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QUANTITATIVE ANALYSIS OF THE ATLANTIC ENTREPRENEURIAL ECOSYSTEM'S INNOVATION ACTIVITIES

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Quantitative Analysis of the Atlantic Entrepreneurial Ecosystem's Innovation Activities

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Abstract

In nature, ecosystems occur when organisms network and interact resulting in value creation, and the total of the value generated exceeds the sum of its parts. Business ecosystems define economic communities participating to create opportunities that exceed those of any one of the organizations alone. Overholm (In press) points out that there is a lack of ecosystem research regarding start-ups role(s) (as opposed to established industries) within ecosystems and a lack of research regarding new ecosystem formation. This study addresses the young firms in the Atlantic entrepreneurial ecosystems using novel network theory. Data was collected from the ecosystem about innovation-driven knowledge-seeking behaviours. The work's contribution is significant in that it applies highly quantitative methods to develop highly visual and easily interpreted results. It adds to the qualitative contributions of the world's leading scholars in regional comparative advantage. Policy makers and ecosystem constituents can readily observe the nature of the patterns within the ecosystem allowing important interpretations.

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Introduction

Interest in entrepreneurial ecosystems has intensified with the acceleration of the importance of entrepreneurship and with the success attributed to specific locations such as Israel, Silicon Valley, Route 128 in Massachusetts, as examples. The discussion has principally focussed on historical ethnographic account of the interactions of personalities, events, the actions of various companies, the recycling of talent, and the composition of a variety of different types of actors and groups in the ecosystem. The research outlined in this report responds to the need to study the dynamics of differing entrepreneurial ecosystems and the investigation of their context and institutional characteristics (Autio, Kenney et al. 2014). We measure the knowledge-seeking behaviours of participants in an ecosystem and chart them using network theory. Stripping away various elements of the ecosystem shows the relative importance of the remaining actors. The results demonstrate that the ecosystem performs better when all of the components are contributing; network average degree weightings decline when any of the supportive constituents is missing. The work contributes to understanding the relative relationships in this ecosystem and suggests implications for comparison work with other regions.

The paper proceeds as follows. First we discuss the study's purpose and the call for quantitative measures based on the historic contributions to regional advantage and entrepreneurial ecosystems. The previous research is a bridge to a description of the emergence of the Atlantic entrepreneurial ecosystem (AEE) and its acceleration over the past decade. The methodology for studying the ecosystem follows; sub-sections outline the type of study, the sampling methodology, the survey protocol and type of analysis. The descriptives of the respondents are included there. This is followed by the results, including network charts and tables of measures. The paper concludes with a discussion of the implications, limitations and opportunities of this methodology.

Study Purpose

Entrepreneurial ecosystems encompass numerous variables including a combination of community, success, concentrations of university talent, growing pools of venture capital funding, and adept abilities to adopt new paradigms (Saxenian 1994). Other than the ethnographic, historical accounts and case studies noted earlier, some of the work highlighted models illustrating the flow of activities amongst the groups (i.e. Bahrami and Evans 1995; Ferrary and Granovetter 2009), and economic models using expenditure and investment data (McCann 1997). In studying ecosystems, Autio, Kenney et al. (2014) created a framework for investigating entrepreneurial ecosystems within the context of the industry, technology, social policy and organizational context, and related

policy concerns, and also including temporal and global, national and regional innovation systems. Some ecosystem research is based on survey data of measurements such as location decisions (Galbraith, Rodriguez et al. 2008), and interpretive analysis resulting in theoretically constructed propositions (Honig and Black 2007). A longitudinal analysis of inventor networks highlighted the emergence of clusters and networks in specific industrial classifications (Ter Wal 2013).

The purpose of this study is to investigate the relationships amongst various groups of actors within an entrepreneurial ecosystem in a more structured manner by using network theory. This shows the distribution of information-seeking activities as well as quantitative measurements amongst the constituents. This study heeds recent calls to introduce context by avoiding focus on the firm or the entrepreneur (Autio, Kenney et al. 2014). We conduct this study using an entrepreneurial ecosystem located on the east coast of Canada where the foci are a number of small provinces that are sparsely populated. This is in sharp contrast to the extant methodologies studying the context of entrepreneurial ecosystems.

Regional Advantage

Entrepreneurial innovation is thought to be a competitive advantage of a nation (Baumol, 2002). Yet nations can be large, and smaller regions have come to dominate success in entrepreneurial innovation. Concentrated systems of entrepreneurial innovation in specific regions has spawned the terminology of entrepreneurial ecosystems. The term goes back beyond 1995 (Bahrami and Evans 1995) where the most famous entrepreneurial ecosystem in the world, Silicon Valley, was characterized by "fleeting opportunities, shifting customer preferences, cascades of technological innovations, brutally short product life cycles, and furious global competition" (p. 62).

In the 20 intervening years, entrepreneurial ecosystems have evolved to represent "networks of actors contributing to joint value creation" and that had "undertaken some degree of co-innovation or adaptation" (Overholm In press). Now, the study of networks based on social constructs are far more prevalent (Pentland 2014) and knowledge-exchange systems that are defined by cooperation need not be spatially proximal or have a local context. This work adopts a general term of entrepreneurial ecosystem to describe a system that has elements of co-location and clustering, but that can also have the far reaching element of networks and innovation systems.

While there is a tendency to place successful ecosystems within their current day context, most of the former, and currently successful, systems have roots well back into the 1940's and 50's and for some, beyond that. The success of regionally-based entrepreneurship undertakings focussed attention on locations such as Silicon Valley, Route 128 in Massachusetts, Start-up Nation Israel, Silicon Glen in Scotland and Sophia-Antipolis in France are just a few. Some attention has been paid on less-than-successful locales (Honig and Black 2007) as well.

The contributions made by innovation and entrepreneurship to these highly successful regions is of interest to other regional economies that are attempting to facilitate similar commercial outcomes. However, the results of imitators have been inconsistent at best (Engel 2015) which has perpetuated an interest in entrepreneurial ecosystems. In nature ecosystems occur when organisms network and interact resulting in value creation, and the total of the value generated exceeds the sum of its parts. Business ecosystems define economic communities participating to create opportunities that exceed those of any one of the organizations alone. Overholm (In press) points out that there is a lack of ecosystem research regarding start-ups role(s) (as opposed to established industries) within ecosystems and a lack of research regarding new ecosystem formation.

The methods of these works have principally focussed on historical ethnographic accounts of the interactions of personalities, events, the actions of various companies, the recycling of talent, and the composition of a variety of different types of actors and groups in the ecosystem. More quantitative approaches have been encouraged in order to contribute a different lens to the highly insightful and subtle qualitative observations made by significant scholars in the area (Engel 2015; Overholm In press).

Atlantic Entrepreneurial Ecosystem

The AEE is on the east coast of Canada with a hub in Halifax Nova Scotia and another in Fredericton, New Brunswick, two small sparsely populated provinces. The provinces of Prince Edward Island and Newfoundland and Labrador round out what is referred to as Atlantic Canada. With approximately three percent of the nation's population, the region suffers difficulties. The most populous province, Nova Scotia (population of 943,000 (2014)) has a declining birth rate as well as a declining population. The number of births in the Province dropped by 6 percent between 2010-2014.

Traditionally focussed on fishing, forestry, and some large industrial pulp and paper and tire manufacturing plants, the sources of these higher paid skilled labour positions are diminishing. One large pulp and paper manufacturer is closed and another faces a precarious future with odour levels that are challenging to correct. One of Michelin's major tire plants has announced it closure. The current trend sees many families supported by Nova Scotians working in oil fields in western Canada and commuting between Alberta and Nova Scotia on a three- to six-week schedules. More recently, the declining price of oil raises concern about even this form of employment. In February, 2015 Alberta lost 14,000 jobs (Babad 2015), many of them expected to be migrating workers from Nova Scotia but the outpouring of youth to western Canada is expected to continue with an improvement in the oil and gas industry (Babad 2015).

Proportionately less is spent on R&D expenditures in Nova Scotia than the Canadian averages. Nova Scotia's private sector R&D expenditures ($505 million) are well below the Canadian average (2014). Canada-wide, private business R&D expenditures contribute 50 percent of the total on average. In Nova Scotia only 16 percent is contributed to R&D expenditures by private business (2014). This point is further

emphasised when the Province's gross expenditure on research & development is expressed as a percentage of gross domestic product. This percentage is only 1.3% for Nova Scotia as compared to 1.8% for Canada.

Yet the Province is very well suited to see significant growth in its GDP by transitioning towards a knowledge based economy. In recent years the foundation for this has been facilitated by the urbanization of the population, as well as the Province's high levels of post-secondary education. With 10 universities, and 13 community college campuses, Nova Scotia produces more post-secondary graduates per capita than any other Canadian province. All three levels of Canadian government have begun to devote resources to encourage growth in the local innovation ecosystem.

Halifax, Nova Scotia's capital city, is the largest population centre in Atlantic Canada and is home to 43 percent of the Province's residents (2014). The city has been recently experiencing a growth in university enrolments that are twice the national average. This strong academic presence contributes significantly to the R&D expenditures in the region, accounting for 74 percent of the total (2014).

With some of Canada's oldest and top rated universities, Halifax is turning a focus towards entrepreneurship, and the knowledge transfer from academia to the private sector. There has long been a foundation of support organizations, from the private sector such as Entrepreneurs Forum (founded 1992), from the federal government such as Atlantic Canada Opportunities Agency (formed 1987), and from the Provincial government with Innovacorp (formed 1994), in the city. By 2000, there were a number of government (Innovacorp, NSBI, Investment New Brunswick) and private venture capital (ACF) options in the region, and more were to come. Entrevestor, an online news service, was founded with the help of local governments, and it follows the developing entrepreneurial ecosystem, with an explicit focus on technology-enabled high growth firms.

The emerging ecosystem saw tremendous growth in the aftermath of a $350 million exit and $640 million exit (reputed) of two entrepreneurial firms in the Region, in New Brunswick. Radian 6 and Q1Labs had similar founders, investors and were both ICT firms. Respectively, they were sold to Salesforce.com and IBM. In 2012, Halifax-based firm, GoInstant, also sold to Salesforce.com. These and the earlier sale of CanStockPhoto and later, Compilr, developed a flow of capital into the region, and some of the founders and early investors recycled their new wealth into the founding of incubators (Volta Labs), accelerators (Launch 36), university support systems (Pond Deshpond Centre) and innumerable programs and pitch contests to encourage entrepreneurship.

The longstanding entrepreneurship program at Saint Mary's University, a major business school in the country, was then supported by Dalhousie University's Starting Lean course and a new Masters in Technology Entrepreneurship and Innovation at the Sobey School of Business.

Methodology

The methodology to effectively measure and map an ecosystem quantitatively is best undertaken with a field study of the knowledge-seeking behaviours of constituents of an entrepreneurial ecosystem. Knowledge-seeking is the measure of innovative behaviour. Using a snowball sampling method, a survey investigated the knowledge-seeking behaviours of constituents of the ecosystem as well as the importance and frequency of the ecosystem's participants' knowledge-seeking activities. The data was analysed using network theory. A more detailed description follows.

Measures

Alavrez and Barnery (2007, p 126) noted that the central measure used in the opportunity literature were "actions that entrepreneurs take to form and exploit opportunities," but not all entrepreneurial actions are innovative (Bosma, 2009). So where performance is driven by entrepreneurial innovation which is a function of entrepreneurial behaviour (Autio, Kenney et al. 2014) knowledge-seeking behaviours were used as the best indicator for entrepreneurial innovation.

In this study, knowledge-seeking behaviours were defined as actions taken by phone, in person or by email/text where a constituent of the ecosystem reached out to another individual in an effort to find information to make a decision related to an entrepreneurial firm. Three dimensions were investigated regarding each knowledge-seeking activity: importance, frequency and type of information sought. The number of times an ecosystem member reached out to someone else was measured, and the importance of the information to the seeker was measured with a seven-point Likert scale. The types of information sought were assessed as either business/market/financial information or product/scientific/technical information.

The survey protocol was executed by means of a "fillable form" survey. Returned surveys implicated other companies which were then sent a survey regardless of their physical proximity to the respondent. This type of survey distribution was adopted to avoid services such as Survey Monkey to ensure that the process of exporting data from the surveys occurred on servers owned, and operated, by Saint Mary's University, as opposed to an independent third party. By ensuring that this data was only retained by the University we were able to better ensure the confidentiality of all personal information collected.

Sample Selection

The sample began with a list of qualified potential respondents drawn from media sources within the entrepreneurial community of Atlantic Canada. The technique of using snowball samples, or respondent-driven sampling, is appropriate for network analysis (Biernacki, 1981). With respondent-driven sampling, respondents indicate

persons from whom they sought advice/information/knowledge about entrepreneurial ventures. The individuals noted by each respondent become the source for enlarging the sample and developing new potential respondents.

There is no list *per se* of all entrepreneurs and all firms and all agencies providing services to entrepreneurs so the boundaries are estimated by the participants of the snowball sample. Using this method, it is possible to access hidden agents participating within the Entrepreneurial Ecosystem. It is also recognized some influencers will not be part of the sample.

To develop a targeted distribution list for the AEE survey a base list of 75 qualified respondents was compiled. These included individuals in organizations that composed the various constituent groups in the ecosystem such as entrepreneurs, venture capitalists, incubators, governments agencies, supportive organizations and others. The list of qualified respondents was generated by carefully evaluating personal contacts of the lead researcher, Entrevestor (an entrepreneurship news service), AllNovaScotia.com (a business news service), and the online networking site, LinkedIn.ca. Those identified by these sources were the initial recipients of the survey. This distribution grew from the initial group of recipients, to 450 recipients in the first week, and snowballing to, and concluding with, 886 recipients after the final (fourth) week of distribution. A large proportion of the final group were not in any physical proximity to the Atlantic region.

Data Collection

All emails were addressed to respondents under the principal author's email to take advantage of her name recognition and to add academic credibility to the requests. Most data was obtained in pdf fillable forms and was exported to a csv file. Therefore, information provided by emailing the fillable form populated the database automatically. Cleaning and coding the data was took place. The data are analysed using the complex network theory program, Gephi (Cherven 2013).

Network theory creates *arcs* for each knowledge-seeking behaviour between two *nodes* which are the seeker and the responder. Duplicate nodes are consolidated to produce a network graph which introduces the concept of centrality in network theory. The type of information sought was also recorded. Because the entrepreneurial network data is from various types of constituents (venture capitalists, entrepreneurs, universities, accountants), research assistants manually coded organizational types.

Survey Descriptives

Table1 describes the response and network descriptive. The survey instrument was responded to by 95 individuals (some of whom declined to participate for specific reasons). The survey was completed by 79 respondents. The total number of different firms to which the respondents referred was 781. A total number of 1477 knowledge-seeking transactions were engaged in by the ecosystem.

Table 1 - Respondent Descriptives

Respondent Descriptives	Count
Individuals responding to survey request (#)	95
Completed Surveys by Individuals (#)	79
Number of firms reported overall	781
Male/Female (%)	75/25

The nature of the respondents' capacities within the ecosystem is outlined in Table 2. Respondents were permitted to self-identify into more than one category. Most of the respondents were entrepreneurs (46.8%) and a class of individuals who reported themselves as consultants (36.7%). As a collection, the next largest group were the venture capitalists (15.2%), the private individual investors (10.1%) and a member of an angel network (1.3%). Professors from the local universities and colleges represented 12.7 percent of the respondents' professions.

Table 2 - Self Identification of Profession (More Than One Category Possible)

Self Identified as	Percent (%)
Entrepreneur	46.8
Venture capitalist	15.2
Private Individual Investor	10.1
Member of Angel Network	1.3
Lawyer	1.3
Government Representative	3.8
Consultant	36.7
Professor	12.7
Employee at a large firm	1.3
Bank Representative	1.3
Mentor	3.8

Professors aside, the level of education amongst the ecosystem is very high. Respondents were highly educated with all but two having had some form of post- secondary education. Combined, more than half of the respondents had a masters' level or a doctorate and 27.1 percent of the group had a bachelors' degree. Fourteen percent of the respondents had a professional designation. Table 3 outlines the educational profiles of the respondents involved.

Table 3 - Level of Education

Level of Education	Percent
High School/Equivalent	2.9
Vocational/Technical School	2.9
Professional Designation	14.3
Bachelor Degree	27.1
Master Degree	42.9
Doctoral Degree	10.0

Results

Three elements of the AEE are dissected in this analysis. The AEE as a whole is assessed along with the functioning of the system when specific groups are removed. That is followed by an analysis of the activities of the entrepreneurs, venture capitalists and universities – three qualities that are always recognized in successful entrepreneurial ecosystems.

Assessment of Entire Atlantic Entrepreneurial Ecosystem

The knowledge-seeking activities of the AEE are numerous and complex. There are 780 different organizations implicated in the reported AEE and 1477 separate knowledge-seeking relationships activities by the 79 respondents. The image of the AEE is displayed in Figure 1. The various types of organizations identified by their colour and a legend displays the number of nodes. Fifty-seven percent of the nodes are represented by entrepreneurial firms. Support organizations, venture capital firms, universities, Federal and Provincial governments, and professional firms represent the bulk of the named organizations that were sought after for some type of knowledge. The size of the node represents the number and importance of the knowledge-seeking behaviours which others sought of the named node. The centrality of a node is an indication of its interconnectedness amongst many different information seekers.

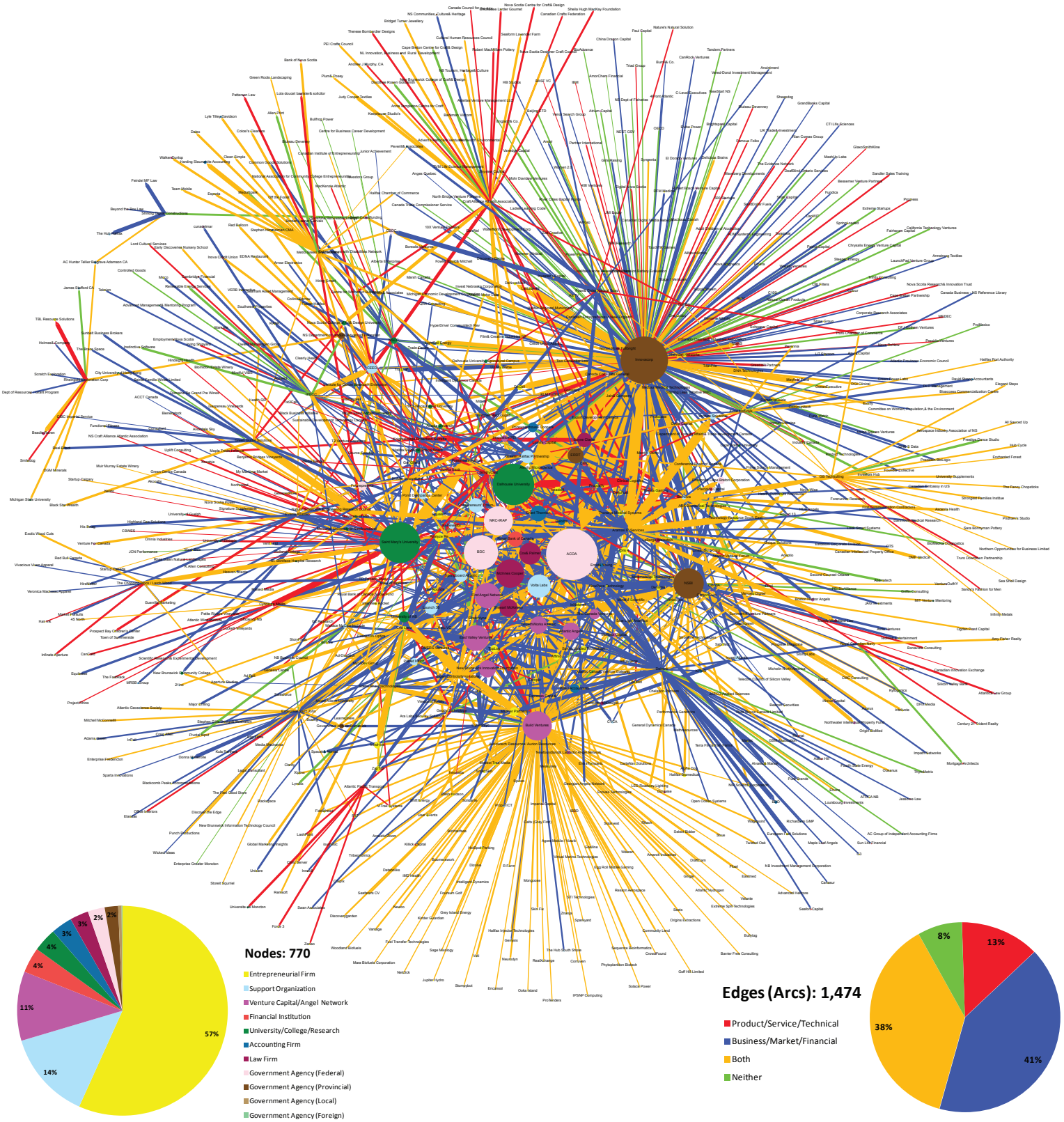
Two key types of information were suggested as the basis for reporting respondents' behaviours. *Product or Service Technical* information indicates science-related, product, programming, equipment, or technical information. Thirteen percent of information requests were of this nature. The legend in Figure 1 displays the types of information sought. Forty-one percent of the requests were for *Business Market or Financial* information which relates to markets, administrations, funds seeking and business operations. Thirty-eight percent of the respondents were looking for both kinds of information from their knowledge-seeking activities and the remaining eight percent indicated they were looking for information other than these two key categories. Careful examination of the arcs reveals numerous other bits of information such as the direction of the information-seeking activity. The small pointed end, terminating on the periphery of a node means the information was *sought from* that organization. Avive Naturals for example has many arcs emanating from theirs. They sought information from Perennia, NSBI, Canada Business Reference Library, Halifax Port Authority, NRC-

IRAP, Export Canada and Port Mexico to name just a few. They, on the other hand, are a very small node because they have not been sought to provide information to others in the AEE.

The major financial institutions, universities, support groups and federal and provincial agencies are very important to the ecosystem. They are more sought-after for information and more connected which drives their nodes it to the centre of the chart. Some entrepreneurial firms that are frequently linked to these organizations are also in the centre of the chart. Many of the firms on the periphery of the chart are those from which information was sought but that have no other knowledge-seeking associations with any other company in the AEE.

A considerable proportion of the knowledge-seeking behaviours of the AEE is not proximal to the Atlantic Canada location. Approximately 75 percent of the nodes are situated in the Atlantic region. Encouragingly, 15 percent of the nodes are from the rest of Canada, nine percent are from the U.S., and one percent are from abroad. This suggests a global group reaching out for information from companies and groups around the world. If these global-facing nodes are connected to entrepreneurs it suggests an inoculation to dis-entrepreneurship as defined by Honig and Black (2007). Dis-entrepreneurship occurs when the community adopts an inward facing orientation rather than an outward orientation in a globalizing world. "Entrepreneurs finding themselves in communities characterized by strong client-patron relations would do well by appealing to broader regional institutions that frequently trump local oligopolies" (Honig and Black 2007. p 286).

Figure 1 – Knowledge- Seeking Activities of the Entire Atlantic Entrepreneurial Ecosystem



Another way of measuring the importance of individual groups of constituents is the proportion of relationships between the edges or arcs (the lines running from node to node) and the number of different constituents (number of nodes). This is called the Average Degree statistic. A larger Average Degree statistic (Arcs/Nodes) indicates that more knowledge-seeking behaviours are taking place per member of the ecosystem.

Table 4: Ecosystem Statistics With and Without Various Ecosystem Groups

	Entire Ecosystem (EE)	EE Minus Federal Participation	EE Minus Provincial Participation	EE Minus Support Orgs	EE Minus University Participation	EE Minus Venture Capital
NODES	770	752	571	633	692	584
EDGES	1474	1359	1059	1145	1282	1045
AVERAGE DEGREE	1.914	1.807	1.855	1.809	1.853	1.789
AVG WEIGHTED DEGREE	12.481	11.669	10.737	12.104	12.172	11.844

Table 4 shows the AEE without various groups of constituents as comparators. The average knowledge-seeking activity decreases when any group is removed from the ecosystem. For example, when the Federal Government's participation is removed from the AEE, the AEE's average degree declines from that of the average degree of the whole ecosystem; the entire ecosystem's knowledge-seeking activity level improves when Federal participation is included. Federal Government constituents punch above their weight in the AEE because the ecosystems' arcs per node declines when the Federal Government is absent. The AEE is most hampered if the Province is withdrawn likely because of the contribution of government-sponsored venture capital in Innovacorp, NSBI and Build Ventures.

A similar situation occurs when considering all of the other major groups noted in Table 4. Removing any one of them causes the average degree of knowledge-seeking behaviours to decline. The AEE is more knowledge-seeking when all the major groups of constituents are in place.

The average weighted degree takes into account the combined importance weights indicated by the respondents to the survey – the *value* of the information sought by the seeker. A higher value indicates more importance. In Table 4, the Weighted Average Degree of the AEE is 12.481 when everyone is participating. However, the AEE's average weighted degree declines the most, to 10.737 when the Provincial governments' contributions are removed (two early-stage venture capital funds).

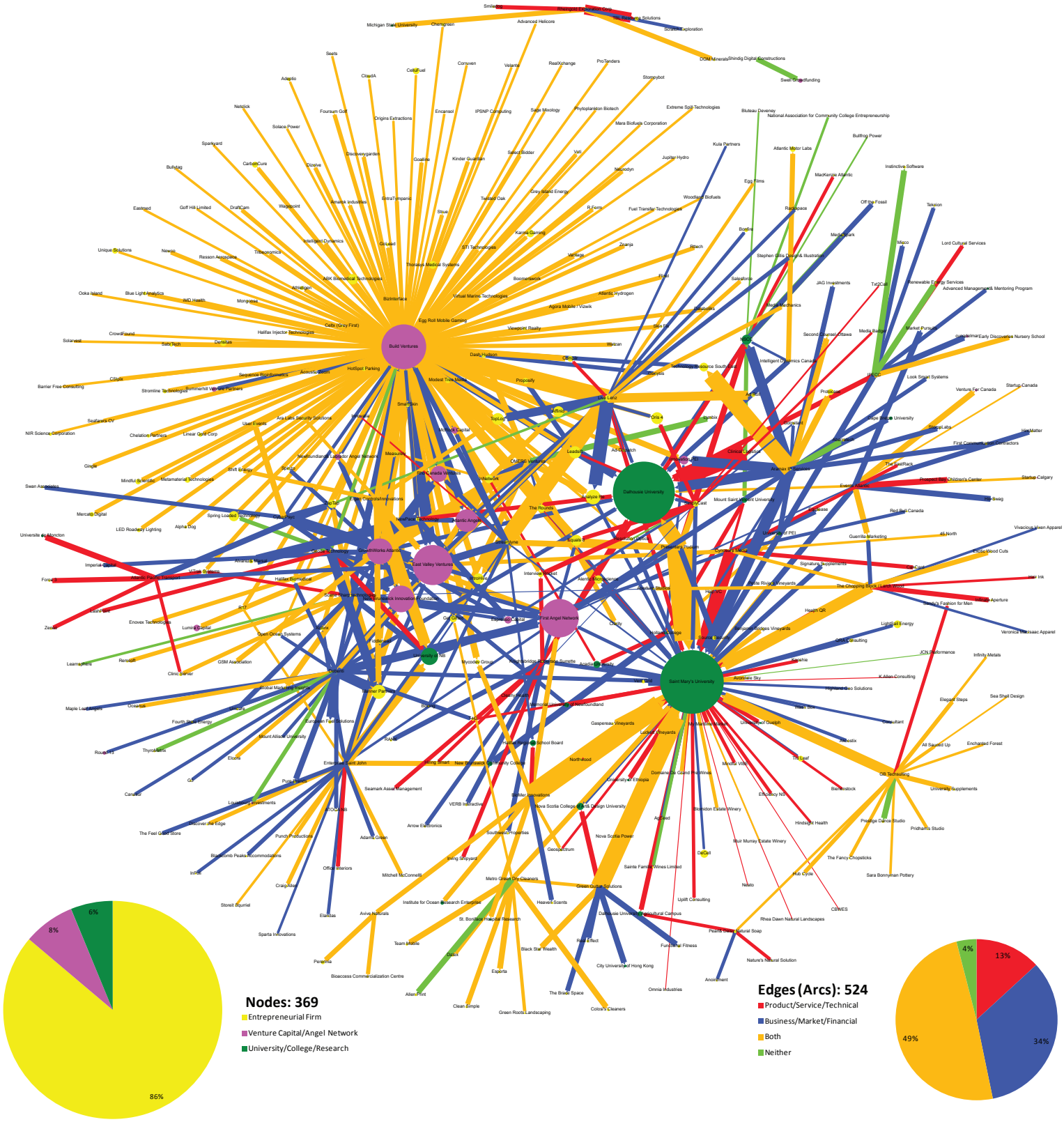
Knowledge-Seeking Activities of Universities, Venture Capital and Entrepreneurs

The stories of Silicon Valley and Route 128 were both dominated by the active participation of universities and personalities within those institutions (Saxenian 1994) and the contribution of available finance and venture capital were considered very valuable (Ferrary and Granovetter 2009). This analysis considers these three components of the system as a group.

The chart showing the interactions amongst the universities, venture capital firms and the entrepreneurs is composed of 369 firms, the vast majority of them being entrepreneurial firms is shown in Figure 2. There are 1.8 edges per node and the importance of the transactions is high, a weighted average degree of 11. 6. This represents about half of the nodes and a third of the edges in the entire AEE. Again, the universities and the venture capital firms are driven to the centre of the chart highlighting their interconnectedness and thereby their importance to the structure of the ecosystem.

An examination of the entrepreneurial firms shows little interaction with other larger firms which has been an approach used in other ecosystems. The mixing and recycling of talent amongst large and smaller firms produces knowledge spinoffs that benefit both parties. Modest encouragement by larger companies in the Province can provide exceptional opportunities developing founders, and very early-stage ventures benefit from close proximity to, and mentorship by, successful high growth firms. Established innovating businesses can mentor aspiring technology oriented entrepreneurs to absorb business models, mentorship, technology, management practices, and the culture of fast-growing businesses.

Figure 2: Knowledge-Seeking Activities of Entrepreneurs, Universities and Venture Capitalists



There is little independent private venture capital in the AEE. Most of the firms are government-sponsored venture capital attempting to fill financing gaps. The larger ones are those which fulfill a government, or quasi-government mandate. For some of them, their mandate has expanded to provide a supportive and mentoring capacity in the ecosystem as well as incubating opportunities.

The universities are sources of both business and technical information for entrepreneurs and founders. This is demonstrated in the different colour arcs emanating from the universities. It is promising to see the role that the universities play in the previous iteration of the ecosystem, but in particular with this iteration, of the entrepreneurial firms. This chart's high average importance rating indicates its value. Clearly, the efforts that are being spent on entrepreneurship education inside the Universities are resulting in considerable involvement. The high levels of education of the AEE's constituents is no doubt related to this observation.

Implications & Opportunities for Future Research

This research calls attention to the multiple parties needed to stimulate entrepreneurial ecosystems (Van de Ven 1993), and addresses a more recent call for investigations into regional and contextual influences on entrepreneurial innovation (Autio, Kenney et al. 2014). This work expands the knowledge of entrepreneurship by focussing on the context of an entrepreneurial ecosystem's knowledge-seeking behaviours. It does so with an information-dense and revealing visual and quantitative examination of entrepreneurial ecosystems' knowledge-seeking behaviours.

Knowledge-seeking behaviours as a measure of innovation necessary for successful entrepreneurship and the use of network theory is a unique contribution to the entrepreneurial literature as well as the network theory literature. Together they endeavour to tease out specifics regarding the nature of the ecosystem's functioning.

Networking is an active way to create entrepreneurial opportunities for high-tech innovation, and high-tech founders exploit existing opportunities and deploy their networks to form new contacts and relationships that form new opportunities (Moensted 2010). Knowledge-seeking networks amongst an ecosystem expose founders to complementary competencies and resources to gain access to new knowledge and people.

The interconnectedness of the constituents in the AEE is amply highlighted in the charts. The AEE has an outward-facing orientation; many of the organizations implicated by the respondents were outside of the Atlantic Region although only one percent were globally based. More research is needed to examine whether the founders specifically had a global orientation, or whether it is other constituents who are reaching out to the world.

Entrepreneurs' overwhelming search for business, market and financial information rather than technical/scientific/product information is a surprising finding. A number of

reasons may explain it. If entrepreneurs are competent in their design, science and production of their products, their needs may be largely related to the development of markets, delivery of product, sales techniques and methods of building a firm. That would be reassuring. In an area of challenged resources and financial capabilities, the search for business acumen and finance may be expected. However, if the entrepreneurs are spending most of their time on business-building activities with little or no product innovations or design improvements, difficulties related to immature innovations may prevail.

Moreover, the metrics associated with the analyses specifically demonstrate the dwindling effectiveness of the AEE's knowledge-seeking behaviours when any one of the major constituents is withdrawn. The incremental value that each group of actors contributes to the ecosystem signifies the synergy present in the combined group of entrepreneurs, governments, support groups, professionals and venture capitalists. Removing any one of the various groups of actors causes the average degree of knowledge-seeking behaviours to decline. On average, the AEE is more knowledge-seeking when all the major constituents are in place. This is corroborated by extant research. It is recognized that governments cannot establish, or mandate, an entrepreneurial ecosystem (Soto-Rodríguez 2014). Only the value creation contributions of many actors working in concert through their interconnectedness (Cohen 2006) results in a functioning and sustainable ecosystem.

Further research opportunities abound using this method. Other research may answer questions about the mix of qualities that are necessary for successful ecosystems and provides opportunities for comparison. Is there more or less focus on university, or professional support, or venture capital funding, or incubators or accelerators in the winning regions compared to those less successful ones? Does success have more to do with the social order, or social capital? Is it influence, contacts, and networks that drive successful ecosystems, or is it capability of a number of key players that lubricate them? Is there a critical mass of venture capital required to grease an entrepreneurial ecosystem? Is there a critical mass of people working in a similar area that drives a cluster to become an innovation network? And if so, what is that critical mass? Future research may seek to investigate these areas.

Are there circumstances that cause dis-entrepreneurship. Dis-entrepreneurship occur if policies or actions cause ecosystems to fail to grow i.e. weak local investment, failure to take advantage of policy opportunities, or poor infrastructure (Honig and Black 2007). Much potential research is possible if similar analyses of other ecosystems' contexts are compared and contrasted.

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