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# Balancing industry collaboration and academic innovation: The contingent role of collaboration-specific attributes☆

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ABSTRACT

This study highlights the effects of industry collaboration in enhancing academic innovation output. We exploit a unique longitudinal dataset on the 110 top U.S. research universities for the last 19 years. Our empirical findings confirm that the relationship between the number of industry collaborations and academic innovation is curvilinear. Moreover, we hypothesized and found that university contribution, collaboration breadth and knowledge capacity moderate the curvilinear relationship between the number of industry collaborations and academic innovation. Poisson, negative binomial and generalized negative binomial regressions are used to test the hypotheses in a panel data of 2090 university-year cases. Our results are robust to the three econometric methods, measures of variety of academic innovation and the findings support our prediction.

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## 1. Research background and purpose

University–industry collaboration has been an important research topic as a means for universities to learn about new technologies and knowledge. Collaboration contributes to cross-fertilization of knowledge and enables the combination of different innovative abilities to create something novel and useful (Wang, 2016). In the U.S., collaboration has been widely viewed as one of the contributors to successful innovation and growth in the past three decades (Hall, 2004).

In today's highly competitive marketplace, the importance of university–industry collaboration in the global innovation economy shows that management scholars have diverse perspectives. Therefore, innovation performance remains an issue of importance throughout the collaborating process. Performance issues have been an enduring research theme in the collaboration literature (Rivera-Huerta et al., 2011). Recent research has emphasized the role of industry collaboration as a conduit for academic innovation to universities. Not only does this research theme focus on industrial firms' knowledge learning or flow from universities, but also on that of innovative knowledge from industrial firms to universities. Universities with industry collaboration have lower scientific research expenses than those that without. Collaboration with firms frequently reflects universities' strategies to integrate dispersed knowledge and/or to develop complementarities with firms' inventors in the production of frontier technology (OECD, 2009).

Owing to university–industry collaboration's increasing importance and difficulties, prior studies have paid attention to the determinants of industry collaboration but the results are inconsistent. Therefore, this study reviews and re-examines the effects of the determinants of collaboration on academic innovation. Two streams of literature point out the different effects of collaborations between universities and industries on academic innovation. Some scholars argue for the benefits of industry collaboration because of the ability to obtain funds for research assistance, lab equipment, and expanding their own research, sharing the risks, testing applications of a theory, and gaining complementary skills and knowledge (e.g. Agrawal & Henderson, 2002; Adams et al., 2005a, b; Azoulay et al., 2009; Breschi et al., 2008; Bruneel et al., 2010; Fabrizio & DiMinin, 2008; Hall, 2004; Heinze et al., 2009; Lee, 1996; Lee, 2000; Lowe & Gonzalez-Brambila, 2007; Perkmann & Walsh, 2009; Rosenberg, 1998; Siegel et al. 2003; Stephan et al., 2007; Stephan, 2012; vanLooy et al., 2006; Zucker & Darby, 2007).

Other scholars, however, attribute the negative impact of industry to broader set of problems, delays or suppression of scientific publication, forms of disclosure and dissemination of preliminary results. Collaboration comes at the expense of basic research, determines the choice of research projects, skews academic research, brings a decline in research quality cross-section integrative efficiency and creates attention problems (e.g. Blumenthal et al., 1996; Czarnitzki et al., 2009; Czarnitzki et al., 2015; Florida & Cohen, 1999; Hicks & Hamilton, 1999; Hottenrott & Lawson, 2014; Meyer-Krahmer & Schmoch, 1998; Nelson, 2004; Ocasio, 1997; Rosenberg & Nelson, 1994; Stern, 2004; Trajtenberg et al., 1994; Toole & Czarnitzki, 2009; Welsh et al., 2008). These arguments imply that the number of industry collaborations is a double-edged sword (Banal-Estanol et al., 2015), and that both positive and negative forces may govern the relationship. Two important strategic questions are as follows. Does collaboration with industry increase or

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decrease academic innovation? Under what conditions do industry collaborations matter to universities' academic innovation?

This paper argues that the relationship between the number of industry collaborations and academic innovation is an inverted U-shape. As a result, academic innovation shall be maximized at intermediate degrees of number of industry collaborations (i.e., the findings support the proposition that though industry collaboration fosters academic innovation at an accelerating rate, it has a curvilinear effect on academic innovation with the number of industry collaborations). In other words, a large number of industry collaborations may impede academic innovation.

In addition, this study contends that researchers' inherent collaboration-specific attributes make them supporters of collaboration. This study focuses on the influence of university–industry collaboration-specific attributes on collaboration strategy. It is a meaningful step in the broader assessment of whether or not such relationships are advantageous. Prior studies have recognized that the influence of university contribution, collaboration breadth and knowledge capacity are easily observable in the industry collaboration decision. In viewing academic innovation as an output of a complex social system, universities that have more contribution, collaboration breadth and knowledge capacity are believed to make good or bad use of it in their strategic collaboration decisions. Building on this idea, this study underscores the different moderating effect to support the selected university's collaborating strategy. We propose that university contribution, collaboration breadth and knowledge capacity have different moderating effects on the number of industry collaborations and the link to academic innovation.

Therefore, this study is based on the idea that the number of industry collaborations affects the main determinants of academic innovation. Our conceptual framework of this study is presented in Fig. 1. The two major research questions that we answer through this conceptual model are the following. Does an increase in the number of industry collaborations enhance academic innovation? What is the role of collaboration-specific attributes (university contribution, collaboration breadth and knowledge capacity) in explaining the relationship between number of industry collaborations and academic innovation? Therefore, the curvilinear relationship (Hypothesis 1) and the moderated relationship (Hypothesis 2, Hypothesis 3 and Hypothesis 4) are hypothesized in this study to focus on the role of collaboration-specific attributes in moderating the curvilinear relationship between number of industry collaborations and academic innovation.

This study tests our proposed hypothesis using the top 110 US universities and the top 200 R&D performing firms from January 1, 1981 to December 31, 1999. Most of the data are drawn from the National Bureau of Economic Research-Rensselaer Scientific Papers Database (Adams & Clemmons, 2008). The rest of the study is structured in the following way. Section 2 considers the literature and sets out the hypotheses of this study. Section 3 presents the methodology for the study, and an overview of the empirical results in Section 4. Finally, conclusion and policy implications are provided in Section 5.

## 2. Literature review and hypotheses

### 2.1. Number of industry collaboration and academic innovation

Industry collaboration is a form of interaction among producers of knowledge, allowing effective communication and exchange; sharing of skills and competencies and resources; working, generation and reporting findings between universities and industrial firms (Ynalvez & Shrum, 2011). In many previous studies, collaboration is conceptualized and measured as co-authorship for academic work. The number of industry collaborations, in academic innovation, is defined as the count of total number of university–industry collaborations. University–industry collaborations point to the crucial role of interaction among researchers as a way to diversify their sources of knowledge. Collaboration with industrial firms can play an important role in the innovation process by giving universities access to a broader pool of resources and knowledge at lower cost; it also offers a way to share the risks with partners.

Collaboration with industry can increase innovation output in at least three ways. First, collaboration can expand academics' research agendas and expand the pool of research ideas (Rosenberg, 1998). Mansfield (1995) shows that a substantial number of publicly sponsored research projects stem from industrial problems encountered in consulting. It helps academics gain new insights for their own research and test the practical application of their theoretical ideas (Lee, 2000). The generation and/or refinement of ideas through puzzle-solving may improve academic outcomes because the resulting ideas can be transformed into more and/or better academic innovation. In particular, industry collaboration might increase the specialization of research, and then increase productive efficiency and effectiveness (Adams et al., 2005a, b). Almeida et al. (2011) find that industry collaborations provide universities with an additional source of knowledge and expertise, and allow insights and access to knowledge from a wider geographical, organizational and scientific spectrum that sets the foundation for further innovation development.

Second, industry collaboration can expand the availability of financial resources. According to Lee (2000), two of the most important reasons for academics to collaborate are to obtain research funds and access to lab equipment. In recent years, industry has been identified as an even more important source of funding for academic research. Private financial support is important in light of progressive declines in direct government funding (OECD, 2009, 2013) and of more competitive research environments (Stephan, 2012). Besides, collaboration on innovation with industrial firms is an important source of knowledge inflows and outflows. It can take a variety of forms with different levels of interaction ranging from simple one-way information flows to highly interactive and formal arrangements. These types of linkages allow universities to access a broader pool of inputs (e.g. information, technologies, human or financial resources) than what is available on their campus (OECD, 2009).

Third, some scholars have found that university participants placed a high priority on obtaining insights into their own research by being able

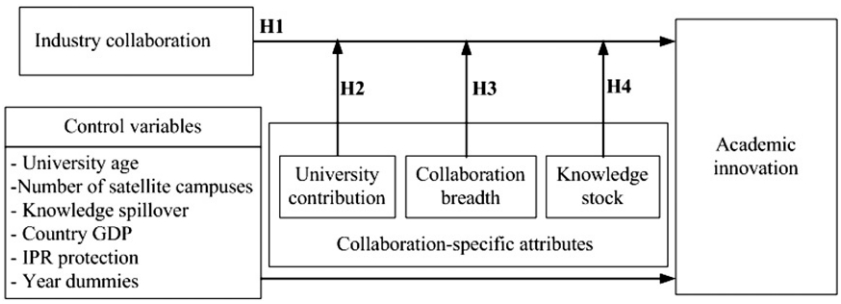


**Fig. 1.** Research framework.

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