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META-ANALYSIS OF NETWORKS

June 2022

Prepared by Dr. Geoff Gregson for Alberta Innovates

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About the Author

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About the Impact Action Lab (IAL)

Impact Action Lab, at Alberta Innovates, partners with ecosystem players to amplify and activate the collective economic and societal impact of our research and innovation investments. The IAL is made up of global and local impact experts. The IAL is creative in developing, assessing, and implementing impact frameworks to action real change. We work with organizations to enhance their capacity by incorporating performance and impact management systems to generate value and benefits to their communities.

About this Report

This report was commissioned by the IAL in collaboration with the Entrepreneurial Investments business unit at Alberta Innovates to understand networks' contribution to (hidden) impact as well as understand lessons learned and actionable insights for networks on a go forward basis. To do this, a meta-analysis approach was taken to understand what works, what doesn't, under what conditions, and how to make enhancements in the future. We would like to acknowledge Doug Holt, Terry Rachwalski and Carla Otto for their support in seeking to explore "network effects" as an important component in strengthening an innovation ecosystem.

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EXECUTIVE SUMMARY

The purpose of this report is to synthesize network effects on entrepreneurial ecosystems and economic and social impacts. The report examines different network analysis techniques to assess and measure networks and discusses network effects associated with high performance and impact. A summary of key insights is presented below, with a more extensive discussion of findings and actionable insights provided in Section 6.

The report suggests multiple advantages for Alberta entrepreneurs and enterprises engaged in networks. Networks are grounded in an information advantage, establish membership affiliation and social relations and set a context for exchange of knowledge, information and resources.

The report identifies the importance of absorptive capacity for regional network advantage. Given Alberta's ambitions in a number of advanced technology areas, the ability of local entrepreneurs and SMEs to recognize and develop new opportunities depends on their capacity and skills to adapt and use critical knowledge generated by Alberta's research institutes, corporations and by external knowledge suppliers.

The report identifies a key role for network brokers, who can make connections between disconnected parts of networks and bridge gaps in communication, information and knowledge. Brokers can play a role in facilitating introductions for entrepreneurs across different networks; for example, during the post-acceleration phase as entrepreneurs graduate and seek new connections to build and scale their ventures.

The report finds that there is no simple, universal or optimal network structure, as it is contingent on multiple factors as well as the behaviors and motivations of network members. The different dimensions of networks make it difficult to directly attribute enterprise performance to the structure of network relations. Social relationships are often difficult to identify beyond individual-to-individual connections and entrepreneurial learning and knowledge accumulation cannot be easily traced as deriving exclusively from any specific network, as an entrepreneur's 'network' may include multiple networks.

The report suggests that a 'network of networks' approach can effectively facilitate the movement of information, knowledge and resources throughout a region if it is able to: leverage already established and successful relations; give participants enough time and opportunities to work together; focus attention on relationships with high generative potential; and ensure that new network members share similar objectives and engagement commitments.

The report describes different evaluation models for entrepreneurial ecosystems that highlight the need to identify system components and their interactions with one another. Adopting a Relational Database Management System offers a way to organize, synthesize and present data from different high-volume sources at once, and may be well suited for Alberta's entrepreneurial ecosystem because of its ability to capture networks of relationships that emerge across disparate sources of data. Another suggestion is use of visualizations, such as dashboards, that can present key performance and impact measures which provide multiple stakeholders with a common story of the state of Alberta's entrepreneurial ecosystem and its development over time.

The report suggests that **entrepreneurial ecosystem policy should not be entirely data-driven.** Complex measures are not suited as independent variables, and even a combination of network

measures is unlikely to capture the full complexity and richness of Alberta's entrepreneurial ecosystem. Mixed methods, multiple data sources, adoption of appropriate data management systems, etc. can provide policy makers with sufficient evidence to make well-informed decisions. The challenge is to make the Alberta entrepreneurial ecosystem visible in the data and to illuminate how networks contribute to outcomes and impacts.

The report suggests that Alberta policy makers consider lessons from the European Union on impact assessment, which emphasizes multi-stakeholder consultancy in policy design, transparent measures regularly shared with stakeholders and ongoing dialogue in assessing the effectiveness of measures, programs and interventions. This may be facilitated through development of an adaptive and learning management system.

Finally, the report makes suggestions for further study related to Alberta's regional innovation networks (RINs) and wider entrepreneurial ecosystem. These include examining how social network ties influence venture resourcing and early firm planning, how intermediaries and brokers influence different networks and determining if there are network structures within the regional ecosystem that are more related to enterprise success or failure than others.

A future research roadmap could also examine the evolving boundaries of Alberta's entrepreneurial ecosystem, the intersection between local and global knowledge flows and how this influences start-up activity and configuration of the ecosystem and local networks.

1. INTRODUCTION

This report provides a meta-analysis of networks that are relevant for the Alberta entrepreneurial ecosystem. The purpose of this scope of work is to continue building on the research evidence to inform Entrepreneurial Investments (EI) on how networks help build a strong and vibrant entrepreneurial ecosystem for Alberta.

The following questions guide the report:

1. How do network theories contribute to understanding entrepreneurial ecosystems?
2. How can network analysis be used to effectively assess and measure network effects that contribute to strong entrepreneurial ecosystems?
3. What network effects most influence high performance and impact?

The approach taken for the report is a qualitative meta-analysis. This requires examining networks as a multi-definitional and multi-dimensional phenomenon, involving extensive secondary analysis of primary qualitative findings in the relevant literature.

The study method adopts previous guidance on secondary source analysis, which includes:

- Defining the theoretical, social and structural characteristics of the phenomenon to be studied.
- Determining how to identify, specify and describe those chacteristics.
- Analysing relevant material related to the study questions.
- Considering the source elements of interest and drawing out key insights and contributions.

The report is structured as follows. Section 2 describes network theories, definitions and characteristics. Section 3 focuses on regional networks, entrepreneurial ecosystems and smart specialization strategy.

Section 4 examines different methods of network analysis that includes social network analysis (SNA), mixed method SNA and value chain analysis.

Section 5 presents a number of methods for measuring and monitoring the performance and impact of entrepreneurial ecosystems, with illustrative examples.

Section 6 provides a discussion on report findings, actionable insights with suggestions for further study. A number of appendices are referenced in the body of the report.

2. NETWORK THEORIES, DEFINITIONS & CHARACTERISTICS

This section examines network theories, definitions and characteristics that provide essential context for subsequent discussion of regional networks and entrepreneurial ecosystems and their analysis.

2.1 Theory of Network Advantage

Network theory suggests multiple advantages for entrepreneurs and enterprises engaged in networks. **Networks are grounded in an information advantage.** This begins when people cluster into groups as a result of interaction opportunities - defined by the places where people meet.

Networks establish membership affiliation. Communication becomes more frequent and influential within groups. People in the same group develop similar views, systems of phrasing, opinions, symbols, and behaviors which define what it means to be a member.[1]

Networks set a context for exchange. Repeated interactions amongst group members shape their mutual expectations towards trustful behavior, which may considerably improve the quality of exchange and results of the interaction.[2]

Network exchange - particularly that of specialized knowledge - benefits from spatial proximity. Knowledge exchange often requires **face-to-face contacts**, especially if the knowledge is tacit.[3] Tacit knowledge is bound to the person that possesses the knowledge and a transfer of this knowledge requires personal contact, which reinforces the importance of network ties within spatial proximity.[4]

What was once explicit knowledge - interpretable by anyone - becomes tacit knowledge that is meaningful primarily to 'insiders' of the group. Over time, **information in the group becomes 'sticky'**- nuanced, interconnected meanings not easily understood by those outside of the group.[5]

Differences in information and knowledge between groups may or may not be consequential. The **'bridge and cluster structure' in social networks** indicates where information is relatively homogeneous (within group) and where information is likely to be heterogeneous (between groups).

Information differences between groups set a stage for **two kinds of network leadership:** specializing within a group or cluster (e.g. closure) or building bridges between groups/clusters (brokerage).[6]

- **Network closure is about strengthening connections** within a group to gain advantage by getting better at what those within the group already know or do.
- **Network brokerage is about connecting across groups** to synthesize new practice from diverse bits of information otherwise segregated in separate groups.

'Closed' Networks

Closed networks is a core prediction from network theory. It suggests that the more closed the network around a person, the less exposed the person is to diverse opinion and practice, which may enforce group conformity and negatively impact their ability to blend previously distinct ideas into new combinations.

[1] Leavitt (1951).
[2] McEvily and Zaheer (2006).
[3] Polanyi (1967).
[4] Lissoni (2001).
[5] Von Hippel (1994).
[6] Burt (2019).

A network is closed to the extent that the people in it are interconnected. This can happen because everyone is tied to everyone else (clique network), or because there is a strong central contact to whom other contacts in the network are strongly connected (e.g. a partner network).[7]

Networks composed of few contacts are more closed than networks containing many contacts. Small networks are more closed, as information is less likely to vary across a few contacts. The more contacts a person has, the more likely the contacts vary in what they know and do. This relates to the notion of strong and weak ties, discussed later on.

The **'cocoon' hypothesis'** suggests that a closed network **provides a safe haven, a 'cocoon,' for group members.** Similarly, dense network 'cliques' expose members to shared understandings via close connections amongst members.

The cocoon 'advantage' appears most relevant early in a project. A closed network may allow entrepreneurs to engage and survive the exploratory trial and error of getting a project ready, which puts the project on secure footing. Entrepreneur reputation can be established and maintained in closed networks along with initial team building and strengthening of personal ties. Disadvantage occurs when the entrepreneur does not subsequently expand out of the cocoon.

A closed network appears **advantageous in securing funds** to launch a business, after which an open network is advantageous in raising funds to expand the business.[8] A closed network of venture investors is also **associated with successful exit during the seed stage**, after which having an open network is associated with successful exit from late stage investments.[9]

Network Brokerage

Brokerage is the act of coordinating across structural holes via bridges between people on opposite sides. Brokerage, and the related concept of network intermediaries (discussed later) are highly relevant in the study and analysis of regional networks.

Structural holes are gaps in communication between groups, indicating where information is likely to differ on each side and not flow easily between groups.[10] Structural holes also offer opportunities for entrepreneurial activity.[11]

Network brokers are the people who build the bridges and who may operate somewhere between formal authority and informal initiative, making connections between disconnected parts of networks and markets, where it is valuable to do so.[12]

Different types of brokerage positions in a network include:[13]

- Brokerage between two private sector firms (**coordinator**);
- Linking two members of the public research sector (**consultant**);
- Brokerage between a private firm and a public research organization, where 'flows' occur from the former to the latter (**representative**);
- Brokerage between a public research organization and a private firm, where 'flows' occur from public research to private businesses (**gatekeeper**).

Network actors can simultaneously assume the role of a 'gatekeeper' and the role of a 'representative' if the exchange of knowledge and information is of a reciprocal nature. **Experienced entrepreneurs**

[7] Burt (2019).
[8] The study by Yoo (2003) was based on a sample of 151 Silicon Valley entrepreneurs.
[9] Everton et al. (2013).
[10] Burt (1992).
[11] Burt (2007).
[12] Burt (1992).
[13] Gould and Fernandez (1989).

may also take on a broker role that builds bridges between nascent entrepreneurs and those holding network knowledge and resources.

Network brokers offer a number of potential advantages to a network:

- **Translate opinion and behavior** familiar from one group into the dialect of a target group, i.e. can translate what is 'known here' into what can be understood and seen to be valuable 'over there.' In economic terms, brokers provide the social mechanism that clears a 'sticky-information' market.[14]
- **Detect productive opportunities** because they are better positioned to sort through many possible opportunities to focus on the most productive.
- **Respond quickly and effectively to problems** by adapting practice from one situation to the demands of a new situation, or inventing a new solution based on a synthesis of their experiences in other situations.
- **Deliver good ideas to a target group, adapted from their familiarity with other groups.**[15] Brokers are more likely to see a novel solution that synthesizes or combines knowledge or practice across different groups.[16] The same holds for recombinant information across multiple industries, regions, products, or channels.
- **Contribute to refining novel solutions to problems across groups**, e.g. what begins as a good idea finishes as one of many possible implementations, with the original idea subject to reframing or reimagining each step along the way.[17]

Network brokers can develop a talent for converting and synthesizing information between groups, for tolerating ambiguity and for seeing when the time is ripe for a particular new combination of knowledge or practice.

Network brokers have **advantage in proportion to their established good reputation**.[18] Reputable brokers are **more likely to be successful in communicating the value of their proposal** to diverse audiences, invoking skills of simile, metaphor, and analogy to communicate their vision to diverse audiences.[19]

Complex projects may be more successful when led by a person embedded in a network rich in brokerage opportunities across structural holes.[20] The advantage is agnostic on the type of project, i.e. the project can be located in any industry or sector.

2.2 Network Definitions

Networks have a **wide range of definitions** that make their analysis and measurement difficult. As leading network scholar Ronald Burt states, "*Given the compelling intuition that networks must matter for entrepreneurial success, the word "network" is used with abandon*."[21]

[14] Sticky-information market refers to information or knowledge that is potentially valuable but costly to acquire, transfer, and use in a new location, e.g. von Hippel (1994).
[15] Burt (2004).
[16] Burt (2010).
[17] Rahman and Barley (2017).
[18] Burt and Merluzzi (2014).
[19] Burt (2019).
[20] Burt (2019). In validating the theory, entrepreneurs were measured for their supportive contact networks and their relative success in growing their business.
[21] Burt (2019).

Networks are typically defined according to actors and their interactions with one another. This may include recurring exchange relationships among a limited number of individuals or organizations that retain residual control of their individual resources yet periodically jointly decide over their use.[22]

An **innovation network** is defined as a loose-knit group of knowledge intensive firms and other organizations that contribute to the development of new products and services.[23]

Important differences exist between innovation networks and clusters or industrial districts. Firms located in a cluster may benefit from other firms or from public research institutions even **without having any explicit relationship to these actors**, e.g., by 'pure' spatial knowledge spillovers.[24]

By comparison, **innovation networks involve direct relations**, and the exchange processes within networks are critically affected by the very nature of knowledge and information. Knowledge and information differ considerably with regard to their sensitivity to spatial distance to a communication partner.

If partners in an innovation network have **closely related interests**, the chances of gaining valuable information and knowledge in such a network are relatively high.[25]

A **business network** is described as '*an integrated and coordinated set of ongoing economic and non-economic relations embedded within, among and outside business firms.'*[26]

Business networks may be constituted by interconnected organizations that encompass particular resource flows and supply and distribution channels, but the **value of a business network** will depend on a number of factors, which include frequency of exchanges, strength of ties, complexity of resource needs and availability.[27]

Social networks are a key determinant of 'economic action.'[28] Social network theory suggests that economic agents are embedded in concrete, ongoing systems of social relations, with these relations facilitating and constraining agent's profits and rent seeking activities.

Entrepreneurs are affected by the level of '**social capital'** available, which is defined as the relationships and assets available in the network and characterized by structural and relational 'embeddedness' dimensions, which are discussed below.

Dimensions of Networks as Social Structures

Structural embeddedness refers to the overall structure of network relations that includes number of individuals and the density of social ties between these individuals.[29] Difficulties in measuring structural embeddedness and its effects on enterprise performance has led to measuring the size of the **'subset of people' who are somehow involved with the entrepreneurs in founding the new venture**.

Entrepreneurs deciding to act in order to achieve the goal of founding a new venture **activate an appropriate subset of their total network.** In turn, those individuals may activate others in their own subset (of their total network) to support the entrepreneur. Collectively, the shared intentionality of those supporting the entrepreneur has been described as an '**entrepreneurial action set**.'[30]

[22] Ebers (1997).
[23] Blundall and Smith (2001).
[24] Fritisch and Kauffeld-Monz (2008).
[25] Cowan et al. (2000).
[26] Yeung (1994: 476).
[27] Jones et al. (1997).
[28] Granovetter (1973, 1985, 1995): 'economic action' is defined as action that is oriented toward the allocation of scarce resources to alternative uses.
[29] Burt (1983).
[30] Katz and Gartner (1988).

Relational embeddedness refers to the extent to which economic actions are affected by the **quality** of actors' personal relations. In contrast to structural embeddedness, relational embeddedness has more direct effects on economic actions and outcomes.[31]

Temporal embeddedness refers to the history of business transaction relationships and associated expectations that entrepreneurs and others bring to the network which will influence future business transactions.[32]

Resource embeddedness refers to the network acting as a 'mechanism' to leverage resources from their owners. Economic rationalisation leads to the notion of the cost and benefit of network engagement and exchange that will be affected by the resource needs of the entrepreneur and enterprise at a given point in time.[33]

A **100% degree of *network cohesion*** is attained if all actors of a network are directly linked to each other. Cohesion may be a key driver of collaborative innovations because it facilitates trust building and development of common norms, such as modes of conduct.

Network *size* is defined as the number of direct ties involving individuals in the network. Large networks tend to be characterized by low densities, although they can involve rather strong ties.[34]

While network size is **positively related to a higher birth rate of new companies and initial performance,** there is conflicting evidence to support the effect of network size on enterprise survival.[35]

'Strong Ties' and 'Weak Ties'

Strong ties can enhance enterprise performance directly through trust building, information transfer and joint problem solving arrangements.[36] As noted by network scholar Ronald Burt, *"a person with a poorly structured network that **includes just one well-placed contact** can do well through that contact's sponsorship regardless of how well the person's network as a whole is structured".*[37]

Weak ties can enhance enterprise performance, with 'vaguely defined' network relationships providing the freedom for entrepreneurs to act upon opportunities without being bound by obligations and expectations.[38] Similarly, information obtained from weak ties is more likely to be unique and less likely to be redundant, with *diversity of information* from weak ties used to explain the introduction of innovations into organisations.[39]

Weaker network ties may be more important during the **exploration or idea generation stage**, while stronger tie engagement is most appropriate for **innovation implementation or exploitation**.[40]

More developed firms can obtain a balance between essential tie strength and local network embeddedness, on the one hand, and the avoidance of 'cognitive lock-in,' (i.e. closed network limitations) on the other hand, by **searching for heterogeneous knowledge outside their network**.[41]

Motivations to Join a Network

[31] Granovetter (1995).
[32] Berger et al (1995).
[33] Casson (1997).
[34] McEvily and Zaheer (1999).
[35] Reese and Aldrich (1995).
[36] Uzzi (1997).
[37] Burt (1992: 272).
[38] Ibid.
[39] Granovetter (1985).
[40] Gronum et al. (2012).
[41] Fritisch and Kauffeld-Monz (2008).

Establishing and maintaining strong network ties require specific investments, particularly in managing networks, which identifies the need to understand what motivates people to join networks and remain actively engaged.

On the one hand, people will **invest in social opportunities** from which they expect to gain or profit. Social investment may be considered in terms of **transaction cost economics** where social activities are motivated by entrepreneurs and enterprises attempting to minimize communication, information search and other costs associated with seeking resources, capabilities and customers.[42]

As individual or organizational interests are presented and the potential for mutual exchange explored, network actors cannot help but consider the costs and benefits of exchange.

On the other hand, social investment may involve a '**joint value maximization principle'** whereby the focus is on exchange partners and the emphasis is on collective value.[43]

Reciprocal value exchange may be a key feature of networks that attract those with complementary needs and resources, which can create a **collaborative culture**, as seen with successful entrepreneurial ecosystems.

However, the **logic of collective benefits** does not preclude those motivated by self-interest who do not invest resources in mutual gain. The ***free rider* phenomenon** may occur in networks from a conscious decision not to contribute or from the lack of resources to exchange.[44]

Thus, the **energy that drives the network process** draws from both calculated and social interest and a blending of commitments in individual network ties that creates ongoing exchange within the network and its level of 'social embeddedness.'[45]

Entrepreneurial Networking

Entrepreneurs may engage in *multiple networks* that serve different functions.[46] They include:

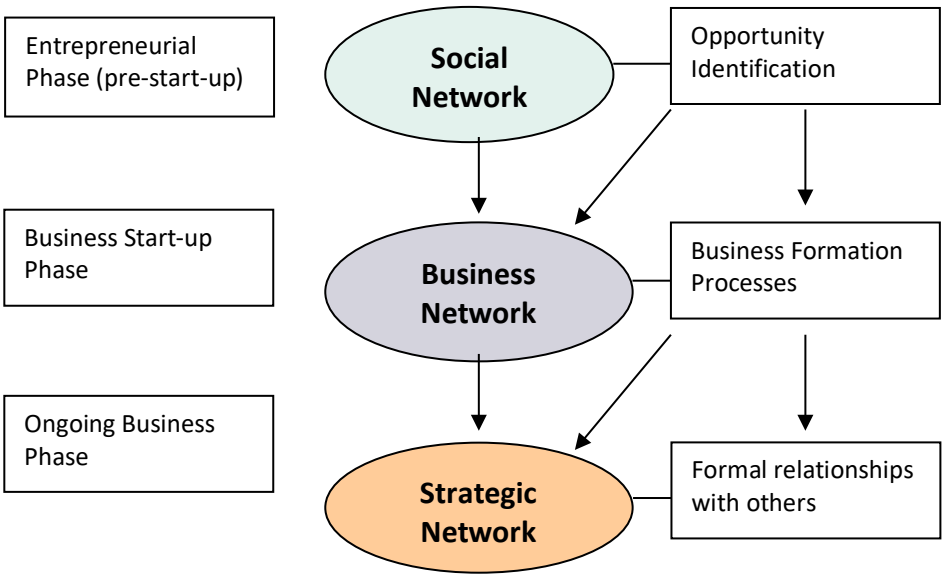
- **Information networks** that provide business intelligence such as business opportunities and information and referrals and introduction to others;
- **Exchange networks** that provide entrepreneur and enterprise with needed resources, including services support and assistance;
- **Networks of influence** that create legitimacy and barriers for competitors, and include opportunities for entrepreneurs to build special relations with potential partners, collaborators or corporate sponsors.
- **Networks of activity** that involve intensive entrepreneurial or product development activity, as observed in a seed accelerator.

Legitimacy is a necessary hurdle for new enterprises to overcome in order to access resources from others. Certain network affiliations may contribute more positively than others in gaining legitimacy and developing a desirable marketplace reputation.

The network model shown in **Figure 1** identifies social networks as a starting point for refining the entrepreneurial opportunity, where entrepreneurs rely heavily on an **informal network** of local social contacts that include family, friends and acquaintances.[47] The entrepreneur's developing social network provides an 'opportunity set' from which to identify and seek to secure intangible and tangible resources.

[42] Williamson (1985).
[43] Zajac and Olsen (1993: 137).
[44] Olson (1965).
[45] Granovetter (1985).
[46] Sanberg and Logan (1998); Johannisson (2000).
[47] Birley (1985).

Figure 1: Entrepreneurial Networks[48]



Initial contacts from social networks evolve into business-focused networks that serve more immediate requirements in developing the business.

Strategic networks allow the entrepreneur and business to further develop and grow through links to other organisations.[49] Entrepreneurs rely more on **formal networks** in later stages of business development that provide access to more defined resource needs and include formal contractual arrangements with others.

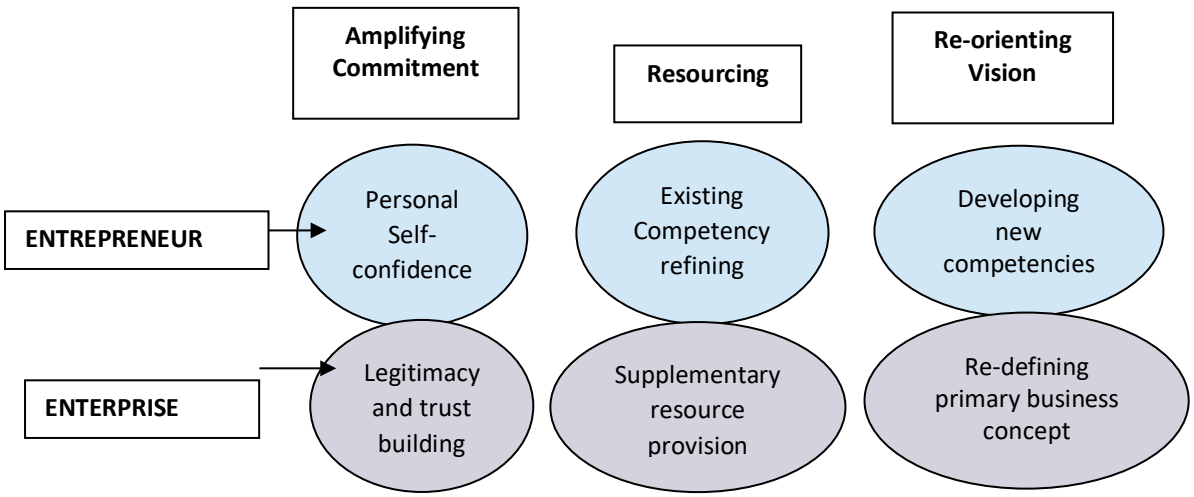
This **evolution of exchange**, or 'crystallisation of relationships', can lead to successful mobilisation of resources for the enterprise.[50] This will be influenced by the entrepreneur's social skills and motivation to seek out pre-selected business contacts, among other factors.[51]

Effective entrepreneurial networking should generate benefits to both entrepreneur and enterprise, as shown in Figure 2. The **entrepreneur, as main network actor,** builds commitments, gathers resources and develops and refines the business vision.[52]

Entrepreneurs also prefer to network with and learn from their peers,[53] with entrepreneurs creating an environment that is understood and operated by the entrepreneur, since the networking process is the enactment of the environment.[54]

[48] Butler and Hansen (1991: 3).
[49] Upson et al (2017); Vătămănescu et al. (2020).
[50] Larson and Starr (1992).
[51] Garnsey (1998).
[52] Johannisson (2000).
[53] Motoyama et al. (2014). A key motivator for joining leading accelerator programs is the strong desire to work closely with other dynamic entrepreneurs (Brown et al. (2019), which corroborates research showing that the main benefit of accelerators is less about hard forms of transactional support (i.e. "know-how") and more about enhancement of social capital or "know-who" (Seet et al (2018).
[54] Jack et al. (2008).

Figure 2: Functions of Entrepreneurial Networking[55]



Networks can provide enterprises with **advantages of larger size**, through more access to resources, complementary skills and capabilities that are not internally available.[56] Small firms usually have specific characteristics compared to large companies and are more dependent on their local area due to their small size.[57]

Networks also allow the enterprise to form collaborative alliances and partnerships with companies, universities and research institutions, among others, to overcome size and capability limitations.[58]

Networking with competitors, rather than upstream and down-stream business partners, fosters firm growth in some sectors.[59] **Service provider 'intermediaries'** have been shown to be indispensable for small manufacturing companies – whose activity is focused entirely on production – who seek to gain complementary competencies from academic and industrial research centres, but who are unlikely to establish such relationships on their own initiative.[60]

As the enterprise grows**, network relationships may evolve** from simple single-dimensional personal exchanges to multi-layered inter-organisational relationships. As the needs of the entrepreneur and enterprise develop and become more complex, **different types of networks may be sought**.[61]

Network Evolution

Networks are not static social entities, but evolve through repeated social interactions and **'continuously organising processes,'** where business relationships and links, ties and bonds between individuals provide sources as well as effects of change.[62]

[55] Johannisson (2000).
[56] Gronum et al. (2012); Pittaway et al. (2004).
[57] Marzo and Scarpino (2016).
[58] Jordao and Novas (2017).
[59] Brown and Butler (1995).
[60] Russo and Rossi (2009).
[61] Falemo (1989).
[62] Hakansson and Snehota (1995); Johannisson (2000).

As individual ties in a network are unique, ongoing entry and exit of different actors ensures that the **evolution of the network does not follow a predictable path**.[63] Instead, the processes of network interaction are more cyclical and iterative.[64]

Network evolution may be influenced by policy and governance mechanisms, where **introduced changes to social structures** can influence the shape and modes of operation in regional networks.

Within some policy circles, there is an expectation that innovation and economic benefits will **spillover as a result of efforts to raise the level of socialized interaction**.[65]

While this may lead to enhanced social interactions and knowledge flows at the regional level, it does not account for the large proportion of economically beneficial knowledge.[66]

Network capital, consisting of relational assets - in the form of more strategic networks designed to facilitate innovation, and accrue economic advantage - better explains the means through which economically beneficial knowledge is generated.[67]

A more **outcome oriented approach** is identified with policies that encourage the development of networks with a clear strategic, and often task-specific, focus to their activities.[68] At the same time, attention must be paid to ensure that such mechanisms are well designed to enable rather than constrain network advantages. **Challenges of network governance** are further discussed in section 5.

[63] Walker (1998).
[64] Ardichvili et al. (2003).
[65] Casson and Della Giusta (2007).
[66] Hauser et al. (2007).
[67] Huggins et al. (2012).
[68] Batterink et al. (2010).

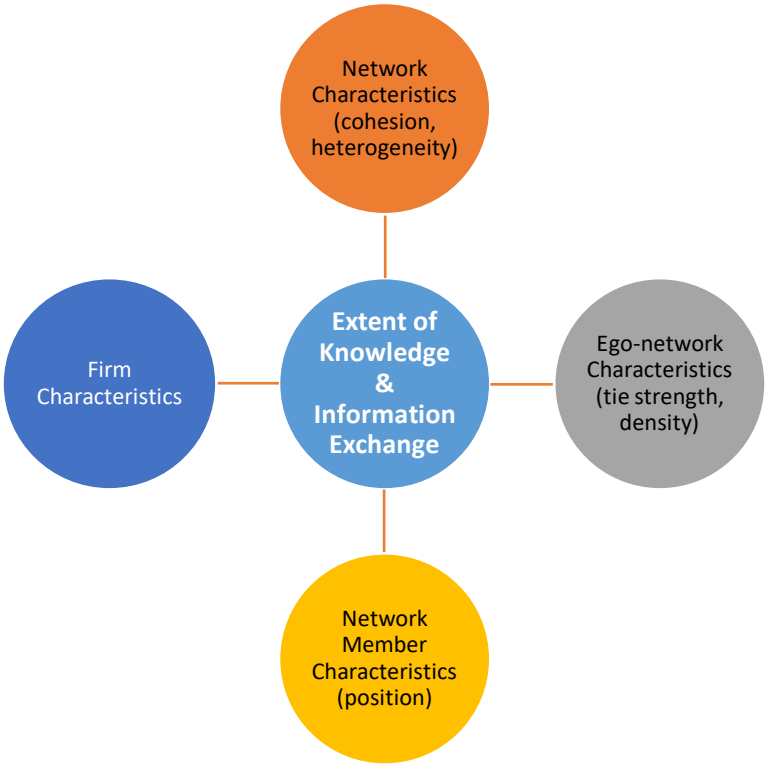
3. REGIONAL NETWORKS AND ENTREPRENEURIAL ECOSYSTEMS

This section examines regional networks, entrepreneurial ecosystems and the concept of smart specialization, which highlights the importance of cross-functional and external networks. The role of network intermediaries is also presented.

3.1 Regional Networks

Regional network advantage relies on business, technological and scientific information and knowledge diffusion and exchange through spatial networks.[69] Figure 3 identifies four spheres of influence that can determine the extent of regional exchange.[70]

Figure 3: Determinants of Regional Knowledge and Information Exchange



The **cohesiveness of an interconnected regional network** is influenced by characteristics of each network member and density of different ego networks drawn in from the region (with ego networks comprising people to which the individual or firm are directly linked).

Individuals will differ in how they identify, cultivate and manage network relationships and in the beneficial outcomes of these efforts, even when network participants have 'equal access' to regional knowledge and information,[71]

[69] Maggioni et al. (2014).
[70] Fritisch and Kauffeld-Monz (2008: 10).
[71] Cooper and Folta (2000).

Absorptive Capacity

Regional network advantage through knowledge and information exchange may require high levels of **'absorptive capacity,'** which suggests that the ability of entrepreneurs and firms to **recognize and develop new opportunities** depends on their capacity to adapt and use critical knowledge generated externally.[72]

At the policy level, improving regional **absorption capacity** could strengthen the **entrepreneurial discovery process**, particularly if regional transformation is reliant on exploiting new sources of knowledge.[73] This could include increasing network participation by research-led enterprises and R&D intensive organizations, building relations with external knowledge suppliers and attracting innovative individuals from outside and anchoring them to the regional innovation system.

Network advantage extends to strategic networking**,** where **inter-organizational relationships** can lead to more tangible exchange activities that are necessary if local entrepreneurial ventures are to grow and scale.[74]

However, developing enterprises and SMEs may not have their own mechanisms for systematizing internally developed information, knowledge and 'know-how.' Additional support provision may be beneficial to improve the absorptive capacity of SMEs.

Supporting Regional SMEs in Managing Knowledge

Support for SMEs in managing and exploiting new knowledge includes professional and personal training to improve relational capital, systematize knowledge in processes, technologies and to develop organizational cultures,[75] based on learning in a network.

At the regional level, policy could help to facilitate a context favorable to establishing common interests, stimulating knowledge sharing and facilitating formation of alliances between regional SMEs to take advantage of emerging business opportunities and improve the economic viability of undertakings through innovation at strategic levels.[76]

Does Proximity Matter in Regional Networks?

With the advent of modern modes of communication, **proximity in a physical sense appears less limiting** on inter-organisational linkages.[77] The COVID-19 pandemic has further highlighted the question of *whether proximity matters* in providing network advantage.

Proximal social networks are **collective repertories of prior experiences that provide learning and advice** on the competencies required to build and operate a successful new venture.[78] Trust and relationship building to facilitate exchange and transfer of such knowledge reinforces the importance of embeddedness in networks and spatial proximity to network partners.[79]

Research suggests that **trade relations become less personalised and less embedded in evolving social relations** the greater the geographical, social and cultural distance between the traders.[80]

[72] Cohen and Levinthal (1989); Boschma and Capone (2015); Ghinoi et al. (2021).
[73] Foray (2014).
[74] McGrath and O'Toole (2013).
[75] Organizational culture refers to the set of concepts and habits, norms, beliefs, rituals, values, feelings and perceptions of SMEs and their networks that influence or determine the behavior of their actors (Jordao and Novas (2017).
[76] Mason et al. (2008).
[77] Hausmann (1996).
[78] Johannisson (1995).
[79] Fritisch and Kauffeld-Monz (2008).
[80] Granovetter (1985).

In the case of **entrepreneurial venturing**, both proximity and time appear critical for networking success. **Proximity** favours personal introductions, initiating and building personal ties and the opportunity to meet and consult, while **time** favours development of trust and shared understanding that facilitates the exchange of knowledge and resources.[81]

The benefit of engaging within a network lies within the flexibility for entrepreneurs to **remain a semi-autonomous node** in their area of specialism whilst also accessing the regional resource pool. This acknowledges that exchange in a social network is mainly through voluntary 'barter' and that ultimately, **knowledge is held at an individual level.**

Yet, **spontaneous social interaction** does not automatically lead to the spread of knowledge within networks, as the mere creation of structural links between organizations does not guarantee the creation and share of knowledge.[82] This requires **some degree of organisational, technological, cultural and social proximity** to make network collaborations effective and productive.[83]

While regional network interactions and exchange should lead to an **efficient allocation of local resources** and creation of new venture opportunities,[84] **overly formal and institutionalized relationships** may unintentionally create network barriers to knowledge exchange, as rigid practices and policies might not enable relationships to be identified and formed autonomously.[85] **Premature formalized relational agreements** may also inadvertently subvert the spontaneity and flexibility necessary for innovation to occur.[86]

Facilitating network value through proximal social network is crucial to establishing and maintaining network participation without overly formalizing interactions.[87] External efforts to build networks often fail because 'value-add' elements and capabilities are absent among external network builders. The importance of **network intermediation** is discussed further in section 3.4.

[81] Lundvall (1992); Johannisson (2000).
[82] Richardson, (2013). While Roger's (2003) diffusion of innovation theory suggests that social networks are conduits for the diffusion of ideas and practices, demonstrating network impact on knowledge diffusion is made difficult by multiple contextual factors, such as the coexistence and strength of personal and professional relationships that alter the usual dynamics of diffusion (e.g. Ceci, and Iubatti, 2012)
[83] Crescenzi et al. (2016).
[84] Acs et al. (2014).
[85] Scott et al. (2019).
[86] Slater et al. (2013).
[87] Gelsing and Nielsen (1996); Pihkala et al. (1999).

3.2 Entrepreneurial Ecosystems

Entrepreneurial ecosystems have attracted much attention from policy makers. An entrepreneurial ecosystem is an **inter-connected network** consisting of various stakeholders, including entrepreneurs (individuals), start-ups, SMEs and large corporations, institutional actors (government and private) and the process of entrepreneurship.[88]

This network of capabilities and relationships facilitates entrepreneurship in a given place, which recognizes **entrepreneurship as largely a local phenomenon,** with the rates of entrepreneurial activity varying substantially by region.[89]

Entrepreneurship is socially constructed and **co-evolves with the similarly socially constructed and dynamic development of regions** and places, necessitating that entrepreneurial practices be adapted to local conditions.[90]

Silicon Valley, for example, has thriving networks where high-profile entrepreneurs and venture capitalists interact and a unique structure and culture that drives entrepreneurial behavior and generates high levels of successful new ventures.[91] Many regions have attempted to emulate this distinctive socially constructed ecosystem with limited success. A major reason why efforts to transplant the ecosystem of Silicon Valley to other locations have been unsuccessful is that the local context—key players, economic strengths and weaknesses, political realities, and cultural norms—have been ignored rather than incorporated.[92]

Entrepreneurial ecosystems also involve **industrial, technological, organizational, institutional, and policy contexts**,[93] which together frame the specific sectoral and group sub-ecosystems.[94] Compared to **innovation ecosystems,** entrepreneurial ecosystems encompass a broader set of elements in the region and **focus on entrepreneurial action**.[95]

An industry-centric view greatly simplifies the characterization of entrepreneurial ecosystems, even though a diverse set of industries each provide unique complementary and competing value offerings.[96] This can lead to geographic/industry stereotyping - such as biotech in Boston, fintech in London, or mobile in Singapore.[97]

An **entrepreneurial ecosystem is a feature of the broader economic ecosystem** in which it is embedded, with the economic ecosystem the 'superset' of complex productive interactions and relationships that functionally define the regional economy in its entirety.[98]

A **complex system perspective** of entrepreneurial ecosystems suggests that actors and the system are self-organizing and adaptable.[99] This suggests that **no single agent be in control of the behaviors of an entrepreneurial ecosystem or its actors**, even though a high-profile entrepreneur, investor, or philanthropist might play a key role in an ecosystem in terms of capital, legitimacy, or connections.[100]

Similarly, although some organizations (e.g., a leading accelerator) might be more influential than others,[101] the behaviors and structure of the ecosystem are emergent and arise from self-

[88] Roundy et al (2017); Spigel (2017); Mason and Brown (2014).
[89] Acs and Armington (2006); Feldman (2003).
[90] Saxenian (1994); Isenberg (2010); Malecki (2018).
[91] Saxenian (1994); Lecuyer (2006).
[92] Engel (2015).
[93] Autio et al. (2014).
[94] Harrington (2017).
[95] Malecki (2018).
[96] Delgado et al. (2010).
[97] Breschi and Malerba (2001); Basole (2019).
[98] Auerswald and Dani (2021).
[99] Roundy et al. (2018).
[100] Feldman and Zoller (2016).
[101] Albort-Morant and Oghazi (2016).

organization rather than 'top-down' control, built out the ego networks and micro-interactions of its individual participants, which, when aggregated, construct the complex system.[102]

Anecdotal evidence suggests that if one agent or organization is too heavy-handed in its attempts to direct an entrepreneurial ecosystem, it can harm its cohesiveness and functioning.[103]

The **purpose of an entrepreneurial ecosystem is its own renewal** and continuous formation of new firms through the support of the ecosystem and existing and prior entrepreneurs (i.e. entrepreneurial recycling).[104] Thus, an entrepreneurial ecosystem is likely not to be tied to a single technology or industry, as successful ones possess **an entrepreneurial dynamism that transcends industries and individual technologies**.

While a complex system perspective suggests that entrepreneurial ecosystems are **geographically bound, they also operate externally**.[105] Indeed, network advantage for entrepreneurial ecosystems extends beyond the local entrepreneurial discovery process to encompass new knowledge exchange relationships that **connect the region with other regions**, irrespective of their geographical location.[106]

Individual and organizational linkages and relationships outside of the ecosystem ensure that the region is connected at some level with other regions. Drawing in external inventors from knowledge-intensive regions, for example, has been shown to **increase the productivity of local inventors**,[107] with this interconnectivity facilitating access to more dispersed international networks that produce additional knowledge spillover opportunities.[108]

This **highlights the importance of relational networks**, as knowledge spreads following flows and absorption patterns that may not follow a geographical pattern.[109]

Established versus Emergent Entrepreneurial Ecosystems

Research identifies the importance of distinguishing between established versus emergent entrepreneurial ecosystems. This is **relevant for regions like Alberta,** where emerging ecosystem activity is seen in sectors such as artificial intelligence (AI), machine learning and data analytics, agriculture tech (e.g. 'smart ag'), med tech and clean tech.

In **established entrepreneurial ecosystems**, individuals and organizations typically spend time undertaking standard organizational maintenance activity, in additional to developing products or processes or creating new knowledge and innovating.[110] An established ecosystem **helps entrepreneurial actors find established partners** who will provide necessary resources[111] and help the local region further grow.[112]

By comparison, **emerging entrepreneurial ecosystems** are less likely to display material elements to the same degree,[113] and may **seem more like knowledge systems,** with their focus on innovation and

[102] Nicolis and Prigogine (1977); Roundy et al (2018).
[103] Feld (2012).
[104] Roundy et al. (2018; Malecki (2018).
[105] Roundy et al. (2018).
[106] Maggioni et al. (2014).
[107] Zhang et al. (2014).
[108] Lorenzen and Mudambi (2012); De Noni et al. (2018).
[109] Transnational entrepreneurs attracted to leading accelerators provide external knowledge linkages, as they embed themselves in new networks while maintaining network ties in their home market (Brown et al. (2019). Another example is the embeddedness of network actors in national and global value chains.
[110] Autio et al. (2018); Spigel (2020).
[111] van Rijnsoever (2020).
[112] Stam (2018).
[113] Malecki (2018).

not yet on material output.[114] Ecosystem supporting infrastructure is likely to be absent, low, or aligned with a local institutional system such as a university.[115]

Culture in Emerging Entrepreneurial Ecosystems

A study of **Alberta's emerging regional ecosystem** around artificial intelligence (AI) suggests the need for policy attention not just on material resources but on the **evolving cultural understandings of *possibilities*** among system members that shape the AI domain.[116]

Policy makers are encouraged to build a **strong cultural fabric** that includes coordinating across university, funding agencies and business sectors to help catalyze policy solutions through formal partnerships, and **more tightly *culturally integrating* key stakeholders** in the broader innovation ecosystems.[117]

Ecosystems are typically analyzed using standard **visible material metrics**, such as new products, patents, startups, VC funding, jobs, and successful exits. However, **emerging entrepreneurial ecosystems** provide possibilities for members that may not be signaled by these metrics, such as the adoption of new business models and new ways of creating and offering value that go beyond existing value chains and expand or create new stakeholder networks.[118]

Emerging ecosystems may also be more difficult to study because **existing material resource and knowledge ties do not track closely with more radical innovations** underpinning new systems.[119] The speed of new product development in emerging entrepreneurial ecosystems may be on a different scale than in most established ones.[120] Companies pursuing radical innovations, compared to incremental innovations, are more likely to safeguard their proprietary knowledge and engage in partnerships and 'coopetition' only in the launch phase to reduce risks and avoid tensions with potential partners.[121]

Emerging systems may therefore challenge policy makers in making informed decisions about the level of public involvement **in fostering emergent entrepreneurial processes,** providing market development incentives and providing regulatory guidelines for new technologies.[122]

3.3 Smart Specialization Strategy

Smart specialization strategy (S3) is an innovation-based regional development approach that combines the **support of entrepreneurs to 'discover' new domains of future opportunities** and the **promotion of structural changes to the region** with non-neutrally designed policy instruments.[123]

Entrepreneurial discovery is a bottom-up process highly dependent on the ability of diverse local players **to create strong connections** with each other.[124] Areas of new opportunities emerge or are 'discovered' through **close network interactions** among domestic firms, local universities and public research organizations and global value chain (GVC) lead firms. One example is the Canadian Agri-Food Automation and Intelligence Network (CAAIN), which involves agri-food producers assisting tech

[114] Kay et al. (2018).
[115] Thomas and Ritala (2021).
[116] Hannigan et al. (2021).
[117] Whitehead et al. (2020).
[118] Ibarra et al. (2018).
[119] Autio et al. (2018).
[120] Stam (2018).
[121] Bouncken et al. (2018).
[122] Hannigan et al. (2021); Seidel et al. (2020): general acceptance of policy involvement holds where collective action failures hinder early stage ecosystem activities that can serve the public good in the long term, but are unlikely to generate short term profits, and therefore are not taken on by the private sector without policy support.
[123] Foray (2015); Santoalha (2019).
[124] Landabaso et al. (2014); Asheim et al. (2017).

companies to understand their unique needs/challenges and develop technological solutions to challenges in the sector.[125]

S3 requires **leveraging resources and capabilities embedded in local networks**, which highlights the importance of inter-regional connectivity amongst key stakeholders.[126] The **absence of entrepreneurs and businesses** will limit technical and commercial knowledge exchange that enhances the regional capacity to innovate.[127]

S3 is about discovering new 'ladders' or new production and market uses of local resources and capabilities *and* developing **areas of industrial specialization** that are cognitively related.[128] Industrial specialization is considered 'smart' if it **grows out of the region's own traditions** instead of the (typically non-replicable) experiences of well-known successful regions located elsewhere.[129]

Value Added and Related Specialization

Value added specialization requires regions to be able to identify 'niches' or specific domains for present and future competitive advantage, and relevant linkages and flows of goods, services and knowledge that reveal possible patterns of integration with partner regions.

Related specialization is defined as the concentration of high interdependencies between specialized industries within a region, relative to the national level of concentration. Related specialization is found to be positively correlated with entrepreneurial outcomes across U.S. metropolitan areas.[130]

Smart specialization can create comparative advantage **only if it builds upon the public and the private sector capabilities in the region**, including co-aligning with the region's lead businesses and mobilizing local entrepreneurial potential.

S3 also requires the mobilization and connection of **extra-regional resources** with inter- and intra-regional resources, as discussed below.[131]

Regional Diversification and Extra-Regional Knowledge Networks

Related diversification of a region's dominant technology is based on the knowledge possessed by the region, but its **extension towards new dimensions may require additional knowledge**, which may not be available locally.[132]

The discovery of **new domains of opportunities** may require the integration of the local knowledge base with scientific or technological knowledge developed in universities, private research institutes or specialized research groups **located in other regions**.

Identifying those regions that possess complementary knowledge, selecting the partners to cooperate with or establishing initial connections, are complex and non-trivial tasks, requiring highly capable network brokers and intermediaries as part of the discovery process.

Global Value Chains

Regions seeking to benefit from S3 should assess how the local production stage of **global value chains (GVCs)** can become a building block for regional innovation strategy.[133]

[125] CAAIN involves technology and agri-food companies, universities, colleges, and research institutions working together to create new technological solutions for Canada's agricultural and food producers: https://caain.ca/.
[126] Dubois et al. (2017).
[127] Hermans et al. (2017).
[128] Santoalha (2019).
[129] Varga et al. (2018).
[130] Auerswald and Dani (2021).
[131] Dubois et al. (2017).
[132] Varga et al. (2018).
[133] Foray (2014).

GVCs represent the new 21st century form of global trading, which connects regions and countries globally in 'chains of value-added activities'.[134] These chains are designed by trading companies, including globally-oriented local firms, and multinational enterprises (MNEs) and result from the fragmentation and internationalization of production and operations and the globalization of market demand.[135]

GVCs involve a **vast interconnected network** of contract relationships, crossing geographic and technological boundaries, which are based on a sequence of value-added activities across input-output markets. GVCs are determined by production technologies, manufacturing processes and final products and services and **correspond both with market segments and product-based industry segments.**

GVC integration into S3 may benefit from an **actor and network approach** to include:

1) Mapping regional firms, technologies, innovators, and broadly, innovation capabilities for smart specialization.
2) Engaging with GVC suppliers and local MNEs and subsidiaries (who are at the intersection of global and national or local sources of knowledge) that can deploy expertise and know how to leverage local capabilities and generate new entrepreneurial opportunities.[136]
3) Coordinating and co-designing, with upstream and downstream partners, the development and exploitation of 'local discoveries' that are better informed by the needs of global markets.

Drawing GVC integration into a regional smart specialization strategy is an opportunity to further strengthen local research, development and innovation (R&D&I) capacities and support new technology-based firms exploiting R&D&I outputs that can serve local and global markets.[137]

For example, developing specific activities or technologies that can be used in multiple supply chains, e.g. producing a standalone component that can be plugged into a variety of downstream products, could lead to **entirely new innovation strategies that go well beyond GVC dependence**.

From a policy perspective, smart specialization or GVC integration on its own will not be enough to overcome the barriers to regional actors' engagement in 'discovery processes'. **S3 and diversified specialization** requires:

- A framework to **identify systematically technological opportunities** and to develop capacity in those technologies that draws on knowledge bases of the region and leads to technological upgrading.[138]
- **Non-neutrally designed policy instruments** that support effective regional routines, capacities and practices of governance,[139] and local government who can support institutional structures for S3.[140]
- Strong incentives (and appropriate policy instruments) to **shift expectations in the direction of long-term R&D&I-oriented** activities and to raise the level of involvement in the international knowledge creation and diffusion process.
- Promoting informal networking to strengthen formal networks in new technologies areas. This could include identifying and supporting central stakeholders, since **informal networks are primarily driven by central stakeholders.**[141] Central stakeholders include industry, business leaders and entrepreneurs, who are experienced in building networks and mobilizing resources.

[134] Todeva and Rakhmatullin (2016).
[135] UNCTAD (2013).
[136] Todeva and Rakhmatullin (2016); Mathews (2002).
[137] Radosevic (2011).
[138] Balland et al. (2019).
[139] Foray (2015); Karo & Kattel (2015); Santoalha (2019).
[140] Uyarra et al. (2020); Xing et al. (2018).
[141] Ghinoi et al. (2021).

Economic impact analysis of S3 policies may require capturing the contributions of local networks, on the one hand, and embedding their complex interrelationship with wider economic mechanisms, on the other, together shaping the impact of smart specialization policies.[142] This includes leveraging regional knowledge bases to develop radical and incremental innovations, fostering structural change to support local and global adoption and exploitation of technological and non-technological innovations (e.g. organization, marketing, supply-chain, etc.), and enabling local knowledge spillovers to strengthen firm and industrial competences and create diversity at the system's level.[143]

3.4 Regional Network *Intermediaries*

Network intermediaries are **individuals or organisations that generate value to other actors** within a system of innovation.[144] Intermediaries includes **those who may charge to facilitate exchange of resources** between different network groups.[145]

Network intermediation may be part of **regional policy intervention,** intentionally established between crucial nodes to stimulate interactions, information flows and knowledge exchange between actors that would not otherwise interact.[146]

Organising and managing a network that is comprised of various actors, roles, expectations and perceptions is challenging,[147] particularly when actors have diverse interests, goals and motivations. Facilitating value captures **within dispersed networks** is particularly challenging.[148]

Network intermediaries can play a key role in establishing shared understanding and mutuality between participating actors.[149] Network intermediaries can influence the shape and strategic direction of policy, which may result in **convergence around the interests of actors within the region**.[150] Therefore, a key function of intermediaries may be developing consensus.[151]

Successful intermediation requires harnessing local personal knowledge and knowledge networks to add value to network actors and enterprises.[152]. More intensive intermediation may involve **making use of knowledge vested in pre-existing relationships** and acquiring 'new' knowledge to fulfil identified and explicit 'knowledge gaps.'

Successful intermediation requires having a better awareness of the needs, resources and competencies of network participants.[153] Intermediaries may access regional knowledge using digital platforms that have information on the interests, knowledge and competences of participants as well as actively developing new relationships with key network nodes.[154]

Facilitating knowledge exchange, as discussed earlier, will also depend on the **underlying absorptive capacity of network participants**, to absorb and internalize new knowledge and knowledge practices, which requires participant skills and capabilities and takes time. Intermediaries need to constantly update and advance their knowledge base,[155] and to **systematically make use of external and internal sources of knowledge**.[156]

[142] Varga et al. (2018).
[143] Carayannis et al. (2017).
[144] Tran et al. (2011).
[145] Kanter (1982): innovators may induce support from others that include financial incentives (including equity), resources, information, policy promises, learning experience and personal development.
[146] Cowan and Jonard (2004).
[147] Steier and Greenwood (2000).
[148] Johnson et al. (2008).
[149] Tjong et al. (2015).
[150] Bouwen (2002).
[151] Meyer et al. (2017).
[152] Huber (2012).
[153] Kauffeld-Monz and Fritsch (2013); De Silva et al. (2018).
[154] Howells and Roberts (2000).
[155] Mount et al. (2015).
[156] Escribano et al. (2009); Lin et al. (2012).

Developing knowledge of the wider entrepreneurial ecosystem is vital to intermediaries in order to identify talent and new opportunities to combine knowledge, bring suitable parties together for collaboration, mitigate uncertainty about the value of collaboration, and assess the potential and value of available intellectual property.[157]

Overall, capable intermediaries can have a significant impact on network value creation. As network integrators and shapers, intermediaries can **impact the system architecture in a region,** in addition to direct support for engaged actors, enterprises and organizations.[158]

Accelerators as Network Intermediaries

Accelerators can play an intermediary role in providing start-ups with enhanced relational connections and networks.[159] Many seed accelerators **resemble a closed network, or 'cocoon'** which allows founders to engage in exploratory trial and error while developing their projects; supported by the accelerator's own network of mentors, investors and alumni.

Accelerators can facilitate 'network advantages' as intermediaries, depending on the extent to which they:

- Embed founders in knowledge-rich environments and 'accelerate' venture development through '**novel learning' effects**.[160]
- **Provide brokerage to founders** to overcome knowledge and inexperience liabilities and to apply novel interpretations to the product-market fit. This includes the role of mentors in connecting founders with other groups and networks.
- Reduce transaction costs by offering a **combination of services or functions** that are each individually costly for entrepreneurs to find & obtain.[161] Aggregating high potential start-ups in a single location may reduce opportunity search and screening costs for regional investors.[162]
- **Demonstrate significant value** that motivates more founders locally and from outside the region to apply, thus stimulating external knowledge flows and new knowledge exchange relationships.[163]
- Contribute to the region's entrepreneurial discovery process and 'innovative milieu.' [164]

Studies of global seed accelerators suggest that they may help develop the ecosystem by speeding up the failure of some firms,[165] while serving as validators of promising innovations.[166] In the context of impact measures, accelerators receiving government support might be judged on the impact of their expertise; namely, their expertise in building connections, developing founders, coordinating mentorship, and selecting participants (both founders and mentors).[167]

Research from Europe has shown that most of the observed entrepreneurial practices in seed accelerators crucially rely on extra-regional resources and thus remain only incompletely embedded into the respective regions.[168] This suggests that **accelerators should be 'architecturally aligned' in the region's knowledge and innovation system,** with accelerator managers recognizing their role and contributions to the local ecosystem and wider economic system.

[157] Kodama (2008).
[158] De Silva et al. (2018).
[159] Gregson (2021).
[160] Hallen et al (2020).
[161] Hochberg (2016).
[162] Fehder & Hochberg (2014).
[163] Basco et al (2018).
[164] Clarysse et al (2005).
[165] Yu (2020).
[166] Drori & Wright (2018).
[167] Goswami et al. (2018).
[168] Kuebart & Ibert (2019).

4. NETWORK ANALYSIS

This section examines network analysis, its challenges, and how it is used for assessing and measuring networks. Different methods to be discussed include social network analysis (SNA), mixed method SNA and value network analysis.

4.1 Challenges in Network Analysis

A key challenge to network analysis is that **social relationships are often difficult to identify** beyond individual-to-individual connections.[169] In larger networks, difficulties arise in tracking relationships involving multiple social interactions, which include individuals representing enterprises and organizations, which makes **attribution of effects** from (strong or weak) relational ties particularly challenging.[170]

Most social network research is quantitatively focused, drawing on primary data collected through **name-generating surveys**, such as snowball sampling or roster recall.[171] **Snowball sampling** is where network actors report on others with whom they are tied, who are then asked for their connections until a data set emerges.

While the snowballing method can reveal the composition and intensity of relational ties, this process can potentially exclude those not connected with the initial set of individuals or those with smaller networks.[172] The **roster recall method**, where all network members are given a roster of others and asked to describe their connections with those individuals, can also be an unfeasible and expensive method for larger networks.[173]

Quantitative or 'count-based' metrics do not adequately capture the **unequal importance of network actors and processes** over time.[174] Traditional measures may also not capture the flows of ideas, advice, and knowledge that are often **exchanged informally** or their impact on recipients and the network as a whole.[175]

Traditional socio-metric sampling techniques also have limitations in identifying and measuring important network-level structures and constructs,[176] and struggle to capture network changes over time, as well as development of new networks.[177]

A **long-term view** is required to identify the co-evolution of firms and resources in a place.[178] At the same time, study participants may refuse to continue or otherwise drop out of studies over long periods of time, which can limit longitudinal research.

Measuring Network Attribution

A key question guiding this report is how regional networks benefit entrepreneurs and enterprise. Measuring network attribution effects on entrepreneurship is difficult for a number of reasons:

- **Multiple factors explain enterprise development and growth.** They include random factors and those uncontrolled by the enterprise (chance, timing, macro-economic change, sectoral

[169] Williams and Shepherd (2015).
[170] Albrecht et al. (2014).
[171] Knox et al. (2006).
[172] Borgatti et al. (2013); Marsden (1990); Scott et al. (2019).
[173] Burt (1983).
[174] Roundy et al. (2017).
[175] Johannisson et al. (2002); Smith (2016).
[176] Erickson & Nosanchuk (1983); Carpenter et al. (2012).
[177] Rivera et al. (2010); Snijders (2011).
[178] Lowe and Feldman (2017).

conditions) as well as various systematic factors such as capital investment, entrepreneurial skills and motivations, location, etc.[179]

- Evidence is lacking as to how **network evolution** affects business growth and the processes in gradually accumulating capabilities and resources.[180] Understanding of the **initial stages of network development** is particularly lacking.[181].
- **Entrepreneurial learning and knowledge accumulation,** a critical collective process and outcome for the enterprise, is not easily traced as deriving exclusively from any specific network.
- The **social or informal character of many networks** makes it difficult to track network effects on the ability of new firms to *assemble* resources and capabilities.[182]
- An entrepreneur's 'network' may include **multiple networks**, as defined by the resources each network provides.[183]
- **Network structure is rarely observed** and evidence is inconclusive regarding **the most effective network structure for supporting entrepreneurship**.[184]

Measuring attribution effects in an entrepreneurial ecosystem is particularly challenging, given the complexity of identifying and measuring factors contributing to economic outcomes.[185]

The aggregated relationships amongst numerous individuals together form 'the economy' or 'politics' of the ecosystem, and will affect individual behavior through actors' perceptions of being part of an invisible collective.[186]

Establishing a clear objective for network analysis is necessary given multiple properties of networks and noted difficulties in measuring attribution effects.

This includes **establishing a coherent framework and accompanying methods of data collection and analysis** that can capture both prescribed and emergent processes of network evolution.

4.2 Social Network Analysis

Social network analysis (SNA) is used to understand **networks as economic entities** with some focus on knowledge flows, intangible outcomes and resource exchanges.[187] SNA can make visible the **patterns of information sharing** within and across strategically important networks.

Identifying **key actors in a social network** is one of the primary uses of SNA. Examples of SNA use in a regional network include:

- Examining how actors (e.g. individuals, enterprise, others) are **connected to one another at the network level** and studying aspects of interdependence among members.[188]
- Distinguishing **different levels of network relationship** and analyzing them separately.
- Studying **kinship and family ties**, with such ties particularly important for early-stage entrepreneurs but often overlooked with traditional network measures.[189]
- Mapping out **all member firms in a given supply network or global value chain** to determine which firms are most important, in what aspect, to generating new entrepreneurial opportunities.

[179] Storey (1994).
[180] Gibb and Davies (1991).
[181] Grandori and Soda (1995).
[182] Malecki (1997); Johannisson (2000).
[183] Sanberg and Logan (1998); Perry-Smith & Mannucci (2017); Sorenson & Stuart (2008).
[184] Large networks are not necessarily better than small networks; weak ties are not generally better than strong ties; having many contacts possessed of similar information offers little advantage; and the network advantage of brokerage is not reliably indicated by tie strength. E.g.: Birley (1985); Davidsson and Honig (2003); Domurath and Patzelt (2016); Semrau and Werner (2014); Burt (1992; 2019).
[185] Stam and Spigel (2015).
[186] Albrecht et al. (2014).
[187] Cross et al. (2002).
[188] Tichy et al. (1979); Wasserman and Faust (1994).
[189] Anderson et al. (2005); Arregle et al. (2013).

SNA also yields metrics that allow for analysis of the **structure of the overall network**, such as network density, network centralization, and network complexity. Structural characteristics refers to the **pattern of relationships** between actors in the network as described below.

1. **Network density** refers to the number of total ties in a network relative to the number of potential ties.
2. **Network centralization** refers to the extent to which the overall connectedness is organized around particular nodes in a network.
3. **Network complexity** is related to network density and network centralization, as denser networks **require more effort to build and maintain**, while decentralized networks (where every node is connected to all other nodes) increase complexity and require the highest coordination costs.[190]
4. **Transactional content,** which refers to *what* is exchanged when two actors are linked (see Appendix A for a list of network properties).[191]

For regional policy and intermediation efforts, SNA can be an effective means of **pinpointing breakdowns in informal networks** that cross functional, hierarchical, geographic, or organizational boundaries (e.g., new venture team formation, new product development, raising investment).

People within these networks must often collaborate effectively to benefit despite the fact that they may reside in different physical locations and/or are contributing different knowledge, resources or being held accountable for different objectives and goals.[192]

Quantitative SNA techniques are able to:

- **Identify** innovation networks, determine network boundaries, define actors within the innovation network and investigate the network position of actors.[193]
- **Capture interactions** between network actors and the social context, to better understand how innovations are implemented and diffused and to identify future opportunities.

Social Network Analysis Tools

SNA software can generate various analytic outputs that reflect individual or group-level behavioral dynamics and capture the **structural intricacy of the whole network** in a more objective way.[194] Sociograms, or **visual representations of social networks**, are used to understand network data and convey the result of the analysis.

Free and commercial social network analysis tools offer different functionality and include **UCINET, Pajek, NetMiner, and Netdraw**. Three common types of data and information are generated from these tools:

1. **Nodes** that represent the individuals, groups, or organizations being studied;
2. **Ties** that represent the different relationships among the nodes (which may be identified as insufficient, just right, or excessive);
3. **Attributes** that make up the different characteristics of the individuals, groups, or organizations under study.

Key measurements include the centrality of the social network analyzed; the makeup of its various subgroups and the nature of network ties.

A key limitation of *quantitative* SNA is that it cannot analyze reasons, motivations, and perceptions behind network structure. These issues can be analyzed by using *qualitative* SNA methods. Qualitative analysis is **well suited for studying entrepreneurial ecosystems** as complex systems because of the

[190] Marczyk (2006); Pudlák et al. (1988).
[191] Tichy et al. (1979).
[192] Cross et al. (2002).
[193] Kolleck (2013).
[194] Kim et al. (2011).

flexibility of qualitative methods (e.g., semi-structured interviewing, ethnographic observation, grounded theory, case studies).

The richness of qualitative data allows analysts to:

- Validate quantitative results as well as disclose subjective perceptions and orientations.
- Unpack multi-faceted, temporally unfolding network characteristics and tease apart different causal relationships.[195]
- Capture opinions, attitudes and perceptions on how knowledge, values, and culture, which form the basis of an ecosystem, are passed between participants.[196]
- **Detect where and how innovations and development processes may be enabled** (or constrained) due to existing structural and subjective conditions in the ecosystem.
- Provide a **retrospective or longitudinal look** at an ecosystem, as observed through case study method (see box below).

Case Studies and SNA

Case research enables an in-depth examination of the **complex features of inter-personal and organizational exchange** unavailable through other means.[197] When coupled with social network analysis, it fits the purpose of understanding how the relationships within the network occurred and evolved over time, with reference to events and changes unfolding within the network.[198]

Semi-structured interviews enable an understanding of the role of key actors and identify the actors' history in relationships, their views on the inner working of the network, e.g. how it formed, significant events, challenges, and benefits, and what they thought were the highest functioning aspects of the relationship. This further contextualizes how and why relationships form, are maintained or abandoned.

Network maps can be integrated into semi-structured interviews in order to generate narratives and disclose relevant relationships and action orientation.

Case studies can provide more detailed explanations of the content of relations and what actually goes on in and between connections.[199] This may overcome the challenge of gathering data on crosscutting relationships in networks.[200]

Case analysis can also **reveal relational interdependence**, including linkages between internal and external actors, and the conditions in which knowledge resource are exchanged.[201]

As a policy contribution, case analysis can assist in **refining the structure of networked exchange** and distilling compositional features to draw out actor-level profiles and interactions amongst entities. This can then be assessed alongside a chronology of core events or policy interventions and exhibited behaviors to allow for an overview of network evolutionary processes.

[195] Graebner et al. (2012).
[196] Martens et al. (2007).
[197] Dubois and Araujo (2007).
[198] Van de Ven (2007).
[199] Jack (2010: 120).
[200] Hoang and Antoncic (2003).
[201] Hanneman andRiddle (2005).

Network Maps and Diagrams

Social network diagrams can be a powerful tool for individuals to actively shape their personal (i.e. ego) networks.[202] At its simplest level, a survey can be used to **obtain a list of people in the defined network,** with each member of the group asked to **characterize their relationship** with each other. It is important to ensure that the kinds of relationships measured are appropriate for the task at hand.

A related approach is to **put people's names on a network diagram and make the diagram available to all group members** as a basis for dialogue. Questions can then be shaped to specific lines of inquiry and designed so that they are not unnecessarily disruptive to existing network relationships.

SNA can also **provide insight into collaborative behavior within and across boundaries** that may yield performance improvement opportunities.

A simple SNA network mapping process is described below:

- A questionnaire is provided to targeted respondents, asking them to mark people in their network, defined by **efforts to contact, cooperate, collaborate, problem-solve, and idea exchange.**
- This establishes **network composition** and the diversity within each person's network (e.g., "Do you engage with the same people in your network"?).
- Respondents are also asked to **assess the quality and contact frequency for each relation mentioned** and to name those persons with whom they cooperated especially closely or had established high levels of trust.
- Respondents score their named connections' impact and the relevance with respect to the diffusion of information and the implementation of collaboration.
- This reveals the **resources that people derive** from these relationships (e.g., new knowledge, referrals, funding and other resources).
- The questionnaire can also include questions on future prospects, desires, and developmental possibilities.
- In order to visualize the networks, empirical results are entered into UCINET and mapped with Netdraw, and Pajek.[203]
- Top-down visualizations of network data are used to generate courses of action, guidance, and network management strategies with respondents and others involved in the process.

Network maps can be used to promote subjective validations of interview narratives as well as to highlight subjective perceptions, reasons, motivations, and network dynamics.

For policy makers and network intermediaries, network visualizations and empirical insights from network mapping can detect weaknesses related to network structural issues, information flows, and communication problems.

For individuals, network mapping can focus attention on the need to **invest in the development of specific kinds of relationships** (and often times, to reduce an investment being made in existing relationships that do not generate value). This recognizes that individuals have a finite amount of time to put into developing and maintaining relationships, particularly when building a new business.

Network analysis may therefore allow people to take a portfolio approach in **considering the constellation of relationships** that is worth investing time and energy to develop and maintain.

[202] Cross et al (2002).
[203] **UCINET** is a software package for analyzing and drawing social networks developed by Lin Freeman, Martin Everett and Steve Borgatti. **Netdraw** is a free Windows based program that can be used for visualizing social network data. **Pajek** are program packages for analysis and visualization of very large networks.

4.3 'Mixed Method' Social Network Analysis

A mixed method approach to social network analysis (SNA) addresses some of limitations of traditional network research methods by:

- Allows for **exploration of network structure** while not forsaking the ''qualitative observations about what is going on within a network''.[204] This helps clarify network flows, or what is transmitted across structural relationships and to what end.
- Accesses **secondary data that is less costly** (in time, data collection, and analysis) to collect and analyze; provides access to important yet hard-to-access network constructs.[205]
- Facilitates the **identification of network ties between and across levels**, such as individuals, teams, organizations or unorganized groups.[206] This can identify specific linkages that tie groups together while considering the **impact of those ties** on other social actors.
- **Identifies network actors** whose ties are disproportionately powerful within the network.[207] These individuals appear **instrumental in facilitating interactions** between disparate network actors (e.g. investors, entrepreneurs, corporations, universities, public agencies) which might not otherwise organize and form ties.[208]

A relevant mixed method SNA approach **for entrepreneurial ecosystems** is to focus primarily on use of qualitative data that can be quantified.[209] This allows for exploration of important network constructs, analysis of social capital and its consequences at multiple levels as well as the development or evolution of contributing networks.

Study variables may include tie strength, network size, density and cohesion, broker relationships, network constraint, as well as exploring what flows are transmitted across networks.[210] **Appendix B** presents a summary of stages of a relevant mixed method SNA process:[211]

A key advantage of mixed method SNA in the study of regional networks is its **potential to explore what flows (i.e. is transmitted) across networks** or how network relationships may explain advantages for those creating or scaling new ventures.

4.4 Value Network Analysis

Value network analysis involves assessing the **value creation dynamics** of entrepreneurs, enterprises and others engaging in value exchanges to support the achievement of specific outcomes and to generate economic and social good.[212]

Value is an emergent property of a regional network, so understanding the functioning of the network as a whole is key to understanding exactly how value is created. **Sustainability of the network** is also dependent upon there being a high level of both transactional and perceived value for stakeholders, particular for private sector members, who will closely monitor and evaluate the costs and benefits of their own network participation.[213]

Value network analysis examines the roles and value exchanges in fulfilling an economic or social goal or output and comprises three phases: mapping, value analysis and value creation.[214]

[204] Crossley (2009: 21)
[205] Williams and Shepherd (2015).
[206] Smith & Moody (2013).
[207] Williams and Shepherd (2015).
[208] Feldman & Zoller (2012).
[209] Sandelowski et al. (2009); Carpenter et al. (2012).
[210] Provan et al. (2007).
[211] Williams and Shepherd (2015).
[212] Allee (2008; 2003).
[213] Audretsch et al. (2009).
[214] Alle (2008).

Mapping

It is necessary to **first map out the value exchanges across the network**. This mapping method relies on three elements – roles, deliverables, and transactions, as described below.

Roles	Transactions	Deliverables
•Participants who provide contributions & carry out functions in the network •Participants can be individuals, enterprises, business units, small groups or teams, industry groups or business associations	•Transactions originate with one participant & end with another •On a network map, **arrow** is used to link representing movement, denotes direction of what passes between two roles •**Dashed lines** depict 'intangible' flows of knowledge, information & benefit. **Solid lines** are formal contract exchanges around product & revenue	•Actual 'things' that move from one role to another •Deliverable can be physical (tangible, e.g. investment) or non-physical (e.g. referral or resource commitment) •Can also be a specific type of knowledge, expertise, advice, or information about something, or a favor or benefit that is bestowed upon the recipient

Value Analysis

Once all of the critical roles, value exchanges and transactions have been identified, then it is possible to do full value network analysis. Analyzing a value network comprises three components and requires addressing key questions and sub-questions or objectives.

Component	Key question	Sub-questions/objectives
Exchange analysis	• What is the overall pattern of exchanges & value creation in the system as a whole? • How healthy is the network & how well is it converting value?	• Is there coherent logic & flow to the way value moves through the system? • Does network have healthy exchanges of both tangibles & intangibles, or is one type of exchange more dominant? • Is there an overall pattern of reciprocity? I.e. is one role extending value without a similar return? • Are there missing or 'dead' links, weak and ineffective ties or bottlenecks? • Is system being optimized, or are some roles benefiting at expense of others?
Impact analysis	• What impact does each value input have on the roles involved in terms of value realization?	• Assess how specific value inputs are bringing value or benefit to each role • Assess overall cost/benefit for each value input • Identify value realization opportunities to better leverage value received • Identify opportunities for value conversion • Link key value network transactions & deliverables to financial & non-financial scorecards
Value creation analysis	• What is the best way to create, extend & leverage value, either through adding value, extending value to other roles, or converting one type of value to another?	• How well are assets being used to create this value output? • What value features or enhancements are provided with this output? • What is the level of benefit to the business in providing this output?

Value Creation

Value creation analysis considers how value is created and what impact it has on other network participants. Five dimensions of value creation can be explored:

1. **Asset utilization** examines how well the participant is leveraging financial and non-financial assets to create value outputs
    - A simple three-point scale could be deployed, e.g. high/medium/low subjective value: **high**: asset is being leveraged or utilized very well to create this output; **medium**: asset is being utilized to an average degree; and **low**: asset is being utilized poorly or not at all.
2. **Value conversion** is achieved by converting one type of value input into another kind of value as an output.
3. **Value enhancements or value features** are created/added that make this value output unique, and include enhancing the basic input or extending a value gain to other participants. Value enhancements can be facilitated through network brokers (see section 2.1).
4. **Perceived value** focuses on the perspective of people who are the direct recipients of this value output, and could be a high/medium/low assessment from participant who receives the value input.
5. **Social value** looks at the value (or negative value in terms of costs) that outputs hold beyond the entrepreneur or enterprise, e.g. for industry, for society, and for the environment; in other words, it assesses what accrues to indirect recipients of the value outputs.

Value network analysis offers a more systematic way to assess the dynamics of intangible value realization, conversion, and creation.[215] Value conversion is one of the most challenging questions when determining the impact and benefits of a network, as **intangibles such as knowledge do not work like other resources,** but are a critical value input and output for entrepreneurs and enterprises.

Example of Value Network Analysis in Practice

A sales and marketing group of a pharmaceutical company, PharmCo, seeks to improve their ability to use customer feedback in developing new products.[216] The first step considers all groups in their network (e.g. **Participants**), both internally and externally, that play key roles in activities of the Sales and Marketing group. Key Participants in the company include four key groups: Sales and Marketing, Research, Product Development, and Manufacturing. Key Participants outside the company include: patients, healthcare providers such as doctors, payers such as insurance companies, and regulators.

Mapping Transactions involves examining intangible exchanges and related **Deliverables** involving Participants (e.g. patient requirements, disease knowledge, informal assurances (e.g. that new product costs will be covered), reports to Regulators of adverse reactions, etc.; and tangible exchanges and Deliverables (e.g. product candidates, process specifications, claims, payments, orders, etc.).

Exchange Analysis involves mapping out the overall network exchange pattern to: determine if the value system appears healthy, sustainable, and expanding; identify if there are missing or 'dead' links, weak or ineffective links, value 'dead ends,' or participant bottlenecks; and assess if the network system is being optimized. It was found that, while the Sales and Marketing group gained knowledge about requirements from patients, this knowledge 'dead ends' and is never passed on to the Research or Product Development groups. Further, there is no channel for two-way communication about disease with patients, providers, or payers. With this pattern revealed, PharmCo developed a strategy to create web-based disease 'communities,' facilitating a real-time, two-way knowledge exchange with users and providers about important research, user feedback and patient concerns.

Impact Analysis examines the inputs and value that Participants are receiving from the system and value they are contributing. Key value inputs included patient requirements, inventory levels, product

[215] Alle (2008).
[216] Alle (2002). The example described is used for illustrative purposes.

information, order information and payment information. A close look at the costs and benefits showed that careless handling of patient input results in low value gain, since knowledge does not get distributed across the company. The only exception is the payment, which traditionally is regarded as having a high positive value. The Sales and Marketing group adopted a strategy that enters patient requirements into a shared, organized knowledge bank to access of customer knowledge across the enterprise.

Value Creation Analysis, similar to an Impact Analysis, analyzes tangible and intangible costs (or risks) and gains for each value output. The Sales and Marketing is an active agent in efforts to reach the target population of patients, providers, and payers, but are not engaged in a value conversion process. It was determined to better leverage their intangible value outputs (products about disease knowledge) into more advanced knowledge products that could be turned into a revenue stream, through web-enabled communication and the launching of an on-line discussion groups to gain immediate feedback for product development. This converted a tangible value to gain back intangible value from product feedback, supporting PharmCo's strategic intent to rapidly response to changing patient and provider needs.

5. NETWORK PERFORMANCE AND IMPACT

This section examines network performance and impact, which considers regional capabilities, network governance, 'network of networks,' and presents different measurement methods for entrepreneurial ecosystems and suggests future directions.

5.1 Economic Outcomes and Impact

As discussed earlier, network advantages arise via **collaborative value** generated from behaviors, capabilities and actions of individual actors, with the scale and depth of collaboration influenced by network brokers, intermediaries, policy mechanisms and markets.

Networks are expected to contribute to regional capabilities, which is a measure of how regions transform localized endowments and attract external endowments in order to produce **economic outcomes**.

However, **economic outcomes** are not always the result of consistent and predictable patterns of actors' behavior, but instead rely on the organic formation of processes and systems that result in a constant evolutionary process, as observed with entrepreneurial ecosystems.[217]

Regional capabilities are defined as the **capacity of a particular geographic location to generate collective performance** of its industry, localized infrastructure, institutional competences and human capital by employing the local bundle of tangible and intangible resources; or by recombining technological and scientific skills, information, knowledge, organizational processes, routines, or prior experience.

While **increasing the volume of entrepreneurial activity and innovative firms** in a region provides more potential for relational development and exchange opportunities, this is not enough to drive the effectiveness of an entrepreneurial ecosystem.

Ecosystem effectiveness is attributed to the **strength and value of networked relationships** for reciprocated knowledge exchange and collaboration at regional, local, individual and enterprise levels. Measuring value creation requires that **boundaries of the ecosystem are defined.**

A **macro-level analysis** of an entrepreneurial ecosystem attempts to assess overall performance by aggregating collective outputs of key system elements, to be discussed in section 5.4.

A **micro-level analysis** focuses more on outcomes of collaborative exchange for individual actors, drawing on SNA methods discussed earlier. This '**operational level'** analysis may include examining stakeholder capabilities, value creation indicators (benefits), problem categories (costs), and solving mechanisms (used and experienced) that are relevant for each actor from an individual perspective.[218]

This 'micro level' approach could also include **value creation indicators for different actors relevant to introduced programs or interventions**, as well as the problem categories and solving mechanisms that actors experience and use while engaged in particular network activities.

Micro-level Effects on Network Actors

A micro-level approach to network analysis could focus on influential actors that generate disruptive knowledge - one of the core elements of an entrepreneurial ecosystem. This may allow for an examination of the evolution of the entrepreneurial ecosystem through the prism of a key network actor, to include measures that weigh the importance of different relationships, network characteristics and interventions that may suggest new and relevant value measures. An effective method for this analysis would be longitudinal case study.

[217] Russell and Smorodinskaya (2018).
[218] Cunningham et al. (2019).

5.2 Policy Intervention and Network Governance

There is a belief that regional governance networks are the better instrument for overseeing regional development, although this assumption is rarely tested empirically.[219] **Regional governance** is defined as a '*regional process of self-steering, including actors from politics, administrations, business, and civil society'*, aimed at regional economic development.[220]

In coordinating efforts from diverse actors, enabling governance mechanisms can be designed to **'orchestrate' network relationships** that lead to more productive economic outcomes. Orchestrating relational activities can help to overcome the complexities of relational alignment and facilitate access to regional resources not currently available to actors.

Policy support for regional governance is justified on the basis that **alignment between 'resource portfolios' of network actors at the regional level** may not emerge without a coordinated effort. Enabling policy mechanisms can allow actors to identify and connect with pools of relevant knowledge, resource and external connections.

However, there are a number of challenges to policy-related network governance. One is that lack of sufficient metrics makes it difficult to have **adequate diagnosis and monitoring in the policy cycle.** The **direction of policy impact**, for example, is highly uncertain at the outset of new programs and support interventions. In the European Union, consultation is a mandatory, key component of impact assessment, typically involving two distinct groups of participant: (1) organized interests, private firms and non-governmental organizations (NGOs), commonly referred to as stakeholders, and (2) citizens.[221]

As discussed earlier, networks are evolving constructs, and while network governance may introduce appropriate rules, structures and norms, the **governance system must adapt as a region develops.**[222] Failure to adapt in response to changing conditions is a key reason why economic policy often fails to achieve its objectives.[223]

Attempting to 'manage and monitor' an **entrepreneurial ecosystem** requires the execution of many functions - such as drawing in multiple stakeholders, stimulating engagement, managing stakeholder diversity, program and project promotion, etc. – **some of which do not contribute to entrepreneurial outcomes**.[224]

The multi-level character of smaller, spatial networks across the region may actually introduce **more complex multi-dimensional structures** that can increase the difficulty of wider network communication and engagement.[225]

Policy Intervention and Network Structures

Introduced changes to social structures can substantially influence the shape and modes of operation in regional networks.[226] Research suggests that **centralized networks** are particularly dynamic, depending on the composition of actors but that network structure can be stable and clearly recognizable over time.

Large open networks with **heterogeneous sub-groups** are especially stable, and although changes may occur in detail, the **plurality itself** appears to be a stabilizing factor.

[219] Lawrence (2004).
[220] Fürst (2006: 42-3); Albrecht et al. (2014).
[221] Dunlop and Radaelli (2019): the value of involving organized stakeholders in impact assessment rests on the negotiation it triggers, with policy-making gains generated from lessons about actors' preferences and costs of cooperation. Hertin et al. (2009).
[222] Noble (2000).
[223] Leendertse et al. (2021).
[224] Cunningham et al. (2016).
[225] Albrecht et al. (2014).
[226] Albrecht et al. (2014).

However, **homogeneous groups inside network structures** can pose a high risk to network stability (measured by cliques and overall composition of network members). Connections amongst homogeneous members can intensify (lock-in effects), and such groups can dissociate themselves from others, risking the collapse of the whole network.

Network governance also requires attention to **external effects**. Network analysis typically focuses only on intra-network structures and may not be able to record the effects of external activities. Positive external effects include knowledge transfer, new technology development, reduced transaction costs, new projects and collaborations, etc.

Insights from smart specialization suggests that cross-regional interactions (such as knowledge imports from other regions and interregional talent migration induced by policy) require that **regional economic impact models incorporate multi-regional aspects**.[227] Thus, the **effects of actors from outside the ecosystem** should be identified and taken into account.[228]

Monitoring as well as signaling mechanisms are difficult to establish in a complex environment as prevalent in entrepreneurial ecosystems**.**[229] Effective signaling will be influenced by the governance agent's previous actions and performance record and are **only valuable if they are visible and verifiable**.[230]

For example, effective evidence-based signaling may **draw in institutional innovators** to share new technologies and ideas and collaborate in commercializing knowledge through new partnership opportunities. Signaling may influence some entrepreneurs to explore new business opportunities that **leverage inter-organizational relationships**.[231]

Similarly, signaling the **competitive advantages available for SMEs** to participate in a network might include promoting the availability of a wide range of skills and innovative technologies and the possibility of reaching new business partners and customers (e.g. higher production volumes, increasing overall market presence and achieving legitimacy).[232] Signaling network advantages for individuals should also be promoted, with studies showing that networking is related to the growth rate of salary over time[233] and positive career outcomes.[234]

5.3 Network of Networks

Network governance can be seen in a 'network of networks,' where a **bridging organization connects different networks to the larger network**. Objectives may include: 1) contributing to the rapid movement of information, knowledge or resources throughout the region; and 2) increasing operational and fiscal efficiencies on behalf of network members.

The structure of a 'network of networks' may be **defined by organizational connections and collaborative projects**.[235] One example would be connections and projects amongst a group of research institutions, who find it difficult to perform innovation without bridging support.

Policy insights from 'network of networks' literature include:

- **Leverage already established relations** in assembling a network of networks, which can anchor future activities to past successes and activate new members and relationships.

[227] Varga et al. (2020).
[228] Cunningham et al (2019).
[229] Freitas et al. (2013).
[230] Cunningham et al. (2019).
[231] Lai et al. (2015).
[232] Crossley et al. (2021).
[233] Wolff and Moser (2009).
[234] Choi (2019).
[235] Russo and Rossi (2009).

- Network participants must **have enough time and opportunities to work together** to facilitate their understanding of respective competences and identities, since the timing of innovation processes and outcomes cannot be foreseen.[236]
- Identify beforehand **those actors who are better able to construct networks of relationships that can support innovation processes**. This could include strengthening interactions with service providers to involve small firms in 'unusual' networks of relationships (e.g. with universities and research centers, or other firms in other sectors), which may **give them access to a wider range of competences**.
- **New network members** should share similar objectives and commitments to engagement and be contributors to network stability.
- Attention should be paid to the **processes of network construction and management**. Monitoring and evaluating requires the definition of appropriate units of analysis, such as relevant nodes, relationships and outcomes, and their appropriate time scales.

If economic outcomes are the primary driver of public investment in a 'network of networks,' policy-makers should support and foster relationships with **high generative potential.** This may require determining:

- Which kinds of interactions support high-potential innovation processes?
- How can interactions with high generative potential be identified, monitored and supported?
- What are the most likely settings that promote the emergence of generative relationships?
- To what extent do local actors belong to local, regional, national, international competence networks?
- Which structures, if any, coordinate the competences required at the local, regional or industry level with the needs of 'network of networks' participants?

<u>Different measures for policy effects on a 'network of networks' could include:</u>

- Number of new 'potentially generative' relationships activated.
- Emergence of new competence networks that can develop new technology areas.
- Extent of systemic effects produced.
- Level of changes in the structure of competence networks.
- Level of change in the patterns of use of products and services.

An illustrative example of a network of networks is shown in the box below. For context, this involved a study of participants from various networks who recognized a growing need for an institutionalized, European Union (EU)-level science-policy interface (SPI) on biodiversity and ecosystem services. [237] This need was based on the perception that policy processes often fail to take into consideration the best available scientific knowledge.

Three advantages were identified in bringing existing networks together: 1) dividing work among available network experts; using the best available knowledge; and increasing the policy relevance of the work of existing networks.

[236] Lane and Maxfield (2005).
[237] Kelemen et al. (2021). The networking and capacity building function of an SPI ensures that diverse knowledge holders (e.g. scientists, decision makers, general public) are connected and collaborate with each other at the interface to effectively resolve issues and policy problems.

Illustrative Example: 'Network of Networks'[238].

The study found overlaps in interests and expertise amongst the networks, which could be a factor that increases competition among network of networks (NoN) members. However, this 'redundancy' overlap was considered beneficial for member networks,[239] by reducing the intensity of work required by an individual network, guaranteeing a reliable and continuous access to relevant expertise, knowledge and data, and creating synergistic outcomes and more robust solutions.

A NoN approach provides opportunities for member networks to link across different geographical and governance scales and upscale their lessons learnt at the local or regional level, as cross-scale interaction is crucial to create dialogue between global problem-opportunity framings and their local manifestations. Different strategies were suggested to help members fill their major capacity and knowledge gaps. Interactive formats, such as training courses, workshops, matchmaking events and pilot demonstrations, were listed by study respondents as the most effective ways of developing personal skills and knowledge.

Creating inter- and transdisciplinary learning environments are suggested to facilitate social connections and learning in order to change organizational cultures and processes, which could include funds to establish joint teams of scientists, policy-makers and the general public that can work in an action-oriented way.

The diversity of existing networks, in terms of their membership, internal structures, processes and funding models, provides a twofold strength when networks join their forces; they are different enough to cover diverse areas of expertise and provide the best available information, and they overlap enough to divide tasks and share responsibility when resources are scarce.

At the same time, contributions from network members are also highly dependent on individual and organizational capacities, suggesting that capacity development and advocacy work be an integral part of the NoN to help its members overcome the most critical challenges that hinder their participation in boundary work.

[238] Kelemen et al. (2021).
[239] Radicch and Bianconi (2017).

5.4 Measuring Entrepreneurial Ecosystems

Entrepreneurial ecosystems are *complex adaptive systems*, which **requires careful consideration of the metrics** used in their evaluation.[240] Traditional economic activity metrics, such as employment, new start-ups and levels of new investment, are insufficient in fully capturing the functioning of the system. Furthermore, the observed mismatch between the analyzed concept (entrepreneurial ecosystem) and the measurement approach (firm - and individual-level data) may explain inconclusive results reported in prior work dealing with country-level entrepreneurship and its repercussions at national and regional levels.[241]

Complex relationships amongst actors that define an ecosystem are difficult to conceptualize, let alone measure, making **large-scale evaluation and measurement** of entrepreneurial strategy and policy extremely difficult.[242]. Connectivity and communication processes dominate relationships that both create and constitute the interactions of an entrepreneurial ecosystem. However, connectivity is one of the least developed areas in terms of good indicators.[243]

The evolving and changing networks of nodes **do not capture the flows** of 'nutrients' in an ecosystem, such as ideas, talent, and capital.[244] The existence of entrepreneurial ecosystems at different points in their evolution has also made external identification difficult.[245]

Capturing Complexity in Entrepreneurial Ecosystems

The behaviors of entrepreneurial ecosystems are largely a result of the **complexity of the interactions among system components.** Effective evaluation needs to acknowledge these interactions and **identify the most important influences resulting from them.** Some entrepreneurial ecosystems appear to be **self-regulating**, where filling in missing elements takes place through a mechanism similar to market evolution at the organizational level, rather than a top-down method imposed by policy.[246]

Policy intervention requires understanding the different mechanisms that drive and sustain the ecosystem in order to figure out the components and **how they interact with one another**.[247] This requires organizing and combining data at **all relevant levels and dimensions** that best capture specific network characteristics that reveal particular strengths and weaknesses.[248]

Despite various measurement challenges, entrepreneurial ecosystems can be '**mapped' as a relational inventory** of participants and how they are connected.[249] This can identify participants and their engagement simultaneously (or sequentially) in several different roles in the ecosystem, along with institutions that may also evolve and take on new roles.[250] Three different 'mapping' models are presented below.

Conceptual Mapping Model

Figure 4 shows a conceptual model of an entrepreneurial ecosystem which includes a number of relational elements that contribute to the **prevalence of entrepreneurship in a region**. It should be noted that, in addition to accelerators, incubators and other related entrepreneurial support entities should be acknowledged in the model.

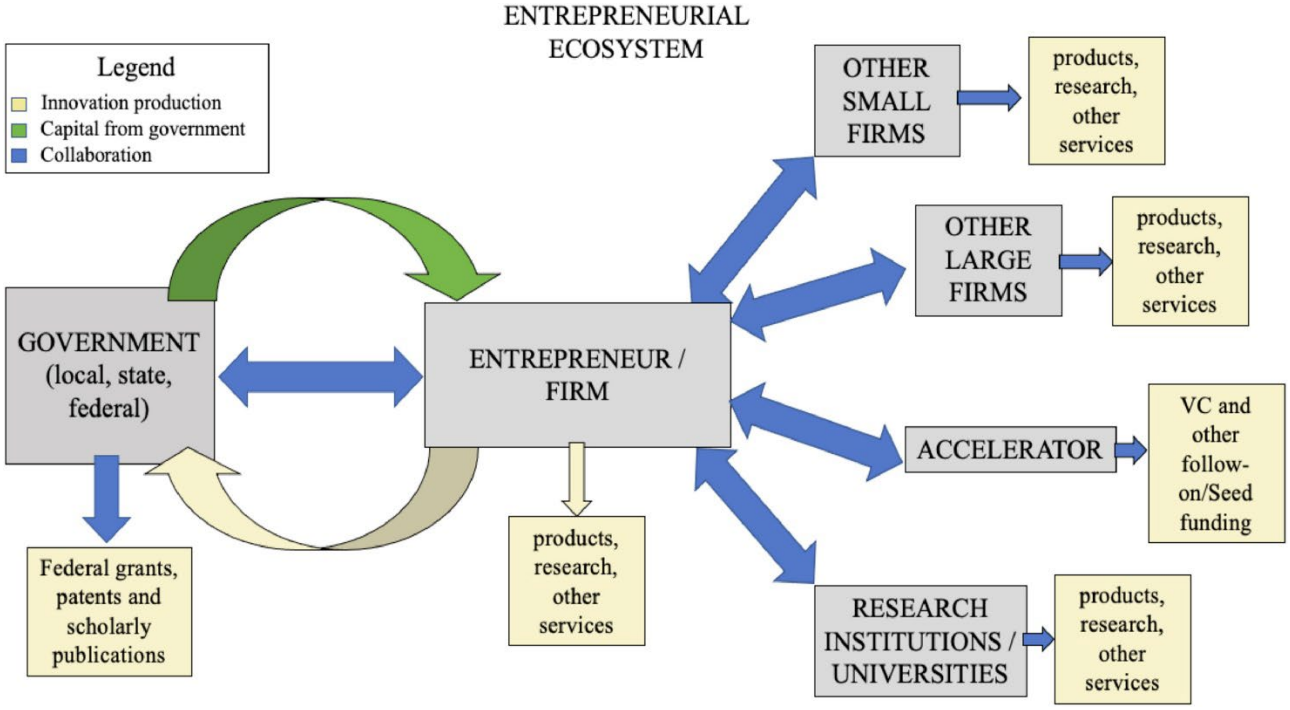
[240] Roundy et al. (2018).
[241] Acs et al. (2018); Lafuente et al. (2021).
[242] Johnson et al. (2022).
[243] Stangler and Bell-Masterson (2015). Previous studies find that all entrepreneurs say connectivity is an important measure, with fewer seeing other measures as important (e.g. Taich et al, 2016).
[244] Hwang and Horowitt (2012).
[245] Bruns et al. (2017).
[246] Ibid. As shown in a study of the St. Louis, Mo. startup ecosystem.
[247] Florida & Hathaway (2018).
[248] Albrecht et al. (2014).
[249] Auerswald (2015).
[250] Lowe and Feldman (2017).

Participant connections are illustrated with causal arrows pointing toward outcomes at various levels. **Entrepreneurs and firms** provide an information flow through the ecosystem, enabling the distribution of knowledge, labor and capital.[251]

Feedback effects are a critical component of entrepreneurial ecosystems, as actors in the entrepreneurial environment both shape and are shaped by the features of their contexts. The figures shows that **outcomes at one level feed back into other ecosystem dimensions**, creating a dynamic system that can serves as the basic structure for a measurement scheme.

In other words, the feedback effects help to **determine the metrics** that are relevant for defining an entrepreneurial ecosystem and studying it as an organic and constantly evolving system.

Figure 4: Conceptual Model of Entrepreneurial Ecosystem[252]



A **relational database structure can then be developed** to enable analysis of real-time data drawn from a multitude of high-volume sources at once. Data should be chosen that affords measurement of processes through which entrepreneurs, firms, communities, universities, labs, and governments interact.

Private-public sector interactions make it even more critical that ecosystem measurement include data on geographic and temporal context, and the corresponding mixes of policy activities. One limitation is gaining access to protected confidential data that may contribute to understanding formal interactions, resource flows and outcomes.

Different data sources may include:

- Statistics Canada and other Canadian and provincial government sources.
- **I**nformation on various research and entrepreneurship hubs such as universities and federal research labs using the **Global Research Identifier (GRID)** database.[253]

[251] Malecki (1997).
[252] Johnson et al. (2022).
[253] https://www.grid.ac/

- **SEED-db** provides detail on seed startup accelerators around the world. This database allows tracking of accelerator activity as well as acquisitions and venture capital funding for 9,000 participating firms.[254]
- **Global Accelerator Network,** which offers an annual data report detailing outcomes from a curated community of accelerators and the startups graduating from their programs.[255]
- For comparison purposes, drawing on methodological insights from the **European Commission**, e.g. Regional Innovation Scoreboard.[256]

Relational Database Management Systems (RDBMS) offer a way to organize and manipulate data from many high-volume sources at once, and may be well suited to establishing metrics for entrepreneurial ecosystems because of its ability to capture networks of relationships that emerge across many disparate sources of data.

Startup Genome Relational Database System[257]

Startup Genome's data infrastructure includes data on over one million companies, 250+ ecosystems, and survey data from more than 10K startup executives across the globe. Data is drawn from sources that include Startup Genome's proprietary data (ecosystem and founder surveys, policy action reviews); Crunchbase (global dataset on funding, exits, and locations of startups and investors); Orb Intelligence (global dataset on company information); PitchBook (private capital market data provider); Dealroom (global dataset on funding, exits, and locations of startups and investors); local ecosystem partners (accelerators, incubators, startup hubs, investors); lists of startups; lists of local exits and funding events; and secondary data sources (e.g. Forbes 200, International IP index, OECD, salaries data, etc.). Selected data timeframes are used for exits and funding rounds.

Global ecosystem rankings are a weighted average of the following factor scores: Performance: 30%; Funding: 25%; Market Reach: 15%; Connectedness: 5%; Experience & Talent: 20%; and Knowledge: 5%. An ecosystem index value is calculated for each factor, based on a sub-factor and metrics formula created by Startup Genome (see footnote for description of methodology).

Integrated Model

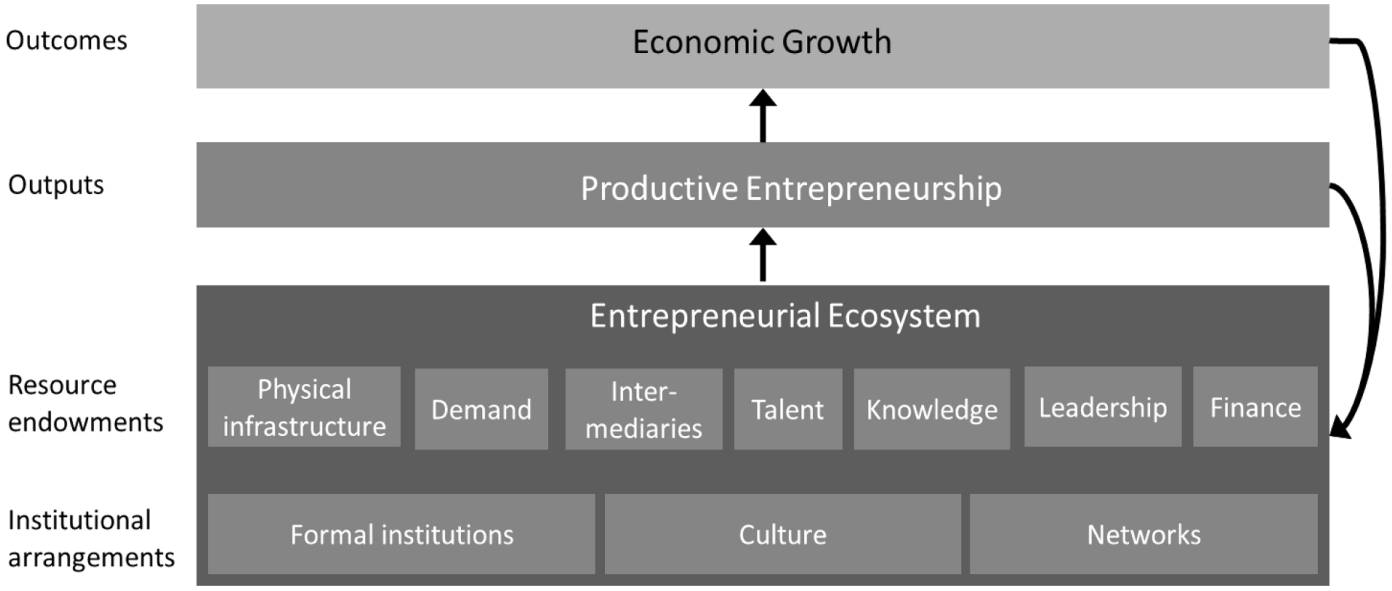
Figure 5 presents an **integrative model of entrepreneurial ecosystems** recently used in a study of European regions.[258] The model consists of three key mechanisms:

1. Interdependence and coevolution of elements.
2. Upward causation of the ecosystem on entrepreneurship.
3. Downward causation of entrepreneurial outputs on the quality of the ecosystem.

Figure 5 identifies **10 ecosystem elements** that contribute to productive entrepreneurship and regional economic growth. I**ndicators and output measures are established for each element** (see Appendix B for measures and indicators used in a study of European regions).

[254] https://www.seed-db.com/accelerators
[255] *https://www.gan.co/*
[256] https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators_en
[257] https://startupgenome.com/article/methodology
[258] Leendertse et al. (2021).

Figure 5: Elements, outputs and outcomes of an entrepreneurial ecosystem[259]



For the **'network' element** in Figure 5, the indicator measure is 'connectedness of businesses for new value creation,' with the output measure being the **number of SMEs that collaborate on innovation projects** as a percentage of all SMEs in a region. While it is acknowledged that not all SMEs will be entrepreneurial firms, this measure attempts to capture the kind of productive collaboration that is likely to contribute to entrepreneurial output.[260]

The study performed **correlation, principal component, cluster, and network analyses** to visualize the interdependencies between elements. Key findings from the study include:

- Entrepreneurial economies are systems with **highly interdependent elements**.
- **Physical infrastructure, finance, formal institutions, and talent** took central positions in the interdependence web of the model, suggesting that these are fundamental conditions for entrepreneurial ecosystems.
- **Prevalence of innovative new firms** is strongly positive and statistically significantly related to the quality of entrepreneurial ecosystems (other studies also identify the importance of leadership and entrepreneurial mindset for innovative firms).[261]
- There is a **significant trade-off** between getting richer context-specific data (only available in a relatively small number of regions) and getting widely available, harmonized data to enable comparisons between regions.

<u>The study generated a number of **policy implications.**</u>

- Construction of large-scale datasets is a necessity for regional policy **if there is a need to benchmark with regions** that have comparable entrepreneurial ecosystems. Spill-over effects between regions could be analyzed with the help of spatial econometrics.
- **Developing tailor-made spatial units** and accounting for clustering of elements (e.g. by cities, municipalities, regions), and neighborhood effects is a challenge for analysis.
- Measures of elements are an essential input for ex-ante policy diagnosis to discover the weaknesses and strengths of entrepreneurial ecosystems.

[259] Adapted from Stam (2015) ;Stam and Van de Ven (2021).
[260] Leendertse et al. (2021).
[261] Kuratko et al. (2021).

- **Focusing on the weakest elements** may provide the most efficient and effective way to improve the overall quality of the entrepreneurial ecosystem and stimulate productive entrepreneurship.[262]
- While metrics may provide insight into *where* to look for improvement, they do not reveal *how* this improvement should be achieved.

A key assertion from the study is that **entrepreneurial ecosystem policy can never be entirely data-driven**, as comprehensive planning is *computationally intractable* (i.e., practically impossible) in large regional entrepreneurial ecosystems.[263] Interdependencies between elements and their emergent properties are also **unlikely to remain stable over time**.

Metrics should therefore **facilitate a collective learning process** to improve regional economies that combines data and dialogue. The diagnosis based on the metrics should, ex-ante, be used to facilitate dialogue between stakeholders of the entrepreneurial ecosystem about policy interventions, and facilitate, ex-post, a dialogue about the effectiveness of these interventions. The box below describes how impact assessment is used to inform policy.

[262] Ács et al. (2014).
[263] Bettencourt (2014).

Impact Assessment in the European Union

Impact assessment (IA) is commonly used in the European Union (EU) as an analytical instrument to bring evidence to policy-makers before policy design is complete. IA functions as a process through which publics are consulted and an arena for policy networks and stakeholders can reshape, negotiate and contest prospective policies.[264] Consultation is a key component of IA and is mandatory in the EU. Consultations provide an opportunity to reach out to hard-to-reach or marginalized groups who may be disproportionately affected by a particular policy option. IA also aids regulatory compliance as it begins to emerge in the legal system as the standing justification used by courts to interpret the original rationale for a decision, policy or regulation. Such an approach provides a broader context for policy assessment, but is less common in Canada and the USA, where IA is dominated more by cost-benefit analysis, risk assessment and adherence to original policy targets and measures.

Kauffman Foundation Model

Kauffman Foundation research identifies 12 measures across four indicators that determine the **level of entrepreneurial ecosystem vibrancy**, as shown in Figure 6.

Figure 6: Entrepreneurial Ecosystem Vibrancy Measures[265]

Indicator	Measure	Possible Sources
 DENSITY	New and young firms per 1,000 people	Census Bureau, Business Dynamics Statistics (BDS)
	Share of employment in new and young firms	Census Bureau, BDS
	Sector density, especially high tech	National Establishment Time Series (NETS)
 FLUIDITY	Population flux	Internal Revenue Service
	Labor market reallocation	Quarterly Workforce Indicators (QWI)
	High-growth firms	Inc. 5000 and NETS
 CONNECTIVITY	Program connectivity	Under development
	Spinoff rate	Possibly: CrunchBase; LinkedIn
	Dealmaker networks	Private databases, including Capital IQ
 DIVERSITY	Multiple economic specializations	Quarterly Census of Employment and Wages (QCEW)
	Mobility	Equality of Opportunity project
	Immigrants	American Community Survey (ACS)

[264] Dunlop & Radaelli (2019).
[265] Stangler and Bell-Masterson (2015); Taich et al (2016).

The Kauffman research used a mixed method approach, involving qualitative and quantitative analysis. [266] The research revealed that entrepreneurial ecosystems **consist of a complicated mix of regional system assets.** *Density* and *connectivity* were identified as the two indicators most meaningful from entrepreneurs' perspectives:

- Density is defined as the **number of new and young companies, their employment level, and extent to which those companies function in similar sectors.** Entrepreneurs value density because it gives entrepreneurs "confidence to see that others have done it."
- Connectivity is defined as the extent of '**connections between the elements'** of an entrepreneurial ecosystem. Connections help entrepreneurs solve problems, find talent, attract funding, build relationships that translate into customers, and innovate.

The Kauffman model continues to evolve and now **measures entrepreneurial activity, financing, and company growth across five metric groupings**: entrepreneurial density, deals and available financing, network interconnectivity, STEM (science, technology, engineering, and mathematics) workforce, and Inc. 500/5000 companies.[267]

This data is presented in the form of a dashboard to provide ecosystem builders ongoing benchmarks to help measure the number of companies being created, the depth of the entrepreneurial ecosystem through the support they receive – talent, funding, and resources – and how that support creates sustainable growth.

As with other studies, the **challenge of data access** is identified in the Kauffman model. More relevant sources of data (e.g. provincial, Canadian) are required for some of the measures shown in Figure 6, when applying the Kauffman index to other regions or countries.

5.5 Illustrative Examples of Entrepreneurial Ecosystem Measurement

Strategic Value Network Assessment of San Francisco/Bay Area

Section 4.4 earlier described value network analysis. This example applies value network analysis to the San Francisco start-up ecosystem, which comprises startups, venture capital funds, business angels, banks, venture incubators and accelerators, co-working spaces, universities and consulting firms.[268]

As shown in Figure 7, the high number of inputs received by startups reflects the ecosystem's intrinsic nature, which supports entrepreneurs through a wide selection of services. The input analysis evaluates the nature of the input and the impact that each of the collaborative players within the ecosystem has on analyzing participants' business activities. The analysis assesses the total value achieved by being part of the ecosystem by calculating the sum of each input value, with impact evaluated through a five-point Likert scale weighted on consensus (e.g., impact: 1 = very low; 2 = low; 3 = medium; 4 = high and 5 = very high).

[266] Stangler and Bell-Masterson (2015); Taich et al (2016). The study delineated **the difference between a measure and an indicator**. A measure is the operationalization of an idea using databases to discretely quantify the idea. An indicator refers to a grouping of measures which represent a broader concept.
[267] https://www.kauffman.org/wp-content/uploads/2019/09/Kauffman_Index_Growth_Entrepreneurship_National_2017.pdf: The calculations regarding high-growth firms in this component of the Kauffman Index use Inc. 500|5000 data on the fastest-growing private companies in America in terms of revenue growth.
[268] Cavallo et al. (2021).

Figure 7: Start-up Inflows

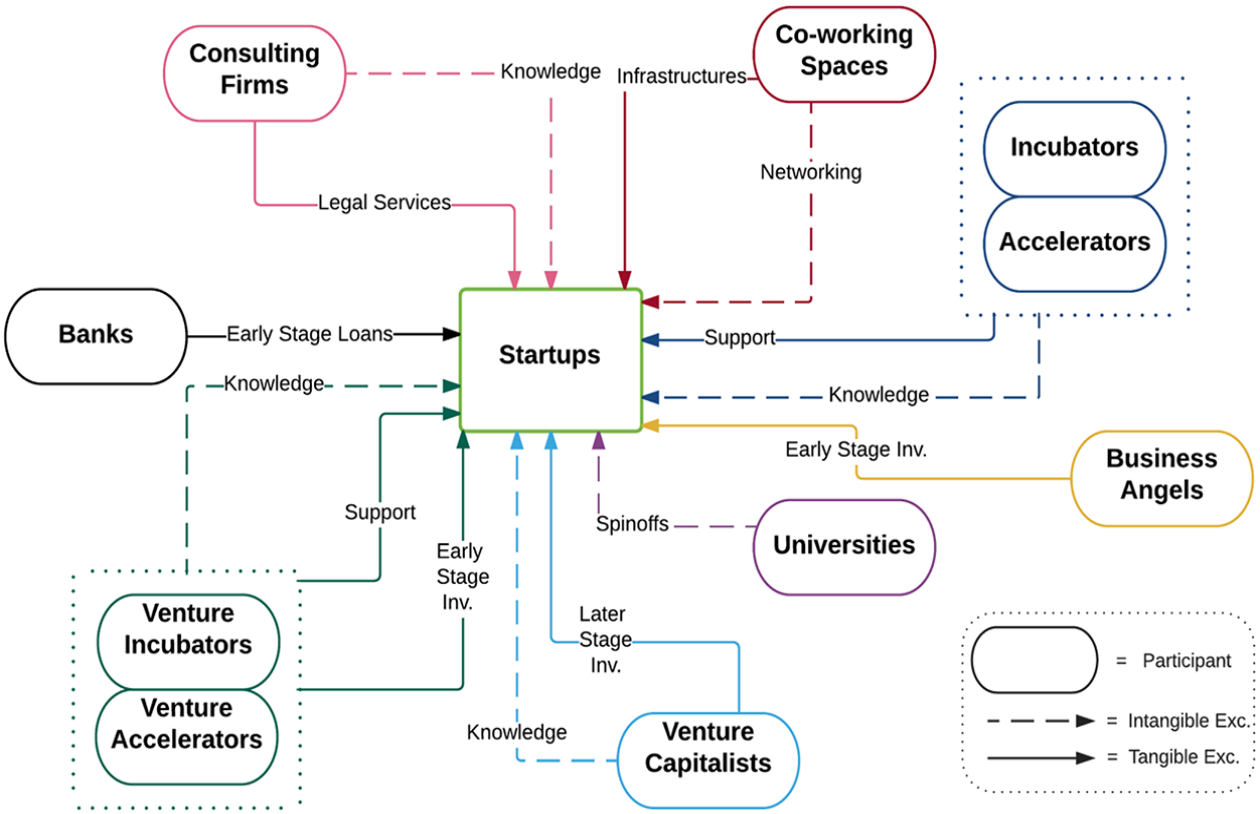
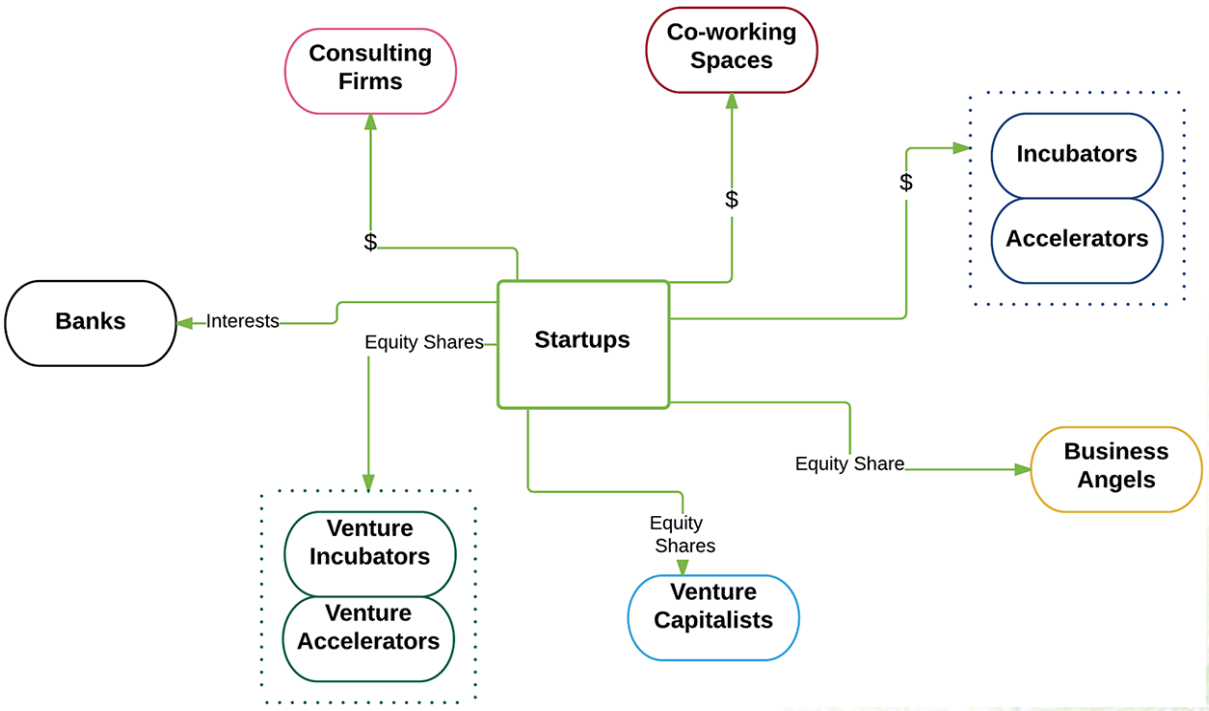


Figure 8 shows output analysis, which captures resource spent for the generation of beneficial value for the ecosystem, focusing on both tangible and intangible resources necessary for the outputs exchange. The value-added cost level is evaluated through a five-point Likert scale.

Figure 8: Start-up Outflows



The sum of all the input generates the value generated by the ecosystem. Subtracting the costs sustained by the participant to the value benefits it receives, the analysis arrives at a number representing the value captured.

Value capture is analysed at both at the participant and ecosystem level. The participant-level capture value represents the ability to capture value from the ecosystem. Similarly, the value capture at the ecosystem level represents the ecosystems' ability to capture value from the participants' interactions and exchanges. In summary, this approach takes the entrepreneurial ecosystem as a process of value exchange among the network's participants.

Start-up Cartography Project (USA)[269]

The Start-up Cartography Project (SCP) is an example of a place-based approach to examining entrepreneurial ecosystems with a focus on start-ups. The SCP combines (USA) state-level business registration records with a predictive analytics approach to estimate the probability of "extreme" growth (IPO or high-value acquisition) at or near the time of founding for the population of newly-registered firms.

The SCP then leverages estimates of entrepreneurial quality to develop **four entrepreneurial ecosystem statistics**, including the rate of start-up formation, average entrepreneurial quality, the quality-adjusted quantity of entrepreneurship, and the entrepreneurial ecosystem performance associated with a given start-up "cohort."

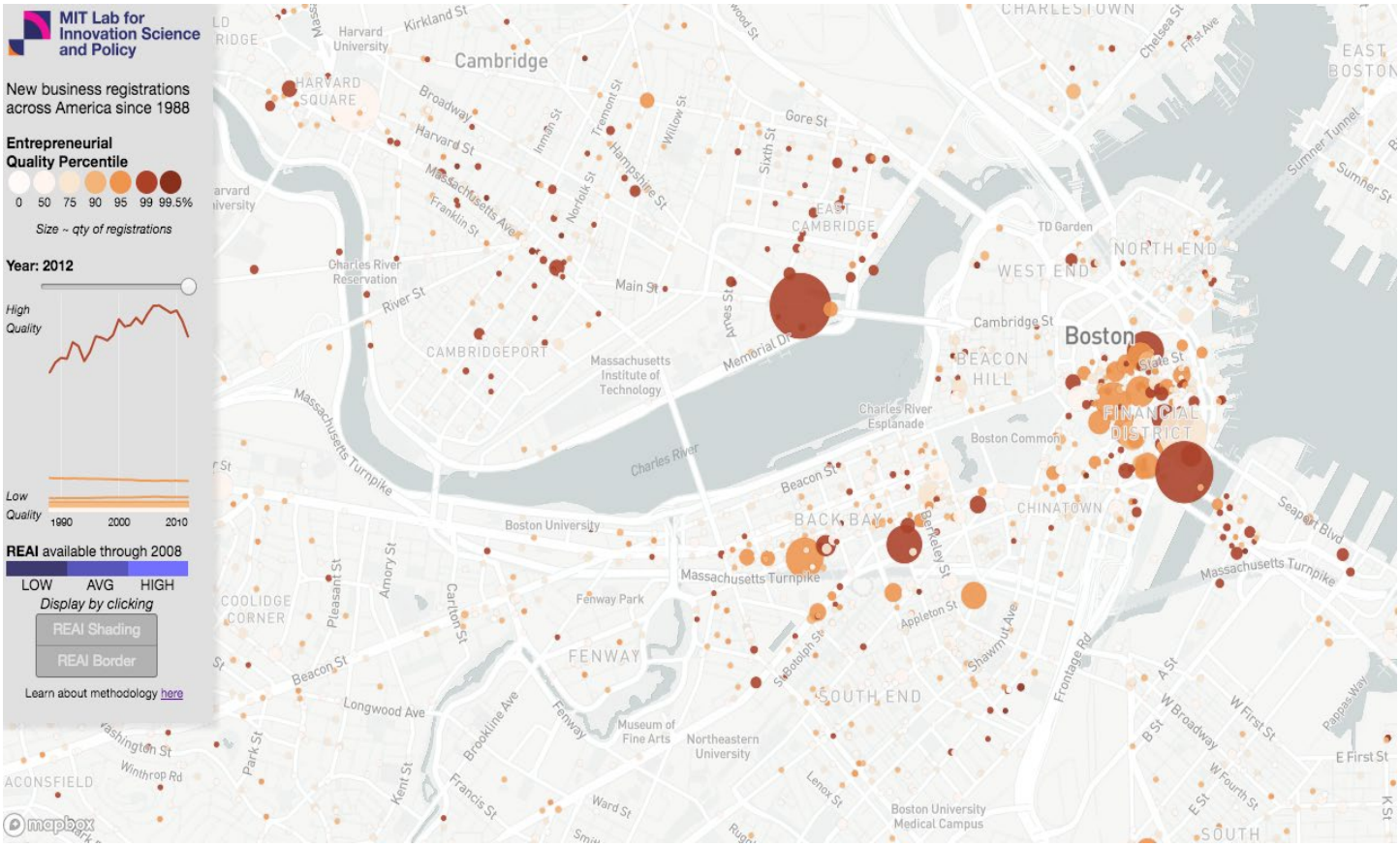
SCP statistics offer refined insight into patterns of regional entrepreneurship, the correlation of quality (but not quantity) with subsequent regional economic growth and the evolution of entrepreneurial ecosystems over time. The SCP includes both a public-access dataset at the state, municipal, county, and zip code level, as well as an interactive map, the U.S. Start-up Map (Figure 9), that allows academic and policy users to assess entrepreneurial ecosystems at an arbitrary level of granularity (e.g. from the level of states down to individual street addresses).

The SCP reflects, in part, work undertaken by the **MIT Regional Entrepreneurship Acceleration Program**, which works with high-level regional stakeholder teams around the world on identifying and implementing programs to enhance entrepreneurial ecosystems.[270]

By **estimating the growth potential** (or entrepreneurial quality) of start-ups at or near the time of founding, SCP indexes provide a view of the skew of entrepreneurship most correlated with later regional economic growth. SCP data allows for cross-town and cross-regional comparisons, identification of local and high growth firms, detection of patterns across time, and other opportunities for insight discovery.[271]

[269] Andrews et al. (2022).
[270] https://reap.mit.edu/
[271] https://www.startupcartography.com/

Figure 9: Start-up Cartography Map of Boston, MA



SCP statistics show that **entrepreneurial quality** is a leading indicator for other outcomes in regional performance, but that it is not enough for regional ecosystems to produce high potential firms; they must also foster an environment that allows firms to grow.

A key suggestion for policy analysts is to **measure and support entrepreneurial quality**, and to observe entrepreneurial dynamics in a more proactive and informed way. This can allow public funders, for example, to design and evaluate interventions that focus on the quality of entrepreneurship rather than only increasing rates of firm formation and for local policymakers and practitioners to have a common understanding of their ecosystem.

5.6 Future Directions in Measurement

As suggested in the above discussion, elements of the entrepreneurial ecosystem do not work in isolation, and their individual assessment is unlikely to produce accurate results.[272] The essential aspect of entrepreneurship is the coordinated actions across stakeholders within a geographically bounded space, which allude to the networked relations that define the ecosystem's configuration. This acknowledges that territorial heterogeneity, with differences in institutions, types of entrepreneurial activity, etc., will lead to the emergence of different configurations of entrepreneurial ecosystems whose effectiveness can also be case-specific.[273]

Entrepreneurial ecosystems are by their nature evolutionary, with successful regional economies continuously refining and reshaping their knowledge base and technological boundaries to develop and also preserve their competitiveness over time.[274] The attainment of 'high impact' outcomes (such

[272] Lafuente et al. (2021).
[273] Brown & Mason (2017).
[274] Buciuni and Pisano (2018).

as creating jobs, commercializing new ideas and technologies, and realizing greater market efficiency through competition, etc.) is the ultimate goal of an entrepreneurial ecosystem - in the sense of creating 'value add' in a region that can fortify the entrepreneurial ecosystem and generate a virtuous circle of successes.

This favors **measuring changes of the ecosystem over time** and drawing in the most appropriate measures that can be regularly collected and tracked, and which align with expected impact outcomes. Such measures may include: large scale collaborations, new programs, leveraged and follow-on funding, patent applications and successful exits.

Impact assessment requires a substantial commitment to a process as well as patience for the process to reveal progress and outcomes.[275] For example, a well-developed entrepreneurial ecosystem is identified as a prerequisite for the consolidation of venture capital markets.[276] Venture capital boosts entrepreneurial initiatives by injecting capital and other intangibles (e.g., managerial expertise or access to networks) to new and established businesses.

While an entrepreneurial ecosystem is rooted in place, with a relatively distinct regional geographic boundary within which is contained mutually dependent components,[277] territorial thinking may underestimate the disruptive qualities of new entrepreneurial practices, for example, those of the digital economy.[278]

Research on leading seed accelerators find that entrepreneurial ecosystems unfold a complex and dynamic geography that **stretches beyond the boundaries of single territories**, suggesting that a territorial view should be complemented with a topological view that highlights the boundary crossing and trans-local character of entrepreneurial ecosystems.[279]

For example, in the pre- and post-program phase, seed accelerators interact over distance through mediated forms of interaction. During the program phase, they utilize temporary co-presence created through mobility and relocation to offer new opportunities for sharing knowledge. Rather than providing stable arenas within which entrepreneurship happens, this suggests that territories can be either points of departure, transit stations or final destinations of entrepreneurial processes.[280]

Successful local ecosystems hinge on the global economy and draw new knowledge from a variety of sources often situated outside its geographical boundaries, thus avoiding 'cognitive myopia', a condition that has caused the demise of numerous traditional industrial clusters.[281]

Furthermore, a globally connected entrepreneurial ecosystem can serve as a global pipeline for entrepreneurs in the region and encourage the development of innovation in related and unrelated technological domains.[282] Critical to this process is the ability of entrepreneurs to mix global market knowledge and local production and technical expertise in the attempt to generate new product, service and process innovations.

As the research on entrepreneurial ecosystems continues to develop, there is a need for a measurement framework and subsequent empirical validation of causal relations between factors. Otherwise, comparative research on entrepreneurial ecosystems risks engaging only in a simple description of successful territories without the possibility of generalizing findings.

[275] Meyers (2015).
[276] Lafuente et al. (2021).
[277] Adams (2021).
[278] Kuebart & Ibert (2019).
[279]
[280] Schmidt et al. (2018).
[281] Buciuni and Pisano (2018).
[282] Cho et al. (2021).

6. DISCUSSION AND ACTIONABLE INSIGHTS

This section summaries findings from the meta-analysis based on the three questions guiding the study.

1. How do **network theories** contribute to understanding entrepreneurial ecosystems?
2. How is network analysis used for assessing and measuring network effects that contribute to strong **entrepreneurial ecosystems**?
3. What network effects most influence high performance and impact?

The discussion offers a number of suggestions (highlighted in boxes), actionable insights and considerations for further study.

Network Theories

The report suggests **multiple advantages for Alberta entrepreneurs and enterprises engaged in networks**. Networks are grounded in an information advantage, establish membership affiliation and social relations and set a context for exchange of knowledge, information and resources. **Network interactions take many forms,** including information transfer and advice, socialization, and financial exchange.

Closed networks are advantageous for entrepreneurs engaged in exploratory trial and error projects and for strengthening personal ties and initial team building. The cocoon 'advantage' is suggested with **seed accelerators**, where small cohorts of entrepreneurs are tied to a centralized program that facilitates intensive knowledge exchange and experiential learning activity.

The downside of closed networks is **less exposure to diverse opinion, critical feedback and new practices**. Closed network may hinder exploring new technology fields, blending ideas into new combinations or seeking market validation, customers and potential business partners.

Networks are associated with **'strong' network ties,** which may benefit innovation implementation or formalizing functions to scale a business, and with '**weak' ties**, characterized by unique and diverse information, which appear more important in idea generation or exploring market fit for a new innovation.

The report identifies a key role for **network brokers**, who can make connections between disconnected parts of networks and bridge gaps in communication, information and knowledge (i.e. structural holes). Brokers may also play a role in facilitating the 'graduation' of entrepreneurs from closed networks into more relevant and appropriate networks as they build their ventures.

The report highlights some of the broker roles (e.g. coordinator, representative, gatekeeper, and consultant) and the advantages they can bring to a network in bridging different types of structural holes. **Complex projects may be more successful** when led by a person embedded in a network rich in brokerage opportunities.

Establishing an inventory of recognized network brokers and intermediaries and further supporting their role within Alberta's entrepreneurial ecosystem could strengthen interconnections between different network groups, e.g. entrepreneurs, new ventures, SMEs, research institutions, corporations, and policy makers.

The report highlights the **different types of networks** (e.g. innovation, business and social) and how network membership and relational interactions are key determinants of economic and non-economic outcomes. If network 'actors' have closely related interests, then the chances of gaining valuable information and knowledge can be relatively high.

The report finds that **there is no simple, universal or optimal network structure**, as it is contingent on multiple factors (e.g. relational, temporal and resource embeddedness) as well as the behaviors

and motivations of network members. The **different dimensions of networks** make it difficult to directly attribute enterprise performance to the structure of network relations.

An important question for policy is what motivates entrepreneurs and others to join a network and remain active and involved. The report finds that the **energy that drives the network process** draws from calculated interests and commitments to individual network ties, which **reinforces the importance of network culture and cohesion**.

Entrepreneurial Ecosystems

Successful entrepreneurial ecosystems comprise dense networks of relational interactions with a **strong entrepreneurial culture at its core**. Entrepreneurs prefer to network with and learn from their peers, but will engage in multiple networks that serve different functions.

For peripheral networks in Alberta (e.g. Regional Innovation Networks), **network dynamism and participation may suffer** in the absence of a critical mass of nascent and experienced entrepreneurs or if the 'opportunity set' of needs required to develop entrepreneur and enterprise are absent or have been outgrown.

The report describes how **network relationships for entrepreneurs will evolve** from single-dimension personal exchanges to multi-layered exchanges and partnerships. As needs of entrepreneur and enterprise become more complex, **network capital will be sought that accrues economic benefits and advantage**.

For policy makers, **efforts to raise the level of social interaction in a network** (e.g. to stimulate more members, facilitate interactions, etc.) might not generate the innovation and economic benefits expected. Instead, **network capital - in the form of more strategic networks –** may generate greater economically beneficial knowledge.

The report identifies the **importance of *absorptive capacity* for regional network advantage.** Given Alberta's ambitions in a number of advanced technology areas, the ability of local entrepreneurs and SMEs to recognize and develop new opportunities depends on their capacity and skills to adapt and use critical knowledge generated by Alberta's research institutes, corporations and by external knowledge suppliers.

A set of coordinated policies to raise levels of absorptive capacity could benefit Alberta's entrepreneurial discovery process. These could include:

- Reverse trade shows, which bring together entrepreneurs, SMEs and corporates with leading local and international technology champions to explore problem-solution opportunities.
- Supporting innovative SMEs to systematize knowledge in processes, technologies and company culture and establish routine compatibility with relevant knowledge partners.
- Job-rotation initiatives or interdepartmental exchange programs involving marketing, sales, and service support units.
- Stimulating knowledge sharing and facilitating formation of alliances between regional enterprise and national and global partners to be 'first-movers' (or fast followers) on emerging opportunities of strategic importance to Alberta.
- Innovation hubs that provide a dedicated point of contact for SMEs to raise enquiries with competent authorities on industry-related issues (e.g. FinTech) and to discuss regulatory and supervisory issues, including licensing requirements.
- Regulatory sandboxes that enable SMEs to test, pursuant to a specific testing plan agreed and monitored by a dedicated function of the competent authority, innovative products, services or business models.

The question of *whether proximity matters* in regional networks has been further highlighted by the COVID-19 pandemic. **For specialized or complex knowledge,** spatial proximity appears critical, as

knowledge may be tacit (e.g. bound to the person possessing the knowledge). However, creating value through tacit knowledge transfer demands prior routine compatibility and trustworthiness, which benefits from proximity and time.

Alberta's entrepreneurial ecosystem should possess a dynamism that transcends industries and individual technologies and extends to international markets. As this report highlights, productive relational networks involve knowledge flows and absorption patterns that may not follow a geographical pattern.

While individual and organizational linkages ensure that Alberta is connected at some level with other regions, **greater interconnectivity locally would facilitate access to more dispersed networks internationally** that should produce additional knowledge spill over opportunities.

The report **distinguishes between established versus emergent entrepreneurial ecosystems,** with a number of implications for Alberta. While established ecosystems possess material resources and exchange partners for entrepreneurs, emerging ecosystems operate more like knowledge systems, with a focus on innovation and not yet on material output.

Policy attention is suggested for Alberta's emerging artificial intelligence (AI) sector (and other emerging sectors) to facilitate material resources and to **build a strong cultural fabric that includes coordinating across exchange partners** (e.g. universities, funders and business sectors) that more tightly integrates key stakeholders in the broader entrepreneurial ecosystem.

However, emerging ecosystems are more difficult to analyse because existing material resource and knowledge ties do not track closely with more radical innovations. The speed of development is also on a different scale, further challenging policy decisions.

Smart Specialization Strategy

The report finds that interest in smart specialization strategy is fuelled by evidence that regions which **amass larger sets of capabilities** tend to produce more specialized products that are hard to copy or imitate and are able to generate higher economic returns.

Lessons from Europe identify high risks associated with **demand-led policy targeting complex and unknown technologies** without embedding it in the appropriate technological and institutional context in the region. Such mission-oriented policies fall into the same traps that smart specialization policy aims to avoid, which is to pick fashionable technology activities from scratch and duplicate major research and innovation investments.

The report offers some suggestions from S3 policy that may be relevant for **Alberta**. One suggestion is to identify diversification opportunities in Alberta based on their scores on relatedness and complexity, after which, within that range of opportunities, the entrepreneurial discovery process will unfold, in which a range of local actors will decide which activities to target and assist.

The other approach is that opportunities are first selected through the bottom-up entrepreneurial discovery process, which are then assessed within Alberta's diversification opportunities. This approach is **highly dependent on the ability of diverse local players to create strong connections with each other** and amongst domestic firms, local universities and public research organizations, as S3 requires leveraging resources and capabilities embedded in local networks.

However, the availability of ambitious and capable entrepreneurs and businesses is **necessary to drive the discovery process**, and appropriate institutional governance structures will be required at the local level when moving into new and more complex technologies. The need to coordinate structural changes, support a wide range of necessary capabilities and attract new skilled labor for related diversification would require special attention from policy makers, particularly in Alberta's peripheral regions.

Another suggestion is to **generate evidence of concentrations of regional and industry capabilities in strategic groups of firms** - as flagship resources – which would allow Alberta to identify relevant linkages and flows of goods, services and knowledge, revealing possible patterns and pathways of integration with partner regions and complementary businesses.

Alberta could also assess how the local production stage of global value chains (GVCs) can become a building block for regional economic strategy, particularly in emerging technology sectors. Mapping GVCs could assist Alberta in multiple ways – from capability audit, to identifying new opportunities for growth, implementing industrial diversification and innovation strategies and developing strategies to capture inter-regional collaborative advantage.

Finally, mapping Alberta firms, technologies, innovators, and broadly, innovation capabilities could lead to engagement with GVC suppliers and local MNEs and subsidiaries that can deploy expertise and know-how to leverage local capabilities and generate new entrepreneurial opportunities. Such engagement could be **facilitated through intermediaries** who have experience and a thorough understanding of GVCs and the local market, as well as corporate sponsors, relevant investors and key public agencies (e.g. trade commissioners, Export Development Canada, etc.).

Network Analysis

The report highlights a number of challenges to network analysis. Social relationships are often difficult to identify beyond individual-to-individual connections. Entrepreneurial learning and knowledge accumulation cannot be easily traced as deriving exclusively from any specific network, as **an entrepreneur's 'network' may include multiple networks**.

Assessing and measuring network effects on entrepreneurship is challenging, as multiple factors explain enterprise development and the ability of entrepreneurs to gradually accumulate capabilities and resources.

Impact assessment of an **entrepreneurial ecosystem** is particularly challenging, given the complexity of identifying and measuring factors contributing to economic outcomes and the aggregated network relationships that will affect individual behaviours.

The report offers a number of suggests on how **social network analysis (SNA)** might be applied in the study of Alberta's entrepreneurial ecosystem. SNA methods could be used to:

- ***Make visible*** **patterns of information sharing** within and across Alberta's regional innovation networks (RINs) to include examining how entrepreneurs, enterprises and others are connect to one another and how these interdependencies influence measured outcomes.
- Examine the effects of **spatial distance on entrepreneurial activity**, e.g. how do entrepreneurs collaborate and gather resources given different physical locations and what effects does this have on enterprise development and growth?
- Map out Alberta enterprises that are **active in supply network or global value chains** to explore relevant linkages to the regional entrepreneurial discovery process and introduce mechanisms for productive interactions.
- Study **kinship and family ties** and their effects on early-stage entrepreneurs from different backgrounds (e.g. gender, ethnicity) and different sectors.

Quantitative **SNA techniques** could identify the network *characteristics* of different RINs**,** to determine how network nodes, ties and the attributes of network members can influence the social and economic outcomes of different RINs given similar policy measures or programs.

Qualitative **SNA methods** could capture opinions, attitudes and perceptions on the **extent of *crosscutting* relationships within RINs,** and how different configurations may improve innovative outcomes, e.g. entrepreneur, technology development advisor (TDA), investor; or entrepreneur, accelerator, corporate partner, etc.

The report suggests that **social network diagrams** could assist RIN participants in actively shaping their personal (i.e. ego) network or 'entrepreneurial action set' by assessing contact quality and frequency and perceived and tangible value derived from these relations. This could focus participant attention on **where to invest in developing specific kinds of relationships**.

Mixed method SNA could study individuals in Alberta's entrepreneurial ecosystem whose ties are disproportionately instrumental in facilitating interactions between disparate groups or whose ties lead disproportionately to economic outcomes, and to further support such individuals.

Value network analysis could examine the roles, patterns of exchanges, transactions and deliverables that characterize the value creation dynamics of entrepreneurs prior to and following completion of a seed accelerator program. This may reveal **value conversion capabilities** of entrepreneurs that carry forward into the scale-up phase.

The report describes the role of policy intervention and network governance in **orchestrating relational activities** to overcome the complexities of relational alignment and to facilitate access to regional resources. The meta-analysis finds limited evidence that regional network governance is a

better instrument for overseeing regional development, given the lack of sufficient metrics to adequately diagnosis and monitor policy effects.[283]

The report suggests that a '**network of networks'** approach can facilitate the effective movement of information, knowledge or resources throughout a region if it is able to: leverage already established and successful relations; give participants enough time and opportunities to work together; focus attention on relationships with high generative potential; and ensure that new network members share similar objectives and engagement commitments.

The report describes different evaluation models for entrepreneurial ecosystems that all **highlight the need to identify system components and their interactions with one another**.

Mapping can identify its **relational inventory of participants and their connections**, where feedback effects from different components create a dynamic system that can serves as the basic structure for measurement. A **relational database structure** enables analysis of real-time data drawn from a multitude of high-volume sources at once.

Adopting a Relational Database Management System (RDBMS) offers a way to organize and manipulate data from many high-volume sources at once, and can inform the most appropriate metrics to analyse Alberta's entrepreneurial ecosystem and capture the most impactful networks of relationships. **Gaps in available data** will influence choice of metrics and limit network analysis or assessment of program impact, which may suggest the need for voluntary incentives or legislated policies requiring disclosure of new information.

The Kauffman model identifies measures across different indicators that determine the level of entrepreneurial ecosystem vibrancy, with **density and connectivity** identified as the two indicators most meaningful from entrepreneurs' perspectives.

The integrated (comparative study) model emphasizes the **interdependence and coevolution of elements**, with upward causation of the ecosystem on entrepreneurship and downward causation of entrepreneurial outputs on the quality of the ecosystem, with indicators and output measures for each of the 10 'quality' elements.

Findings from the comparative study offer some suggestions for Alberta. **Physical infrastructure, finance, formal institutions, and talent** appear to be fundamental conditions for entrepreneurial ecosystems, with the **prevalence of innovative new firms** strongly associated with the quality of the entrepreneurial ecosystem.

Focusing on the weakest elements may provide the most efficient and effective way to improve the overall quality of the entrepreneurial ecosystem and stimulate productive entrepreneurship.

Illustrative examples identify an entrepreneurial ecosystem as a process of **value exchange** among active participants and highlight the importance of **entrepreneurial quality** and fostering an environment that allows firms to grow in supporting place-based start-up activity.

Actionable Insights

This report has described how network theories contribute to understanding entrepreneurial ecosystems and presented different methods for assessing and measuring network effects, performance, and impact.

[283] A policy evaluation of a network funding intervention is beyond the scope of this report. It would require measuring the causal effect and outcome variables of such policy by comparing similar regions, one where a network intervention was introduced and one where it was not. This attempts to address the counterfactual argument, i.e. that outcomes attributed to policy support would have happened in the absence of such intervention.

Networks provide an interacting and exchange medium *for a set of inter-related actors and components, within a geographic region, that enable productive entrepreneurship*. Therefore, **networks are integral to the definition of an entrepreneurial ecosystem** (definition in italics[284]).

As a policy mechanism, networks have the capacity to stimulate human, structural and relational capital, unite key actors in innovative practice in the region and leverage regional strengths and capacities in relation to policy priorities, such as smart specialization.

Network analysis requires establishing a clear objective, given multiple properties of networks and noted difficulties in measuring attribution effects. This includes establishing a coherent framework and accompanying methods of data collection and analysis that can capture both prescribed and emergent processes of network development and evolution.

The report suggests that **entrepreneurial ecosystem policy should not be entirely data-driven.** Complex measures are not suited as independent variables, and even a combination of network measures is unlikely to capture the full complexity and richness of Alberta's entrepreneurial ecosystem. Choosing accurate entrepreneurship variables that generate economically impactful policies is challenged by the unpredictable nature of entrepreneurial outcomes.

Although establishing where the relevant ecosystem boundaries lie is challenging, it is an important step in collecting better data efficiently. Measures and metrics should **facilitate a collective learning process that combines data and dialogue.**

One suggestion for policy makers is to consider lessons from the European Union on impact assessment, which emphasizes multi-stakeholder consultancy in policy design, transparent measures regularly shared with stakeholders and ongoing dialogue in assessing the effectiveness of measures, programs and interventions.

As Alberta's entrepreneurial ecosystem continues to develop, policy makers may consider **targeting complementary aspects** of the ecosystem that enhance the interaction between economic agents and institutions. This includes external linkages to ensure that Alberta entrepreneurs and enterprises can draw on new knowledge from a variety of sources situated outside the province's geographical boundaries and encourage innovation in related and unrelated technological domains.

The report poses a number of questions that may guide further study related to Alberta's regional innovation networks (RINs) and wider entrepreneurial ecosystem.

- How does variance in an entrepreneur's social network ties (specifically, brokerage relationships) influence venture resourcing (i.e., bricolage) and early firm planning (i.e., effectuation).[285]
- How do network intermediaries and brokers influence different networks and what are the social and economic consequences?
- How does the evolving network structure of founders change as competition increases or as they develop new products?
- Are there network structures within the regional ecosystem that are more related to enterprise success or failure than others?

A future research roadmap could examine the evolving boundaries of Alberta's entrepreneurial ecosystem, sources of new knowledge and the actors blending them with the existing knowledge base, and whether ecosystem evolution is guided by the visible hand of Government or is it less visibly anchored by SMEs, large corporations or institutions such as local universities. This may shed further

[284] Stam (2015).
[285] **Bricolage:** Given resource challenges, entrepreneurs might engage in resourceful behavior, including repurposing resources on hand to new ends (e.g. Baker and Nelson, 2005); **Effectuation:** entrepreneurs may engage in resourceful decision-making logic and employ an idea with a sense of purpose without having a predefined plan for an outcome, with outcomes achieved through negotiations with stakeholders (e.g. Sarasvathy, 2001).

light on the intersection between local and global knowledge flows and identify how this influences the configuration of the local ecosystem.

Although the entrepreneurial ecosystem concept is broader in scope than individual industry clusters,[286] future investigations could also examine entrepreneurs and firms operating in a variety of co-located industry clusters to assess their interdependence and its impact on Alberta's competitiveness.

[286] Autio et al. (2018).

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Appendix A: Network Properties[287]

Category	Property	Explanation
Nature of Network Links	Intensity	Strength of the relation between individuals.
	Reciprocity	Degree to which a relation is commonly perceived and agreed on by all parties to the relation (i.e., the degree of symmetry)
	Clarity of Expectations	Degree to which every pair of individuals has clearly defined expectations about each other's behavior in the relation
	Multiplexity	Degree to which pairs of individuals are linked by multiple relations
Structural Characteristics	Size	Number of individuals participating in the network
	Density	Number of actual links in network as ratio of number of possible links.
	Clustering	Number of dense regions in the network.
	Openness	Number of actual external links of a social unit as a ratio of the number of possible external links.
	Stability	Degree to which a network pattern changes over time
	Reachability	Average number of links between any two individuals in the network.
	Centrality	Degree to which relations are guided by the formal hierarchy
	Bridge	Individual who is a member of multiple clusters in the network (and who may be a broker or intermediary)
	Liaison	Individual who is not a cluster member but links two or more clusters
	Star	Individual with the highest number of nominations.
	Gatekeeper	Star who also links the social unit with external domains
	Isolate	Individual who has uncoupled from the network.
Transaction Content		• Exchange of affect (liking, friendship) • Exchange of influence or power • Exchange of information • Exchange of goods or services

[287] Tichy et al. (1979).

Appendix B: Mixed Method SNA Process[288]

Stage	Process Steps
Stage 1: Data Sourcing	• **Gather secondary sources of information**: e.g. on prior transactions between individuals, enterprises and organizations or groups that represent evidence of network tie relationships, which can be validated through additional secondary sources. • **To determine secondary sources**, researchers should: a) Define the **structural characteristics of network relationships** they seek to explore, i.e., brokerage (connecting two non-connected actors); centrality (how powerful or central an actor is in a network), structural holes (the absence of ties between some actors within a network), etc.). b) Determine how they will **formally specify network ties** to represent those connections. c) Outline a standardized procedure to identify relevant information on an **adequate sample of informants** (i.e., individual, team, or organization). d) Consider the network content **elements of interest** (i.e. what is transmitted across network ties).
Stage 2a: Data Development & Conversion	• **Prepare data for analysis:** combine source material for content analysis and identify topics for exploration. • Gather and collate different sources of data to create as complete of a story as possible regarding the unit of focus. • **Separate data by units of time**, which can assist in determining variables of interest (e.g. changes in network structure, growth of networks and an enterprise, etc.). • E.g.: analysis may identify the impact of subtle or sudden shifts in network development and how such shifts influence individual, team, or firm outcomes. • **Data-structuring techniques** are used to uncover themes, categories, and aggregate dimensions that can then be converted for *quantitative* analysis.[289]
Stage 2b: Measure Development, Conversion & Analysis	• Determine **how to measure variables of interest** where qualitative data is to be converted to quantitative data and analysed using descriptive and inferential statistics, including network analysis. • **Identify relevant codes or themes** in the data. As common nodes emerge, use of qualitative software like NVivo can help to organize, classify, and analyse data. • Organize data into a formal data structure, e.g. formulating dynamic relationships among aggregate dimensions. • **Qualitative text is coded** according to classification categories and computer-aided text analysis. • Network structure measures are derived, with content analysis used to identify relationships, transactions between individuals, services provided to others, etc.
Stage 3: Quantitative Analysis	• **Key inputs for quantitative analysis** include network structure data derived from identified binary ties and content variables (measured either as count or Likert scale rated). • **Quantitative techniques then used** to explore research questions of interest, e.g. focusing exclusively on SNA techniques (as discussed earlier) or involving network variables using UCINET, structural equation modeling, multiple regression, etc.

[288] Williams and Shepherd (2015).
[289] Gioia et al. (2013).

Appendix C: Entrepreneurial ecosystem elements, indicators & output[290]

Elements	Description	Indicators	Data Source
Formal Institutions	Rules of the game in society	• Overall quality of government (scores for corruption, accountability & impartiality • Ease of doing business	• Quality of Government Survey • World Bank Doing Business Report
Entrepreneur-ship Culture	Degree to which entrepreneurship is valued in region	• Entrepreneurial motivation, cultural & social norms, importance of being innovative, and trust in others	Global Entrepreneurship Monitor (GEM); Start-up Genome
Networks	Connectedness of businesses for new value creation	Percentage of SMEs engaging in innovative collaborations as % of all SMEs in business population	Regional Innovation Scoreboard (RIS)
Physical Infrastructure	Transport and digital infrastructures	• Accessibility by road, rail & number of passenger flights • Percentage of households with access to internet	Regional Competitiveness Index (RSI)
Finance	Availability of venture capital & access to finance	• Average amount of venture capital per capita • Percentage of SMEs that are credit constrained	Pitchbook; Global Accelerator Network (GAN)
Leadership	Presence of actors taking a leadership role in ecosystem	Number of coordinators on innovation projects per capita	Community Research & Development Information Service (CORDIS)
Talent	Prevalence of individuals with high levels of human capital (formal education & skills)	• % of population with tertiary education • % of working population in lifelong learning • % of population with entrep. education • % of population with e-skills	Eurostat; Global Entrepreneurship Monitor (GEM), GAN, Start-up Genome
New Knowledge	Investments in new knowledge	Intramural R&D expenditure as a % Gross Regional Product	Eurostat
Demand	Potential market demand	• Disposable income per capita • Potential market size expressed in GRP • Potential market size in population. All relative to national average.	Regional Competitiveness Index (RCI)
Intermediate Services	Supply & accessibility of intermediate business services	• % of employment in knowledge-intensive market services • No. of incubators/accelerators per capita	Eurostat and Crunchbase
Output	Entrepreneurial output Unicorn output	• Number of Crunchbase firms founded in past 5 years per Capita • Number of unicorns founded in last 10 years	Crunchbase; CB Insights and Dealroom

[290] Leendertse et al. (2021).