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Absorptive capacity, innovation, and financial performance

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ABSTRACT

This study here examines the role of absorptive capacity as both a mechanism to identify and translate external knowledge inflows into tangible benefits, as well as a means of achieving superior innovation and time-lagged financial performance. Using path analysis in a sample of 461 Greek enterprises participating in the third Community Innovation Survey, this study demonstrates that external knowledge inflows are directly related to absorptive capacity and indirectly related to innovation. Absorptive capacity contributes, directly and indirectly, to innovation and financial performance but in different time spans. This study, therefore, contributes to the understanding of absorptive capacity's antecedents and outcomes by providing empirical evidence of longitudinal form that offers important research and practical implications.

1. Introduction

In the contemporary knowledge-intensive business environment, firms increasingly depend upon external sources of information to promote innovation and improve their performance (Cassiman and Veugelers, 2002; Morgan and Berthon, 2008). Many of them, however, confront strong difficulties in benefiting from external knowledge flows, even in industries of easy-to-access sources of information (Cassiman and Veugelers, 2006; Escribano et al., 2009). To outweigh such deficiencies, enterprises need to develop their absorptive capacity, that is the "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990: 128). The concept of absorptive capacity (ACAP) is a prominent topic of scientific inquiry (e.g., Camisón and Forés, 2010; Jansen et al., 2005; Zahra and George, 2002). The concept is gradually gaining recognition as a key driver of a firm's competitive advantage (Lichtenthaler, 2009).

Although prior research provides theoretical models to explicate the nature, antecedents, and consequences of ACAP (Lane et al., 2006; Zahra and George, 2002), few empirical studies examine the specificities of these models (Jansen et al., 2005). For instance, evidence is scarce for explaining the role of different sources of external knowledge flows (Grimpe and Sofka, 2009), and, more importantly, whether ACAP intervenes to translate these flows into realized benefits, such as innovation (Todorova and Durisin, 2007). This empirical deficit amplifies considering firms' variation in successfully identifying and utilizing external knowledge inflows (Escribano et al., 2009).

In addition, research on absorptive capacity outcomes still lacks integrative examinations of innovation as well as financial measures of performance, while extant work falls short in exploring the interrelationships between them (Lane et al., 2006). Most studies consider innovation as the only outcome of ACAP, a fact that "stands in marked contrast to Cohen and Levinthal's (1989) and 1990 texts that discuss the general commercial application of acquired knowledge" (Lane et al., 2006: 858). Lastly, pertinent research primarily utilizes technology-intensive research settings. However, in order to enhance ACAP's validity as a construct, scholars should further test and replicate it's basic theoretical assumptions in environments of diverse technological, economic, and cultural conditions (Tsang and Kwan, 1999).

The present study, therefore, aims to address the previously mentioned gaps and add to the literature in three important ways. First, this study investigates the effects of different external knowledge inflows on absorptive capacity, and demonstrates the bridging role of ACAP in generating value out of these inflows. Extant research includes starts at empirically assessing such relations (Abecassis-Moedas and Mahmoud-Jouini, 2008; Escribano et al., 2009; Camisón and Forés, 2010). The current work extends this research by assigning to ACAP the role of the mediator in the relationship between external knowledge inflows and innovation, hence providing an accurate test of this fundamental theoretical proposition of ACAP (Todorova and Durisin, 2007; Zahra and George, 2002).

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Second, contributing to an emerging body of literature on the outcomes of absorptive capacity (e.g., Arbussa and Coenders, 2007; Fosfuri and Tribó, 2008), this research provides a combinative, time-based investigation of innovation as well as financial performance outcomes of ACAP. Using time-lagged financial indicators drawn from a separate database, the present study tests for direct and indirect effects of ACAP on innovation and financial performance, respectively. In this manner the work at hand adopts a research design of a longitudinal form, which offers more valid empirical evidence that illustrates absorptive capacity's role in leading to innovation and, through this, to time-lagged financial advantages. To date, such longitudinal designs are missing from most of research on ACAP (Lane et al., 2006); thus, their implementation in the present study constitutes a significant contribution that improves the understanding of ACAP as a source of competitive advantage.

Finally, this study tests related theory on a large sample of Greek manufacturing and services firms that participated in the third Community Innovation Survey (CIS), which is the official survey on firm innovation activities coordinated by Eurostat for all EU member states. Greek CIS offers an excellent opportunity to extend the study of ACAP and innovation in national contexts of reduced technology intensity, while, at the same time, draw statistical conclusions from a dataset containing detailed (perceptual and objective) information about different firm knowledge and innovation activities measured within the reliable CIS framework.

The remainder of this paper is organized as follows. Section 2 presents the research hypotheses. Section 3 focuses on the empirical study, outlining data and variable measurement, followed by the presentation of results based on the path analysis method. The paper concludes with a discussion of the findings as well as with a number of implications for research and practice.

2. Theoretical background and hypotheses

The primary input of ACAP is external knowledge inflows (Cohen and Levinthal, 1990; Zahra and George, 2002). Several studies document the importance of external knowledge flows for various firm operations, such as strategic decision-making (Cassiman and Veugelers, 2002), innovation success (Love and Roper, 2004), increased novelty of products and services (Landry and Amara, 2002), or higher returns on R&D investments (Nadiri, 1993).

However, what authors identify as external knowledge inflows varies somewhat across studies. For instance, some research focuses on certain types of knowledge such as the transfer of skills and technology (Tsai, 2002), the exchange of business practices (Szulanski, 1996), or the acquisition of tacit knowledge (Kogut and Zander, 1993; Subramaniam and Venkatraman, 2001). Following the work of prominent scholars in the field (i.e., Gupta and Govindarajan, 2000; Schulz, 2001, 2003; Mom et al., 2007), this study adopts a broader perspective on external knowledge inflows to denote the aggregate amount of (tacit and explicit) complementary knowledge—pertaining to several domains such as technology, products, processes, strategies, and markets—that a firm receives or gathers from other persons and/or organizations. Complementary knowledge refers to new external knowledge that is related to and at the same time different from the firm's existing knowledge bases (Lofstrom, 2000). A firm may use different sources to accumulate external knowledge as conceptualized in the present study, including, for instance, suppliers, clients, competitors, universities, other research institutions, specialized journals, conferences and meetings (Von Hippel, 1988).

In order to produce tangible benefits, however, firms need to identify, process, and exploit these external knowledge inflows (Cohen and Levinthal, 1989; Gottfredson et al., 2005). This focus refers exactly to absorptive capacity's role in enabling firms to recognize the value of new external knowledge, acquire, and assimilate this external knowledge in concert with existing knowledge stocks so as to generate commercializable outputs (Todorova and Durisin, 2007; Zahra and George, 2002). Firms, however, may vary in their ability to identify and exploit external knowledge inflows; even those firms belonging to the same sector or experiencing the same amount of knowledge inflows (Escribano et al., 2009). Therefore, absorptive capacity can be a source of gaining increased competitive returns from external knowledge.

2.1. External knowledge inflows, ACAP, and innovation

The exposure of firms to external knowledge within their environment contributes to the quality of decision-making (March and Simon, 1993), extends the array of available resources (Brown and Eisenhardt, 1995), facilitates the development of future capabilities (McGrath et al., 1995), and, ultimately, promotes the level of experiential learning accumulated to manage and generate value from outside information (Fosfuri and Tribó, 2008; Norman, 2004). For example, a firm that consistently creates and sustains close relationships with suppliers of state-of-the-art technology or with specialized research or market institutions is in a better position to readily identify and assimilate new external knowledge (e.g., technological advancements, regulation changes, and customers' preferences) in case it needs it. Cohen and Levinthal (1990) recognize the value of such relationships by postulating that those firms that maintain a broad and active network of external partners will become aware of each other's unique competencies and knowledge, hence increasing their incentive to build absorptive capacity. In a similar fashion, other scholars argue that enterprises systematically participating in knowledge-intensive collaborations are more likely to increase the breadth and depth of their knowledge bases, and thus improve their internal competences and knowledge-processing skills (Van Wijk et al., 2001; Kumar and Nti, 1998).

The complementarity (relatedness and diversity) of the new knowledge acquired from external sources with the firm's existing knowledge or current innovation activities (e.g., complementarity with internal new product development projects or R&D contractual agreements in progress), should further amplify these beneficial effects (Lofstrom, 2000). Research drawing from resource-based theory provide support for this argument, by suggesting that benefits from resource combination (e.g., combining new with existing knowledge) are more likely to occur when based on complementarity rather than similarity (Teece, 1986; Harrisson et al., 2001). When a firm has access to complementary knowledge inflows from various external sources it is more likely to engage in knowledge acquisition, assimilation, and exploitation because of the value and growth opportunities that these inflows could create (Lane and Lubatkin, 1998; Zahra and George, 2002; Abecassis-Moedas and Mahmoud-Jouini, 2008); hence, stimulating the level of its absorptive capacity.

Hypothesis 1. Complementary external knowledge inflows positively relates to a firm's absorptive capacity.

A firm's ACAP is not a goal in itself but can generate important organizational outcomes (Fosfuri and Tribó, 2008). Cohen and Levinthal (1990), for example, relate ACAP to, among others, innovative capabilities and innovation performance. The core rationale is that ACAP promotes the speed, frequency, and magnitude of innovation, which in turn may produce knowledge that becomes part of a firm's future absorptive capacity (Zahra and George, 2002). However, this relationship between ACAP and innovation receives relatively limited empirical attention, thus hindering the testing and practical implications of important theoretical arguments (Fosfuri and Tribó, 2008; Lane et al., 2006). This work focuses specifically on this relation, examining whether absorptive capacity translates into innovation outcomes.

A high level of absorptive capacity facilitates firms to achieve superior innovation performance coupled with first mover advantages,

quick responsiveness to customers, and avoidance of "lock-out effects" and "competency traps" (Hamel, 1991; Zahra and George, 2002). Firms that consistently invest on assimilating and exploiting new external knowledge are more likely to capitalize on changing environmental conditions by generating innovative products and meeting the needs of emerging markets (Chen and Huang, 2009; Jansen et al., 2006; Lichtenthaler, 2009). In a similar vein, Nonaka and Takeuchi (1995) posit that via exchange and combination of newly acquired with existing knowledge, novel ideas and concepts convert into innovation outcomes (e.g., new products and services) that usually vary significantly from the current product portfolio of the enterprise. Through access to complementary external knowledge firms may begin to question and reform the prevailing premises behind existing knowledge (e.g., how they develop their products, what are the key technologies, how they manage people, and how they stimulate creativity), thus expanding their problem-solving repertoire and increasing their ability to exploit and create new knowledge. Reforming well-established norms and practices and enriching problem-solving skills can thus enhance a firm's absorptive capacity towards generating innovation (Smith et al., 2005; Subramaniam and Youndt, 2005; Wu and Shanley, 2009).

Furthermore, ACAP can act as a conduit of transferring knowledge between different organizational units, knowledge that can be instrumental in facilitating a firm's innovation activities (Tsai, 2001). As Hargadon and Sutton (1997) argue, knowledge is imperfectly spread across groups and units in an organization, and ideas or information from one unit can provide innovative input to another if exchanges are made between these units. Accordingly, absorptive capacity may contribute to firms' innovation performance by operating both as a tool for processing new external knowledge, as well as a pathway for transferring the necessary knowledge for cross-organizational innovation activities.

Hypothesis 2. A firm's absorptive capacity relates positively to innovation performance.

This study further posits that absorptive capacity mediates the relationship between external knowledge inflows and firms' innovation performance. This proposition draws from existing models of ACAP (Todorova and Durisin, 2007; Zahra and George, 2002) that typically propose, albeit not empirically testing, that new external knowledge functions as an antecedent of ACAP, which, in turn, impacts innovation performance. Following these frameworks and the points mentioned previously, this study postulates that ACAP enables firms to generate value from, otherwise purposeless, external knowledge flows. In other words, a firm that is not able to identify, assimilate, and apply new external knowledge will not derive any innovation benefit from external knowledge flows. Even the most "ready to use" external knowledge (e.g., acquisition of a prototype, adoption of a new information system) has to go through a process phase in which new knowledge is added, modified and transformed to yield tangible results. Hence, absorptive capacity permits firms to identify more available knowledge flows, as well as to exploit more innovatively a given quantity of acquired external knowledge inflows.

Hypothesis 3. A firm's absorptive capacity mediates the relationship of external knowledge inflows with innovation performance.

2.2. The effects of innovation and ACAP on financial performance

Firms innovate as a means to cope with organizational adaptation, pressures from intense competition, shifting customer demands, and the constant requirement for new and better products and services (Jansen et al., 2006; Prajogo and Ahmed, 2006). Through innovation, firms aim at responding effectively to environmental demands and thereby achieve their goal of maintaining or improving their performance (Damanpour et al., 2009). The success of innovation, however, is not guaranteed. It is quite uncertain whether customers will adopt the new products and services introduced into the market or whether such innovations will yield the sought after return for the company (Baker and Sinkula, 2005). Such concerns could provide an explanation for the somewhat conflicting empirical findings regarding the relationship between innovation and financial measures of performance (Gatignon et al., 2002; Morgan and Berthon, 2008; Walker, 2004).

Despite the debate in the extant literature, recent evidence suggests that a positive link between innovation and financial performance does actually exist. For example, Geroski et al. (1993), in a study related to the innovations introduced by manufacturing firms in the United Kingdom during the period 1945–1983, report a statistically significant positive effect of innovation on profitability. Walker (2004), in a quantitative review of the findings of 30 empirical studies from 1984 to 2003, demonstrates that in most cases innovation positively influences performance. In addition, Jansen et al. (2006) demonstrate that, under different environmental conditions, exploratory and exploitative innovations contribute to profitability-based measures of performance. Others report similar positive effects between disruptive types of innovation and total sales and gross profit margin (Govindarajan and Kopalle, 2006), or between innovation and cash flows and future profitability (Sorescu et al., 2007).

Several theoretical arguments support the positive role of innovation on firms' financial performance. First, due to shifting customer demands and impulsive consumer preferences, organizations that introduce innovative products with advanced features and capabilities, are more likely to remain up to date and achieve higher levels of sales and firm growth (Bayus et al., 2003; Srinivasan et al., 2009). Such companies can also gain first or early mover advantages that have been associated with superior long-term firm profitability (Lieberman and Montgomery, 1988; Roberts and Amit, 2003). Second, innovating firms may realize performance benefits through penetrating further on their existing customer base, especially in those segments of high financial margins or shifting demands, thus offsetting potential costs of targeting and attracting new customers (Bayus et al., 2003). Alternatively, firms with a more long-term orientation can reduce the vulnerability of their cash flows by launching innovative products to new customers (Srinivasan et al., 2009).

Furthermore, by planning and implementing innovation on a continuous basis firms may also benefit indirectly. If a firm consistently, and as a part of its corporate strategy, explores and develops new products and services, then is more likely to recognize and acquire new knowledge that could generate successive rounds of innovation with corresponding financial benefits over time (Cohen and Levinthal, 1990). In other words, through continuous innovation, firms are able to build a set of dynamic capabilities (Eisenhardt and Martin, 2000; Teece et al., 1997) that allows the reconfiguration of their competencies to changing market conditions, hence enhancing the prospect of benefiting from future innovation activities (Damanpour et al., 2009; Roberts and Amit, 2003). Such benefits can create, over time, economic advantages that competitors will find very difficult to achieve (Bayus et al., 2003).

Hypothesis 4. A firm's innovation performance positively relates to financial performance.

This study also asserts that innovation mediates the relationship between absorptive capacity and financial performance. ACAP facilitates the development of new cognitive schemas and the modification of existing organizational practices. Through such changes, firms are better able to pursue new product developments and product line extensions (Kazanjian et al., 2002), which, in turn, can promote financial performance and contribute to the achievement of competitive advantage (Lane et al., 2006; Zahra and George, 2002). As such, the mere processing and assimilation of new knowledge, without the effective introduction and commercialization of specific innovation

outputs, cannot lead to tangible financial results for the organization over time.

Hypothesis 5. Innovation performance mediates the relationship of a firm's ACAP with its financial performance.

Fig. 1 presents the research hypotheses of the study.

3. Methods

3.1. Data

Data were drawn from the third Community Innovation Survey (CIS-3) administered in Greece by the General Secretariat for Research and Technology (GSRT). The CIS, coordinated by Eurostat for all EU member states, offers the most comprehensive dataset on firms' innovation activities (Frenz and Ietto-Gillies, 2009; Schmiedeberg, 2008). CIS covers the majority of manufacturing and services sectors as well as small and large enterprises, and includes a range of direct and self-reported measures of innovation performance and related factors that are particularly relevant to the present study. CIS is also subject to extensive pre and pilot testing in various countries and enterprises, thus increasing its interpretability, reliability and validity (Laursen and Salter, 2006).

For the analysis the sample comprises only of innovating firms, that is firms that have a R&D budget or have performed activities in order to develop new products or processes during the CIS-3 (i.e., from 1998 to 2000) period (for a similar approach see also Arbussa and Coenders, 2007; Cassiman and Veugelers, 2002; Fosfuri and Tribó, 2008; Schmiedeberg, 2008). Consequently, from the initial CIS-3 dataset of 1592 Greek enterprises, and after removing additional cases with missing values, a sample of 461 manufacturing and services firms was finally retained. In order to obtain time-lagged measures of firms' financial performance (from 2000 to 2002), and hence provide a more robust test of Hypotheses 4 and 5, the set of 461 firms was matched with relevant company information collected through the ICAP SA data, a large database containing cross-sectional financial information for most of Greek enterprises. This study also tested whether the cases that were removed for missing values were different, in some observable dimensions (e.g., firm size), from the final sample used. In addition, a Heckman's two-stage selection model was estimated utilizing the full sample (see also Fosfuri and Tribó, 2008; Escribano et al., 2009). The results of these estimations, available upon request, showed that sample selection bias was not a serious issue in the data employed.

3.2. Variable definition and measurement

3.2.1. External knowledge inflows

External knowledge inflows were measured on a four-point scale in which firms rated the importance (1 = *high,* to 4 = *not at all*) of seven different sources of related and diverse information that they used to generate new products/services: suppliers, clients, competitors, universities, other research institutions, specialized journals, conferences and meetings (see also Escribano et al., 2009). Cronbach alpha for this scale was 0.73. For the analysis, the arithmetic mean of the scores on the seven variables capturing the role of the aforementioned sources was computed to create a composite indicator that measures external knowledge inflows.

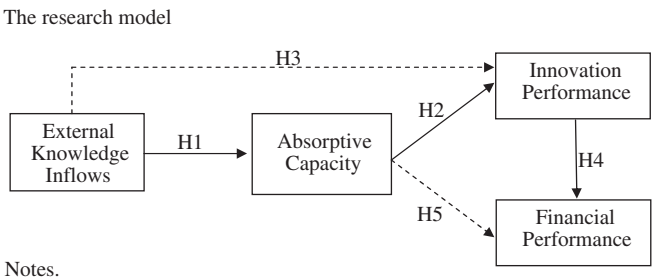


Fig. 1. The research model.

3.2.2. Absorptive capacity

Extant research adopts either a quantitative or a qualitative approach towards measuring absorptive capacity. Several scholars, for instance, utilize quantitative measures of ACAP ranging from total R&D expenditures and R&D intensity (i.e., R&D expenditures divided by sales) (Cohen and Levinthal, 1990; Tsai, 2001) to the number of employees with university education (Grimpe and Sofka, 2009), the proportion of scientific and technical personnel relative to the total number of employees (Spanos and Voudouris, 2009), the amount of investment in scientific and technical training (Mowery and Oxley, 1995), or the fact that the firm has (or not) an operational R&D department (dummy variable; Cassiman and Veugelers, 2002). Conversely, others use qualitative measures (i.e., self reports) that capture different dimensions and processes of ACAP (e.g., Jansen et al., 2005; Lichtenthaler, 2009).

Given this diversity and lack of consensus regarding operationalization of ACAP, this study adopts an integrative approach. In particular, the present work follows the procedure proposed by Escribano et al. (2009) to build an indicator of absorptive capacity that is the principal component of: (1) the firm's total R&D expenditures, (2) the number of employees with bachelor degrees, (3) a dummy that equals to 1 if the firm had consistently performed R&D activities (i.e., development of new technological applications, prototypes or production designs, submission of applications for patents or copyrights) during the period under study (i.e., from 1998 to 2000), and (4) a dummy that equals to 1 if the firm had provided training (i.e., specialized seminars, skills development programs, graduate college courses or workshops) to its R&D personnel during the period under study. This composite proxy has two main advantages. First, it is based on R&D (expenditures, activities, and training) that is considered as a key feature for the conceptualization and measurement of ACAP (Zahra and George, 2002). Indeed, Cohen and Levinthal (1990) in their seminal work argue that R&D is both a source of innovation and a reliable proxy for various capabilities that comprise ACAP (e.g., knowledge acquisition, assimilation, and exploitation). Second, our measure offers a combinative and more objective operationalization of ACAP, which is often regarded as a necessity for an unbiased estimation of absorptive capacity (e.g., Zahra and Hayton, 2008).

3.2.3. Innovation performance

Following Fosfuri and Tribó (2008) and He and Wong (2004), innovation performance was measured as the ratio of the annual sales (for the year 2000) that originated from new or substantially improved products/services introduced over the period 1998–2000 divided by the total annual sales of the company for the same period. For robustness purposes, the analysis was also performed with a different measure of innovation performance, that is, a dummy variable that equals 1 if the firm has introduced a product or process innovation over the period 1998–2000 and 0 otherwise. The results of this analysis are consistent with the findings described in the later part (see Hagedoorn and Cloodt, 2003 for a discussion of the different measures of innovation performance).

3.2.4. Financial performance

Time-lagged indicators of financial performance were utilized to assess, in a more reliable way, the effects of firms' ACAP and innovation. Specifically, two different measures of financial performance were

employed over the period 2000–2002: Return on Sales (ROS) and Return on Assets (ROA). ROS and ROA constitute two of the most popular financial indicators of profitability that firms consider in evaluating their strategic decisions and goals. ROS captures the profitability originating from the total sales, and ROA represents the profitability of the firm with respect to the total assets under its control, that is, the resources that provide the company with its competitive advantage (Barney, 1991). To guard against random fluctuations in the data, both measures were calculated as the average of the annual percentage difference during the financial years 2000–2002.

3.2.5. Control variables

This study includes a number of control variables that may influence a firm's ACAP and innovation performance: firm size, operationalized as the log transformation of the number of employees, firm age, as the log transformation of the number of years in operation, and market type (i.e., 1 = operating in the local/regional market, 2 = operating in the market of a neighbor country, 3 = operating in the national market, 4 = operating in the broad international market). This research also employed two additional control variables capturing the importance (1 = *not at all*, to 4 = *high*) of conditions that hamper innovation performance: Organizational barriers (the arithmetic mean of three items measuring organizational rigidness, lack or specialized personnel, and lack of technological information; Cronbach alpha was 0.75), and economic barriers (the arithmetic mean of three items measuring excessive risk, large sunk investment, and short pocket; Cronbach alpha was 0.79). This study further accounted for previous financial performance by using as control variables the average of the annual percentage difference of ROS (i.e., previous ROS) and ROA (i.e., previous ROA) during the period 1998–2000. Finally, two additional controls were entered for sector and technology-specific sources of heterogeneity in innovation and financial performance. Specifically, a dummy variable (i.e., sector1) was entered distinguishing between manufacturing (coded as 1) and services firms (coded as 0), according to the two-digit NACE-Rev.2 classification (Eurostat, 2008). Another dummy variable (i.e., sector2) was included to distinguish between firms belonging to sectors of low and medium-low technology intensity (coded as 0) and firms belonging to sectors of medium-high and high technology intensity (coded as 1), based on OECD (2003) classification (for a similar approach see Arbussa and Coenders, 2007).

3.3. Statistical technique

Hypotheses were tested with the use of path analysis, a subset of structural equation modeling (SEM) in which only single indicators (i.e., observed variables) are employed, with maximum likelihood robust estimates in EQS 6.1 Structural Equations Program (Bentler, 2004). Robust estimation method corrects for non-normality in the data (Bentler, 2004). Path analysis was particularly appropriate for this study because it permits the simultaneous estimation of multiple causal relationships between one or more independent variables and one or more dependent variables, either continuous or discrete (Kline, 2005; Medsker et al., 1994). However, path analysis, and SEM more generally, may produce unreliable estimates or may not even reach a solution when the sample size is small. The sample of 461 firms clearly exceeded the recommended ratio of five observations per parameter to be estimated, hence providing an appropriate dataset to attain valid statistical conclusions (Bentler and Chou, 1988; Hair et al., 1998; Kline, 2005).

4. Empirical results

Table 1 presents descriptive statistics and inter-correlations. As expected, external knowledge inflows are significantly associated with absorptive capacity, while significant correlations are found for both absorptive capacity-innovation and innovation-financial performance relationships.

The hypothesized path model provides an excellent fit to the data with a non-significant Satorra-Bentler scaled chi-square statistic (Satorra-Bentler scaled χ^2 [d.f. = 55, N = 461] = 58.9, p > 0.30), and with other goodness-of-fit indices also satisfying the recommended criteria (comparative fit index [CFI] = 0.987, non-normed fit index [NNFI] = 0.979, incremental fit index [IFI] = 0.989, normed-χ^2 [χ^2/d.f.] = 1.07, root mean-square error of approximation [RMSEA] = 0.013). Multiple squared correlation coefficients for absorptive capacity, innovation performance, and financial performance are 0.17, 0.09, 0.06 (ROS), and 0.04 (ROA), respectively. Fig. 2 presents the standardized coefficients of the path model.

Path estimates in Fig. 2 provide support for Hypothesis 1, as external knowledge inflows is significantly positively related to absorptive capacity (β = 0.091, p < 0.01). The results also provide support for Hypothesis 2, as absorptive capacity is significantly positively related to firms' innovation performance (β = 0.209, p < 0.01). The path coefficients of innovation performance on the two different time-lagged measures of financial performance (i.e., ROS and ROA) are both positive and significant (β = 0.193, p < 0.01; β = 0.137, p < 0.01; respectively), hence confirming Hypothesis 4.

Hypothesis 3 posits that absorptive capacity mediates the effects of external knowledge inflows on innovation performance, while Hypothesis 5 asserts that innovation holds the role of the mediator in the relationship between absorptive capacity and financial performance. To provide empirical evidence for mediation, this study examines direct and indirect effects in the path analysis tests following the related procedures in EQS that generated standard errors and path coefficients for these effects (see also Hempel et al., 2008; MacKinnon et al., 2002; Zhang et al., 2007). As shown in Fig. 2, the indirect effect of external knowledge inflows on innovation performance is significant (β = 0.042, p < 0.05), while the corresponding direct effect is not. This finding suggests that absorptive capacity fully mediates the relationship of external knowledge inflows with innovation performance, in accordance with Hypothesis 3. In a similar fashion, the indirect effects of absorptive capacity on financial performance measures are significant (β = 0.044, p < 0.05 for ROS; β = 0.032, p < 0.05 for ROA), while the corresponding direct effects are not. This finding indicates that innovation fully mediates the relationship between absorptive capacity and financial performance, hence lending support to Hypothesis 5.

The present study also tests for plausible alternative path models. These include, among others, a model in which knowledge inflows and absorptive capacity are treated only as direct antecedents of innovation and financial performance, respectively. This model demonstrates poor fit to the data (Satorra-Bentler scaled χ^2 [d.f. = 29, N = 142] = 93.75, p < 0.001; CFI = 0.781; RMSEA = 0.07). The proposed path model performs significantly better than all alternative models.

5. Discussion and conclusions

Since the pioneering work of Cohen and Levinthal (1989, 1990), an emerging body of literature is studying the importance of a firm's ability to acquire, assimilate, and generate commercializable outputs from new external knowledge; that is, to develop its absorptive capacity (Lichtenthaler, 2009; Tsai, 2001; Zahra and George, 2002). Despite the proliferation of studies, however, research still lacks empirical comprehension regarding key theoretical assertions on ACAP's antecedent conditions, such as knowledge inflows, and outcomes, such as innovation and financial performance (Lane et al., 2006). The work at hand addresses these deficits by providing strong evidence of absorptive capacity as both a tool to identify and translate external knowledge inflows into tangible benefits, as well as a means to achieve superior innovation and financial results over time. In so doing, this study contributes to the relevant literature and offers some insights to practitioners.

Table 1
Descriptive statistics and inter-correlations ($N = 461$).

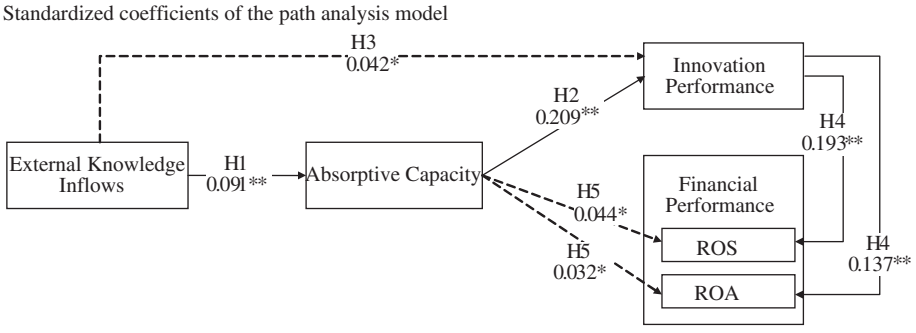
	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Firm size [b]	1.6	0.57													
2. Firm age [b]	0.5	0.25	0.08												
3. Market type	2.8	0.97	0.19**	−0.02											
4. Previous ROS	−0.2	6.34	0.04	−0.03	−0.01										
5. Previous ROA	0.2	5.16	−0.00	−0.03	0.05	0.30**									
6. Sector1 [a]	0.8	0.43	−0.02	−0.12*	0.00	0.05	0.04								
7. Sector2 [a]	0.5	0.50	−0.00	−0.02	0.00	−0.11*	−0.09	−0.36**							
8. Organizational barriers	1.9	0.82	0.01	−0.05	0.01	−0.07	0.003	0.03	0.03						
9. Economic barriers	2.5	1.01	−0.13**	−0.04	−0.08	−0.01	−0.06	−0.01	−0.01	0.38**					
10. External knowledge inflows	2.1	0.62	0.23**	−0.01	0.13**	0.01	−0.06	0.02	−0.07	0.16**	0.13**				
11 Absorptive capacity	0.0	0.59	0.36**	0.03	0.03	0.02	−0.08	0.04	0.13**	0.03	0.03	0.16**			
12. Innovation Performance	0.2	0.27	−0.10*	−0.13**	0.06	−0.08	−0.03	0.04	−0.02	0.05	0.05	0.10*	0.14**		
13. ROS	1.0	13.18	0.06	0.01	0.03	−0.04	−0.04	−0.04	0.05	0.04	0.00	0.07	0.11*	0.18**	
14. ROA	−9.7	20.40	−0.01	−0.05	−0.04	0.04	−0.02	−0.01	0.01	0.02	0.04	0.01	0.08	0.15**	0.18**

[a] Dummy variable.
[b] Logarithm.
* $p<0.05$, ** $p<0.01$.

First, the findings of the study indicate that firms' involvement in innovation collaborations with various outside parties (e.g., suppliers, clients, competitors, and research institutions) enriches their knowledge base and develops a better ability to assimilate and exploit (related and diverse) external knowledge. This result points to the importance of a firm's exposure to complementary external knowledge flows, which recent research proposes as a key type of knowledge for promoting a firm's ACAP (Zahra and George, 2002). Having access to complementary knowledge allows firms to simultaneously take advantage of two critical learning opportunities: gain access to a diverse array of novel knowledge and skills, and develop the abilities to interpret and apply this diverse input via identifying similarities and overlaps with existing knowledge bases. Future research, however, should examine in greater detail the type of knowledge that each external partner contributes and the specific mechanisms through which a firm recognizes similarities and develops cognitive schemata to assimilate and apply this knowledge.

More importantly, and in relation to the previous point, this study offers first empirical evidence that demonstrate the mediating role of absorptive capacity in the relationship between external knowledge flows and innovation. The results of the path analysis clearly suggest that external knowledge inflows advance innovation performance exclusively through ACAP (i.e., a full mediation). This finding refines previous research (e.g., Escribano et al., 2009; Fosfuri and Tribó, 2008) and provides empirical support to one of the key theoretical assumptions of ACAP theory: firms are to derive innovation benefits from new external knowledge only if they will recognize the value of this knowledge, internalize and exploit it (Cohen and Levinthal, 1990; Zahra and George, 2002). Otherwise, enterprises may fall into competence traps (Ahuja and Lampert, 2001) leading them to lose sight of or not being able to grasp the opportunities that new external knowledge offers (e.g., novel competitive products, radical technologies that can transform an industry). Building further on this insight, the study's results also deepen the understanding of cross-firm heterogeneity in profiting from external knowledge flows (Cassiman and Veugelers, 2006); absorptive capacity could explain a substantial part of these variations.

Furthermore, the present work offers a combined examination of innovation as well as financial performance outcomes of ACAP within a longitudinal-type research design. In response to recent calls in the literature (Lane et al., 2006), the present work demonstrates that ACAP contributes directly to innovation and indirectly (i.e., via innovation) to subsequent financial performance. This result confirms the general



Notes. For reasons of simplicity, the control variables and error variances are not shown in this path diagram.
H: Hypotheses.
Dotted lines represent mediation (indirect) effects.
Satorra-Bentler scaled χ^2 (d.f. = 55, N = 461) = 58.9, $p > 0.30$, CFI = 0.987, NNFI = 0.979, IFI = 0.989, normed-χ^2 = 1.07, RMSEA = 0.013.
* $p < 0.05$, ** $p < 0.01$

Fig. 2. Standardized coefficients of the path analysis model.

research consensus that ACAP leads to innovation but, more importantly, further suggests that absorptive capacity can be a source of financial advantage by stimulating innovation benefits over time. With the use of time-lagged financial indicators (i.e., for the period 2000–2002), this study adds validity to this finding and shows that ACAP can enhance different aspects of firm performance in different time spans. Additional tests performed during data analysis clearly indicate that if this research had not utilized time-lagged financial indicators (i.e., measure financial performance with indicators corresponding to the CIS-3 period—from 1998 to 2000) then ACAP and innovation would not have any significant (direct or indirect) impact on financial performance. These analyses performed by substituting in the original path analysis model the time-lagged measures of financial performance (i.e., for the period 2000–2002) with financial measures for the period 1998 to 2000. The financial measures for the period 1998 to 2000 included as control variables to the original path model, showing no significant effect. Therefore, the outcomes of absorptive capacity materialize not only as a straightforward improvement in innovation, but also seem to diffuse and develop into a valuable source of economic advantage over time. In addition, this finding contributes to the ongoing debate regarding the relationship between innovation and performance (e.g., Morgan and Berthon, 2008), revealing that innovation is a complex knowledge-based process that might initially have no (or even negative) effect to firm performance, but across time its effects tend to enhance financial results.

This finding also corroborates the emerging dynamic-capability view of ACAP (Zahra and George, 2002). Dynamic capabilities are "higher-level" capabilities that serve to explain firm success and failure, wealth creation, and competitive advantage over time (Teece, 2007). Absorptive capacity, as the present study reveals, can explain such performance outcomes by acting as a mechanism through which firms can attain innovation and subsequent financial benefits. Therefore, an ongoing investment in absorptive capacity (e.g., increasing R&D expenditures, employing highly qualified and experienced personnel) may result to sustainable performance differences, and provide explanations for those performance differences across firms (Todorova and Durisin, 2007). In addition, by viewing ACAP as a dynamic capability, the present research demonstrates the value of the dynamic capabilities framework in more stable environments (i.e., Greek enterprises); hence, challenging the conventional wisdom that this framework is useful only in dynamic environments.

Elaborating further on the type of external environment, the work at hand also extends the use of the ACAP construct in national contexts characterized as "catching up" in terms of economic growth, technology usage, and overall innovativeness. By utilizing a sample of Greek manufacturing and services firms participating in the third Community Innovation Survey, this study is able to propose alternative modes of improving innovation as well as financial performance, hence informing practitioners and policy makers. Specifically, and since firms' absorptive capacity relates to a country's absorptive capacity (Mowery and Oxley, 1995), a policy planned to develop firms' ACAP may be "very effective in making the country more receptive to international knowledge flows" (Escribano et al., 2009: 104). This is especially the case for Greece that presents, compared to other EU member states, certain inadequacies regarding technology production and access to resources critical for generating innovation (e.g., technology infrastructure, effective networking with state-of-the-art suppliers or research institutions worldwide).

Formulating policies that aim at stimulating firms' absorptive capacity (e.g., facilitating the mobility of scientists, promoting the linkages between producers, suppliers, clients, and research organizations, enhancing the technological skills of employees) can prove an effective means of establishing a cross-industry channel for transferring, diffusing and exploiting external knowledge that, in turn, create conditions for increasing innovation at the national level. If this is further combined with the time-lagged indirect effects of ACAP on financial performance, as evidenced in this study, then such policies may even produce, over time, the necessary economic resources that could finance future knowledge inflows and innovation activities. Consequently, absorptive capacity can act as a valuable complement to the traditional array of policy interventions aiming at enhancing the innovation performance of catching up economies such as Greece. Recent studies provide similar insights by using CIS data in related contexts such as the Czech Republic (Murovec and Prodan, 2009) and Spain (Fosfuri and Tribó, 2008).

Despite its contributions, the present work includes a number of limitations that future research should seek to address. First, some of the data are of self-report nature. Although CIS constitutes a reliable research instrument following various testing phases, the possibility of single-informant and common method bias cannot be completely excluded. However, collecting objective financial performance data from a different source (i.e., ICAP SA database) and in different time spans mitigates such concerns and increases confidence on causality assumptions. Second, the CIS dataset require selectivity on measuring absorptive capacity. Despite the advantages of using multiple knowledge components to structure a composite absorptive capacity indicator, still this metric is a proxy that lacks precision in measuring the subtle qualities of the different dimensions of absorptive capacity. Research using more qualitative measures of ACAP processes (e.g., acquisition, assimilation, transformation, and exploitation; see Jansen et al., 2005) would add to the generalizability of the study's results. Third, this research focuses on a specific national context. Future research can easily test concerns of nationality bias by utilizing CIS data of other European countries. Also, scholars could examine the effects of ACAP on different types of innovation, such as radical and incremental, in order to identify possible differences in those effects. Finally, given that CIS-4 data (i.e., for the period 2000–2002) have recently become available, future research could further apply longitudinal designs to verify the theoretical contention that absorptive capacity develops in a path-dependent process (Todorova and Durisin, 2007: 782). Panel data analysis, for instance, could show whether absorptive capacity leads to innovation and whether innovation subsequently feeds into future absorptive capacity that, in turn, fosters innovation and firm performance at different time periods.

In conclusion, the work at hand demonstrates the value of absorptive capacity as a means of attaining superior innovation and financial performance, and transforming external knowledge inflows into related performance gains. This study, therefore, advances extant literature by testing key theoretical assumptions regarding ACAP's antecedents and outcomes, and informs practitioners engaging in innovation policies.

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