Knowledge ecosystems and business innovation: an exploratory study of the channels of collaborations and key success factors between universities and Canadian small businesses

Introduction

The literature highlights the advantages of geographic co-location hotspots of universities with innovation processes (Clarysse et al., 2014; Link and Scott, 2003; Van Looy et al., 2003). These hotspots are referred to as knowledge ecosystems where local universities play a central role in advancing innovation. The main advantages of geographic co-location identified in the literature include the continuous flow of knowledge between and among enterprises and the mobility of personnel. However, to date, it is not clear what knowledge ecosystems factors drive success in innovation. Also not clear are the elements modelling effective business and university relationships. Not surprising, specific to business innovation collaboration channels, scholars are calling into question the networks and modes of engagement between universities and businesses, i.e., they are asking what and how contextual factors within university-firm collaboration relationships contribute to success in business innovation? Hence, in this study by focussing on the characteristics underlining successful knowledge ecosystems, we explore and identify the vehicles of university–firm collaboration and contextual relationships within the knowledge ecosystem which impacts upon success innovations among small and mediums sized enterprises (SMEs) in Canada.

Researchers have long established the importance of external knowledge sources to firm-level innovation. There is great awareness that innovation often requires novelty of sources. The knowledge based view on innovation, for instance, emphasizes “the interactive processes through which knowledge is created and exchanged both within and outside firms and other organisations” (OECD, 2005, p. 29). Also highlighted in most studies, is the importance of multiple channels of collaboration, citing that exposure to dissimilar, complementary bodies of knowledge actuate new ideas and creativity (Boschma, 2005). A number of studies have thus explored channels of collaboration, including university-industry collaboration and channels of knowledge transfer and creation. However, despite the abundance of studies around the channels of knowledge transfer and the factors that facilitate university-industry collaboration, it is still unclear how they contribute to the SMEs innovation processes. The aim of this research is to contribute to the existing literature in identifying the channels through which universities can contribute to innovation in small businesses and the factors that enhance university-SME collaboration.

We seek to make several contributions related to knowledge ecosystems and business innovation. First, we conceptualize university-firm collaboration and the knowledge ecosystems contextual factors that drive success in SMEs innovation. This theorization focusses on explaining the channel elements and contextual factors underscoring SME-university collaboration and provide a solid framework for SME knowledge ecosystems and innovation success. Second, we expand current notions of university-industry collaboration beyond processes of knowledge transfer or commercialization of academic research to include benefits to firm level innovation processes, a topic that is gaining in currency. To our knowledge, most of the research on university-industry collaboration has focused on exploring the process of knowledge transfer or commercialization of academic research through patenting, licensing and university spin-offs. In this paper, we adopt a different approach by investigating the channels of collaboration through the lens of the knowledge ecosystem in relation to their benefits to the SME innovation process. Specifically, we evaluate their contribution to the three main steps of the SME innovation process: 1) New ideas leading to a new product/service concept, 2) Collaborative research and development (R&D), and 3) Commercialization of newly developed products/services.

Third, we bring to the literature on business innovation a deeper understanding on innovation in SMEs. Much of the work in the area of university-firm collaboration and knowledge transfer has focused on large firms. Thus, although there is evidence that firms may get access to new sources of innovation ideas and see a positive impact on their R&D project when collaborating with universities, specific to SMEs, it
is still unclear. Moreover, as the OECD (2005) aptly concluded, “while R&D plays a vital role in the innovation process, much innovation activity is not R&D-based, yet relies on highly skilled workers, on interactions with other firms and public research institutions, and on an organisational structure that is conducive to learning and exploiting knowledge” (p. 28). We still know surprisingly little about the mechanisms and characteristics of channels of knowledge transfer and knowledge exploitation, as well as complementarities across channels in SMEs. Further, we did not find any specific work explaining how university-industry collaboration can be beneficial to SMEs for the commercialization of SMEs new products. Our research, thus, recognizes the importance of innovation in SMEs, including services and low-technology manufacturing firms. In short, research that investigates the channels together with the key ecosystem contextual factors that positively impact the SME innovation process is therefore long overdue.

To date, the complete literature on knowledge ecosystems and business innovation as it pertains to the three main steps of the innovation processes has not been reviewed in a single study. No summary of the current evidence regarding university-firm collaboration and factors of success in innovation in relation to Canadian SMEs is available. With these gaps in mind, our study methodology takes a unique approach, which we believe contributes significantly to understanding university-firm collaboration and the knowledge ecosystems contextual factors that drive success in innovation in SMEs. It first begins by following the meta-synthesis approach (Sandelski and Barroso, 2007), to examine, compare, interpret, convert and combine knowledge ecosystems, knowledge transfer, collaborative R&D, and commercialization of newly developed products’ current evidence base for university–firm collaboration and SMEs innovation in the Canadian context. This establishes the breadth of attributes based on legacy research, contributing to the development of a unified coherent framework. The review, which is reported in this paper, thus provides a solid foundation for the future stages of our work.

We aim to develop an empirically tested framework for SME knowledge ecosystems and innovation success. Our framework, coupled with suitable measures and activity definitions, will allow universities, SMEs, policy makers, and scholars to obtain a clearer understanding of how to leverage on university-firm collaboration for business innovation. Specifically, our study advances knowledge of the elements modelling effective business and university relationships in the Canadian context. Canada is recognized internationally for its quantity and quality of scientific research. Among Canadians, it is well understood that collaboration between universities and businesses fuels innovation and economic growth. Thus, there is increasing focus among Canadian stakeholder communities on mapping out strategies to strengthen university-firm collaboration and boost innovation. In addition, as of December 2015, 99.7% of employer businesses in Canada were SMEs (Government of Canada, 2016). Hence, we consider an in-depth investigation of University-SMEs collaboration, knowledge ecosystems and SMEs innovation processes as crucial to better understanding the broader Canadian knowledge ecosystem and innovation spectrum. In particular, the results of our research will contribute to the existing knowledge on SME innovation management and may help to formulate public policies that foster university-SME collaboration and the creation of successful knowledge hubs on the Canadian landscape.

Our research progresses in stages that include: (1) systemic reviewing of the literature (2) survey of Canadian SMEs and (3) interviews of a sample of universities and SMEs actors. This paper presents the results of the first stage of our research, the systemic review. Following, we present the background of our research, followed by the research methodology, synthesizing of findings, discussion and conclusion.

Background

University-Firm Channels of Collaboration
Multiple channels of collaborations have been identified in previous studies. Some studies have investigated the channels of collaboration by grouping them into formal collaborations and informal collaborations depending on the channels used to transfer knowledge from universities to firms. Knowledge transmitted through publications, articles, conferences or informal discussions are considered as informal channels of collaborations. In contrast, knowledge transmitted through patents, research contracts and employment of university researchers, student placements are considered as formal channels of collaboration. There is mixed evidence in the literature about the importance of the informal channels over the formal one. For instance, Monjon (2003), using the same categorization of the channels of collaboration, finds that highly innovative firms engage in formal collaboration with domestic and foreign universities since it provides more benefits to the innovation process. In contrast, another study by Cohen and al. (2002), using the Carnegie Mellon Survey on Industrial Research and Development, finds that informal channels such as published paper and reports, conferences, meetings, informal information exchange and formal channel such as consulting are keys channels for universities to have an impact on industrial research and development (R&D).

However, the impact on R&D of these channels is greater for large firms than start-ups in high-tech industries. The same study also provided evidence that the impact on firm R&D depends on the industrial sector and the research field. As such, research in engineering and applied science fields seem to have a greater impact on industrial R&D. Bekkers and Bodas Freitas (2008) surveyed industrial and university researchers that perform R&D tasks and found that the impact of the channels is not related to the industrial sector but instead to the basic characteristics of the knowledge, the discipline, the characteristics of the researcher and his organization. Therefore, we can expect that SME that are involved in collaborative R&D project with engineering and applied sciences researchers are more likely to innovate whether they use formal or informal channels of collaboration.

Another group of studies have focused on the factors that can facilitate or impede university-industry collaboration. For instance, D’Este and Patel (2007) find that the intensity of collaborative research with firms depends more on the individual characteristics of the researcher than institutional characteristics (i.e. department or universities). Among the individual characteristics, seniority is a factor that explains why some researchers are more engaged in collaborative research with firms than others. As such, young researchers are found to be more involved in university-industry partnership. This finding has also been confirmed by Ambos and al. (2008), in their study of the tensions between academic and commercially-oriented activities, which provided evidence that ambidextrous junior faculty researchers with excellent research abilities are more comfortable with the conflicting demands of academia and industry. Therefore, it is reasonable to expect that SMEs involved in university-industry R&D projects with a junior faculty researcher as principal investigator, are more likely to innovate.

Nevertheless, institutional factors can affect the channels of collaboration especially interactions between firms and researchers. Lee (1996) surveyed 1000 US faculty members at research-intensive universities and found that institutional factors such as institutional policies and institutional infrastructures can refrain researchers from engaging in collaborative projects with firms. Their motivation will depend on whether or not their universities institutional policies value this type of research for career advancement and the university has proper structures such as technology transfer offices and proper incentives such as acceptable intellectual property policies. Therefore, we can expect that SME engaged in collaborative projects will more likely to innovate if the principal investigator is comfortable with the university’s institutional policies and infrastructures.

**Knowledge Ecosystems and Innovation**

In this study we view knowledge ecosystems as complex systems defined by both the structures of, and relationships between interacting actors with the main focus being the creation of new knowledge and
technologies through joint research work, collaboration, or the development of knowledge base (Valkokari, 2015). Accordingly, in line with Quin et al. (1998) we consider the main outcome of a knowledge ecosystem as new knowledge, and this outcome as shaped by the networks of actor nodes where the knowledge is created and retained. The relationships between the actors play a central role and underscores the flow, exploration, and exploitation of data, information and knowledge for value creation. Table 1 summarizes some of the key characteristics of the knowledge ecosystem as defined by their outcomes, interactions, actor roles, and logic of action.

Table 1. Characteristics of knowledge ecosystems

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>Baseline of Ecosystem</th>
<th>Relationships and Connectivity</th>
<th>Actors and Roles</th>
<th>Logic of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge exploration and new knowledge creation</td>
<td>Decentralized and disturbed knowledge nodes, synergies through knowledge exchange</td>
<td>Universities, SME entrepreneurs serve as knowledge nodes</td>
<td>A large number of actors that are grouped around knowledge exchange or a central non-proprietary resource for the benefit of all actors</td>
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Source: Adapted from Valkokari, 2015.

It is well accepted that universities are an important source of new knowledge and thus considered key actors in the knowledge ecosystem. As noted above multiple channels of university-firm collaborations have been identified in previous studies. What is not clearly understood is how firms in general, and SMEs in particular, acquire and utilize this knowledge. There is a growing literature exploring the characteristics of the firm that influence its ability to utilize externally generated new knowledge, such as that which is transferred from universities (Agrawal, 2001). However, a number of researchers point to the need for further empirical research that examines the impact of various contextual factors in the creation of effective university-firm collaboration (Agrawal, 2001; Perkmann and Walsh, 2007). In fact, research that contributes to a deeper understanding of the factors and channels of collaboration, and how knowledge is transferred to the development of innovation would offer a worthy contribution to the work in this area.

The literature defines innovation in a variety ways depending on whether the focus is on the organization or the geographic location and the environment of the organization. Our focus is on the organizational level and more specifically on SMEs. We therefore define innovation broadly as:

‘the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (…) A common feature of an innovation is that it must have been implemented. A new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organisational methods are implemented when they are brought into actual use in the firm’s operations.’ (OECD, 2005, p. 46-47),

In today’s knowledge economy defined by rapid advances in technology and information flows, knowledge is more and more viewed as a central driver of innovation (OECD, 2005). Pertinent to our research, is the view that innovation is an “integrating mechanism between the exploration of new knowledge and its exploitation for value co-creation” (Valkokari, 2015). New models of innovation have established that innovators rarely innovate alone. The literature highlights the importance of different actors within the ecosystem working together “in iterative processes of trial and error to bring about the successful commercial exploitation of a new idea” (Laursen and Salter, 2006). Importantly, firms search
for knowledge in close proximity to their existing knowledge base, meaning that “knowledge creation and innovations are often cumulative and localized outcomes of search processes within firm” (Boschma, 2005). Also evident is the notion that innovation often requires novelty of sources, i.e., exposure to dissimilar, complementary bodies of knowledge gives birth to new ideas and creativity. Accordingly, research has focused considerable attention on the geographic arrangement of economic activities, as exemplified by Silicon Valley, as the main thrust of knowledge creation actuating innovation (Maskell, 2001, Porter, 1998). Nevertheless, as Boschma (2005) observed knowledge creation depends on a capacity to coordinate the exchange of complementary pieces of knowledge owned by a variety of actors within and between organizations” (p. 64). Thus for this study not only do we view universities as mechanisms that coordinate transactions, but also we consider them vehicles that enable the transfer, exchange and exploitation of knowledge for value co-creation. We therefore question what factors within the knowledge ecosystems (actor interaction and interdependencies) offer information that can contribute to our understanding of value co-creation and capture within SMEs. The essential point is to understand that different channels, contextual factors and forms of interaction are required to facilitate university-SME collaboration for successful innovation outcomes.

**Research Methodology**

Our study began with a systematic search and review of the literature. The review employed transparent methods, including appraisal and validation steps in accordance with the principle of replicability. We utilized the meta-synthesis qualitative method to systematically analyze and interpret the main themes in the literature (Sandelowski and Barroso, 2007). Qualitative meta-synthesis is a method of inquiry that does not entail a secondary data analysis of the primary data from the selected studies, but rather an analysis of the findings of these studies (Zimmer, 2006). Aptly stated, meta-synthesis is neither an integrated review of qualitative literature on a given topic nor is it a secondary data analysis of the primary data from the selected studies, but rather it is an analysis of the findings of these studies (Yahyapour, Shamizanjani, & Mosakhani, 2015). One of the purposes for choosing a meta-synthesis is theoretical development which “refers to the synthesis of findings into a product that is ‘thickly descriptive, and comprehensive’ and thus more complete than any of the constituent studies alone” (Schreiber et al., 1997, p. 315), a purpose that is well suited to the primary objective of our research at this stage. As stated above we aim to develop a comprehensive framework unifying previous studies. We adapted Sandelowski and Barroso’s (2007) seven-step meta-synthesis methodology (see Figure 1). We categorized the seven-step meta-synthesis methodology steps into four major steps: (1), searching and selecting studies, (2) classifying and rating the selected articles (3) synthesizing findings, and (4) presenting the results.
Searching and selecting studies (Step 1):
This step included first determining the research question that would be informed by the synthesis of the studies. The question this synthesis aimed to address was: What are and how do the channels and factors of university–firm collaboration within the knowledge ecosystem impact upon success in innovations among SMEs in Canada? Notably, the bilingual and multidisciplinary nature of our research team was of great benefit to the processes of refining the question, searching and selecting the literature, as it allowed a range of perspectives to be incorporated into the process. Focused on including many different forms of valid and relevant evidence, we conducted an extensive systematic search all types of evidence in both French-language and English-language relevant to our understanding. An experienced research librarian (the principal investigator is a librarian) designed a strategy to search for articles in electronic databases (e.g., Web of Science, ABI Inform, and Business Source Complete). The following (and variations of) search terms were utilized (“knowledge ecosystems” OR “knowledge transfer” OR “knowledge creation” OR “knowledge exchange” OR “collaborative R&D” OR Commercialization) AND (Universit* OR college*) AND (“small and medium sized enterprise*” OR SME*) combined with innovation AND (success OR outcome) AND Canada. We also reviewed the reference list of the retrieved articles (backward tracking of citations) to identify additional articles. Further, we searched for papers and reports deposited in institutional repositories, as well as publication lists of Canadian research centers and researchers involved in collaboration activities. We utilized a list of 58 repositories assembled by Canadian Association of Research Libraries (CARL) as a comprehensive gateway to the digital archive of Canadian institutions’ intellectual output. The goal was to ensure we capture broadly the available literature and then through consensus screening of abstracts and selection of articles identify articles of highest-quality and relevancy. Our research team specified in advance a set of inclusion and exclusion criteria. Our inclusion criteria included: research papers or reports with findings relevant to our research question, with emphasis on university–firm collaboration, knowledge ecosystems, innovation, and Canadian SMEs, and published in both English and French languages. Our aim was to prioritise papers that appeared to be relevant, rather than particular study types or research that meet specific methodological standards (Makani et al., 2016). The titles and abstracts of potential documents were screened for inclusion by the research team working independently first and then collaboratively to compare their findings. We only read the full-text of the article in situations where the relevance of a study was unclear from the abstract. Any conflicts were resolved by consensus. Appendix A presents the literature search work flow.
Classifying and rating the selected articles (Step 2):
Researchers point to finding, classifying, and integrating findings from studies using multiple methods from several analytical and theoretical perspectives as the main challenges of the meta-synthesis approach (Bondas and Hall, 2007). We therefore took extra steps to investigate each paper based on author(s), methodology, approach, references and quality. To achieve this we conducted a bibliometric analysis. The research team developed a data classification form to assist in systematically identifying characteristics of each article. We classified articles based on the following classification scheme:

- Author(s)
- Number of times cited
- Year of publication
- Journal and journal impact factor
- Article Focus (i.e., was collaborative R&D and commercialization a major focus of the paper?)
- Article type (Empirical or non-empirical)
- Study method (e.g., quantitative, qualitative, literature review, policy/management development)
- Industry sector focus based on the North American Industry Classification System Codes
- Language (English or French)

A fundamental issue in reviewing research is the appraisal of study quality (Mays et al., 2005, Dixon-Woods, 2004). Our research team developed two quality rating matrices, one for empirical and one for non-empirical articles. Our research team therefore drafted two quality rating matrices, one for empirical and one for non-empirical articles (see appendices B & C).

Synthesizing findings (Step 3)
Our research team is still working on step 1 and 2 outlined above. We will employ the constant comparison analysis approach to extract findings from the text. This will entail “systematically reducing source(s) to codes inductively, then developing themes from the codes” (Onwuegbuzie and Frels, 2015). Data handling and analysis will be facilitated through the use of the NVIVO software. The use of NVIVO will add to the transparency of our data analysis. We will also use NVIVO to assess inter-coder reliability.

Presenting the results (Step 4)
By completing the steps of the meta-synthesis method, a framework will then be developed.

References


Appendix A

Literature Search Workflow

Studies initially identified through searching databases and referrals

Studies screened for inclusion/exclusion

Studies excluded: e.g., not published in English or French

Duplicates removed

Studies reviewed for inclusion

Studies excluded: deemed irrelevant e.g., not about university-firm collaboration, Canadian SMEs & innovation

Studies examined for classification

Studies removed – deemed irrelevant

Studies included in synthesis

Empirical studies

Non-empirical studies (e.g., reports, policy documents)
Appendix B
Empirical articles Quality Rating Sheets

Article Reference ID:

Empirical Article Quality Rating Sheet

Legend
0 – not present or reported anywhere in the article
1 – present but low quality
2 – present and midrange quality
3 – present and high quality

/3 Literature Review: Directly related recent literature is reviewed and research gap(s) identified.

/3 Research Questions and Design: Apriori research questions are stated, and hypotheses, a research purpose statement, and/or a general line of inquiry is outlined. A study design or research approach is articulated.

/3 Population and Sampling: The setting, target population, participants, and approach to sampling are outlined in detail.

/3 Data Collection and Capture: Key concepts/measures/variables are defined. A systematic approach to data collection is reported. Response or participation rate and/or completeness of information capture is reported.

/3 Analysis and Results Reporting: An approach to analysis and a plan to carry out that analysis is specified. Results are clear and comprehensive. Conclusions follow logically from findings.

/15 = Total Score
Appendix C
Non-Empirical Article Quality Rating Sheet

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<th>15</th>
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<td>– Barely relevant</td>
<td>– one or two interesting ideas but not innovative</td>
<td>– Relevant and a few interesting ideas</td>
<td>– Quite good</td>
<td>– Preeminent, groundbreaking paper</td>
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<td>– authors with low-level, non-research-related credentials</td>
<td>– Fairly unknown authors</td>
<td>– Authors’ credentials uncertain</td>
<td>– Authors’ credentials credible</td>
<td>by leading researcher in field</td>
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<td>– Poor writing</td>
<td>– “Stale” or ideas covered in more recent material</td>
<td>– Of average interest</td>
<td>– Raises new ideas</td>
<td>– Strong Conceptualization</td>
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<td>– Local experience</td>
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<td>– Redundant &amp; at old age of date range</td>
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<td>– Obscure journal</td>
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<td>– Uncertain about journal</td>
<td>– Good journal</td>
<td>– Prestigious journal</td>
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<tr>
<td>– Best not to include</td>
<td>Will not be missed</td>
<td>May reinforce ideas; perhaps should include</td>
<td>Definitely include</td>
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/15 = Total Score

Source: Adapted from Makani et al., 2016