 195). This is consistent with previous studies that assert that the acquisition of external knowledge has a positive effect on performance (see, for example, Caloghirou et al., 2004; Kessler, Bierly, & Gopalakrishnan, 2000).

Another explanation may be context-driven. After the imposition of sanctions, foreign firms ceased their operations in Iran. Some foreign firms terminated their agreements with their Iranian partners, creating a difficult and isolated situation for the Iranian firms, who lacked access to some key knowledge and technologies. According to our interviews with managers in the Iranian automotive component sector, a key challenge for firms was to identify all potential sources of knowledge that might help to sustain them in the market, especially because they were under pressure by both customers and the government to reach pre-sanction production levels, which had fallen dramatically post-sanctions. In essence, the Iranian firms explored as many search channels as possible – sometimes quite creatively, given the sanctions – in order to acquire knowledge that is critical to their operations. Out

of necessity, they have developed and applied routines[4] that allow them to identify knowledge and technologies that can be acquired rapidly and understood with relative ease. Focusing on knowledge and technologies that fit with those existing within their organizations allows the firms to better digest and leverage the additions. New knowledge may embody heuristics that are very different from those already in use, impeding comprehension (Zahra & George, 2002), especially when the value of the new knowledge depends on the existence of complementary knowledge within the firm (Teece, 1981). However, such a strong emphasis on modifying and developing familiar knowledge, instead of working with newly-acquired knowledge, may lead firms into familiarity traps (Zahra & George, 2002). While a set of familiar solutions and ideas can address many issues in an effective way, "the likelihood that some principles will be inappropriately applied rises as a constrained set of competencies is applied to more and varied technological problems" (Ahuja and Lampert, 2001, p. 526). Overreliance on familiar and well-understood knowledge for solving problems may thus limit the firm's ability to develop its performance (Ahuja and Lampert, 2001). Therefore, it is critical for managers to find a balance between exploring novel ideas and technologies and overemphasizing investment in prevailing and well-understood technologies.

Apart from this context-specific reasoning, another possible explanation for the finding that RAC is not marginally related to performance pertains to the exploitation dimension, which is what helps firms to apply new knowledge in their operations (Zahra & George, 2002). The exploitation of newly-generated knowledge relies on the mechanisms that firms put in place to choose projects and solutions in which to invest, along with the level of resources to allocate to them. In this way, RAC is affected by both managerial discretion and the availability of human and financial resources; suboptimality in any of these may limit the performance contributions of externally-sourced knowledge.

[4] The fact that the Iranian automotive supplier firms in our study had considerable experience in collaborating with their foreign partners prior to the sanctions served to facilitate the process of refining, extending, leveraging, and incorporating newly-acquired knowledge into their operations. Our interviews provided evidence that the firms had already established internal metaroutines pertaining to learning from these partners; Lewin, Massini, and Peeters (2011, p. 85) define metaroutines "as higher-level routines that define the general, abstract purpose of routines and that are expressed by practiced routines, which are firm specific, idiosyncratic, and observable".

It is also possible that the knowledge that firms acquire and assimilate from external environment is fragmented, inhibiting its immediate utility. Winter (1984) asserts that the quality and amount of such knowledge tend to be lower than what is required. Therefore, the exploitation and development of such acquired knowledge requires complementary resources from the receiving firm (Zhang, Li, Li, & Zhou, 2010). Firm size comes into play; larger firms are likely to have more complementary expertise that can be used to exploit the newly-acquired knowledge, in order to generate novel products and processes (Katila & Ahuja, 2002). Our sample firms, which are predominately SMEs, may lack the requisite complementary resources to enable them to gain the full benefit of external knowledge in order to generate performance. Knowledge gaps may also mean that more time elapses before the newly-generated knowledge can be applied within the organization; if the benefit of technological knowledge expires before it can be exploited, it cannot contribute to the firm's competitive advantage (Tsai, 2009).

Our lack of empirical support for previous arguments that the capability to transform and exploit external knowledge (RAC) may improve performance (see, for example, Tsai, 2001; Daghfous, 2004; Teece, 2006), highlights the notion that PAC and RAC are distinct capabilities, each having different antecedents and impacts on firm-level performance. However, this does not imply that firms should invest only in PAC and not RAC. Rather, this finding emphasizes the fact that, in order to reap the benefits of external knowledge, managers should pay attention to, and leverage, both components of AC. Further research is also required to develop a better understanding of the impact of each of the aspects of AC (acquisition, assimilation, transformation, exploitation) on performance.

6.1. Determinants of AC

This research provides some deeper insights into the antecedents of PAC and RAC. In our modeling, external search breadth exhibits a positive relationship with PAC. Breadth may enhance the firm's flexibility in adjusting to unforeseen changes, while also expanding the technology and market opportunities available to it. Having relationships with a variety of sources may also help firms to gain access to different knowledge stocks, facilitating the generation of novel ideas and solutions (Daghfous, 2004). For example, the activities of Iranian firms have been restricted by international sanctions

(Business Monitor International, 2015). The sanctions caused substantial decreases in firms' profits, and ultimately led managers to find other ways to enhance their knowledge capital and to diversify the risks associated with innovative activities[5]. As an R&D manager from one of the Iranian automobile suppliers in our study explained:

> *One of the lessons we have learned being under sanctions is to be more proactive and pay attention to factors we had not considered before. We have learned that it is vital to have co-operations with more than one partner. If a partnership breaks apart for any reason, we need to have a "plan B" in place. Even if we had the best partnership in the world, still we should not just focus on that one partner, but have several to work with.*

Scholars have noted that, when firms cannot improve their performance, they may scan more broadly for technology from other firms, to extend or defend their core business (see, for example, Chesbrough and Crowther 2006). Garriga, von Krogh, and Spaeth (2013) argue that the resources available for generating new ideas affect each firm's strategy for searching for novel knowledge. Therefore, it is critical, especially for firms with constraints on their innovation activities, to embrace the potential of external knowledge, even if this requires substantial modification in the strategy, design, and structure of the organization in order to make firms more outward-looking and receptive to external knowledge (Fosfuri & Tribó, 2008).

While previous studies have shown that external search breadth may help to develop the firm's ability to generate new products and services (see, for example, Asakawa et al., 2010; Lööf & Heshmati, 2006), we find evidence of a negative relationship with RAC. This may relate to the detrimental effect of over-searching, in terms of exploiting external knowledge (Laursen & Salter, 2006). For example, Iranian managers may focus too much on openness when searching for new ideas from the external environment, due to the lack of internal resources and capabilities for generating novel solutions

[5] Iranian suppliers in the automotive industry have expanded their access to as many search channels as possible, internationally as well as domestically, to become more aware of novel ideas and technological developments. In doing so, they have worked to identify a broad range of potential sources that might sustain them in the market. For example, before the sanctions, Iranian firms had relationships mainly with European partners. International sanctions led them to look for other possible sources of knowledge. While they still collaborate with some European firms, they have expanded their network by searching for knowledge from firms in other countries, such as China and India. Searching for knowledge from a diverse range of external sources increases the possibility that at least one of these sources will have the knowledge required to improve the Iranian firm's capabilities. Previous scholars have discussed the importance of collaborating with a diverse range of external sources (see, for example, Leiponen & Helfat, 2010), and we observed this among the Iranian firms in our study.

(Edwards, Delbridge, & Munday, 2005); this may have led to insufficient focus on the mechanisms and structures needed to support a large number of collaborators (Laursen & Salter, 2014). Having many search channels, absent the structures to deal with the resulting knowledge, may cause confusion for managers, who need to identify the potential value of newly-acquired knowledge as well as internalizing this knowledge within the firm (see, for example, Ferreras-Méndez et al., 2016). Koput (1997) discusses how over-searching impairs the firm's capacity for applying external knowledge; generating too many potential solutions can lead to having many new ideas generated for the organization, but not at the right time or in the right place to be fully utilized.

Also unexpectedly, we find no significant marginal contribution of search depth to PAC, suggesting that a strong focus on having deep relationships with a small number of external sources does not help firms with PAC. Generating intense relationships with external linkages takes time and resources (Laursen & Salter, 2006). Larger firms are likely to have more of the resources necessary to develop deep relationships with external partners (Tsai, 2001), allowing them to better acquire and assimilate external knowledge. The fact that most of the firms in our study are SMEs may help to explain the lack of support for the hypothesized relationship between search depth and PAC.

In contrast, we find evidence that external search depth is related to RAC, suggesting that facilitating the transfer of tacit knowledge that allows organizations to generate new ideas through the combination of new information with market opportunities (Chiang & Hung, 2010). Sustaining deep collaborations with specific partners, over time, can help to build shared understanding, and create effective patterns of interactions and common ways of working together; these are critical for reducing the reticence of sharing sensitive knowledge with partners (Laursen & Salter, 2014).

6.2. Managerial implications

There are several practical implications from our study. Our research provides evidence that external knowledge search provides performance benefits for firms, even in a traditional sector. Due, in part, to international isolation, most of the firms in our study are not able to rely solely on their internal resources; they need to access other resources, through collaboration, in order to be competitive. In

particular, given that many smaller firms lack the resources and capabilities to innovate effectively (Vermeulen, 2005), SME managers should be aware of the key potential of search breadth for developing competitive position; this may open new doors and provide fresh opportunities to develop the firm's performance.

Our study also suggests that it is useful for managers to be aware of their external relationships in order to expand AC, and to develop strategies for identifying a balance between depth and breadth, depending on the firm's needs. If a firm wants to acquire and assimilate new knowledge from its environment (potential absorptive capacity), the focus may be on developing many linkages, in order to expand the firm's knowledge stock. However, if the goal is to exploit acquired knowledge, it may be better to work on developing a smaller number of deep relationships and intense interactions with key sources.

6.3. Limitations and directions for further research

Our study is subject to some limitations, which offer guidance for future research. While our empirical context is the automotive industry in Iran, a nation that has seldom been studied in the AC and innovation literatures, it would be useful to investigate other geographical contexts and industries, in order to build a more general understanding. Our finding that RAC is not related the development of performance means that future research should explore more about the roles of capabilities related to transformation and exploitation, including the internal processes, routines, and mechanisms that are needed to help firms to digest and leverage newly-acquired knowledge. This may shed light on the question of why some firms are able to acquire and assimilate external knowledge without enjoying the anticipated benefits. National policy also plays a role; some countries provide policy-driven incentives for firms, to encourage the learning process. Future research could address the issue of how governmental policies affect firms' external search strategies and capabilities for developing a competitive advantage.

In this study, we use a perceptual measure of performance, which is the norm when surveying SMEs. Future work that employs objective performance measures and accounts for time lags between

actions and performance will provide additional insights into the relationship between RAC and performance[6]. Future studies could also investigate the timing of collaboration with external sources, which is a limitation of the operationalization of search depth in this study. It would also be interesting to evaluate the effects of search depth and breadth on each component of PAC and RAC (acquisition, assimilation, transformation, and exploitation), and consideration of some relational factors, such as social capital and the level of trust, may provide additional insights into knowledge transfer and the development of PAC and RAC. Other firm-specific factors, such as structure and culture, may also affect absorptive capacity and performance. In addition, examining how national context and the availability of external sources affect a firm's search for new ideas seems a fruitful avenue for future study. Finally, a longitudinal study may offer a deeper understanding of the dynamic nature of absorptive capacity, and how it can help firms to become more globally competitive through collaboration with external sources of knowledge.

7. Conclusion

In summary, our study contributes to the literature on absorptive capacity by theoretically addressing the concept from a process perspective, and by demonstrating empirically that inter-organizational antecedents have both positive and negative relationships with firm-level capabilities. While previous studies have addressed AC as complementary to external knowledge search strategies aimed at developing performance (e.g., Chen et al., 2011; Laursen & Salter, 2006), they have not considered its multidimensional nature. The generally-employed operationalization of AC using R&D intensity has been a limitation, as this does not account for key aspects of absorptive capacity, including the role of capabilities in allowing firms to successfully acquire, assimilate, transform, and exploit external knowledge in order to generate profit (Todorova & Durisin, 2007; Zahra & George, 2002).

Furthermore, we find evidence that external knowledge is being utilized by Iranian firms in a traditional sector, with positive outcomes for their performance. Although Iranian firms have been isolated from international markets and have weathered environmental turbulence, due to sanctions, we

[6] We are grateful to an anonymous referee for making this point.

show that searching for knowledge from external sources plays a role in helping them to develop their performance. Despite the sanctions, these firms have found ways to connect internationally. While Chesbrough and Crowther (2006) used case studies to illustrate that, even in traditional industries, firms may employ external knowledge sources, our findings support their argument using a quantitative approach. This also responds to a call from Van de Vrande, De Jong, Vanhaverbeke, and De Rochemont (2009) for more research on the use of external sources and firm performance.

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Appendix

Appendix A: Measurement of performance

Please assess your firm's performance compared with competitors on a scale from 1 "much worse than our competitors" to 7 "much better than our competitors":	
Item	**Literature sources**
Profit growth Return on assets Sales growth Market share growth Cash flow	Wiklund and Shepherd, 2005, Jaworski and Kohli (1993), Reinaetz et al. (2004), Cohen & Malerba (2001)

Appendix B: Measurement of innovation

Please think about the sources of information your organization has used to innovate and assess the level of importance of each of the following sources:	
Item	**Literature sources**
Other organizations within the business group Competitors and other enterprises from the same industry Suppliers of equipment, materials, components or software Clients or customers Consultants Laboratories or R&D companies Universities or other higher education institutes Government research organizations Private research institutes Professional conferences and meetings Professional workshops and seminars	Chen, Chen, & Vanhaverbeke (2011), Laursen & Salter (2006), Murovec & Prodan (2009)

Appendix C: Measurement of competitive environment

Please indicate the degree to which each of the following statements describes your firm's main competitive environment:	
Item	**Literature sources**
Our firm has relatively strong competitors. Competition in our local market is extremely high. Price competition is a hallmark of our local market.	Jaworski & Kohli (1993), Birkinshaw, Hood, & Jonsson (1998)

Appendix D: Measurement of PAC and RAC

Please indicate your level of agreement with the following statements about your organization:	
Item	**Literature sources**
Potential Absorptive Capacity	Jansen, Van Den Bosch, & Volberda (2005), Szulanski (1996)
Acquisition	
Our company observes external sources of new products and technologies in detail.	
Our company frequently scans the environment for new technologies.	
Our company thoroughly observes technological trends.	
Our company has information on the state-of-the-art of external technologies within our industry.	
Our company regularly utilizes new opportunities in new market.	
Our company collects industry information.	
Our employees regularly approach the external environment to acquire technological knowledge.	
Assimilation	
Our company periodically organizes special meetings with external partners to acquire new technologies.	
Our company quickly understands new opportunities in our market (e.g., emerging customer needs).	
Our company quickly analyses and interprets changing market demands (e.g., shifting structure of competition).	
Our company quickly analyses and interprets new technology trends.	
Our employees store technological knowledge for future reference.	
Realized Absorptive Capacity	Jansen et al. (2005), Smith & Tushman (2005), Szulanski (1996)
Transformation	
Our company communicates relevant knowledge across the units of our firm.	
New opportunities to serve our customers with existing technologies are quickly understood.	
Our company regularly matches new technologies with ideas for new products.	
Employees share practical experiences.	
We grasp the opportunities for our firm from new external knowledge.	
Exploitation	
Our company regularly applies technologies in new products.	
Our company considers how to better exploit technologies.	
Our employees have a common language regarding our products and services.	