
ACCELERATING THE PACE OF INNOVATION THROUGH UNIVERSITY-INDUSTRY COLLABORATION ENHANCEMENT: IN SEARCH OF MUTUAL BENEFITS AND TRUST BUILDING

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ABSTRACT

Given the ever-changing landscape of R&D and the boundaries of science and technology, innovation through partnerships has become unavoidable at both the national and international levels. As a result, the time has come to explore various avenues that foster the growth and success of university-industry collaboration (U-I collaboration). The development of such collaboration is seen as a key issue in a competitive knowledge-based economy (OECD, 2002). This qualitative study contributes to the literature on U-I collaboration management. The results reveal the need to review current collaboration methods and procedures and to consider stakeholder motivations in order to achieve a greater consensus with regard to the sharing and fulfilment of their interests. Furthermore, instilling a stronger climate of trust within U-I collaboration projects will help projects materialize and further the development of innovation ecosystems, the economy and society in general.

Keywords: university-industry collaboration, academic researchers, R&D cooperation, roles of intermediaries, success factors, motivations, trust

1. INTRODUCTION

OCDE countries have seen a significant increase in the number of R&D projects carried out in collaboration with colleges or universities through industry funding (OECD, 2011). These types of partnerships are indeed increasingly common and sought after (Boardman, 2009). Furthermore, in a knowledge-based economy, where scientific and technological pathways (nanotechnology, biotechnology, genomics, etc.) progress very quickly and crossover among disciplines is accentuated (engineering, genetics, computational biology, nutrigenomics, etc.), university-industry R&D projects are deemed to represent the best transfer of knowledge strategies to fuel innovation (Burnside and Witkin, 2008; D’Este and Patel, 2011). Thus, fundamental scientific research, which is usually conducted in university laboratories, can now be more quickly driven toward commercial applications and lead to regional, national or even international innovations.

In recent years, the debate as to whether universities should engage in a third mission focused on economic development, in addition to research and teaching, has received much attention (Johnson, 2008; Lai, 2011; Mueller, 2006; Perkmann and Walsh, 2009). It is generally understood that universities are the fuel that propels knowledge-based economies (Comacchio et al., 2012; Perkmann and Walsh, 2009; Woolgar, 2007). This mission focused on economic development, through collaborations with industry, provides a very significant mechanism to generate economic benefits. R&D interactions between universities and industry, where both parties engage in a collaborative effort, represent the type of link by which the main influence of science on economy is carried out (Morandi, 2011; Mueller, 2006). Several
st States economic development. More systematic of universities, industries aim to increasing significance of U.K., actual property rights, the dissemination of knowledge, issues of confidentiality, locally recognized and valued as part of their academic duties expected results will have to be given to structuring U.R. (Rafferty, 2008; Charles, 2003; Geiger and Sa, 2009; Mowery and Sampat, 2006) institutionalized, and this work will have to be recog

2. 1. 1. questions specifically, we investigated the points of view of academic researchers, industry representatives and University was selected for study based on its involvement in regional e

To that effect, the Faculté des sciences et de génie (FSG – Faculty of Science and Engineering) at Laval University was selected for study based on its involvement in regional economic development. More specifically, we investigated the points of view of academic researchers, industry representatives and governmental agents regarding university-industry collaboration. In particular, the following research questions were examined:

1. How can profitable U-I collaborations that meet the expectations of both parties be established?
2. How can a climate of trust between partners be established in U-I collaborations?

These questions are relevant for three reasons. Firstly, despite the increasing significance of U-I collaborations for the advancement of knowledge, the propulsion of leading edge technology and innovations, the new role of universities as participants in economic development requires further investigation (Bercovitz and Feldman, 2008; Etzkowitz, 2010). Indeed, this role is not always adequately and sufficiently defined by political decision makers, which creates a number of ambiguities for the management of knowledge and obstacles to the creation of profitable U-I collaborations. In other words, if the commercialization of university research is a significant aspect of a knowledge-based economy, new practices that enable academic researchers to dedicate time to those U-I collaborations will have to be institutionalized, and this work will have to be recognized and valued as part of their academic duties (Rafferty, 2008; Charles, 2003; Geiger and Sa, 2009; Mowery and Sampat, 2006). Furthermore, attention will have to be given to structuring U-I collaborations in order for them to be productive and generate expected results (Kyoung-Joo, 2011; Perkmann et al., 2011).
Secondly, the essential importance of U-I collaborations to the development of innovation requires further examination of the mutual benefits that both researchers and industry stakeholders can reap from those collaborations (Azagra-Caro et al., 2006). It is not suggested here that universities become an extension of corporate R&D departments. We must further investigate the motivations that may unite partners from very different worlds. Furthermore, in the context of a knowledge-based economy and in the search for a regional and even national competitive advantage, strategies that facilitate U-I collaborations must be considered. Thus, by examining the very foundations of how productive collaborations are created, a certain reflexive basis is brought to light and, in so doing, underscores a number of significant advantages of U-I collaborations, which could result in even higher numbers of such collaborations, since partners understand their validity and importance and share certain values with regard to their achievement.

Lastly, certain core procedures in the establishment of U-I collaborations may perhaps generate a higher degree of trust between partners. Interventions by intermediary stakeholders with a good understanding of the situation of both parties facilitates communication, in particular by virtue of their roles as filters, validators and legitimizers (Ankrah et al., 2013; Comacchio et al., 2012; Wright et al., 2008; Johnson, 2008). Few studies, however, have focused on this aspect of U-I collaboration (Bjerregaard, 2010).

This article is structured as follows. The section below outlines this study’s key concepts: U-I collaboration, U-I motivations, the respective roles of intermediary organizations and trust, followed by a presentation of our methodology and data collection. Sections 6 and 7 provide an analysis and discussion of the results. The final section presents the conclusions and implications of our study.

2. UNIVERSITY-INDUSTRY COLLABORATION

In a world of extraordinarily rapid developments in technology, firms cannot afford to innovate in a vacuum. As a result, R&D collaborations have become significant development avenues (Spithoven and Knockaert, 2012; Bjerregaard, 2010). We define U-I collaboration as a relationship between a private enterprise and a university characterized by a mutual commitment to achieving a common R&D objective, either by pooling their resources or by coordinating specific research activities. The current complexity of problems and the need for multidisciplinary approaches require an interaction of ideas and an exchange of knowledge. The exchange of information between universities and industries is bi-directional (Barbolla and Corredora, 2009; Lai, 2011). Industry problems and market needs are fundamental to research objectives in the university environment. The results of this research are then directed to firms in the form of solutions that can be implemented for the benefit of the industry and the economy overall. This relationship with firms also provides researchers with a better understanding of how the technology is applied within the market, and with it, new knowledge. Most of the economic benefits derived from university research are generated by inventions developed by the private sector based on scientific and technological advances created by university researchers (Burnside and Witkin, 2008).

The process of transferring knowledge between a university and an industry is carried out through multiple channels (Lai, 2011; Coviello et al., 2011). This transfer of knowledge is defined as the process by which technology and knowledge, developed in a given environment by a university, are adapted and applied to another context to support the development of an innovation to meet the requirements of the firm (Wu, 2010). The three transfer of knowledge channels most often referred to in the literature are collaborative research, research contracts and consultation (Mueller, 2006; Mueller, 2006; Perkmann and Walsh, 2009). Collaborative research studies are formal agreements entered into for the purpose of conducting joint R&D. Such studies are often subsidized through public funds. Research contracts are defined as research studies directly mandated by firms and conducted by a university. Lastly, consultation refers to a service provided by a researcher, on an individual basis, for a firm. Among the various types of instruments used to transfer technology from a university to an industry, collaborative research remains among the most significant (Wu, 2010).

Investments in research and U-I collaborations generate new and innovative products and processes, which in turn result in high returns and a positive impact on the labour market (Perkmann and Walsh,
2009; Morandi, 2011). International competition, changes in and the increasing complexity of technology as well as tight development deadlines and short product life cycles encourage increasing numbers of firms to collaborate with external entities in their R&I efforts (Morandi, 2011). According to a survey conducted by Lee (2000), the most important reasons for collaborating with universities are access to new research and knowledge, the development of new products and a desire to maintain relationships with university researchers. It has been shown that technological SMEs mainly use links with universities to solve problems related to the firm’s essential and core activities, whereas larger firms mainly use those links to develop competencies in other related fields. Thus, a collaboration contract represents a real tool that allows for the transfer of knowledge (Wright et al., 2008). Some authors also claim that the desire to reap profits from their R&D funding also constitutes a motivation for firms (Zukauskaite, 2012). Several countries have government programs that provide funding to firms that collaborate with universities. Furthermore, such collaboration enhances the reputation of a firm in that environment and helps with employee recruitment (Johnson, 2008). Barbolla et Corredera (2010) developed a model that highlights the characteristics sought by firms when transferring technology with a university. The four characteristics they identified are technological maturity, perceived usefulness of the project, the capacity of the firm to incorporate the results into its value chain and confidence in the university team and its results. Other authors stipulate that firms focus on the availability of research resources, the emphasis placed on entrepreneurship and the quality of previous research by the universities to gauge their willingness to collaborate with them (Lai, 2011; Johnson, 2008; Coviello et al., 2011).

From the university point of view, studies have identified the reasons that lead them to agree to enter into a relationship with an industry. Several universities consider access to funding, applicability and commercialization of research, access to skills and industrial facilities and the desire to remain up to date with current problems facing the firm as significant sources of motivation (Theodorakopoulos et al., 2012; Lai, 2011; Morandi, 2011). Other authors indicate that universities are motivated by the desire to find new research ideas and diversified sources of funding (Johnson, 2008; Mueller, 2006). Effective collaboration with industry enhances the reputation of a university, which can help attract new students (Yusuf, 2008). The criteria used by universities to collaborate with firms have been studied by numerous authors (Johnson, 2008; Cosh and Hughes, 2010). These characteristics are the age and size of the firm, industry sector, R&D activities conducted by the firm and its openness to new ideas.

3. THE ROLE OF INTERMEDIARY ORGANIZATIONS

Within innovation ecosystems, intermediary organizations become involved to foster the growth and success of U-I collaborations. These intermediaries may be internal or external to the university (Wright et al., 2008). External organizations may be public, non-profit or private and may take various forms, such as science parks, business incubators, regional development agencies or industrial associations (Comacchio et al., 2012). There is a great diversity of such organizations, which generally work together as their contribution varies according to the role they play (Johnson, 2008; Spithoven and Knockaert, 2012; Yusuf, 2008; Landry et al., 2013).

Through their knowledge of both the academic and industrial environments, mediating intermediaries are in a position to identify, qualify and select collaboration opportunities. Their neutral role enables them to build bridges between two institutional, cultural and social realities (Yusuf, 2008). In light of the needs identified, the intermediaries instill a climate of trust, stimulate the search for solutions via the transfer of knowledge and, in so doing, reduce transaction costs (Ankrah et al., 2013; Kodama, 2008). Their human capital and social skills enable them to amalgamate multidisciplinary teams to coordinate collaborations (Comacchio et al., 2012; Theodorakopoulos et al., 2012; Lai, 2011). Their contribution is of particular benefit to SMEs and low-tech enterprises (Comacchio et al., 2012). Some organizations even become sponsors through financial contributions to the collaboration project (Johnson, 2008).
4. TRUST IN UNIVERSITY-INDUSTRY COLLABORATION

The cultural differences mentioned above between universities and the industry are sometimes the source of obstacles in their exchanges (Kyoung-Joo, 2011; Spithoven and Knockaert, 2012; Theodorakopoulos et al., 2012; Zukauskaite, 2012). These divergent objectives may result in a lack of trust between partners, which may hinder the success of the relationship. The research subject, the timetable, and the way in which the results are revealed often lead to conflict between partners (Ahrweiler et al., 2011; Wu, 2010). Such conflicts occur due to inappropriate partner selection or poorly defined structural governance (Boardman, 2009; Burnside and Witkin, 2008). Since a large number of obstacles found in university-industry agreements are rooted in divergent objectives and the different organizational cultures of both parties, collaborative agreements must be structured and managed adequately in order for them to be productive and yield the expected results (Zukauskaite, 2012; Kyoung-Joo, 2011).

In order for a collaboration project between a university and a firm to be successful, it is important that common principles and clear procedures be established (Spithoven and Knockaert, 2012). This means building an efficient and productive team by clearly defining the roles of each party, establishing fixed deadlines and organizing face-to-face meetings in order to create team cohesion among the members of the university and the firm. It is also essential to come to an agreement regarding expected outcomes and the means to achieve them right from the start of the collaboration (Wu, 2010). Collaborating on R&D projects requires that both parties learn to work with an organization whose reality, structure and mission are different by developing specific operational methods and practices so as to manage expectations regarding results and production and development timeframes (Ahrweiler et al., 2011). These procedures become better developed with experience.

A high degree of trust between two parties helps reduce the fear of opportunistic behaviour (Kyoung-Joo, 2011). Trust allows universities and firms to work together to solve problems (Kodama, 2008). This obviously also shows a willingness to understand and adjust one’s behaviour to align with the needs and expectations of one’s partners. A serious commitment on the part of every team member is also necessary.

In light of the conceptual framework that has been adopted for this study, we have formulated the following proposals.

Proposal 1: Other factors can rally partners in U-I collaborations
Proposal 2: Different structural bases for a new U-I collaboration model

5. METHODOLOGY AND DATA COLLECTION

This study attempts to deepen our understanding of the U-I collaboration phenomenon and, more specifically, the underlying motivations, trust relationships and the role of intermediary organizations. It aims to infer conclusions on the success factors and obstacles to collaborations by answering the following questions:

1. How can profitable U-I collaborations that meet the expectations of both parties be established?
2. How can a climate of trust between partners be established in U-I collaborations?

The research approach used to investigate these research questions was a case study, conducted in compliance with the recommendations of Yin (2009). This approach was deemed the most appropriate to provide a thorough understanding of complex, multi-facetted and little-analyzed processes such as motivational factors, expectations, and the degree of trust between partners in U-I collaboration projects. This type of methodology is also appropriate when searching for answers to "how"-type questions concerning a set of events over which the researcher has little or no control. In this study, a case study is defined as an empirical investigation that (1) investigates a current event in a real context; where (2) the boundaries between the phenomenon and the context are not clearly evident and (3) several sources of evidence are used. Our general analytical strategy is based on theoretical proposals. We thus developed a series of questions, conducted a review of the literature and generated two new research proposals. The analytical technique used focused on drafting an explanation of the case to generate a significant
theoretical contribution. This analytical perspective was selected because, although U-I collaborations are difficult and filled with paradoxes and challenges, great achievements have been realized as a result of such cooperation (Barbolla and Corredera, 2009). In the event that answers to the initial research questions would lead us toward other factors, we attempted to draft a new analysis directed toward our rival research explanations (Proposals 1 and 2), as mentioned above. Our intention was to provide sensitizing concepts, as defined by Blumer (1954) in Bowen (2006): “Whereas definitive concepts provide prescriptions of what to see, sensitizing concepts merely suggest directions along which to look”. According to Bowen (2006), sensitizing concepts may be effective in providing an analytical framework for empirical data and, ultimately, developing a deeper understanding of a given phenomenon. It is essential, however, to move beyond a merely descriptive level into an interpretation and explanation of the themes.

The case under study is an illustration of a network of effective U-I collaborations by the FSG at Laval University. In the Québec City area in the Province of Québec, Canada, Laval University is a true economic engine that is dedicated to its community. Laval University is ranked among the top 10 Canadian research universities by Research Infosource Inc. It employs 1,350 professors and its student body includes nearly 4,300 students registered in 150 graduate research programs, in addition to 400 post-doctoral interns and 700 research professionals. Over the last five years, it has focused its research development on partnerships with the business environment, in particular with firms located in Québec City’s technological park. This strategy has generated an increase of $20 million in research funding and 35% in partnership chairs for a total of $307 million in research funding and 68 partnership chairs, with more than 800 private and public investors.

The FSG distinguishes itself, in particular, through its network of U-I collaborations. A total of 250 professors manage $84 in annual research funds and supervise more than 1,100 graduate students. The Faculty owns 23 active licences covering technology borne of the work of 19 principal researchers and students. With the exception of one licence granted to an external research centre, the licences were granted to 21 private, mostly technological SMEs. It should be noted that several of these licences are the result of a transfer of technology through spin-offs.

In order to allow triangulation to ensure the validity of the study and to obtain a more comprehensive and accurate view of the topic, data were collected from multiple sources of secondary information (university, faculty, intermediate organisation websites, university databases, corporate documentation, media), and semi-structured interviews with academic and institutional actors (industry and governmental representatives). The former were considered as initiators of discoveries and/or innovations and the latter as actors who supported innovation projects. Statements were collected via 60-minute interviews. The interview protocol was based on the review of literature and written material on current and past FSG university-industry collaborations. The data collected in this case study were subsequently used to answer the two research questions.

In order to obtain the point of view of researchers on U-I collaborations, a stratified sample of one professor per department was used, i.e. the professor with the most collaborations with the industry where at least one such collaboration was still valid in the previous 12 months. In total, seven professors, six full professors and one associate professor were interviewed at their offices.

Industry representatives and economic development agents, who were the institutional actors, were targeted as industry opinion leaders. Their position enables them to get opinions from numerous business leaders on R&D collaborations with university researchers on a daily basis. They were selected by non-probabilistic sampling per cluster. In this specific case, the population was composed of all of the organizations identified as active in the high technology value chain in the Québec City area (n=78). From this number, organizations were selected through non-probabilistic sampling by rational selection in order to retain those that were most affected by connections between universities and firms (n=24). In the end, 9 stakeholders from government agencies, valuation agencies, non-profit organizations and entrepreneur associations were met at their offices.
6. UNIVERSITY-INDUSTRY COLLABORATIONS: MOTIVATIONS, SUCCESS FACTORS AND OBSTACLES

This section presents the results of the main factors that have shaped the creation, execution and fulfilment of U-I collaborations at the FSG. The results illustrate the U-I collaborations conducted at the FSG over the last three years and, more specifically, those of the academic respondents. We have noted motivational differences among U-I collaboration partners, but we have also noted a degree of convergence with regard to certain expectations. Lastly, other factors do not foster the growth of U-I collaborations and should be re-examined in terms of their current functional structure.

6.1 COLLABORATION PROJECT DESCRIPTIONS

This study focused on the FSG, in which 5,500 students are enrolled annually, 1,100 of whom are graduate students. The department’s 250 professor-researchers manage $84 million in annual research funding. The Faculty is home to 32 research chairs, 14 centres and institutes, 16 groups and laboratories, 1 excellence centre network and 1 strategic network. Over the last three years, the FSG has obtained 16, 11 and 14 patents respectively.

Table 1 describes the FSG’s U-I collaboration projects carried out since 2013. These contributions are growing both in terms of their numbers and their combined in-kind and monetary value. The number of firms and professors involved in such agreements is also on the increase.

<table>
<thead>
<tr>
<th>Description</th>
<th>2013</th>
<th>2014</th>
<th>2015 (underway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of U-I collaborations</td>
<td>125</td>
<td>145</td>
<td>55</td>
</tr>
<tr>
<td>Collaboration value ($ + in kind)</td>
<td>$8,769,760</td>
<td>$8,958,207</td>
<td>$5,198,982</td>
</tr>
<tr>
<td>No. of firms that funded at least one project</td>
<td>138</td>
<td>147</td>
<td>81</td>
</tr>
<tr>
<td>No. of professors with at least one U-I collaboration project</td>
<td>186</td>
<td>196</td>
<td>114</td>
</tr>
</tbody>
</table>

The FSG is also recognized for the high quality of its U-I collaborations. The Natural Sciences and Engineering Research Council of Canada gives out the annual Synergy Awards for Innovation in recognition of collaborations that serve as models of effective partnership between industry and universities. Winners of this prestigious award receive a $200,000 research subsidy. In 2013, an FSG researcher received the award in the “Large Companies” category, and another FSG researcher received the award in the “Two or More Companies” category in 2014.

The Faculty owns 23 active licences covering technologies borne of the work of 19 principal researchers and students. The most common type is the exclusive licence (70%), far ahead of the user licence (13%) and other types (17%). Other than one licence granted to an external research centre, the licences were granted to 21 private firms, most of which are technology SMEs. Nearly half (10) are located in the Québec City region. It should be noted that several of these licences are the result of a transfer of technology through spin-offs, five firms of which are still active. One of those firms has 1-5 employees, three have between 11 and 25 employees and the fifth employs between 26 and 29 people.

The FSG’s greatest success was the collaboration with the Creaform company, which resulted in the development of its first line of products. This company continues to collaborate with the FSG to this day. It has invested one million dollars over five years for the creation of a research chair on three-dimensional digitization. In 2013, the company was acquired by Ametek, an international manufacturer of electronic instruments and electromechanical devices that currently employs nearly 250 people in the Québec City region.
6.2 MOTIVATIONS OF UNIVERSITY RESEARCHERS

Motivations to collaborate with the industry expressed by the academic respondents were categorized on the basis of the number of times they were mentioned. The main motivation among researchers involved the possibility of conducting research in an industrial environment. This opportunity allows them to find a practical application to their research and deepen their understanding of the field. In a less significant proportion, training and preparing students for the labour market also figured among the motivations expressed by researchers. Research infrastructure funding and fueling their teaching also ranked as motivations equal to personal advancement and surpassing oneself. In a context of scarcity of financial resources, partnerships with private firms are seen as alternatives to traditional funding by granting agencies in order to maintain or buy costly equipment to stay at the cutting edge of technology. As for its impact on teaching, it allows professors to stay on page with industry needs and realities, to give current and concrete examples opening to industrial career perspective. Lastly, personal economic gain provided by research contracts with the industry and meeting personal challenges were also raised as indicators, but in a lesser proportion.

6.3 MOTIVATIONS OF UNIVERSITY RESEARCHERS FROM THE INSTITUTIONAL ACTORS’ POINT OF VIEW

According to the institutional actors, the principal motivation of researchers to establish collaborations is to find a practical application for the research results and better understand the field. Obtaining a financial leverage to conduct their research efforts ranks second among their motivations. In a lesser proportion, gaining visibility for their research is also perceived as a motivation specific to researchers, followed by the desire to create intellectual property that can be transferred to the firm to contribute to economic development. Visibility is particularly obtained through publications either in academic or professional journals. Lastly, the institutional actors view training and personal issues (ego or economic gain) as motivations of lesser importance for researchers.

6.4 MOTIVATIONS OF ENTREPRENEURS FROM THE INSTITUTIONAL ACTORS’ POINT OF VIEW

When asked about the motivations of entrepreneurs to collaborate with university researchers, the institutional actors mentioned the following factors equally most frequently: benefitting from the unique expertise of the researcher, his or her network and infrastructures, lower costs and long-term collaboration possibilities. The cost saving motivation can be explained while compared to consultant fees or the constitution of a specialised team inside the firm, especially when it is a punctual need of expertise. Governments also offer grants as incentives to U-I collaborations. Next in order of importance, access to interns and qualified labour represented real motivations in a context of human resources shortage. In addition, student trainees are perceived as more flexible than full time employees. Lastly, firms are motivated by the competitiveness they can gain through this type of collaboration, as well as the possibility of transferring knowledge to employees once the project ends and the researcher leaves. Understanding an unexplained phenomenon through fundamental research and becoming familiar with the possibilities of joint research are less frequently mentioned motivations.

In the presentation of the most determinative motivations, we noted some striking similarities. Thus, although the principle motivations of researchers and entrepreneurs are different, they are not contradictory. Furthermore, we noted a relative understanding of the incentives on both sides that may facilitate the approach to eventual university-industry collaborations.
6.5 SUCCESS FACTORS IN THE ESTABLISHMENT AND DEPLOYMENT OF UNIVERSITY-INDUSTRY COLLABORATIONS

When asked about the success factors for U-I collaborations, researchers gave the highest ranking to the importance of benefiting from the technical support of professionals who are in a position to deal with the business sector in terms of drafting and preparing the documents related to their collaboration. This success factor was also raised by the firms, as indicated by the institutional actors.

According to the institutional actors’ point of view, seeking collaboration where everybody wins right from the start appears to be a determinative success factor. For firms, such collaboration translates into an equal partner approach where deadlines are determined, methods of functioning and deliverables are clearly defined and a transparent agreement on the sharing of intellectual property is entered into. All of these factors are facilitated by regular coordination meetings to foster mutual understanding of everyone’s interests. For one-third of the researchers interviewed, it is also crucial that expectations and deliverables be clarified from the very beginning.

Another factor deemed determinative by the institutional actors was taking inspiration from best practices to stimulate opportunities and activities that foster closer contact between researchers and entrepreneurs. In addition, streamlining the administrative and decision-making structures stemming from university bureaucracy is a success factor raised in equal proportions by both parties. Developing and maintaining healthy relationships between researchers and entrepreneurs also appears to be a determinative factor in the eyes of researchers. Forentrepreneurs, it is important that researchers be able to benefit from the tools designed to help them tightly manage their projects and budgets and that showcase technological projects be prioritized to stimulate collaboration.

Although the factors mentioned above by the various parties illustrate some differences, we noted some convergence with regard to certain concerns shared by researchers and entrepreneurs about streamlining administrative structures to simplify the deployment of collaboration agreements. Furthermore, better communication that fosters the sharing of visions and the interests of all parties also appears to emerge among the success factors mentioned by both parties. These factors are summarized in Table 2 below.

<table>
<thead>
<tr>
<th>University Researchers</th>
<th>Institutional Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Benefiting from the technical support of professionals capable of dealing with the business sector; preparing and drafting the required documents.</td>
<td>1. Seeking, from the start, a U-I collaboration where everyone wins.</td>
</tr>
<tr>
<td>2. Making sure from the start to clarify expectations, deliverables and contracts.</td>
<td>2. Implementing in-house liaison officers involved with the industry and entrepreneurs.</td>
</tr>
<tr>
<td>3. Ensuring better coordination between the various university authorities to streamline the decision-making process.</td>
<td>3. Creating opportunities that foster closer contact between researchers and entrepreneurs by taking inspiration from best practices.</td>
</tr>
<tr>
<td>4. Developing and maintaining a healthy relationship between the researcher and representatives of the firm.</td>
<td>4. Streamlining administrative procedures; decentralizing the decision-making authority to facilitate collaboration.</td>
</tr>
<tr>
<td></td>
<td>5. Helping researchers to tightly manage projects and respect budgets.</td>
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<tr>
<td></td>
<td>6. Prioritizing and promoting showcase technological projects.</td>
</tr>
</tbody>
</table>

6.6 OBSTACLES TO UNIVERSITY-INDUSTRY COLLABORATIONS

Table 3 clearly indicates that the cumbersome administrative procedures involved in negotiating and managing collaboration contracts is a major obstacle for researchers. According to institutional actors, entrepreneurs believe that universities are not adapted to the industrial environment and that there are two speed lanes – one for universities and another for firms – which are viewed as major irritants. The heavy bureaucracy is also perceived as an obstacle by firms, but to a lesser degree than by researchers.
Both entrepreneurs, as stated by institutional actors, and researchers claim to be equally concerned by the complexity surrounding negotiations of intellectual property rights in a collaboration agreement. In addition, divergent interests between entrepreneurs and researchers with regard to the publication of the collaboration results are a factor perceived as bothersome mainly by firms. In addition, the issue of related fees charged by the university is seen as an obstacle for firms, and researchers also view this aspect as a hindrance in their collaborations. According to the institutional actors surveyed, the lack of technical expertise within the firm may hinder the transfer of knowledge once the collaboration has ended. Furthermore, firms sometimes have difficulty accepting the advice of a researcher. For researchers, coordinating the timing between research and the firm’s strategies is often difficult, which represents an additional irritant.

In brief, we have noted that the contextual differences in which researchers and firms operate give rise to several obstacles and hinder or, at the very least, slow down U-I collaboration.

7. DISCUSSION

7.1 MOTIVATIONS OF UNIVERSITY-INDUSTRY COLLABORATION PARTNERS

The data analysis has revealed that the motivations of U-I collaboration partners are consistent with several theoretical foundations previously reviewed. With regard to university researchers, the data clearly show that access to funding and the applicability of university research are significant sources of motivation (D’Este and Patel, 2007; Loof and Brostrom, 2008; Morandi, 2011). However, other motivational factors of a more intrinsic nature were revealed in this study. In other words, the data suggest that additional factors to those previously indicated in the literature contribute to the success of U-I collaboration, which is relevant to Proposal 1 (Other factors can rally partners in U-I collaborations). It should be mentioned that learning and surpassing oneself, as well as personal challenges (motivational factors mentioned by university researchers) constitute sensitizing concepts that must be taken into account in the U-I collaboration phenomenon. Also, to be considered is the point of view of institutional actors on the motivations of university researchers. Those actors also mentioned two intrinsic motivations: visibility of the researcher and contributions to the development of society. However, it is interesting to
note that the researchers interviewed were long-term veterans of U-I collaborations, and are in fact viewed as success models by their university. Thus, despite the fact that they have acquired a certain degree of experience and success with U-I collaborations, the intrinsic motivations identified remain significant in the establishment and selection of R&D projects with the industry. Fundamentally, it appears that the motivations raised by the FSG researchers to cooperate with the industry are centred around support for their research rather than potential commercialization (D’Este and Patel, 2007). At the very least, this aspect did not clearly emerge from the reported motivations. This may suggest that those elements must be taken into consideration in the structural bases for U-I collaborations (Proposal 2 – Different structural bases for a new U-I collaboration model).

With regard to the motivations of entrepreneurs as reported by the institutional actors, they are similarly corroborated in the review of the literature. The convergent factors revealed in this study and the theoretical elements that were previously identified are the following: the desire to maintain a relationship with university researchers (Lee, 2000); the transfer of knowledge (Wright et al., 2008); cost-sharing and R&D (Perkmann et al., 2011); obtaining leading-edge technology and the quality of the researcher (Barbolla and Corredera, 2009); and easier recruitment of specialized labour (De Fuentes and Dutrenit, 2012). Thus, no new motivational factors were revealed in our results analysis. This therefore confirms the main reasons that lead entrepreneurs to collaborate with university researchers.

Lastly, it may be understood that both U-I collaboration partners share certain motivational factors, such as funding research infrastructures and R&D as well as student training and placement in an industrial context.

7.2 SUCCESS FACTORS AND OBSTACLES IN THE ESTABLISHMENT AND DEPLOYMENT OF UNIVERSITY-INDUSTRY COLLABORATION AGREEMENTS

Firstly, certain elements found in the literature regarding success factors were raised by both the university researchers and the institutional actors during the interviews. The analysis supports the importance of establishing, right from the beginning, a set of common principles, clear procedures and a definition of each partner’s respective roles (Burnside and Witkin, 2008). Respondents were in unanimous agreement on this point. The determination of outcomes to work toward and the various subsequent steps (strict management of the projects and deliverables) are replies we obtained that Barbolla and Corredera (2009) also deemed essential factors for a successful partnership.

Management of the agreements was underscored and must translate into streamlined and simplified administrative and decision-making structures in terms of university bureaucracy and the deployment of collaboration agreements (Kyoung-Joo, 2011). Both categories of respondents made specific reference to simplifying the decision-making processes, administrative procedures and decentralizing decision-making authority in order to facilitate U-I collaborations. As part of an attempt to answer our first research question (how to establish profitable U-I collaborations?), it may be suggested that the current state of the U-I collaboration system fails to meet partner expectations. As a result, this situation also fails to generate a climate of trust between the partners (answer to Question 2). It bears repeating that the results are from interviews with individuals who have experience with U-I collaborations and that they confirmed the theoretical concepts that had previously been identified. This led us to shift our analysis toward our rival explanations, namely, Proposals 1 and 2 (other factors rallying partners and a new model of U-I collaboration). Thus, it may be understood that the success factors identified by the respondents, which are consistent with the literature, suggest that new modalities should be considered in order to increase the number of U-I collaborations and the degree of trust between partners. For example, in the search for sensitizing concepts to explain the U-I collaboration phenomenon, we have witnessed the role intermediary organizations can play in bringing parties closer together in order to foster this type of cooperation (Yusuf, 2008). As neutral stakeholders who are familiar with the motivations of both parties, they may also succeed in reconciling their respective expectations (Ankrah et al., 2013). In so doing, they can also help develop and maintain healthy relationships between researchers and industrial actors, foster opportunities for a rapprochement, and assist in the management and promotion of R&D products (Comacchio et al., 2012). Thus, perhaps the time has come to institutionalize new practices by decentralizing, for instance, the establishment and management of U-I collaboration projects toward intermediary organizations that are neutral and independent from the university and industrial systems.
Secondly, the analysis of the data on obstacles to U-I collaborations is consistent with the key success factors identified. The streamlining of administrative structures and the decision-making process advocated by the respondents as a success factor becomes an identified obstacle when they refer to the cumbersome administration and confusing university system as it applies to the management of U-I collaborations (Kyoung-Joo, 2011). However, another sizeable challenge was corroborated in this study and the review of the literature: managing intellectual property in U-I collaboration. As indicated by Morandi (2013), this is a crucial element that requires particular attention. The possibility exists that a trade/industrial secret be eventually transferred as part of subsequent collaboration with another firm. Faced with this serious issue, firms are obviously justified in finding means to prevent such an occurrence. This issue was in fact raised as a concern on the part of the firms in our study. For their part, researchers essentially perceived intellectual property as an element of negotiation. The fundamental problem, as was initially identified in this study, is that the system that governs the academic world is different from the system that governs industry (Bruneel et al., 2010). On this subject, the OCDE (2002) suggests that countries review the frameworks that govern intellectual property rights. Once again, we have noted that additional factors explain the obstacles to U-I collaborations and the lack of trust between partners (Proposal 1 and Question 2). In its recommendation, the OECD suggests, in particular, that clear rules be established with regard to intellectual property rights stemming from U-I collaborations by providing enough independence to research institutions. A good practice may be to grant intellectual property rights to an effective research organization while ensuring that researchers receive a fair share of the resulting royalties (OECD, 2002). To do so, a specific agreement on the sharing of intellectual property is strongly recommended. Although this is a complex issue that generates a low level of trust in universities on the part of firms, it is crucial that we continue to examine ways in which a consensus among national partners can be reached. Failure to do so could result in an increasing trend toward the creation of agreements with foreign universities (Kramer, 2008), with the negative consequences to be expected in terms of the economy and technological innovation.

In this era of a knowledge-based economy, in which technological innovations are crucial in providing a competitive advantage on both the national and international levels, finding governance mechanisms for U-I collaborations to create winning conditions for cooperation between partners is essential. We have noted that university researchers essentially enter into U-I collaborations to pursue their research efforts and establish their scientific reputation. In other words, despite the recognized importance of commercializing research, the university system continues to function under the auspices of a model that is more or less adapted to this new reality (Bercovitz and Feldman, 2011; Bruneel et al., 2010). For example, university researchers may rest their reputation on the number of publications produced and the amount of research grants they have received. These are in fact the very criteria on the basis of which they will be judged in terms of their contribution to their institution and the future of their academic career. Therefore, if we wish to further develop productive and profitable U-I collaborations, to the satisfaction of all partners and in a climate of trust, the current mode of functioning will need to be revised. It is possible to suggest that intermediary organizations could take the reins from university institutions to implement collaborations under a different mode of governance, where the expectations of each partner are well-defined from the beginning (Proposal 2). This study has revealed that the degree of trust in university researchers on the part of entrepreneurs, according to the point of view of the institutional actors, is very low. This situation is also confirmed in the literature (Howells et al., 2012). Intermediary organizations, acting as guardians of the relationships between universities and industries, could build a base of trust for firms right from the beginning through various means, while taking great care to define the tangible outcomes targeted by the collaboration project, such as joint research papers, joint research publications, doctoral dissertations, patents, patent applications or new products or processes (Santoro and Saparito, 2003). They should also make sure to establish and maintain frequent communications between researchers and industrial partners; communications that inform both parties about progress and results, and that such communications be personalized. Gopalakrishnan and Santoro (2004) have indeed found that trust is the adhesive that binds U-I collaborations and creates a climate that facilitates joint activities and positive outcomes.

Lastly, it should also be noted that, regardless of the fact that a new mode of governance for U-I collaborations appears to be a promising solution for the future, universities will nevertheless be required
to review their incentive systems, which currently do not necessarily foster R&D projects geared toward the production of market-bound innovations (Howells et al., 2012). In other words, if we wish to see increasing numbers of researchers interested in taking part in U-I collaborations, an appropriate incentive system in which intrinsic and extrinsic motivations are taken into account, whether in terms of the researchers’ reputation, their visibility, monetary incentives, career advancement or a vocation as an academic entrepreneur and partner in the economic development of their region and country will be required.

8. CONCLUSIONS AND IMPLICATIONS

This study provided an opportunity to conduct interviews with researchers and industry professionals to gain perspective on the convergence and divergence of various points of view concerning motivations, obstacles and the success factors of U-I collaboration as presented above.

University-industry partners share motivational factors, namely, research funding and infrastructures, as well as student training. In addition, university researchers’ motivations include access to funding, applicability of research, learning, surpassing oneself, personal challenges, visibility, and contributing to the development of society. Enhanced university incentives and recognition systems would further stimulate researchers’ interest. As for entrepreneurs, they wish to maintain a relationship with university researchers, have access to high-quality research and leading-edge technology through the transfer of knowledge, share R&D costs, and recruit specialized labour more easily.

Elements from the literature were raised to highlight the determinative actions that must be included in future collaborations so as to foster profitable researcher-industry partnerships in a climate of trust. Firstly, future collaborations must allow for an initial contact between researchers and entrepreneurs, given that the latter have little knowledge of the available research expertise in most cases. Simplified university administrative procedures that aim to streamline the negotiation process and the establishment of contracts between researchers and industry are required. This will help in preventing this obstacle from growing in scale. Future collaborations must foster the sharing and convergence of interests by implementing methods that enable healthy understanding. Promoting communication before and during the collaboration project is also necessary. Lastly, future collaborations must provide for professional accompaniment in the project’s management and budgetary supervision, essentially for the benefit of researchers. Intermediary organizations are therefore called upon to play a more prominent role in light of their neutrality to guide stakeholders through their initial contact, expose their mutual expectations, define the project’s targeted outcomes, reach a consensus for the sharing of intellectual property, and manage their innovation project, particularly by ensuring that information is shared on a regular basis between partners.

This study’s limitations with regard to its context and data collection method pave the way for future research. A multi-site or even multi-country study with a larger sample of professors, entrepreneurs and intermediaries, in particular by conducting a survey, could provide statistical generalization of this study’s conclusions. An examination of the networks that exist within targeted regional ecosystems could provide an assessment of the impact of the position of researchers on the degree of trust the industry harbours toward them. Conversely, by analyzing past links between entrepreneurs and academic researchers, the influence of the degree of trust on the part of researchers could be measured. Further refinement of the statements on the basis of collaboration types, their scope in terms of value and the number of researchers involved, as well as the size of the industrial partner, would expand our knowledge of such relationships.

This study has shed light on the opinions and needs of both researchers and industry. Knowledge about the respective motivations and selection criteria could enable both parties to assert themselves and establish connections with each other and thus better manage the relationship on the basis of mutual expectations. The results should enable teaching establishments that would like to see their researchers
develop collaborations with industry to identify new valuation approaches to encourage such initiatives. Furthermore, depending on their organizational context, certain anticipated obstacles can be avoided. By applying the suggested methods and procedures, an increase in successful transfer of knowledge through university-industry collaborations will enhance the new role of universities in economic development. Intermediary organizations can also take inspiration from these results as they implement their training and networking activities to expand the number of contacts between the academic and industrial worlds in order to promote the benefits and growth of such collaborations. A new business model for such organizations appears to be emerging in response to a need expressed by both parties, thereby allowing these organizations to play a more prominent role in the ecosystem. The support of policy makers toward such initiatives will play a decisive role in the enhancement strategies of U-I collaborations to reach the goal of developing a regional and national competitive advantage. Armed with the knowledge of the conditions that are favourable to successful university-industry collaboration, all actors within the innovation ecosystems can work together to promote the socio-economic development of their territory.

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