Journal of Business Research xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

# Collaboration with higher education institutions for successful firm innovation

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ARTICLE INFO

*Keywords:*
People-based activities
Problem-solving activities
Open innovation
Absorptive capacity

ABSTRACT

Firms need to open up their boundaries to attain valuable knowledge from external partners because external partners can support their innovation activities by providing knowledge and resources. In this context, higher education institutions (HEIs) are an important source of innovation. Yet, despite the importance of universities, this topic has received scant academic attention. Thus, this research examines the effect of specific activities supported by universities on the innovation outcomes of firms. The study also investigates the moderating role of a firm's absorptive capacity in the relationship between universities' involvement and firm innovation outcomes. The findings show that specific types of HEI activities positively affect a firm's innovation performance, while absorptive capacity has differential effects on the relationships between HEI activities and firm innovation outcomes.

## 1. Introduction

Shorter innovation cycles, the huge cost of research and development (R & D), and a dearth of resources compel firms to search for new innovation sources (Gassmann & Enkel, 2004). Extant research argues that firms need to open up their boundaries to attain valuable knowledge from external partners so that they can extend the innovation function beyond their own walls (Song, Kim, & Kang, 2016). In this context, research identifies universities, or higher education institutions (HEIs), as an important source of innovation (e.g., Lambert, 2003). Indeed, by focusing on technology transfer that underlies the process of the commercialization of science, universities undertake a third mission in addition to their core missions of research and teaching (Etzkowitz, Webster, Gebhardt, & Terra, 2000), benefitting firms by such collaborations. While the risk of opportunism is inherently embedded in relationships with HEIs, the support HEIs provide firms cannot be imitated by competitors because of the novelty and uniqueness of the devised ideas.

Despite the important role of universities, academic research does not devote systematic theoretical attention to the topic. Ironically, in terms of knowledge transfer for firm innovation, research examines university and industry links less frequently than those with other sources (e.g., suppliers, customers) and value them less (Hughes, 2011). Extant research examines collaborations between universities and firms using descriptive analysis (e.g., Laursen & Salter, 2004) and anecdotal evidence (e.g., Cosh & Hughes, 2010; Hughes & Kitson, 2012) but provides little empirical evidence regarding firm performance, such as firm innovation outcomes, when the firms receive support from universities.

While universities can successfully support firm innovation through diverse activities, understanding the specific types of interactions with universities that benefit specific innovation outcomes is important. For example, universities can train employees or conduct joint research with firms and thus provide valuable knowledge for better firm innovation outcomes. Nevertheless, extant studies do not adequately specify the types or form of knowledge transfer supported by universities (e.g., Laursen & Salter, 2004), as they fail to identify the specific activities that influence specific innovation outcomes. Building on prior research (e.g., Hughes, 2011; Hughes & Kitson, 2012), we focus on two types of activities that HEIs undertake when interacting with firms: people-based and problem-solving activities.

The literature defines people-based activities as activities supported by universities, such as conferences and special lectures, with the aim to transfer knowledge to firms (e.g., universities can transfer knowledge by training firm employees). Problem-solving activities are knowledge-exchange activities focused on specific problems a firm faces (e.g., joint research and consulting services). As both activities support successful firm innovations, examining them simultaneously can provide a fine-grained approach to help explain how different types of activities influence diverse firm innovation outcomes. Furthermore, because a firm's learning capability, which involves knowledge transfer, plays a

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http://dx.doi.org/10.1016/j.jbusres.2017.09.033
Received 17 November 2016; Received in revised form 15 September 2017; Accepted 17 September 2017
0148-2963/ Published by Elsevier Inc.

key role in achieving firm innovation (Cohen & Levinthal, 1990), we argue that a firm's absorptive capacity can explain the relationship between supporting activities by universities and firm innovation outcomes. Therefore, this research also examines how a firm's absorptive capacity affects the relationship between HEI involvement and a firm's innovation performance.

Our broad-based investigation makes two key contributions. First, our study is the first to show empirically the differential effects of the two types of HEI activities on firm innovation outcomes. Second, the study shows that a firm's absorptive capacity influences the relationship between HEI-supported activities and a firm's innovation outcomes, an effect that extant literature has hitherto not explored. This finding will help researchers in the field of entrepreneurship and innovation by including the construct of firm absorptive capacity within the nomological network of the HEI–industry research framework.

The remainder of the article proceeds as follows: we develop our hypotheses regarding the impact of HEI activities on a firm's innovation outcomes as it varies across a firm's absorptive capacity. Next, we describe our methodology and data and discuss the results of our analysis. We close with a discussion of implications and future research suggestions.

## 2. Conceptual framework

### 2.1. HEI activities

Many countries support increased interactions between universities and industry in the commercialization of new technology. In practice, several successful collaborations have existed between universities and firms, such as those between Johnson & Johnson and Vanderbilt University, British Petroleum and University of California Berkeley, and IBM and SUNY Albany. Such partnerships underscore the importance of university–industry collaborations in increasing successful firm innovation, achieving new product radicalness, and enhancing the firm's competitive position (Gassmann & Enkel, 2004).

Scholars argue that basic scientific insights achieved through collaboration with universities are more likely to have significant and positive effects on innovative performance in the long run, because universities focus on fundamental and basic research projects (e.g., Laursen & Salter, 2004). Firms gain ideas from external sources such as universities to enhance innovation performance, and their acquisition of novel ideas from universities helps improve their competitive position (Gassmann & Enkel, 2004). Universities can strengthen firms through the utilization of skilled graduates, stronger networks, and research outputs that can be applied in practice (Hughes & Kitson, 2012). In addition, universities are a predominant source of highly creative technologies and information critical to achieving cutting-edge firm innovation (Mateos-Garcia & Sapsed, 2011). Cohen and Levinthal (1990) argue that the knowledge acquired from universities is unique, as it differs from the knowledge acquired from other sources (e.g., suppliers, customer, and competitors), and that it creates firm innovation success. Overall, extant research strongly suggests that the activities of HEIs support successful firm innovation through the transfer of new knowledge, information, and technologies.

As noted previously, universities support two types of activities. First, the most effective form of knowledge transfer in creating successful firm innovation is through the movement of people (Hughes & Kitson, 2012). Universities play a central role in educating people, who can further help in successful firm performance. Those who have earned a degree at a university can create improved new products and process innovations and enhance firm performance further downstream. Knowledge exchange can occur through the transfer of people into the firm's working process and thus help create successful innovation outcomes. Second, universities can provide support for successful firm performance by focusing on problem-solving activities (Hughes & Kitson, 2012). Accordingly, we forward people-based and problem-solving activities as two types of activities that universities undertake when they collaborate with firms, with an aim to create innovation.

### 2.2. Absorptive capacity

Absorptive capacity is a firm's ability to identify, assimilate, and exploit knowledge from the environment (Cohen & Levinthal, 1990). Knowledge acquisition and assimilation capabilities stem from the capture of external knowledge sources, whereas knowledge transformation and exploitation capabilities are a by-product of internal R & D investment. Extant research on absorptive capacity has proliferated because it helps firms link external and internal resources that contribute to their innovation performance, and it provides a unique perspective that can be applied to many popular research areas.

Absorptive capacity links valuable outcomes such as organizational learning and innovation and is influenced by a firm's interactions with its external partners, which play a role in building the firm's knowledge acquisition and assimilation (Cohen & Levinthal, 1990). Furthermore, firms require not only a different internal learning mechanism but also different external collaborative partners to develop radical innovation. Mere acquisition and exploitation of knowledge from external networks cannot guarantee successful firm innovation. To create that, the firm must have a learning capability to process knowledge from the external partners (e.g., HEIs). Therefore, both internal and external capabilities are not sufficient to create a successful firm innovation; a firm must also focus on learning activities to understand how the knowledge taken across HEIs is acquired and transferred to the firm. These activities allow the firm to keep pace with the most promising innovations.

## 3. Hypotheses

### 3.1. The impact of HEIs' activities on firm innovation

People-based activities are the most frequent form of a firm's interaction with universities (Hughes & Kitson, 2012). People-based activities involve the activities firms undertake to increase their business competitiveness. Universities transfer knowledge through people-based activities such as conferences, special lectures, education programs, and social networks, which can affect firm innovation performance. Because people are critical to the discovery of new products and processes, people-focused programs such as training programs help supplement knowledge, leading to specific innovation outcomes. Other people-related activities, such as placing university staff on a firm's board of directors, can also encourage the exchange of knowledge and information and result in cutting-edge product and process innovation. Tether and Tajar (2008) find that firms that participate in professional meetings or conferences held by HEIs have a better chance of surpassing their current innovation performance.

Firms can improve innovation performance by ensuring that their partners support their human assets. Working together with partners helps increase work efficiency, due to improved communication, knowledge sharing, and partners' relative capacity to absorb knowledge for innovation (Koivisto & Mattila, 2012; Phan, Thomas, & Heine, 2011). Furthermore, universities lower barriers to engagement with firms because of a lack of bureaucracy, lower transaction costs, and increased reaction times (Mateos-Garcia & Sapsed, 2011). Therefore, HEIs serve a key role in the transfer of new knowledge through people-based activities, resulting in new products and processes. Thus:

**H1.** A firm's people-based activities with HEIs are positively related to the firm's innovation.

HEIs play a distinct role in affecting firm innovation performance through problem-solving activities. Firms that acquire knowledge from HEIs improve their market position, bestowing upon them a competitive advantage over firms that do not engage in such activities

(Gassmann & Enkel, 2004). For example, while U.S. firms sponsored more than $4 billion worth of university research in 2009 (Kurman, 2011), U.S. universities own nearly one-quarter of patents in the fields of nanotechnology and biotechnology. Thus, firms that collaborate with universities can achieve cutting-edge product and process innovation (Kurman, 2011).

Universities engage in problem-solving activities such as joint research, contract research, consulting services, and informal advice and provide access to specialized instrumentation, equipment or materials, and product prototyping, which have been a long-standing part of the mission of universities to help firms achieve innovation. Such activities with HEIs can help firms increasingly develop their expertise to solve problems in their businesses and are valuable for firms that lack the time and resources to develop such activities internally (Mateos-Garcia & Sapsed, 2011). Extant research suggests that as technologies and new industries become more sophisticated, HEIs' problem-solving activities will play a key role in process innovation (Cosh & Hughes, 2010). Hosting workshops and performing joint research with universities are core problem-solving activities that have helped IBM successfully launch new products into the market (Gassmann & Enkel, 2004). For example, IBM hosts an average of 350 workshops per year and engages in 50–100 ongoing research projects with universities. Thus:

**H2.** A firm's problem-solving activities with HEIs are positively related to the firm's innovation.

### 3.2. The moderating effect of absorptive capacity

In highly competitive environments characterized by rapid churn in technology and customer demands, involvement with HEIs is increasingly important for firms' innovation success, as integrating external sources of knowledge from HEIs can result in major competitive advantages (Rappert, Webster, & Charles, 1999). Because HEIs' people-based and problem-solving activities cannot replace their internal innovation activities, firms undertake a great deal of their own innovation activities. Furthermore, collaboration with other partners does not always provide better innovation performance, because firms may lack the capability to process valuable knowledge from outside partners (Cohen & Levinthal, 1990). Thus, mere acquisition and exploitation of knowledge from HEIs does not guarantee successful innovation.

To create successful innovation, a firm should possess absorptive capacity, that is, the learning capability to process the knowledge acquired from the HEIs into the firm's internal workings. While the effects of successful R & D spillover (i.e., absorptive capacity) depend on the activities of human capital (Keller, 1996), Cohen and Levinthal (1990) argue that firms can increase their absorptive capacity directly, when they send personnel for advanced technical training (i.e., people-based activities). Furthermore, absorptive capacity is a major factor in developing problem-solving skills that enable a firm to develop new knowledge (Kim, 1998). As such, absorptive capacity represents the internal capability to acquire and assimilate outside knowledge into a firm, while HEI involvement is an external resource enhancing a firm's innovation. Therefore, identifying the role of absorptive capacity helps explain the effect of HEIs' people-based and problem-solving activities on firm innovation.

Tether and Tajar (2008) find a positive moderating effect of a firm's absorptive capacity on the positive relationship between an HEI's activities and firm innovation, suggesting that a firm with a high level of absorptive capacity is better able to exploit the knowledge generated from people-based activities in its innovation performance. However, prior research also finds that absorptive capacity affects new product development performance in a non-linear manner (Stock, Greis, & Fischer, 2001) and negatively moderates the relationship between collaboration and firm innovation performance (e.g., Gao, Xu, & Yang, 2008; Nooteboom, Haverbeke, Duysters, Gilsing, & Van Den Oord, 2007). This suggests that absorptive capacity can negatively affect the impact of people-based activities on innovation performance. According to Nooteboom et al. (2007, p. 1028), “a broader scope of technological capability becomes a liability” for absorption that would happen at higher levels of people-based HEI activities, as higher absorptive capacity results in a wider field of competence, which would make it more difficult for innovation partners to understand novel ideas. While people attending conferences or lectures may acquire novel knowledge that can influence a firm's innovation, when a firm has a wider field of competence than normally required, the HEI activities may negatively affect firm innovation outcomes. Thus:

**H3.** The positive effect of a firm's people-based activities with HEIs on the firm's innovation becomes weaker at a higher level of absorptive capacity.

People-based activities supported by universities affect the introduction of new products/processes, radical products, and process innovations. In this research, the term “new product/process radicalness” refers to radical innovations that create major disruptive changes to a market and to the economic activity of firms in that market (e.g., by changing the structure of the market, creating new markets, or rendering existing products obsolete). People-based activities affect innovation performance by improving processes, such as increasing work efficiency from improved communication and knowledge sharing among partners (Lane, Koka, & Pathak, 2006). Furthermore, universities enjoy superior processes in the form of lower barriers to engagement with firms, such as a lack of bureaucracy, lower transaction costs, and speedier reaction times (Mateos-Garcia & Sapsed, 2011).

Absorptive capacity allows firms to recognize more available knowledge as well as to exploit more knowledge to support their innovation outcomes. A firm's absorptive capacity depends on the absorptive capacities of its individual members (Cohen & Levinthal, 1990). As absorptive capacity is a firm's ability to identify, assimilate, and exploit knowledge from the environment (Cohen & Levinthal, 1990), a higher level of absorptive capacity improves the firm's internal capability to acquire and assimilate outside knowledge into the firm. Thus, a higher level of absorptive capacity results in process efficiencies that benefit a firm's innovation outcomes. Prior research suggests that improvements in efficiency in processes have the potential to affect the specific types of innovation outputs that firms can deliver (e.g., Benner & Tushman, 2002). According to the innovation literature, better efficiency and coordination may speed responsiveness, but they may also lead to resistance to change and inadequate or inappropriate responses to changing environments (Leonard-Barton, 1992). As firm absorptive capacity increases, it may facilitate the transfer of incremental learning associated with processes between the university and the firm through people-based activities. Thus, the firm may become more efficient in a set of practices and also more reliable from a reduction in the variation in its performance, directly affecting the firm's incremental innovations (Benner & Tushman, 2002).

A higher level of absorptive capacity can assist in the assimilation and application of efficient organizational routines shared and communicated through people-based activities between firms and universities, resulting in stability and a focus on incremental change (Benner & Tushman, 2002). Therefore, with its influence on how people-based activities affect firm processes, an increase in absorptive capacity will result in a firm's increased focus on continuous innovation and change. This increased focus will likely result in searches for solutions in the neighborhood of existing skills and knowledge and spur innovations that use existing and/or familiar knowledge (Benner & Tushman, 2002), all to the detriment of radical innovations. Thus:

**H4a.** The positive effect of a firm's people-based activities with HEIs on new product radicalness becomes weaker at a higher level of absorptive capacity.

**H4b.** The positive effect of a firm's people-based activities with HEIs on new process radicalness becomes weaker at a higher level of absorptive capacity.

Scholars report that linkages to universities create significant advantage in terms of receiving general assistance with problem solving (Rappert et al., 1999). Similarly, a firm can acquire important technology information through personal contacts in universities. HEIs provide problem-solving activities through informal advice, which is the most frequent form of problem-solving activity affecting firm innovation performance (Cosh & Hughes, 2010). Firms can gain access to knowledge or resources by developing informal links with HEIs and thus are likely to facilitate technological innovation and productivity (Westhead & Storey, 1994). In addition, by giving local entrepreneurs access to research infrastructure, universities can help new and small local businesses make use of equipment at minimal cost. For example, Georgia Tech's Enterprise Innovation Institute allows firms to use the university's resources to help their manufacturing processes. Sharing specialized equipment and providing informal advice to firms are core problem-solving activities that lead to a positive impact on innovation.

Extant literature shows that absorptive capacity positively moderates the effect of external partner involvement on firm innovation performance (e.g., Tether & Tajar, 2008). The impact of a university's problem-solving activities on innovation outcomes may be much stronger for firms with a high level of absorptive capacity and thus help develop new products and processes (Cohen & Levinthal, 1990). This indicates that an HEI's problem-solving activities can positively affect innovation outcomes, and this effect is stronger under a high level of absorptive capacity. Thus:

**H5.** The positive effect of a firm's problem-solving activities with HEIs on firm innovation becomes stronger at a higher level of absorptive capacity.

Firms increasingly rely on external knowledge to enhance their radical innovation outcomes. To achieve radical innovations, a firm should satisfy the market demand faster than its competition; therefore, a faster response to the market is crucial for achieving radical innovations. Although interactions with HEIs may be positively associated with the development of more radical innovations (Tether, 2002), effective processing and usage of the new external knowledge obtained from the HEIs could pose a challenge to achieving a speedy response to the market (Cassiman & Veugelers, 2006). Thus, while problem-solving activities with HEIs may result in radical innovations, the optimal effect may not be achieved because of faster market response requirements in the face of competition. We argue that absorptive capacity helps firms manage this dilemma and strengthen the positive effect of HEI interactions on radical innovations.

A higher level of absorptive capacity in a firm can lead to better acquisition and application of external knowledge to specific innovation-related problems (Cohen & Levinthal, 1990). Because absorptive capacity can lead to the effective transfer of the knowledge gained from HEIs and the effective use of problem-solving skills (Kim, 1998), absorptive capacity can help firms overcome the challenges of using the additional knowledge accrued from the external partner (i.e., university), while enabling them to respond faster than the competition to the market. Therefore, a firm's absorptive capacity strengthens the positive role of problem-solving activities in achieving a firm's radical innovation (e.g., Tether & Tajar, 2008). Thus:

**H6a.** The positive effect of a firm's problem-solving activities with HEIs on new product radicalness becomes stronger at a higher level of absorptive capacity.

**H6b.** The positive effect of a firm's problem-solving activities with HEIs on new process radicalness becomes stronger at a higher level of absorptive capacity.

## 4. Overview of studies

We test the hypotheses presented across two studies. The purpose of Study 1 is to validate our prediction about how HEI activities affect firm innovation performance (H1 and H2). Study 2 expands this initial research frame by validating the moderating effects of a firm's absorptive capacity on firm innovation outcomes (H3 to H6b).

Based on past literature (Hughes, 2011; Hughes & Kitson, 2012), in Study 1 we hypothesize the influence of both people-based activities and problem-solving activities on a firm's innovation. However, in Study 1 we find that people-based activities do not affect the firm innovation. We assume that this is because of a firm's capability to learn and apply outside knowledge into its internal work process, its absorptive capacity. Therefore, we test the role of a firm's absorptive capacity in Study 2. Lane et al. (2006) argue that a firm's absorptive capacity should be viewed at two levels: one at an individual level that explains the function of individual personnel to absorptive external knowledge, and the other at a corporate level to explain corporate characteristics (i.e., structure, culture, etc.) that help absorb knowledge from the environment into its internal process. We conceptualize that the individual level absorptive capacity is related to people-based activities because individual personnel decide a firm's absorptive capacity. However, corporate level absorptive capacity is related to problem-solving activities because a firm's tendency to collaborate with HEIs to resolve problems influences its absorptive capacity. Thus, understanding these interactions can shed light on how the combined effects of HEIs' activities and a firm's absorptive capacity influence a firm's innovation outcomes. Hence, we test the interaction effects between a firm's people-based and problem-solving activities and its absorptive capacity, as related to the firm's innovation outcomes.

### 4.1. Study 1 method

For Study 1, to test H1 and H2, we use data collected from the *Survey of University-Firm Interactions and Innovation*, conducted by the UK Economic and Social Research Council, to develop an understanding of the impacts of higher education institutions (HEIs) on the innovativeness and competitiveness of regional economies. The sampling frame consists of UK Businesses, specifically 2400 firms each from North West and East England, and 1200 firms from Wales. The number of firms in each region was determined using their activity, size and location. In each region, 1% of firms by economic activity contributed to the sample. For each region, a random sample of firms was drawn after stratification by economic activity and size using the FAME (Financial Analysis Made Easy) database. After an initial pilot survey, and the distribution of a total of 6000 questionnaires for the survey, 140 were returned due to wrong address, or because the firms were no longer operational. Overall, 450 questionnaires were gathered, at an 8% response rate. Of these, 79 cases were deleted because they lacked sufficient data to analyze the current model, resulting in 371 respondents as a final sample for Study 1.

#### 4.1.1. Measurement

In this research, people-based activities were measured using the multi-item indicators ($\alpha = 0.71$) used in past research by Hughes (2011), and Hughes and Kitson (2012), through four items that ask respondents about their participation in such activities as having university staff serve on boards of directors, participating in training supported by a university, engaging in personnel exchange programs, and attending university-supported conferences. Problem-solving activities were measured using the multi-item indicators ($\alpha = 0.77$) used in past research by Hughes and Kitson (2012) and Hughes (2011), through four items that ask respondents about their participation in such activities as ad-hoc consultancies, the use of university research facilities, the conductor research projects together, and licensing. We define firm innovation as any type of innovation introduced by the firm,

**Table 1**
Descriptive statistics and correlation matrix for Study 1.

| Mean | | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 1. People-based activities | 0.1051 | 0.4676 | 1.00 | | | | |
| 2. Problem solving activities | 0.1995 | 0.7698 | 0.65** | 1.00 | | | |
| 3. Firm innovation | 0.3144 | 0.7437 | 0.18** | 0.20** | 1.00 | | |
| 4. Firm age | 2.60 | 0.9976 | − 0.01 | − 0.08 | − 0.16** | 1.00 | |
| 5. Firm size | 1.71 | 1.33 | 0.20** | 0.10 | 0.09 | 0.37** | 1.00 |

*$p < 0.05$.
** $p < 0.01$.

including product and/or process innovation. Firm innovation was measured using a single item by asking whether the firm recently introduced any significant new products and/or processes.

We include firm age and firm size as control variables to rule out alternative explanations for the results. We control for firm age because the firm's know-how may lead to a high potential for creating firm innovation (Nooteboom et al., 2007) and use the logarithm the year the firm was founded. We also control for firm size using the logarithm of the number of employees, as past research find a positive effect of firm size on innovation (e.g., Chaney & Devinney, 1992).

#### 4.1.2. Study 1 findings and discussion

Table 1 shows the descriptive statistics along with correlations in Study 1. Additionally, Table 2 shows the results of ordinary least squares (OLS) regression in Study 1, indicating that firm age is negatively associated with firm innovation performance, while firm size positively affects firm innovation.

H1 hypothesizes a positive effect of people-based activities of HEIs on firm innovation. According to the regression coefficients, people-based activities do not have a significant positive impact on firm innovation. Thus, H1 is not supported. H2 hypothesizes that problem-solving activities of HEIs positively affects firm innovation. The result shown in Table 2 indicates that problem-solving activities positively affect firm innovation, supporting H2. In summary, Study 1 provides partial evidence for the positive impact of collaboration between firms and HEIs' on the firms' innovation outcome.

### 4.2. Study 2 method

Study 2 tests H3 to H6b with data collected from the *Cambridge Centre for Business Research Survey of Knowledge Exchange Activity*, conducted by the UK Economic and Social Research Council. The survey includes questions on business performance and innovation, and on how firms perceive interactions with other organizations such as HEIs. The sampling frame for the data comes from the Dun & Bradstreet Marketing database, which includes businesses employing five people or more and covers the whole private sector. To account for the extreme skewness in the size distribution of businesses in the UK, a stratified random sampling approach was used, by oversampling in the larger size classes to produce usable sample sizes in all size ranges. After an initial pilot study, questionnaires were mailed to a total of 25,015 firms in two phases separated by 5 months. Of these, 2530 usable responses were obtained, representing a response rate of 11.3%. A test for response bias that compares respondents with the underlying sampling frame and analysis by response wave showed that the sample is not biased in terms of size since there is no difference between successive waves (Hughes & Kitson, 2012).

**Table 2**
Regression result for Study 1.

| IVs | Firm innovation | | Firm innovation | |
|---|---|---|---|---|
| | Estimate | t | Estimate | t |
| Firm age | − 0.17** | − 3.97 | − 0.16** | − 3.60 |
| Firm size | 0.10** | 3.12 | 0.08** | 2.52 |
| People-based activities | | | 0.08 | 0.77 |
| Problem solving activities | | | 0.13* | 1.99 |
| $R^2$ | 0.05 | | 0.08 | |
| F | 9.46** | | 7.67** | |

* $p < 0.05$.
** $p < 0.01$.

#### 4.2.1. Measurement

People-based activities were measured with the multi-item indicators ($\alpha = 0.83$) used in past research by Hughes and Kitson (2012) and Hughes (2011), through nine items that ask respondents about their participation in such activities as training staff through enrollment on HEI courses or through personnel exchange, supervising in-course student projects, developing joint curricula with HEIs, attending conferences which have HEI participation, attending conferences organized by HEIs, participating in standard-setting forums involving HEIs, participating in networks involving HEIs, sitting on advisory boards of HEIs, and organizing invited lectures.

Problem-solving activities were measured with the multi-item indicators ($\alpha = 0.80$) used in past research by Hughes and Kitson (2012) and Hughes (2011) through eight items that ask respondents about their participation in activities hosting academics on a short- or long-term basis in order to address specific needs of their firms, using personnel secondment to HEIs, engaging in joint research with HEIs, using contract research, participating in research consortia, consulting, seeking informal advice, and using HEIs for prototyping and testing.

Absorptive capacity was measured using R & D expenditures incurred by the firm in the previous three years. Past research (e.g., Cohen & Levinthal, 1990) similarly uses R & D intensity as a measure of absorptive capacity. Firm innovation was measured by asking participants to indicate success of their new products and/or processes with 5-point Likert-type items (1 = completely unsuccessful to 5 = completely successful). New product radicalness was measured by asking if the technologically new or significantly improved manufactured product is totally new to the respondent's firm and to the industry. New process radicalness was measured by asking if the new method to produce and deliver the service product is totally new to the firm and to its industry.

We use competitive intensity, firm age and firm size as control variables in our model. Competitive intensity can affect firm innovation through the aggregate activities' effect on firm innovation. To assess the extent of competition in different areas, we use the item “How many firms do you regard as serious competitors?” and use the logarithm of the number of competitors.

#### 4.2.2. Study 2 findings and discussion

Table 3 shows the descriptive statistics along with correlations in Study 2. Primarily, we employ hierarchical regression analysis to estimate the interaction between HEI activities and absorptive capacity on firm innovation outcomes. We build various models for each set of dependent variables. Model 1 lists both control variables and independent variables and Model 2 lists interaction effects of absorptive capacity and HEI activities on the firm's innovations. Then, we estimate the same models with different dependent variables in Models 3, 4 and Models 5, 6 (Table 4).

H3 hypothesizes that absorptive capacity negatively moderates the effects of people-based activities on a firm's innovation, and H4a and H4b hypothesize that absorptive capacity negatively moderates the effects of people-based activities on a firm's new product and process radicalness.

As Table 4 shows, absorptive capacity moderates the effect of people-based activities and problem-solving activities on the firm's innovation ($p < 0.05$; Columns A and C in Fig. 1). In addition,

**Table 3**
Descriptive statistics and correlation matrix for Study 2.

| Mean | | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. People-based activities | 0.7104 | 1.55 | 1.00 | | | | | | | | |
| 2. Problem solving activities | 0.2988 | 0.9793 | 0.68** | 1.00 | | | | | | | |
| 3. Firm innovation | 2.80 | 1.01 | 0.09 | 0.20* | 1.00 | | | | | | |
| 4. New product radicalness | 1.34 | 0.5793 | 0.20** | 0.22** | 0.01 | 1.00 | | | | | |
| 5. New process radicalness | 1.24 | 0.5191 | 0.20** | 0.14** | − 0.02 | 0.31** | 1.00 | | | | |
| 6. Absorptive capacity | 0.0173 | 0.0717 | 0.21** | 0.20** | 0.01 | 0.15** | 0.10** | 1.00 | | | |
| 7. Firm age | 3.32 | 0.6992 | 0.13** | 0.10** | 0.03 | 0.01 | − 0.03 | − 0.05 | 1.00 | | |
| 8. Firm size | 2.76 | 1.57 | 0.45** | 0.32** | − 0.01 | 0.21** | 0.20** | − 0.05 | 0.31** | 1.00 | |
| 9. Competition | 1.80 | 1.02 | 0.10** | 0.06** | − 0.12 | 0.05* | 0.08** | 0.01 | 0.01 | 0.17** | 1.00 |

* $p < 0.05$.
** $p < 0.01$.

absorptive capacity significantly moderates the effect of people-based activities on new product radicalness ($p < 0.05$, Column B in Fig. 1). Therefore, H3, H4a, and H5 are supported. However, since none of the other hypotheses have significant effects, H4b, H6a and H6b are not supported. In summary, Study 2 provides strong evidence of the influence of a firm's absorptive capacity on the effect of HEI activities and a firm's innovation outcomes.

## 5. General discussion

Lambert (2003) argues that transferring knowledge from HEIs to firms is difficult because of the cultural differences between the two parties. Nevertheless, universities play an increasingly strategic role in stimulating innovation in firms through the transfer of technology. Prior scholarship largely disregards the specific activities HEIs undertake, such as people-based and problem-solving activities. Little attention focuses on how these activities affect firm innovation performance. Our findings lead to important practical implications, in that they help firms identify the specific activities that improve new product or process innovation, resulting in huge cost savings in the innovation process.

### 5.1. Theoretical contributions

Although prior research reports substantial benefits of HEIs for firm innovation, it largely fails to empirically trace such effects. Research attempts to evaluate the impact of such transfer by HEIs (e.g., Laursen & Salter, 2004), but an extensive empirical examination of the role of HEIs in the firm's innovation process is missing. Our research shows that HEIs' specific activities affect firm innovation, suggesting that firms should efficiently manage collaborations with HEIs so that the outcomes benefit both parties.

Our findings show differential effects of HEIs' diverse activities on firm innovation performance. The two studies we report provide evidence that the two types of activities supported by HEIs affect firm innovation outcomes differently. We identify the impacts of these different HEI activities using different innovation outcomes (i.e., the introduction of a new product/process and new product/process radicalness) because each type of activity plays a distinct role in influencing the firm's innovation outcomes. Moreover, we underscore the role of absorptive capacity in this framework. We find that a firm's absorptive capacity has a moderating role in the relationship between HEI collaboration and firm innovation. This finding lends support to the assertion that a proper level of absorptive capacity creates maximum firm innovation outcomes (e.g., Stock et al., 2001). The strategic management literature identifies absorptive capacity as one of the most important resources required to achieve successful innovation. Overall, we confirm the strategic nature of HEIs' diverse activities on firm innovation performance, given a firm's absorptive capacity.

### 5.2. Practical implications

The findings from our analysis have several managerial implications for effective collaboration between HEIs and firms. Firms supported by people-based activities benefit from improved firm innovation outcomes. Furthermore, firms that conduct joint research with HEIs to resolve their problems or use a consulting service have better innovation performance. However, while people-based activities have no

**Table 4**
Regression result for Study 2.

| IVs | Model 1: Firm innovation | | Model 2: Firm innovation | | Model 3: New product radicalness | | Model 4: New product radicalness | | Model 5: New process radicalness | | Model 6: New process radicalness | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estimate | t | Estimate | t | Estimate | t | Estimate | t | Estimate | t | Estimate | t |
| Firm age | − 0.15 | − 0.94 | | | − 0.07** | − 2.24 | | | − 0.12*** | − 4.35 | | |
| Firm size | 0.12* | 1.57 | | | 0.07*** | 5.08 | | | 0.08*** | 6.31 | | |
| Competition | − 0.35*** | − 2.49 | | | 0.01 | 0.12 | | | 0.02 | 1.02 | | |
| People-based activities | − 0.01 | − 0.17 | | | 0.02 | 0.79 | | | 0.03** | 1.99 | | |
| Problem solving activities | 0.15** | 1.95 | | | 0.05** | 2.16 | | | − 0.04** | − 1.86 | | |
| Absorptive capacity | 0.63 | 0.52 | | | 1.33*** | 4.23 | | | 1.50*** | 5.29 | | |
| People * AC | | | − 2.10** | − 2.23 | | | − 0.25** | − 2.11 | | | − 0.07 | − 0.67 |
| Problem * AC | | | 2.69** | 1.79 | | | − 0.32 | − 1.20 | | | 0.29 | 1.18 |
| $R^2$ | 0.16 | | 0.21 | | 0.09 | | 0.11 | | 0.10 | | 0.10 | |
| F | 2.38** | | 2.48*** | | 15.15*** | | 13.61*** | | 16.46*** | | 12.51*** | |

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$ (one-tailed).

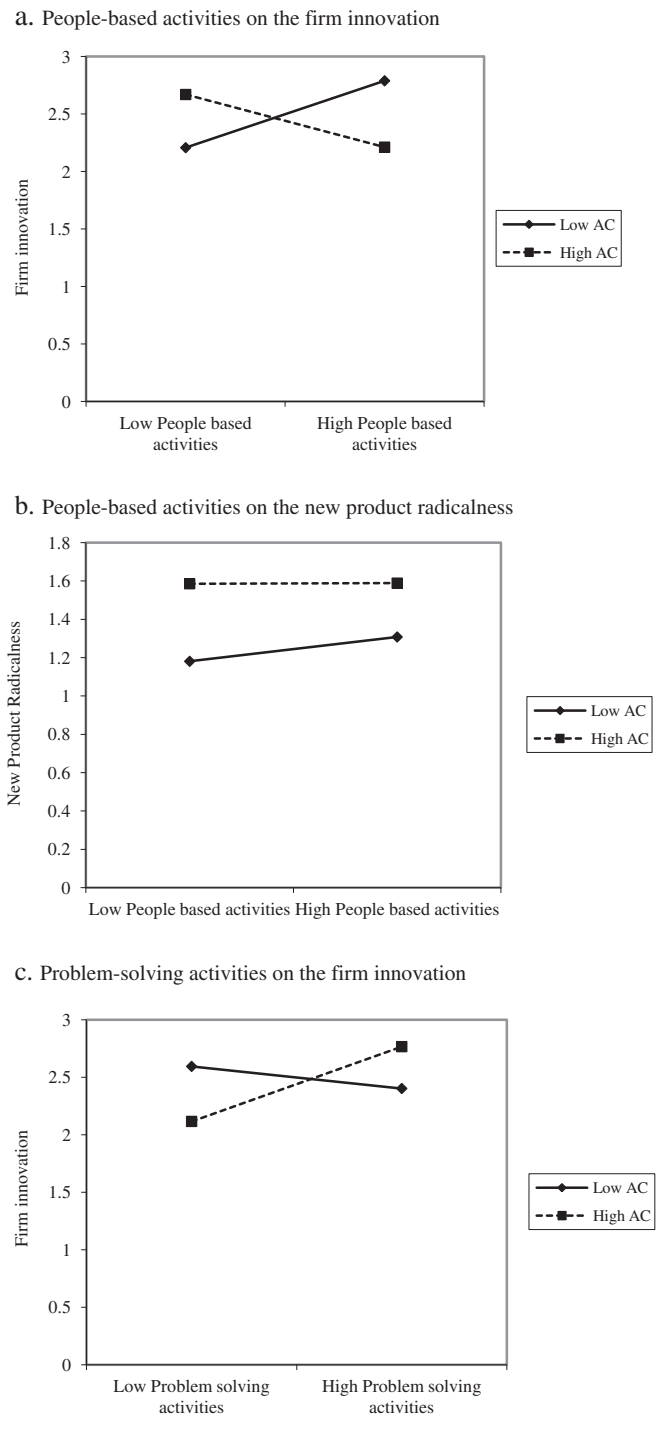


**Fig. 1.** Results of moderating effects of absorptive capacity for Study 2.

effect on firm innovation, problem-solving activities are positively related to firm innovation. If a firm faces a problem that results in losing its market position, it should resolve the problem through a consulting service or a joint project with an HEI, rather than focusing on participation in HEI-sponsored conferences (i.e., people-based activities). Another major problem-solving HEI activity available for firms is using specialized instrumentation, equipment, or materials. Furthermore, as Study 1 measures firm innovation with three-year time windows, people-based activities may help firms achieve long-term innovation outcomes, while problem-solving activities affect short-term innovation outcomes. Therefore, if firms want to achieve successful innovation in the short run, they should focus on problem-solving activities with HEIs.

We find that a firm's absorptive capacity has a moderating effect on the relationship between HEIs' people-based activities and the firm's innovations and new product radicalness. Under a high level of firm absorptive capacity, people-based activities negatively affect firm innovation outcomes. This indicates that high absorptive capacity in a firm may create processes that are too complicated, leading to managerial problems; in turn, such processes may delay innovation decisions in a firm. Knowledge created by people-based activities that is too novel or too diverse may overload a firm because of the limitation in firm absorptive capacity, creating an "attention allocation problem" (Laursen & Salter, 2006). Furthermore, the greater a firm's absorptive capacity and the more it knows, the farther away it must search for novelty (Nooteboom et al., 2007). Sharing valuable resources through people-based activities with HEIs may positively affect new product radicalness. However, high levels of absorptive capacity may negatively affect the relationship between people-based activities and new product radicalness. Too much absorptive capacity may also lead to delayed decision making with regard to radical innovations. Stock et al. (2001) find that only an optimum level of absorptive capacity can create maximum success for new product development. Thus, firms should have an appropriate level of absorptive capacity to ensure radical product and process innovations.

Our results show that absorptive capacity has a positive moderating effect on the relationship between HEIs' problem-solving activities and firm innovation. Seeking informal advice, engaging in joint research, using consulting services, and sharing a university's equipment are core problem-solving activities. By working closely with HEIs through joint research, firms can derive significant benefits and improve their innovation performance. Furthermore, in contrast with people-based activities, problem-solving activities can provide fast feedback and in-depth knowledge transfer to firms.

We find no moderation effect of a firm's absorptive capacity on the impact of people-based and problem-solving activities on new process radicalness. Achieving radical product innovations is easier than achieving radical process innovations because the former is more visible to the external market (Dooley & O'Sullivan, 2008). In addition, because process innovations in general take a long time to be realized, the moderating effect of a firm's absorptive capacity on radical process innovations may be absent.

### 5.3. Limitations and further research

In this research, we demonstrate how HEIs' involvement can affect firm innovation outcomes. However, as with any research, ours has several limitations. First, Tether and Tajar (2008) argue that in addition to absorptive capacity, firms should have networking capabilities and social capital, to gain synergy in firm innovation performance. Absorptive capacity can also affect the relationship between HEI involvement and firm innovation outcomes in other ways. Although we examine the effect of absorptive capacity in our analysis, other specific factors in the internal and external environment may affect the relationship between HEI activities and firm innovation performance (e.g., technology, environmental turbulence). Therefore, future research should further consider environmental contingencies that affect the relationship between HEI involvement and a firm's innovation outcomes. Second, the involvement of competitors may strongly affect a firm's incremental innovation. Therefore, future research should assess different types of involvement (i.e., competitors) on diverse firm innovation performance (i.e., incremental or radical innovation). Third, the measurement of a firm's absorptive capacity with R & D intensity could be a limitation (Lane et al., 2006), as the measure does not capture a firm's learning capability. Extant studies almost exclusively define and measure absorptive capacity focusing on R & D-related activities because of the ease of measuring and acquiring data. However,

this approach may not actually measure absorptive capacity because it treats absorptive capacity as a static resource, not as a process and a dynamic capability (Lane et al., 2006). Future research should measure firms' absorptive capacity using other proxy measurements. Despite these limitations, this research substantially contributes to the innovation research stream by examining the effect of the activities supported by HEIs on firm innovation outcomes and the moderating influence of a firm's absorptive capacity on this relationship.

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